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TRANSLATION OF BIOLOGY ARTICLES IN BOTH ENGLISH AND SPANISH

Thesis Submitted to Obtain the Licentiate Degree in English with Concentration in Translation

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Dedication

At this moment, finishing my second thesis, I would like to dedicate this thesis to my parents. They have supported me all throughout my studies and have helped me when I needed. Without them, I would not have had the same opportunities to finish my career as I have.

I would also like to dedicate this thesis to both of my grandparents who have always helped and supported me in life and in my studies.

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Abstract

In this thesis, using a qualitative research method, various instruments were carried out in order to answer this thesis' research question: What is the effect of the procedures and methods used to translate various documents from Spanish into English and from English into Spanish for the National University of Costa Rica (UNA)? The instruments that were carried out were carried out were a text analysis table in order to identify important text characteristics in order to transfer them effectively to the target texts; a color coding system in order to analyze the translation process and to identify the translation procedures that were utilized; and a glossary table in order clarify the specific terminology. The documents that were translated were scientific articles regarding biological and environmental topics. It was found that most of the texts presented the characteristic elements of scientific texts (no redundancies, direct, and presenting scientific vocabulary). Due to this, the procedures that were utilized for the translations were chosen specifically to transmit all the elements of the source texts as possible.

Resumen

En esta tesis, usando un metodo cualitativo de investigación, varios elementos se llevaron a cabo para darle una respuesta a la pregunta de investigación de esta tesis: ¿Cuál es el efecto de los procedimientos y métodos utilizados para traducir varios documentos de Epañol a Inglés y de Inglés a Español para la Universidad Nacional de Costa Rica (UNA)? Los instrumentos que se llevaron a cabo fueron una tabla de analisis de textos para identificar las caracteristicas importantes de los textos para transferirlos de manera efectiva a los textos meta; un sistema de codificación de color para analizar el proceso de traducción e identificar los procedimientos que se utilizaron en el processo; y una tabla glossario para clarificar la terminologia específica. Los documentos que se tradujeron fueron articulos científicos acerca de temas biologicos y ambientales. Se descubrió que la mayoria de los textos presentaban los elementos caracteristicos de los textos científicos (sin redundancias, directos y presentando vocabulario científico). Debido a esto, los procedimientos que se utilizaron para las traducciones se eligieron especificamente para transmitir todos los elementos de los textos fuente como fuera posible.

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CHAPTER I
INTRODUCTORY FRAMEWORK

1.1. Problem Statement

Over the last century there have been many scientific discoveries and studies from various fields all around the world. These discoveries and studies have been of great help for the development of both science and society. Unfortunately, not everyone is able to reach these researches because of one impediment, a language barrier. This barrier prevents people who do not understand one language from accessing the contents of these investigations.

Nowadays, it can be said that the lingua franca of these times, especially in the scientific field, is English. Most of the new discoveries and investigations are written in English with the hopes of reaching more people, but there are still people who do not understand this language. On the other hand, there are many discoveries and investigations written in other languages that English speaking people are unable to reach because of that same reason. This is the situation that is taking place in the Nacional University of Costa Rica (UNA). There are students who wish to access certain documents, but are unable to because they do not understand the language. Furthermore, there are students who wish to improve their English knowledge by reading documents related to their studies, but there is a lack of the documents they are searching for in the language.

For this thesis, several biological documents in both, English and Spanish, will be translated in order to help decrease this problem. These biological documents are from the environmental and zoological fields. The procedures and methods that will be applied in these translations will expectantly convey the terminologies, messages, and ideas clearly from the source languages to the target languages, and their effects on the final documents will be analyzed.

This thesis will try to answer the question "What is the effect of the procedures and methods used to translate various documents from Spanish into English and from English into Spanish for the National University of Costa Rica (UNA)?" As it was stated previously, this thesis will be of great use for the university students looking either to research for information in Spanish because they are not able to understand the language or students looking to improve their English skills, although they are not the only ones who can benefit from these translations. University teachers, staff members, and even the authors can also benefit from having the material in another language.

1.2. Objectives of the Investigation

1.1.1. General Objective.

To analyze the effect of procedure and methods used to translate various documents from Spanish into English and from English into Spanish for the National University of Costa Rica.

1.1.2. Specific Objectives.

- To translate the documents entitled *Consideraciones éticas y ambientales en el proceso de acidificación oceánica, Industrias de fundición: aspectos ambientales e indicadores de condición ambiental, ¿ES EL ECOTURISMO UNA FUENTE INAGOTABLE DE RIQUEZA? Recomendaciones para su sostenibilidad, and ¿Por qué es necesario estudiar el comportamiento animal?* from Spanish into English and the documents entitled *Conservation in Human-Dominated Landscapes: Lessons from the Distribution of the Central American Squirrel Monkey, Evaluating Management Strategies in the Conservation of the Critically Endangered Blue-throated Macaw (Ara Glaucogularis), Reproductive Parameters in the Critically Endangered Blue-Throated Macaw: Limits to the Recovery of a Parrot under*

Intensive Management, and Impact of Jaguar Panthera Onca (Carnívora: Felidae) Predation on Marine Turtle Populations in Tortuguero, Caribbean Coast of Costa Rica from English to Spanish for the National University of Costa Rica.

- To apply various translation techniques to the documents in order to achieve communicative texts
- To evaluate the effect of the translation techniques applied on the documents
- To create a glossary with the most relevant terminology found in both texts

1.3. Justification of the Study

In National University of Costa Rica's online library, there are several documents written only in English and Spanish with no translation available. There are students who are unable to find the reading material that they are looking for because it is not available in the language that they need. The goal of this thesis is to translate several documents from both English and Spanish in order to make the material accessible for the students. This thesis will not only solve this problem, but it will also expand the content of the library. It will also show the importance of translating information in order for people from different cultures to have access to information. There are many people that can benefit from having these translations. Students will mainly benefit from these translations since they will be able to find the information they are looking for in the language that they need, and in this way have more references in order to carry out more thorough projects. Additionally, university teachers and staff members will also benefit from these translations; they will be able to access the information to expand their knowledge, enhance their lessons with a more globalized approach, and keep up with the new discoveries and studies that have been made. Finally, the authors will also benefit from these translations since more people will be able to read their work.

1.4. Antecedents

There have been various investigations and articles about the many topics that surround translation practices. Below are some studies that have been carried out that will provide some helpful information, insight, and context to this thesis. The topics of these investigations are those that are related to the types of texts that will be dealt with, the languages that they will be translated into, and some history of translations practices.

This first document that will be used as an antecedent for this thesis is entitled "Translating and Translations in the History of Science". This document was written on 2016 by Bettina Dietz in Hong Kong, and it is the editorial for an issue of a scientific journal. The author wrote about translations made in the past in a different decade in the scientific field. Dietz started off by explaining how scientific translation in the past was considered of little importance since it did not generate new information; it merely just transferred information into another language. The author then moved on to different people's concepts of translation. They considered that it was not only about the transfer of one language to another but also about the appropriation of science, and the reception of the text in different cultures. Dietz also mentioned that in the eighteen century, with the decline of Latin as the lingua franca, many scientific texts were written in the language of the scientists, and this threatened French scientists from being updated in the discoveries. The translation of articles from scientific periodicals proved to be the solution for that problem. There were also several versions of the articles targeted to different readers, and it was the translators' job to add or simplify the information. The author also mentioned that during the cold war, people tried to solve that same problem with machine translation. Later on, people realized that machines could not translate complex scientific texts. The author finished the editorial by stating that multilingual scientists are still irreplaceable in the field.

The second document that will serve as an antecedent was written on 2015 by Javier Franco Aixelá for the University of Alicante. This document is entitled "Translation of Scientific and Technical Texts". The article analyzes characteristics of scientific and technical texts in order to present an overview of them with particular features that they present. The author started by explaining that the term "scientific-technical" would be more appropriate to describe the texts to be analyzed than the term "specialized" because almost every text presents specific vocabulary. Later on, the author mentioned the difference between scientific texts and technical texts. Aixelá stated that scientific texts are theoretical and speculative, designed to investigate reality and question the acquired knowledge, while technical texts are applied and instrumental, designed to learn how to do things or solve concrete problems. He also wrote that both texts can share terminology and some linguistic characteristics while their objectives are different. For this reason, the author decided to address them together. Aixelá continued the article by stating that scientific- technical translation has been the foundation that allows us to enjoy a technological advanced world. He mentioned that if the work of various western and eastern philosophers and scientists had not been translated, they would have faded into oblivion. After that, the author addressed some myths related to the terminology and nature of those texts. He explained that an exact equivalence of a word does not always exist, and that sometimes in order to achieve the exact meaning, a combination of terms and formulations is required. In addition, the author mentioned two wrong notions related to the translation of those texts: the notion that scientific and technical texts should be devoid of cultural or ideological content and the notion that the original texts were perfect. The author explained that those texts are the product of a concrete time and society, and that there will always be a remnant of that. He also explained that some of the most common problems of translating is not trying to live up to the original author, but to avoid the mistakes made in the original. Next, the author mentions the source language interference in translation and the translators' beliefs about it. Aixelá classified interferences in two types: absolute and frequent. An absolute interference is when a new word is introduced to the language, and a frequent interference is when a word existed previously in the target language, but the term in the source language is the most used. After that, the author explained that there are two approaches that translations have applied towards interference. The author explained that there are the purists who reject the term in the source language and seek to use the term in the translated form, and that there are the frequentists who place communicability before the correct translated term. Following that, the author mentions the skills that translators should possess in order to translate: linguistic, extralinguistic, transfer, professional, and strategic competence. Finally, the author stated that this type of translations is better paid, and that the language of highest demand is English since it has become the lingua franca in this area of translation. Furthermore, he also mentioned that translators normally work autonomously or for intermediary translation agencies. At the end of the article, Aixelá stated that the work of translators is not given the attention and importance that it should, and that it leads to clients not giving them enough time to finish the translations, leading to a decline in quality.

The following document was written by Gustavo Adolfo Meneses Benavides on 2011 for the University of Antioquia. The document is entitled "Common Difficulties Observed in Abstracts Written in English by People Having Spanish as Mother Tongue". This study analyzed how the mother tongue interferes in the translation of several abstracts into English. Meneses analyzed 80 abstracts that were translated by people who were not translators, retranslated the texts, classified the type of texts, and classified the errors. Several orthographic, semantic, and syntactical errors were found. The author stated that the level of severity of the orthographic errors was not high, considering that they could be solved easily by consulting a dictionary. Meneses mentioned that the semantic errors stemmed from incorrect translation procedures such as, literal and word-for-word translation and from the authors applying Spanish grammatical structures when writing in English. The author added that other errors are produced using false cognates as equivalents. For the errors in syntax, the author stated that they originate from the author's lack of knowledge of the language. Meneses mentioned that the mother tongue interferes with the target language when the person is not aware of the differences between the two languages. The interference happens when the person adapts mother tongue structures into the target language. The author added that word choice is very important in order to convey the message properly, and that a poor choice of words can diminish the seriousness of the work. The author also highlighted the importance of knowing the culture in which the text is being translated to since the lack of thereof can lead to confusion and loss of meaning. Meneses concluded the study by explaining that people who just have knowledge of the language are not able to deal with the various challenges that come with translating texts.

The next document that will be of great use for this thesis is entitled *Correct Use of Spanish when Writing Biological Papers*. This article was written by Julián Monge-Nájera and Silvia Méndez Anchía in 2008 for the University of Costa Rica and the UNED. This article provides a list of the most common errors that are made when translating biology documents into Spanish as well as several recommended options to avoid them. The article started by stating that there is a small number of scientific articles written in Spanish, and that a belief exists that most people would rather read scientific works in other languages. The authors continued by explaining that the article has had various corrections and recommendations, based on frequent errors, that have been classified according to their type. The recommendations were classified as lexical, orthographic, morphological, and stylistic. They also mentioned that they used as reference the Royal Spanish Academy for aspects of the Spanish language and the Council of Science Editors for science writing aspects. The authors continued by explaining that most lexical errors are made because people use the English terms instead of the correct terms in Spanish; they proceeded by listing several misused words and the correct equivalents. After that, the authors mention that the orthographic errors can be corrected by using a spelling-check program in a computer, and continue with some common orthographic mistakes and their corrections with the corresponding explanation for their correction. For the morphological errors, the authors explained that there were many difficulties in the use of prepositions, adverbs, and gerunds due to the frequency with which they appear in scientific works in English. Finally, for the stylistic errors, the authors mentioned that the passive voice should be avoided, that scientific texts should not have repetitions, and that the texts must be kept simple without any redundancies in order for the information to be understood better and faster. The authors also provided some recommendations for these errors.

The final document that will provide important information for this thesis was written by M. Isabel Diéguez and Ileana Cabrera for the Pontifical Catholic University of Chile in 1998. This study was entitled “Machine Translation and Mixed Translation: Results from a Comparative Study”. This study analyzed the results of both machine translation and mixed translation in order for translators to choose the most convenient method for them. The authors began by explaining what machine translation and mixed translation are. They continued by mentioning that translators were unsure of the most useful methods for them when translating. The authors mentioned that their university carried out a project that would evaluate the variables related to subject areas and the typology of texts in order to help people decide the best method for translating, and optimize time, cost, and quality parameters. During the first year of the project, the most sought-after translation fields were analyzed and identified. Based on this, several documents from the most sought-after fields were selected in order to be translated: economic, legal, and mining. Two students of the same university translated the document using different methods: mixed translation and traditional translation. During the second year of the project, with the help of a civil engineer, an economic evaluation of each text was carried out, and the results of the study were shown. The translation of the economic text proved to be better using the traditional human translation since there were many variables that surfaced with machine translation. The translation of the legal text also proved to be better using human translation due to the format of most legal documents which results very difficult to process in a mixed translation. The authors also stated that in most legal documents, the translators have to make several adaptations to the text in order for the document to meet the client's expectations. Finally, the translation of the mining document also proved to be better with human translation due to the complexity of the text. The authors concluded the study by stating that translators should not use machine translation extensively because their efficiency varies in every situation, and that translators should be aware of all the variables when they have to choose to use human translation or mixed translation.

As it was mentioned previously, these studies will provide important information for this thesis. Bettina Dietz's investigation will provide important background knowledge regarding the history of translation. It will also help to understand the role it played in the past and how it has changed over the years until reaching the contemporary times. In addition, Javier Franco Aixelá's investigation will also contribute with the understanding of translation in the past and contemporary translation. His work will also help to identify specific characteristics of scientific texts. Furthermore, Gustavo Adolfo Meneses Benavides' research will help to understand common mistakes that Spanish speakers make when translating. Since various documents will be translated from Spanish to English in this thesis, this research will prove to be more useful in helping the author identify mistakes related to language interference. Next, Julián Monge-Nájera and Silvia Méndez's work will also help the author identify some common lexical, orthographic, morphological, and stylistic mistakes in the translations from English to Spanish. Finally, M. Isabel Diéguez and Ileana Cabrera's investigation will help the author to identify important elements that can help in the translation process.

1.5. Scope

In order for this thesis to have a clear objective as well as clear and understandable results, it is important to establish what the desired results will be and how far this thesis will go. By the end of this thesis, it is expected:

- To have translated all of the documents from both English and Spanish for the National University of Costa Rica
- To have applied various translation techniques to the documents
- To have evaluated the effect of the translation techniques applied on the translations
- To have created a glossary with the most relevant terminology found in both texts

The main purpose of this thesis is to translate the documents from both English and Spanish. During the translation process, important terminology will be collected in order to prepare the glossary. After finishing the translations, the analysis of the text will be done. In order to reach those expectations, the analyses will be done with the help of tools that will make the analysis process smoother. After applying all of these elements, the translations and their analyses will be achieved, and this thesis will be completed.

CHAPTER II
THEORETICAL FRAMEWORK

In this section of the thesis, all of the concepts and theoretical elements that will be present in this thesis will be defined and explained. The information that will be explained in this chapter will be useful for both, the student and the readers of this thesis, in order to understand the analysis that will be carried out in the following chapters. In this way, every element present in the analysis will be understood clearly without any type of ambiguity.

2.1. Text Analysis

First, the concept of text analysis will be defined and explained in order to understand what will be done with the texts that will be translated. According to the Merriam Webster Dictionary, the term *analysis* is defined as, “a detailed examination of anything complex in order to understand its nature or to determine its essential features: a thorough study” (“Analysis,” n.d.). Based on this definition, it can be understood that a text analysis is a thorough investigation of a text and all of its components.

After clarifying the term, it is important to explain why text analysis is an important element in the translation process. Dicerto stated, “At the beginning of each textual analysis, some contextual information on the setting of the message and its author is provided as appropriate” (Dicerto, 2018, p. 101). In addition to that information, Christiane Nord mentioned,

> Translation-oriented text analysis should not only ensure full comprehension and correct interpretation of the text or explain its linguistic and textual structures and their relationship with the system and norms of the source language (SL). It should also provide a reliable foundation for each and every decision which the translator has to make in a particular translation process (Nord, 2005, p. 1).

Based on the information provided by these two sources, it can be said that text analysis is important for the translation process because it allows the translator to fully understand the text and provides him/her important information about it that will be imperative in the implementation of the translation. Some of that information includes the purpose of the text and the way in which the ideas are expressed. This information proves to be crucial in the implementation of the translation, since it sets the parameters for the translator to choose the translation methods and terminology that will be used in the translation.

Now that the importance of text analysis has been clarified, it is necessary to mention and detail what elements of a text are analyzed during the analytical process. One of the elements that is examined is the style of the text. Boase-Beier mentioned in his book the definition of the term *style* which was taken from the book by Katie Wales. The term was defined as follows, " the perceived distinctive manner of expression" (Wales, as cited in Boase-Beier, 2006, p.4). In other words, style is the way in which the ideas are presented in a text. Boase-Beier also mentioned in his book the importance of a text style in the translation process. He mentioned that style affects how the translator reads and perceives the text. That in turn affects the translation choices that the translator will make in the translation. Finally, those elements will affect how the translation is perceived by others (Boase-Beier, 2006, p 1).

Now that the importance of style has been stated, it is important to mention the types of styles that can be found. In *A Textbook of Translation*, Peter Newmark, with the information provided by Nida, listed the types of text styles that can be found and gave a brief description for each of them. The four types of text styles are narrative, descriptive, discussion, and dialogue (Nida, as cited in Newmark, 1988, p.13). For the narrative style, Newmark explained that it is " a dynamic sequence of events, where the emphasis is on the verbs or, for English, 'dummy' or 'empty' verbs plus verb-nouns or phrasal verbs”. For the descriptive style, Newmark stated, “which is static, with emphasis on linking verbs, adjectives, adjectival nouns”. For the discussion style, he mentioned, “treatment of ideas, with emphasis on abstract nouns (concepts),verbs of thought, mental activity ('consider', 'argue', etc.), logical argument and connectives”. Finally, Newmark stated the following for the dialogue style, “with emphasis on colloquialisms and phaticisms” (Nida, as cited in Newmark, 1988, p.13). From those explanations, it can be understood that every style emphasizes on different elements in a text. Knowing the style of a text will guide the translator in the translation process in order for him/her to know which aspects require more consideration, and which ideas the author wants to transmit.

The stylistic elements that will be examined in the analysis of texts of this thesis are the ones that are presented as stylistic scales by Newmark. Those stylistic scales are of formality, generality or difficulty, and emotional tone (Newmark, 1988, p.14).

According to Wardhaugh, there are many ways in which people express their ideas, and that is influenced by many factors like specific circumstances, age, differences between speakers, and so forth (Wardhaugh, 2010, p. 47-48). That means that there are many stylistic varieties where people choose from to express their thoughts. With that information in mind, it can be inferred that the information that is found in any text has a specific set of stylistic characteristics that define it, and those characteristics provide important information about the text apart from its meaning.

One of those characteristics present in texts is the level of formality. In his book, Wardhaugh mentions the following about the levels of formality,

> We appreciate that such distinctions exist when we recognize the stylistic appropriateness of *What do you intend to do, your majesty?* and the inappropriateness of *Waddya intend*

> *doin', Rex?* While it may be difficult to characterize discrete levels of formality, it is nevertheless possible to show that native speakers of all languages control a range of stylistic varieties (Wardhaugh, 2010, p. 48).

It can be evidenced that the level of formality, an indirect characteristic present in a text, is a very important part of a text that defines how the information is presented to the readers. This characteristic might be overlooked by monolingual readers, since their only purpose is to understand the information, but for translators, it outlines how the information should be translated and presented in the text, and that is an important element that should be considered in the translation process. Newmark proposed the following scale of formality: officialese, official, formal, neutral, informal, colloquial, slang, and taboo (Newmark, 1988, p.14). The scales that he presented show the different levels of formality ranging from the most formal and accurate styles to the most simple and informal. After the translator has identified the scale of formality, he/she will be able to decide the way in which the text will address its readers based on the source text. It can also be inferred that the scale of formality also deals with how the author addresses himself and the elements that he/she is writing about.

The following characteristic that will be analyzed is the level of generality or difficulty of a text. According to Hendrik J. Kockaert and Frieda Steurs, translation difficulties may appear for different reasons. Translators may face difficulties in the translation process if there is an unclear meaning of a word, since they will have to look for the meaning to avoid making a mistake. Another difficulty can come from multiword terms where the relationship of each word is unclear (Kockaert & Steurs, 2015, p. 383). Based on this information, it can be said that specific vocabulary might cause difficulties in the translation process. Identifying the generality or difficulty of a text will avoid unnecessary delays during the translation process. It is also very important to consider the level of difficulty of the vocabulary because it outlines the terminology that the translator has to use in the translation. This is a characteristic that can also be overlooked by monolingual readers, since their goal is simply to understand the information. However, translators, apart from having to understand the information, must analyze the text from a different perspective in order to be able to transfer the elements of the text into the target language. Newmark presented the following scale of generality or difficulty: simple, popular, neutral, educated, technical, and opaquely technical (Newmark, 1988, p.14). These scales describe the vocabulary that can be presented in various texts ranging from the simplest terminology to the terminology that is unique to specific study fields. After identifying the generality or difficulty of a text, the translator will research the terminology that should be used and apply it to the translation correctly.

The final characteristic that will be analyzed is the emotional tone. According to Newmark, emotional tone refers to the register and pragmatic features of a text (Newmark, 1988, p.55). In order to fully understand what the emotional tone entails, it is necessary to have a clear definition of pragmatics. The Cambridge Dictionary defines *pragmatics* as, "the study of how language is affected by the situation in which it is used, of how language is used to get things or perform actions, and of how words can express things that are different from what they appear to mean" (Pragmatics, n.d.). With that information, it can be understood that the emotional tone of a text deals with how the context of the text influences its meaning and how it is used in order to express ideas. Analyzing this element is also an imperative, since it will help the translator choose the right words and expressions to carry across the same meaning that the source text has. The scale of emotional tone that Newmark presented is intense, warm, factual, and understatement (Newmark, 1988, p.14). These scales show how the emotional tone of a text can make it appear unambiguous, earnest, accurate, and even carrying implicit elements.

Apart from the stylistic scales, the text function will also be examined in the text analysis. Katarina Reiss stated, “Since texts require the medium of language for their expression (although mathematical formulae may not require translation), each text must be examined to determine precisely what function of language it represents” (Reiss, 2000, p.24-25). In addition to that information, In *Text Typology and Translation*, Christiane Nord stated, “ The sender intends to achieve a certain purpose and therefore chooses certain strategies of text production considered appropriate for this purpose, using structural features in order to “signal” their intention to the addressee.” (Nord, 1997, p.49).

From this information, it can be understood that text function deals with how language is used to express ideas to the readers. A translator should have this in mind during the translation process in order to be able to use the right words to convey the right meaning and intention that the author wanted to express. In her book, Reiss mentioned Bühler’s classification of text functions, in which he said that texts can represent from an objective point of view, express from a subjective point of view, and appeal in a persuasive manner (Bühler, as cited in Reiss, 200, p.25). Reiss and Vermeer explained that if the author wants to express factual information, the text is informative, if the author wants to express artistic information, the text is expressive, and if the author wants to express information in a persuasive way, the text is operative. (Reiss & Vermeer, 2013, p. 182) Newmark also identified the same text functions: informative, expressive and vocative (Newmark, 1988, p.21).

According to Newmark, the informative function is present when the author is reporting an external element. (Newmark, 1988, p.41). With the information that has already been provided, it can be said that a text is informative when its content is impartial, and it is only rendering facts. Newmark mentioned that the texts that have informative functions are commonly textbooks, reports, newspaper articles, and so forth (Newmark, 1988, p.41). Since the texts that will be translated in this thesis are scientific documents, it can be said that their text function will be mainly informative. That means that their main purpose will be to inform its readers.

In accordance with Newmark, the expressive function is focused on the author who expresses his/her opinions. (Newmark, 1988, p.39). With that information it can be understood that the expressive function of a text aims to demonstrate what the author feels. This function differs from the informative function since its content is not impartial. That means that the information that is conveyed is biased and it may not always be a verifiable truth. Newmark also mentioned that the types of texts that have expressive functions are literature works, authoritative statements, and autobiographies. (Newmark, 1988, p.39).

For the vocative or operative function, Newmark explained that this function is used in order to evoke something from the readers, either an action or a feeling (Newmark, 1988, p.41). It can be said that the information is placed strategically in order to help the author achieve a desired reaction from the readers. This means that in the translation process, the translator must make certain decisions in order to place the information so that it will create a similar reaction in the target readership. The vocative function can be found in texts like speeches and advertisements that require something from its readers.

Finally, other elements that will be valuable in the text analysis are translation methods.

According to Newmark, there has been a lot consideration over the years regarding how translation should be approached. It has been argued between taking a literal word for word method or a free method, conveying the meaning using different words (Newmark, 1988, p.45).

Beeby mentioned that those methods are similar to Tytler's first and third laws. The third law aims to evoke the same reaction in the readers from the SL and TL, and the first law aims to transfer the same meaning of the SL adhering to the established rules of the TL (Beeby, 1996, p. 29). As it can be evidenced from this information, translation can be used to convey different elements from the ST. Therefore, the results can also vary greatly, since they can use the same or similar expressions in the ST to convey a message and they can also use completely different expressions to convey the message.

Newmark referred to these methods as semantic and communicative. The semantic translation is based on what the author expressed in the source text (ST), and it will try to remain faithful to the style and sound in the ST. This means that it may compromise the meaning in order to produce a similar text to the ST (Newmark, 1988, p.46-47). From that information it can be said that the goal of the semantic translation is to transmit the message as closely as possible to the source text even if it means that some expressions will not fit in the target language. Furthermore, in *About Translation,* Newmark explained that semantic translation is faithful to the original text and that it is shorter, coarser and more complex than the original text (Newmark, 1991, p.11).

On the other hand, the communicative method has a different approach. In accordance with Newmark, this method aims to convey the same meaning of the ST in a way that will be acceptable for the target text (TT) readers (Newmark, 1988, p.47). In other words, this method aims to adapt the text for TT readers in order to achieve full comprehension. That means that the translator will try to find the closest equivalences in the TL in order for its readers to understand what is being expressed. By doing this some elements of the ST are being changed or omitted, but for this approach, the translator can separate slightly from the ST. Newmark also mentioned that this method is effect oriented, more natural, and that it is still faithful but freer from the original text (Newmark, 1991, p.11).

All of the elements that have been previously described are very valuable for the text analyses that will be done, and they will be considered and examined in the translation process, since, as it has been explained, they are very important aspects that can define many decisions that must be taken in the process.

2.2. Translation Procedures

In addition to those elements, other essential aspects that need to be clarified for the translation process are the translation procedures. The Merriam Webster Dictionary defined procedure as “a particular way of accomplishing something or of acting” (“Procedure,” n.d.). Based on this definition, it can be said that a translation procedure is the way of rewriting the context of the text to be translated in order to do it as natural as possible. From all of the elements that can be analyzed in a text to produce a translation and from the different translation methods and aims that have been explained previously, it can be inferred that there are also numerous translation procedures that can be followed in order to achieve different goals and effects. Newmark mentioned that the shorter a text is, the closer the translation is to the original text and the longer a text is, the farther it is from the original text (Newmark, 1991, p.3). It can be said that long texts require different translation procedures in order to properly convey their meaning to the target text. Below, a number of translation procedures will be defined, explained, and exemplified in order to be able to distinguish each of them in the translation process that will be carried out in this thesis.

The first procedure that will be explained is transposition. According to David Pollard and Sin-wai Chan, the term was introduced to the translation field by Vinay and Darbelnet, and the definition that they gave for it was,

> A procedure through which the signified unit of language, typically a word, a group or a clause, but occasionally a co-ordinate or complex sentence, changes its grammatical category when translated; the lexis remains unchanged by standards of literal or close translation. (Pollard & Chan, 2001, p.879)

Based on this information, transposition can be understood as a procedure that requires a grammatical change in order for the message to be conveyed. It can be said that in this procedure, there is no change in terminology, only in the grammatical elements of the sentence. In addition, Pollard & Chan explained that in most cases, the focus of the sentence can be moved to another element in the sentence. To exemplify this, they presented the translation of the following phrase “An exceptionally important fact”. The French translation of this phrase is “ Un fait d’une importance exceptionelle”. They explained that in English, there is an emphasis in the word “fact”, while in French, the emphasis is placed on the word “exceptionelle” (Pollard & Chan, 2001, p.880). Moreover, Newmark mentioned that the grammatical changes can be in verb tenses, in singular and plural forms, and simplifying complex sentences. (Newmark, 1988, p. 87). From the examples provided by Pollard and Chan it can also be said that word order is another grammatical element that can change in a transposition. Besides that, López Guix and Minett mentioned that transpositions can also be a stylistic choice (López Guix & Minett 1997, p.261). Based on this information, it can be inferred that there are cases where a transposition is not necessary, but its use can add to the stylistic value, and in that case, it would be up to the translator to use it.

In order to further clarify this procedure, various examples will be presented. More examples presented by Pollard and Chan are, the translation of the word “trousers” for “un pantalón”; the translation of the word “des conseils” for “advice”(the transposition can be evidenced in the change from plural to singular and vice versa) and the translation of “the white house” for “ la maison blanche” (the transposition can be evidenced in the change in word order) (Pollard & Chan, 2001, p.880). López and Minett provided the following transposition examples, the translation of “after she left” for “tras su partida” and the translation of “out of order” for “no funciona” (the transposition can be evidenced in the grammatical change) (López & Minett1997, p.261).

The next translation procedure that will be explained is modulation. Vinay and Darbelnet defined this procedure as, “…a variation of the form of the message, obtained by a change in the point of view” (Vinay & Darbelnet,1995, p. 36). From this information, modulation can be understood as a change in the way a message is being transmitted. According to Vázquez-Ayora, this procedure deals with thought and logic categories. He explained that while transposition deals with grammatical changes, modulation deals with people’s thoughts (Vázquez-Ayora, 1977, p.293). In other words, for this procedure, the translator changes the way in which an idea is presented in the source text and conveys the same meaning providing a different context and different vocabulary. Furthermore, Vinay and Darbelnet mentioned that this procedure is used when the translation that has been made is grammatically correct but is unnatural in the target language (Vinay & Darbelnet,1995, p. 36). Moreover, Vázquez-Ayora mentioned that this procedure must be done with the utmost care because if it is done wrongly, it can change the meaning of the sentence. For this reason, he explained that in order to be able to use this procedure, the translator should have significant knowledge of the language and its culture in order to avoid those types of mistakes. (Vázquez-Ayora, 1977, p.293). Some of the examples that Vázquez-Ayora provided are, the translation of "I like to have a good look at the people we employ" for "Me gusta hacer un examen detenido de la gente que trabaja para nosotros"; the translation of "A cop stopped me and asked to see my papers" for "Un policía me detuvo y me pidió identificación"; the translation of "The clothing no longer fit him" for "Dejó de servirle la ropa"; and the translation of "To have second thoughts" for "Cambiar de idea" (Vázquez, 1977, p.294). In addition to those examples, Vinay and Darbelnet provided the translation of " It is not difficult to show" for "Il est facile de démontrer" as a modulation example (Vinay & Darbelnet,1995, p. 37). It can be evidenced that in all of the provided examples, there was a change in the point of view, either in the vocabulary, in the context of the phrases, or in both.

The following procedure that will be described is omission. Barik stated the following regarding this procedure,

> … refer to items present in the original version which are left out of the translation by the T. Here we are dealing with clear omissions and not omissions resulting from the substitution of one thing for another by the T… (Barik, 1994, p. 122)

In other words, this procedure is the elimination of data from the source text by the translator. It refers to data that is not being replaced in the target text. Moreover, Vázquez-Ayora explained that this procedure is commonly overlooked because there are translators who believe that they have to translate every single word in the source text. He mentioned that the result of this is creating a text brimming with unnecessary and awkward elements. He concluded his explanation by stating that omission in some cases is obligatory in order to achieve a fluid and natural text (Vázquez-Ayora, 1977, p.361). In addition to this information, Orellana mentioned that when trying to lighten a text, the translator is free to remove, adjust, and express the ideas better (Orellana, 2002, p.274). In the examples that she provided she explained that the paragraph that was translated as " ¿ Por qué hay un deterioro tan grande en las carreteras chilenas?- Las carreteras se deterioran por diversas razones. Uno de los motivos es porque se diseñaron hace 15 años y fueron proyectadas para camiones y vehículos de tonelaje mediano" could have been translated in a shorter version as "¿ Por qué hay un deterioro tan grande en las carreteras chilenas? – Por diversas razones (motivos) y, entre otras, porque se diseñaron hace 15 años y fueron proyectadas…" (Orellana, 2002, p.274).. Another example that Orellana provided is the translation of " The delegate of the United Kingdom made some recommendations. They are:" for "El Delegado del Reino Unido formula las siguientes recomendaciones:" (Orellana, 2002, p.275-276). In both examples, it can be evidenced that the meanings of the texts remain the same in the shorter versions, and they sounds more natural and fluid than the first ones. Vázquez-Ayora exemplifies this procedure with the example of the translation of " To speak of a mutual convertibility from one particular language to another" for "Hablar de una convertibilidad recíproca de una lengua a otra" (Vázquez-Ayora, 1977, p.364). It can also be evidenced that the omission of the word "particular" does not affect the meaning of the phrase.

The following procedure that will be defined is amplification. Vinay and Darbelnet defined this procedure as, " The translation technique whereby a target language unit requires more words than the source language to express the same idea" (Vinay &Darbelnet,1995, p.339). Based on this information, this procedure can be understood as a way of conveying meaning using more words than the source text. The example that they gave is the translation of "the charge against him" for " l'accusation portée contre lui". (Vinay &Darbelnet,1995, p.339). To exemplify this procedure further, these are some of the examples presented by Vázquez-Ayora, the translation of " to endager" for "pone en peligro"; the translation of "to surface" for "salir a la superficie"; and the translation of "I intend to discuss the economy of your programs" for " Deseo discutir la economía de los programas que ustedes dirigen" (Vázquez-Ayora, 1977, p.341). With these examples, it can be evidenced that the translations require more words in the TL in order for the meaning to be understood.

In addition to that, Fawcett stated, " Amplification is what we should use… providing explanations rather than making cultural adaptations as a strategy for bridging anticipated gaps"(Fawcett, 2014, p.45). With that information, it can be said that amplification can also be used to provide background knowledge to the readers. That means that this procedure is not always obligatory, and it can be used in order to further clarify the message. Fawcett provided the following example, "What is one to think of the translator who was content to produce the sentence *It reminded many people of the story of the Medusa raft,* which would in fact remind most readers of nothing at all?" (Fawcett, 2014, p.45). Based on this information it can be said that this procedure can sometimes be up to the translator, since it would require him/her to delve deeper into the task at hand, taking into account the readership in the target culture, to produce more than is required. It is also important to mention that this procedure is different from compensation (a procedure that will be explained later on), since there is no omission that took place beforehand.

The next procedure that will be defined is explicitation. Vázquez-Ayora explained that this procedure is a type of amplification that deals with semantic characteristics. He mentioned that in this procedure, elements that are implicit in the ST are described in the TT. He also explained that this procedure is done in order to clarify elements regarding to grammatical structure and the main reasons of why this procedure is needed are to explain an element that might not be understood in the TL, to specify an element that might be confused in the TL, and to manifest an action that appears in the passive voice in the TL. Furthermore, he explained that this procedure is done in order to avoid losing the ST meaning, and that the translator must be mindful when he/she uses it because if a new element is added, the meaning of the ST changes. He also advised that if the translator cannot see a way of expressing the idea without using literal translation, then this procedure should not be used. (Vázquez-Ayora, 1977, p.349-351). Some of the examples that he provided are the translation of “El descenso que se inició en el decenio de 1920 se prolongó hasta el de 1940, época en que muchos árboles fueron atacados por la escoba de la bruja” for “The decline which began in the 1920s went on into the 1940s when many of the trees became affected by the witches-broom disease”; the translation of “Sounded in a voice of highest ceremony” for “Sonaron en una voz solemne propia de las altas ceremonias”; and the translation of “The run of the play is amazing” for “ Es asombroso el número de veces que se ha dado esa obra” (Vázquez-Ayora, 1977, p. 351, 353). The examples that have been provided demonstrate that in the source language, there are implicit connotations that the audience in the target language might miss or confuse. It can also be said that for this procedure, the author must take into consideration the readership in the target language in order to identify which elements might need explicitation.

The procedure that will be detailed next is literal translation. According to Pilar Elena García, literal translation is a procedure that can be used in instances where the SL has the same structural and functional compositions in the TL. In these cases, the translator only focuses in the lexical equivalence of the languages. To exemplify this, she presented the translation of “ Die Kinder singen ein Lied” for “ Los niños cantan una canción” (García, 1990, p.56). In this example, it can be evidenced that every element of the sentence has an equivalent in the target language, and both texts express the same meaning in the same way. García also mentions the difference between what is known as word for word translation and literal translation. She mentioned that word for word translation is used as a way for understanding the meaning of a text, since this translation does not follow any syntactic rules. It just translates the words in the exact order that they appear. On the other hand, she explained that literal translation does take into account syntactic rules, so the sentences that are formed are grammatically correct. She demonstrated this by giving the following translations. The word for word translation of " Ich habe das Buch gelesen" for " Yo he el libro leído" and the literal translation of "Ich habe das Buch gelesen" for "Yo he leído el libro" (García, 1990, p.50). Based on this information, it can be said that as long as every element of a sentence in the SL matches with the sentence elements of the TL a literal translation procedure can be utilized in the translation of the texts.

The following procedures that will be explained are punctuation changes. The Merriam Webster Dictionary defined *punctuation* as "the act or practice of inserting standardized marks or signs in written matter to clarify the meaning and separate structural units" ("Punctuation," n.d.). This definition helps to clarify that punctuation is a way to highlight or separate certain elements in a sentence. David William Foster, Daniel Altamiranda, and Carmen Urioste-Azcorra stated,

> In general, Spanish punctuation follows the same basic principles as English writing to indicate the inflections and pauses of learned talking and to assure the conceptual and organizational clarity of discourse. However, written traditions in the two languages differ in some important details. (Foster, Altamiranda, and Urioste-Azcorra,1999, p.1)

Some of the differences that they mentioned are that in Spanish, there is no comma before conjunctions like "y", "ni", and "o". They also stated, "suspension marks are always three points with no spaces between them" (Foster, Altamiranda, and Urioste-Azcorra,1999, p.1). They explained that different typographical marks like commas, dashes, and parentheses separate interpolated or parenthetical words and phrases and that dashes are used to introduce dialogues (Foster, Altamiranda, and Urioste-Azcorra,1999, p.1).

Moreover, Jack Child also mentioned some of the most significant differences in punctuation between both languages (English and Spanish). He mentioned that in Spanish, the upside question and exclamation marks must always be placed. He also explained that in English, commas and periods are placed inside the quotation mark and in Spanish, they are placed outside. Finally, he mentioned that in the target language, the translator uses quotation marks to bring attention to an unfamiliar word (Child, 2010, p.76).

In addition to that, Eugene Nida explained that punctuation should not be used to correct errors from the source text. The message that is being transmitted should already be clear without punctuation marks, and these should be used to reinforce that meaning rather than to clarify it. He stated that they should be used in that manner because readers do not pay attention to punctuation marks. (Nida, 1914, p. 51). Based on that information, it can be said in order to avoid TL readers from trying to look for punctuation marks in order to understand the meaning, the translation should be fluid and clear even before adding punctuation marks.

The succeeding procedure that will be made clear is compensation. Hervey, Higgins, and Loughridge explained this procedure as, "… techniques of making up for the loss of important ST features through replicating ST effects approximately in the TT by means other than those used in the ST" (Hervey, Higgins, and Loughridge, 2005, p. 23). Based on this information it can be said that this procedure is used to avoid the loss of meaning from the ST in the TT. Newmark explained that the loss can be of meaning, sound effect, metaphor, or pragmatic effect. He also mentioned that the compensation can be placed in another place or sentence, and not necessarily in the same place where the meaning is in the ST (Newmark, 1988, p.90).

Hervey, Higgins, and Loughridge classified four types of this procedure based on the feature that is being compensated: compensation in kind, compensation in place, compensation by merging, and compensation by splitting. They explained that compensation in kind makes up for a specific effect in the ST that is lost in the TT. They exemplified this by mentioning the word gender that exists in German that does not exist in English. Compensation in place makes up for the loss of an effect in a particular place in the text by compensating it in a different place. For this type of compensation, they provided a poem as an example, and they showed how the sound effect was compensated by different sounds in a different place. Compensation by merging is done by abbreviating a long passage while still conveying the same meaning. They provided the translation of " Und wesentlich häufiger Busse und Bahnen nutzen" for "And make much greater use of public transport" as an example. They explained that explaining the term in German would be too long, and the shorter translation still carries the same meaning as the ST. They also explained that this procedure also helps to achieve a balance between both languages. Finally, they stated that compensation by splitting is done by expressing one term in various words when there is no single term for one word in the TL. They explained this type of compensation with the German word *Bahnen* which encompasses various elements. The translation of this word would be done as "trains and trams". (Hervey, Higgins, and Loughridge, 2005, p. 23-26). Another compensation example can be evidenced in the way the word *please* is expressed in Danish. Since there is no actual word for *please* in the language, people normally compensate this by the phrase *would you be so kind to*, which carries the same meaning as the word. With these examples, it can be evidenced that this procedure is very helpful when dealing with two differing languages because there are specific terms and expressions that need additional information to be understood, and expressions that need to be shortened to create equity between the languages.

The next procedure that will be defined is equivalence. Vinay and Darbelnet stated, “We have repeatedly stressed that one and the same situation can be rendered by two texts using completely different stylistic and structural methods. In such cases we are dealing with the method which produces equivalent texts” (Vinay & Darbelnet, 1995, p.38). In addition to that, Juan Gabriel López Guix and Jacqueline Minett explained that this term aims to keep the function of the source text in the target text (Guix & Minett, 1997, p.271). From this information, equivalence can be understood as the procedure that aims to produce a counterpart in the target text using expressions that are common in the target language that recreate the same message. Moreover, Mott mentioned that many equivalences can be found between languages that share a same language family, and that there are also cases where equivalences can be found between languages that have different language families. He exemplified this by giving the expression “to touch wood” and the metaphor “to be armed to the teeth”, which are both used in English and Spanish (Mott, 2011, p.32). Mott stated, “Even if two languages appear to have equivalent terms in a lexical set, we often find that the semantic space they occupy is different “ (Mott, 2009 p.71). This means that the translator has to analyze the meaning and context of the text in order to place an equivalent that is wrong in that particular context. Mott gave the example of the words *rubio* and *moreno*. He explained that those words have an English equivalent: fair and light, but that they are perceived differently in both cultures (Mott, 2009 p.71). Some of the examples that Vázquez-Ayora provided are the translation of “ They are as like as two peas” for “Se parecen como dos gotas de agua” and the translation of “Every cloud has a silver lining” for “No hay mal que por bien no venga” (Vázquez-Ayora, 1977, p. 317). In those examples, it can be evidenced that the idea that is being transmitted is the same, and the elements that change in the translation are the vocabulary and the way in which the ideas are expressed.

The following procedure that will be detailed is adaptation. Vinay and Darbelnet stated,

> … it is used in those cases where the type of situation being referred to by the SL message is unknown in the TL culture. In such cases translators have to create a new situation that can be considered as being equivalent. (Vinay & Darbelnet, 1995, p.39)

Based on this information, this procedure can be understood as the creation of an element in the TL due to its lack of an equivalent element. In other words, it is the creation of an equivalent in the TL. This procedure is different from the equivalence procedure because for this procedure (adaptation), there is no existing equivalent in the TL, and for the equivalence procedure to be utilized, an equivalent already needs to exist in the TL.

The example that Vinay and Darbelnet explained is the adaptation of an English text where a father kisses his daughter on the mouth for the father hugging his daughter in the French translation. They explained that translating the English version as it was would not be accepted in the French culture, hence the need for the adaptation. Furthermore, they explained that this procedure is normally avoided because it can change the syntactic structure of the text and how ideas are expressed. They also mentioned that the choice of not using this procedure is obvious in the TT because the element would not fit, or the element might not be understandable. (Vinay & Darbelnet, 1995, p.39). Based on this information it can be said that this procedure is obligatory to a degree in order to not only convey the meaning but also to make sure that the meaning is understood with the right context. Another example was provided by Cristina Valdés Rodríguez. She provided the translation of the slogan “After dark. Tía María. Neat, mixed or over ice? It’s your mistery" for " After dark. Tía María. ¿Solo o con hielo? Descubre su misterio". She explained that the translation was done taking into account the target culture where drinks are normaly taken with ice or alone as opposed to the source culture where drinks are either taken alone, with ice, or mixed (Valdés, 2008, p.181). Based on the examples that were provided, it can be said that in order to be able to present a corresponding adaptation, the translator must have sufficient knowledge of both cultures in order to understand the meaning and context and transform them in the translation process.

The following procedure that will be explained is borrowing. Vinay and Darbelnet explained that this procedure is " to borrow a SL word or expression for introducing an element of local colour" (Vinay & Darbelnet, 1995, p. 32). From that information it can be understood that borrowing is the procedure in which a word is introduced in the TL without translating it, noting that the word does not exist in the TL. Alhaj explained that this procedure guarantees an accurate conveyance of cultural information to the TL, and that it has the advantage of the term being used freely in various expressions and contexts within the TL (Alhaj, 2015, p.17). In addition to that, Aranda stated, " Borrowings from English are called Anglicisms and those from Spanish Hispanicisms, and both are considered naturalized once they appear in dictionaries…" (Aranda, 2007, p.15). She also mentioned what García Yebra stated, that is that every language has foreign words in them (García, as cited in Aranda, 2007, p.15). From this information, it can be said that borrowings can be considered a common procedure between translators, since, as it has been stated and as it will be further exemplified, many borrowings can be found in every language. Vinay and Darbelnet also mentioned that this procedure is both stylistic and semantic, and that it is a decision of the translator (Vinay & Darbelnet, 1995, p. 32). Based on that, it can also be said that this procedure is not obligatory, but it is encouraged since having to explain a term would make the TT unnecessarily long. Vinay and Darbelnet provided the words *tequila* and *tortillas* as borrowing examples (Vinay & Darbelnet, 1995, p. 32). In addition to those examples, Lucía Aranda provided the following examples: *corral*, *burro*, *flan*, *machismo* and *mosquito*) (Aranda, 2007, p.15). Moreover, Alhaj also presented some borrowing examples: the words *software* (borrowed from English), *resumé* (borrowed from French), and *hamburger* and *kindergarten* (borrowed from German) (Alhaj, 2015, p.17).

The following procedure that will be defined is calque. Ali Alhaj stated, " Calque is a special kind of borrowing where the source language expression or structure is transferred in literal translation" (Alhaj, 2015, p.19). In addition to that information, Hervey, Higgins and Haywood mentioned that a calque is unidiomatic in the TL because it was translated literally. They also explained that a bad calque will be so close to the SL that it will be ungrammatical in the TL and a good calque will have a balance between both languages without it being ungrammatical in the TL (Hervey, Higgins and Haywood, 1995, p.26). From this information, calque can be understood as the literal translation of a phrase in the TL. It can also be said that this literal translation is introduced in the TL because there is no equivalent in the TL.

Moreover, Hervey, Higgins and Haywood further explained the difference between calque and borrowing. They stated,

> Calquing may also be seen as a form of cultural borrowing, although, instead of verbatim borrowing of expressions, only the model of SL grammatical structures is borrowed. For example, if ST ´Santa Teresa del niño Jesús´ is rendered in the TT as ´Santa Teresa del niño Jesús´, this is a cultural borrowing proper, whereas TT ´Saint Teresa of the Child Jesus´ is a calque. (Hervey, Higgins and Haywood, 1995, p.26)

That explanation clarifies that borrowing is the transfer of an expression without being translated to the TL and that calque is the literal translation of an expression that has been slightly modified in order for the meaning to be understood in the TL.

Lucía Aranda provided the following examples: the translation of the word *kindergarten* for *jardín de niños*, the translation of *skyscraper* for *rascacielos*, and the translation of *sangre azul* for *blue-blood*. (Aranda, 2007, p.15).

The final procedure that will be clarified is sentence inversion. Mona Baker and Martha Cheung provided Loh's definition of this procedure: "the constituent elements of a sentence are arranged in a way that is different from the general rules of word-order of the language in question" (Loh, as cited by Baker & Cheung, 2009 p.362). From this definition, inversion can be understood as the way in which a sentence is arranged differently in the TL from the SL. According to Baker and Cheung, Loh proposed a translation procedure that was similar to Vinay and Darbelnet's modulation. He referred to it as inversion, which was also a change in a sentence structure. They also mentioned significant differences between both procedures. They explained that Loh's inversion dealt with lexical and syntactic changes in sentences, while modulation deals only with lexical changes in sentences. (Baker & Cheung, 2009, p.366). In other words, this procedure deals with not only the vocabulary that is being used in the translation but also the grammar of the TL.

Baker and Cheung also mentioned that Loh identified two types of inversion: necessary and optional. They explained that the only element that requires necessary inversion in specific situations are objects (Baker &Cheung, 2009, p.362). They provided the following translations from English to Chinese as examples for necessary inversion, the translation of "I have told him everything I know" for "All I know have told him" and the translation of "They would not believe the report – not even the evidence" for "They do not believe this report, even the evidence is not believed" (Baker &Cheung, 2009, p.362 & 363). In these examples, the inversion can be evidenced in the change in position that the elements have in the TT. Baker and Cheung explained that optional inversion can be utilized for the subject and object in a sentence. They provided the following examples for optional inversion in the translations from English to Chinese, the translation of "In the dark there came in a man" for "In the dark came in a man" or "In the dark a man came in" and the translation of "We are glad to accept your suggestion" for "Your suggestion we are glad to accept" (Baker &Cheung, 2009, p.363). Based on these examples, it can be said that optional inversion is done to provide a certain stylistic effect that does not alter the message that is being conveyed from the ST. It can also be said that for optional inversion, it is up to the translator to utilize it during the translation process.

2.3 Glossary

Now that all of the procedures that will be of great help in the translation of the texts for this thesis have been defined, explained, and exemplified, it is important to define another element that will be very useful in the translation process. That element is a glossary. The Merriam Webster Dictionary defined glossary as "a collection of textual glosses or of specialized terms with their meanings" ("Glossary," n.d.). Based on this definition a glossary can be understood as the compilation of specific terms. For this thesis, a glossary will prove to be of great use since the texts that will be translated will contain specific scientific terms.

In *Translation and Localization Project Management: The Art of the Possible*, Natalia Levitina mentioned that in the creation of a text, authors must provide a glossary containing the terminology that is used with the corresponding definitions and examples so that the readership and translators will not be confused with the terms (Levitina, 2011, p. 108). She also stated,

> … an approved glossary will answer any of the translators' terminological questions that would otherwise require the submission of queries, and enable editors, proofreaders and reviewers to avoid making unnecessary and/or purely preferential changes. In sum, the usage of approved glossaries during authoring and translation helps to ensure terminological consistency in all languages. (Levitina, 2011, p. 108)

Based on this information, it can be said that a glossary is very important for a translator in order to correctly translate specific terms in the TL and to avoid ambiguous terms in the translation. It can also be said that making a glossary prior to the commencement of the translation of the documents saves time for the translator, since he/she will already know which terms need an equivalent or an explanation. For this thesis, the glossaries will be created by the student, since a glossary with the terminology was not provided with the texts.

Ahlam F. Sawsaa provided the following elements in his glossary of information science terms: concept name, synonyms, acronyms, description and type (Sawsaa, 2016, p.110). With the use of this information and the information that was provided beforehand, the elements that will be used in the creation of the glossary for this thesis are the ones provided by Sawsaa minus the type category and the acronym. In addition to that, the target word for the term and an example of how the terminology is used will be added to the glossary. It is important for the translator to fully understand the message that is being conveyed, and for this reason, all of these elements will be included in the glossary, even if some categories have no information, since it will help the translator to gather as much additional information about the topic.

All of the elements that have been explained in this chapter will be the theoretical foundation for this thesis. In other words, all of the elements that will be mentioned in the development of the translations and their analysis have been explained and exemplified in this section of the thesis. This section of the thesis will be of great use for the student if she will need to consult the theory in the translation process. In addition, this section will also help future readers to understand what will be written in the analysis section of this thesis.

CHAPTER III
METHODOLOGICAL FRAMEWORK

Now that all of the theoretical elements that will help in the understanding of the analysis of this thesis have been clarified, all of the elements and processes that will be implemented in this thesis will be defined and explained in this section of the thesis. Before carrying out the translation of the documents and their analysis, it is important to make clear what will be done during that process, the function of each element that will be applied and what information is expected to be gathered from them.

3.1. Research Approach

The Cambridge Dictionary defines *approach* as, “a way of considering or doing something”. Based on that definition, a research approach can be understood as a means of investigating an element. Creswell mentioned three research approaches: quantitative, qualitative, and mixed. Creswell explained that in order to select a research approach, the research question, the researcher’s experiences and the audience for the study should be considered. (Creswell,2013, p. 3). He stated, “Often the distinction between qualitative research and quantitative research is framed in terms of using words (qualitative) rather than numbers (quantitative), or using closed-ended questions (quantitative hypotheses) rather than open-ended questions (qualitative interview questions)” (Creswell,2013, p. 4). Based on this information, it can be said that the qualitative research deals with incalculable information, the information that comes in words, and that this information can lead to various interpretations. It can also be said that quantitative research deals with measurable information like in numbers and that this information is factual and leaves no room for different interpretations. Creswell explained that the mixed approach has elements from both approaches and that it is believed that this approach provides a better explanation of the research question than the use of both of them separately

(Creswell, 2013, p.4). Based on the information that was gathered and on the nature of the research question of this thesis, the research approach that will be applied for this analysis will be the qualitative approach due to the fact that the information that will be analyzed is incalculable and most of the questions that will be asked will be open ended.

3.2. Research Design

Creswell stated, “Research designs are types of inquiry within qualitative, quantitative, and mixed methods approaches that provide specific direction for procedures in a research design” (Creswell, 2013, p.13). Based on this information, a research design can be understood as way in which questions will be asked in the research approach to gather the data. Jeane W. Anastas mentioned three research designs: descriptive, relational and experimental. For the descriptive design, she stated “The goal of descriptive research is to describe selected, predefined properties of a phenomenon on selected, predefined dimensions” (Anastas, 2000, p .26). From this information, it can be understood that this design aims to analyze and understand an element without altering it. For the relational design, she stated, “The goal of relational research is to describe relationships between selected, predefined properties of one or more phenomena and/or selected, predefined properties of others” (Anastas, 2000, p. 27). From this information it can be understood that this design aims to understand how an element relates with other elements. She also mentioned that this method does not involve any experimentation. ”(Anastas, 2000, p. 27). Finally, for the experimental design, she stated, “The goal of experimental research is to describe how changes in a manipulated phenomenon or variable affect specific characteristics of those who have participated in the study” (Anastas, 2000, p. 27). Based on this explanation, it can be said that this procedure aims to analyze the changes that are applied to an element.

Based on the research question of this thesis, the research design that will be utilized in this research is the descriptive design, since the main objective is to analyze the original and translated texts.

3.3. Information Sources

Singh stated, “The goal of the information sources is to provide information that is valuable and valid so that the decision taken by the user can be optimally beneficial” (Singh, 2013, p.3). Based on this information, it can be said that the analysis of the elements in a thesis and the elements that are used to carry out said analysis are based on information sources. It can also be said that information sources must be reliable in order for the results of a thesis to be accurate.

In addition to that information, Singh also explained that the sources of information that have been documented can be divided into three categories: primary, secondary, and tertiary (Singh, 2013, p.4). Eyerdam explained primary sources of information as “A primary source is information that someone has recorded firsthand. It is the most direct way a person can formulate and record information” (Eyerdam, 2003, p.20). In addition to that, Singh stated, “Primary sources are the original documents representing unfiltered original ideas” and “Primary sources consist of original theories, ideas, discoveries and inventions”(Singh, 2013, p.5). In other words, primary sources are written testimonies that explain an idea or element that has not been discovered before, and that does not have previous information available. Based on the information that has been provided, it can be said that this information is not analyzed by another person, and it has just been recorded by the original author or witness of the event. Eyerdam also mentioned that some examples of primary sources are eyewitness accounts, letters, diaries, interviews, archives, and so forth (Eyerdam, 2003, p.20).

For the secondary sources, Bittle stated, “Secondary sources of data are those that involve a presentation or opinion that is expressed by another person” (Bittle, 2000, p.43). Furthermore, Singh stated the following regarding secondary sources, “They analyze, interpret and discuss information about the primary sources” and “ Secondary sources do not carry new and original information but guide the users to primary sources of information” (Singh, 2013, p.13). Based on that information, secondary sources can be understood as the interpretation of someone who was not involved in the gathering of a primary source of information. It can also be said that secondary sources do not introduce or contribute to the original account of a primary source; they only contribute to the analysis of the original source. Some secondary source examples that Ray Booth provided are biographical works, commentaries, criticisms, and magazine and newspaper articles (Booth, 2018, p.75).

Lawson, Gill, Feekery, Witsel, Lewis, and Cenere explained tertiary sources as, “Information that is collated from primary and secondary sources, usually presented as a collection or list” (Lawson, Gill, Feekery, Witsel, Lewis, and Cenere, 2019, p.240). In addition to that, Singh also stated, “The main function of tertiary sources of information is to help the researcher in the use of primary and secondary sources of information” (Singh, 2013, p. 19). Singh also mentioned that some tertiary sources of information are directories, almanacs, yearbooks, bibliographies, and databases (Singh, 2013, p.22). Furthermore, Dwyer also mentioned that dictionaries and encyclopaedias are also considered tertiary sources (Dwyer,2013, p.331). Based on that information, it can be said that tertiary sources help investigators to carry out an analysis from the information that originates from primary and secondary sources.

For this thesis, all of the three categories of information sources will be utilized in order to carry out the translations of the documents and their analysis.

3.4. Analysis Categories

In this section of the thesis, elements that will be analyzed in the investigation and mentioned in the theoretical framework will be explained in order to fully understand every element that is mentioned throughout this thesis.

The first category of analysis is source language (SL). Munday referred to a source language as “the original verbal language” (Munday, 2008, p.5). In addition to that, the Merriam Webster Dictionary defined source language as “a language which is to be translated into another language” (“Source language,” n.d.). Based on that information, it can be said that a source language is the language in which the author wrote the text that will be translated.

The second category of analysis is target language (TL). The Merriam Webster Dictionary defined target language as “a language into which another language is to be translated” (“Target language,” n.d.). In other words, target language is a different language from the source text in which the translation should be written on.

The following category of analysis is source text (ST). Munday stated,

> The process of translation between two different written languages involves the translator changing an original written text (the source text or ST) in the original verbal language (the source language or SL) into a written text (the target text or TT) in a different verbal language (the target language or TL) (Munday, 2008, p.5).

Based on that information, a source text can be understood as the text that is written in the source language that will be translated into a different language. It can be said that the source text is the base text for the creation of the translation.

The next category is target text (TT). Based on the information that was provided for the previous category, it can be said that a target text is a text in a different language from the ST that provides the same information. A target text can be understood as the final result of the translation.

The following category is readership. Dictionary.com defined readership as “the people who read or are thought to read a particular book, newspaper, magazine, and so forth” (“Readership”, n.d.). Based on that definition, it can be said that a readership is the people to whom a text is intended to or the people who will read a particular text. For example, the readership of the texts that will be translated in this thesis can be scientists, teachers, and environmentalists.

The next category of analysis is connotation. The Merriam Webster Dictionary provided the following definitions for the term “something suggested by a word or thing” and “the suggesting of a meaning by a word apart from the thing it explicitly names or describes” (“Connotation”, n.d.). In other words, a connotation is an idea that a text expresses implicitly, that is, without it being named in the actual text. In order to make this concept clear, The Merriam Webster Dictionary explained that the word “home”, for example, means a place like a house or an apartment, but it also carries other ideas and meanings like warmth or security. (“Connotation”, n.d.).

Another category of analysis is denotation. Dictionary.com defined denotation as,

> The explicit or direct meaning or set of meanings of a word or expression, as distinguished from the ideas or meanings associated with it or suggested by it; the association or set of associations that a word usually elicits for most speakers of a

language, as distinguished from those elicited for any individual speaker because of personal experience (“Denotation”, n.d.).

Based on that information, denotation can be understood as the literal meaning of an idea or element that is specifically mentioned or referred to in a text. The example provided by the Merriam Webster Dictionary that was used for the previous category of analysis is also helpful to understand what this concept is. As it has been explained before, the word “home” means a place, such as a house or an apartment. The literal meaning of the word is its denotation (“Connotation”, n.d.).

The following category is extra-linguistic knowledge. Nordquist explained this concept as “…the non-linguistic information that helps a reader or listener interpret the meanings of words and sentences” (Nordquist, 2020). In other words, extra-linguistic knowledge is the compilation of knowledge in different subjects that a person has acquired without taking into account their knowledge of a language. For example, during the translation of the texts for this thesis, the translator will be able to understand the source texts due to her previous existing knowledge (extra-linguistic knowledge) of science.

The final category of analysis is terminology. The Merriam Webster Dictionary defined terminology as “the technical or special terms used in a business, art, science, or special subject” (“Terminology”, n.d.). Based on that definition, terminology can be understood as specialized concepts that appear in texts of a certain field of work. According to the Oxford Learner’s Dictionaries, some language terminology examples are direct speech, discourse marker, emphatic pronoun, quantifier, strong form and weak form (“Language terminology, n.d.).

3.5. Data Collection Instruments

In this section of the thesis, the instruments that will be used in order to carry out the analysis of the translations will be presented and explained. This is an essential part of the thesis, since it will clarify what the instruments are, what they are used for, and what results they are expected to obtain from the analysis. In addition to that, they will help the reader to understand how the analysis will be carried out. Three instruments were selected to be utilized for this thesis: a text analysis table, a glossary table, and a color coding system.

The first instrument that will be used is the text analysis table. Dictionary.com defined table as "an arrangement of words, numbers, or signs, or combinations of them, as in parallel columns, to exhibit a set of facts or relations in a definite, compact, and comprehensive form; a synopsis or scheme" ("Table," n.d.). Based on this definition, a table can be understood as an instrument used to present information in a clear and organized way in order to facilitate the content's comprehension. This instrument will be used to analyze the translations of the scientific documents. The use of this instrument will compile important information in one place, and it will make it easier for the student to identify the texts, gather their characteristics, and analyze the procedures that were used for each one them. The text analysis table that will be used will be the following one.

Table 1.
Text Analysis Table Template

Text Title	Text Style	Text Function	Scale of Formality	Scale of Generality or Difficulty	Emotional Tone	Example of the Final Translation

Note: Table 1 shows the first data collection instrument that will be developed in this thesis for the text analysis. Source: The researcher's own creation.

The second instrument that will be used for this thesis is the glossary table. This instrument will be useful to organize the specific terms that are in the texts and their respective definitions. In addition to that, this table will also be useful to gather important information about each concept in one place in order to facilitate the text analysis process. In addition to that, this table will be useful for the student to consult in one place for the information that is needed during both the translation process and the text analysis process. The glossary table that will be utilized for this thesis is the following.

Table 2.
Glossary Table Template

Text	Concept	Definition	Synonyms	Example of how the concept is used in other texts	Target Word

Note: Table 2 shows the second data collection instrument that will be developed in this thesis for the text analysis. Source: The researcher's own creation.

The final instrument that will be utilized is the color coding system. The Collins Dictionary defined color code as "any system of marking or visual designation that uses specific colors for indicating or simplifying, as on a chart or map or in an industrial plant" ("Color code," n.d.). Based on that definition, a color code can be understood as a tool used to highlight information. For the purpose of this thesis, the information that will be highlighted will be on the translated texts. This tool will be very useful in the analysis process since it will highlight the elements that will be analyzed in the translated texts. Moreover, this tool will also help to differentiate the elements from one another so that they can be properly studied. The colors corresponding for each translation procedure are the following.

Table 3.
Color Coding System Corresponding Colors Table

Translation Procedure	Corresponding Color
Transposition	
Modulation	
Omission	
Amplification	
Explicitation	
Literal Translation	
Punctuation Changes	
Compensation	
Equivalence	
Adaptation	
Borrowing	
Calque	
Sentence Inversion	

Note: Table 3 shows the second data collection instrument that will be developed in this thesis for the text analysis. Source: The researcher's own creation.

3.6. Collection Data Process and Data Analysis

In this section of the thesis, the process of collecting data and its analysis will be explained. In other words, the actions that will be carried out in this thesis will be explained in this section.

First, an initial reading of all the documents will be carried out in order to obtain a general understanding of the texts' content. During the initial reading, the student will mark the specific terminology for further use. After that, the texts' characteristics will be identified using the text analysis table. The table will consist of seven columns containing an element that will be gathered from the source text. The elements that the table will contain are the text title, style, function, scale of formality, scale of generality or difficulty, emotional tone, and an example of the translated text taking into account the source text's elements. The first six elements will be of great importance since they will provide the translator with important details that must be reflected in the target text. These six elements will be identified at this stage. In addition to those elements, the last element that will be provided will help to demonstrate how these elements are reflected in the translated text. It is also important to mention that the last column will be filled out after the translation of the document is completed.

After completing the first six columns of the text analysis table, the glossary table will be developed. After the initial reading, the student must have collected the specific terminology that appears in the text. It is with these terms that the glossary table will be developed. This table will consist of five columns that contain important information about each term. The information that columns will contain is the name of the text in which the concept appears, the name of the concept, its definition, its synonyms, an example of how the concept is used in other texts, and the target word in the target language. This information will be very useful for the student since it will provide additional knowledge and insight to what the concept is and how it is used and described.

Following the creation of this table, the translation of the documents will be carried out taking into account the information that has been gathered from both tables. After the translations are carried out, the color coding system will be conducted. The purpose of this tool is to show the translation procedures that were used in the translation of the texts. The procedures that will be used in the translation were the ones that were explained and exemplified in chapter two. A different color will be assigned to each translation procedure in order to identify each procedure easily. There will be 13 different colors signifying a different translation procedure. After that, 15 paragraphs of the translations from English and 15 paragraphs of the translations from Spanish will be selected in order to analyze and identify the translation procedures used in the translation process. This tool will be very useful to analyze the translation process and the decisions that were made in the process. After the creation of the color coding system, the final column of the text analysis table will be filled out with examples from the target texts.

Once all of the instruments are completed, the student will analyze the translation process and the final translations based on the information that was gathered before and after the translation process.

CHAPTER IV
TRANSLATIONS

4.1. Translations from English to Spanish

4.1.1. Text 1.

Efecto de la depredación por jaguares, *Panthera onca* (Carnívora: *Felidae*), sobre las poblaciones de tortugas marinas de Tortuguero, costa caribeña de Costa Rica

By: Stephanny Arroyo-Arce and Roberto Salom-Pérez

Las interacciones de depredador-presa tienen un rol crítico en la dinámica de los ecosistemas (Heithaus, Wirsing, Thomson, & Burkholder, 2008). Los depredadores tienen un efecto directo en las presas debido al consumo de individuos (Nelson, Matthews, y Rosenheim, 2004; Heithaus et al., 2008). Sin embargo, los depredadores también pueden inducir cambios de conducta en las presas que pueden resultar en un cambio en los patrones de actividad, reducción en tiempo de forrajeo o redistribución territorial y temporal, entre otros (Nelson et al., 2004; Heithaus et al., 2008, Valeix et al., 2009; Fitzpatrick et al., 2012). No obstante, el efecto que poseen los depredadores sobre las tortugas marinas adultas se ha ignorado, ya que esta interacción puede ser difícil de observar y cuantificar (Heithaus et al., 2007; Hays, 2008; Fitzpatrick et al., 2012; Bornatowski, Heithaus, Batista, y Mascar-enhas, 2012).

Heithaus et al. (2008) plantearon que los depredadores de tortugas marinas adultas pueden influenciar los tamaños de dichas poblaciones, a pesar de los bajos índices de depredación. Pitman y Dutton (2004) indicaron que, incluso, la depredación oportunista por parte de las orcas (*Orcinus orca*) debería ser considerada como un factor en los esfuerzos de recuperación para la población de tortugas baula (*Der-mochelys coriacea*) en el Pacífico nororiental. A su vez, Fergusson, Compagno y Marks (2000) mencionaron que el impacto de la depredación por el tiburón blanco (*Carcharodon carcharias*) en las poblaciones de tortugas marinas en el mar Mediterráneo es desconocida, pero es probable que sea extremadamente pequeña comparada con otras fuentes de mortalidad (p. ej. causas antropogénicas). Ortiz, Plotkin y Owens (1997) indicaron que la depredación por parte del cocodrilo americano (*Crocodylus acutus*) en las tortugas marinas lora (*Lepidochelys olivacea*) tiene poco o ningún efecto en la población anidadora en Playa Nancite en Costa Rica. Asimismo, señalaron que esta interacción puede reforzar la supervivencia de la población local de los cocodrilos. Heithaus et al. (2007) también enfatizaron que la pérdida de depredadores de tortugas marinas podría tener un impacto negativo en las dinámicas de los ecosistemas.

Aunque la depredación por el jaguar (*Panthera onca*) en las tortugas marinas se ha registrado por toda América (Autar, 1994; Carrillo, Morera y Wong, 1994; Fretey, 1977; Troeng, 2000a; Keeran, 2013; Cuevas, Faller-Menen-dez y Angulo, 2014), los índices de depredación no son significativamente grandes para influenciar la población de tortugas marinas.

Sin embargo, en los últimos años, esta interacción de depredador y presa ha llamado la atención en el Parque Nacional Tortuguero, Costa Rica (Verissimo, Jones, Chaverri, y; Meyer, 2012; Barca, 2013; Arroyo-Arce, Guilder, y; Salom-Pérez, 2014). Troeng (2000a) mencionó que la población de tortugas verdes (*Chelonia mydas*) que se anida en Tortuguero no se ve amenazada de manera significativa por la depredación por parte de los jaguares. Por el contrario, Verissimo et al. (2012) indicaron que los jaguares deberían ser clasificados junto a, o más alto que, otras amenazas documentadas. En este trabajo, se evalúa el impacto de la depredación por el jaguar en otras tres especies de tortugas marinas *(C. mydas, D. coriacea, Eretmochelys imbricata)* que se anidan en la Playa Tortuguero. También se analiza cómo la disponibilidad de las tortugas marinas podría estar afectando la población local de los jaguares.

MATERIALES Y MÉTODOS

Lugar del estudio: este estudio abarcó aproximadamente 29 km de costa en el Parque Nacional Tortuguero, en la costa del Caribe nororiental de Costa Rica (10°32'28" N - 83°30'08" O). La playa se extiende desde la desembocadura del río Tortuguero en el norte hasta la desembocadura del río Jalova en el sur y limita con un bosque tropical húmedo (Holdridge, 1969). Las temperaturas promedio oscilan entre 25 ºC y 30 ºC con una precipitación media anual de 6 000 mm (Bermúdez y; Hernández, 2004).

Recolección de datos: los datos se recolectaron usando dos metodologías. Primero, se revisó la literatura existente para obtener registros acerca de la depredación de tortugas marinas por jaguares en el Parque Nacional Tortuguero previo al 2005. Para esto, solo se consideraron fuentes confiables, incluyendo reportes y publicaciones científicas. En segundo lugar, se llevaron a cabo estudios semanales en la playa desde el 2005 hasta el 2013. Por razones logísticas, entre el 2005 y el 2009, se alternó el punto inicial entre los extremos norte y sur, mientras que todos los estudios después de enero del 2010 comenzaron en el extremo sur. El programa de monitoreo de tortugas ya existente había dividido la playa a lo largo de su longitud por señales permanentes marcadas en secciones de 0.8 km que iban de norte a sur (Fig. 1). Se consideraron estas secciones como unidades de muestreo.

Los estudios consistieron en registrar datos acerca de la presencia o ausencia de jaguares al encontrar huellas identificables de jaguares en cada unidad de muestreo. Las tortugas marinas que fueron depredadas por jaguares (de aquí en adelante conocidas como cazas) también se registraron al contar las carcasas de tortugas marinas en cada unidad de muestreo. Cuando se encontraba una carcasa, esta se examinaba en busca de evidencia de depredación por jaguar (p. ej. mordeduras en el cuello, marcas de arrastre, huellas de jaguar). Es importante señalar que el jaguar es el único félido registrado en playa Tortuguero que caza tortugas marinas. Si se determinaba como un resultado de depredación por jaguares, la especie de tortuga marina se registraba.

Para evitar la duplicación de carcasas, solo se registraron las tortugas verdes que se estimaron fueron depredadas en menos de 7 días. Dado el hecho de que la depredación en tortugas Baula y Carey ocurre en menor cantidad, es improbable que la duplicación ocurra, debido a que todas las carcasas se registraron independientemente del número de días que pasaron desde que fueron cazadas. Ver Verissimo et al. (2012) y Arroyo-Arce y Thomson (2015) para una descripción completa de la metodología.

Fig. 1: Distribución territorial de la depredación de las tortugas marinas y la presencia del jaguar *Panthera onca* dentro de la playa Tortuguero, Parque Nacional Tortuguero, Costa Rica. La primera columna indica la depredación en el 2005 (A) y el 2013 (C); la segunda columna indica la presencia de jaguares en el 2005 (B) y el 2013 (D).

Impacto de los jaguares en la población anidadora de tortugas marinas: para las tortugas verdes, se estimaron cálculos anuales de la población anidadora basados en la metodología de Troeng y Rankin's (2005). Los cálculos de depredación se determinaron usando la Ecuación A. Para las tortugas baula, los cálculos anuales de la población anidadora se estimaron basándose en la metodología de Spotila et al. (1996). Los cálculos de depredación se determinaron usando la Ecuación B. El impacto de los jaguares en las tortugas carey no se estimó porque se desconoce la frecuencia de la puesta de huevos para la colonia estudiada.

Ecuación A: $P_{min}=Nest_{Cm.season}/6$, $P_{max}=Nest_{Cm.season}/2.8$, $Pre_{min}=Kills_{Cm}*100/P_{max}$, $Pre_{max}=Kills_{Cm}*100/P_{min}$

Ecuación B: $P_{est}=Nest_{Dc.season}/5$, $Pre_{est}=Kills_{Dc}*100/P_{est}$.

donde P_{mm}= cálculos anuales mínimos de la población anidadora de tortugas verdes; $Nest_{Cm\ season}$= número anual de nidos de tortugas verdes calculados para la playa Tortuguero de acuerdo con los reportes de Sea Turtle Conservancy (Sea Turtle Conservancy, 2014; E. Harrison, comunicación personal, Mayo 6, 2014); 6= la frecuencia de puesta de huevos anual máxima calculada para las tortugas verdes (Troeng y Rankin, 2005); P_{max}= cálculos anuales máximos de la población anidadora de tortugas verdes; 2.8= la frecuencia de puesta de huevos anual mínima calculada para las tortugas verdes (Troeng y Rankin, 2005); Pre_{min}= cálculos anuales mínimos de la depredación de tortugas verdes; $Kills_{Cm}$= número total de tortugas verdes depredadas por año; Pre_{max}= cálculos anuales máximos del porcentaje de depredación de tortugas verdes; P_{est}= cálculos anuales de la población anidadora de las tortugas baula; $Nest\text{-}_{Dc\ season}$= número anual de nidos de tortugas baula apareadas para la playa Tortuguero de acuerdo con los reportes de Sea Turtle Conservancy (Sea Turtle Conservancy, 2014; E. Harrison, comunicación personal, Mayo 6, 2014); 5= frecuencia anual de puesta de huevos calculada para las tortugas baula (Spotila et al., 1996); Pre_{est}= cálculos anuales del porcentaje de depredación de tortugas baula, $Kills_{Dc}$= número total de tortugas baula depredadas por año.

Asimismo, se utilizó una prueba de Kruskal-Wallis para comparar los índices de depredación a través de los años. La prueba estadística se llevó a cabo utilizando R (v 3.0.3; R Foundation for Statistical Computing, Viena, Austria).

Para estos análisis, solo se utilizó la información recolectada en los estudios semanales. La información que se obtuvo a través de la revisión de literatura no se utilizó debido a diferencias en las metodologías, sin embargo, se utilizó como referencia de registros históricos previos al año 2005.

Centros de depredación y actividad de jaguares

La estimación de densidad Kernel (Worton, 1989) se utilizó para trazar la distribución territorial de la depredación de tortugas y la presencia de jaguares entre el 2005 y el 2013, y para calcular cómo la densidad de los eventos varió durante el área de estudio a través de los años. Los cálculos de densidad se registraron y se trazaron usando el programa ArcMap (v 10; Environmental Systems Research Institute, Redlands, CA, USA).

RESULTADOS

Basado en la revisión de literatura, se encontró un total de 380 registros de depredación en el lugar de estudio entre 1981 y 2004. La primera tortuga verde que fue depredada por un jaguar se reportó en 1981. Los eventos de depredación en las tortugas verdes incrementaron en los siguientes años con un máximo de 97 registros en el 2001 y para el 2004, solo se documentaron 48 tortugas depredadas. Los jaguares también cazaron tortugas baula y carey. Es importante señalar que en 1999 y 2001 dos tortugas baula y cuatro tortugas carey fueron depredadas, respectivamente; estos registros constituyen la primera vez que ambas de estas especies se documentaron como cazadas por jaguares (Tabla 1).

Entre el 2005 y 2013, después de realizar un total de 267 estudios (media ± SD= 34±5 estudios por año, 3±1 estudios por mes), se pudo documentar tres especies de tortugas marinas *(C. mydas, E. imbricata* y *D. coriácea)* y un total de 1 110 carcasas depredadas por jaguares.

La depredación en tortugas verdes aumentó de 63 carcasas en el 2005 a 196 en el 2013 (Fig. 2), con un total de 1078 individuos depredados desde el principio del estudio. A pesar de este aumento en la depredación, no hubo una diferencia significativa entre los años ($H= 10.136$, $d.f.= 8$, $p= 0.256$). En todo este tiempo, los eventos fueron mayores durante el apogeo de la temporada de anidación de las tortugas verdes (de mediados de julio a mediados de octubre). Los datos también indicaron que la depredación aumentó a medida que la población anidadora aumentaba (y viceversa) y que los jaguares consumían anualmente un promedio de 120 tortugas verdes (SD= 45; Fig. 2).

Tabla 1: Revisión de literatura sobre la depredación de tortugas marinas por el jaguar *Panthera onca* en el Parque Nacional Tortuguero, Costa Rica. Depredados[1]

Fig. 2: El impacto del jaguar *Panthera onca* en las poblaciones anidadoras de tortugas verdes *Chelonia mydas* y baula *Dermochelys coriacea* en el Parque Nacional Tortuguero, Costa Rica. Línea sólida: cálculos de la población; línea punteada: número total de tortugas que fueron depredadas; área sombreada: cálculos mínimos y máximos de la población; en paréntesis: porcentaje de cálculos de depredación.

Desde el 2005, los jaguares depredaban un total de 15 tortugas baula sin eventos de depredación documentados hasta el 2010 (Fig. 2); los eventos de depredación ocurrieron solo entre febrero y mayo. Parece que la depredación por parte de los jaguares también aumentó a medida que la población anidadora se agrandaba y que los jaguares consumían un promedio de dos tortugas baula por año (SD= 3; Fig. 2). Los jaguares también depredaban un total de 17 tortugas carey (media±SD= 2±2 cazas por año) sin cazas reportadas durante el 2006 y el 2008; los eventos de depredación ocurrieron entre abril y noviembre.

Los datos indicaron que la distribución de las tortugas depredadas y la presencia de los jaguares variaba en espacio; asimismo, se revelaron áreas distintas de alta densidad a través del hábitat de la costa. En el 2005, tres centros principales de depredación y actividad de jaguares se identificaron dentro del área de estudio (Fig. 1A y Fig. 1C). Los centros de depredación abarcaban hasta cuatro tortugas que habían sido depredadas. A lo largo de los años, hubo un cambio en la depredación y en la presencia de los jaguares en el sector sur de la playa. Para el

2013, se identificaron cuatro centros de depredación (Fig. 1B) que abarcaban lugares con hasta 18 tortugas depredadas. El sector sur de la playa también parece ser un área principal de actividad de los jaguares (Fig. 1D).

DISCUSIÓN

A través de los años, la depredación de las tortugas verdes por los jaguares era significativamente mayor comparada con la de las tortugas baula y carey, lo que podría ser atribuido a su abundancia y disponibilidad. En la playa Tortuguero, la población anidadora estimada de tortugas verdes es más grande que la de las tortugas baula y carey (Troeng y Rankin, 2005; Troeng, Harrison, Evans, Haro, y Vargas, 2007; Galean y Harrison, 2012). Asimismo, la temporada de anidación de tortugas verdes ocurre durante un periodo más largo (de febrero a noviembre) comparado con el de las tortugas baula (de febrero a mayo) y las carey (anidación esporádica durante todo el año). Varios estudios (Karanth y Sunquist, 1995; González y Miller, 2002; Polisar et al., 2003; Azevedo y Murray, 2007) proponen que la abundancia y la disponibilidad de las presas son los factores ecológicos más importantes que explican la selectividad de las presas por parte de los félidos grandes.

La mayor depredación en tortugas verdes también se debe a cambios en la presencia de los jaguares durante la temporada. En la playa Tortuguero, la presencia de los jaguares tiende a ser menor durante la temporada de anidación de las tortugas baula, pero aumenta a medida que se avecina la temporada de anidación de las tortugas verdes (Arroyo-Arce, inédito). Este patrón podría responder al hecho de que los jaguares restringen sus patrones de movimiento al hábitat de la costa en los meses cuando hay más disponibilidad de presas (temporada de anidación de tortugas verdes, Arroyo-Arce et al., 2014). Otros estudios también mostraron como el movimiento y los patrones de actividad de los jaguares dependen de aquellos de su presa principal (Rabinowitz y Nottingham, 1986; Carrillo, Fuller, y Sáenz, 2009; Harmsen, Foster, Silver, Ostro, y Doncaster, 2011).

El aumento en la depredación de tortugas marinas que se reportó en 1981 puede estar relacionado con la degradación del hábitat (debido a la expansión de la frontera agricultora) que se dio en el interior a través de la zona colchón del parque a principios de los años 90 (Troeng, 2000a; Arroyo-Arce et al., 2014). Otro factor que potencialmente influye en los índices de depredación es el declive aparente de las especies de presas principales (p. ej. *Tayassu pecari, Mazama americana, Cuniculus paca* y *Dasyprocta punctata)* debido a la caza ilegal dentro del parque (Troeng, 2000 a; Arroyo-Arce et al., 2014). Estas presiones antropogénicas pueden tener un rol importante, lo cual lleva a los jaguares hacia el hábitat de la costa y causa que el félido seleccione tortugas marinas como presa (Troeng, 2000a; Veríssimo et al., 2012; Arroyo-Arce et al., 2014). Un aumento en la población local de jaguares también podría explicar el aumento en los índices de depredación (Arroyo-Arce, inédito). Aunque se han observado jaguares en la playa Tortuguero desde los años cincuenta (Harrison, Troeng, y Fletcher, 2005), no habían índices de población hasta el 2010, cuando se usaron cámaras trampa por primera vez. Desde entonces, el número de jaguares alimentándose de tortugas marinas ha aumentado de dos machos a 15 (3 machos adultos, 2 machos cachorros, 7 hembras adultas, 1 hembra cachorra, 1 adulto de sexo no identificado y 1 cachorro de sexo no identificado) individuos para el 2013 (Arroyo-Arce, inédito).

Los resultados señalan que los indicios actuales de depredación no representan una amenaza significativa para la población de tortugas verdes que se anida en la playa Tortuguero (Troeng, 2000a), lo cual difiere de Verissimo et al. (2012), quienes mencionaron que la depredación por parte de los jaguares debería ser considerada como una amenaza máxima.

Algunos autores (Troeng, 2000a; Campbell y Lagueux, 2005) mencionan que las actividades humanas (p. ej. la caza furitiva, pesca comercial) tienen un mayor impacto que la depredación por jaguares, por ejemplo, en 1996 al menos 10 166 tortugas verdes fueron capturadas por la pesca comercial en zonas de alimentación de Nicaragua (Lagueux, 1998); individuos que provienen muy probablemente de la población de Tortuguero (Bass, Lagueux, y Bowen, 1998). En 1997, se calcula que cerca de 1 783 tortugas verdes hembras fueron capturadas por humanos en playa Tortuguero (Troeng, 1997), sin embargo, solo cuatro individuos fueron depredados por jaguares (Troeng, 1997; Troeng, 2000a). Otra amenaza es la población de perros salvajes (Canis familiaris) en el pueblo de Tortuguero (Verissimo et al., 2012), que han depredado casi 388 nidos durante el periodo del 2005-2012 (Sea Turtle Conservancy, 2014). Los mayores índices de depredación ocurrieron en el 2007 y el 2010 con 199 y 180 nidos víctimas de la caza furitiva, respectivamente (Debade, Nolasco, y Harrison, 2008; Atkinson, Nolasco, y Harrison, 2011). Otras especies como los coatís (*Nasua narica*), el buitre negro americano (*Coragyps atratus*), el buitre americano cabecirrojo (*Cathartes aura*), así como los cangrejos fantasmas (*Ocypode quadrata*; Sea Turtle Conservancy, 2014), se alimentan de nidos o animales en el proceso de eclosión cuando están en la playa. Es importante señalar que, a pesar de estas amenazas, la población de tortugas verdes de Tortuguero ha aumentado en un 61 % desde 1986 (Troeng y Rankin, 2005).

La población anidadora de tortugas baula en la playa Tortuguero está sujeta a mucha adversidad; esto debido a que la población disminuyó un 67 % durante el periodo de 1995 y 2006 (Troeng et al., 2007). Un patrón similar se ha reportado en otras dos playas (Gandoca y Pacuare) cerca de Tortuguero (Troeng, Chacón, y Dick, 2004). Algunos factores que contribuyen con la disminución en la población local de tortugas baula son la mortalidad de tortugas adultas y jóvenes en las pescas por captura accesoria en zonas de alimentación, y la caza furitiva de tortugas hembras y nidos en Tortuguero y playas cercanas (Troeng et al., 2004; Troeng et al., 2007; Sea Turtle Conservancy, 2014). La depredación de las tortugas baula por parte de los jaguares se reportó por primera vez en 1999 y los índices de depredación fluctuaron en gran medida a través de las temporadas. No está claro si la depredación de las tortugas baula por los jaguares tiene un efecto significativo en la disminución de la población de las tortugas, pero se cree que no es la principal causa, ya que el número de tortugas baula que fueron depredadas entre 1997 y el 2006 solo era de tres, mientras que la población tuvo una disminución significativa durante aproximadamente el mismo periodo (Troeng et al., 2007).

En el Parque Nacional Tortuguero, ha habido una disminución significativa en la población anidadora de tortugas baula durante el periodo desde 1956 al 2003 (Bjorndal, Bolten, y Lagueux, 1993; Meylan, y Donnelly, 1993; Troeng, Dutton, y Evans, 2005). Esta especie se enfrenta a amenazas similares a las que han sufrido otras tortugas marinas, tales como la explotación comercial (p. ej. huevos, carne y caparazón) y captura accidental en equipo de pesca (Meylan y Donnelly, 1993; Troeng et al., 2005).   La depredación por jaguares de esta especie se ha observado, como con las tortugas baula, en intervalos irregulares que corresponden con el comportamiento esporádico de anidación de esta especie en Tortuguero. Por lo tanto, se considera que los indicios actuales de depredación no representan una amenaza significativa para la población local anidadora. Sin embargo, Troeng et al. (2005) indicaron que la depredación por jaguares puede dificultar la recuperación de esta especie en la playa Tortuguero. Esto también podría ocurrir con las tortugas baula.

Los jaguares tienden a evitar áreas dominadas por humanos (Cullen, Sana, Lima, Abreu, y Uezu, 2013); por lo tanto, se espera que las zonas principales de actividad de los jaguares y de depredación se localicen lejos del pueblo de Tortuguero, que se encuentra en el extremo norte de la playa. El extremo sur de la playa también reportó números bajos de depredación y actividad jaguar, lo que podría estar relacionado con la presencia de un rancho pequeño, un asentamiento de cocos y una estación de investigación que se encuentran en este extremo de la playa, así como la presencia del pueblo Parismina al otro lado de la desembocadura del río Jalova (Verissimo et al. (2012), áreas que describieron un patrón similar.

Estos datos muestran que los índices de depredación más altos ocurren en áreas con una densidad de anidación más alta. En la playa Tortuguero, la densidad de tortugas anidadoras tendió a ser más baja más cerca de las desembocaduras de los ríos Tortuguero y Jalova, las cuales son las áreas menos estables del hábitat de anidación (Gonzales, Guerrero, y Harrison, 2013). Asimismo, entre los años 2005 y 2013, los niveles de anidación más altos se registraron entre los kilómetros 6 y 22 (Haro y Troeng, 2006; Gonzales et al., 2013) que correspondían con los centros de depredación. Por lo tanto, la distribución territorial de las hembras anidadoras a lo largo de la playa también podría afectar la distribución territorial de la actividad de los jaguares y los centros de depredación. Esto difiere con lo señalado por Veríssimo et al. (2012), quienes consideraban que la presencia de las tortugas no era un indicador importante para la depredación por jaguares.

Este estudio propone que la depredación por jaguares no representa una amenaza para la población de tortugas verdes que anida en el parque nacional Tortuguero, y por lo tanto no es la causa principal de la disminución de población de las tortugas baula y carey. Sin embargo, todavía desconocemos aspectos de la interacción entre jaguares y tortugas marinas (p. ej. ¿Influencia la depredación por jaguares el comportamiento de tortugas marinas?). Por lo tanto, es importante hacer monitoreos de manera continua y evaluar la relación depredador-presa para comprender como esta evolucionará en el futuro. Asimismo, se requiere más conocimiento sobre este asunto para obtener un manejo efectivo de la población de jaguares local, así como las especies de tortugas marinas que se anidan en el parque nacional Tortuguero.

Los hallazgos también enfatizan la importancia potencial de la playa Tortuguero para apoyar a la población local de jaguares. La playa no solo alberga una comunidad de presas estables (tortugas marinas), sino también una población conocida de jaguares residentes y migratorios, que pueden facilitar el flujo genético y la conectividad entre poblaciones, así como ser un área reproductiva y un lugar de crianza (I. Thomson, comunicación personal, octubre 1, 2014). La conservación de esta área podría ser crítica para la supervivencia a largo plazo de las especies en esta región. También, más investigación acerca de la abundancia de las especies presa terrestres es esencial para comprender mejor las dinámicas de esta relación de depredador-presa.

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4.1.2. Text 2.

Evaluación de las estrategias de manejo en la conservación del guacamayo barbazul (*Ara glaucogularis*) en grave peligro de extinción

María Laura Maestri, Rosana Ferrati, Igor Berkunsky

Resumen

Se modelaron las dinámicas de la población silvestre restante del guacamayo barbazul (*Ara glaucogularis*), la cual es una especie endémica de Bolivia que está en grave peligro de extinción y está expuesta a diferentes estrategias de manejo. El modelo se convierte en una herramienta para calcular qué tan efectivas pueden ser las medidas de gestión. Se construyó un modelo de matriz de producción estructurado en etapas, determinístico, de pulso reproductivo y postreproductivo, para describir las dinámicas de la población. El modelo muestra que el crecimiento de la población es sensible a cambios en la probabilidad de supervivencia en la etapa adulta, seguido por cambios en la fertilidad. Se describió el comportamiento a largo plazo de la población como resultado de la combinación de la función de maternidad y la probabilidad de supervivencia de los polluelos que no han dejado el nido. En las situaciones hipotéticas de crecimiento de población, el número de años necesarios para duplicar la población silvestre actual varió entre 33 y 215 años sin reintroducción, y entre 7 y 46 años si los guacamayos adultos se reintroducen 10 años después de que empiece la simulación. Las partes interesadas de Bluethroated Macaw Conservation Project podrán beneficiarse de una simple herramienta gráfica basada en este modelo para la toma de decisiones de gestión. Al conocer el tamaño de la población adulta y el número de huevos eclosionados al principio de cada temporada de reproducción, el equipo de campo podría evaluar el esfuerzo necesario en el manejo de los polluelos para incrementar las posibilidades de un crecimiento de población positivo. Evaluar de

antemano el impacto de las medidas de gestión en los guacamayos barbazul podría contribuir con el mejoramiento y la eficacia de las medidas de conservación en la población de guacamayos barbazul en grave peligro de extinción.

1. Introducción

Los guacamayos son el grupo que está en más peligro de extinción de la familia *Psittacidae*, por lo tanto, se cuenta como una especie extinta de las tres en grave peligro de extinción. La pérdida de hábitats, el comercio y la caza por vestidos de plumas ornamentales indígenas son las principales causas de la disminución de la población de guacamayos (Snyder, 2000; Birdlife International, 2016). Más del 50 % de las especies de guacamayos están incluidas en la Lista Roja como especies en peligro de extinción, vulnerables o casi amenazadas (Birdlife International, 2016). El guacamayo barbazul (*Ara glaucogularis*), redescubierto en las sabanas de Bolivia en 1992, es el último guacamayo en grave peligro de extinción que todavía conserva una población silvestre (Birdlife International, 2016; Forshaw, 1989; Hesse y Duffield, 2000). Puede ser posible que la población silvestre del guacamayo barbazul no sume más de 115-125 individuos (Birdlife International, 2016). En los últimos 15 años, se llevaron a cabo una gran cantidad de medidas de conservación con el fin de recuperar la población silvestre. Sin embargo, nuestro conocimiento de la biología de la especie está limitado a las descripciones y cálculos de ámbito, el uso del hábitat, el tamaño de la población y algunos parámetros básicos reproductivos, que se describieron recientemente (Hesse y Duffield, 2000; Yamashita y Barros, 1997; Herrera et al., 2007; Berkunsky et al., 2014).

Las iniciativas de conservación del guacamayo barbazul se enfocan en medidas dirigidas a proporcionar soluciones a largo plazo (Berkunsky et al., 2014). Tal como sucede en muchas poblaciones pequeñas, el número limitado de individuos es una de las amenazas más serias, por consiguiente, todos los esfuerzos se llevan a cabo con el fin de impulsar el rendimiento reproductivo a través del manejo de la población silvestre y reforzarlo con reintroducciones de individuos criados en cautiverio. La efectividad de estas medidas de gestión debe estar relacionada con qué precisión se pueden identificar amenazas actuales y factores limitantes, como la depredación de nidos, las inundaciones de nidos, la reducción de camadas y la disponibilidad de sitios de nidos (Berkunsky et al., 2014; Kyle, 2006). Estas medidas incluyen la protección de nidos naturales, la provisión y protección de cajas nido, el uso de defensas contra depredadores y sistemas de drenaje para las cajas y la alimentación manual de los polluelos que no han dejado el nido durante las primeras semanas de vida (Berkunsky et al., 2014). Aunque se conoce la efectividad relativa de las medidas de gestión, estas nunca se analizaron en un contexto global. Por lo tanto, como parte de la estrategia de gestión, el conocimiento del impacto y el alcance de cada acción facilitan la toma de decisiones y optimizan recursos para la conservación.

La simulación produce una herramienta efectiva para calcular qué tan efectivas pueden ser las medidas de gestión, y puede ayudar a comprender mejor con qué precisión se identifican las amenazas y los factores limitantes (Noon y Sauer, 1992; Simons, 1984). Strem (2008) desarrolló un modelo demográfico de la población de guacamayos barbazul en el 2008. Asimismo, realizó un análisis de viabilidad poblacional (PVA) por medio de programas basados en individuos (VORTEX 9.72) y en cohortes (RAMAS GIS 4.0). La acumulación de nuevos datos y planes para la reintroducción desde el 2008 indica que es tiempo de reevaluar los proyectos de población y conservación (Berkunsky et al., 2014). Los modelos determinísticos pueden ser una herramienta útil y simple para el manejo de especies en peligro de extinción (Caswell, 2001). Una pequeña cantidad de variables de entrada proporcionan buenos cálculos de los efectos de perturbaciones antropogénicas en las especies cerca del umbral de extinción.

Asimismo, puede proporcionar conocimiento de las consecuencias potenciales de los procesos amenazantes y enfatizar la urgencia con la que las autoridades de manejo tienen que actuar (Otway et al., 2004). En este trabajo, se modelaron las dinámicas de la población silvestre del guacamayo barbazul bajo diferentes estrategias de gestión. Al calcular el impacto de las medidas de gestión en los guacamayos barbazul, se espera contribuir al mejoramiento y eficacia de los proyectos y medidas de conservación de estos.

2. Materiales y métodos

2.1. Sitio de estudio

Los llanos de Mojos son una extensión de 160,000 km2 de sabanas estacionalmente inundadas en el norte de Bolivia, el cual se encuentra distribuido en un mosaico complejo de islas forestales y bosques de galería fluviales, ocupando la cuenca extremadamente plana Beni-Mamore-Itenez en el suroeste de la Amazonia, situada entre el escudo precámbrico al este y los Andes al oeste y al sur (Forshaw, 1989). El panorama está dominado por zonas bajas planas, que se inundan estacionalmente y están cubiertas por una sabana abierta sin arboles (Langstroth, 1996). Las islas forestales son escasas y están restringidas a zonas elevadas (colinas) que están lo suficiente elevadas para evadir las inundaciones anuales. La mayoría de las islas forestales son reliquias erosionadas de diques naturales o terrazas de canales de ríos abandonados y, por lo tanto, constituyen fragmentos de un bosque de galera previo (Hanagarth y Sarmiento, 1990).

2.2. Biología y manejo del guacamayo barbazul

El guacamayo barbazul es un loro endémico de los Llanos de Mojos en grave peligro de extinción (Jordan y Munn, 1993), el cual se encuentra a través de un rango geográfico de 2508 km2 en el departamento del Beni, Bolivia (Hesse y Duffield, 2000). La disponibilidad del hábitat es suficiente para mantener una población grande de guacamayos y no hay evidencia de recursos limitantes para la especie, al menos con estas bajas cantidades (Hesse y Duffield, 2000; Berkunsky et al., 2014; Strem, 2008).

La especie tiene un sistema de apareamiento monógamo (Snyder, 2000; Forshaw, 1989). En cautiverio, un individuo alcanza la madurez sexual, en promedio, a los 5 años (Bueno, 2000; Voss, 2005). En su hábitat natural, la temporada de reproducción de los guacamayos barbazul comienza durante la estación seca (agosto) y se extiende hasta la estación lluviosa, hasta febrero (Berkunsky et al., 2014). En su hábitat natural, la puesta de huevos varía de 1 a 3 huevos, el segundo siendo el más común. Los huevos son puestos en intervalos de 1-2 días, el periodo de eclosión es de 25-26 días y los polluelos salen del nido aproximadamente 90 días después de eclosionar (Berkunsky et al., 2014). Los datos de la proporción sexual son escasos, sin embargo, la proporción sexual (machos/hembras) en la Fundación Loroparque, la cual es la población en cautiverio más grande en el mundo que cuenta con 150 individuos, se aproxima a 1:1 (Bueno, 2000).

Tabla 1. Cantidad de parejas e individuos contados por año y mediana de la población monitoreada del guacamayo barbazul en el periodo del 2004–2011 por The World Parrot.

En la actualidad, no existe información acerca de la expectativa de vida promedio del guacamayo barbazul en su hábitat natural. Por consiguiente, tomamos en cuenta el valor reportado por Strem (2008), quien lo calculó en al menos 40 años. Ya que no hay evidencia de que sugiera una etapa postreproductiva, se asume que la edad de la última reproducción y la edad máxima es la misma.

Se calcula que la población silvestre del guacamayo barbazul es de 115 y 125 individuos. Se identificaron al menos 16 parejas reproductoras y se monitorearon por 8 años. Durante este periodo de estudio, no se introdujeron nuevas parejas adultas en la población reproductora. La

Tabla 1 resume la información recolectada durante ocho temporadas de reproducción consecutivas del 2004 al 2011 (Berkunsky et al., 2014; Kyle, 2006). Las variables que se evaluaron fueron la cantidad de adultos y jóvenes, parejas reproductoras exitosas, huevos eclosionados y polluelos que han dejado el nido por cada nido. Entre 2 y 10 parejas pusieron huevos cada año con una mediana de 6 parejas, y produjeron entre 0 y 10 polluelos que dejaron el nido, con una mediana de 2.5 polluelos. Por lo tanto, se estableció el manejo de la conservación a largo plazo para el guacamayo barbazul en Beni, Bolivia, desde el 2000 (Hesse y Duffield, 2000). Asimismo, se instalaron agujeros de drenaje o techos en todos los nidos propensos a inundaciones para reducir el fallo de anidación. Otras medidas dirigidas para evitar el fallo de anidación incluyeron defensas antidepredadoras pasivas y activas. Las defensas pasivas fueron hojas de metal envueltas en los troncos de los árboles y el recorte de las ramas en las cavidades para reducir los depredadores trepadores. Las defensas activas integran un nivel alto de monitoreo de los voluntarios. La mayoría de las defensas parecen ser efectivas, ya que ningún nido se ha inundado desde el 2008, y el 2010 fue el primer año, desde el comienzo del monitoreo de los nidos de los guacamayos barbazul, sin depredaciones registradas.

El proyecto de conservación también proporcionó las cajas nido que tienen un buen drenaje y pueden colocarse en posiciones más seguras. Sin embargo, los guacamayos necesitan tiempo para acostumbrarse a las cajas nido, desde el 2014, solo cinco parejas usaron las cajas nido en 14 intentos diferentes. Para evitar la reducción de las camadas, el proyecto monitorea los nidos todos los días, identificando los polluelos que no han dejado el nido y que necesitan un estímulo, además, los ayudan con alimentación manual. Desde el 2007, gracias a esta intervención, ningún polluelo que no haya dejado el nido ha muerto por reducción de las camadas y la cantidad promedio de polluelos que han dejado el nido por cada nido ha incrementado de uno a dos. Otra acción de manejo ha sido mover a los individuos que están en cautiverio a un centro de custodia de vida silvestre en Sachojere, Beni, Bolivia. Hasta la fecha, seis individuos se han recuperado y serán reintroducidos en los Llanos de Mojos para fortalecer las poblaciones existentes. En una primera etapa, se espera reintroducir al menos 50 individuos.

2.3. Desarrollo del modelo de matriz

Se utilizó un modelo de matriz de producción estructurado en etapas, determinístico, de pulso reproductivo, postreproductivo para describir las dinámicas de la población total del guacamayo barbazul, tal como fue propuesto por Caswell (2001). La ecuación que describe este modelo es:

$n(t + 1) = An(t)$, donde el vector $n(t)$ da la población en cada etapa en el tiempo t y A es una matriz de proyección Lefkovitch.

Fig. 1. Gráfico de ciclo de vida y la matriz de población Lefkovitch correspondiente al guacamayo barbazul en Beni, Bolivia, considerando tres etapas: polluelo que ha salido del nido, joven y adulto; y estadísticas vitales: permanencia (P), crecimiento (G) y fertilidad (F).

La población del guacamayo barbazul se modeló tomando en cuenta tres etapas biológicamente definidas con un intervalo de proyección (tiempo de t a $t + 1$) de un año: (1) polluelos que han salido del nido, (2) jóvenes y (3) adultos. Los parámetros de la matriz de proyección de la población (p. ej. estadísticas vitales) son permanencia (P), crecimiento (G) y fertilidad (F). P_i es la probabilidad de que un individuo en la etapa i (en tiempo t) sobreviva y se mantenga en la etapa i (en tiempo $t + 1$); G_i es la probabilidad de que un individuo en la etapa i (en tiempo t) sobreviva y crezca a la etapa i $i + 1$ (en tiempo $t + 1$), y F_i se define como el número de crías en el tiempo $t + 1$, por individuo en la etapa i en el tiempo t.

En la Fig. 1 se muestra el gráfico del ciclo de vida y la matriz de población Lefkovitch correspondiente al guacamayo barbazul en Beni, Bolivia.

La matriz de proyección A es primitiva (p. ej. A es no negativa y hay una K tal que A^k es positiva) y cumple con la hipótesis del Teorema Ergódico Fuerte, ya que la población es ergódica, lo que significa que su comportamiento a largo plazo es independiente de su estado inicial (Caswell, 2001; Cohen, 1979). Considerando que λ1 es el valor propio real dominante de A, cuya existencia se garantiza por el teorema Perron-Frobenius (Gantmacher, 1959), y w1 el vector propio asociado, se obtiene que lim n(t) = c1 λ^{t}_{1}w1. Por consiguiente, la población modelada $t \rightarrow \infty$ aumentará a un ritmo otorgado por el valor propio dominante (λ1) e, independientemente del vector de población inicial, la distribución de etapas estable se dará por el vector propio derecho asociado (w1) al valor propio dominante. Cuando se alcance una distribución estable, este vector propio otorgará información acerca de la proporción de la población en cada etapa.

2.3.1. Cálculo y sensibilidad de las estadísticas vitales

Los parámetros Pi y Gi, en un modelo estructurado en etapas, se pueden calcular a partir de información acerca de la duración de las etapas. Caswell (2001) propuso separar el proceso de supervivencia y crecimiento al introducir dos probabilidades:

σ_i = P (supervivencia de un individuo en la etapa i)

y_i = P (crecimiento de i a i + 1|supervivencia)

lo que resultó

$G_i = \sigma_i \, y_i$

$P_i = \sigma_i \,(1-y_i)$

En cada etapa, σi es la constante y la distribución de edades dentro de la etapa es: estable para una distribución de edad estable en cada etapa. El cálculo de y1 se realiza utilizando:

$$\gamma_i = \frac{\left(\frac{\sigma_i}{\lambda}\right)^{T_i} - \left(\frac{\sigma_i}{\lambda}\right)^{T_i - 1}}{\left(\frac{\sigma_i}{\lambda}\right)^{T_i} - 1},$$

donde Ti representa la duración de la etapa i.

Se considera que la población vive hasta los 40 años, la duración de la etapa de polluelos que no han salido del nido es de 4 años y los individuos se pueden reproducir hasta su muerte. El valor de σ1 se tomó de Strem (2008), donde se calculó en 0.7. El valor de y1 es 1, ya que en un paso todos los individuos en la primera etapa crecen hasta la siguiente etapa, de joven. Dada la incapacidad para distinguir los jóvenes de los adultos, cuando se realizaron los censos para esta población en Beni, Bolivia y el hecho de que las observaciones de las poblaciones en cautiverio no indican diferencias significativas en la supervivencia de jóvenes y adultos, se asume que: σ2= σ3= σ.

La fertilidad (Fi) se define como la cantidad de crías en el tiempo t + 1, por individuo adulto en el tiempo t y se describe usualmente como Fi = miPi, donde mi es el producto entre el número anticipado de huevos eclosionados por el individual en la etapa adulta por año, la función de maternidad (m) y la probabilidad de supervivencia de estos huevos eclosionados para la fracción del intervalo de tiempo p de eclosión a polluelo que ha dejado el nido, (l(p)). Entonces, el polinomio característico de A es:

$$\chi_A(\lambda) = \begin{vmatrix} \lambda & 0 & -ml(0.25)\sigma(1-\frac{(\frac{\sigma}{\lambda})^{35}-(\frac{\sigma}{\lambda})^{34}}{(\frac{\sigma}{\lambda})^{35}-1}) \\ -0.7 & \lambda-\sigma(1-\frac{(\frac{\sigma}{\lambda})^{4}-(\frac{\sigma}{\lambda})^{3}}{(\frac{\sigma}{\lambda})^{4}-1}) & 0 \\ 0 & -\sigma(\frac{(\frac{\sigma}{\lambda})^{4}-(\frac{\sigma}{\lambda})^{3}}{(\frac{\sigma}{\lambda})^{4}-1}) & \lambda-\sigma(1-\frac{(\frac{\sigma}{\lambda})^{35}-(\frac{\sigma}{\lambda})^{34}}{(\frac{\sigma}{\lambda})^{35}-1}) \end{vmatrix}$$

La sensibilidad predice el impacto de alteraciones hipotéticas en los parámetros acerca de la tasa de crecimiento poblacional (De Kroon et al., 1986). La sensibilidad de λ, ante cambios pequeños en un parámetro modelo a_{ij}, es como estableció Caswell (Caswell, 2001), que es el derivado parcial de λ con respecto a a_{ij}. La sensibilidad de λ ante todos los a_{ij} se puede calcular en una matriz de sensibilidad S:

$$\left(\frac{\partial\lambda}{\partial a_{ij}}\right)$$

Tabla 2. Cálculo de la cantidad de adultos, los valores de maternidad (m) y la supervivencia de los polluelos que no han dejado el nido (l) de la población monitoreada de guacamayos barbazul por el periodo 2004-2011 por The World Parrot Trust en Beni, Bolivia.

2.4. Cómo afectan las medidas de gestión a los parámetros

Las medidas de gestión pueden afectar la fertilidad (F) en diferentes maneras. Por ejemplo, la protección de las cavidades tiene como resultado una cantidad mayor de huevos eclosionados y, por consecuencia, la función de maternidad (m) aumenta su valor. Por otro lado, la protección y alimentación manual de los polluelos que no han dejado el nido aumenta su probabilidad de sobrevivir (l). Por lo tanto, se combinan los cuartiles de la función de maternidad (m) y la supervivencia de los polluelos para identificar cuál combinación de sus valores permite el crecimiento de la población. Asimismo, se calcula la cantidad de años que se necesitan para duplicar la población silvestre actual de los guacamayos, bajo tres hipótesis de reintroducción: (a) ninguna reintroducción; (b) la reintroducción de 50 guacamayos adultos en grupos de diez individuos por año durante 5 años consecutivos y (c) la reintroducción de 50 guacamayos adultos en un solo grupo.

3. Resultados

De los valores en la Tabla 1, se registra la cantidad de huevos eclosionados por individuo en la etapa adulta por año (m) y la probabilidad de supervivencia de estos huevos eclosionados para la fracción del intervalo de tiempo p, desde la eclosión hasta el polluelo que dejó el nido (3 meses, p = 0.25), calculados como el número de polluelos que dejaron el nido sobre el número de huevos eclosionados. Los resultados obtenidos se muestran en la Tabla 2.

Se utilizaron medianas y cuartiles para calcular los parámetros del modelo. Del polinomio característico A(1) = 0 y, suponiendo que la población es estable, se tiene
2 = 3 = 0.9735 y por consecuencia:

$$\gamma_2 = \frac{\sigma_2^4 - \sigma_2^3}{\sigma_2^4 - 1} \simeq 0.2400$$
$$\gamma_3 = \frac{\sigma_3^{35} - \sigma_3^{34}}{\sigma_3^{35} - 1} \simeq 0.01745$$

Tabla 3. Valores de las probabilidades de supervivencia (σi y l), crecimiento (λi) y el número anticipado de huevos eclosionados por adulto por año (m) para el guacamayo barbazul en Beni, Bolivia.

Tabla 4. Análisis de sensibilidad (λ = 1) para las estadísticas vitales de la matriz de proyección del modelo de población estructurado en etapas para el guacamayo barbazul en el Beni, Bolivia.

De las probabilidades de supervivencia, crecimiento y el número anticipado de huevos eclosionados por adulto por año (Tabla 3) y considerando las proporciones sexuales (1:1), el crecimiento independiente de la densidad y la población cerrada a migración, se calcula la permanencia (P), crecimiento (G) y fertilidad (F) de la matriz de proyección de la población para la población de guacamayos barbazul en Beni, Bolivia. El análisis de sensibilidad que se realizó en las estadísticas vitales de esta matriz de proyección mostró que el crecimiento de la población es más sensible a cambios en la probabilidad de sobrevivir y permanecer en la etapa adulta (P3), seguido por cambios en la fertilidad (F3). La Tabla 4 muestra los valores de sensibilidad para $\lambda = 1$. La Tabla 5 muestra el comportamiento a largo plazo de la población (decreciente, estable o en aumento) como resultado de la combinación de cuartiles de la función de maternidad (m) y la probabilidad de supervivencia de los polluelos que no han dejado el nido (l). En las cuatro hipótesis de población en aumento, la cantidad de años necesarios para duplicar la población silvestre actual varió entre 33 y 215 años sin reintroducción y entre 7 y 46 años si 50 guacamayos adultos se reintroducen (Tabla 6). Por lo que, respecto al valor propio dominante, la distribución de la población estable se alcanzó dentro de un periodo de 12-15 años.

Tabla 5. El comportamiento a largo plazo de la población del guacamayo barbazul silvestre se determinó de cada valor propio dominante (el valor en paréntesis) como resultado de la combinación de cuartiles de la cantidad de huevos eclosionados por adulto por año [m] y la supervivencia de los polluelos que no han dejado el nido desde la eclosión hasta emplumecer [l]. Un valor propio dominante mayor que 1 implica que la población incrementará.

Tabla 6. El tiempo (en años) necesario para duplicar la población silvestre actual para cada hipótesis de población en aumento para el guacamayo barbazul en Beni, Bolivia.

Fig. 2. Relación entre la cantidad total de huevos eclosionados por año y el porcentaje de polluelos exitosos que dejaron el nido para tres poblaciones estables de 50, 75 y 100 guacamayos barbazul adultos (p. ej. $\lambda = 1$). Los valores por encima de las curvas implican que la población incrementará.

4. Discusión

Se ha creado un modelo de población de tiempo discreto, estructurado en etapas, que permitió analizar las dinámicas de la población silvestre restante de los guacamayos barbazul. Los resultados fueron respaldados por la información recolectada mediante el monitoreo de esta población silvestre durante ocho temporadas de reproducción consecutivas (Berkunsky et al., 2014). El análisis de sensibilidad mostró que el crecimiento de la población es sensible a la supervivencia de los adultos, seguido por su fertilidad. Las prioridades de la gestión de la población silvestre deberían tener como fin mejorar estos dos parámetros. El método determinístico llegó a la misma conclusión que un método estocástico previo (p. ej. el análisis de la viabilidad poblacional llevado a cabo por Strem (2008)), donde la mortalidad adulta tenía un impacto mayor en la probabilidad de extinción. Medidas exitosas con el fin de evitar la caza de adultos incrementarían las probabilidades de viabilidad de la población. Mientras tanto, incrementar la cantidad de polluelos que dejan el nido también tendrá un impacto positivo en el tamaño de la población. La combinación de cuartiles de la función de maternidad y la probabilidad de supervivencia de los polluelos que no han dejado el nido permitieron identificar cuál combinación de valores tuvo como resultado el crecimiento de la población. En las poblaciones adultas silvestres actuales, cuando la maternidad se acerca al valor de la mediana (p. ej. seis huevos eclosionados por año, Tabla 1), una supervivencia de al menos 67 % de los polluelos que no han dejado el nido (p. ej. cuatro polluelos que han dejado el nido) se necesita para un crecimiento de la población positivo, lo que implica grandes esfuerzos en la alimentación y protección de los polluelos que no han dejado el nido coincidiendo con las conclusiones de Strem (2008). Por otra parte, nueve huevos eclosionados aumentan las posibilidades de un crecimiento de la población positivo en las tres hipótesis de la supervivencia de los polluelos que no han dejado el nido. La cantidad de huevos eclosionados podría incrementarse aumentando la disponibilidad y protección de las cavidades, o introduciendo guacamayos adultos en la población silvestre. El modelo permitió impulsar diferentes opciones de reintroducción. La reintroducción de 50 guacamayos adultos reduciría entre 4 y 5 veces la cantidad de años necesarios para duplicar la población silvestre bajo las condiciones de gestión actuales. La reintroducción de 50 guacamayos adultos en el mejor caso de gestión duplicaría la población silvestre en menos de 10 años. Por otra parte, sin la reintroducción y si se mantienen las acciones de gestión actuales, serían necesarios entre 33 y 215 años para duplicar la población silvestre. Ambas de las estrategias de reintroducción, todas individuales en un solo grupo o cinco grupos de diez individuos introducidas en los años consecutivos, mostraron tiempos similares necesarios para duplicar la población silvestre actual.

Se cree que este modelo puede ser una herramienta efectiva para calcular el efecto de las medidas de gestión, ya que estas medidas se pueden convertir en cambios en los parámetros vitales. Las partes interesadas de Bluethroated Macaw Conservation Project pueden tener una herramienta gráfica simple para gestionar la toma de decisiones (Fig. 2). Al conocer el tamaño de la población adulta y la cantidad de huevos eclosionados al principio de cada temporada de reproducción, el equipo de campo podrá evaluar el esfuerzo necesario en el manejo de los polluelos que no han dejado el nido, para aumentar las probabilidades de un crecimiento de la población positivo. Al calcular el impacto de las medidas de gestión de los guacamayos barbazul, se espera contribuir con el mejoramiento y efectividad de las medidas de conservación en la especie que se encuentra en grave peligro de extinción.

5. Reconocimientos

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4.1.3. Text 3.

Parámetros reproductivos del guacamayo barbazul en grave peligro de extinción: Límites hacia la recuperación de un loro bajo gestión intensiva

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Resumen

Pese a ser redescubierto en la naturaleza hace 20 años, la biología reproductiva de los guacamayos barbazul silvestre se mantiene inexplorada, sin embargo, esta es esencial para su conservación y recuperación efectiva. En este estudio, se analizan los parámetros reproductivos

en una población de guacamayos barbazul silvestre gestionada de manera intensiva, proporcionando la primera información acerca de la biología reproductiva de esta especie en grave peligro de extinción. Durante el periodo de estudio de 6 años (2007-2012), el número activo de parejas reproductoras se mantuvo constante o disminuyó, según el sitio, asimismo, no se descubrieron nuevas parejas reproductoras a pesar de la búsqueda extensa. Se documentaron los intentos de anidación en cavidades naturales en palmeras muertas o en maderas duras vivas y en cajas nido artificiales. La puesta de huevos se concentró durante la finalización de la estación seca y el comienzo de la estación húmeda, de agosto a diciembre. El fracaso de eclosión fue la mayor causa de la pérdida de los huevos. La mitad de los intentos de reproducción de los guacamayos barbazul produjo al menos un polluelo que salió del nido, en promedio dos, después de un periodo de 85 días de que un polluelo no saliera del nido. Un promedio de 4.3 polluelos que habían salido del nido emplumecieron de todos los nidos silvestres conocidos combinados. Cada pareja perdió aproximadamente un 65 % de su inversión reproductiva inicial en cada intento de anidación. En la mayoría de los intentos exitosos de anidación de parejas individualizadas, no se detectó un nuevo intento de anidación en el año siguiente. Todas las parejas reproductoras monitoreadas mostraron una fidelidad al nido, reusando las cavidades de árboles de madera dura y cajas nido. Estos descubrimientos contribuyen con los esfuerzos de conservación al refinar las medidas actuales y al impulsar nuevos métodos para la conservación y recuperación del guacamayo barbazul.

Introducción

Casi la mitad de las 152 especies de loros neotropicales están amenazadas o casi amenazadas con la extinción; la mayoría de las especies restantes está disminuyendo debido a la explotación para el comercio de los animales silvestres, la caza por comida y plumas o la destrucción del hábitat [1–3]. Aunque el trabajo de investigación es extenso y la conservación de loros es un proceso continuo en el neotrópico, nos falta obtener información biológica básica para muchos taxones, lo cual dificulta la identificación de amenazas específicas, el monitoreo efectivo de las poblaciones y la implementación de medidas de conservación efectivas.

Los guacamayos son el grupo más amenazado de la familia *Psittacidae* con al menos cinco especies extintas, tres en grave peligro de extinción (una posiblemente extinta [*Anodorhynchus glaucus*] y una especie [Cyanopsitta spixii] que sobrevive solo en cautiverio), y siete de las 15 especies que permanecen en la naturaleza se encuentran en la Lista Roja como amenazados, vulnerables o casi amenazados [3,4]. El guacamayo barbazul *Ara glaucogularis* es una especie endémica boliviana y una de las dos especies de guacamayos en grave peligro de extinción que todavía existe en la naturaleza (como *A. glaucus* está posiblemente extinta y *C. spixii* solo se puede encontrar en cautiverio) [5,6]. En su hábitat natural, es difícil que este guacamayo sume más de 115-125 individuos divididos en dos subpoblaciones [7]. Por lo tanto, se ha llevado a cabo una cantidad de medidas de conservación con el fin de recuperar la población silvestre del guacamayo barbazul en los últimos 10 años, sin embargo, el conocimiento de la biología de la especie está limitado a descripciones y cálculos de ámbito, uso del hábitat y el tamaño de la población [6,8–10]. Los parámetros reproductivos básicos para los guacamayos barbazul permanecen inaccesibles, no obstante, son fundamentales para su conservación y recuperación.

En este estudio, se analiza una variedad de parámetros reproductivos, tal como el número de la puesta de huevos, el éxito de eclosión, el éxito de polluelos que dejan el nido y el éxito de los nidos, en una población silvestre de guacamayos barbazul gestionada de manera intensiva. Esta investigación proporciona la primera información publicada acerca de la biología reproductiva de esta especie en grave peligro de extinción. Las observaciones se realizaron de manera simultánea con el programa intensivo de conservación práctico, con el objetivo principal de maximizar estos parámetros reproductivos. Los descubrimientos contribuirán con los esfuerzos de conservación refinando las medidas actuales e impulsando nuevos métodos para la conservación y recuperación del guacamayo barbazul y otros loros que se enfrentan a amenazas similares.

Métodos

Sitio de estudio

Se llevaron a cabo estudios en los Llanos de Mojos, en el departamento Beni, norte de Bolivia (Fig. 1). Los Llanos de Mojos tienen una extensión de 160,000 km^2 de sabanas estacionalmente inundadas, los cuales se distribuyen en un mosaico complejo de islas forestales y bosques de galería fluviales, ocupando la cuenca extremadamente plana Beni–Mamoré–Iténez en el suroeste de la Amazonia, situada entre el escudo precámbrico al este y los Andes al oeste y al sur [11]. Numerosos ríos de aguas blancas y cientos de lagos poco profundos de fondo plano cubren el panorama. La precipitación media anual varía de 1,300 a 2,000 mm en la región, sucediendo en gran parte entre setiembre y mayo [12].

El panorama está dominado por zonas bajas planas, que se inundan estacionalmente y están cubiertas por una sabana en su totalidad abierta sin árboles [13]. Por otro lado, las islas forestales son escasas y están restringidas a zonas elevadas (colinas) que están lo suficiente elevadas para evadir las inundaciones anuales. La mayoría de las islas forestales son reliquias erosionadas de diques naturales o terrazas de canales de ríos abandonados, por lo tanto, constituyen fragmentos de un bosque de galera previo [14]. La región de estudio mantiene una alta diversidad y abundancia de loros, incluyendo guacamayos grandes (*Ara choropterus y Ara* *ararauna*) [8]. La mayoría de las poblaciones de loros en el área parecen sanas, sin embargo, el guacamayo barbazul parece ser la única especie altamente amenazada. La presencia humana en el área de estudio se da en densidades bajas (1.4 personas por kilómetro cuadrado), con 43 asentamientos abarcando las municipalidades de Trinidad, San Javier, San Ramón, Santa Ana de Yacuma, San Andrés y Loreto. La ocupación principal de los residentes es la ganadería [11] como ha sido el caso por varios cientos de años.

Recolección de datos

Los datos se recolectaron desde principios de agosto hasta finales de marzo durante cinco temporadas de reproducción (2007–2008 hasta 2011–2012). En cada temporada de reproducción, se buscaron nidos de guacamayos barbazul de manera intensiva en la temporada, se visitaron todas las zonas de anidación conocidas de la especie, por lo que se cubrieron aproximadamente 5200 km^2 del departamento de Beni. Asimismo, se identificaron algunos individuos al fotografiar sus tractos de plumas faciales distintivas (permitiendo la confirmación de fidelidad del lugar). Se encontraron nidos principalmente al observar el comportamiento de las parejas reproductoras. Después de localizar un posible nido (un árbol con una cavidad y actividad de guacamayos), se alcanzó el agujero de la entrada usando técnicas de asenso por cuerda modificadas [15]. Se señaló lo siguiente para cada nido: la especie del árbol, el diámetro a la altura del pecho (DAP), la altura del agujero de la entrada, el diámetro mínimo y máximo del agujero de entrada, el diámetro interno y la profundidad de la cavidad.

Figura 1. Ubicación de las parejas reproductoras activas. Este mapa muestra todas las parejas reproductoras activas de guacamayos barbazul (puntos negros) durante el periodo del 2007-2012. doi:10.1371/journal.pone.0099941.g001

Se asignó una fecha de inicio a cada nido con base en la fecha en que se puso el primer huevo en cada nido. Se definió como intento de anidación cuando al menos se puso un huevo en un nido. La fecha de inicio de los nidos encontrada después o durante la etapa de puesta de huevos se determinó directamente. La fecha de inicio de los nidos durante las etapas de incubación y polluelos que no han dejado el nido se determinó por medio de un conteo regresivo desde la fecha de eclosión del primer huevo y la suposición de una incubación de 25 días (basado en los huevos de una puesta conocida y fechas de eclosión). Además, se calculó la duración de la etapa de puesta de huevos como la cantidad de días entre el primer y último evento de puesta de la temporada.

En algunos casos, los nidos se observaron desde puestos entre 25 y 40 m de los árboles nidos. Observaciones diarias se concentraron durante la mañana (amanecer hasta 10:00) y la tarde (15:00 hasta el atardecer). La frecuencia de las visitas de los nidos por parte de los guacamayos adultos fue variable y estaba relacionada a la ubicación y la etapa del nido. Para los nidos monitoreados, se escalaron los árboles una vez por semana durante la incubación; todos los días o de día por medio durante las primeras tres semanas del desarrollo de los polluelos que no habían dejado el nido; y dos veces por semana hasta que los polluelos que no habían salido del nido emplumecieran. Por su parte, se registró el contenido de los nidos cada vez que se inspeccionó un nido.

Para cada nido, se definió la duración de 1) el periodo de incubación como la diferencia en días entre la fecha de puesta de huevos y la fecha de eclosión del último huevo y 2) el periodo de polluelos que no han dejado el nido como la diferencia en días entre la fecha de eclosión y la fecha de abandono del nido del primer polluelo que no había dejado el nido [16].

Para calcular los tamaños de las puestas de huevos y las camadas, se contaron los huevos y los polluelos que no habían dejado el nido en cuatro etapas del periodo de reproducción: a) al final del periodo de la puesta de huevos (Puesta de huevos total), b) al final de la incubación (tamaño de la puesta de huevos en la eclosión), c) inmediatamente después de la eclosión (tamaño de la camada eclosionada) y d) inmediatamente antes de que los polluelos que no han dejado el nido emplumezcan (tamaño de la camada en el emplumecimiento). También se calculó la supervivencia de los huevos por cada nido y la proporción de huevos que completan el periodo de incubación; el éxito de eclosión y la proporción de los huevos en la eclosión que produjeron polluelos que no dejan el nido; además, la supervivencia de polluelos que no han dejado el nido y la proporción de polluelos que no han dejado el nido eclosionados que emplumecieron exitosamente del nido (p. ej. polluelos que han dejado el nido). Un nido se consideró exitoso si produjo al menos un polluelo que lo dejó. Cuando ocurrieron pérdidas, se registró la causa más probable como:

a) depredación (p. ej. huevos faltantes o rotos sin ninguna causa aparente, o huevos o polluelos que no han dejado el nido, desaparecidos del nido, con cáscaras de huevo o plumas en el interior del nido); b) enfermedad desconocida (polluelos que no han salido del nido, muertos sin señal externa que permitiera determinar la causa de muerte); c) fallo durante la eclosión (huevos que no habían eclosionado en una semana o diez días después de la fecha de eclosión esperada); d) clima adverso (p.ej. una cavidad inundada, una cavidad abierta por el viento); e) nido abandonado durante la incubación; f) caza furtiva de los nidos y g) hambruna. La mayoría de los huevos no eclosionados se dejaron dentro de los nidos. En algunos casos, se removieron esos huevos y examinaron su contenido.

La emplumación se confirmó por al menos dos de los siguientes criterios: polluelos emplumados vistos en el nido; nuevos polluelos que han dejado el nido que se vieron o se escucharon en las cercanías; el nido sin perturbaciones y en buena condición combinado con otro de los criterios. Estadísticas descriptivas se presentan como promedio ± SE. Se llevaron a cabo todos los análisis estadísticos con significación estadística aceptada en $P<0.05$.

Las observaciones se hicieron concurrentes al programa de conservación intensivo, el cual incluyó un rango de medidas diseñadas para mejorar el éxito de anidación. Veinticinco cajas nido de madera dura y 12 de PVC (para detalles vea [17,18]) se instalaron en sitios donde era probable que fueran adoptadas por parejas conocidas. Se protegieron de depredadores la mayoría de árboles de nidos ocupados cada año, con hojas de metal y recortando las ramas, y defendiendo de manera activa los lugares de nidos de puestos durante las horas diurnas.

Se manipularon las cavidades de los árboles para mantenerlos secos y seguros redirigiendo el agua lejos de la entrada de la cavidad y se colocaron drenajes en la cavidad o ambos. Finalmente, en algunos casos, los polluelos que no habían dejado el nido recibieron comida suplementaria hasta que sus ritmos de crecimiento alcanzaran los niveles de edad apropiados. El estudio involucró una especie en grave peligro de extinción y protegida; este protocolo de campo fue aprobado por la Dirección General de Biodiversidad, el Viceministerio de Medio Ambiente de Bolivia (Número de Permiso: 1239-11, Nombre del Proyecto: Proyecto de Conservación de la Paraba Barba Azul: Manejo poblacional). El estudio se llevó a cabo en propiedades privadas (los nombres de los dueños se mencionan en los reconocimientos).

Resultados

Durante el periodo del 2007-2012, se identificaron 64 individuos en el área de estudio, de los cuales, al menos 32 eran aves reproductoras activas, específicamente, 16 parejas distintas que pusieron al menos un huevo (Fig. 1). Durante este estudio, la cantidad de parejas reproductoras activas en un área determinada o se mantuvo constante o disminuyó, dependiendo del sitio. Se monitorearon 31 intentos de anidación (n= 12 en 2007–2008, n= 2 en 2008–2009, n= 8 en 2009–2010, n =4 en 2010–2011, y n= 5 en 2011–2012). Estos intentos de anidación se dieron en 19 cavidades naturales diferentes, seis cajas nido de madera y una caja nido de PVC.

Doce cavidades naturales se encontraban en palmeras muertas: 11 en *Attalea phalerata* y una en *Acrocomia aculeata*; y seis en árboles de madera dura vivos: cuatro *Gallesia integrifolia*, dos *Anaedanthera colubrina* y uno en *Sterculia apetala*. La Tabla 1 muestra las características de los árboles y cavidades. La mayoría de las cavidades en los árboles de madera dura y en las cajas nido fueron reusadas por guacamayos barbazul al menos una vez durante el periodo de estudio, mientras que las cavidades en palmeras muertas nunca fueron reusadas debido a la degradación acelerada. Todas las parejas que aceptaron cajas nido habían anidado en el mismo árbol o en un árbol no tan lejos de unos metros de donde la pareja se había reproducido en temporadas previas.

La puesta de huevos se concentró, generalmente, durante la finalización de la estación seca (p. ej. setiembre y octubre) en la población del norte y durante el principio de la estación húmeda en la población del sur, lo que resultó en un intervalo de puesta de huevos extenso de agosto a mayo (Fig. 2).

El tamaño promedio de la puesta de huevos fue de 2.53 ± 0.10 huevos por cada puesta (n = 29), con un rango de uno a tres y una moda de tres huevos por cada puesta. El reemplazo de puesta de huevos se observó dos veces y solo en los nidos que fallaron durante la incubación. Ningún huevo de las segundas puestas eclosionó.

La duración precisa de la incubación se documentó claramente por un nido y duró 25 días por cada huevo. Durante la puesta de huevos y la incubación, las hembras pasaron la mayoría de su tiempo dentro del nido o se mantuvieron cerca y los machos casi nunca se vieron ingresar a la cavidad del nido, aunque a menudo se mantuvieron cerca. Las pérdidas parciales durante la incubación fueron bajas: dos huevos rotos fueron eliminados por los padres antes de la fecha de eclosión.

El tamaño promedio de la puesta de huevos en la eclosión fue de 2.10 ± 0.18 huevos por cada puesta (rango: 1-3; n =21). El éxito de eclosión fue 72 ±7% (n = 23) y el fallo de eclosión fue la mayor causa de pérdidas de huevos (28/30 huevos). En la mayoría de los nidos, todos los huevos eclosionaron

(52 %, n = 12) y, en algunos nidos, un huevo (30%, n = 9) falló en eclosionar y en dos nidos ninguno de los huevos eclosionó (9%, n = 2). Dos de cada cuatro (50 %) huevos sin eclosionar que se removieron tenían un embrión parcialmente desarrollado. La fecha promedio de eclosión para el primer polluelo que no había dejado el nido fue el 23 de octubre (del 3 de mayo al 15 de enero, n= 21).

El tamaño de la puesta de huevos promedio en la emplumación fue de 2.00 ± 0.25 polluelos que dejaron el nido por cada puesta (rango: 1-3; n =13 nidos). En los nidos exitosos, la supervivencia de los polluelos que no habían dejado el nido fue de 100 % (n = 25 polluelos que no habían dejado el nido).

El periodo de polluelos que no habían dejado el nido duró aproximadamente 3 meses (85 días).

Si se juntan todos los nidos, de 74 huevos (n= 29 nidos), 30 huevos se perdieron durante el periodo de incubación y 18 polluelos que no habían dejado el nido se perdieron durante el periodo de la crianza de los polluelos que no habían dejado el nido (59 % de la supervivencia general de los polluelos recién eclosionados). Entre el 2007 y el 2012, un total de 26 polluelos que no habían dejado el nido de guacamayos barbazul emplumecieron exitosamente, lo que significa que un promedio de 4.3 polluelos que no habían dejado el nido por cada año emplumecieron, de todos los nidos conocidos durante el periodo de estudio. Dado que el promedio total de la puesta de huevos fue de 2.5 huevos por cada intento de anidación y el promedio de 0.89 polluelos que habían dejado el nido por cada intento de anidación, en promedio, cada pareja pierde un 65 % de su inversión reproductiva en cada intento de anidación.

De 30 intentos de anidación de guacamayos barbazul, un 77 % de estos (n =23) completaría la etapa de incubación y 45 % (n =13) produciría al menos un polluelo que dejó el nido (p. ej. éxito de anidación).

Un 57 % de 30 nidos monitoreados falló. La mayoría de los fallos ocurrió durante la etapa de incubación (Fig.3). Las causas de fallo de los nidos fueron diversas (Tabla 2). Toda la evidencia de identidad de depredadores fue indirecta. En dos casos, la evidencia indicó depredación por serpientes. Una enfermedad desconocida parece estar afectando el éxito de reproducción en una pareja reproductora y fue responsable por la muerte de todos los polluelos que no habían dejado el nido en la puesta, en tres intentos de anidación en años consecutivos. El abandono del nido como resultado del clima adverso incluyó caídas de árboles nido y cavidades inundadas.

En siete de ocho intentos de anidación exitosos de parejas individualizadas, no se detectó un nuevo intento de anidación el año siguiente (Tabla 3). Todas las parejas reproductoras monitoreadas mostraron una alta fidelidad al nido reusando las cavidades de madera dura y cajas nido.

Discusión

Durante el periodo de estudio, no se introdujeron parejas adultas en la población reproductora. Esta falta de reclutamiento de parejas reproductoras podría ser una consecuencia de un bajo índice de supervivencia de jóvenes o aves prereproductoras o una densidad impidiendo la formación de parejas efectivas. No se tiene información acerca de la supervivencia de las aves pre reproductoras y la densidad de las parejas reproductoras es de 0.003 parejas/km^2 (p. ej. 16 parejas reproductoras en 5200 km^2). El fallo de introducir parejas reproductoras nuevas en la población, por supuesto, limitará de manera severa el potencial para que esta especie en grave peligro de extinción prospere de nuevo en la naturaleza.

Figura 2. Comienzo de la puesta de huevos. Fenología del comienzo de la puesta de huevos para 31 intentos de anidación del guacamayo barbazul durante cinco temporadas de reproducción (2007–2008 a 2011–2012). doi:10.1371/journal.pone.0099941.g002

Figura 3. Curva de supervivencia de los nidos. Curva de supervivencia Kaplan-Meir para los nidos de guacamayo barbazul (N = 30 intentos de anidación) en las sabanas de Beni. doi:10.1371/journal.pone.0099941.g003

Los tamaños de las puestas de huevos fueron similares a los valores reportados en parejas en cautiverio y silvestres, donde la moda de tres huevos también es común [18,19,21,22]. El tamaño promedio de la puesta de huevos para los guacamayos grandes silvestres (*A. macao*, *A. chloropterus* y *A. ararauna*; masa corporal 1015–1250 g) es de 2.5–2.8, un poco más alto que el promedio de 2.1 reportado para el guacamayo barbazul en este estudio [17,18]. El éxito de eclosión de guacamayo barbazul (72 %) fue similar al de otras especies de guacamayo reportadas del bosque lluvioso peruano donde usualmente un huevo no eclosiona; 77 % del éxito de eclosión en el guacamayo aliverde (*Ara chloropterus*) y 50 % en el guacamayo rojo (*Ara macao*); y considerablemente más alto que el 36 % del éxito de eclosión reportado en el guacamayo azul amarillo (*Ara ararauna*) [17,18]. Además, tal como se descubrió en los guacamayos grandes del bosque lluvioso peruviano, todos los huevos eclosionaron en un 61 % de los nidos habitados [18]. Debido a que la depresión endogámica (o la pérdida de heterocigosis) en aves se indica usualmente por un éxito de eclosión reducido, las observaciones indican que estas aves todavía no han sufrido un cuello de botella significativo, probablemente porque su disminución de población fue tan reciente [21].

El remplazo de la puesta de huevos no se observó en nidos que fallaron durante la crianza de los polluelos que no habían dejado el nido. Se observa una puesta de huevos de reemplazo solo en dos ocasiones y en ambos casos los nidos fallaron durante los primeros días de incubación. Las segundas puestas de huevos no son comunes en los loros silvestres, de hecho, en el caso de los guacamayos, solo se ha documentado en los guacamayos rojos [15,22,23]. La decisión de algunas parejas de guacamayos de iniciar una segunda puesta de huevos puede estar relacionada con una buena condición corporal de la hembra o alimento abundante durante el periodo de reproducción, o ambos. Los intentos de anidación y éxitos de anidación variaron entre los años. En algunos años, hasta 10 parejas anidaron y en otros solo se realizaron dos intentos. El éxito de anidación del guacamayo barbazul (45 %) fue similar a los de otras especies de guacamayos donde, usualmente, la mitad de los intentos de anidación fueron exitosos: 54 % en los guacamayos azul amarillo (*Ara ararauna*), 44 % en los guacamayos rojo (*Ara macao*) y 41 % en los guacamayos aliverde (*Ara chloropterus*); pero el valor fue más bajo que el 70 % reportado para los guacamayos Jacinto (*Anodorhynchus hyacinthinus*) [18,24,25]. Sin embargo, la cantidad de polluelos que dejaron el nido por cada nido iniciado (0.89) en los barbazul fue más alta que los valores reportados para las especies de guacamayos en el bosque lluvioso peruviano (entre 0.55 y 0.65) y similar al valor reportado de 0.98 en los guacamayos Jacinto [24,25]. Las

diferencias en esos índices son una consecuencia de la cantidad de polluelos que dejaron el nido por cada nido exitoso. Se observaron dos polluelos que habían dejado el nido por cada pareja exitosa, un valor de
38 % más alto que el valor máximo reportado para un guacamayo grande en la naturaleza (p. ej. 144 polluelos que dejaron el nido/nido exitoso en el *Ara macao*) [18]. Esta alta supervivencia de polluelos que no han dejado el nido (100 %) en parejas exitosas es probablemente una consecuencia del programa intensivo de manejo de conservación.

Dos terceras partes de cavidades naturales se encontraron en palmeras muertas. La mayoría de las cavidades en árboles de madera dura fueron reusados por guacamayos barbazul al menos una vez durante el periodo de estudio, mientras que las cavidades en las palmeras muertas de *Attalea phalerata* nunca se reusaron antes que cayeran de manera natural.

Tabla 2. Intentos fallidos de anidación y causas de fallo de anidación de las parejas de guacamayos barbazul por cada temporada de reproducción.

Tabla 3. Historias de intentos de reproducción de siete parejas de guacamayos barbazul.

Al igual que los otros guacamayos [17,18,26], los barbazul estaban dispuestos a anidar en varios tipos de cajas nido, pero en todos los casos, seleccionaron las cajas establecidas en el mismo árbol o en un árbol a unos metros de donde la pareja se había reproducido en temporadas previas.

Ahora se tiene una mejor idea acerca de las características de las cavidades seleccionadas por los guacamayos barbazul para reproducirse. Los descubrimientos sobre las dimensiones no indican nada inusual acerca de estos guacamayos, pero los resultados son útiles para el próximo diseño de cajas nido, que puede ser adaptado con más detalle a las necesidades y preferencias de la especie. Estudios futuros de la selección del lugar de los nidos deberían evaluar la disponibilidad de cavidades similares en la región.

Los resultados indican que es difícil que las parejas reproductoras exitosas se reproduzcan el próximo año; si bien es cierto, este factor limita de manera drástica la habilidad de esta especie de recuperarse de su estado actual en grave peligro de extinción. En algunos años, se observa que las parejas reproductoras, acompañadas de sus polluelos que habían dejado el nido del año previo, no mostraban comportamiento reproductor. Los padres parecen atender a sus polluelos que han dejado el nido (p. ej. proporcionándoles alimento, aprendizaje social, etc.) por un periodo extendido, posiblemente a través de la temporada reproductora sucesiva en algunos casos. Se necesitan más estudios para comprender las relaciones postreproductoras entre los adultos y sus jóvenes dependientes. Este factor tiene consecuencias potencialmente dramáticas para el rendimiento reproductivo de las parejas reproductoras más productivas y atentas. La información también indica que es difícil que las parejas reproductoras que fallaron en un año determinado realicen un intento de reproducción el siguiente año o, en algunos casos, podrán haberse separado o trasladado a zonas de reproducción diferentes y desconocidas. Las expectativas de las dinámicas de la población y recuperación potencial para las especies deben integrar estas limitaciones naturales para ser exactas y útiles para el planeamiento de la conservación.

Se reconoce totalmente que existen equivalentes para llevar a cabo investigaciones y la conservación aplicada de manera simultánea en los mismos individuos en la naturaleza. Para una especie en grave peligro de extinción como el guacamayo barbazul, normalmente con menos de diez parejas intentando reproducirse en un año determinado, se considera que un método balanceado que tenga como prioridad la conservación y la recolección de datos de segundo es adecuado. Este método ha contribuido con la recuperación de la especie mientras genera de manera simultánea descubrimientos biológicos, que informan opciones de conservación y manejo en curso y futuras. No se puede saber cómo las poblaciones sin manejo resultarían en términos de intentos de anidación, índices de depredación, éxito de eclosión e introducción de polluelos que han dejado el nido, ya que tales parámetros han sido influenciados directamente por estas medidas. A medida que la cantidad de estos guacamayos mejore en los años futuros, se podrá tener la oportunidad de realizar comparaciones directas entre parejas controladas y no controladas, pero tomando en cuenta que el reclutamiento anual todavía se promedia en dígitos singulares, todavía no se tiene el lujo de tomar un método menos práctico.

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Contribuciones del autor

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4.1.4. Text 4.

Conservación en terrenos dominados por humanos: Lecciones de la distribución del mono ardilla de América Central

By: Gerardo Ceballos, Paul R. Ehrlich, Jesús Pacheco, Natalia Valverde Zúñiga, and Gretchen C. Daily.

Cada vez es más evidente que muchas especies pueden tolerar diferentes grados de perturbación del hábitat y que, a menudo, subestimamos la capacidad de algunos terrenos modificados por humanos de mantener poblaciones de especies decadentes. Se proporcionan nuevas perspectivas de la distribución del mono ardilla de América Central en peligro de extinción y el hábitat cambiado en los últimos 20 años. La especie ha presentado una disminución aproximada de 60 % entre la extensión de ocurrencia histórica y presente, con un área de ocupación también alrededor de 60 % de la extensión de ocurrencia presente. A pesar de la gran alteración del hábitat, los resultados muestran que, sorprendentemente, este mono en peligro de extinción puede persistir en terrenos altamente perturbados. Esto da la oportunidad de mejorar sus probabilidades de supervivencia a largo plazo, a través de medidas de conservación para proteger y restaurar su hábitat, así como reducir la mortalidad directa del mono. Sorprendentemente, se descubrieron varias tropas en 16 localidades en una gran área a lo largo del río Coto Brus, donde no se había registrado el mono ardilla de América Central. Algunas de las observaciones se hicieron en bosques nubosos en una altitud récord para esta especie. Se especula que los monos utilizan estas áreas de tierras altas como un corredor entre hábitats de tierras bajas adecuados en las regiones de Coto Brus y el río Sierpe en la Península de Osa. Como respuesta, se sugieren estrategias para ayudar con la conservación a largo plazo de los monos que puede ser utilizada como un ejemplo para otras especies en peligro de extinción.

Introducción

Actualmente, la tierra está experimentando una gran pérdida de biodiversidad, la cual es única en la historia de la humanidad. La sexta extinción masiva ya ha demostrado la desaparición de miles de especies y de billones de poblaciones y, peor aún, el alto índice actual de extinción parece estar destinado a incrementar (Ceballos et al., 2015, 2017; IUCN, 2019). Al menos 35 especies de mamíferos se han extinguido desde 1600 y alrededor de un 30 % de todas las especies mamíferas están en peligro de extinción (Ceballos et al., 2015; IUCN, 2019). Los primates son particularmente vulnerables al impacto humano, la mayoría están relacionados en forma estrecha con los hábitats forestales que se están fragmentando o desapareciendo en su totalidad. La pérdida rápida de bosques tropicales ya ha causado la extirpación de muchas de sus poblaciones a través del mundo (Oates et al., 2000; Estrada et al., 2017). Muchas especies de primates, como el recién descubierto orangután de Tapanuli (*Pongo tapanuliensis*) en los bosques de tierras bajas de Sumatra noroeste (Nater et al., 2017); el kipunji o el mangabey de tierras altas (*Rungwecebus kipunji*), un nuevo género y especie del bosque tropical de las montañas del monte Rungwe en Tanzania (Davenport et al., 2008); y el mono sin nariz de Birmania (*Rhinopithecus strykeri*) del bosque lluvioso en Birmania y China (Geissmann et al., 2011; Long et al., 2012), tienen poblaciones de < 1000 individuos. Los primates son objetivos favoritos para aquellos que casan por la carne de animal silvestre, exhibiciones de zoológicos, pruebas farmacéuticas o mascotas. Muchos de ellos también tienen bajos índices reproductivos. Como resultado de los impactos de esos factores, aproximadamente un 60 % de las > 500 especies reconocidas están en peligro de extinción (Jernvall y Wright, 1998; Cowlishaw, 1999; Wong et al., 2008). Sin embargo, la inhabilidad logística clara para conseguir el nivel de conocimiento necesario para la conservación de la mayoría de billones de especies y poblaciones en peligro de extinción dicta que se debe tratar de lidiar con dos preguntas fundamentales. Primero, ¿cómo podemos lidiar con los impulsores globales de la pérdida de biodiversidad: la sobrepoblación humana, el hiperconsumo (especialmente por parte de los adinerados)? y segundo, ¿cómo, a través de métodos estándar y nuevos, incrementar grandemente los esfuerzos con el fin de proteger refugios para la biodiversidad, expandirlos y modificar los impactos en terrenos dominados por humanos para hacerlos más hospitalarios para estas indispensables criaturas semejantes?

Fig. 1. Localidades de observación del mono ardilla de América Central (*Saimiri oerstedii*) reportado en esta investigación junto con la gradiente altitudinal regional en el sur de la vertiente del Pacífico, Costa Rica.

La conservación de los mamíferos en peligro de extinción, los primates en particular y otros vertebrados en general, requiere cada vez más el uso de métodos tradicionales y nuevos en respuesta a las causas de disminución diversas y dinámicas. Dejar a un lado las áreas protegidas y corredores biológicos, apoyar a los terratenientes locales para mantener el hábitat a través de incentivas de conservación, la reintroducción de especies meta en hábitats adecuados y desarrollar actividades económicas como el ecoturismo para incentivar a las personas locales a proteger los bosques, deberían ser métodos para promover su conservación a largo plazo (ver también Caughley y Gunn, 1996; Goehring et al., 2007). Los métodos más inusuales y a veces más drásticos, como las traslocaciones a hábitats adecuados desocupados, ahora deberían probarse extensamente.

Es particularmente importante conservar a los primates, ya que son carismáticos, conspicuos e informativos debido a su relación evolucionaria hacia nosotros. Muchas especies, incluyendo las grandes como los monos aulladores (*Allouatta spp.*), son capaces de persistir en terrenos dominados por humanos bajo ciertas circunstancias. Además, ya que muchas especies mamíferas tienen rangos geográficos relativamente extensos, pueden funcionar como “especies paraguas”, protegiendo poblaciones de muchos otros organismos menos carismáticos. Es importante la determinación cuidadosa de rangos geográficos usando dos medidas amplias (sensu Gaston, 2003): la extensión de ocurrencia, la cual es el área definida por los límites externos del rango, y el área de ocupación, la cual es el área utilizada por la especie dentro de la extensión de ocurrencia. El comprender el rango geográfico de un taxón en peligro de extinción es crítico para el desarrollo y la aplicación de efectivas estrategias de gestión adaptivas (Holling, 2005; Blair et al., 2013a). La extensión de ocurrencia de una población o especie puede diferir de manera significativa del área de ocupación, ya que los organismos raramente ocupan todos los hábitats o regiones dentro de su rango (Gaston, 1994; Brown y Lomolino, 1998; Hurlbert y White, 2005; Goehring et al., 2007). El subestimar el área de ocupación de una especie en peligro de extinción puede resultar en un fallo en la creación de estrategias de protección para él, reduciendo así las probabilidades de conservación a largo plazo de las poblaciones o incrementando los costos de implementación (Thomas y Abery, 1995; Caughley y Gunn, 1996). Por otro lado, asumir que toda la extensión de ocurrencia está totalmente ocupada por un taxón puede resultar en infravaloraciones de la vulnerabilidad de extinción, como se ha observado en muchos mamíferos terrestres (Ceballos y Ehrlich, 2002).

Existe evidencia abundante de la capacidad de los mamíferos y otros vertebrados de persistir en terrenos dominados por humanos. Por ejemplo, en la misma área donde se estudia a los monos ardilla, el programa de investigación sobre la capacidad de terrenos agrícolas para promover la biodiversidad ha demostrado que un terreno mixto de parches de bosque y terrenos agrícolas puede mantener una muestra sustancial de la biodiversidad del bosque regional sin perturbaciones. Asimismo, se descubrió que, dentro de un área de estudio de 23,600 ha, las pequeñas franjas de bosque que atraviesan el campo de cultivo incrementaron de manera colectiva el tamaño efectivo de una reserva forestal local de 326 ha hasta 16 veces para los vertebrados e invertebrados (Daily et al., 2003; Pacheco et al., 2006; Mendenhall et al., 2014).

Muchas especies de primates tan diversos como los orangutanes, chimpancés, gibones, monos aulladores, lorinos y monos ardilla son capaces de persistir en terrenos dominados por humanos.

Varias especies de monos ardilla están relativamente extendidas en regiones tropicales de América del sur (Rylands et al., 2013; Lynch Alfaro et al., 2015). No obstante, el mono ardilla de América Central (*Saimiri oerstedii*) tiene un pequeño rango geográfico histórico disyunto de otras especies de monos ardilla y restringido a las tierras bajas del Pacífico sur de Costa Rica y el norte de Panamá (Reid, 2009; Rylands et al., 2013). Se categoriza como una especie en peligro de extinción debido a la pérdida de hábitat, la fragmentación de la población y la caza (Boinski y Siwt, 1997; Boinski et al., 1998; Sierra et al., 2003; Reid, 2009). La especie casi se ha erradicado de Panamá (Rylands et al., 2006), y la destrucción del hábitat ha dividido su rango geográfico histórico en Costa Rica en dos áreas separadas (Boinski et al., 1998). Sobrevive en hábitats dominados por humanos y, por esa razón, puede funcionar como un modelo de conservación.

Asimismo, se descubrió una población relativamente larga de monos ardilla en la región de Coto Brus, en el sur de Costa Rica, lo cual incitó a realizar un análisis del rango geográfico actual de la especie. La nueva información acerca de la distribución de *S. oerstedii* puede ayudar a mejorar los esfuerzos para restaurar el hábitat y proteger a este primate carismático, así como proporcionar conocimiento para la conservación de otras especies de primates. En este artículo, se abordan los siguientes temas: i) analizar la extensión de ocurrencia actual del mono ardilla; ii) documentar el cambio del hábitat de los últimos 20 años; y iii) identificar las estrategias de conservación de terreno para la conservación de la especie.

1. Métodos

1.1. Área de estudio

El estudio se llevó a cabo en las tierras bajas del Pacífico central y sur de Costa Rica desde el Parque Nacional Carara hasta la frontera con Panamá (Fig. 1). Se cubrió todo el rango geográfico conocido de la especie y áreas cercanas. Asimismo, se realizó la mayoría del trabajo de campo entre febrero y mayo de 1999, con periodos de estudio adicionales en marzo del 2001, 2002, 2014 y 2015. Se estudió en un área de aproximadamente 140,000 ha en la región del río Coto Brus, situado justo al norte del Golfo Dulce en el sur de Costa Rica. Se seleccionó el área de estudio basada en entrevistas con personas locales que observaron monos ardilla en la región. Se entrevistó de manera informal a campesinos, ganaderos y cazadores que tenían un buen conocimiento de la fauna local y se contrató a uno de ellos como el guía principal. En las entrevistas, se les mostraron fotografías de monos araña, aulladores y ardilla, para que identificaran la especie presente. Además, se realizaron siete transectos lineales de un día para determinar la presencia de tropas de mono ardilla en diferentes localidades en los distritos de San Vito, Aguabuena, Limoncito, Pittier, Changuena, Potrero Grande y Corredor (Tabla 1). Con la excepción de los bosques empinados y aislados adyacentes al lugar de estudio, se estudió la mayoría de las áreas accesibles. Sin embargo, es probable que algunos grupos de monos ardilla no se registraran. Cada vez que se observaron los monos ardilla, se registró su ubicación de GPS, altitud y tipo de vegetación. Durante las visitas de seguimiento del 2014 y 2015 a las localidades estudiadas, se reafirma la presencia de tropas de *S. oerstedii* en la región del río Coto Brus. También se observa *S. oerstedii* en localidades alrededor del Parque Nacional Marino Ballena durante los estudios en la región costarricense del Pacífico sur central.

1.2. Rango histórico de *S. oerstedii*

Además, se determinó la distribución histórica y presente de los monos ardilla en Costa Rica a partir del análisis de información publicada, principalmente, por Boinski et al. (1998), Morera-Ávila (2000, 2002), Sierra et al. (2003), Solano-Rojas (2007), Blair et al. (2013b), y de nuestra propia información. Se utilizó la información de rango de IUCN (Wong et al., 2008) para determinar la extensión de ocurrencia histórica de *S. oerstedii.* Todos los registros que se utilizaron son de las localidades boscosas en elevaciones por debajo de 500 m.s.n.m. en un área a lo largo de la costa del Pacífico, entre el río Tulín en el norte a la frontera sur de Costa Rica en la península de Burica. Para calcular el área forestal dentro de la extensión de ocurrencia histórica, se asumió un 85 % de la cobertura forestal para el año 1900 (Keogh, 1984). La extensión de ocurrencia presente se definió como la suma de todos los parches de bosque más grandes que 3 ha, dentro de un polígono delimitado por las localidades donde la presencia de *S. oerstedii* se ha reportado desde 1998 hasta la fecha actual. El área forestal se calculó por medio de los mapas del Inventario Nacional Forestal (SINAC, 2013). Cada localidad consistió en un radio de 5 km alrededor de los puntos de observación reportados (Boinski et al., 1998; Morera-Ávila, 2000, 2002; Sierra et al., 2003; Solano-Rojas, 2007; Blair et al., 2013b, y nuestra propia información). El radio de 5 km se definió por el movimiento diario de las tropas de *S. oerstedii* reportadas por Baldwin y Baldwin (1972). Se excluyeron aquellas regiones donde la especie se ha perdido según Boinski et al. (1998).

Se consideraron dos hipótesis para calcular el área de ocupación (Gaston, 2003). La hipótesis conservadora consideró el área de ocupación como la suma de todos los fragmentos forestales más grandes que 15 ha, dentro de un radio de 5 km de cada punto de observación, y la hipótesis menos conservadora incluyó todos los fragmentos forestales más grandes de 5 ha, dentro de un radio de 5 km desde cada punto de observación. Se utilizó el mapa del Inventario Nacional Forestal (SINAC, 2013) para calcular el área forestal para ambas hipótesis; la selección de ambos fragmentos de valores se basó en el área mínima considerada como bosque (5 ha) por la legislación costarricense y el tamaño de fragmento mínimo (15 ha) requerido por la especie para la supervivencia a largo plazo (Sáenz y Sáenz, 2008).

1.3. Teledetección del cambio al hábitat de S. oerstedii

Se utiliza el mapa de uso del suelo costarricense de 1992 (MAG, 2008) y el mapa del Inventario Nacional Forestal del 2012, para identificar los cambios en la ubicación y la extensión de cobertura forestal del rango de distribución de *S. oerstedii*; asimismo, se analiza la información con ArcGIS 10 (ESRI, 2011) y la extensión Patch Analyst (Rempel et al., 2012). El mapa de uso del suelo costarricense se generó de imágenes Landsat 5 y otras no especificadas en el mapa de metadatos, la resolución es 30 × 30 m. El mapa del Inventario Nacional Forestal del 2012 se generó con imágenes Rapid Eye, que tiene una mejor resolución.

Después se editaron y reclasificaron ambos mapas para hacerlos comparables para el análisis de terreno y se definió un parche de hábitat como cualquier bosque maduro o secundario, o segmento de manglar más grande que 3 ha.

Se determinó el cambio de hábitat que ocurrió dentro de la extensión de ocurrencia actual al calcular cuatro métricas de terreno: área, cantidad de parches, tamaño medio de parche, e índice de forma media para 1992 y 2012 y por cada tipo de hábitat (p.ej. bosque, bosque secundario y manglar). Por área, se refiere a la métrica de clase de área, la cual indica la suma de áreas de todos los parches dentro de una clase de cobertura. En este caso, la clase corresponde al área forestal (en el terreno). Todas las capas de datos se analizaron bajo el Sistema de Coordenadas Proyectado para Costa Rica (CRTM05/WGS84). Utilizando estos datos y la fórmula empleada por Puyravaud (2003), se calcula el índice anual de cambio en el hábitat, cantidad de parches y tamaño medio de parche utilizando la siguiente fórmula: $\frac{1}{t2-t1} \times ln\frac{A1}{A2}$, donde A1 y A2 son la cobertura forestal en t1 y t2, t2, respectivamente, la unidad podría ser por año o porcentaje por año.

2. Resultados

2.1. Nuevos detalles acerca de la distribución de *S. oerstedii*

Se descubrió evidencia directa e indirecta (p.ej. entrevista) de monos ardilla en 16 localidades a lo largo de ríos y fragmentos forestales en la región de Coto Brus (Tabla 1). La mayoría de las localidades estaban por debajo de 700 m.s.n.m., en restos de tierras bajas tropicales y bosques riparios rodeados por pastizales. Sin embargo, se registra la presencia de *S. oerstedii* en cinco localidades por encima de 900 m.s.n.m. en los bosques húmedos premontanos del río Java cerca de la reserva Las Cruces, incluyendo dos por encima de 1000 m.s.n.m. (Figs. 1 y 2, ver Daily et al., 2003 y Pacheco et al., 2006 para una descripción de esta región y su fauna mamífera). Estas son las primeras observaciones de *S. oerstedii* reportadas a esta elevación en Costa Rica y las primeras en los bosques de Las Cruces. Se fotografió una tropa de monos ardilla cruzando un pastizal al Jardín Botánico Wilson a través de una cerca para ganado en la Finca Gamboa en 1999 (Fig. 2; Tabla 1); los dueños locales de la granja adyacente al jardín mencionaron que habían empezado ocasionalmente a observar monos ardilla en la región ese año. Además, se registraron monos ardilla en seis localidades alrededor del área de Bahía Ballena (vertiente del Pacífico centro-sur) lo que suma 22 localidades en total en este estudio (Tabla 1).

Tabla 1. Observaciones de campo de los monos ardilla de América Central (*Saimiri oerstedii*) en Costa Rica. Todos los registros están basados en observaciones (O), entrevistas (I) o fotografías (P). Las localidades en negrita representan nuevos registros altitudinales máximos para la especie.

Fig. 2. Un mono ardilla de América Central (*Saimiri oerstedii*) cruzando un pastizal a través de una cerca para alcanzar el Jardín Botánico Wilson en la región de San Vito en el sur de Costa Rica (Foto: Gerardo Ceballos).

Con base en el análisis y trabajo de campo, se calcula que la extensión de ocurrencia histórica de *S. oerstedii* en Costa Rica es aproximadamente de 550,000 ha (5500 km^2) y la extensión de ocurrencia histórica de *S. oerstedii* en Costa Rica es aproximadamente de 225,000 ha (2.250 km^2), lo que indica una disminución de aproximadamente de 60 % entre 1900 y el 2012 (Fig. 3). También se calcula que el área ocupación actual es de 57-62 % de la extensión de ocurrencia presente, lo que significa que la especie ocupa un área de aproximadamente 128,00–138,700 ha (1280–1387 km^2) en Costa Rica, incluyendo bosque maduro, bosque secundario y manglar. El bosque maduro fue el tipo de bosque dominante en el área de ocupación (Tabla 2). En relación con el estado de protección del hábitat, los monos ardilla están sobreviviendo en parches de bosque dentro y cerca de los Parques Nacionales Manuel Antonio, Marino Ballena y Corcovado. En cambio, las tropas presentes en las regiones de Coto Brus, Golfito, Puriscal y Parrita no están protegidas.

2.2. Cambio del hábitat a lo largo de la extensión de ocurrencia presente de *S. oerstedii*

Se descubrieron importantes diferencias en la estructura del terreno en los años estudiados (Tabla 3). El área cubierta por el hábitat de mono ardilla no mostró cambios drásticos durante el periodo de estudio, pero el número de parches fue más alto y su tamaño promedio más pequeño, aunque más irregular al final. Este patrón de cambio territorial fue consistente en todas las categorías de hábitat, pero la variación más significativa ocurrió en las áreas forestales maduras y secundarias que presentaron índices anuales de cambio entre 13 y 15 % en el número de fragmentos y su tamaño medio. En contraste, el área de manglar presentó índices anuales de cambio en alrededor de 1 %, que no denotan un cambio en esta categoría de hábitat durante el periodo de estudio. Aunque el tamaño medio de fragmento ha disminuido, se mantiene adecuado para la supervivencia de tropas de *S. oerstedii* (Boinski y Siwt, 1997; Sáenz Sáenz, 2008). El hábitat adecuado fuera de las áreas protegidas está más fragmentado y aislado de grandes áreas de cobertura forestal continuas, como la región de Coto Brus, volviéndolos enormemente inadecuados para las tropas de monos ardilla.

2.3. Estrategias de conservación del terreno

Con base en los resultados, se proponen estrategias de conservación para consolidar la distribución de monos ardilla, las cuales incluyen áreas protegidas, corredores biológicos, pagos ecosistémicos para los terratenientes de terrenos críticos sin protección e introducciones a nuevas áreas (Fig. 4). Es importante expandir y mejorar la conectividad en los parques nacionales Manuel Antonio, Marino Ballena y Corcovado. Estos son corredores biológicos ya establecidos en esas regiones, como Paso de las Lapas, Paso de la Danta, Fila Langusiana y Osa, pero es necesario mejorar su protección y funcionalidad. Las reservas indígenas podrían tener un rol crítico como parches de conexión entre corredores y áreas protegidas, mientras estas comunidades se involucran en la conservación de especies carismáticas y así potencialmente generar beneficios sociales. Además, donde es posible, nuevas áreas protegidas deberían crearse en las regiones del río Térraba, río Coto Brus y el Térraba Sierpe, que tienen poblaciones de monos ardilla; estas áreas también pueden actuar como corredores. Es particularmente importante dejar a un lado las áreas protegidas en el valle de Ciudad Nelly, donde la mayoría del hábitat está acabado y los pocos bosques nativos restantes no están dentro de ninguna categoría de protección. El programa de pago de conservación del gobierno federal en terrenos privados debería expandirse para abarcar todos los hábitats identificados en este estudio (Fig. 4). Esos hábitats incluyen reservas indígenas, fincas privadas y terrenos campesinos. Además, es esencial probar nuevos métodos como introducir monos ardilla en el Parque Nacional Carara y las tierras bajas del corredor biológico Paso de la Danta. Tales regiones son adyacentes al rango geográfico histórico de los monos ardilla y tienen un hábitat muy similar a las áreas actuales que están ocupadas por la especie.

3. Discusión

3.1. Nuevos detalles acerca de la distribución de *S. oerstedii*

Las observaciones de *S. oerstedii* en elevaciones más altas que las que se reportaron previamente muestran que el rango altitudinal de la especie se ha estado expandiendo hacia arriba por al menos las últimas dos décadas. En la región de Coto Brus, este rango se extiende hasta ~1200 m.s.n.m. Aunque algunos reportes de ocurrencia identificaron 800 m.s.n.m. como el límite ascendente (Morera Ávila, 2000, 2002; Pacheco et al., 2006); históricamente, e incluso en publicaciones recientes (Sierra et al., 2003; Wong et al., 2008; Blair et al., 2013b), el límite de la distribución de *S. oerstedii* se indicó por debajo de 500 m.s.n.m. Las observaciones de *S. oerstedii* en elevaciones significativamente más altas indican que se ha identificado una adición relativamente grande a su rango geográfico de extensión de ocurrencia conocido en una región bastante accesible y biológicamente bien estudiada (Daily et al., 2003; Pacheco et al., 2006). Además, la información indica que puede haber otras localidades en elevaciones altas con monos ardilla en los alrededores de Las Alturas en la Cordillera de Talamanca, a lo largo de la frontera de Costa Rica con Panamá. Aunque estos descubrimientos son nuevos para esta especie centroamericana, los monos ardilla en América del sur han establecido poblaciones en altitudes altas frecuentemente. Es probable, considerando el centro de evolución suramericano del grupo, que *S. orestedii* está preadaptado para moverse hacia arriba (Lynch Alfaro et al., 2015; Ruiz-García et al., 2015).

4.2. Translations from Spanish to English

4.2.1. Text 1.

Is ecotourism an inexhaustible source of wealth? Recommendations for its sustainability

By: Conrado Carrascosa López and Marival Segarra Oña

Introduction: Tourism plays a fundamental role as a development generator (Artesi, 2002), and it is one of the economic activities with greater increase across the world. Tourism is important for practically every country, but it is even more important for developing countries, since due to it, a greater number of international flight arrivals are produced (Arrieta and Rivera, 2006). In Latin America, competition in the tourism sector has increased, due to, among other things, the appearance of new tourist destinations and the arrival of international tourism operators as a result of the globalization process. This is why, it is important to analyze the factors that can influence its competitivity (Arrieta and Rivera, 2006).

Many different ecotourism definitions can be found in academic literature; for example, ecotourism can be defined as the tourism that is based on the protection of natural areas, a tourism alternative that allows the obtention of benefits based on the preservation of the natural environment (Smith, 2010). According to Sánchez and Ramírez (2011), ecotourism is designated to the trips in which their main purpose is the contemplation of nature, the increase of their knowledge, and the participation and promotion of its conservation and in which their destination is barely modified areas by human action. Furthermore, ecotourism could be defined as an environmentally responsible tourist modality, consisting in visiting natural areas with the goal of valuing, enjoying, and studying the native landscape, flora and fauna. It differs from the simple nature tourism, as it focuses on education and environmental conservation (Alvarado, 2010; Molina, 2011). This type of tourism is known by many names, such as bio tourism, environmental tourism, green tourism, academic… according to the aspect it is focused on.

Ecotourism does not yet represent a big part of the totality of global tourism; even though, its reach has been rising over the last years, and its growth rates exceed those of conventional tourism (Schulte, 2003). In Latin America, specifically, its development potential is significant due to its great abundance and biological diversity (Torres, González, Martín and Kirkby, 2011). Many authors clearly consider the proven existing relationship of the best nature conservation, where ecotourism occurs, especially in protected natural areas, which is where they most frequently occur (Álvarez, Segura and Campos, 2012).

In addition, the correspondence between environmental education and the existence of protected natural areas is evident, since the creation of projects that help the conservation of said protected areas and that also generate upgrades in living conditions, is fundamental (Reyes and Castro, 2008). Ecotourism stimulates environmental education and the ecological values that help to improve people´s relationship with the environment (Lee and Moscardo, 2005). This unquestionable relationship can be appreciated in ecotourism and environmental education, unlike other types of tourism (Álvarez et al., 2012).

Usually, the places to practice ecotourism are rural settlements near protected natural areas, since these play an important attraction role for the tourists (Sánchez and Ramírez, 2011). Ecotourism near protected areas increases job possibilities for people who live in neighboring areas (Palacio, 2010).

Ecotourism can be defined as the tourism that is based on nature and its protection. It entails a small portion of tourism even though it has recently had a great development.

Many authors consider ecotourism more as a tool that is capable of contributing to the local rural development and that at the same time, promotes nature conservation (Torres et al., 2011; Casas, Soler and Jaime, 2012, Alvarado, 2010). Other authors name this occurrence as communal tourism, based on local communities and in charge of reinforcing tourism relationships with nature; this communal tourism enables the improvement of living standards of rural regions by involving the local population and allowing them to receive their share of associated economic benefits (Casas et al., 2012; Coria and Calfucura, 2012)

Some authors differ in some respects, and they question to a certain degree the results of some eco-touristic projects, especially those referring to the supposed improvement of the natural area conditions that accommodate them (Álvarez et al., 2012). One example of this discrepancy is the decrease of land in some protected natural areas (Alvarado, 2010). Other authors are also alerting about the effects of ecotourism in the Galápagos islands, famous for being home to very eye-catching endemic animal species since, according to González-Pérez and Cubero-Pardo (2010), even if the environment of said fauna is fully respected, the mere human presence provokes direct reactions in the behavior of these species that can, in fact, affect biodiversity.

Ecotourism has many positive aspects that are clear and very valuable to promote. However, the authors of this article regard as more interesting to know which are the characteristics that can be improved, as those appear once their implementation is specified. This is why the objective analysis of the changes associated with ecotourism is completely necessary to evaluate its real impact (Alvarado, 2010). Over the last years, numerous initiatives have been developed, focused on ecotourism in various Latin American countries. We will study some of them in order to analyze its effects, observe its benefits, and analyze its improvement possibilities.

The main objective of this article is to delve deeper into the knowledge of ecotourism through the analysis of various eco-touristic projects that have been carried out recently in different places. The best knowledge makes it possible to maximize the ecotourism potential as a very valid tool that promotes nature conservation in conjunction with the improvement of living conditions of the areas where it is practiced (Torres et al., 2011). Improving something good is not easy; it is easier to improve something bad. This is the case of ecotourism, since in order to improve it, there must be an effort in increasing its advantages and trying to decrease its associated inconveniences to the minimum possible.

Methodology: The methodology followed for the elaboration of this article is the review of the current academic literature on ecotourism, particularly in Costa Rica and its neighboring countries. This study tries to find out what is the current status of ecotourism by studying different eco-touristic projects that have been possible to observe and analyze the improvement possibilities.

In the studied academic literature, the interest in different case studies carried out in different countries and environments of Costa Rica and other Latin American countries stands out. Comparing them among each other, similarities and differences are found, but above all, what is most important is that it allows the development of improvement ideas that can be of great use for all.

Costa Rica, an Ecotourism Paradise: Costa Rica is an eminently touristic country; therefore, the tourism industry is the country's main source of profit. In addition, Costa Rica is a pioneer country in the ecotourism development. It made itself known as such during the 90s; however, there were conservation concerns of its natural riches since before then. The exotic beauty of its natural environment makes it one of the more sought-after paradises. In spite of its small extension, it has more fauna and flora variety than the United States and Canada (Alvarado, 2010). However, not all of its tourism is ecological, since there is a lot of beach tourism; even though, ecotourism is the one used as a differentiating element (Barrado, 2001), and the whole country is grouped as a natural destination image (Alvarado, 2010). Costa Rica is considered a leading country in the ecotourism development across the world. (Chen and García, 2011).

Costa Rica has a great number of natural appeals. This has allowed the development of a very varied offer of ecotourism, such as visiting a national park, the stroll through its different forest types, birds, alligators, and exotic animals watching, visiting its two coasts in the Caribbean and Pacific Ocean, where scuba diving and the observation of coral reefs, dolphins, sharks, different kinds of fish, and the egg laying of turtles can be enjoyed. People can walk along trails among exuberant vegetation, visit waterfalls, cross rivers, climb volcanoes…

People can also enjoy ethno-tourism. According to Pilquiman and Skewes (2009), ethno-tourism centers its interest in the indigenous cultures. There is the possibility of visiting native settlements to assess their customs. Tourists can cohabit with them for a few days to carry out different agricultural, cultural, culinary, artisanal activities, etc., to learn about their ancestral traditions; for example, the observation of the culture and art of the Bribrí or Guaymí ethnicities in Puntarenas (Chen and García, 2011).

The visit and accommodation in rural communities where people can participate in their daily activities is recommended. These tasks in rural communities are generally driven by different communal associations. The country's government endorses the creation of local associations, since it is aware of its benefits and promotes the creation of support local associations for the eco-touristic sector, such as cooperatives, local development associations, support groups for the conservation, women groups, etc. Some examples of this fact, are the creation of associations like the Asociación de Talamanca para el Ecoturismo y la Conservación (ATEC) created for the promotion of ecotourism in the Parque Nacional Cahuita protected area, the Kè Koldi indigenous reserve and the Refugio de Vida Silvestre of Manzanillo (Palacio, 2010). More examples can be named: ASEPALECO, Los Buzos de Paquera, Los Planes de Drake farmer settlement, Playa Grande organized groups or Asociación de Damas Ecoturísticas de la Isla de Chira. These associations were created to develop different environmental activities (Chen and García, 2011). The existence of these associations and their combined work allow to develop their capacities easier and to improve the harnessing of its environment more efficiently (Chen and García, 2011).

These associations can be found all over the country, and it can be observed that the local population is benefited through them and the negative tourism impact is simultaneously able to be reduced Matarrita-Cascante, Brennan and Luloff, 2010). Another very interesting example can be found in La Fortuna, where the improvement of the local products through the increase of competition towards them is promoted, in this way increasing its quality and causing local economy to grow in quality and quantity (Matarrita-Cascante et al., 2010).

Another characteristic of these associations is that local people maintain the ownership of the lands, many of its inhabitants even maintain their agricultural activities along with its touristic activity, in this way diversifying their income (Matarrita-Cascante et al., 2010). In spite of this, there are not only advantages, since some Costa Rican local communities do not always obtain the benefits that were expected from ecotourism (Coria and Calfucura, 2012), which brings out opposition and rejection reactions when they are not equally included in the benefit distribution. Reyes, Feria and Aguilar (2013) mention that in the Caño Negro case, there is a project whose results are poor, for its deterioration has increased and furthermore, the local population development has been slight. This occurrence does not only occur in Costa Rica, as more of it occurs in Latin America, for example, in Peru. In the Lima declaration, natives are encouraged to participate in ecotourism, since it helps the development of their communities; however, the indigenous tourism forum rejected it because they do not feel respected (Dachary and Arnaiz, 2009).

Highlighting the success cases in the collaboration between tour operators and indigenous communities is interesting, like the Posada Amazonas case where there is a positive collaboration between both parties, since they signed an agreement to work together and to equally share the benefits (Coria and Calfucura, 2012). Another success case can be observed in Ecuador: the Achuar community carries out the project practically alone after a private company financed the project; they worked together for 10 years until it was transferred to the local community when they had acquired management skills (Stronza and Gordillo, 2008).

Education is a very important success factor to take into account, since it underlies the eco-touristic projects and increases awareness towards the conservation and positive attitude towards the environment. The Rara Avis case, which incorporates the bilateral knowledge between visitors and locals, is a good example (Sander, 2012). Forestry ecotourism also has a positive influence in the social and environmental development in Costa Rica, as Bien (2010) claims in his study.

The state level government support to ecotourism is also significant; many institutions that deal with the monitoring of the environment matters associated with ecotourism were created: Instituto Costarricense de Turismo (ICT), Ministerio del Ambiente (MINAE), Sistema Nacional de Áreas de Conservación, Tribunal Ambiental, Secretaría Técnica Nacional Ambiental and Tribunal Ambiental (Alvarado, 2010).

In Costa Rica, people can even study Ecotourism in the University of Costa Rica, with its branch in Guanacaste. It is pioneer in Latin America. It was created for the first time in 1991 with the objective of creating specialist professionals in said field (Arrieta and Rivera, 2006). Its fundamental task is to contribute to the local and the country's eco-touristic development; its main objective is to promote eco-touristic research to be able to identify the changes that are produced with ecotourism, and therefore, be able to improve the efficiency of the operations by trying to avoid altering the environment. This study course offers exchange programs with the Higher Polytechnic School of Chimborazo (Ecuador), Guadalajara University(Mexico) and Bremen University (Germany).

Many authors regard ecotourism as a tool that, at the same time promotes nature conservation and is able to contribute to the local rural development.

Furthermore, the Observatorio del Turismo Sostenible in Guanacaste has been created, with the purpose of supporting the creation of new projects. Conversely, in Costa Rica some authors point out the existence of many contradiction between theoretical ecotourism and the real one, since it is observed that, for example, some protected areas are losing land, endangering biodiversity (Alvarado, 2010). Precisely, due to the fact that Costa Rican economy directly depends on tourism, efforts are taken to attract even more visitors; recently, international hotel chains that have been installed in the country are promoting beach tourism, with a visitor profile that generates the most number of waste with a bigger environmental impact that threatens certain species, like the threat to the golden toad in Monteverde (Chen and García, 2011).

This same fact is reported in other Latin American areas by other authors; for example Torres et al. (2011) alert about overexploitation because of the excessive number of visitors that Machu Picchu suffers, and they advise to increase control and reduce its number. According to González-Pérez and Cubero-Pardo (2010), in the Galapagos Islands, the excess of visitors negatively affects the relationship of the numerous endemic and unique species that live there. These contradictions between theoretical ecotourism and its real implementation should be adequately taken into account, be evaluated, and corrected, since it could come a time where Costa Rica's image be damaged and lose its fundamental value of environmental paradise. Another notable matter is that ecotourism's focus is placed mainly on foreign tourists with a high spending capacity, mostly Europeans and north Americans. Ironically, Costa Ricans are usually excluded from the eco-touristic experience (Alvarado, 2010), a fact that should be evaluated, since it is ironic that own citizens can not enjoy in the same way the virtues of nature as the foreign tourists do.

Conclusions: We initiate the conclusions with the question that was made in the title of this article: is ecotourism an inexhaustible source of wealth? It could be answered as, it depends. It depends on the management that is given on the Costa Rican protected natural areas of an exceptional wealth, with the objective of acquiring a better sustainable economic development with time.

The ecotourist profile has changed over the last years, since in its beginning, the tourist enjoyed walking through tough trails to reach the destination place, and that made part of the experience; however, it now demands better life conditions during the stay (Alvarado, 2010). This situation has turned into pressure for the infrastructure construction that can entail an irreversible habitat degradation.

The ability for the obtention of ecotourism profitability depends on the followed strategy. An essential factor to have in mind is to achieve greater awareness and local participation.

Many of these exploitations are given to foreign franchises, which is why the union between native communities and specialized tourism companies equipped with knowledge, experience, and awareness is recommended to therefore develop ecotourism projects so that in this way, its benefits equally reach local communities.

Foreign franchises typically have greater capital and management skills, while local communities have a better understanding of their environment and a greater interest in its conservation, for it is their home. Literature that mentions that the synergistic combination of both parties shows the best long term results is abundant: Coria and Calfucura, 2012; Carrascosa-Lopez, Segarra-Oña, Peiró-Signes and De-Miguel-Molina, 2015; Stronza and Gordillo, 2008; Li, 2013; Elliot, 2014).

It would be easier to debate which touristic development model is more adequate from the perspective of its social and environmental impact as well as evaluating which is the best for the development of the local economy. In this debate, all the involved members should be represented, from the public authorities to the private sector and the local population in general (Chen and García, 2011). The combination of the local skills with those of the tourist companies contributes to a better distribution of wealth. (Matarrita-Cascante et al., 2010).

Subsequently, the elaboration of an action plan articulated according to the competitive advantages of the landscape and its inhabitants would be recommended. The objective would be the development of an eco-touristic cluster that would take advantage of the local tourist appeals, encourage its conservation, and allow and promote favorable competitiveness for its development without losing sight of which is the main differentiating factor: nature, with the goal of maintaining its fundamental essence (Chen y García, 2011). The fact that nature attracts tourism should be remembered (Matarrita-Cascante et al., 2010), and any doubt regarding this must be avoided. For example, it would be completely necessary to restructure some of the exploitations in order to ensure the ecotourism sustainability (González-Pérez and Cubero-Pardo, 2010; Torres et al., 2011), as well as reinforcing the environmental legislation to make sure that ecotourism development does not damage the environment.

Another notable matter is that ecotourism's focus is placed mainly on foreign tourists with a high spending capacity, which costaricans are ironically usually excluded from the eco-touristic experience (Alvarado, 2010). For the cluster development, the encouragement of a demanding local demand is fundamental (Porter, 2000). That is why the promotion of ecotourism values in all of society statuses, mainly starting from the education base is fundamental so that this greater knowledge pressures society towards the increase of the enjoyment of all citizens. Even Sander (2012) mentions the necessity of developing the "eco-touristic pride" concept in Costa Rica.

As a final conclusion, three general recommendations could be added that will help that the eco-touristic projects be sustainable in the time and maintain its essence:

1.-There must be minimum impact in the interaction with the environment.

2.- The control and the economic benefits must reasonably satisfy the local communities so that, in this way, the environmental, cultural, and economic sustainability occur.

3.- A learning and research atmosphere must be created, for which education is the basic factor on which it is supported on.

The main danger that must be avoided is that ecotourism loses its essence, no type of doubt must be shown about ecotourism maintaining its intrinsic nature, that it is a sustainability model, that it preserves the ecosystems, and that it satisfies local inhabitants with the improvement of its life conditions.

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4.2.2. Text 2.

Ethical and Environmental Considerations in the Process of Ocean Acidification

By: Nelson de Jesús Gil-Luna

Introduction: Since the first meeting carried out on October 1984, where the World Commission on Environment and Development was created, the planet turned to the environment and started to pay more attention on its care. However, the industrial and domestic processes have affected the environment in such a way that it is necessary to intervene to try to take it to a less affected state (1).

The global climate change is considered one of the most critical threats to the ecosystem in the whole world. This is, without a doubt, one of the most important environmental problems that humankind has faced (2). Ocean acidification (OA) has also started to be recognized, since at least five years ago, as "the other CO2 problem," since this gas has the characteristic of being a greenhouse gas (GHG), a situation that makes it partly responsible for the present global warming process (3). This fact has affected the environment in such a way that we can now observe changes in ocean chemistry and earth climate.

As a Start: Marine ecosystems provide goods and services to mankind, including serving as a food source for many nations and thousands of millions of people who depend on this ecosystem as a main source for animal protein obtention at a low cost. The recent investigation has brought to light other factors that can underlie the variability in sensitivity among and within taxonomic groups.

High temperatures can increase the metabolic rate of the organisms inside their thermal tolerance range; however, they can cause a rapid deterioration of the cellular processes and performance beyond tolerance limits.

For example, the food or nutrient increase could compensate the reductions in calcification and growth related to the acidification in corals, as well as mussels (4, 5), which are affected by the pH reduction and the aragonite availability in the marine environment to produce its exoskeletons and shells (6, 7).

Moreover, adaptation can make a population more or less sensitive than another of the same species. Some species can be able to acclimate themselves to the acidification for longer periods (8).

In addition, the increasing levels of atmospheric CO_2 are simultaneously prompting an ocean warming, and an increasing number of experiments has proved the combined effect of acidification and warming. High temperatures can increase the metabolic rate of organisms within its thermal tolerance range, however, they can cause a rapid deterioration of the cellular processes and performance beyond tolerance limits (9). Therefore, predicting the combined effect of warming and acidification is difficult, as well as indicating that warming also could not counter the effects of ocean acidification (10), or aggravate it through an accumulation of thermal stress effects (11). Due to this, science has dedicated itself to evaluate the answer of the three main planetary reservoirs (terrestrial, oceanic, and atmospheric) in light of the increase in the CO_2 emissions to the atmosphere and the greenhouse gas accumulation, together with the identification of the disruptions that the global carbon and climate cycle generate (12).

It is not necessary to clarify that environmental problems have anthropogenic origin, which was possibly generated by a sense of superiority of humankind towards the environment, since it is " a being that we do not understand, with whom we do not know how to dialogue with" (13). Although Genesis[1] states that man was made "to dominate over all land and animals," this element — that seems evident for most western society— comes to generate a dominance attempt of the environment. In Venezuela, Simón Bolívar, our Liberator, demonstrates this with his famous phrase “ If nature resists, we will fight against it and we will make it obey us!” In this respect, some people could presume that by a divine mandate, “civilized” man is lord and master of everything around him and has made humankind believe that it can do as it pleases with the environment**.** Just as Quiñones Colarte (14) states, humankind has not understood that the planet deals with the consequences of a climate change without precedents, a product—among other things— of its own doing.

However, beliefs at some moment considered “primitive” or ancestral (called ancestral wisdoms) allowed indigenous people from different parts of the world to learn to live in balance with the environment, taking from nature what was necessary for their livelihood, and as “payment” for this environmental service, they provided it with life and avoided, through different practices, to alter natural cycles, for they had taken part in their lives and allowed their livelihood; that is why they transmitted, and still do, this sustainable lessons from generation to generation.

People can speculate endlessly as to why this happens, and maybe all of the possible answers will lead to a common place. For example, one of the possible answers could be young and not so young people’s lack of education and information on ecological aspects, aspects regarding fully knowing the ecological system in which they live in, analyzing the individual, group, and community as an ecological relationship and maintaining the balances in the ecosystems created by man (15). However, it is widely demonstrated that factors like the indiscriminate increase of population and the social and technological development that was produced on recent years have resulted in an important increase in carbon dioxide (CO_2) accumulation in the atmosphere and oceans, a situation that has the potential to restructure marine ecosystems (16). This occurrence makes the atmospheric CO_2 increase to attributable levels to human activity to have reduced the ocean pH in approximately 0,1 units. Likewise, modernity in the use of new ways of contaminating energy or political-economic systems that go hand in hand with environmental degradation are responsible in these facts.

Currently, the studies that have been carried out to estimate the Co2 exchange between the atmosphere and the coastal oceans, provide unclear results. The few available studies report areas of intense Co2 exchange in the air-water interface, which act both ways: as sources and sinks regarding the atmosphere.

CO_2 in the Ocean: It is a known fact that the earth's crust and the ocean are large carbon reservoirs (12). The coastal ocean contains some of the most biologically productive areas of the global oceans (17). These coastal regions support a great part of the marine resources captured by man (18), in spite of the fact that they cover only a narrow strip of the total superficial area of the oceans. It is to be expected that these regions act as strong anthropogenic carbon dioxide (CO_2) sinks due to its high rates of photosynthetic carbon fixation (17).

The carbon cycle of the oceans at the continental platform level has been strongly disrupted by anthropogenic activities since the beginning of the Industrial Revolution (19). The carbon dioxide (CO_2) case present in the atmosphere only constitutes ~0,038 % of the total of the combination of existing gases (380 ppm or µatm in partial pressure units). However, its solubility in seawater is greater than nitrogen's and oxygen's due to the fact that this gas, when dissolved, reacts with the water to form carbonic acid and its dissociation products, bicarbonate and carbonate, as it is shown in the following equation (20):

CO2 (gas) + H2OfgH3CO3fgH$^+$ + HCO3$^-$fg2H$^+$ + CO3^{2-} (A)

The resulting species of the (A) reaction and its relationship with the pH range of sea water, make the CO_2 presence as dissolved gas to be found in very small quantities in seawater (~0,23 ml l^{-1} o < 0,23 ppm), in other words, it does not reach 2 % of the TCO_2 , in contrast to bicarbonate, which is the most abundant chemical species and is consumed by photosynthesis (20), which generates important changes in the carbon cycle as well as organic and inorganic in rivers and marshes (21, 22), as well as by the alterations in the intensity of the CO_2 exchange in the air-water interface of the coastal oceans (1).

Currently, the studies that have been carried out to estimate the CO_2 exchange between the atmosphere and coastal oceans provide unclear results (19). The few available studies report areas of intense Co2 exchange in the air-water interface, which act both ways: as sources (22-24) and sinks (25-27) regarding the atmosphere.

In the past decade, various studies estimated the atmospheric CO_2 assimilation by coastal oceans between 0,18 and 0,45 Pg C y^{-1}. However, Laruelle, Lauerwald, Pfeil and Regnier (28) estimated that coastal oceans act as weak atmospheric CO_2 sinks, and set -0,19 Pg C y^{-1} on average. These results are consistent with those obtained by Wanninkhof *et al*. (29), who estimated the atmospheric CO_2 fixation by coastal oceans in -0,18 Pg C y^{-1}.

PH in the Marine Environment and its Relationship with CO_2 : In the ocean, pH has shown changes not only in time and space due to advection processes, but also as a result of the exchange in the anthropogenic CO_2 absorption (30). This CO_2 increase in the ocean has provoked changes in the depth of the aragonite saturation horizons (HSΩA) (31, 32).

Ocean acidification, as a result of pH variability, provokes changes in ecosystems and marine biodiversity. This process can affect food security and limits the ocean capacity to absorb the CO_2 that comes from anthropogenic emissions. The economic repercussions of ocean acidification could be significant (33).

It has been stated that the oceanic absorption of atmospheric CO_2 that comes from the burning of fossil fuels could generate big pH changes in the seawater in the coming centuries (34, 5).

According to the Intergovernmental Panel on Climate Change (IPCC) (35), pH has decreased in 0,1 units since the Industrial Revolution, a tendency that in the last decades has remained in a rhythm from -0,0014 to -0,0024 per year, and Marsh (36) states that pH could decrease in o,5 units until 2100, even when other investigations also state that such reduction could be between 0,065 and 0,31 units (16).

Ocean Acidification, Aragonite Availability and Impact in the Marine Ecosystems and its Calcareous Organisms: Ocean acidification has had impact on marine ecosystems, that include tropical reef-building corals, cold-water corals, coralline fouling algae and sea grasses, among others; a fact which has caused changes in their functions (36, 37) and in coral reefs, and causes the reduction of their biodiversity, bleaching and, in some occasions, their death (38, 39).

In the bibliography, the detrimental effects that pH change in the ocean has had in corals are widely discussed, such as skeleton growth decrease, zooxanthellae density reduction, calcification decrease and variations in the associated marine communities (40-43).

Ocean acidification also affects macroalgae communities, with the decrease of some species richness and their habitat alteration (44). Sea grasses, as they are known, are populations of aquatic macrophytes (vascular plants like *Thallasia testudinum* or *Poisodonia oceánica*) that can also be affected by this pH decrease; its impact varies according to the species and environmental conditions. These disruptions are evidenced in the distribution when altering the competition between sea grass species and their populations and algae populations (45, 46).

Researches state that even though during the past century pH decreased in 0.1 units, coral calcification rates have increased, just like temperature and Co2 concentration; therefore, the potential decrease of ocean pH does not seem to have caused a detriment in corals and other marine life forms, a fact which generates controversial results.

This acidification equally affects mangrove ecosystems, since pH reduction affects chemical solubility, nutrient availability, organic matter decomposition, organic matter diagenetic mineralization and causes alterations in the food chain of the estuaries associated to this ecosystem (47, 48).

However, researches state that during the past century, pH decreased in 0,1 units, coral calcification rates have increased, just like temperature and CO_2 concentration, therefore, the potential ocean pH does not seem to have caused a detriment in corals and other marine life forms, a fact which generates controversial results (49).

There are few researches for the Caribbean, in which the marine pH variation is related with the CO_2 absorption, and how this variation impacts the aragonite availability that is located in the marine environment, to generate the calcium carbonate cover ($CaCO_3$) in calcareous marine photosynthetic organisms.

From a bioethical perspective, which principles are violated or strengthened? In light of what has been stated, bioethics, or even an environmental ethic or eco-bioethics, is shown as the right one to answer the main questions that we ask ourselves regarding this situation. This is the focal point of this text: to understand, from a bioethical perspective, how man can decrease acidification processes, or at least mitigate this point taking into account these different principles in order to raise awareness for a sustainable environment and guarantee the proposed principles in the Brundtland report: " To guarantee the necessities of today without compromising the possibilities of future generations to satisfy their own needs." It is necessary to remember what ethics and bioethics consist of. Initially, ethics, from an initial simpler concept, the Greek one, is defined as the science of customs (50); however, in the present day, it is defined as " the science of conduct, either derived from human nature for the goal that must be carried out and from the means that were entrusted to achieve it, be the motor to impulse human conduct and the actions that determine it" (50). Bioethics is a discipline initiated by van Rensselaer Potter, who established the systematic study of human conduct in the life sciences and the philosophy of healthcare field, analyzed in light of values and moral principles (51), which allows for the making of value judgements on biological aspects, in the broadest sense of the word, and act consequently.

However, this cannot be only analyzed from this perspective, it is necessary to include ecology as a science that, together with bioethics, not only makes it to analyze the principles and moral values about life, but also provides the sense of globality regarding life and nature as a system. This is the basic objective of eco-bioethics. To be able to understand how we value marine organisms' life so much as environment balance and, collaterally, the decrease of quality of life of the communities adjacent to coastal areas and the whole global community, since these alterations globally affect our planet.

The bioethical principles universally known and established by Beauchamp y Childres (52) are insufficient for this type of problems. For that reason, according to what was previously stated about the difference between bioethics and eco-bioethics, other principles surge that are directly related with the way of addressing and appropriating the environmental problem from other perspectives, not only ecological, but also from an economic, social and cultural tripod, that represents the main compartments or dimensions of sustainable development. Then, based on these evaluations, the sustainability principles, the precautionary, progressivity, differentiated responsibility and concertation, solidarity and conservation principles will be discussed and included.

Consecutively, an analysis of these affected principles is carried out.

Sustainability Principle: Human beings always tend and aspire to prosperity. Being sustainable can be defined as the capacity of satisfying the current generation's needs without scarifying future generations' capacity of satisfying its own needs (53). If a system destroys its own biophysical base, it proves to be unsustainable (54); for this, economic and social development and the harnessing of natural resources must be carried out with an adequate management. In other words, to channel or think about two aspects that are of great importance: respect to biological limits (input and output of elements in the environment) and to think about the future (54). These two aspects or dimensions of the sustainability principle do not seem to be established in those moments, since the increase of greenhouse gases (mainly CO2), a product of the incomplete combustion in industrial chimneys and the burning of fossil fuels by motor vehicles, without an advanced process of investigation in alternative energies, for both houses and cars (the ones that exist are, until now, meager processes), do not guarantee a decrease of carbon quantities present in the environment and consequently, a stable maintenance in the pH levels in the marine environment.

Freedom and Autonomy Principles: This principle determines the freedom and autonomy that man has to act according to positive aspects for the environment, and concurrently with it. However, a great number of people misinterpret this principle and state that they can do as they please. It is the free will idea, which is basically the power that human beings have to act at their discretion. However, from an ethical perspective, does everything that man do in the environment, is done in its favor? In recent years, the marine environment has been a victim of pollution by plastic. According to the European Environment Agency, approximately 10 million tons of trash end up in seas and oceans of the world, and the main type of these wastes is plastic, such as drink bottles and disposable bags. Man, according to this principle, must learn to act positively, to do good in favor of the environment and himself. This action would improve the process of sustainable development, which would guarantee to future generations an environment in adequate conditions and an “economic” sustainability that would allow to not compromise neither current resources nor the future ones at this moment.

Precaution or Precautionary Principle: Not having scientific information about a serious or irreversible damage does not imply delaying the implementation of effective measures to prevent it. In this case, the researches that have been carried out about ocean acidification processes do not provide conclusive results, since they depend on the investigation paradigm that the scientist implements.

Contemporary science has become a key element in the domination and appropriation of nature, and it carries a positivist tradition. It presents itself as an objective, materialist, universal, and rational unit.

However, the corrosive effects that were stated and that can be observed, immediately demand to take into account this principle and to act in the most responsible way in favor of the environment. Just as Gudynas (55) states, contemporary science has become a key element in the domination and appropriation of nature, and it carries a positivist tradition. It presents itself as an objective, materialistic, universal, and rational unit. Its goal is to look for the truth and appeals to procedures known as "scientific method," which are unique, experimental, and factual. This very simplistic position has cost strong critics to the scientific processes that try to explain the phenomena that occur in the planet from an environmental perspective, since it legitimized the domain over the environment. In this aspect, Gudynas himself stated that "be a part of the assumption that everything is knowable and thus manageable and manipulable. Nature, the other living beings, and the inorganic environment are at the service of human beings and don't have their own values. Thus, this science is profoundly anthropocentric" (55).

The beneficence principle is based on the moral obligation of acting in favor of the others and the environment that surrounds us, one of the most striking elements in the ocean acidification process, and that sends a significant Co2 amount to the environment is deforestation, both in coastal areas and jungles.

Beneficence and Non-Maleficence Principles: The beneficence principle is based on the moral obligation to act in favor of the others and the environment that surrounds us. One of the most striking elements in the ocean acidification process, and that sends a significant Co2 amount to the environment, is deforestation, both in coastal areas and jungles. This deforestation in coastal areas is related with urban developments. It is possible to think that communities' life is being improved, but in the end, the ocean is degraded, and this is an act in favor of the others, but not in favor of the environment. Which implies that the beneficence principle is achieved halfway.

This is associated with the developmental paradigm, which formulates an unlimited material progress that sets the following guidelines: "what is important is accumulating a great number of livelihoods, material riches, goods and services in order to be able to enjoy our short time on Earth" (15).

When a person degrades the ocean, the principle of non-maleficence is also violated, which refers to not harming the environment and preventing its harm. When the ocean pH is contaminated or it diminishes, the marine biota is affected, that is to say, life forms are affected. Ethics turns ecology into awareness. This causes the translation and transformation of scientific conclusions into behavior imperatives that allow environmental care. Not harming or damaging is different from not producing benefits. Even though we are not obliged to harm others, we are also not obliged to benefit them, but we will never be sure of not harming others with our actions and interventions (be them in humanity, nature, other living beings, among others).

Progressivity Principle: The progressivity principle states that the environmental objectives must be achieved gradually, with short, medium, and long-term goals, to facilitate the achievement of the activities and diminish the environmental impact that they might carry. In its 2015 report, the United Nations (UN) stated the achieved objectives for that year, which were formulated in 2000, were denominated the Millennium Development Goals. In its 7^{th} objective, “guaranteeing environment sustainability” was stated, and even though it is stated in the presented report that “the substances that wear the ozone layer have practically been eliminated and the ozone layer is expected to recover halfway through this century,” it is also informed that “the carbon dioxide emissions have increased in more than 50% since 1990 in the whole world.”

From this perspective, the main objective — maintaining the neutral ocean pH to avoid acidification effects— has not been achieved, and the impact on the marine-coastal communities and on their inhabitants remains an impending danger. The degradation of this environment will progressively affect these communities’ human rights, and who will speak up for the poorest people of the planet? Which government from industrialized countries will dare, with ethical defense elements, to speak up and defend the rights of the poorest countries, mainly affected by industrialization and their own refusal to invest in cleaner and environmentally friendly technologies? All of these questions remain unanswered for the debate in its time.

Differentiated Responsibility and Concertation Principle: This bioethical principle is of utmost importance, since it states that whoever generates damaging effects to the environment must be responsible for the costs of the prevention and correction actions to mitigate the caused present or future impacts, that is to say, “he who breaks, pays.” One basic question can come up here: who bears the cost of this acidification? Who answers for all the damages that were caused to thousands of inhabitants of economically disadvantaged areas that live along coastal areas? However, beyond all these questions, who can face the consequences for the animals and the affected environment itself, which in the end will affect all of us who live on Earth? If a person takes into account the ideas of international environmental law and indicates “what is and what should not be,” it is necessary to address environmental protection consisting of common goods or humanity’s general interests from two perspectives, a negative one and a positive one. The first one consists of the belief that “protected goods are common heritage of humanity, and have brought evanescence in the international responsibilities and rights of the parties of international law” (56).

The second indicates the proclamation by the United Nations that “the environment is common heritage of humanity granting the individual, more specifically the person, rights to reclaim international protection as a member of that humanity, but regarding who is the legitimization bearer, it is everyone and no one; that is to say everyone is responsible, and at the same time no one is (56). That is to say, at the same time, everyone and no one can be held responsible for the environmental impacts that occur in the planet, and this makes building and initiating a system that can internationally generate protection in the environment to administrate common goods of outmost importance. However, ethically, this directly clashes with the autonomy principle, since state sovereignty functions as a basic principle of international law, in which states propose a negative logic to grant its environmental competencies even it were only to solve global problems (57). Nevertheless, before the ocean, we are as if in an immense residential compound with an immense common area. The obligatory question is, how do we manage this space?

Justice Principle: Those responsible for environmental protection must monitor the use of the environment to guarantee that current and future generations can enjoy it, but from this perspective, who is responsible for environmental protection? Those responsible are all those who live in the planet since this action of monitoring the use of the environment to guarantee the enjoyment of current and future generations, is transversal to life. Human race, as a pinnacle of evolution, has as justice principle the care of the environment for both current and future generations.

According to Gudynas (55), the principles of a sustainable society (that directly concern the justice principle) would be a) The respect and care of the community of living beings, b) The improvement in quality of human life, c) Earth’s vitality and diversity conservation, d) The reduction to the minimum of the depletion of non-renewable resources, e) The modification of attitudes and personal practices, and f) The establishment of a global alliance. All of these elements allow the establishment of a behavioral pattern that is environmentally sustainable, and justice and equity that would facilitate environmental care and mainly the care of the most sensitive human communities.

Solidarity and Cooperation Principle: This principle is principally managed by state entities, since it grants the national government, through all regional and national public management department that are related to the environment, the responsibility of environmental effects and mitigation measures of risks regarding the ecological systems shared with bordering countries, with measures developed together, and the use of natural resources and ecological systems shared equitably and rationally. However, it is not easy to establish said solidarity at a marine level, since the limits are very vague in the way of mitigating the impacts that initiate ocean acidification. Generally, these impacts come from solid ground and are referred to the large processes of industrialization and inappropriate technology management that gravely impact the environment, based on the national development premise.

The few control mechanisms go through the international consensus and proposal adherence, protocols (I.e. the Kyoto Protocol) that are often signed and remain as a dead letter.

As it can be assessed in this dissertation, the environmental ethical approaches to a determined problem are wide and the limits are very unclear. Everything that we do in favor of the environment in a determined place will favorably impact one of the most extensive regions of the planet, the sea, which was our birth and could become our death.

Conclusions: The processes associated to ocean acidification (OA) are complex just like its impacts. After the cursory analysis that was carried out, we can draw out some conclusions. The main polluting event is the amount of CO_2 that is sent to the atmosphere by large companies generated by the burning of fossil fuels or organic elements. This demonstrates the scope that this problem has, as it is not a specific problem but a global one. The ocean functions as a buffer element that absorbs CO_2 emissions, but this action diminishes its natural pH. It is estimated that for the year 2100, its value will be of 7,7, which will generate great damages to calcareous marine organisms.

Communities that depend on tourism, an enterprise that globally moves millions of dollars, will be affected by the loss of natural beauties attacked by ocean acidity, which will affect the quality of life of these inhabitants.

If the CO_2 emissions remain at the current level, great biodiversity losses will occur, and large fishing and seafood companies will be globally affected.

As collateral actions, the poorest populations of the planet will suffer the lack of these provisions since it is the cheapest or most artisanal way of obtaining animal protein.

Communities that depend on tourism, an enterprise that globally moves millions of dollars, will be affected by the loss of natural beauties attacked by ocean acidity, which will affect the quality of life of these inhabitants.

OA is not an easy problem to analyze and it is not completely understood, which is why current models do not show a clear relationship between the problem and the possible mitigation causes.

The study of OA requires an ethical and philosophical pragmatic base, and that internationally is not simply a discursive and rhetorical approximation; it demands strategies, plans, actions, investments and budgets that little by little and it a coherent and consistent way, function as input of a new paradigm, most certainly, with the fulfillment of al bioethics principles.

The future of the planet depends on the concept of environment and how we are immersed in this process. Future generations are the ones who can end up helping or sinking our ecosystem.

4.2.3. Text 3.

Why is it necessary to study animal behavior?

By: Emilio Ribes Iñesta

Most laymen consider that psychology is a "human" science; that is to say that its object of knowledge is exclusively centered on the *Homo sapiens sapiens* species; however, this assumption is incorrect. My goal is to examine various reasons why the fact that psychology studies animal behavior is not only justified but also deemed as indispensable. These reasons are not all of the same level; nevertheless, they point to the importance of animal behavior for the understanding of psychological phenomena. This research will carry out a brief outlook on each one of them.

Human Behavior as an Evolutionary Result: In spite of the creationist hardships in the United States, no one doubts the fact that man (to refer to the *Homo sapiens sapiens* species with no discrimination of sexual or gender differences in the species itself) is the result of biological evolution on Earth and that, in this sense, shares processes and characteristics with many of its ancestors. Human species is, in a strict sense, an animal. Obviously, no one can question that it is a very special and singular animal, not only in its biological characteristics, but also regarding its behavior. It is the only animal whose origin as a species was possible and is embedded in the creation of a social environment, structured from the work division and the deferred exchange of work products. It is also the only species that developed language in a diversity of natural and technical languages, as a necessary condition for the social work division. Finally, biologically, it is perhaps a species more vulnerable than others in many aspects, as it possesses the most developed nervous system in evolution and a highly differentiated locomotion motor system and fine manipulation. For these reasons, among others, it is unquestionable that the psychological characteristics of human beings are special. However, that does not mean that other species do not present psychological manifestations.

How to know if psychological processes can be attributed to other species in the different biological kingdoms? The focal problem consists of the way we understand and define psychological phenomena. In the case of human beings, psychological phenomena are identified from and in the form of identifiable ordinary language practices through (although not exclusively) "mental" terms and expressions (emotions, feelings, memories, thoughts, etc.). However, due to the fact that human beings are the only species that acts linguistically, it is not possible to limit to this criterion the identification of psychological processes in the zoological scale of the animal kingdom (taking for granted that in the other kingdoms, they do not have said processes: prokaryotes, fungi, plants and protists). This does not prevent us to unsystematically, attribute animals with psychological phenomena based on what Darwin denominated vestigial responses that we share with them.

The issue is in the criteria to distinguish the strictly biological behavior of the psychological behavior; even, if it seems strange to use the term behavior in two contexts with different meanings. In fact, this term is not exclusive to psychology, since it is used not only in everyday speech, but also in all other scientific disciplines like physics, chemistry, biology, sociology, economy, and others; when particle, molecule, cell, institution and market behavior is mentioned, respectively.

Biological behavior can be identified in reactivity terms, phylogenetically determined, specific to each species and in that way, it is invariant in the vital cycle of individual organisms. Conversely, psychological behavior consists of the development of functions in ontogeny, in which relationships with objects, events, and other organisms in the environment are differentiated, reorganized, and diversified beyond fixed responses linked to nutrition, reproduction, and defense. Reactive differentiation and flexibility is a characteristic of psychological behavior and, consequently, can only take place when the species has differentiated reactive systems for each of the aforementioned survival biological functions.

Fungi, plants, and protists lack these characteristics in a way that psychological behavior appears linked to the phylogenetic emergence of the nervous tissue, which function is to coordinate differential and specialized reactive systems. It is the transition from irritability to sensitivity and motility. The evolution of the nervous tissue itself, from the ganglions to the complex structure that it presents in hominids, is the result of a subtle interaction with the differentiation of reactive systems (sensory and motor, mainly) and the survival contingencies and the corresponding ecological niche adjustment. Following this criterion, we can extend the psychology knowledge object to all those animal species with nervous tissue and, consequently, with different levels of reactive differentiation. This is the first reason why psychology should study animal behavior.

Comparative Study of Behavior: After establishing that psychological behavior takes place in a myriad of animal species, apart from man, and that psychological behavior can be identified from reactive differentiation (sensitivity and motility) that supports the emergence of the nervous tissue in phylogeny, a natural step is to assume that psychology, among other objectives, should consider the comparative study of behavior (psychological, obviously), and also that comparative psychology is a legitimate branch of scientific knowledge.

Comparative psychology, in a broad sense, contemplates various branches of the same importance:

1. The comparative study of the psychological processes in different species and the particular way in which they are organized, considering its ecological environment and its sociocultural environment; this last one in the case of man. The identification of comparative processes for different or all species, as well as the processes exclusive for only some or one species (once again in the case of man), is not only of primary importance for the external validation of the general behavior theory, but also it constitutes a multidisciplinary field that is exceptionally rich among psychology, human prehistory and paleontology, and evolution biology. The evolution of the psychological functions is an ontogenetic nature process. However, it cannot be separated from phylogenetic evolution and how from the diverse evolutionary convergences and divergences, emerged species sharing or distributing different biological potencies and functions, that depending on ecological and habitat demands, supported the surge of different forms of functional organization of psychological behavior. The same can be applied in the case of man to its evolution from superior primates and the progressive creation of coexistence social environments of increasing organizational complexity. Even though, psychological behavior does not have phylogeny in a strict sense, nor is a direct function of sociocultural variables, its evolution (still inconclusive, I believe) can´t be understood without understanding biological evolution and the history of social formations.

2. The comparative study of a same kind of behavior in different species leads to the inevitable formulation of behavior comparability criteria. The criteria that can be used to compare the behavior of different species are diverse. However, the fundamental matter consists of what is compared: the kind of behavior, the type of apparatus or experimental preparation, habitat characteristics, involves biological function, utilized stimuli characteristics, respective consummatory responses, behavior functional organization types, significance of behavior as a

species pattern, underlying processes, and more others. In the case of psychology, the object of fundamental interest is the complex evolutionary interaction among effective behavior for survival, reactive structure of the organism, ecological contingencies, and progressive modifications of the species' biology. It must not be forgotten that the natural selection proposed by Darwin is not the reason, but the result of evolution, and that species, like population of special organisms, represent ultimately groups of individuals that interact in an ecological niche with its cospecific individuals, as well as individuals of other species and with the variations of the distinct components that integrate its ecological niche. This was the historic motive of the first studies on animal intelligence, that prompted what was later denominated learning theories; and

3. The comparative study of the stages of psychological development in different species, and of a same species in different niches, this last one is an equivalent of the comparative studies of the human psychological development in different cultures. The analysis of the behavior development and its processes involves a longitudinal methodology with the individual as the point of observation with regard to the progressive contingencies of a specific environment; in the human case, a determined cultural group, while in animals, the environment is defined in terms of specific ecological niches. The comparative study of behavior development does not only consist of the establishment of parallelisms between different species and niches regarding the sequence of "stages," "cycles," or "moments," and its terminal stages, but it allows the transversal analysis of a same condition or circumstance of development in different species and niches. This transversal analysis can include both ethological studies and restricted observational studies, as well as experimental studies. Regrettably, the potential richness of these analyses has not been explored.

Controlled Study of Behavioral Processes: The psychological behavior is the function of a diversity of factors, among those individual interactive history itself, environmental contingency complexity, criteria or demands of adjustment of the environment stand out as, well as different types of situational and organismic variables, many of them of difficult or impossible practical manipulation. In the case of human beings, for obvious reasons, it is not possible to study behavior under rigorous experimental conditions; where conditions and circumstances that are guarantors of humans' rights consecrated by different laws are restricted, nor carrying out prolonged observational studies, both due to reasons of the privacy of the observed as the complexity itself of the situations that take place in human interactions.

What is possible to study in animal behavior that informs us about human behavior? To the degree that the psychological behavior is a result of biological evolution and the means that facilitate, support and stimulate it, the relevance of the investigation of animal behavior for a better understanding of human behavior becomes clear. Firstly, the investigation on animals allows us to experimentally study, under restriction conditions, the psychological processes that we humans and sub-humans share, without the limitations already mentioned that legislations impose and, considering, some recent safeguard and proper treatment of the animal species regulations (environmental and movement restrictions, excessive effort demands, water, food, aversive stimuli, drug management, chronic preparations, isolation, and more others). Secondly, said investigation not only facilitates a more rigorously and parametrically analysis of the variables involved in basic behavior processes, but also allows to distinguish the organization differences of said processes among different species and man, given the prevalence of the social and cultural environment in this last case and the central role that language plays as much as a reactive system, as a component of psychological interactions, and as an inherent functional part of all objects and contingencies in the environment. Thirdly, relevant functional stories can be "built" to evaluate the effect of the experience in different types of situations. Finally, complex life environments can be designed in which it is possible to systematically experience and observe the processes that regulate the behavior.

Formative and Logic Value of the Research with Animals: Animal behavior research has an added value in its formative impact on those scholars who study behavior in general. Three important contributions can be underlined in this aspect:

Firstly, research with animals –even though not always successfully given the anthropomorphic theories currently in vogue– develops explanations that are not based on casual internal fictions of various kinds: estimations and calculations, complex associations, representations, codifications, and more others. As Morgan's Canon obliges to look for the simplest and most logically elegant interpretation of the phenomena, the experts in behavior study, generally notice the vagueness and ambiguity of the explanations based on colloquial attributions of the everyday speech, normally utilized in everyday life but without a technical meaning. Conversely, the use of concepts and explanations that have a technical nature and that are oriented to functional, parametric, and abstract analysis of the phenomena observed as a product of manipulations, observations, and meticulous registers, are promoted.

Secondly, the animal behavior scholar, as he has to justify and design special experimental preparations, is obliged to have consistency regarding the theorical concepts that direct his examination, the characteristics of the employed experimental situation, the nature of the registers and data to be considered, and the way in which they will be interpreted. The ad hoc and a posteriori interpretations are thinly appreciated, and people learn to gradually discard the hermeneutic modus operandi that is so well received by most psychologists. People learn that what is easy is not necessarily what is right.

Finally, and in accordance with what has previously been said, the questions that guide the study of animal behavior, apart from being governed by the prudence of the processes that can be deduced from the observed phenomena, have to be coherent with the theorical criteria that establish how said processes can be related to the most complex phenomena that are characteristic of human behavior. This necessity of logic coherence between the different levels of behavior explanation obliges the placement of what is studied in the framework of a general phenomena field, preventing to a certain degree the tendency to the compartmentalization of the phenomena and research fields, and the theorical fragmentation of psychology.

Design of Experimental Models : The animal behavior research has a wide utility in the multidisciplinary and interdisciplinary collaboration field. In both cases, experimental preparations based on the knowledge on behavioral processes in animals can be designed, in order to use them as models for the study of phenomena of theoretical interest or applied for other disciplines.

An experimental model consists on an analogue of a phenomenon or general condition that will be experimentally evaluated in a systematic way. There are no experimental models for only a few studies and, in that case, it means that the model in question resulted inadequate for the goals that were set. As a model constitutes an analogue under controlled observation, manipulation, and variable register conditions, it requires satisfying two criteria. The first deals with the ecological validity of the experimental preparation; that is to say, such preparation must contemplate the circumstances and variables that define a determined phenomenon. For example, if a person intends to develop an experimental model of food search in a given species, the functional characteristics that define said phenomenon must be included, like the number of individuals of the same species that compete, or that search for, the food, the presence or absence of predators, the food diversity that make up the diet of said species, the spatial properties of the respective habitat, the nutrition cycles, spatial and temporal availability of the food and more others. If these aspects are not taken into consideration, the model stops being a valid analogue of the phenomenon and it can excessively simplify the studied condition. The second criterion has to do with the selection of variables and parameters to be evaluated systematically and, in a way that in this case, the behavior theory can interpret the individual processes that underlie the phenomenon under analysis.

The experimental models using animal behavior can be useful in the study of ethological and ecological phenomena, of correlations between physiological systems (specially of the nervous system, but not exclusively) and the behavior of clinical alterations, pharmacological evaluation and additions, both in evolutionary biology and psychology, parasocial behavior in animals, and prelinguistic and paralinguistic behavior in animals' studies. In all of these cases, the experimental theory and methodology of psychology can contribute with relevant experimental preparations for the study of phenomena of other disciplines or professions, that constitute the essence of the multidisciplinary and interdisciplinary collaboration.

Systematic and Heuristic Value of Animal Research: The main goal of scientific research is the understanding of natural and social phenomena from two perspectives: systematical and heuristic . In both cases, animal behavior research is of essential importance in the continuous process of construction of a general behavior theory.

The scientific theory advances as it is able to classify, associate and, in this way, explain all those phenomena that make up a part of its study field. Said task is done based on a coherent logic that allows distinguishing or identifying those phenomena in terms of properties and functions detached by the theory. From this perspective, a theory is more robust and powerful as it can consider a larger amount of phenomena, distinguish their properties, associate and explain them through one categorical logic. This is the systematic function of the scientific theory, that includes both the classification and the explanation of the phenomena. Animal research puts to the test the logic of any general theory regarding the categorical location of the different types of data obtained and its relationship with the obtained with humans. In that measure, a general theory of the behavior must have categories in place that can logically locate the observed processes in animals and humans and establish the comparability, equivalence and divergence criteria.

Moreover, the heuristic function of the scientific theory has to do with the observability horizon that its analysis logic opens to the empirical examination. This observability horizon is not detached from the experimental and data and phenomena representation possibilities that support and allow the research of animal behavior and investigation with animals and, in that measure, it is also related with the systematizing power of its categories. In science, every observation is an observation that is theorically determined. For this reason, the facts to observe are those that a theory contemplates from its logic. The narrower (and undifferentiated) this logic is, the less will be able to be "seen" with said theory. The theories that include animal research as a legitimate domain of observation in turn raise the relationship criteria of the animal behavior measures with those of human behavior. The possibility of observing and representing new functional relationships from the observed ones in animal behavior is a heuristic addition that only the theories that contemplate animal research as a necessary part of its investigative doing possess. Paraphrasing the English philosopher J. L. Austin "Animal behavior research is not the end but the beginning."

4.2.4. Text 4.

Foundry Industries: Environmental Aspects and Environmental Condition Indicators

By: B.S. Sosa, R.B. Banda-Noriega and E.M. Guerrero

1. Introduction: The rapid economic and industrial growth of the last decades has brought serious environmental pollution problems with it, like air, water, and soil pollution. Meanwhile, the demands and controls regarding the activity/environment relation, by audit organizations, have promoted the creation of tools that are of use for the evaluation of the environment status. The environmental indicators are an example of it.

The antecedents in the use of environmental condition indicators (ECI) correlate, generally, with large scale companies that possess an environmental management system (EMS), and evaluation of the environmental performance according to ISO 14031. ISO 14032 exemplifies the development of ECI internationally (like the case of Iran Khodro Co, Iranian car factories), where companies residing in Argentina are located, like Alvher Containers, Dinan Industrial Division S.A., laminated flexible container, YPF Lujan de Cuyo Refinery, a multinational petroleum company refinery and Cuyo S. A. I. C. Petrochemistry [1].

Regarding the foundry industries specifically (much less in the scale that is considered SME), there are no ECI antecedents, but environmental sustainability indicators are found. The "Worldsteel Sustainability Indicator Methodology" project defines and calculates a methodology for sustainability indicators of iron and steel [2]. Nationwide, the Acindar Grupo Arcelor Mital company, in its Villa Constitution factory, has the environmental performance index implemented where, through environmental management indicators, emissions to the atmosphere are controlled, the liquid effluent pollution and the production of residue are evaluated[3].

Regarding the environment status conditions, the available information is referred to as " environment status reports" in matters that are related to global issues and monitoring indicators (I.e. greenhouse gas concentration), but they are nor associated with and/ or determined by an activity in particular (see I.e. the Latin American and Caribbean Initiative for Sustainable Development[4]; Latin America and Caribbean GEO[5]; First Compendium of Environmental Statistics, Argentinian Republic[6]).

While the enterprise/environment relation has characteristics that are individual for each place where it is developed, there are environmental aspects that can be recovered and generalized for a particular activity. In this way, developing tools capable of preventing environmental problems resulting from the interaction that is element of the activity/environment is of interest. The access difficulty to research antecedents that develop environmental performance indicators in foundry industries and the absence of the ECI that make up part of this group even more, gives motive to its construction in this research and constitutes the objective of the current project. It is expected then that these tools allow for the carrying out of monitoring and control of the environment status in the foundry setting.

It is briefly brought forward that (there is a methodological section specific for it) the methodological decisions carried out for the ECI selection are based on relevant criteria; that is to say, of relevance of the indicator for the problems or decisions in which the use and relation that these have with specific regulations that exist in the country or that in other territorial scales is required, which situates it in state of affairs in public politics and citizen information terms.

2. Description of the Study Area: The industrialization process from the spatial point of view in Argentina, was produced differentially and in relation with certain localization factors like means of transport, raw material localization, the market, energy sources, infrastructure, and of course, tax facilities of each place[7].

In the Tandil city, from the1920s and until the first decade of the XXI century, the metal industries and the foundry ones specifically have been economic growth and job generating motors[8]. This parallel process of industrial and urban development, somewhat disorganized, has generated that with the pass of time industries were left immersed in urban and peri-urban areas (Fig. 1).

According to current local and provincial regulation (Municipal Ordinance Nº 9865/05, Municipal Decree Nº 3085/07, Provincial Law Decree Nº 11.459/93, Provincial Decree Nº 8912/77, Provincial Regulatory Decree Nº 1741/96), the foundry industries are localized in the general regulation areas. That is to say, they are located in sectors with homogeneous characteristics regarding its socioeconomic, scenic, and environmental aspects, regarding the uses and land occupancy, the urban-architectural heritage and, particularly, in the role they play in the general structuring and the functional dynamic of the territorial space of Tandil. In said area, the establishment of industries of second (Law 11.459, Art 15 section "b") and third (Law 11.459, Art 15 section "c") category, even though the foundry industries, by the characteristics that they bring together, belong to these categories[8].

Previous studies describe foundries according to their productive, operative, and environmental conditions. Of the existing 30 industries, 80% are dedicated to the production of pieces of only one type of material. The remaining 20% is distributed between foundries of Al/Fe, AL/Fe/Cu+Sn (bronze), and Al/Cu+Sn. From the 80%, the 60% is dedicated to iron and its alloys, and the 40% to aluminum. According to estimations corresponding to 2010, the production in tons (t) of molten pieces in this locality rises to 3.011 t per month, of which 2.978,5 t correspond to gray iron and iron alloys, 30,5 t constitute aluminum and 2 t belong to bronze[9]; it should be emphasized that only one industry concentrates 80% of the monthly production.

Regarding the operative conditions, from the OCDE classification of 2001, which deals with the I+D intensities (it is calculated from two production measures: production value and value added), and of the ISIC Rev 3 (International Standard Industrial Classification) denominations and codes, Argentina identifies the base metal manufacturing industry as of medium low technology[10]. Local studies also indicate that these industries are mostly small in size (according to the number of employees by company), being the operative and of compliance conditions with current legislation worrying regarding the control of the effluents[9].

In this sense, the environmental conditions indicate problems like lack of chimneys or gaseous effluent treatments that worsen with the, still significant, use of cupola furnaces in enterprises that found gray iron. The furnaces that found aluminum (crucible and reverberatory) generally possess fume hoods, with no treatment and with low height chimneys. In this activity, there are only chimneys to evacuate the gases captured in the work environment, disregarding regulatory obligations (Table I).

With the exception of sanitary effluents, the volume of industrial wastewater of the foundries is less significant. The main problem may be due to the contact of runoff water with foundry, slag, mud, ash, and other waste raw materials[11]. Twenty-one industries spill the liquid effluents of the process to the sanitary sewage system. Two of them are excluded from this service and dispose of the wastewater in absorbent wells, and another seven remain in the Tandil

Industrial Park (PIT) which infrastructure has a drainage channel (from 1970) that serves for all the companies in the park and releases water below in the Langueyú stream. However, as it will be mentioned, most of these industries are located in areas with a sewage system which would not present a significant environmental problem if it is considered that the collected water by said system is treated afterwards.

According to what has been presented, it is necessary to address the soil use incompatibility situations and environmental issues of the emissions that the activity generates.

3. Typical Environmental Processes and Aspects in Foundry Industries: Foundry industries are establishments that obtain, as a result of their process, pieces of metal that could not be produced by forging lamination or welding processes. The processes that are carried out in every foundry present variants that depend on the type of metal to melt (foundry of ferrous metals like gray iron, nodular iron, non-ferrous steel like aluminum, bronze, copper, zinc, lead and nickel among others), from the applied methods and technologies.

The different methods for the obtention of the pieces will depend on the type of piece and quantity to be produced. The stages generally involve material manipulation and storage, mold and puller manufacturing, metal founding, casting, and cleaning of castings. Consecutively (Table II), the stages that are implemented in the foundry field and the associated environmental aspects are presented. Environmental aspect is understood as any element of the activity that is able to interact with the environment and produce an impact[12].

According to the environmental aspects identified in the different stages of the process, ECIs are mainly related with the gaseous emissions (particulate matter and other atmospheric contaminants) and with solid residue, mainly waste sand and slag. Taking into account factors like the current technologies of foundry furnaces that exceed the old technologies that had a significant water use, similarly the size, medium to small, of the foundry industries of the study area, the access of most to the sanitary sewage system and the production of negligible volumes of liquid effluents (see section 2), these effluents are considered an aspect of little relevance for the activity. However, the water resource will be addressed the same way, since a risk of pollution to the underground water resource is identified due to the disposal of foundry sand residue in diggings originated by the granite extraction and currently abandoned, characteristics of this study area.

Other environmental aspects to take into account in this activity, with secondary importance, are the production of diffuse emissions, smells, and smoke that cause inconveniences of various kinds (smell during foundry hours, degradation of the neighbor construction fronts by smoke and particulate matter emission, specially by gray iron foundry in cupola furnaces) and the noise that originates from the factory operating, from the mobility of vehicles for loading and unloading materials, waste and castings.

4. Methodology: The area under investigation comprised the total of foundry industries of the Tandil city, involving 30 establishments identified during the survey carried out in the March-April 2010 period. It must be emphasized here that the possibility that undeclared establishments operate in housing funds or sheds without authorization exists.

The group subjected to analysis was defined by the five types of existing productive processes in the study area that correspond to the following metals: aluminum (Al), aluminum/iron (Al/Fe), aluminum/bronze (Al/Cu+Sn), aluminum/iron/bronze (Al /Fe /Cu+Sn), iron (Fe). The methodological steps followed in the construction of the indicators are taken and adapted from the methodology proposed by Jane Barr (2006)[8 y 15], where: a) the interaction points between the environment and the activity are identified, for which a bibliographical review was carried out,

obtaining the environmental aspects complied in Table II; b) the affected environmental factors are described; primary topics were identified regarding local environmental problems and the activity in question about the basis of interviews to qualified informants from the Environmental Management System of the Environment Management of the Tandil Municipality from the private sector and the specific bibliography about the environment natural conditions, and c) condition indicators are built for said factors[15 and 16]. In this last step, apart from meeting the common criteria to every indicator (availability of statistical information of quality, simplicity, precision and clarity, internal consistency of the methodological sheet, etc.) [16], elements like for whom it is destined to, what are the data sources and deficiencies considered, and its strength and weakness are evaluated. At the same time and with the goal of clarifying the descriptive fields that make the indicator even further, fields suggested by Quiroga Martínez (2009)[16] were enclosed for its development: indicator description, data periodicity (time period in which it is updated) and the indicator calculation formula.

The proposed environmental condition indicators are grouped according to the resource with affectation potential. This way, there are three ECI groups for the Tandil foundry industries: ECI for the air, soil, and water resource, by the order of importance.

The analytical framework for the indicator selection is based on the importance of the environmental aspect identified in the context of the environmental problems that the activity generates. Therefore, the selection criteria applied to each indicator answers to its relevance in the problems or decisions, in which said indicator is to be utilized and the relation it has with specific regulations that exist in the country or in other territorial scales, which situates it in state of affairs in public policies and citizen information[16]. In this sense, an adequate methodology for each particular case is utilized, which is clarified during project development.

5. Environmental Condition Indicators: Consecutively, ECI are developed for the air, soil, and water resource.

5.1. ECI for Environmental Aspects that Impact the Air Resource: In the construction of the indicators to be measured, people worked on the basis of the Technical Guides for the Measuring, Estimation, and Calculation of the Emissions to the Air, IHOBE [17-19]. In these technical documents, the contaminants that originate from the melting furnace are detailed using the type of furnace and raw material as variables, without the need of describing the capacity of the furnaces or the type of combustibles, among others. This method does not consider, for the estimation of emissions, the application of treatment systems of gaseous effluents, considering, in this way, the worst possible situation. Due to this, for this study, its application where most of the industries do not have treatment systems (see section 2), is appropriate. A table was generated where the data related with the local operative characteristics was compiled; that is to say, type of furnace (cupola, electric, reverberatory) and raw material (iron, aluminum and copper). The list of obtained contaminants was compared with the ones considered in the national (Provincial Law N° 5.965, Regulatory Decree N° 3.395/96, Resolution N° 242/97 [20]) and international (National Ambient Air Quality Standards (NAAQS) [21] and OMS 2005Air Quality Guides[22])) regulations that consider human health and care of material goods criteria. The creation of the guide levels of the environment air quality and of the guide levels of emission, that is to say, of the legal limits (obligatory and suggested) corresponding to atmospheric contaminants are based on these criteria. During the analysis, primary contaminants -those emitted by a source directly to the atmosphere without going through a chemical transformation from the moment they go out from its emission point- (SO_2, NO_x, CO, etc.) as well as secondary contaminants were considered, that is to say, those that once they have evolved in the environment and have reacted chemically or photochemically (formaldehyde).

In this context, ECIs are proposed for the case of foundries' gaseous effluent immission (Table III). The proposed frequency surges from the antecedents linked to monitoring and control programs of the local foundry industries approved by the application organization (OPDS) in the framework of the current provincial legislation: –Law 5965/58 of protection of the provision sources, courses and recipients of water and the atmosphere; Regulatory Decrees 3395/96; Resolution Nº 242/97; Complementary Decree 3395/96; Resolution Nº 279/96; Presentation of the Affidavit of Industrial Gaseous Effluents –.

5.2. ECI for Environmental Aspects that Impact the Soil Resource: The main generated solid wastes are the waste sand, slag, debris (swarfs and scraps), dust and sand retained in baghouses. In nonferrous foundries, dangerous and lead, copper, nickel, and zinc contaminated waste , frequently in total and extractible elevated concentrations, that mainly come from the slag, can be generated[5].

The waste sands are, in the general process and in solid waste in particular, one of the most abundant effluents generated by this activity and therefore an element that should be considered.

If we consider the generated waste sand tons regarding the produced tons of pieces , we found that in the iron and steel alloys, the relation is 1:1, while in the aluminum ones it is 4:1[11]. Based on these data, currently, in some place, there are around 2.978,5 t of waste sands per month that originate from ferrous foundries, and at least around 122 t of waste sands originating from nonferrous foundries.

In Tandil, the municipality has prohibited its disposition in the city landfill, arguing that there is lack of knowledge about if it is about special waste or not, just like the Provincial Law 11 720 of Special Waste and its Reglementary Decree 806/97 [23] establishes. Currently (and historically), foundry waste are deposited in quarry, brickyard, and lowland diggings, located inside or near the town center with no kind of control[24].

Similarly. an antecedent study has been able to locate a total of 39 ousted locations, of which 8 belong to current dispositions, 19 to places at a standstill and 7 to places with partial dispositions of foundry waste sands (RAF) [24] (Fig. 2).

Even though the control organisms and the foundry industries tend to consider these waste as special or dangerous, a large part of the available literature states that the RAFs are mainly non dangerous waste [25 y 26]. Local antecedents make evidence the need and importance of the phenol and heavy metals like cadmium, copper, chromium, lead, and zinc monitoring due to the use of phenolic resins [27]. As long as the values of these elements are below what is stipulated by the legislation (Decree 831/93 [28], EPA SW 846 1311 [29]), the RAFs can be considered as non-dangerous waste in the framework of the Dangerous Waste Law 24.051 [28]. Therefore, the ECIs that appear in Table IV are proposed.

CHAPTER V
DATA ANALYSIS

In this chapter, the analysis of the source texts, the translation process, and the target texts will be carried out. In order to do this, the elements that have been explained and exemplified in Chapter 2 will be considered for the analysis that will be carried out; in other words, the elements that will be analyzed are the ones that have been mentioned previously, and the analysis will be based on the information that has been provided. This chapter is essential for this thesis, since it explains what the student has done throughout in the translation process and the reasons why the student has done so. This chapter will also be essential for the understanding of all of the elements of this thesis.

5.1 Analysis and Interpretation of the Results

As it was mentioned previously, three instruments were selected in order to carry out the analysis of the source texts, the translation process, and the target texts: a text analysis table, a glossary, and a color coding system. These instruments will be presented in this chapter, as well as the description of each of them. The findings will be located below the corresponding instrument.

5.1.1. Text Analysis.

The first instrument that will be presented and detailed in this chapter is the text analysis table. This table presented the necessary information to analyze the source texts before the translation was carried out. The information that this table compiled was the title of the text, in order to easily identify the source text that was being analyzed; the text style, in order to identify how the authors presented the ideas in the text and how they linked those ideas together; the text function, in order to identify the intention of the authors and how they utilized the language to carry out their intentions; the scale of formality, in order to identify how the authors address the readers and the elements that they are writing about; the scale of generality and difficulty, in order to identify the type of vocabulary that is used in the texts; the emotional tone, in order to identify how the text can appear to the readers; and finally, an example of the final translation in order to exemplify how all of the previous elements influence the translation of the source text. The analysis table is the following.

Table 4.
Text Analysis Table

Text title	Text style	Text function	Scale of formality	Scale of generality or difficulty	Emotional tone	Example of the final translation
Impact of jaguar *Panthera onca* (Carnívora: Felidae) predation on marine turtle populations in Tortuguero, Caribbean coast of Costa Rica	Descriptive	Informative	Formal	Technical	Factual	La información que se obtuvo a través de la revisión de literatura no se utilizó debido a diferencias en las metodologías; sin embargo, se utilizó como referencia de registros históricos previos al año 2005.
Evaluating Management Strategies in the Conservation of the Critically Endangered Blue-Throated Macaw (Ara glaucogularis)	Descriptive	Informative	Formal	Technical	Factual	Los guacamayos son el grupo que está en más peligro de extinción de la familia Psittacidae; por lo tanto se cuenta como una especie extinta, tres en grave peligro de extinción.
Reproductive Parameters in the	Descriptive	Informative	Formal	Technical	Factual	Asimismo, se identificaron

Critically Endangered Blue-Throated Macaw: Limits to the Recovery of a Parrot under Intensive Management						algunos individuos al fotografiar sus tractos de plumas faciales distintivas (permitiendo la confirmación de fidelidad del lugar).
Conservation in Human-Dominated Landscapes: Lessons from the Distribution of the Central American Squirrel Monkey	Descriptive	Vocative	Formal	Technical	Warm	Dejar a un lado las áreas protegidas y corredores biológicos, apoyar a los terratenientes locales para mantener el hábitat a través de incentivas de conservación, la reintroducción de especies meta en hábitats adecuados y desarrollar actividades económicas como el ecoturismo para incentivar a las personas locales para proteger los bosques, deberían ser métodos para promover su conservación a largo plazo… .
Is Ecotourism an Inexhaustible Source of Wealth? Recommendations for its Sustainability	Descriptive	Vocative	Neutral	Neutral	Warm	These contradictions between theoretical ecotourism and its real implementation should be adequately taken into

						account, be evaluated, and corrected, since it could come a time where Costa Rica's image be damaged and lose its fundamental value of environmental paradise.
Ethical and Environmental Considerations in the Process of Ocean Acidification	Discussion	Vocative	Formal	Technical	Warm	Those responsible for environmental protection must monitor the use of the environment to guarantee that current and future generations can enjoy it, but from this perspective, who is responsible for environmental protection?
Why Is It Necessary to Study Animal Behavior?	Discussion	Vocative	Formal	Technical	Warm	The evolution of the nervous tissue itself, from the ganglions to the complex structure that it presents in hominids, is the result of a subtle interaction with the differentiation of reactive systems (sensory and motor, mainly) and the survival contingencies

						and the corresponding ecological niche adjustment.
Foundry Industries: Environmental Aspects and Environmental Condition Indicators	Descriptive	Informative	Formal	Technical	Factual	According to estimations corresponding to 2010, the production in tons (t) of molten pieces in this locality rises to 3.011 t per month, of which 2.978,5 t correspond to gray iron and iron alloys, 30,5 t constitute aluminum and 2 t belong to bronze… .

Note: Table 4 presents the first completed instrument Source: The researcher's own creation.

The first texts that will be analyzed are the texts that have been translated from English to Spanish.

Due to the format and academic field of the first three documents(*Impact of Jaguar Panthera Onca (Carnívora: Felidae) Predation on Marine Turtle Populations in Tortuguero, Caribbean Coast of Costa Rica*; *Evaluating Management Strategies in the Conservation of the Critically Endangered Blue-Throated Macaw (Ara Glaucogularis)*; and *Reproductive Parameters in the Critically Endangered Blue-Throated Macaw: Limits to the Recovery of a Parrot under Intensive Management*), the characteristics of each of them are the same. Their text style is descriptive; their text function is informative; their scale of formality is formal; their scale of generality or difficulty is technical, and their emotional tone is factual.

From that information, it can be said that the texts mainly describe the study that was carried out as well as its processes. For example, in the excerpt from one target text, the authors describe in detail where they obtained the information for the study: “La información que se obtuvo a través de la revisión de literatura no se utilizó debido a diferencias en las metodologías; sin embargo, se utilizó como referencia de registros históricos previos al año 2005.”

The function of the texts is only to inform the reader about the topics of the documents. In one of the excerpts from one of the target texts, it can be evidenced that the text is providing background information about the topic that will be discussed: “Los guacamayos son el grupo que está en más peligro de extinción de la familia Psittacidae; por lo tanto se cuenta como una especie extinta, tres en grave peligro de extinción.”

Since the texts are scientific articles, the way in which they address the topics is accurate and direct without redundancies. For example, in one of the excerpts from one of the target texts the authors mentioned the process that was followed in the study and what allowed them to do it without adding unnecesary information: “Asimismo, se identificaron algunos individuos al fotografiar sus tractos de plumas faciales distintivas (permitiendo la confirmación de fidelidad del lugar).”

The texts are directed to scientists, biologists, students of those fields or people who are interested in those topics. For that reason, the vocabulary that is utilized in the texts is scientific and technical. That means that while there are simpler and more colloquial terms for several terms in the texts, they are not used because the text is intended for people who understand the scientific terms. For example, in one of the excerpts from one of the target texts, the authors mentioned the Psittacidae family, which was translated as the scientific name “Psittacidae”, but it could have also been translated as “la familia de los pericos”, which is a more colloquial term for the word.

Finally, it can be evidenced that the information that is given is completely objective and based on facts from scientific studies. That means that the authors are not giving their personal opinions on the matter. For example, in of the excerpts from the target texts, it can be evidenced that the authors used historical data as reference because the literary information that was found did not coincide with each other and not because the authors themselves thought it was not sufficient or because they did not agree with it: “La información que se obtuvo a través de la revisión de literatura no se utilizó debido a diferencias en las metodologías; sin embargo, se utilizó como referencia de registros históricos previos al año 2005.”

All of these elements can be evidenced in the translation of the texts. It can be evidenced that these elements were transmitted to the target texts.

The fourth text (Conservation in Human-Dominated Landscapes: Lessons from the Distribution of the Central American Squirrel Monkey) is also a scientific document; however, it presented two different characteristics from the other texts. Its text style is descriptive; its text function is vocative; its scale of formality is formal; its scale of generality or difficulty is technical, and its emotional tone is warm. From that information the following characteristics were able to be identified.

This text also shares some of the characteristics from the previous texts because it is also a scientific text; that means that the text mainly describes the study that has been carried out and all of its elements. The way in which the authors address the topics is accurate and straightforward. Also, the vocabulary that is used in the text is scientific and technical because it is directed to scientists, biologists, students of those fields, or people who are interested in those topics.

The characteristics that differ from the other texts are the text function and the emotional tone. The first characteristic that differs from the other texts is the text function. While this text does inform the reader about the topic, the study and its processes, it also states that certain measures should be implemented, and provides the information in order to support those statements. In doing this, the text compels the reader to accept that those measures should be implemented. In other words, the text has the intention of making the reader think in a certain way. This can be evidenced in the exerpt from the target text: "Dejar a un lado las áreas protegidas y corredores biológicos, apoyar a los terratenientes locales para mantener el hábitat a través de incentivas de conservación, la reintroducción de especies meta en hábitats adecuados y desarrollar actividades económicas como el ecoturismo para incentivar a las personas locales para proteger los bosques, deberían ser métodos para promover su conservación a largo plazo… ."

The second characteristic that differs from the other texts is the emotional tone. In spite of the fact that this text provides several references for the information of the study, this text cannot be classified as having a factual emotional tone due to its vocative characteristic because it means that the text is not objective. For example, when the authors write that certain measures should be implemented, they are expressing their personal opinion on the matter. It should also be mentioned that despite of the fact that the text might try to convince its readers about a certain topic, the context of the text remains courteous and cordial.

Now that the texts from English to Spanish have been analyzed, the analysis of the texts from Spanish to English will be carried out. Most of these texts deal with environmental topics and only one of them presents biological topics like the other texts.

The first text that was translated from Spanish to English (Is Ecotourism an Inexhaustible Source of Wealth? Recommendations for its Sustainability) presents the following characteristics. Its text style is descriptive; its text function is vocative; its scale of formality is neutral; its scale of generality or difficulty is neutral; and, its emotional tone is warm. From that information, the following aspects were identified, and will be explained below.

This text describes the topic of the document, all of its aspects, and even aspects related to them.

In spite of the fact that the text does provide a lot of factual information to the readers, its function is to convince the reader that ecotourism is an excellent alternative and how to enhance its potential, so all of the information that is provided supports the approach of the authors. This can also be evidenced in the excerpt of the text in which the authors suggest that certain elements should be taken into account: “These contradictions between theoretical ecotourism and its real implementation should be adequately taken into account, be evaluated, and corrected, since it could come a time where Costa Rica’s image be damaged and lose its fundamental value of environmental paradise.”

Unlike the rest of the texts that were translated, this text addresses its topics in a simpler way. For that reason, the text appears to be less formal than the scientific documents. For instance, in the example that was provided from the target text, the authors mention Costa Rica’s image, a very simple term which could appear as “the depiction of Costa Rica” or “the representation of Costa Rica” if the scale of formality were formal. In addition to that, this text provides additional information about the topic and topics related to it. For example, even though the text is about ecotourism and its benefits, it also provides background information about the history of the career in Costa Rica and where it can be studied in different countries.

Also, in contrast to the other texts, the vocabulary that is used in this text is not specialized. The vocabulary is basic and can be understood by someone who has no prior knowledge about ecotourism. The text does use terms that are not common in the everyday vocabulary like “beach tourism” and “ecotourism cluster”, but the words can be easily understood in the context. For that reason, it can be said that this text is intended for any person that is interested in the topic. Finally, like the previous text, the emotional tone of it is warm, since the text is not completely objective and its context appears cordial and courteous to the readers.

The following two texts (*Ethical and Environmental Considerations in the Process of Ocean Acidification* and *Why is it Necessary to Study Animal Behavior?*) present the same characteristics. Their text style is a discussion; their text function is vocative; their scale of formality is formal; their scale of generality or difficulty is technical; and their emotional tone is warm. That information indicates the aspects that will be explained below.

These particular texts deal with various abstract topics regarding philosophy and science. For that reason the texts go into detail about those topics and their connotations. That makes the texts more argumentative, where the reader requires to consider what is being written and their own thoughts as well instead of just taking in the information that is being provided like with the descriptive texts. This can be evidenced in this excerpt from one of the texts: “Those responsible for environmental protection must monitor the use of the environment to guarantee that current and future generations can enjoy it, but from this perspective, who is responsible for environmental protection?” Unlike the previous texts, this text does not describe in detail any of the concepts or actions that are mentioned. In addition, the text provides a rhetorical question for the reader, which makes him/her consider his/her own opinions on the matter.

The function of these texts is to convince the reader of the topic or idea that is being presented in the texts. The authors also provide references and information about these topics, but the reason for being there is to support the authors' claims in order for the text to be more convincing to the readers. In addition to that, in the same excerpt that was provided for the previous category: "Those responsible for environmental protection must monitor the use of the environment to guarantee that current and future generations can enjoy it, but from this perspective, who is responsible for environmental protection?", it can also be evidenced that the authors also mention that environmental protection must monitor the use of the environment. That information is not an actual fact, but rather it is a personal opinion. That means that the authors are imposing a certain idea to the readers to a certain degree.

Since these texts can also be considered as scientific, due to the factual information that they provide and their readership, the way in which the authors address the topics discussed in the texts is serious and professional, and does not provide additional information that is not relevant for the discussion. Due to the philosophical focus of these texts, the authors do provide various examples for what they mention, but, as it has been mentioned, those examples prove to be necessary to clarify what the authors have mentioned. This can be evidenced in this excerpt from one of the texts: "In this respect, some people could presume that by a divine mandate, "civilized" man is lord and master of everything around him and has made humankind believe that it can do as it pleases with the environment."

Due to the fact that these texts are scientific in nature, it can be said that the intended audience for these texts are ecologists, biologists, or professionals from these fields of study. Therefore, the vocabulary that is utilized in this text is technical and scientific. Due to this, a person who has no knowledge on the topics that are discussed in these texts would not be able to follow the meaning of it. This can be evidenced in one of the excerpts that was provided, since they present the concepts “nervous tissue” and “ganglions”, which are strictly scientific terms.

Finally, as it is with the case of the other texts with a warm emotional tone, the context of the texts remains cordial and courteous. As it has been stated before, in spite of the fact that these texts provide factual information, these texts cannot be considered as factual since the authors are expressing their personal beliefs among the factual information; however, they remain cordial and formal since they are scientific texts.

The final document (*Foundry Industries: Environmental Aspects and Environmental Condition Indicators*) is very similar to the previous biological texts translated from English to Spanish. That is, it strictly presents scientific factual information and does not present subjective information. Its text style is descriptive; its text function is informative; its scale of formality is formal; its scale of generality or difficulty is technical; and, its emotional tone is factual. From those characteristics, it can be said that the text describes in detail the study that was carried out as well as its aspects. This can be evidenced in the excerpt from the text where the authors describe the information that was retrieved: “According to estimations corresponding to 2010, the production in tons (t) of molten pieces in this locality rises to 3.011 t per month, of which 2.978,5 t correspond to gray iron and iron alloys, 30,5 t constitute aluminum and 2 t belong to bronze”

It can also be said that the intention of the authors is solely to inform the readers about the study that was carried out, since the text only provides academic references and the details of the study.

In addition to that, the way in which the authors address the topics in the text is professional and straightforward. For example, “correspondientes al año 2010” was translated as corresponding to 2010. If the scale of formality were neutral, this phrase would have been translated as “of 2010” or just “2010” (used as an adjective).

Moreover, the vocabulary that is used in the text is technical since the intended audience are professionals of the academic field of the study. For example, the text presents the terms “cupola” and “reverberatory”, which are terms that only professionals in the field are able to identify.

Finally, the context of the text is objective since the authors do not express their personal opinions on the subject of the study.

5.1.2. Color Coding System.

The second instrument that will be presented and clarified is the color coding system. The texts that are presented and highlighted in the system will be taken from the target texts. The elements that will be highlighted are the texts in which a specific translation procedure has been applied in order to be translated. In addition, if two or more procedures have been applied in a phrase, the words of the phrase will be highlighted with different colors, and the text will be underlined with the corresponding color. This will make it possible to analyze the procedures used and why. Besides, the different colors in the system will also help to identify the translation procedures that have been utilized. The following table presents the colors that will signal the different translation procedures.

Table 5.
Color Coding System Corresponding Colors Table

Translation Procedure	Corresponding Color
Transposition	
Modulation	
Omission	

Amplification	
Explicitation	
Literal Translation	
Punctuation Changes	
Compensation	
Equivalence	
Adaptation	
Borrowing	
Calque	
Sentence Inversion	

Note: Table 3 shows the second data collection instrument that will be developed in this thesis for the text analysis. Source: The researcher's own creation.

5.1.2.1. Texts from English to Spanish.

Excerpt 1 from *Efecto de la depredación por jaguares, Panthera onca (Carnívora: Felidae), sobre las poblaciones de tortugas marinas de Tortuguero, costa caribeña de Costa Rica*

"Heithaus et al. (2008) suggested that predators of adult marine turtles can influence turtle population sizes in spite of low predation rates. Pitman and Dutton (2004) also indicated that even opportunistic predation by killer whales *(Orcinus orca)* should be considered a factor in recovery efforts for the leatherback *(Der-mochelys coriacea)* population in the Northeast Pacific. In turn, Fergusson, Compagno and Marks (2000) mentioned that the impact of white shark *(Carcharodon carcharias)* predation upon marine turtle populations in the Mediterranean sea is unknown but probably extremely small compared to other sources of mortality (e.g. anthropogenic causes). Ortiz, Plotkin and Owens (1997) indicated that American crocodile *(Crocodylus acutus)* predation on the olive ridley sea turtles *(Lepidochelys olivacea)* have little or no effect on the nesting population at Playa Nancite in Costa Rica."

Heithaus et al. (2008) plantearon que los depredadores de tortugas marinas adultas pueden influenciar los tamaños de dichas poblaciones, a pesar de los bajos índices de depredación. Pitman y Dutton (2004) indicaron que, incluso, la depredación oportunista por parte de las orcas (*Orcinus orca*) debería ser considerada como un factor en los esfuerzos de recuperación para la población de tortugas baula (*Der-mochelys coriacea*) en el Pacífico nororiental. A su vez, Fergusson, Compagno y Marks (2000) mencionaron que el impacto de la depredación por el tiburón blanco (*Carcharodon carcharias*) en las poblaciones de tortugas marinas en el mar Mediterráneo es desconocida, pero es probable que sea extremadamente pequeña comparada con otras fuentes de mortalidad (p. ej. causas antropogénicas). Ortiz, Plotkin y Owens (1997) indicaron que la depredación por parte del cocodrilo americano (*Crocodylus acutus*) en las tortugas marinas lora (*Lepidochelys olivacea*) tiene poco o ningún efecto en la población anidadora en Playa Nancite en Costa Rica.

Excerpt 2 from *Efecto de la depredación por jaguares, Panthera onca (Carnívora: Felidae), sobre las poblaciones de tortugas marinas de Tortuguero, costa caribeña de Costa Rica*

"However, in recent years this predator-prey interaction has drawn attention in Tortuguero National Park, Costa Rica (Verissimo, Jones, Chaverri, & Meyer, 2012; Barca, 2013; Arroyo-Arce, Guilder, & Salom-Perez, 2014). Troeng (2000a) mentioned that the green turtle *(Chelonia mydas)* population that nests in Tortuguero is not significantly threatened by jaguar predation. Contrary to this, Verissimo et al. (2012) indicated that jaguars should rank alongside, if not higher than, other documented threats. In this paper, we evaluated the impact of jaguar predation on three species of marine turtles *(C. mydas, D. coriacea, Eretmochelys imbricata)* that nest in Tortuguero beach. We also discuss how the availability of marine turtles may be affecting the local jaguar population."

Sin embargo, en los últimos años, esta interacción de depredador y presa ha llamado la atención en el Parque Nacional Tortuguero, Costa Rica (Verissimo, Jones, Chaverri, y; Meyer, 2012; Barca, 2013; Arroyo-Arce, Guilder, y; Salom-Pérez, 2014). Troeng (2000a) mencionó que la población de tortugas verdes (*Chelonia mydas*) que se anida en Tortuguero no se ve amenazada de manera significativa por la depredación por parte de los jaguares. Por el contrario, Verissimo et al. (2012) indicaron que los jaguares deberían ser clasificados junto a, o más alto que, otras amenazas documentadas. En este trabajo, se evalúa el impacto de la depredación por el jaguar en otras tres especies de tortugas marinas *(C. mydas, D. coriacea, Eretmochelys imbricata)* que se anidan en la Playa Tortuguero. También se analiza cómo la disponibilidad de las tortugas marinas podría estar afectando la población local de los jaguares.

Excerpt 3 from *Efecto de la depredación por jaguares, Panthera onca (Carnívora: Felidae), sobre las poblaciones de tortugas marinas de Tortuguero, costa caribeña de Costa Rica*

"Surveys consisted of recording data on presence or absence of jaguars by counting identifiable jaguar tracks on each sampling unit. Predated marine turtles by jaguars (hereafter known as kills) were also recorded by counting marine turtle carcasses on each sampling unit. When a carcass was found it was examined for evidence of jaguar predation (e.g. bite marks on the neck, drag marks, jaguar tracks). It is important to highlight that the jaguar is the only felid recorded in Tortuguero beach that predate marine turtles. If it was determined to be the result of jaguar predation the marine turtle species was recorded. In order to avoid duplication of carcasses only green turtles that were estimated to have being killed in less than seven days were recorded."

Los estudios consistieron en registrar datos acerca de la presencia o ausencia de jaguares al encontrar huellas identificables de jaguares en cada unidad de muestreo. Las tortugas marinas que fueron depredadas por jaguares (de aquí en adelante conocidas como cazas) también se registraron al contar las carcasas de tortugas marinas en cada unidad de muestreo. Cuando se encontraba una carcasa, esta se examinaba en busca de evidencia de depredación por jaguar (p. ej. mordeduras en el cuello, marcas de arrastre, huellas de jaguar). Es importante señalar que el jaguar es el único félido registrado en playa Tortuguero que caza tortugas marinas. Si se determinaba como un resultado de depredación por jaguares, la especie de tortuga marina se registraba. Para evitar la duplicación de carcasas, solo se registraron las tortugas verdes que se estimaron fueron depredadas en menos de 7 días.

Excerpt 4 from *Efecto de la depredación por jaguares, Panthera onca (Carnívora: Felidae), sobre las poblaciones de tortugas marinas de Tortuguero, costa caribeña de Costa Rica*

"Based on the literature review, a total of 380 predation records were found for the study site between 1981 and 2004; the first green turtle predated by jaguar was reported in 1981. Predation events on green turtles tended to increase in the following years with a maximum of 97 records in 2001, and by 2004 only 48 predated turtles were documented. Jaguars also preyed upon leatherbacks and hawksbills, it is important to highlight that in 1999 and 2001 two leatherbacks and four hawksbills were killed, respectively; these records constitute the first time both of these species were documented as predated by jaguar (Table 1).

Between 2005 and 2013, after a total of 267 surveys (mean ± SD= 34±5 surveys per year, 3±1 surveys per month) we were able to document three species of marine turtles (C. mydas, E. imbricata and D. coriácea) and a total of 1 110 carcasses predated by jaguars."

Basado en la revisión de literatura, se encontró un total de 380 registros de depredación en el lugar de estudio entre 1981 y 2004. La primera tortuga verde que fue depredada por un jaguar se reportó en 1981. Los eventos de depredación en las tortugas verdes incrementaron en los siguientes años con un máximo de 97 registros en el 2001 y para el 2004, solo se documentaron 48 tortugas depredadas. Los jaguares también cazaron tortugas baula y carey. Es importante señalar que en 1999 y 2001 dos tortugas baula y cuatro tortugas carey fueron depredadas, respectivamente; estos registros constituyen la primera vez que ambas de estas especies se documentaron como cazadas por jaguares (Tabla 1).

Entre el 2005 y 2013, después de realizar un total de 267 estudios (media ± SD= 34±5 estudios por año, 3±1 estudios por mes), se pudo documentar tres especies de tortugas marinas *(C. mydas, E. imbricata* y *D. coriácea)* y un total de 1 110 carcasas depredadas por jaguares.

Excerpt 5 from *Evaluación de las estrategias de manejo en la conservación del guacamayo barbazul (Ara glaucogularis) en grave peligro de extinción*

"How effective these management actions will be, must be related to how precisely current threats and limiting factors, such as nest predation, nest flooding, brood reduction and nest site availability (Berkunsky et al., 2014; Kyle, 2006), can be identified. These actions include the protection of natural nests, the provision and protection of nest boxes, the use of defenses against predators and drainage systems for the boxes, and the hand-feeding of nestlings during first weeks of life (Berkunsky et al., 2014). Although the relative effectiveness of management actions is known, yet these were never analyzed in the global context. As part of a management strategy, knowledge of the impact and scope of each action facilitates decision-making and optimizes resources for conservation. Modeling results in an effective tool for quantifying how effective management actions may be, and can help to better understand how accurately the current threats and limiting factors are being identified (Noon and Sauer, 1992; Simons, 1984)."

La efectividad de estas medidas de gestión debe estar relacionada con qué precisión se pueden identificar amenazas actuales y factores limitantes, como la depredación de nidos, las inundaciones de nidos, la reducción de camadas y la disponibilidad de sitios de nidos (Berkunsky et al., 2014; Kyle, 2006). Estas medidas incluyen la protección de nidos naturales, la provisión y protección de cajas nido, el uso de defensas contra depredadores y sistemas de drenaje para las cajas y la alimentación manual de los polluelos que no han dejado el nido durante las primeras semanas de vida (Berkunsky et al., 2014). Aunque se conoce la efectividad relativa de las medidas de gestión, estas nunca se analizaron en un contexto global. Por lo tanto, como parte de la estrategia de gestión, el conocimiento del impacto y el alcance de cada acción facilitan la toma de decisiones y optimizan recursos para la conservación. La simulación produce una herramienta efectiva para calcular qué tan efectivas pueden ser las medidas de gestión, y puede ayudar a comprender mejor con qué precisión se identifican las amenazas y los factores limitantes (Noon y Sauer, 1992; Simons, 1984).

Excerpt 6 from *Evaluación de las estrategias de manejo en la conservación del guacamayo barbazul (Ara glaucogularis) en grave peligro de extinción*

"Each year, between 2 and 10 pairs laid eggs, with a median of 6 pairs. They produced between 0 and 10 fledglings, with a median of 2.5 fledglings. Long term conservation management is in place for the Blue-throated Macaw in Beni, Bolivia since 2000 (Hesse and Duffield,2000). To reduce nesting failure, drainage holes or roofs were installed in all known nests prone to flooding. Other actions aimed at avoiding nest failure included passive and active anti-predator defenses. Passive defenses are metal flashing wrapped around tree trunks and branches pruned back from cavities to abate climbing predators. Active defenses involve a high level of daily monitoring by volunteers. Most of the defenses seem to be effective given that no nests have been flooded since 2008, and that 2010 was the first year since the beginning of Blue-throated Macaw nest monitoring with no recorded predation."

Entre 2 y 10 parejas pusieron huevos cada año con una mediana de 6 parejas, y produjeron entre 0 y 10 polluelos que dejaron el nido, con una mediana de 2.5 polluelos. Por lo tanto, se estableció el manejo de la conservación a largo plazo para el guacamayo barbazul en Beni, Bolivia, desde el 2000 (Hesse y Duffield, 2000). Asimismo, se instalaron agujeros de drenaje o techos en todos los nidos propensos a inundaciones para reducir el fallo de anidación. Otras medidas dirigidas para evitar el fallo de anidación incluyeron defensas antidepredadoras pasivas y activas. Las defensas pasivas fueron hojas de metal envueltas en los troncos de los árboles y el recorte de las ramas en las cavidades para reducir los depredadores trepadores. Las defensas activas integran un nivel alto de monitoreo de los voluntarios. La mayoría de las defensas parecen ser efectivas, ya que ningún nido se ha inundado desde el 2008, y el 2010 fue el primer año, desde el comienzo del monitoreo de los nidos de los guacamayos barbazul, sin depredaciones registradas.

Excerpt 7 from *Evaluación de las estrategias de manejo en la conservación del guacamayo barbazul (Ara glaucogularis) en grave peligro de extinción*

"However, it takes time for Macaws to get used to nest boxes, since until 2014 only five pairs had used nest-boxes in fourteen different attempts. To avoid brood reduction, the project monitors nests in a daily basis, identifying nestlings that need a boost, and helping them by hand-feeding. Since 2007, thanks to this intervention, no nestlings have died because of brood reduction and the average number of fledglings per nest has increased from one to two. Another management action has been moving individuals who are in captivity to a Wildlife's Custody Center in Sachojere, Beni,Bolivia. Up to date, six individuals have already been recovered, whose final destination will be their reintroduction in Llanos de Moxos to strengthen existing populations. In a first stage, at least50 individuals are expected to be reintroduced."

Sin embargo, los guacamayos necesitan tiempo para acostumbrarse a las cajas nido, desde el 2014, solo cinco parejas usaron las cajas nido en 14 intentos diferentes. Para evitar la reducción de las camadas, el proyecto monitorea los nidos todos los días, identificando los polluelos que no han dejado el nido y que necesitan un estímulo, además, los ayudan con alimentación manual. Desde el 2007, gracias a esta intervención, ningún polluelo que no haya dejado el nido ha muerto por reducción de las camadas y la cantidad promedio de polluelos que han dejado el nido por cada nido ha incrementado de uno a dos. Otra acción de manejo ha sido mover a los individuos que están en cautiverio a un centro de custodia de vida silvestre en Sachojere, Beni, Bolivia. Hasta la fecha, seis individuos se han recuperado y serán reintroducidos en los Llanos de Mojos para fortalecer las poblaciones existentes. En una primera etapa, se espera reintroducir al menos 50 individuos.

Excerpt 8 from *Evaluación de las estrategias de manejo en la conservación del guacamayo barbazul (Ara glaucogularis) en grave peligro de extinción*

"Here we have built a structured stage, discrete-time population model which allowed us to analyze the dynamics of the remaining wild population of Blue-throated Macaw. Our results were supported by the information gathered by monitoring this wild population during eight consecutive breeding seasons (Berkunsky et al., 2014).The sensitivity analysis showed population growth is sensitive to the survival of adults, followed by their fertility. The priorities of management of the wild population should aim at enhancing these two parameters. Our deterministic approach reached the same conclusion as a previous stochastic approach (i.e. the Population Viability Analysis conducted by Strem (2008)) where adult mortality had a greater impact on the probability of extinction. Successful actions aimed at avoiding the hunting of adults would increase the chances of viability of the population."

Se ha creado un modelo de población de tiempo discreto, estructurado en etapas, que permitió analizar las dinámicas de la población silvestre restante de los guacamayos barbazul. Los resultados fueron respaldados por la información recolectada mediante el monitoreo de esta población silvestre durante ocho temporadas de reproducción consecutivas (Berkunsky et al., 2014). El análisis de sensibilidad mostró que el crecimiento de la población es sensible a la supervivencia de los adultos, seguido por su fertilidad. Las prioridades de la gestión de la población silvestre deberían tener como fin mejorar estos dos parámetros. El método determinístico llegó a la misma conclusión que un método estocástico previo (p. ej. el análisis de la viabilidad poblacional llevado a cabo por Strem (2008), donde la mortalidad adulta tenía un impacto mayor en la probabilidad de extinción. Medidas exitosas con el fin de evitar la caza de adultos incrementarían las probabilidades de viabilidad de la población

Excerpt 9 from *Parámetros reproductivos del guacamayo barbazul en grave peligro de extinción: Límites hacia la recuperación de un loro bajo gestión intensiva*

"Like other macaws [17,18,26], Blue-throats were willing to nest in various kinds of nest boxes, but in all cases, they selected boxes placed in the same tree or in a tree few meters from where the pair had bred in previous seasons. We now have a better idea about the characteristics of cavities selected by Blue-throated Macaw to breed. Our findings on the dimensions suggested nothing unusual about these macaws, but the results are useful for future nest box design, which can be more carefully tailored to the species' needs and preferences. Future studies of nest site selection should assess the availability of similar cavities in the region."

Al igual que los otros guacamayos [17,18,26], los barbazul estaban dispuestos a anidar en varios tipos de cajas nido, pero en todos los casos, seleccionaron las cajas establecidas en el mismo árbol o en un árbol a unos metros de donde la pareja se había reproducido en temporadas previas. Ahora se tiene una mejor idea acerca de las características de las cavidades seleccionadas por los guacamayos barbazul para reproducirse. Los descubrimientos sobre las dimensiones no indican nada inusual acerca de estos guacamayos, pero los resultados son útiles para el próximo diseño de cajas nido, que puede ser adaptado con más detalle a las necesidades y preferencias de la especie. Estudios futuros de la selección del lugar de los nidos deberían evaluar la disponibilidad de cavidades similares en la región.

Excerpt 10 from *Parámetros reproductivos del guacamayo barbazul en grave peligro de extinción: Límites hacia la recuperación de un loro bajo gestión intensiva*

" Our results suggest that successful breeding pairs are unlikely to breed the following year; if true, this factor dramatically constrains this species' ability to recover from its current critically endangered status. In some years we observed breeding pairs accompanied with their fledglings of previous year, and they were not showing breeding behavior. Parents appear to attend to their fledglings (i.e. providing food, social learning, etc.) for an extended period, possibly through the subsequent breeding season in some cases. Further studies are needed to understand post-breeding relationships between adults and their dependent juveniles. This factor has potentially dramatic consequences for the reproductive output of the most productive and attentive breeding pairs."

Los resultados indican que es difícil que las parejas reproductoras exitosas se reproduzcan el próximo año; si bien es cierto, este factor limita de manera drástica la habilidad de esta especie de recuperarse de su estado actual en grave peligro de extinción. En algunos años, se observa que las parejas reproductoras, acompañadas de sus polluelos que habían dejado el nido del año previo, no mostraban comportamiento reproductor. Los padres parecen atender a sus polluelos que han dejado el nido (p. ej. proporcionándoles alimento, aprendizaje social, etc.) por un periodo extendido, posiblemente a través de la temporada reproductora sucesiva en algunos casos. Se necesitan más estudios para comprender las relaciones postreproductoras entre los adultos y sus jóvenes dependientes. Este factor tiene consecuencias potencialmente dramáticas para el rendimiento reproductivo de las parejas reproductoras más productivas y atentas.

Excerpt 11 from *Parámetros reproductivos del guacamayo barbazul en grave peligro de extinción: Límites hacia la recuperación de un loro bajo gestión intensiva*

"For a critically endangered species like the Bluethroated Macaw, with typically fewer than ten pairs attempting to breed in a given year, we feel a balanced approach putting conservation first, data gathering second, is appropriate. This approach has aided the species recovery while simultaneously generating biological findings, which inform ongoing and future conservation and management options. We cannot know how unmanaged populations would fare in terms of nesting attempts, rates of predation, hatching success, and recruitment of fledglings as all such parameters have been directly influenced by our actions. As this macaw's numbers improve in future years, we may have the opportunity to make direct comparisons between managed and unmanaged pairs, but with annual recruitment still averaging in the single digits, we do not yet have the luxury of taking such a hands-off approach."

Para una especie en grave peligro de extinción como el guacamayo barbazul, normalmente con menos de diez parejas intentando reproducirse en un año determinado, se considera que un método balanceado que tenga como prioridad la conservación y la recolección de datos de segundo es adecuado. Este método ha contribuido con la recuperación de la especie mientras genera de manera simultánea descubrimientos biológicos, que informan opciones de conservación y manejo en curso y futuras. No se puede saber cómo las poblaciones sin manejo resultarían en términos de intentos de anidación, índices de depredación, éxito de eclosión e introducción de polluelos que han dejado el nido, ya que tales parámetros han sido influenciados directamente por estas medidas. A medida que la cantidad de estos guacamayos mejore en los años futuros, se podrá tener la oportunidad de realizar comparaciones directas entre parejas controladas y no controladas, pero tomando en cuenta que el reclutamiento anual todavía se promedia en dígitos singulares, todavía no se tiene el lujo de tomar un método menos práctico.

Excerpt 12 from *Conservación en terrenos dominados por humanos: Lecciones de la distribución del mono ardilla de América Central*

"This offers opportunities to improve its long-term chances of survival through conservation actions to protect and restore its habitat on the one hand, and to reduce the monkey's direct mortality on the other. Surprisingly we found several troops in 16 localities in a large area along the Rio Coto Brus where the Central American squirrel monkey was previously unrecorded. Some of our observations were made in cloud forests at a record high altitude for this species. We speculate the monkeys are using these highland areas as a corridor between suitable lowland habitats in the Coto Brus and the Rio Sierpe-Osa Peninsula regions. In response, we suggest strategies to help in the monkey's long-term conservation, that can be used as an example for other endangered species."

Esto da la oportunidad de mejorar sus probabilidades de supervivencia a largo plazo, a través de medidas de conservación para proteger y restaurar su hábitat, así como reducir la mortalidad directa del mono. Sorprendentemente, se descubrieron varias tropas en 16 localidades en una gran área a lo largo del río Coto Brus, donde no se había registrado el mono ardilla de

América Central. Algunas de las observaciones se hicieron en bosques nubosos en una altitud récord para esta especie. Se especula que los monos utilizan estas áreas de tierras altas como un corredor entre hábitats de tierras bajas adecuados en las regiones de Coto Brus y el río Sierpe en la Península de Osa. Como respuesta, se sugieren estrategias para ayudar con la conservación a largo plazo de los monos que puede ser utilizada como un ejemplo para otras especies en peligro de extinción.

Excerpt 13 from *Conservación en terrenos dominados por humanos: Lecciones de la distribución del mono ardilla de América Central*

"Primates are favorite targets for those hunting for bush-meat, zoo exhibits, pharmaceutical testing, or pets. Many also have low reproductive rates. As result of the impacts of those factors, approximately 60% of the>500 recognized species are in danger of extinction (Jernvall and Wright, 1998; Cowlishaw, 1999; Wong et al., 2008). Nevertheless, the clear logistic inability to gain the necessary level of understanding for the conservation of the vast majority of billions of endangered species and populations dictates we must try to deal with two fundamental questions. First, how can we deal with the global drivers of biodiversity loss: human overpopulation, overconsumption (especially by the rich)? And second, how through standard and novel approaches, greatly increase efforts to protect refuges for biodiversity, expand them, and modify our impacts on human dominated landscapes to make them more hospitable to our indispensable fellow creatures?"

Los primates son objetivos favoritos para aquellos que casan por la carne de animal silvestre, exhibiciones de zoológicos, pruebas farmacéuticas o mascotas. Muchos de ellos también tienen bajos índices reproductivos. Como resultado de los impactos de esos factores, aproximadamente un 60 % de las > 500 especies reconocidas están en peligro de extinción

(Jernvall y Wright, 1998; Cowlishaw, 1999; Wong et al., 2008). Sin embargo, la inhabilidad logística clara para conseguir el nivel de conocimiento necesario para la conservación de la mayoría de billones de especies y poblaciones en peligro de extinción dicta que se debe tratar de lidiar con dos preguntas fundamentales. Primero, ¿cómo podemos lidiar con los impulsores globales de la pérdida de biodiversidad: la sobrepoblación humana, el hiperconsumo (especialmente por parte de los adinerados)? y segundo, ¿cómo, a través de métodos estándar y nuevos, incrementar grandemente los esfuerzos con el fin de proteger refugios para la biodiversidad, expandirlos y modificar los impactos en terrenos dominados por humanos para hacerlos más hospitalarios para estas indispensables criaturas semejantes?

Excerpt 14 from *Conservación en terrenos dominados por humanos: Lecciones de la distribución del mono ardilla de América Central*

"More unusual, sometimes bolder approaches, such as translocations to previously unoccupied suitable habitat, should be more widely tested now. Primates are particularly important to conserve as they are charismatic, conspicuous, and informative because of their evolutionary relationship to us. Many species, including large ones such as howler monkeys (Alloutta spp.), are able to persist in human-dominated landscapes under certain circumstances. Additionally, because many mammal species have relatively extensive geographic ranges, they can serve as "umbrella species," protecting populations of many other less charismatic organisms. Careful determining of geographic ranges using two broad measurements (sensu Gaston, 2003): the extent of occurrence, which is the area defined by the outer limits of the range, and the area of occupancy, which is the area used by the species within the extent of occurrence, is important."

Los métodos más inusuales y a veces más drásticos, como las traslocaciones a hábitats adecuados desocupados, ahora deberían probarse extensamente. Es particularmente importante conservar a los primates, ya que son carismáticos, conspicuos e informativos debido a su relación evolucionaria hacia nosotros. Muchas especies, incluyendo las grandes como los monos aulladores (***Allouatta spp.***), son capaces de persistir en terrenos dominados por humanos bajo ciertas circunstancias. Además, ya que muchas especies mamíferas tienen rangos geográficos relativamente extensos, pueden funcionar como "especies paraguas", protegiendo poblaciones de muchos otros organismos menos carismáticos. Es importante la determinación cuidadosa de rangos geográficos usando dos medidas amplias (sensu Gaston, 2003): la extensión de ocurrencia, la cual es el área definida por los límites externos del rango, y el área de ocupación, la cual es el área utilizada por la especie dentro de la extensión de ocurrencia.

Excerpt 15 from *Conservación en terrenos dominados por humanos: Lecciones de la distribución del mono ardilla de América Central*

"Underestimating the area of occupancy of an endangered species may lead to oversight when developing protection strategies for it, thus reducing the chances for long-term conservation of populations or increasing implementation costs (Thomas y Abery, 1995; Caughley y Gunn, 1996). Conversely, assuming that the entire extent of occurrence is fully occupied by a taxon can lead to underestimates of extinction vulnerability, as has previously been observed in many terrestrial mammals (Ceballos y Ehrlich, 2002). There is abundant evidence of the capacity of mammals and other vertebrates to persist in human – dominated landscapes. For example, in the same area where we studied the squirrel monkeys, our research program on the capacity of agricultural landscapes to support biodiversity has showed that a tropical mixed forest-patch and agriculture landscape can support a substantial sample of the biodiversity of regional undisturbed forest."

El subestimar el área de ocupación de una especie en peligro de extinción puede resultar en un fallo en la creación de estrategias de protección para él, reduciendo así las probabilidades de conservación a largo plazo de las poblaciones o incrementando los costos de implementación (Thomas and Abery, 1995; Caughley and Gunn, 1996). Por otro lado, asumir que toda la extensión de ocurrencia está totalmente ocupada por un taxón puede resultar en infravaloraciones de la vulnerabilidad de extinción, como se ha observado en muchos mamíferos terrestres (Ceballos y Ehrlich, 2002). Existe evidencia abundante de la capacidad de los mamíferos y otros vertebrados de persistir en terrenos dominados por humanos. Por ejemplo, en la misma área donde se estudia a los monos ardilla, el programa de investigación sobre la capacidad de terrenos agrícolas para promover la biodiversidad ha demostrado que un terreno mixto de parches de bosque y terrenos agrícolas puede mantener una muestra sustancial de la biodiversidad del bosque regional sin perturbaciones.

5.1.2.2. Texts from Spanish to English.

Excerpt 1 from *Is Ecotourism an Inexhaustible Source of Wealth? Recommendations for its Sustainability*

"Se pueden encontrar diferentes definiciones de ecoturismo en la literatura académica; por ejemplo, se puede definir el ecoturismo como el turismo basado en la protección de áreas naturales, una alternativa de turismo que permite la obtención de beneficios fundamentándose en la preservación del entorno natural (Smith, 2010). Según Sánchez y Ramírez (2011), ecoturismo se denomina a los viajes cuyo principal propósito es la contemplación de la naturaleza, aumentar su conocimiento y la participación y promoción de su conservación, y cuyo destino son áreas poco modificadas por la acción humana. Asimismo, se podría definir el ecoturismo como la modalidad turística ambientalmente responsable, consistente en visitar áreas naturales con el fin de apreciar, disfrutar y estudiar el paisaje, la flora o la fauna autóctona. Se distingue del simple turismo de naturaleza por su énfasis en la educación y la conservación medioambiental (Alvarado, 2010; Molina, 2011). A este tipo de turismo se le conoce con varios nombres, como por ejemplo, bio turismo, turismo ambiental, verde, académico… según la faceta en la que se enfoque."

Many different ecotourism definitions can be found in academic literature; for example, ecotourism can be defined as the tourism that is based on the protection of natural areas, a tourism alternative that allows the obtention of benefits based on the preservation of the natural environment (Smith, 2010). According to Sánchez and Ramírez (2011), ecotourism is designated to the trips in which their main purpose is the contemplation of nature, the increase of their knowledge, and the participation and promotion of its conservation and in which their destination is barely modified areas by human action. Furthermore, ecotourism could be defined as an environmentally responsible tourist modality, consisting in visiting natural areas with the goal of valuing, enjoying, and studying the native landscape, flora and fauna. It differs from the simple nature tourism, as it focuses on education and environmental conservation (Alvarado, 2010; Molina, 2011). This type of tourism is known by many names, such as bio tourism, environmental tourism, green tourism, academic… according to the aspect it is focused on.

Excerpt 2 from *Is Ecotourism an Inexhaustible Source of Wealth? Recommendations for its Sustainability*

"Esta relación innegable se aprecia claramente entre el ecoturismo y la educación ambiental, a diferencia de otros tipos de turismo (Álvarez et al., 2012). Habitualmente los lugares para la práctica del ecoturismo suelen ser los asentamientos rurales en las cercanías de áreas naturales protegidas, ya que estas ejercen una acción de atracción importante sobre los turistas (Sánchez y Ramírez, 2011). El ecoturismo cercano a zonas protegidas aumenta las posibilidades de empleo para las personas que viven en zonas adyacentes (Palacio, 2010). El ecoturismo se puede definir como aquel turismo que se fundamenta en la naturaleza y su protección. Supone una pequeña porción del turismo, aunque ha tenido un gran desarrollo recientemente. Muchos autores contemplan el ecoturismo cada vez más como una herramienta que, al mismo tiempo que promueve la conservación de la naturaleza, es capaz de contribuir al desarrollo local rural (Torres et al., 2011; Casas, Soler y Jaime, 2012, Alvarado, 2010)."

This unquestionable relationship can be appreciated in ecotourism and environmental education, unlike other types of tourism (Álvarez et al., 2012). Usually, the places to practice ecotourism are rural settlements near protected natural areas, since these play an important attraction role for the tourists (Sánchez and Ramírez, 2011). Ecotourism near protected areas increases job possibilities for people who live in neighboring areas (Palacio, 2010). *Ecotourism can be defined as the tourism that is based on nature and its protection. It entails a small portion of tourism even though it has recently had a great development.* Many authors consider ecotourism more as a tool that is capable of contributing to the local rural development and that at the same time, promotes nature conservation (Torres et al., 2011; Casas, Soler and Jaime, 2012, Alvarado, 2010).

Excerpt 3 from *Is Ecotourism an Inexhaustible Source of Wealth? Recommendations for its Sustainability*

"Estas asociaciones nacieron para desarrollar diferentes actividades de carácter medioambiental (Chen y García, 2011). La existencia de estas asociaciones y el trabajo conjunto de ellas permiten facilitar el desarrollo de sus capacidades y mejora el aprovechamiento de su entorno de una forma más eficiente (Chen y García, 2011). Estas asociaciones se dan por todo el país y se observa que a través de ellas se beneficia a la población local, y a la vez se es capaz de reducir el impacto negativo del turismo (Matarrita-Cascante, Brennan y Luloff, 2010). Otro ejemplo muy interesante se halla en La Fortuna, donde se promueve la mejora de los productos locales a través del aumento de la competencia hacia ellos, aumentando, de este modo, su calidad y provocando que la economía local crezca en calidad y cantidad (Matarrita-Cascante et al., 2010)."

These associations were created to develop different environmental activities (Chen and García, 2011). The existence of these associations and their combined work allow to develop their capacities easier and to improve the harnessing of its environment more efficiently (Chen and García, 2011). These associations can be found all over the country, and it can be observed that the local population is benefited through them and the negative tourism impact is simultaneously able to be reduced Matarrita-Cascante, Brennan and Luloff, 2010). Another very interesting example can be found in La Fortuna, where the improvement of the local products through the increase of competition towards them is promoted, in this way increasing its quality and causing local economy to grow in quality and quantity (Matarrita-Cascante et al., 2010).

Excerpt 4 from *Ethical and Environmental Considerations in the Process of Ocean Acidification*

"No es necesario aclarar que los problemas ambientales tienen su origen antropogénico, generado posiblemente por una sensación de superioridad de la especie humana frente al ambiente pues este es "un ser que no entendemos, con el que no sabemos entablar un diálogo" (13). Si bien el Génesis[1] plantea que el hombre fue hecho "para que domine sobre toda la tierra y sobre todo animal", este elemento —que parece evidente para la mayoría de la sociedad occidental— pasa a generar un intento de dominio del ambiente. En Venezuela, Simón Bolívar, nuestro Libertador, lo demuestra con su famosa frase "¡Si la naturaleza se opone, lucharemos contra ella y haremos que nos obedezca!" En este aspecto algunas personas pudieran presumir que por mandato divino el hombre "civilizado" es amo y señor de todo lo que le rodea, y ha hecho creer a la especie humana que puede hacer lo que quiera con el ambiente,"

It is not necessary to clarify that environmental problems have anthropogenic origin, which was possibly generated by a sense of superiority of humankind towards the environment, since it is " a being that we do not understand, with whom we do not know how to dialogue with" (13). Although Genesis[1] states that man was made "to dominate over all land and animals," this element — that seems evident for most western society— comes to generate a dominance attempt of the environment. In Venezuela, Simón Bolívar, our Liberator, demonstrates this with his famous phrase "If nature resists, we will fight against it and we will make it obey us!" In this respect, some people could presume that by a divine mandate, "civilized" man is lord and master of everything around him and has made humankind believe that it can do as it pleases with the environment.

Excerpt 5 from *Ethical and Environmental Considerations in the Process of Ocean Acidification*

"Se puede plantear hasta la saciedad por qué ocurre esto y quizás todas las respuestas posibles nos lleven a un lugar común. Por ejemplo, la falta de formación e información de los jóvenes, y no tan jóvenes, en aspectos ecológicos de totalidad, de conocer plenamente el sistema ecológico dentro del cual viven, así como analizar al individuo, al grupo y a la comunidad como relación ecológica y mantener los equilibrios en los ecosistemas creados por el hombre (15) pudiera ser una de las posibles respuestas, pero es harto demostrado que factores como el crecimiento indiscriminado de la población y el desarrollo social y tecnológico producido en los últimos años han dado como resultado un incremento importante en la acumulación de dióxido de carbono (CO2) en la atmósfera y los océanos, situación que tiene el potencial para reestructurar los ecosistemas marinos (16)."

People can speculate endlessly as to why this happens, and maybe all of the possible answers will lead to a common place. For example, one of the possible answers could be young and not so young people's lack of education and information on ecological aspects, aspects regarding fully knowing the ecological system in which they live in, analyzing the individual, group, and community as an ecological relationship and maintaining the balances in the ecosystems created by man (15). However, it is widely demonstrated that factors like the indiscriminate increase of population and the social and technological development that was produced on recent years have resulted in an important increase in carbon dioxide (CO_2) accumulation in the atmosphere and oceans, a situation that has the potential to restructure marine ecosystems (16).

Excerpt 6 from *Ethical and Environmental Considerations in the Process of Ocean Acidification*

“Desde la bioética ¿qué principios se violan o se fortalecen? A la luz de lo expuesto la bioética, o más aún una ética ambiental o eco bioética, se muestra como la indicada para responder las principales preguntas que nos hacemos con relación con esta situación. Este es el punto central de este escrito: tratar de ver, desde una perspectiva bioética, como el hombre puede disminuir los procesos de acidificación, o por lo menos mitigar este punto tomando en cuenta estos diferentes principios, a fin de generar conciencia por un ambiente sostenible y garantizar los principios propuestos en el informe Brundtland: “Garantizar las necesidades del presente sin comprometer las posibilidades de las generaciones futuras para satisfacer sus propias necesidades”. Es necesario recordar en qué consisten la ética y la bioética”

From a bioethical perspective, which principles are violated or strengthened? In light of what has been stated, bioethics, or even an environmental ethic or eco-bioethics, is shown as the right one to answer the main questions that we ask ourselves regarding this situation. This is the focal point of this text: to understand, from a bioethical perspective, how man can decrease acidification processes, or at least mitigate this point taking into account these different principles in order to raise awareness for a sustainable environment and guarantee the proposed principles in the Brundtland report: “ To guarantee the necessities of today without compromising the possibilities of future generations to satisfy their own needs.” It is necessary to remember what ethics and bioethics consist of.

Excerpt 7 from *Ethical and Environmental Considerations in the Process of Ocean Acidification*

“Este principio determina la libertad y la autonomía que tiene el hombre para obrar en función de aspectos positivos para el ambiente, y de manera concurrente para con él. No obstante, se observa que un gran número de personas malinterpretan este principio y plantean que pueden hacer lo que quieran. Es la idea del libre albedrio, que es básicamente la potestad que el ser humano tiene de obrar según considere y elija. Pero, desde una perspectiva ética, .todo lo que el hombre hace en el ambiente, lo hace a favor de este? En los últimos años se ha visto como el ambiente marino es presa de la contaminación por plástico. De acuerdo con la Agencia Europea del Medio Ambiente, aproximadamente 10 millones de toneladas de basura van a parar a los mares y océanos del mundo, y la forma principal de estos desechos es plástico, tales como las botellas de bebidas y las bolsas desechables."

This principle determines the freedom and autonomy that man has to act according to positive aspects for the environment, and concurrently with it. However, a great number of people misinterpret this principle and state that they can do as they please. It is the free will idea, which is basically the power that human beings have to act at their discretion. However, from an ethical perspective, does everything that man do in the environment, is done in its favor? In recent years, the marine environment has been a victim of pollution by plastic. According to the European Environment Agency, approximately 10 million tons of trash end up in seas and oceans of the world, and the main type of these wastes is plastic, such as drink bottles and disposable bags.

Excerpt 8 from *Ethical and Environmental Considerations in the Process of Ocean Acidification*

"Esto se encuentra asociado al paradigma desarrollista, que plantea un progreso material ilimitado que fija las siguientes pautas: "lo importante es acumular gran número de medios de vida, de riquezas materiales, de bienes y servicios, a fin de poder disfrutar nuestro corto paso por la Tierra" (15). Al degradar el océano también se viola el principio de no maleficencia, que se refiere a no producir daño al ambiente y prevenirlo. Cuando se contamina o se disminuye el pH de los mares, se afecta la biota marina, es decir, se afectan formas de vida. La ética convierte a la ecología en la conciencia. Esto hace que se traduzcan conclusiones científicas y se transformen en imperativos de comportamiento que permitan el cuidado del ambiente. No dañar o perjudicar es diferente de no producir beneficios: si bien estamos obligados a no perjudicar a otros, no estamos obligados en la misma medida a beneficiarlos, pero nunca podremos tener certeza —o al menos, seguridad— de no perjudicar a otros con nuestras acciones e intervenciones (sean estas en la humanidad, en la naturaleza, en otros seres vivos, entre otros). "

This is associated with the developmental paradigm, which formulates an unlimited material progress that sets the following guidelines: "what is important is accumulating a great number of livelihoods, material riches, goods and services in order to be able to enjoy our short time on Earth" (15). When a person degrades the ocean, the principle of non-maleficence is also violated, which refers to not harming the environment and preventing its harm. When the ocean pH is contaminated or diminishes, the marine biota is affected, that is to say, life forms are affected. Ethics turns ecology into awareness. This causes the translation and transformation of scientific conclusions into behavior imperatives that allow environmental care. Not harming or damaging is different from not producing benefits. Even though we are not obliged to harm others, we are also not obliged to benefit them, but we will never be sure of not harming others with our actions and interventions (be them in humanity, nature, other living beings, among others).

Excerpt 9 from *Ethical and Environmental Considerations in the Process of Ocean Acidification*

"Acá puede surgir la pregunta básica, ¿quién asume el costo de esta acidificación? ¿Quién responde por los danos causados a miles de habitantes de zonas deprimidas económicamente que viven a lo largo de zonas costeras? Pero más allá de todas esas preguntas,¿ quién puede dar la cara por los animales y por el propio ambiente afectado, que al final nos afectara a todos los que vivimos en esta isla sideral llamada planeta Tierra? Si se toman en cuenta ideas del derecho ambiental internacional y se indica "lo que es y no lo que debe ser", es necesario abordar la protección ambiental consistente en bienes comunes o intereses generales de la humanidad desde dos perspectivas, una negativa y otra positiva. La primera consiste en que la creencia de que "los bienes protegidos son patrimonio común de la Humanidad ha traído aparejada evanescencia en los deberes y derechos internacionales de los sujetos del derecho internacional" (56)."

One basic question can come up here: who bears the cost of this acidification? Who answers for all the damages that were caused to thousands of inhabitants of economically disadvantaged areas that live along coastal areas? However, beyond all these questions, who can face the consequences for the animals and the affected environment itself, which in the end will affect all of us who live on Earth? If a person takes into account the ideas of international environmental law and indicates "what is and what should not be," it is necessary to address environmental protection consisting of common goods or humanity's general interests from two perspectives, a negative one and a positive one. The first one consists of the belief that "protected goods are common heritage of humanity, and have brought evanescence in the international responsibilities and rights of the parties of international law" (56).

Excerpt 10 from *Why is it Necessary to Study Animal Behavior?*

"La mayor parte de los legos considera que la psicología es una ciencia "humana", es decir, que su objeto de conocimiento se centra exclusivamente en la especie *Homo sapiens sapiens*; sin embargo, esta suposición no es correcta. Es mi propósito examinar varias razones por las que, no sólo se justifica, sino que es indispensable que la psicología estudie el comportamiento animal. Estas razones no son todas del mismo nivel, sin embargo, apuntan a la importancia del comportamiento animal para la comprensión de los fenómenos psicológicos. Este trabajo hará un breve recorrido por cada una de ellas.

El Comportamiento Humano como Resultado Evolutivo

A pesar de los embates creacionistas en los Estados Unidos, ya nadie pone en duda el hecho de que el hombre (para referirme a la especie *Homo sapiens sapiens,* sin ningún ánimo discriminatorio de las diferencias sexuales, ni de género, en la propia especie) es el resultado de la evolución biológica en el planeta Tierra y que, en esa medida, comparte procesos y características con muchos de sus ancestros."

Most laymen consider that psychology is a "human" science; that is to say that its object of knowledge is exclusively centered on the *Homo sapiens sapiens* species; however, this assumption is incorrect. My goal is to examine various reasons why the fact that psychology studies animal behavior is not only justified but also deemed as indispensable. These reasons are not all of the same level; nevertheless, they point to the importance of animal behavior for the understanding of psychological phenomena. This research will carry out a brief outlook on each one of them.

Human Behavior as an Evolutionary Result

In spite of the creationist hardships in the United States, no one doubts the fact that man (to refer to the *Homo sapiens sapiens* species with no discrimination of sexual or gender differences in the species itself) is the result of biological evolution on Earth and that, in this sense, shares processes and characteristics with many of its ancestors.

Excerpt 11 from *Why is it Necessary to Study Animal Behavior?*

"En segundo lugar, el estudioso del comportamiento animal, en la medida en que tiene que justificar y diseñar preparaciones experimentales especiales, se ve obligado a tener consistencia en relación con los planteamientos teóricos que orientan su indagación, las características de la situación experimental empleada, la naturaleza de los registros y datos a ser considerados, y la forma en que se van a interpretar. Las interpretaciones ad hoc y a posteriori son poco apreciadas y se aprende paulatinamente a desechar el modus operandi hermenéutico tan bien acogido por la mayoría de los psicólogos. Se aprende que lo fácil no es necesariamente lo correcto. Finalmente, y en congruencia con lo anterior, las preguntas que guían el estudio del comportamiento animal, además de regirse por la prudencia de los procesos que pueden colegirse de los fenómenos observados, tienen que ser coherentes con los criterios teóricos que establecen cómo pueden relacionarse dichos procesos con los fenómenos más complejos característicos del comportamiento humano."

Secondly, the animal behavior scholar, as he has to justify and design special experimental preparations, is obliged to have consistency regarding the theorical concepts that direct his examination, the characteristics of the employed experimental situation, the nature of the registers and data to be considered, and the way in which they will be interpreted. The ad hoc and a posteriori interpretations are thinly appreciated, and people learn to gradually discard the hermeneutic modus operandi that is so well received by most psychologists. People learn that what is easy is not necessarily what is right. Finally, and in accordance with what has previously been said, the questions that guide the study of animal behavior, apart from being governed by the prudence of the processes that can be deduced from the observed phenomena, have to be coherent with the theorical criteria that establish how said processes can be related to the most complex phenomena that are characteristic of human behavior.

Excerpt 12 from *Why is it Necessary to Study Animal Behavior?*

"Toda observación en ciencia es una observación determinada teóricamente. Por esta razón, los hechos a observar son los que una teoría contempla desde su lógica. Mientras más estrecha (e indiferenciada) sea esa lógica, menor será lo que se puede "ver" con dicha teoría. Las teorías que incluyen a la investigación animal como un dominio legítimo de observación, se plantean a su vez los criterios de relación de las medidas de la conducta animal con las del comportamiento humano. La posibilidad de observar y representar relaciones funcionales nuevas a partir de las observadas en el comportamiento animal es un agregado heurístico que sólo poseen las teorías que contemplan a la investigación animal como parte necesaria de su hacer indagatorio. Parafraseando al filósofo inglés J. L. Austin, "La investigación del comportamiento animal no es el final pero sí es el principio"."

In science, every observation is an observation that is theoretically determined. For this reason, the facts to observe are those that a theory contemplates from its logic. The narrower (and undifferentiated) this logic is, the less will be able to be "seen" with said theory. The theories that include animal research as a legitimate domain of observation in turn raise the relationship criteria of the animal behavior measures with those of human behavior. The possibility of observing and representing new functional relationships from the observed ones in animal behavior is a heuristic addition that only the theories that contemplate animal research as a necessary part of its investigative doing possess. Paraphrasing the English philosopher J. L. Austin "Animal behavior research is not the end but the beginning."

Excerpt 13 from *Foundry Industries: Environmental Aspects and Environmental Condition Indicators*

“Si bien la relación empresa/entorno tiene características propias de cada lugar donde ésta se desarrolla, hay aspectos ambientales que se pueden recuperar y generalizar para una actividad en particular. Es de interés por tanto desarrollar herramientas capaces de prevenir problemas ambientales consecuentes de la interacción elemento de la actividad/entorno. La dificultad de acceso a antecedentes de investigación que desarrollen indicadores de desempeño ambiental en industrias de fundición, y más aún la ausencia de los ICA que forman parte de este grupo, es lo que da motivo a su construcción en esta investigación, y constituye el objetivo del presente trabajo. Se espera entonces que estas herramientas permitan hacer el seguimiento y control del estado del ambiente en el entorno de las fundiciones.”

While the enterprise/environment relation has characteristics that are individual for each place where it is developed, there are environmental aspects that can be recovered and generalized for a particular activity. In this way, developing tools capable of preventing environmental problems resulting from the interaction that is element of the activity/environment is of interest. The access difficulty to research antecedents that develop environmental performance indicators in foundry industries and the absence of the ECI that make up part of this group even more, gives motive to its construction in this research and constitutes the objective of the current project. It is expected then that these tools allow for the carrying out of monitoring and control of the environment status in the foundry setting.

Excerpt 14 from *Foundry Industries: Environmental Aspects and Environmental Condition Indicators*

“Los hornos que funden aluminio (crisol y reverbero) en general poseen campanas de extracción de gases, sin tratamiento y con chimeneas de baja altura. En esta actividad, sólo se cuenta con chimeneas para evacuar los gases captados en el ambiente laboral, desatendiendo las obligaciones normativas (Tabla I). A excepción de los efluentes sanitarios, el volumen de aguas residuales industriales de las fundiciones es poco significativo. El principal problema puede darse por el contacto del agua de escorrentía con materias primas de fundición, escorias, lodos, cenizas y otros residuos[11]. Veintiuna industrias vierten los efluentes líquidos del proceso al sistema de alcantarillado sanitario. Dos quedan por fuera de este servicio y disponen las aguas residuales en pozos absorbentes, y otras siete restantes se radican en el Parque Industrial Tandil (PIT) cuya infraestructura cuenta con un canal de desagüe (del año 1970) que sirve a todas las empresas en el parque y descarga aguas abajo en el arroyo Langueyú."

The furnaces that found aluminum (crucible and reverberatory) generally possess fume hoods, with no treatment and with low height chimneys. In this activity, there are only chimneys to evacuate the gases captured in the work environment, disregarding regulatory obligations (Table I). With the exception of sanitary effluents, the volume of industrial wastewater of the foundries is less significant. The main problem may be due to the contact of runoff water with foundry, slag, mud, ash, and other waste raw materials[11]. Twenty-one industries spill the liquid effluents of the process to the sanitary sewage system. Two of them are excluded from this service and dispose of the wastewater in absorbent wells, and another seven remain in the Tandil Industrial Park (PIT) which infrastructure has a drainage channel (from 1970) that serves for all the companies in the park and releases water below in the Langueyú stream.

Excerpt 15 from *Foundry Industries: Environmental Aspects and Environmental Condition Indicators*

"La lista de contaminantes obtenidos se comparó con los considerados en las normas nacionales (Ley Provincial N° 5.965, Decreto Reglamentario N° 3.395/96, Resolución N° 242/97 [20]) e internacionales (National Ambient Air Quality Standards (NAAQS) [21] y Guías de

Calidad de Aire de la OMS 2005 [22]) que consideran criterios de salud humana y el cuidado de los bienes materiales. La creación de los niveles guías de la calidad de aire ambiente, y de los niveles guías de emisión, es decir, de los límites legales (obligatorios y sugeridos) correspondientes a contaminantes atmosféricos se fundamentan en estos criterios. Durante el análisis se consideraron tanto contaminantes primarios -aquellos emitidos por una fuente directamente a la atmósfera sin sufrir transformación química desde el momento que salen de su punto de emisión- (SO2, NOx, CO, etc.), como contaminantes secundarios, es decir una vez que han evolucionado en el medio y han reaccionado química o fotoquímicamente (formaldehido)."

The list of obtained contaminants was compared with the ones considered in the national (Provincial Law N° 5.965, Regulatory Decree N° 3.395/96, Resolution N° 242/97 [20]) and international (National Ambient Air Quality Standards (NAAQS) [21] and OMS 2005Air Quality Guides[22])) regulations that consider human health and care of material goods criteria.
The creation of the guide levels of the environment air quality and of the guide levels of emission, that is to say, of the legal limits (obligatory and suggested) corresponding to atmospheric contaminants are based on these criteria.
During the analysis, primary contaminants -those emitted by a source directly to the atmosphere without going through a chemical transformation from the moment they go out from its emission point- (SO_2, NO_x, CO, etc.) as well as secondary contaminants were considered, that is to say, those that once they have evolved in the environment and have reacted chemically or photochemically (formaldehyde).

In addition to the given excerpts, it is also necessary to mention that some of the jargon used in the texts was misspelled, and in order for the readership of the target language to understand the meaning of the texts, those terms were corrected in the translations.

Based on the chosen text excerpts, it can be said that the most commonly used procedures were literal translation, transposition, modulation, omission, amplification, explicitation, calque, and punctuation changes. It can be inferred that due to the nature of the texts (scientific), most texts are direct; that means that the way in which the ideas are presented is straight to the point with almost no redundancies. Due to this, compensation, equivalence, adaptation, and sentence inversion, which are procedures in which the translator has to modify more elements in the sentences, were the least or not used at all in the translation of these documents.

In addition to that, it can be evidenced that the translated texts from English to Spanish were longer than the ones translated from Spanish to English due to the individual characteristics of each language. An example of this is the need of articles in Spanish when referring to nouns, while in English, it is not always necessary.

5.1.3. Glossary Table

The final instrument that will be presented and detailed in this chapter is the glossary table. This table presents the specialized vocabulary that was used in the source texts. This table was utilized to organize the specific vocabulary as well as to gather additional data about the concept to better understand it and to use it correctly.

The information that this table compiled is the title of the text, in order to identify the text to which the term belongs; the name of the concept, in order to know which concept is being clarified; the definition of the concept, in order to understand it; the synonyms that the concept might have, in order to further clarify the term; an example of how the concept is used in other texts, in order to see how the term appears in different contexts from the one in which it has been translated; and finally, the target word in the target language, in order to be able to carry out the translation of the document.

The information that appears on the glossary table was taken from various resources, such as books, scientific studies, scientific articles, and websites. In order to avoid misunderstandings when reading the chart, the references for the synonym column were presented in the references at the end of the thesis, since the citations can be longer than the synonym itself. The glossary table is the following.

Table 6.
Glossary Table

Text	Concept	Definition	Synonyms	Example of how the concept is used in other texts	Target Word
Impact of jaguar *Panthera once* (Carnívora: Felidae) predation on marine turtle populations in Tortuguero, Caribbean coast of Costa Rica	Panthera Onca (Carnívora: Felidae) (Noun)	"a large cat (Panthera onca) chiefly of Central and South America that is larger and stockier than the leopard and is brownish yellow or buff with black spots" ("Jaguar", n.d.)	Jaguar	"The largest felid in the Americas, the Jaguar (Panthera onca) has had its geographical distribution reduced to approximately half the original range throughout the years…" (Casanova & Bernardo, 2017, p.1).	Panthera Onca (Carnívora: Felidae)
	Chelonia Mydas (Noun)	"a large usually herbivorous sea turtle (Chelonia mydas) of warm waters with a smooth greenish or olive-colored shell" ("Green Turtle", n.d.)	Green Turtle	"Green turtles Chelonia mydas are megaherbivores occurring in tropical regions worldwide" (Wallace, DiMatteo, Bolten, Chaloupka, Hutchinson, Abreu-Grobois, et al. G, 2011, as cited by Cardona, Campos, and Velásquez-Vacca, 2020, p. 2).	Chelonia Mydas

	Dermochelys Coriacea (Noun)	"the largest existing sea turtle (Dermochelys coriacea) distinguished by its flexible carapace composed of a mosaic of small bones embedded in a thick leathery skin" ("Leatherback", n.d.)	Leatherback, Leathery Turtle, Luth, and Trunkback Turtle	"The leatherback sea turtle (Dermochelys coriacea) is listed as vulnerable internationally" (Stacy, Chabot, Innis, Cray, Fraser, Rigano, et al., 2019, p.3).	Dermochelys Coriacea
	Eretmochelys Imbricata (Noun)	"a small- to medium-sized sea turtle (Eretmochelys imbricata) of warm waters that has a narrow hawk-like beak, an upper shell of overlapping horny plates, and usually two claws on each forelimb" ("Hawksbill", n.d.).	Hawksbill Turtle	"The hawksbill turtle (Eretmochelys imbricata) is listed as Critically Endangered on the International Union for Conservation of Nature (IUCN) Red List (IUCN, 2017)" (IUCN,2017, as cited by Méndez-Salgado , Chacón-Chaverri, Fonseca &. Seminoff, 2020, p.115)	Eretmochelys Imbricata
	Standard Deviation (SD) (Noun)	"a measurement of the degree to which each number in a set of numbers is different from the average" ("Standard Deviation", n.d.).		"The standard deviation (SD) measures the amount of variability, or dispersion, for a subject set of data from the mean..." (Investopedia Staff, 2019)	Desviación Estándar (SD)
	Orcinus Orca (Noun)	"a relatively small toothed whale (Orcinus orca of the family Delphinidae) that is black above with white underparts and	Killer Whale and Orca	"Killer whales (Orcinus orca) are widely distributed in all ocean basins, however, their occurrence, distribution, and ecology in the	Orcinus Orca

		white oval-shaped patches behind the eyes, attains a length of 20 to 30 feet (6 to 9 meters), typically hunts in groups, and preys chiefly on sea mammals (such as seals, sea lions, and other whales), large fish, and squid" ("Killer Whale", n.d.)		southeast Pacific, including Peru, is poorly defined" (Testino, Petit, Alcorta, Pacheco, Silva, Alfaro-Shigueto, Sarmiento, Quiñones, More Eche, Motta, Fernandez, Campbell, Carrillo, Epstein, Llapapasca, and González-Pestana, 2019, p. 261)	
	Carcharodon Carcharias (Noun)	"a large mackerel shark (Carcharodon carcharias) of warm seas that is bluish when young but becomes whitish with age and has been known to attack humans" ("Great White Shark", n.d.)	Great White Shark and White Shark	"The white shark (Carcharodon carcharias) is responsible for 49% of shark-related injuries in South Africa…" (Gennari, Kock, Smale, Towner, Khan, Bester, Johnson, Fischer, Meÿer, and Morse1, 2019, p.54)	Carcharodon Carcharias
	Crocodylus Acutus (Noun)	"a tropical American crocodile (*Crocodylus acutus*) whose range extends to Florida" ("American Crocodile", n.d.)	American Crocodile and American Saltwater Crocodile	"In southern Florida, *Crocodylus Acutus* occurs in coastal habitats that support high abundances of mosquitoes" (Reeves, Krysko, and Connelly, 2019, p.131)	Crocodylus Acutus
	Lepidochelys Olivacea (Noun)	"a relatively small sea turtle (Lepidochelys olivacea) that has a uniformly olive-colored carapace and is found along coasts and in the open sea of	Olive Ridley and Pacific Ridley	"Mexico's Pacific coast hosts nesting of 4 species of sea turtle: green (Chelonia mydas), hawksbill (Eretmochelys imbricata),	Lepidochelys Olivacea

		the tropical parts of the Pacific, Indian, and Atlantic oceans" ("Olive Ridley", n.d.)		leatherback (Dermochelys coriacea), and olive ridley (Lepidochelys olivacea), with the latter being the most numerous" (Hart, Maldonado-Gasca, Ley-Quiñonez, Flores-Peregrina, Romero-Villarruel, Aranda-Mena, Plata-Rosas, Tena-Espinoza, Llamas-González, Zavala-Norzagaray, Godley,Abreu-Grobois, 2018, p.28)	
	Felid (Noun)	"any of a family (Felidae) of carnivorous usually solitary and nocturnal mammals (such as the domestic cat, lion, tiger, leopard, jaguar, cougar, wildcat, lynx, and cheetah)" ("Felid", n.d.)	Domestic and Wild Cats	"A total of 59,517 domestic cats and 2733 wild felids were evaluated for T. gondii antibodies from 1967 to 31 December 2017 in different geographical locations worldwide" (Montazeri, Galeh, Moosazadeh, Sarvi, Dodangeh, Javidnia, Sharif, and Daryani, 2020, p.3)	Félido
	Clutch (Noun)	"A group of eggs fertilized at the same time, laid in a single session and (in birds) incubated together." ("Clutch", n.d.)	A Group of Eggs	"Painted turtles lay 1–14 eggs per clutch with up to two clutches per year" (Rollinson, Edge, and Brooks, 2013, p.975)	Puesta de huevos

	Rookery (Noun)	"the nests or breeding place of a colony of rooks" ("Rookery", n.d.)	Breeding ground	"Our failure to find a relationship between nest density and the incidence of multiple paternity was likely the result of high variation in levels of multiple paternity for the smaller rookery sizes" (Frankel & Williams, 2020, p.53)	Colonia
	Kruskal-Wallis Test (Noun)	"The Kruskal-Wallis test is the nonparametric equivalent to the one-way analysis of variance (ANOVA)…" (Vasilopoulos, 2019, p.134)	—	"The Kruskal-Wallis test can be used to analyze k ordinal data sets and does not depend on any assumption about the shape of the populations from which the data was drawn from" (Vasilopoulos, 2019, p.134)	Prueba de Kruskal-Wallis
	R Software (Noun)	"R is a system for statistical computation and graphics" (RFAQ as cited by Rizzo, 2007, p.3)	—	"More and more people are reporting their results in the context of R, and it is important to know what they are talking about" (Crawley, 2007, p.vii)	Software R
	Kernel Density Estimation (Noun)	A nonparametric technique of multivariate statistics used to estimate the probability of the density function of a random variable (Valbuena, 2017)	Parzen Window Density Estimation and Parzen-Rosenblatt Window Method	"For later use and as an introduction to random designs, we consider uniform error bounds for kernel density estimation with convolution-like kernels on [0,1]" (LaRiccia & Eggermont, 2009, p.121)	Estimación de densidad Kernel

	Buffer Zone (Noun)	"a neutral area separating conflicting forces" ("Buffer Zone", n.d.)	Neutral Zone, Line of Demarcation, and Neutral Territory	"Buffer zones are important for maintaining the condition of a natural World Heritage site" (Hungarian UNESCO site a step closer to legal protection from mining, 2016)	Zona colchón
	Unsexed (Adjective)	An immature animal or otherwise unclassified (Minto, Hinde, and Coelho,2018, p.283)	Unclassified sex	"Unclassified individuals are typically immature but could also consist of a sample of unsexed mature animals" (Minto, Hinde, and Coelho,2018, p.283)	De sexo no identificado
	Tayassu Pecari (Noun)	"a peccary (Tayassu pecari) that is larger than the collared peccary and predominantly blackish with whitish cheeks" ("White-Lipped Peccary", n.d.)	White-Lipped Peccary	"Tayassu pecari has an elevational range from sea level to over 2000 m on the eastern slopes of the Andes" (Altrichter et al., 2012 as cited by Mena & Hiyo-Bellido, 2016, p.41)	Tayassu Pecari
	Mazama Americana (Noun)	A species of red brocket deer	Red Brocket and Red Brocket Deer	"The taxonomy of Mazama americana is still uncertain" (IUCN 2020)	Mazama Americana
	Cuniculus Paca (Noun)	"either of two large nocturnal chiefly Central and South American rodents (Agouti paca synonym Cuniculus paca and A.	Lowland Paca and Paca	"Five adult lowland pacas (Cuniculus paca) were used" (Leal, De Freitas, Sasahara, and Machado, 2016, p.154)	Cuniculus Paca

		taczanowskii synonym C. taczanowskii) that typically have a white-spotted brownish coat" ("Paca", n.d.)			
	Dasyprocta Punctata (Noun)	A species of agouti	Central American Agouti	"There are 2 medium-sized rodent species in the study area, Cuniculus paca Linnaeus 1776 (tepezcuintle) and Dasyprocta punctata Gray 1842 (sereque), both of which are hunted as bush meat throughout the entire area studied (Gutiérrez-Granados & Dirzo 2010 as cited by Gutierrez Granados, 2011, p.75)	Dasyprocta Punctata
	Canis Familiaris (Noun)	"a highly variable domestic mammal (Canis familiaris) closely related to the gray wolf" ("Dog", n.d.)	Dog and Domestic Dog	"Domestic dogs (Canis familiaris) are one of the most common companion animals in the world" (Kanthaswamy, Oldt, Montes, and A. Falak, 2019, p.105)	Canis Familiaris
	Nasua Narica (Noun)	"either of two tropical American mammals (Nasua nasua and N. narica) related to the raccoon but with a longer body and tail and a long flexible snout" ("Coati", n.d.)	White-Nosed Coati	"The procyonid genus Nasua contains 2 species: Nasua nasua and Nasua narica" (Wilson and Reeder 2005 as cited by Espinosa-Flores & López-	Nasua Narica

				González, 2015, p.224).	
	Coragyps Atratus (Noun)	"an American vulture (Coragyps atratus) that is smaller than the turkey buzzard and heavier in flight" ("Black Vulture", n.d.)	Black Vulture	"Knowledge of black vulture (Coragyps atratus) and turkey vulture (Cathartes aura) spatial ecology is surprisingly limited despite their vital ecological roles" (Holland, Byrne, Bryan, DeVault, Rhodes, and Beasley, 2017, p.1)	Coragyps Atratus
	Cathartes Aura (Noun)	"an American vulture (Cathartes aura) with a red head and whitish bill" ("Turkey Vulture", n.d.)	Turkey Vulture	"The Turkey Vulture {Cathartes aura) is the most widely distributed of the New World vultures…" (Kirk and Mossman, 1998 as cited by Rollack, Wiebe, and Stoffel, 2013, p.154)	Cathartes Aura
	Ocypode Quadrata (Noun)	"A pale yellowish crab that lives in a burrow in the sand above the high-water mark and goes down to the sea at night to feed" ("Ghost Crab", n.d.)	Ghost Crab	"Spatial distribution patterns of the ghost crab Ocypode quadrata were analysed using different approaches at one disturbed and two preserved reflective sandy beaches of the Mexican Caribbean" (Ocaña , De Jesús-Navarrete, and Hernández-Arana, 2017, p.1)	Ocypode Quadrata

	Fisheries by 'catch' (Noun)	"the portion of a commercial fishing catch that consists of marine animals caught unintentionally" ("Bycatch", n.d.)	Bycatch	"Bycatch — catch of nontargeted species — occurs in nearly every commercial and recreational fishery and in many cases is a serious environmental and economic problem (Alverson et al. 1994; Davies et al. 2009 as cited by Stock, Ward, Eguchi, Jannot, Thorson, Feist, and Semmens, 2020, p.146).	Captura accesoria
	Mean (Noun)	"The value obtained by dividing the sum of several quantities by their number; an average" ("Mean", n.d.)	A middle point between extremes ("Mean", n.d.)	"Observations of countless data sets have shown that most of the time the difference between the mean and the mode is three times the difference between the mean and the median" (Taylor, 2020)	Media
	Carapace (Noun)	"The hard upper shell of a tortoise, crustacean, or arachnid" ("Carapace", n.d.)	Shell	"In contrast to macroscopic filamentous algae, microalgae on turtle carapaces have been little studied, but recent reports indicate a combination of generalists and host specialists" (Wu & Bergey, 2017, p.2)	Caparazón
Evaluating Manageme nt Strategies in the	Psittacidae (Noun)	"any of numerous widely distributed tropical birds (order Psittaciformes	Parrot	"The study involved birds of prey and from Psittacidae	Psittacidae

Conservation of the Critically Endangered Blue-Throated Macaw (Ara glaucogularis)		and especially family Psittacidae) that are often crested and brightly colored, have a distinctive stout hooked bill and zygodactyl feet, and include some excellent mimics" ("Parrot", n.d.)		family maintained in indoor public enclosures and under quarantine" (Simia, Leite-Jra, Paula, Hoffmann-Santosa, Takahara, and Hahna, 2019, p.415)	
	Ara Glaucogularis (Noun)	A macaw that is endemic to Bolivia (WWF, n.d.)	Blue-Throated Macaw	"So far, representative mitochondrial genomes were sequenced only for Ara glaucogularis (blue and yellow coloration), Ara macao (predominantly red/scarlet) and Ara militaris (predominantly green) species" (Urantowkaa , Mackiewicz and Strzala, 2015, p. 1)	Ara Glaucogularis
	Brood (Noun)	"A family of birds or other young animals produced at one hatching or birth" ("Brood", n.d.)	Offspring	"Recent evidence suggests that the White-tailed Eagle (Haliaeetus albicilla)- the largest avian predator to have recently recovered in Europe- may prey on mesopredators and their broods" (Kamarauskaite, Dementavičius, Skuja, Dagys, & Treinys, 2020, p.26)	Camada

	Clutch (Noun)	"A group of eggs fertilized at the same time, laid in a single session and (in birds) incubated together." ("Clutch", n.d.)	A Group of Eggs	"Painted turtles lay 1–14 eggs per clutch with up to two clutches per year" (Rollinson, Edge, and Brooks, 2013, p.975)	Puesta de huevos
	Lefkovitch Population Matrix (Noun)	A model that allows a population to be grouped by life stages instead of by their age (Manly, 2013)	—	"We used a standard Lefkovitch matrix model [13] to project population growth for three different tephritid species, each with four life stages (e.g., egg, larva, pupa, and adult)." (Banks, Vargas, Ackleh, and Stark, 2017, p.2)	Matriz de población Lefkovitch
	Nonnegative (Adjective)	"Either positive or equal to zero." ("Nonnegative", n.d.)	Non-negative, Positive, and Equal to Zero	"He noted the need for non-negative coefficients and used linear programming to estimate the coeficients in row 1 of the transition matrix" (Manly, 2013, p.106)	No negativo
	Eigenvalue (Noun)	"Each of a set of values of a parameter for which a differential equation has a non-zero solution (an eigenfunction) under given conditions" ("Eigenvalue", n.d.)	Characteristic Roots and Characteristic Values	"As for Lefkovitch's model, the dominant eigenvalue of the transition matrix indicates the long-term of the population and the corresponding eigenvector indicates the stable proportions in different stages" (Manly, 2013, p.106)	Valor propio

	Eigenvector (Noun)	"A vector which when operated on by a given operator gives a scalar multiple of itself" ("Eigenvector", n.d.)	Characteristic Vector	"The Lanczos algorithm is an algorithm for computing the eigenvalues and eigenvectors for large symmetric sparse matrices" (Weisstein, n.d.)	Vector propio
	Polynomial (Noun)	"An expression of more than two algebraic terms, especially the sum of several terms that contain different powers of the same variable(s)." ("Polynomial", n.d.)	—	"Similarly, the product of two polynomials is obtained by multiplying term by term and combining the results" (Weisstein, n.d.)	Polinomio
	Median (Noun)	"a value in an ordered set of values below and above which there is an equal number of values or which is the arithmetic mean of the two middle values if there is no one middle number" ("Median", n.d.)	Intermediate	"The median is calculated by listing the data values in ascending order, then finding the middle value in the list." (Taylor,2020)	Mediana
	Quartile (Noun)	"any of the three values that divide the items of a frequency distribution into four classes with each containing one fourth of the total population"("Quartile", n.d.)	"A quarter of a specific group that has been tested or evaluated in specific ways" ("Quartile", n.d.)	"On the post-test, 85 per cent of those with initial cholesterols in the upper quartile said they were making a greater effort to watch dietary intake of cholesterol as opposed to 67 per cent in the lower quartile (|5 < .05)" (Podell, Keller, Mulvihill, Berger, and Kent, 1978, p.574)	Cuartil

	Birth-Pulse Model (Noun)	"A model in which its census takes place just before or just after the breeding" (Ferson & Burgman, 2000, p.153)	—	"In birth-pulse models, transition matrices calculated for a post-breeding census do not have a row/column for newborns…" (Ferson & Burgman, 2000, p.153)	Modelo de pulso reproductivo
	Extintion Threshold (Noun)	"a tipping point commonly used to indicate when populations become vulnerable to extinction and to trigger changes in conservation actions" (Laufenberg, Clark, and Chandler, 2018, p.1)	Tipping Point	"We conclude that population projections and conditional classification trees can be valuable tools for identifying extinction thresholds used in monitoring programs" (Laufenberg, Clark, and Chandler, 2018, p.1)	Umbral de extinción.
	Vital Rate (Noun)	"relative frequencies of vital occurrences that affect changes in the size and composition of a population" (The Editors of Encyclopaedia Britannica, 1998)	—	"This paper investigated the influence of both climate and fishing on summer flounder abundance and demonstrated the use of statistical models to incorporate environmental influences on population vital rates" (O'Leary, Miller, Thorson, and Nye, 2019, p. 1276)	Estadística vital
	Discrete-Time Model (Noun)	"a model in which the system jumps from one state to the next at fixed	—	"To build a theoretical framework, we developed and	Modelo de población de tiempo discreto

		intervals or timesteps" (Biologyonline.com, n.d.)		analysed discrete-time models for mosquitoes, including the four distinct stages with timedependent(in dependent) birth rates and nonlinear survivorship rates." (Xing, Liu, & Guo, 2019, p.20)	
	Fledge (Verb)	"to acquire the feathers necessary for flight or independent activity" ("Fledge", n.d.)	—	"The young birds haven't yet fledged" ("Fledge", n.d.)	Salir del nido
	Hatchling (Noun)	"a recently hatched animal" ("Hatchling", n.d.)	Newborn and Chick	"In European shag hatchlings, plasma retinol levels also were correlated with RPCBs as well as several ∑PCB congeners" (Murvoll et al. 2006, as cited by Champoux, Boily, and Fitzgerald, 2017, p.211).	Polluelo recién eclosionado
	Nestling (Noun)	"a young bird that has not left the nest" ("Nestling", n.d.)	Newborn and Chick	"We hypothesized that heron nestlings from colonies closer to contaminant sources would exhibit higher levels of OHCs compared with reference sites" (Champoux, Boily, and Fitzgerald, 2017, p.201)	Polluelo que no ha dejado el nido
	Fledgling (Noun)	"a young bird just fledged" ("Fledgling", n.d.)	Newborn and Chick	"Hg risk to reproductive	Polluelo que ha dejado el nido

				success has been previously associated with Hg concentrations higher than 20 mg/kg in feather of fledglings of piscivorous birds…"(Scheuhammer, 1991, as cited by Champoux, Boily, and Fitzgerald, 2017, p.204)	
Reproductive Parameters in the Critically Endangered Blue-Throated Macaw: Limits to the Recovery of a Parrot under Intensive Management	Fledgling (Noun)	"a young bird just fledged" ("Fledgling", n.d.)	Newborn and Chick	"Hg risk to reproductive success has been previously associated with Hg concentrations higher than 20 mg/kg in feather of fledglings of piscivorous birds…"(Scheuhammer, 1991, as cited by Champoux, Boily, and Fitzgerald, 2017, p.204)	Polluelo que ha dejado el nido
	Fledge (Verb)	"to acquire the feathers necessary for flight or independent activity" ("Fledge", n.d.)	—	"The young birds haven't yet fledged" ("Fledge", n.d.)	Salir del nido
	Anodorhynchus Glaucus (Noun)	" A 70 cm, large blue macaw. Pale turquoise-blue with large greyish head. Proportionally long tail and massive bill. Yellow, bare eye-ring and half-moon-shaped lappets bordering mandible" (IUCN	Glaucous Macaw	"Spix's Macaw and another species, The Glaucous Macaw *Anodorhynchus Glaucus*, are not yet classed as extinct in the wild by IUCN because a remote possibility exists that they could persist in nature	Anodorhynchus Glaucus

		Red List of Threatened Species, 2019)		in areas not yet searched" (Toft & Wright, 2012, p. 223)	
	Cyanopsitta Spixii (Noun)	"A 55-57 cm, delicate, blue-grey macaw with long tail and wings. Pale ashy-blue head, distinctively square shaped. Pale blue underparts. More vividly blue in upperparts, wings and long tail" (IUCN Red List of Threatened Species, 2019)	Spix's Macaw	"Spix's Macaw Cyanopsitta spixii is one of eight species primed to have their extinctions either confirmed or deemed highly likely, following a new study by BirdLife International" (Dale, 2018)	Cyanopsitta Spixii
	Ara Glaucogularis (Noun)	A macaw that is endemic to Bolivia (WWF, n.d.)	Blue-Throated Macaw	"So far, representative mitochondrial genomes were sequenced only for Ara glaucogularis (blue and yellow coloration), Ara macao (predominantly red/scarlet) and Ara militaris (predominantly green) species" (Urantowkaa , Mackiewicz and Strzala, 2015, p. 1)	Ara Glaucogularis
	Clutch (Noun)	"A group of eggs fertilized at the same time, laid in a single session and (in birds) incubated together." ("Clutch", n.d.)	A Group of Eggs	"Painted turtles lay 1–14 eggs per clutch with up to two clutches per year" (Rollinson, Edge, and Brooks, 2013, p.975)	Puesta de huevos

	Ara Chloropterus (Noun)	A 90cm macaw that is slightly larger is of a darker red than the ara macaw with blue flight feathers, back rump, and tail-coverts; green median wing coverts, scapulars and tertials; red tipped blue tail and bare faced with conspicuous lines of red feathers (Forshaw, 2010)	Red-and-Green Macaw and Green-Winged Macaw	"In this context, the aim of this study was to analyze the karyotypes of two species of macaws (Ara chloropterus and Anodorhynchus hyacinthinus) by chromosome painting using GGA and LAL whole chromosome probes" (de Oliveira Furo, Kretschmer , O'Brien, Ferguson-Smith, and Corrêa de Oliveira, 2015, p.2)	Ara Chloropterus
	Ara Ararauna (Noun)	"a large macaw (Ara ararauna) of Central and South America that has blue upperparts, golden-yellow underparts, a greenish-blue forehead, and a black bib below the bill" ("Blue-and-Gold Macaw", n.d.)	Blue-and-Gold Macaw and Blue-and-Yellow Macaw	"In this study, we described the food plants available to Blue-and-Yellow Macaws (Ara ararauna), its feeding habits and the relationship between these parameters with feeding niche breadth" (Santos & Ragusa-Netto, 2014, p.429)	Ara Ararauna
	Feather Tract (Noun)	"one of the definite areas of the skin of a bird on which feathers grow" ("Feather Tract", n.d.)	Pteryla	"This suggests that either fault bar avoidance mechanisms are costly to implement or that the characteristics of feather growth leading to fault bars have evolved separately in different feather tracts or even at	Tracto de plumas

				the individual feather level" (Jovani, Blas, Stoffel, Bortolotti, & Bortolotti, 2010, p.98)	
	Diameter at Breast Height (Noun)	"the most common tree measurement made on a tree by tree professionals" (Nix, 2020)	—	"At two sites, we measured coarse root (diameter ‡2 mm) biomass by diameter class and their mineralomass for sugar maple (Acer saccharum Marsh.), black spruce (Picea mariana (Mill.) BSP), and jack pine (Pinus banksiana Lamb.) trees to relate them to stem diameter at breast height (DBH)" (Ouimet, Camiré, Brazeau, & Moore, 2008, p.92)	Diámetro a la altura del pecho
	Brood (Noun)	"A family of birds or other young animals produced at one hatching or birth" ("Brood", n.d.)	Offspring	"Recent evidence suggests that the White-tailed Eagle (Haliaeetus albicilla)- the largest avian predator to have recently recovered in Europe- may prey on mesopredators and their broods" (Kamarauskaite, Dementavičius, Skuja, Dagys, & Treinys, 2020, p.26)	Camada
	Standard Error (SE) (Noun)	"A measure of the statistical accuracy of an estimate, equal to the standard	—	"The standard error (SE) of a statistic is the approximate standard deviation	Error estándar (SE)

		deviation of the theoretical distribution of a large population of such estimates" ("Standard Error", n.d.)		of a statistical sample population" (Kenton, 2019)	
	Attalea Phalerata (Noun)	"a palm tree found in the central highlands of Bolivia, Brazil, Paraguay, and Peru [1], popularly known as the "bacuri," and has economic importance as a source of vegetable oil [2]." (Baldivia, Sanjinez-Argandonã, Antunes, Moraes, Dos Santos, & de Picoli Souza, 2018, p.1)	Bacuri	"The authors thank the owners of the Hotel Cabanas for their help in collecting the Attalea phalerata fruit" (Baldivia, Sanjinez-Argandonã, Antunes, Moraes, Dos Santos, & de Picoli Souza, 2018, p.9)	Attalea Phalerata
	Gallesia Integrifolia (Noun)	"an evergreen tree with a wide crown; it can grow up to 30 metres tall" (Tropical Plants Database, n.d.)	Garlic Plant	"Root segments from Swietenia macrophylla, Gallesia integrifólia, Swietenia sp., Schinus molle, Handroanthus heptaphyllus, and Acrocarpus fraxinifolius were obtained during a micro-burst phenomenon that occurred in Campinas, São Paulo, Brazil, in June 2016" (Ornelas Cavalcanti, Goncalves, Brazolin,	Gallesia Integrifolia

				Bertoldo, & Ruy, 2018, p.2)	
	Anaedanthera colubrina (Noun)	A species of hardwood tree	Vilca	“The natural tree cavities included 11 in dead Attalea palms, one in a dead Acrocomia palm, one in a Panama tree Sterculia apelata and, of the remaining six in living hardwood trees, four were in ajo-ajo Gallesia integrifolia and two were in vilca Anaedanthera colubrina” (Forshaw, 2017, p.225)	Anaedanthera colubrina
	Sterculia Apetala (Noun)	“…a large, deciduous tree with an attractive, dense, umbrella-shaped crown” (Tropical Plants Database, n.d.)	Panama Tree	“The consumption of roasted Sterculia apetala seeds among the southeastern Mexican population is very common” (Herrera-Meza, Martínez, Sánchez-Otero, Mendoza-López, García-Barradas, Ortiz-Viverosa, & Oliart-Rose, 2014, p.5)	Sterculia Apetala
	Phenology (Noun)	“periodic biological phenomena that are correlated with climatic conditions” (“Phenology”, n.d.)	—	“Global climate change appears to be interfering with the phenology of many species, at the very heart of species interactions” (Beaudry, 2020)	Fenología

	Kaplan-Meir Survival Curve (Noun)	The visual representation of the survival function that shows what the probability of an event (for example, survival) is at a certain time interval (Van Paemel, 2019)	—	"Kaplan-Meier curves are widely used in clinical and fundamental research, but there are some important pitfalls to keep in mind when making or interpreting them" (Van Paemel, 2019)	Curva de supervivencia Kaplan-Meir
	Ara macao (Noun)	"a macaw (Ara macao) that is the largest and showiest of Mexican parrots and has predominantly scarlet or vermilion plumage with bright yellow wing coverts, deep purplish remiges, and azure blue lower back, rump, and tail coverts" ("Scarlet Macaw", n.d.)	Scarlet Macaw	"To provide novel information on psittacine diets, we examined the nutrient composition of crop contents collected from free-living scarlet macaw {Ara macao) chicks from Tamhopata Research Center in the lowland forests of south-eastern Peru" (Brightsmith, McDonald, Matsafuji, & Bailey, 2010, p. 9-10)	Ara macao
	Anodorhynchus Hyacinthinus (Noun)	"A 100 cm, huge, blue macaw with yellow facial skin. Intense cobalt blue coloration with black underwings, bare yellow orbital area and lappet bordering the lower mandible. Long tail and huge bill" (IUCN Red List of Threatened Species, 2016)	Hyacinth Macaw	The Hyacinth Macaw (Anodorhynchus Hyacinthinus) is the world's largest parrot" (Cameron, 2012, p.18)	Anodorhynchus Hyacinthinus
	Mode (Noun)	"the most frequent value of	—	"The mode is calculated by	Moda

		a set of data" ("Mode", n.d.)		counting how many times each value occurs" (Taylor, 2020)	
	Population Bottleneck (Noun)	"…a radical reduction in population size that is usually accompanied by a loss of genetic diversity" (Rowe, John, and Sweet, 2017, p. 218)	Genetic Bottleneck	"Fortunately, some genetic tests are now available that can reveal the signature of a population bottleneck" (Rowe, Sweet, and John, 2017, p. 218)	Cuello de botella
	Reproductive investment (Noun)	"the absolute amount of resources put into reproductive structures" (Reekie &Bazzaz, 2011, p.4)	—	"With the same reproductive investment (number of eggs), females that reproduce asexually can have twice as many second-generation descendants as females that reproduce sexually…" (Fusco & Minelli, 2019, p. 107)	Inversión reproductiva
Conservation in Human-Dominated Landscapes: Lessons from the Distribution of the Central American Squirrel Monkey	Troop (Noun)	"a flock of mammals or birds" ("Troop", n.d.)	Flock	"Each troop consists of six to 15 animals, usually containing one to three adult males." (Helmenstine, 2020)	Tropa
	Pongo Tapanuliensis (Noun)	An orangutan species	Tapanuli Orangutan	"The analyses show that there was a small gene flow between P. abelii and P. tapanuliensis until 10–20 ka" (Nowak, Rianti, Wich , Meijaard, & Fredriksson, 2017)	Pongo Tapanuliensis

	Rungwecebus Kipunji (Noun)	“Africa's most recently discovered (2003) and described (2006) genus of monkey (Davenport et al. 2006)” (Davenport, 2019)	Kipunji	“The genus to which R. kipunji belongs was questioned by Ehardt and Butynski (2006), but considerable further evidence supports the phylogenetic position and taxonomic status of Rungwecebus (Olson et al. 2008, Roberts et al. 2009).” (Davenport, 2019)	Rungwecebus Kipunji
	Rhinopithecus Strykeri (Noun)	“This is a new species of Snub-nosed Monkey from the high altitudes of northeastern Kachin state, northeastern Myanmar” (Geissmann, Momberg, & Whitten, 2012)	Myanmar Snub-Nosed Monkey	“Discovered in 2010 and identified as a new species in 2011, the Myanmar snub-nosed monkey (Rhinopithecus strykeri) lives between N’mai Hka River and Salween River in Kashin State at the border of Myanmar and China” (Abrams, 2018)	Rhinopithecus Strykeri
	Bush-Meat (Noun)	“a catchall phrase for the meat of wild animals” (Actman, 2019)	Wild Animal Meat	“Although no one keeps track of how much bushmeat is hunted in total, conservation experts estimate that up to six million tons of bushmeat are taken from the Amazon and the Congo Basin each year” (Actman, 2019)	Carne de animal silvestre

	Allouatta Spp (Noun)	A species of howler monkey	Howler Monkey	"Howler monkeys (genus Alouatta) are the largest New World monkeys" (Helmenstine, 2020)	Allouatta Spp
	Umbrella Species (Noun)	"species that provide protection for many other species in some way" (Klappenbach, 2020)	—	"If the umbrella species remains healthy and protected, then that protection also protects a host of smaller species as well" (Klappenbach, 2020)	Especie paraguas
	Forest-Patch (Noun)	"Communities or species assemblages surrounded by other dissimilar assemblages" (Kricher, National Audubon Society, and National Wildlife Federation, 1998, p. 211)	—	"Strip corridors are very important because they permit dispersal of species from one forest patch to another" (Kricher, National Audubon Society, and National Wildlife Federation, 1998, p. 212)	Parche de bosque
	Ha (Noun)	"a unit of area equal to 10,000 square meters" ("Hectare", n.d.)	Hectare	"Your farm's average yield per hectare for carrots is 8 tons/ha for corn and 10 tons/ha for carrots" (Lim, 2018)	Hectárea (Ha)
	Saimiri Oerstedii (Noun)	"a type of small monkey that lives in trees in the forests (= areas covered with trees) in Central and South America" ("Squirrel Monkey", n.d.)	Central American Squirrel Monkey	"In S. oerstedii, females do not form dominance hierarchies, and there is no evidence of coalition formation in social interactions" (Wong, Cuarón,	Saimiri Oerstedii

				Rodriguez-Luna, & de Grammont, 2008)	
	Line Transect (Noun)	“A tape or string laid along the ground in a straight line between two poles as a guide to a sampling method used to measure the distribution of organisms” (“line transect”, n.d.)	—	“Line transects can be used to measure density by recording the perpendicular distance of plants from the transect line” (Hill, Fasham, Tucker, Shewry, and Shaw, 2005, p.219)	Transecto lineal
	Masl (Noun)	Meters Above Sea Level (Haug, Setaro, and Suárez, 2019)	—	“Lower elevations (1000 and 2000 masl) were dominated by members of Glomeraceae, whereas Acaulosporaceae were more abundant in higher elevations (3000 and 4000 masl)” (Haug, Setaro, and Suárez, 2019, p.1)	m.s.n.m.
	Forest Cover (Noun)	“land cover consisting of forest : the plants of a forest together with the products of their decay” (“Forest Cover”, n.d.)	Land Cover	“Here are United States Forest Service geographic maps defining the 20 major forest cover types in the United States and where common trees are most often located based on frequency of occurrence” (Nix, 2020)	Cobertura forestal
	Mean Patch Size (Noun)	“ a measure of the subdivision of the class or landscape” (Botequilha	—	“At the class level, AREA_MN is the average or mean patch size for a particular	Tamaño medio de parche

		Leitao, Miller, Ahern, and McGarigal, 2012, p. 83)		class of LCTs" (Botequilha Leitao, Miller, Ahern, and McGarigal, 2012, p. 86)	
	Mean Shape Index (Noun)	A value given by "the sum of the patch perimeter divided by the square root of patch area for each patch in the landscape, adjusted by a constant for a square standard, divided by the number of patches" (Howard, 2005, p.43)	—	"The reason for the discrepancy between these indices is not clear; however, the mean shape index is more consistent with the results of other indices and therefore is probably more reliable in this case" (McGarigal, 1995, p.38)	Índice de forma media
	Class Area Metric (Noun)	A value given by "the sum of areas of all patches within a coverage class" (Ceballos, Ehrlich, Pacheco, Valverde-Zúñiga, & Daily, 2019)	—	"Five metrics were selected including class area (CA), number of patches (NP), largest patch index (LPI), edge density (ED), and contagion index (CONTAG) to measure and describe the level, pattern, heterogeneity, and complexity of the urban area" (Kaewthani & Keeratikasikorn, 2019, p.65)	Métrica de clase de área
	Fold (Noun)	"multiplied by (a specified number) : times" ("Fold", n.d.)	Times	"Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a tenfold increase	Veces

				in measured amplitude…” (Bellis, 2020)	
¿Es el ecoturismo una fuente inagotable de riqueza? Recomendaciones para su sostenibilidad	Turismo de sol y playa (Noun)	Tourism in which the main motivation is to enjoy destinations located in coastal areas to do activities outdoors in areas with good weather (Cajal, 2019)	Turismo Litoral	“Para España el turismo de sol y playa tiene una importancia enorme, pero no todo son ventajas…” (Romero Martínez, 2007, p.2)	Beach Tourism (Picken, 2017).
	Cluster ecoturístico (Noun)	An eco-touristic sectoral and geographic concentration of enterprises	—	“El cluster ecoturístico de LaFortuna de San Carlos debe su origen a las espectaculares erupciones del volcán Arenal, que no han dejado de sucederse desde 1968” (Ortega & Hidalgo, 2010, p.3)	Ecotourism Cluster
	Living-labs (Noun)	Innovation-open ecosystems induced by users based on enterprises, citizens, and institutions in which users take an active rol in the investigation, development, and innovation (González & León, 2010, p.88)	—	“Rural Inclusion cuenta con cinco Living Labs donde la innovacioón centrada en el usuario sirve a lo largo de la vida del proyecto para la dettección de necesidades…” (Lasala Calleja, 2011, p.216)	Living Labs
Consideraciones éticas y ambientales en el proceso de acidificación oceánica	Gas de efecto invernadero (GEI) (Noun)	“any gas that has the property of absorbing infrared radiation (net heat energy) emitted from Earth’s surface and reradiating it back to Earth’s surface,	—	“ En el caso especifico del CO2 atmosférico, este gas de efecto invernadero es absorbido por las plantas y otros organismos…” (Figueroa	Greenhouse Gas (GHG)

		thus contributing to the greenhouse effect" (Mann, 2019)		Clemente, 2007, p.85)	
	Mejillón (Noun)	a marine bivalve mollusk (especially genus Mytilus) usually having a dark elongated shell ("Mussel", n.d.)	—	"El peso de la carne del mejillón puede llegar a ser el 50% del peso total en el momento de mejor condición" (Figueras, 2007, p.25)	Mussel
	Aragonita (Noun)	"a mineral similar to calcite in consisting of calcium carbonate but differing from calcite in its orthorhombic crystallization, greater density, and less distinct cleavage" ("Aragonite", n.d.)	—	"La aragonita, en cambio, precipita como partículas suspendidas en el agua y se adhiere poco sobre dichas superficies…" (Del Toro Rodríguez, & Maurant, 2001, p.20)	Aragonite
	Exoesqueleto (Noun)	"an external supportive covering of an animal (such as an arthropod)" ("Exoskeleton", n.d.)	Shell and Cocoon	"En el caso específico de la langosta espinosa (Panulirus argus), también se han publicado trabajos sobre la composición química de su exoesqueleto, fundamentalmente de los constituyentes y elementos químicos mayoritarios" (Ramírez-Arrebato, Tania Rodríguez, Andrés Alfonso, Azocar, Vázquez, Alfonso-Hernández, & Peniche-Covas, 2010, p.100)	Exoskeleton

	Tasa Metabólica (Noun)	"The rate at which metabolism occurs in a living organism" ("Metabolic Rate", n.d.)	—	"El consumo de oxígeno es una respuesta fisiológica que se puede correlacionar con las variaciones de los factores ambientales, por lo que la tasa respiratoria, medida en términos de consumo de oxígeno es un indicador de la estimación de la tasa metabólica de crustáceo" (Hernández-Sandoval, Peraza Gómez, Bacasegua-Villegas, Armenta-Valenzuela, Martínez-Valenzuela, Alanis-Escalante, López-Sánchez, & García-Guerrero, 2018, p.354)	Metabolic Rate
	Sumidero (Noun)	Duct or canal where water is submerged ("Sumidero", n.d.)	Conducto	"Los bosques con gestión forestal son importantes sumideros de carbono (C) para el planeta porque ayudan a mitigar el cambio climático producido por los gases de efecto invernadero" (Palacios-Cruz, De los Santos-Posadas, Ángeles-Pérez, Fierros-González, &	Sink

				Santiago-García, 2020, p.241)	
	Ppm (Noun)	“parts per million” (“ppm”, n.d.)	—	“Los resultados de los oligoelementos evaluados se expresan por un rango definido por el valor encontrado en dos lugeres de procedencia que son: elementos mayores (N, P, K, Ca, Mg) en g por hg (%) (Tabla 3), y elementos menores (Na, Fe, Mn, Cu, Zn) en partes por millón (ppm) (Tabla 4)” (Cáceres, Martínez-Arévalo, Mérida-Reyes, Sacbajá, López, & Cruz, 2019, p.48)	ppm
	Pg (Noun)	A useful unit for large mass quantities which ammounts to billion tons (Figueroa Clemente, 2007, p.61)	—	“Los organismos vivientes que forman la Biosfera contienen en su biomasa un total de 800 pg de carbono” (Figueroa Clemente, 2007, p.61)	Pg
	Advección (Noun)	“the usually horizontal movement of a mass of fluid (such as air or an ocean current)” (“Advection”, n.d.)	—	“Considerando que el humedal Medellincito se encuentra ubicado en el estrecho topográfico a 5º19N y 75º54W, es posible que la advección de humedad proveniente de la corriente de	Advection

				Chorro del Chocó sea uno de los principales factores que determinen su humedad y la de sectores aledaños…” (Acevedo, Velásquez., Pardo-Trujillo, Vélez, Vallejo, Jaramillo, & Trejos, 2020, p. 64,65)	
	Calcáreo (Adjective)	“consisting of or containing calcium carbonate” (“Calcareous", n.d.)	Calizo and Calar	“Este método no es recomendable para suelos calcáreos debido a que el carbonato neutraliza el pH ácido de la solución de extracción, y el calcio forma fluoruro de calcio que reacciona con P y lo precipita” (Perez, Dunnel Guerra, Storniolo, Vanzolini, & Kloster, 2019, p.12)	Calcareous
	Zooxantela (Noun)	“any of various symbiotic dinoflagellates that live within the cells of other organisms (such as reef-building coral polyps)” (“Zooxanthella”, n.d.)	Symbiotic Dinoflagell ate	“El fenómeno del blanqueamiento ha incrementado el interés en la biología de las zooxantelas en las últimas décadas” (Walther-Mendoza, Reyes-Bonilla, Lajeunesse, & López-Pérez, 2016, p.418)	Zooxanthella
	Macrófitas (Noun)	“An aquatic plant large enough to be seen by the	Plantas Acuáticas	“Factores como el clima, condiciones	Macrophyte

		naked eye" ("Macrophyte", n.d.)		geológicas, hídricas y topografía son fundamentales para determinar la distribución de las macrófitas" (Vázquez Chacón, 2019)	
	Thallasia testudinum (Noun)	" a submerged monocotyledonous marine plant (Thalassia testudinum of the family Hydrocharitaceae) of the coasts of Florida and the West Indies having long ribbonlike leaves" ("Turtle Grass", n.d.)	Praderas Submarinas and Hierba de Tortuga	"Teniendo en cuenta el rendimiento obtenido en esta extracción, el objetivo de este trabajo fue optimizar las condiciones de extracción de los polifenoles totales en el extracto de la angiosperma marina Thalassia testudinum, con vistas a obtener un mayor rendimiento" (Núñez Moreira, Quintana Ricardo, Gutiérrez-Cuesta, Valdés Iglesias, González García, Hernández Rivera, Acosta Suarez, & Ortiz Guillarte, 2019, p.102)	Thallasia testudinum
	Posidonia oceánica (Noun)	A marine plant of the posidoniaceae family, alismatales order and liliopsida class that is most recognized as Posidonia oceanica prairies (Morelle Hungría, 2018, p.3)	Praderas de Posidonia	" La Posidonia oceanica está catalogada en situación de especial protección en su población del Mediterráneo" (Morelle Hungría, 2018, p.7)	Poisodonia oceánica
	Diagenética (Adjective)	Adjetive for the"recombination or	—	"En la alteración diagenética los minerales rellenan	Diagenetic ("Diagenesis", n.d.)

		rearrangement of constituents (as of a chemical or mineral) resulting in a new product" ("Diagenesis", n.d.)		fracturas perlíticas y comienza la sustitución de los minerales primarios en la roca…" (Álvarez-Ortiz, María Cruz-Gámez, Lastra-Rivero, & Velasco-Tapia, 2019, p.28)	
	Cadena Trófica (Noun)	"an arrangement of the organisms of an ecological community according to the order of predation in which each uses the next usually lower member as a food source" ("Food Chain", n.d.)	Cadena Alimenticia and Cadena Alimentaria	"Relevantes en la cadena trófi ca y de incidencia en salud pública, ya que algunos son vectores biológicos de agentes causales de enfermedades que afectan al hombre" (Rojas Céspedes, Forero Céspedes, and Reinoso Flórez, 2018, p.18)	Food Chain
	Biota (Noun)	"the flora and fauna of a region" ("Biota", n.d.)	Flora y Fauna	"De lo contrario, se presentan afectaciones en la biota al ocasionarse mortandad debido a la extracción de agua para uso doméstico y agroindustrial, así como descargas de aguas residuales al río" (Izquierdo Santacruz, & Madroñero Palacios, 2013, p. 87)	Biota
	Seguridad Alimentaria (Noun)	"The state of having reliable access to a sufficient quantity	—	"La FAO mide la inseguridad alimentaria utilizando la	Food Security

		of affordable, nutritious food" ("Food Security", n.d.)		Escala de Experiencia de Inseguridad Alimentaria (FIES, por sus siglas en inglés)" (Rodríguez Pecino, 2019)	
	Ácido Carbónico (Noun)	"a weak dibasic acid H2CO3 known only in solution that reacts with bases to form carbonates" ("Carbonic Acid", n.d.)	—	"El *ácido carbónico* HO-CO-OH, que se puede considerar como el hidrato de dioxido de carbono, o como el *ácido hidroxifórmico*, no existe en estado libre" (Beyer & Walter, 1987, p.373)	Carbonic Acid
Why Is It Necessary to Study Animal Behavior?	Vestigial (Adjective)	"(of an organ or part of the body) degenerate, rudimentary, or atrophied, having become functionless in the course of evolution." ("Vestigial", n.d.)	Rudimentario	"Los resultados del presente estudio confirman que las flores de S. balansae estructuralmente perfectas son funcionalmente pistiladas, ya que los estambres no producen tejido esporógeno y carecen por lo tanto de cualquier posibilidad de formar polen, mientras que en las flores estaminadas la estructura descripta como pistilo vestigial o rudimentario no es más que la excrecencia del ápice del receptáculo, cubiertas por tejido nectarífero"	Vestigial

				(Gonzalez, 2013, p.109)	
	Filogenia (Noun)	“the evolution of a genetically related group of organisms as distinguished from the development of the individual organism” (“Phylogeny”, n.d.)	—	“El punto de partida para conocer la filogenia de los seres vivos es establecer similitudes entre diferentes especies” (Montagud Rubio, n.d.)	Phylogeny
	Ontogenia (Noun)	“the development or course of development especially of an individual organism” (“Ontogeny”, n.d.)	—	“ La ontogenia reconoce diferentes etapas en el desarrollo de organismo, dándose su inicio con la fecundación de una célula reproductiva con otra, esto es, la unión entre dos gametos (en muchas especies animales)” (Montagud Rubio, n.d.)	Ontogeny
	Motricidad (Noun)	“ the quality or state of being motile : capability of movement” (“Motility”, n.d.)	Mobility	“Tradicionalmente la motricidad del alumnado de educación infantil era trabajada por las propias maestras tutoras; en mayor o menor grado, en función de los conocimientos que tuvieran, las instalaciones y materiales de que dispusieran y la programación de cada semana” (Pastor, 2008, p.140)	Motility

	Ganglio (Noun)	“a mass of nerve tissue containing cell bodies of neurons external to the brain or spinal cord” (“Ganglion”, n.d.)	—	“ El entendimiento de la anatomía de la cadena simpática cervicotorácica y de los ganglios es vital para precisar si el bloqueo neural fue terapéutico y evitar procedimientos neuroablativos innecesarios” (Serna-Gutiérrez, 2015, p.279)	Ganglion
	Homínido (Noun)	“ any of a family (Hominidae) of erect bipedal primate mammals that includes recent humans together with extinct ancestral and related forms and in some recent classifications the great apes (the orangutan, gorilla, chimpanzee, and bonobo)” (“Hominid”, n.d.)	Hominino	“Se puede considerar, por otra parte, a los homínidos como la familia de los primates hominoideos que incluye tanto al ser humano como a sus parientes más cercanos: los chimpancés, los bonobos, los gorilas y los orangutanes” (Pérez Porto & Gardey, 2011)	Hominid
	Coespecífico (Noun)	An organism from the same species of another (“Conspecific”, n.d.)	—	“Los felinos silvestres, en general (excepto leones y guepardos), no viven en grupos sociales, por lo que mo es necesario enseñarles mucho sobre como comportarse en un grupo de coespecíficos” (Drews, 1999, p.380)	Conspecific

	Canon de Morgan (Noun)	“the principle that the behavior of a nonhuman animal should not be interpreted in complex psychological terms if it can instead be interpreted with simpler concepts” (“Lloyd Morgan’s canon”, n.d.)	—	“Se ha insistido en muchas ocasiones, y desde perspectivas muy variadas, en la importancia histórica del establecimiento del llamado «Canon de Morgan» en el desenvolvimiento de la psicología comparada” (Ongay de Felipe, 2014)	Morgan’s Canon
	Hermenéutico (Adjective)	“of or relating to hermeneutics” (“Hermeneutical”, n.d.)	—	“ El objetivo de esta investigación consistió en repensar críticamente la importancia del paradigma hermenéutico como nuevo marco epistémico para la comprensión del "reconocimiento del otro" en las comunidades indígenas del Ecuador” (Méndez Cabrita, Marín Pérez, Cruz Enríquez & Rosero Martínez, 2019, p.1)	Hermeneutical
	Parasocial (Adjective)	Adjective for a group of unrelated individuals from the same species that tend to each other(Asakura, 2011, p. 286, and Barrows, 2000, p.642)	—	“Después del huracán decrecieron especies solitarias, parasociales y sociales y principalmente las especies que	Parasocial

				anidan en cavidades preexistentes y en la madera" (Ramírez, Ayala & González, 2016, p.718)	
	Prelingüístico (Adjective)	"occurring before an individual has developed the use of language" ("Prelingual", n.d.)	—	"Según este pensador, hay una diferencia esencial entre el ser humano prelingüístico, el in-fante (carente de lenguaje), y el sujeto" (Segura Peraita, 2019, p.23)	Prelinguistic
	Paralingüístico (Adjective)	"Relating to or denoting paralanguage or the non-lexical elements of communication by speech" ("Paralinguistic", n.d.)	—	"El sistema paralingüístico, pese a su gran importancia en la comunicación humana, todavía no se ha estudiado en profundidad" (Gómez &Herranz, 2016, p.100)	Paralinguistic
	Heurístico (Adjective)	"involving or serving as an aid to learning, discovery, or problem-solving by experimental and especially trial-and-error methods" ("Heuristic", n.d.)	—	"En la aplicación de todos los modelos heurísticos, la interacción y la retroalimentación administrativaa deberían desempeñar quizá un papel aún más importante que cuando se trata de modelos más formales…" (Eppen & Gould, 2000, p.428)	Heuristic
Foundry Industries:	Pyme (Noun)	A small and medium enterprise ("Pyme", n.d.)	—	"Se analizaron empíricamente las relaciones entre tres tipos de	SME (Liberto, 2019)

Environmental Aspects and Environmental Condition Indicators				cooperación y el desarrollo de innovación tecnológica en la PYME, así como el impacto que esta tiene en el desempeño, según datos de PYMES chilenas” (Castillo-Vergara& Torres Aranibar, 2019, p.47)	
	Periurbano (Adjective)	“ of or relating to an area immediately surrounding a city or town” (“Peri-Urban”, n.d.)	—	“Los aeropuertos, por otra parte, se construyen en áreas periurbanas principalmente por motivos de seguridad” (Pérez Porto, & Gardey, 2013)	Peri-Urban
	Aleación (Noun)	“a substance composed of two or more metals or of a metal and a nonmetal intimately united usually by being fused together and dissolving in each other when molten” (“Alloy”, n.d.)	—	“Esto se debe principalmente a sus excelentes propiedades, como su resistencia mecánica en varias aleaciones, su resistencia a la corrosión en varios medios, su alta conductividad eléctrica y térmica, su bajo peso y su buena ductilidad, entre otros” (Garzón, García, & Sánchez, 2019, p. 102)	Alloy
	Hornos Cubilotes (Noun)	“a vertical cylindrical furnace for melting iron in the foundry that has tuyeres and tapping spouts	—	“Es un material no metálico formado por sílice, carbono y otras bases producto de la fusión del hierro en el horno de	Cupola

		near the bottom" ("Cupola", n.d.)		cubilote" (Cruz Hernández, Franco Durán, & Pérez Bustos, 2014, p.84)	
	Crisol (Noun)	"A ceramic or metal container in which metals or other substances may be melted or subjected to very high temperatures" ("Crisol", n.d.)	Container	" El proceso de fusión-reducción se realiza en un horno de arco eléctrico con crisol de grafito y con la presencia de coque como reductor, lo que garantiza la obtención de aleaciones de alto contenido de carbono (5–6 %)" (Perdomo-González, Quintana-Puchol, Cruz-Crespo, & Gómez-Pérez, 2018, p.92)	Crisol
	Horno de Reverbero (Noun)	"A furnace in which the roof and walls are heated by flames and radiate heat on to material in the centre of the furnace" ("Reverberatory Furnace", n.d.)	—	"En este trabajo se utilizaron escorias de cobre,provenientes de la operación del horno reverbero y del Convertidor Teniente, ambos de la Fundición Hernán Videla Lira de la ENAMI Chile" (Valderrama, González, Santander, & Zazzali, 2018, p. 42)	Reverberatory Furnace
	Agua de Escorrentía (Noun)	"quantity of water discharged in surface streams" (The Editors of Encyclopaedia Britannica, 2020)	Aliviadero, Desagüe, and Torrentera	"La recolección de agua de lluvia, es una tecnología en la que la escorrentía superficial es	Runoff

				recolectada de forma eficaz" (Loera-Alvarado, Torres-Aquino, Martínez-Montoya, Cisneros-Almazán, & de Jesús Martínez-Hernández, 2019, p.284)	
	Forja (Adjective)	Adjective for "the art or process of forging" ("Forging", n.d.)	Fragua	"Este trabajo es un estudio comparativo de dos especímenes para realizar pruebas para forja y así obtener las curvas de flujo bajo cargas de compresión, a diferentes temperaturas, utilizando el método del elemento finito" (Ledesma-Orozco, Aguilera-Gómez, Plascencia Mora, Ruiz-López, Gómez-Márquez, & Reveles-Arredondo, 2020, p.107)	Forging
	Hierro Gris (Noun)	"pig or cast iron containing much graphitic carbon which causes its fracture to be dark gray" ("Gray Iron", n.d.)	Hierro Fundido Gris	"Según Wang y otros investigadores (2006) una característica distintiva del hierro gris es que el carbono se encuentra, generalmente, en forma de grafito que adopta formas irregulares, descritas como fractura, en las	Gray Iron

				piezas elaboradas con esta aleación" (Aguirre-Breffe, Fernández-Columbié, Rodríguez-González, Castillo-Matos, & Izaguirre-Bonilla, 2019, p.61)	
	Escoria (Noun)	"Stony waste matter separated from metals during the smelting or refining of ore" ("Slag", n.d.)	Desecho	"La escoria proviene de una industria colombiana que se dedica a la producción y comercialización de baterías de plomo-ácido" (Torres Castelblanco, Mosquera Idrobo, Torres Agredo, Valencia Vivas, S. Gallego Restrepo, & Alvarez Hincapie, 2019, p.257)	Slag
	Hierro Nodular (Noun)	"cast iron in which the graphite is present as tiny nodules of characteristic structure" ("Nodular Iron", n.d.)	Hierro Dúctil	"La característica más notable de esta aleación ferrosa relativamente nueva, es que partiendo de un hierro nodular con buenos índices de calidad es posible obtener, mediante un tratamiento de austempering, diferentes combinaciones de propiedades mecánicas en dependencia de la temperatura de tratamiento aplicada"	Nodular Iron

				(Ordóñez-Hernández, Parada-de-la-Puente, Figueroa-Hernández, Mondelo-García, Barba-Pingarrón, & del-Castillo-Serpa, 2015, p.72)	
	Galpón (Noun)	“a slight structure built for shelter or storage” (“Shed”, n.d.)	Depósito, Nave, Bodega, Almacén, Granero, Barracón and Despensa	“Un tipo de construcción muy difundida tanto en ámbitos urbanos como rurales son los galpones de planta rectangular, con techo de directriz curva” (Balbastro & Sonzogni, 2008, p.37)	Shed
	Horno de Fusión (Noun)	Furnances where iron, steel, nonferrous metals and materials of different compositions are melted (Gerling, 1979, p.26)	—	“Para realizar el diseño mecánico del Horno de Fusión al Arco Eléctrico se hizo necesario determinar algunos parámetros” (Cervantes Fernández, Saltarín Jiménez, Santos, Barraza Botet, & Silgado, 2013, p.28)	Melting Furnance (Cervantes Fernández, Saltarín Jiménez, Santos, Barraza Botet, & Silgado, 2013)
	Filtro de Mangas (Noun)	“a device or facility in which particulates are removed from a stream of exhaust gases (as from a blast furnace) as the stream passes through a large cloth bag” (“Baghouse”, n.d.)	—	“ Debido a las consideraciones actuales y futuras expuestas anteriormente, la transformación de un precipitador electrostático en un filtro de mangas, es un proyecto que ofrece atractivas ventajas y se adapta a las	Baghouse

				exigencias medioambientales cada vez más estrictas (Manzano-Agugliaro, & Carrillo-Valle, 2016, p.191)	
	Campana de Extracción de Gases (Noun)	a “ventilated enclosure that removes hazardous chemical fumes and volatile vapors from the laboratory…” (Burdg, 2016)	—	“Recientemente se inició también el diseño de una campana de extracción de gases para el área de fusión, que absorberá la mayor parte de los gases que se generan en el momento del vaciado” (Hernández, 2001, p.93)	Fume Hood (Kaplan, 2014, p. 567)
	Formaldehido (Noun)	“a colorless pungent irritating gas CH2O used chiefly in aqueous solution as a disinfectant and preservative and in chemical synthesis” (“Formaldehyde”, n.d.)	—	“La *velocidad de reacción* disminuye, por tanto, con el aumento de la concentración de formaldehído” (Beyer & Walter, 1987, p. 456)	Formaldehyde
	No Ferrosa (Adjective)	“not containing, including, or relating to iron” (“Nonferrous”, n.d.)	—	“La chatarra se pudiera clasificar al igual que los metales, es decir, en chatarra ferrosa y no ferrosa; la primera es aquella en la que el metal base es el hierro (acero y hierro fundidos) y la segunda, la que tiene como metal base el aluminio, cobre, níquel,	Nonferrous

				estaño entre otros" (Castañeda, Corvo, González, Pérez, Portilla, Valdés, & Martín, 2006, p.182)	
	Viruta (Noun)	"material (such as metallic particles and abrasive fragments) removed by a cutting or grinding tool" ("Swarf", n.d.)	—	"El aspecto exterior de las virutas es diferente de unas a otras (fig. 11,1). y viene especialmente determinado por el material" (Bartsch, 1971, p.11)	Swarf
	Fenol (Noun)	"a white crystalline soluble poisonous acidic derivative of benzene, used as an anticeptic and disinfectant and in the manufacture of resins, nylon, dyes, explosives, and pharmaceuticals; hydroxybenzene. Formula: C_6H_5OH" ("Phenol", n.d.)	Ácido Carbólico	"Este estudio se centró en determinar cualitativamente los alcaloides y fenoles en cinco muestras de muña de expendio informal procedentes de mercados populares de la provincia de Lima, frente a una muestra de referencia Minthostachys mollis" (Pucurimay Dalia, Park Joon Su, Moscoso Max, & Granara Alberto, 2018, p. 26)	Phenol

Note: Table 6 presents the third instrument that was carried out. Source: The researcher's own creation.

The information displayed in the columns proved to be very useful throughout the translation process. The first two columns (text title and concept) provide a useful organization of the information, and for this reason, the concepts are easily identifiable when they should be consulted.

The following column (definition) was the most important one, since it provided the necessary information in order to understand the terms that appeared in the texts.

The next two columns (synonyms and example of how the concept is used in other texts) provided essential information for the translator, since they allowed the translator to fully understand not only the concepts themselves, but also important concepts of the study field. Due to this, the translator was able to acquire background knowledge about the topics, which proved to be extremely useful, since most of the texts were from the same study fields. Due to this, the translator was able to identify the specific terminology, understand it, and translate it correctly.

Finally, the last column (target word) provided the term in the language that the text was going to be translated to. Based on the information that was already provided in the other columns, the translator could correctly translate the specific terminology before the translations were carried out. This was very useful in the translation process, since it saved a lot of time. Translating the specific terminology before starting to translate the documents allowed the translator to carry out the translations faster without having to stop to look for the terminology and how to translate it.

CHAPTER VI
CONCLUSIONS AND RECOMMENDATIONS

6.1. Purpose of the Conclusion

In this chapter, the conclusions and final statements on this thesis will be presented. A conclusion is a very important part of a research project, since it summarizes the work that has been carried out, and it highlights its findings. In addition to that, the conclusion also restates the elements that have been expected to be discovered before beginning the study as well as unexpected elements that may come up during it, and, therefore, it becomes a new addition to the study. Finally, a conclusion is essential to finalize the study, show its results, and analyze if it was successful in achieving the objectives and the research question.

The conclusion for this thesis indicates if the research question has been answered throughout the analysis carried out or if it needs to be modified. It also presents the findings for each objective. In addition to that, the thesis also offers recommendations for future translators regarding the translation of these type of documents. By doing this, the thesis will come to a conclusion.

6.2. Conclusions

6.2.1. To translate the documents entitled *Consideraciones éticas y ambientales en el proceso de acidificación oceánica*; *Industrias de fundición: aspectos ambientales e indicadores de condición ambiental*; *¿ES EL ECOTURISMO UNA FUENTE INAGOTABLE DE RIQUEZA? Recomendaciones para su sostenibilidad*; *and ¿Por qué es necesario estudiar el comportamiento animal?* from Spanish into English and the documents entitled *Conservation in Human-Dominated Landscapes: Lessons from the Distribution of the Central American Squirrel Monkey*; *Evaluating Management Strategies in the Conservation of the Critically Endangered Blue-throated Macaw (Ara Glaucogularis)*; *Reproductive Parameters*

***in the Critically Endangered Blue-Throated Macaw: Limits to the Recovery of a Parrot under Intensive Management*; *and Impact of Jaguar Panthera Onca (Carnívora: Felidae) Predation on Marine Turtle Populations in Tortuguero, Caribbean Coast of Costa Rica* from English to Spanish for the National University of Costa Rica**

This objective was of utmost importance, since the rest of the objectives were to be applied or used in the translation of the documents. This objective was successfully achieved. In order to carry out this objective, the texts were given an initial reading in order for the translator to be familiarized with the text. During the initial reading, the specified vocabulary was identified, researched, and clarified in order to fully understand the texts and to prepare the glossary. The first instrument that was devised was the text analysis table. This instrument is very useful for the translation of the texts, since it compiles important characteristics of them that should be applied to the translation such as, text style, function, scale of formality, scale of generality and difficulty, and emotional tone. In addition to that, the table also provides the title of the texts so that they can be easily found, as well as for the organization of the table. An example of the target texts is given in order to demonstrate how those elements were applied in the target text. Then, the glossary was prepared, and the translation of the specialized vocabulary was provided in it. Afterwards, after understanding the texts and their elements, the translation of the documents was carried out. After finishing the translations, the texts were read once again in order to identify any inconsistency that may have slipped during the translation process. This was done to be sure that the translations were carried out effectively.

6.2.2. To apply various translation techniques to the documents in order to achieve communicative texts

This objective was essential for the translation of the documents, since it guarantees that the words in the texts were, not only being translated into another language, but also that their meanings had been translated correctly into the target language. This objective was fulfilled during the translation process, and everything that was done in it, even before the translations were carried out, was done in order to make sure that the texts transferred the ideas from the source text effectively into the target text. The initial reading was carried out in order for the translator to be familiarized with the text and the glossary was prepared in order for the translator to completely understand the message. These elements were essential, since in order to transfer, not only the terms, but also the ideas naturally into the target text, the translator had to completely understand the text and be sure of what was written and what was going to be translated. This objective was also successfully achieved. The translator utilized several translation procedures that were able to transfer the message effectively. However, as it was stated in Chapter 5, the main translation procedures that were used were literal translation, transposition, modulation, omission, amplification, explicitation, calque, and punctuation changes due to the scientific nature of the texts.

6.2.3. To evaluate the effect of the translation techniques applied on the documents

The instrument that was selected to carry out this objective was the color coding system. This instrument was selected in order to identify the different translation procedures that were applied during the translation process, as well as to differentiate them in the text. With the help of this instrument, this objective was also accomplished. This instrument was carried out after the translations of the documents were finalized. Thirty texts were selected in total and were placed below their corresponding source text. This was very useful, since it could be evidenced that the target texts had the same meaning as the source texts despite the slight changes that had been applied during the translation process. After that, the different translation procedures were highlighted with different colors in order to be identified. This instrument also evidenced the fact that the texts that were translated from English to Spanish grew were longer than those translated from Spanish to English. This was due to the grammatical characteristics that each language has. For example, in English, certain elements such as articles can be removed without making the text lose its naturalness, and in Spanish, some elements needed to be added in order to achieve text coherence.

6.2.4 To create a glossary with the most relevant terminology found in both texts

This objective was necessary for carrying out of the translations, since it provided important information regarding the specialized terminology of the texts. This objective was also successfully accomplished. The information that was compiled in the glossary table helped the translator not only to understand the text but also to understand elements about the topics where the terminology is used. The elaboration of the glossary was important, especially because the translated documents were scientific. The glossary table was prepared after the initial reading of the texts was done and before beginning the translations of the texts. The columns of the table provided the title of the text, the name of the concept, the definition of the concept, the synonyms for the concept, an example of how the term is used in other texts, and the target word. The glossary table that was carried out not only provided the necessary organization for the localizing of the terms but also additional information that helped in the full understanding of the concepts.

6.3. Restatement of the Research Question

The research question for this thesis was, “What is the effect of the procedures and methods used to translate various documents from Spanish into English and from English into Spanish for the National University of Costa Rica (UNA)?”. The answer to this question will provide the necessary information to conclude the thesis. Due to the fact that the research and the translations performed fully answer the research question, it was not necessary to modify it.

The data collection instruments that were used in this thesis before, during, and after the the translations of the documents provided important elements that characterize the translation process and the translations themselves. Without them, the translations would have turned out to be poor, generalized, and unclear. As it has been stated previously, the instruments exceeded the expectations for the translation of the documents, since they helped the translations be as informative, accurate, and natural as they could be. It can be evidenced that the translation procedures that were utilized in the translation process, successfully transferred all of the ideas into the target text.

Finally, it can be said that the instruments that were selected to carry out this thesis provided the necessary information to perform it, as well as to achieve every objective, and answer the research question effectively.

6.4. Recommendations

The recommendations that will be presented in this thesis are for those future translators who will have to translate technical and scientific texts like the ones that have been translated in this thesis. They will be very useful if they look for the background information in order to carry out an accurate translation as well as to save time during the translation process.

One of the main characteristics about technical and scientific texts is that they present specialized vocabulary that only experts on that field of study understand. That is the main challenge that translators must face because it makes the translation process more complicated, not only when translating the document, but also when understanding the text before translating it. That is why a translator must understand every term before starting the translation. For this thesis, additional information was gathered in the glossary chart, such as synonyms and an example of how the term is used in other texts. It would be very useful for future translators to delve deeper into terms, so as to find acronyms and terms related to it. In this way, the translator would have complete domain of the terms and would carry out a more accurate translation.

Another important recommendation is to research every aspect about the text, including its terminology, before initiating the translation. This will prove to be very useful during the translation process, since the translator will be able to just focus on translating the ideas. Otherwise, the translator will have to stop his/her thought process during the translation process to look up the necessary information, and this will make the translation process longer.

Finally, an aspect that is essential in every translation is rereading the text after the translation is concluded. Doing this will help to identify small details such as, articles, verb tenses, subject verb agreement, and punctuation that need to be modified. These elements might be overlooked during the translation, since the translator might be focused on how the ideas are linked specific terminology has been used. After finishing the translation, the translator must be sure that the texts sound as natural as possible and that the ideas have been translated accurately and coherently.

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APPENDIXES

Text Analysis Tables

Text title	Text style	Text function	Scale of formality	Scale of generality or difficulty	Emotional tone	Example of the final translation

Glossary Table

Text	Concept	Definition	Synonyms	Example of how the concept is used in other texts	Target word

Color Coding System Corresponding Colors Table

Translation Procedure	Corresponding Color
Transposition	
Modulation	
Omission	
Amplification	
Explicitation	
Literal Translation	
Punctuation Changes	
Compensation	
Equivalence	
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VERTEBRADOS TERRESTRES

Impact of jaguar *Panthera onca* (Carnívora: Felidae) predation on marine turtle populations in Tortuguero, Caribbean coast of Costa Rica

Efecto de la depredación por jaguares, Panthera onca (Carnívora: Felidae), sobre las poblaciones de tortugas marinas de Tortuguero, costa caribeña de Costa Rica

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ABSTRACT

Little is known about the effects of jaguars on the population of marine turtles nesting in Tortuguero National Park, Costa Rica. This study assessed jaguar predation impact on three species of marine turtles *(Chelonia mydas, Dermochelys coriácea* and *Eretmochelys imbricata)* that nest in Tortuguero beach. Jaguar predation data was obtained by using two methodologies, literature review (historical records prior the year 2005) and weekly surveys along the 29 km stretch of beach during the period 2005-2013. Our results indicated that jaguar predation has increased from one marine turtle in 1981 to 198 in 2013. Jaguars consumed annually an average of 120 (SD= 45) and 2 (SD= 3) green turtles and leatherbacks in Tortuguero beach, respectively. Based on our results we concluded that jaguars do not represent a threat to the population of green turtles that nest in Tortuguero beach, and it is not the main cause for population decline for leatherbacks and hawksbills. Future research should focus on continuing to monitor this predator-prey relationship as well as the factors that influence it so the proper management decisions can be taken.

Key words: Chelonia mydas ; Dermochelys coriacea ; Eretmochelys imbricata ; marine turtles; Panthera onca ; predator-prey interaction; Tortuguero National Park

RESUMEN

Existe poco conocimiento sobre el impacto que tienen los jaguares sobre las tortugas marinas que anidan en el Parque Nacional Tortuguero, Costa Rica. Este estudio evaluó el impacto de la depredación de jaguar sobre tres especies de tortugas marinas *(Chelonia mydas, Dermo-chelys coriácea* y *Eretmochelys imbricata)* que anidan en Tortuguero. Los reportes de depredación fueron obtenidos empleando dos metodologías, revisión literaria (eventos registrados antes del 2005) y monitoreos semanales a lo largo de la playa (durante el periodo 2005-2013). La depredación del jaguar se ha incrementado de una tortuga en 1981 a 198 tortugas en 2013. Asimismo, los jaguares consumieron anualmente un promedio de 120 (SD= 45) y 2 (SD= 3) tortugas verdes y tortugas baula en Tortuguero, respectivamente. Nuestros resultados indican que los jaguares no representan una amenaza para la población de tortugas verdes que anida en Tortuguero, y no son la causa principal de la disminución poblacional de la tortuga baula y carey. No obstante, se recomienda continuar con el monitoreo con el fin de entender cómo esta interacción depredador-presa evolucionará en el futuro.

Palabras clave: Chelonia mydas ; Dermochelys coriacea ; Eretmochelys imbricata ; tortugas marinas; Panthera onca ; interacción depredador-presa; Parque Nacional Tortuguero

Predator-prey interactions play a critical role in the dynamics of the ecosystems (Heithaus, Wirsing, Thomson, & Burkholder, 2008). It is well known that predators can have a direct effect on prey due to consumption of prey individuals (Nelson, Matthews, & Rosenheim, 2004; Heithaus et al., 2008). However, predators can also induce behavioral changes in prey which may lead to shift in activity patterns, reduction in foraging time or spatial and temporal redistribution, among others (Nelson et al., 2004; Heithaus et al., 2008, Valeix et al., 2009; Fitzpatrick et al., 2012). Nonetheless, the effect of predators on adult marine turtles has been overlooked since this interaction can be difficult to observe and quantify (Heithaus et al., 2007; Hays, 2008; Fitzpatrick et al., 2012; Bornatowski, Heithaus, Batista, & Mascar-enhas, 2012).

Heithaus et al. (2008) suggested that predators of adult marine turtles can influence turtle population sizes in spite of low predation rates. Pitman and Dutton (2004) also indicated that even opportunistic predation by killer whales *(Orcinus orca)* should be considered a factor in recovery efforts for the leatherback *(Der-mochelys coriacea)* population in the Northeast Pacific. In turn, Fergusson, Compagno and Marks (2000) mentioned that the impact of white shark *(Carcharodon carcharias)* predation upon marine turtle populations in the Mediterranean sea is unknown but probably extremely small compared to other sources of mortality (e.g. anthropogenic causes). Ortiz, Plotkin and Owens (1997) indicated that American crocodile *(Crocodylus acutus)* predation on the olive ridley sea turtles *(Lepidochelys olivacea)* have little or no effect on the nesting population at Playa Nancite in Costa Rica. They also highlighted that this interaction may enhance the survival of the local population of crocodiles. Heithaus et al. (2007) also emphasized that the loss of marine turtle predators could result in a negative impact in the ecosystem dynamics.

Although jaguar *(Panthera onca)* predation on marine turtles has been recorded throughout America (Autar, 1994; Carrillo, Morera, & Wong, 1994; Fretey, 1977; Troeng, 2000a; Keeran, 2013; Cuevas, Faller-Menen-dez, & Angulo, 2014) it seems that predation rates are not significantly large enough to influence the marine turtle population. However, in recent years this predator-prey interaction has drawn attention in Tortuguero National Park, Costa Rica (Verissimo, Jones, Chaverri, & Meyer, 2012; Barca, 2013; Arroyo-Arce, Guilder, & Salom-Perez, 2014). Troeng (2000a) mentioned that the green turtle *(Chelonia mydas)* population that nests in Tortuguero is not significantly threatened by jaguar predation. Contrary to this, Verissimo et al. (2012) indicated that jaguars should rank alongside, if not higher than, other documented threats. In this paper, we evaluated the impact of jaguar predation on three species of marine turtles *(C. mydas, D. coriacea, Eretmochelys imbricata)* that nest in Tortuguero beach. We also discuss how the availability of marine turtles may be affecting the local jaguar population.

MATERIALS AND METHODS

Study site: This study encompassed approximately 29 km of coastline in Tor-tuguero National Park, on the Northeastern Caribbean coast of Costa Rica (10°32'28" N - 83°30'08" W). The beach extends from the Tortuguero River mouth in the North, to the Jalova River mouth in the South, and it is bordered by tropical wet forest (Holdridge, 1969). Average temperatures are between 25 °C to 30 °C with a mean annual precipitation of 6 000 mm (Bermudez & Hernandez, 2004).

Data collection: Data was collected by using two methodologies. First, we reviewed the existing literature in order to obtain records on predation of marine turtles by jaguars in Tortuguero National Park prior to the year 2005. For this we only considered reliable sources, including reports and scientific publications. Secondly, weekly surveys were conducted along the beach from 2005 to 2013. For logistic reasons, between 2005 and 2009 the starting point of the survey was alternated between the North and South ends, while all surveys after January 2010 started at the South end. The pre-existing turtle monitoring program had divided the beach along its length by permanent marked signs into 0.8 km sections running North to South (Fig. 1). These sections we considered our sampling units.

Surveys consisted of recording data on presence or absence of jaguars by counting identifiable jaguar tracks on each sampling unit. Predated marine turtles by jaguars (hereafter known as kills) were also recorded by counting marine turtle carcasses on each sampling unit. When a carcass was found it was examined for evidence of jaguar predation (e.g. bite marks on the neck, drag marks, jaguar tracks). It is important to highlight that the jaguar is the only felid recorded in Tortuguero beach that predate marine turtles. If it was determined to be the result of jaguar predation the marine turtle species was recorded.

In order to avoid duplication of carcasses only green turtles that were estimated to have being killed in less than seven days were recorded. Due to the fact that predation on leatherbacks and hawksbills occurs to a lesser extent and therefore duplication is unlikely to occur, all carcasses were recorded regardless of the number of days that passed since they were predated. See Verissimo et al. (2012), Arroyo-Arce and Thomson (2015) for a throughout description of the methodology.

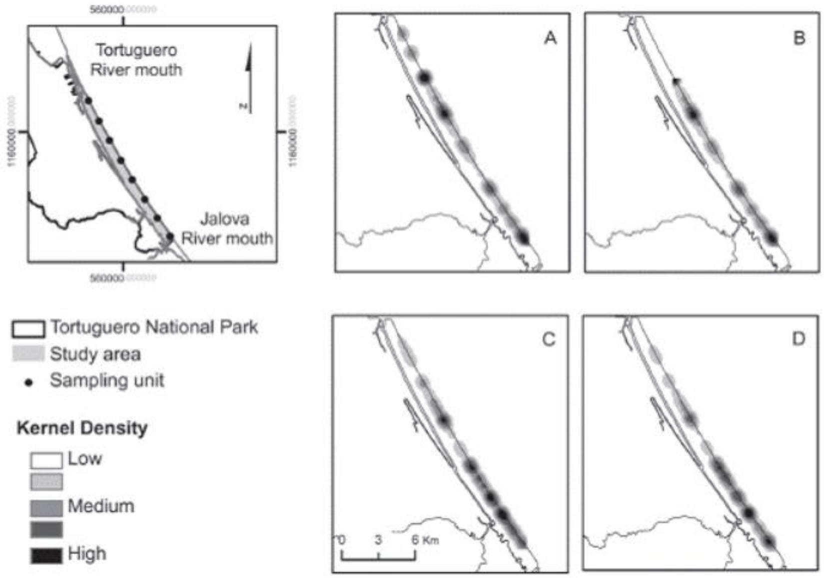

Fig. 1: Spatial distribution of marine turtle predation and jaguar *Panthera onca* presence within Tortuguero beach, Tortuguero National Park, Costa Rica. The first column indicates predation for 2005 (A) and 2013 (C); the second column indicates jaguar presence for 2005 (B) and 2013 (D).

Jaguar impact on marine turtle nesting population: For green turtles, annual nesting population estimates were calculated based on Troeng and Rankin's (2005) methodology. Predation estimates were determined using Equation A. For leatherbacks, annual nesting population estimates were calculated based on Spotila et al.'s (1996) methodology. Predation estimates were determined using Equation B. Jaguar impact on hawksbills was not estimated because the clutch frequency for the studied rookery is unknown.

Equation A: $P_{min}=Nest_{Cm.season}/6$, $P_{max}=Nest_{Cm.season}/2.8$, $Pre_{min}=Kills_{Cm}*100/P_{max}$, $Pre_{max}=Kills_{Cm}*100/P_{min}$

Equation B: $P_{est}=Nest_{Dc.season}/5$, $Pre_{est}=Kills_{Dc}*100/P_{est}$. where P_{mm}= minimum annual green turtle nesting population estimates, $Nest_{Cm\ season}$= annual green turtle nest number estimated for Tortu-guero beach according to Sea Turtle Conservancy reports (Sea Turtle Conservancy, 2014; E. Harrison, personal communication, May 6, 2014), 6= maximum estimated annual clutch frequency for green turtles (Troeng & Rankin, 2005), P_{max}= maximum annual green turtle nesting population estimates, 2.8= minimum estimated annual clutch frequency for green turtles (Troeng & Rankin, 2005), Pre_{min}= minimum annual green turtle predation estimates, $Kills_{Cm}$= total number of green turtles predated per year, Pre_{max}= maximum annual green turtle predation percentage estimates, P_{est}= annual leatherback nesting population estimates, $Nest\text{-}_{Dc\ season}$= annual leatherback nest number esti-Dc.season mated for Tortuguero beach according to Sea Turtle Conservancy reports (Sea Turtle Conservancy, 2014; E. Harrison, pers. comm., May 6, 2014), 5= estimated annual clutch frequency for leatherbacks (Spotila et al., 1996), Pre_{est}= annual leatherback predation percentage estimates, $Kills_{Dc}$= total number of leatherbacks predated per year.

Kruskal-Wallis test was also used to compare predation rates throughout the years. The statistical test was performed using R (v 3.0.3; R Foundation for Statistical Computing, Vienna, Austria). For these analyses only information collected during the weekly surveys was used. The information obtained through the literature review was not used in these analyses due to differences in methodologies; however, it was used as a reference of historical records prior to the year 2005.

Predation and jaguar activity hotspots:

Kernel Density estimation (Worton, 1989) was used to map the spatial distribution of turtle predation and jaguar presence between 2005 and 2013, and to estimate how the density of events varied over the study area throughout the years. The density estimates were computed and mapped using ArcMap software (v 10; Environmental Systems Research Institute, Redlands, CA, USA).

RESULTS

Based on the literature review, a total of 380 predation records were found for the study site between 1981 and 2004; the first green turtle predated by jaguar was reported in 1981. Predation events on green turtles tended to increase in the following years with a maximum of 97 records in 2001, and by 2004 only 48 predated turtles were documented. Jaguars also preyed upon leatherbacks and hawksbills, it is important to highlight that in 1999 and 2001 two leatherbacks and four hawksbills were killed, respectively; these records constitute the first time both of these species were documented as predated by jaguar (Table 1).

Between 2005 and 2013, after a total of 267 surveys (mean ± SD= 34±5 surveys per year, 3±1 surveys per month) we were able to document three species of marine turtles *(C. mydas, E. imbricata* and *D. coriácea)* and a total of 1 110 carcasses predated by jaguars.

Predation on green turtles increased from 63 carcasses in 2005 to 196 in 2013 (Fig. 2), with a total of 1 078 individuals predated since the beginning of the study. Despite this increase in predation, there was not a significant difference between years ($H= 10.136$, $d.f.= 8$, $p= 0.256$). In all years, predation events were higher during the peak of the green turtle nesting season (from mid-July to mid-October). Data also indicated that predation increased as the nesting population increased (and vice versa) and that jaguars consumed annually an average of 120 green turtles (SD= 45; Fig. 2).

Table 1: Literature review on predation of marine turtles by jaguar *Panthera onca* in Tortuguero National Park, Costa Rica Predated[1]

Year	Predated[1]			Source
	Cm[2]	Dc[3]	Ei[4]	
1981	1	0	0	Carrillo, Morera & Wong, 1994
1984	1	0	0	Tröeng, 2000a
1997	4	0	0	Tröeng, 1997; Tröeng, 2000a
1998	25	0	0	Tröeng, 1999; Tröeng, 2000a
1999	22	2	0	Tröeng, 2000a; Tröeng, 2000b; Tröeng, 2000c
2000	60	0	0	Mangel & Tröeng, 2001
2001	97	1	4	Reyes & Tröeng, 2001; Reyes & Tröeng, 2002
2002	86	0	0	Harrison & Tröeng, 2003
2003	28	0	1	Harrison & Tröeng, 2004
2004	48	0	0	Harrison & Tröeng, 2005

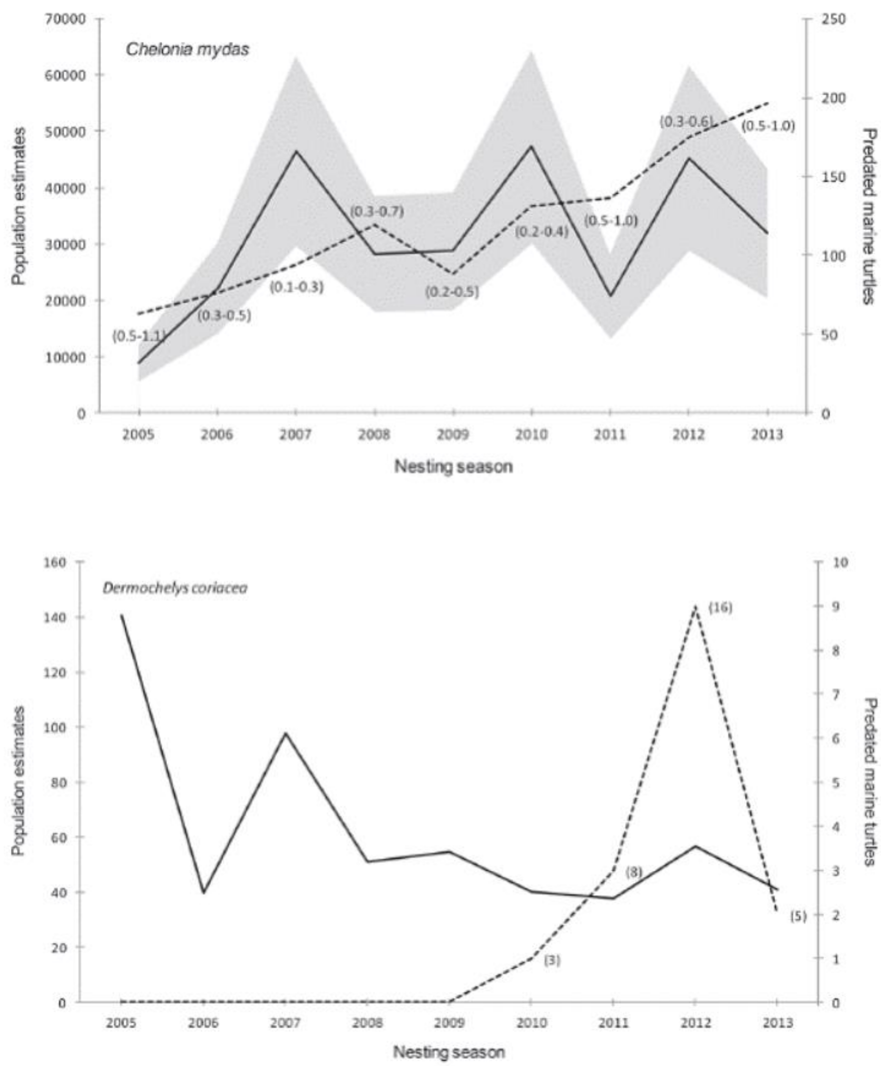

Fig. 2: Jaguar *Panthera onca* impact on green turtle *Chelonia mydas* and leatherback *Dermochelys coriacea* nesting populations in Tortuguero National Park, Costa Rica. Solid line: population estimates; dash line: total number of predated turtles; shade area: minimum and maximum population estimates; in parentheses: percentage of predation estimates.

Since 2005, jaguars predated a total of 15 leatherbacks with no predation events documented until 2010 (Fig. 2); predation events occurred only between February to May. It seems that jaguar predation also increased as the nesting population increased, and that jaguars consumed an average of 2 leatherbacks per year (SD=

3; Fig. 2). A total of 17 hawks-bills (mean±SD= 2±2 kills per year) were also predated by jaguars with no kills reported during 2006 and 2008; predation events occurred between April to November.

Data indicated that the distribution of predated turtles and jaguar presence varied spatially, and revealed distinct high-density areas across the coastal habitat. In 2005 three major hotspots for both predation and jaguar activity were identified within the study area (Fig. 1A and Fig. 1C). Predation hotspots encompassed up to four predated turtles. Over the years, there was a shift of both predation and jaguar presence to the Southern sector of the beach. By 2013 four predation hotspots were identified (Fig. 1B) encompassing sites with up to 18 predated turtles. The Southern sector of the beach also seems to be a core area of jaguar activity (Fig. 1D).

DISCUSSION

Throughout the years jaguar predation on green turtles was significantly higher compared to that of leatherbacks and hawksbills, which could be attributed to its abundance and availability. In Tortuguero beach, the estimated green turtle nesting population is significantly larger than the leatherback and hawksbill (Troeng & Rankin, 2005; Troeng, Harrison, Evans, Haro, & Vargas, 2007; Galean & Harrison, 2012). Furthermore, green nesting season occurs over a longer period of time (from February to November) compared to the leath-erback (from February to May) and hawksbill (sporadic nesting throughout the year). Several researches (Karanth & Sunquist, 1995; Gonzalez & Miller, 2002; Polisar et al., 2003; Azevedo & Murray, 2007) suggest that prey abundance and prey availability are the most important ecological factors that explain prey selectivity in large felids.

The higher predation on green turtles could also be due to changes in the presence of jaguars throughout the season. In Tortuguero beach, jaguar presence tends to be lower during the leatherback nesting season but increases as the green nesting season approaches (Arroyo-Arce, unpublished). This pattern could respond to jaguars restricting their movement patterns to the coastal habitat in the months when there is greater prey availability (green nesting season, Arroyo-Arce et al., 2014). Other studies also showed how movement and activity patterns of jaguars depend on those of their main prey (Rabinowitz & Nottingham, 1986; Carrillo, Fuller, & Sáenz, 2009; Harmsen, Foster, Silver, Ostro, & Doncaster, 2011).

The increase in marine turtle predation reported since 1981 could be related to habitat degradation (due to the expansion of the agricultural frontier) that took place inland across the Park's buffer zone in the early 1990s (Troeng, 2000a; Arroyo-Arce et al., 2014). Another factor potentially influencing predation rates is the apparent decline of the main prey species (e.g. *Tayassu pecari, Mazama americana, Cuniculus paca* and *Dasyprocta punctata)* due to illegal hunting inside the Park (Troeng, 2000a; Arroyo-Arce et al., 2014). These anthropogenic pressures may be playing an important role in driving the jaguars towards the coastal habitat, and causing the felid to increasingly select marine turtles as prey (Troeng, 2000a; Veríssimo et al., 2012; Arroyo-Arce et al., 2014). An increase in the local population of jaguars could also explain the increase in predation rates (Arroyo-Arce, unpublished). Although jaguars have been observed in Tortuguero beach since the 1950s (Harrison, Troeng, & Fletcher, 2005) there were no population estimates until 2010, when cameras traps where first used. Since then, the number ofjaguars preying on marine turtles has increased from two males to 15 (3 adult males, 2 cub males, 7 adult females, 1 cub female, 1 adult unsexed and 1 cub unsexed) individuals by 2013 (Arroyo-Arce, unpublished).

Our results suggest that current predation rates do not represent a significant threat to the green turtle population that nest in Tortuguero beach (Troeng, 2000a), which differs from Verissimo et al. (2012) who mentioned that jaguar predation should be considered as one of the highest threats. Some authors (Troeng, 2000a; Campbell & Lagueux, 2005) mention that human activities (e.g. illegal poaching, commercial fishing) have a greater impact than jaguar predation. For example, in 1996 at least 10 166 green turtles were captured by commercial fishing in the feeding grounds of Nicaragua (Lagueux, 1998); individuals that are most likely from the Tortuguero population (Bass, Lagueux, & Bowen, 1998). In 1997 an estimate of 1 783 green turtles females were taken by humans at Tortuguero beach (Troeng, 1997), however, only four individuals were predated by jaguars (Troeng, 1997; Troeng, 2000a). Another threat is the population of feral domestic dogs *(Canis familiaris)* in Tortuguero village (Verissimo et al., 2012), which have predated nearly 388 nests during the period 2005-2012 (Sea Turtle Conservancy, 2014). The higher predation rates occurred in 2007 and 2010 with 199 and 180 nests poached, respectively (Debade, Nolasco, & Harrison, 2008; Atkinson, Nolasco, & Harrison, 2011). Other species predating upon nests or hatch-lings while on the beach are coatis *(Nasua narica),* black vulture *(Coragyps atratus),* turkey vulture *(Cathartes aura)* as well as ghost crabs *(Ocypode quadrata;* Sea Turtle Conservancy, 2014). It is important to highlight that in despite of these threats, the Tortuguero green turtle population has increased by 61% since 1986 (Troeng & Rankin, 2005).

The leatherback nesting population in Tor-tuguero beach is subject to much adversity, with a population decreasing by 67 % during the period 1995 and 2006 (Troeng et al., 2007). A similar pattern has been reported in two other beaches (Gandoca and Pacuare) near Tortuguero (Troeng, Chacon, & Dick, 2004). Some factors that could be contributing to the decline in the local leatherback population are mortality of adults and juveniles in fisheries by 'catch' in feeding areas, and illegal poaching of female turtles and nests in Tortuguero and nearby beaches (Troeng et al., 2004; Troeng et al., 2007; Sea Turtle Conservancy, 2014). Jaguar predation on leatherbacks was first reported in 1999, and predation rates fluctuated greatly throughout the seasons. It is not clear if jaguar predation on leatherbacks is having a significant effect on the turtle's population decline, but we believe it is not the main cause as the number of predated leatherbacks between 1997 and 2006 was only three while the population had a significant decline during roughly the same period (Troeng et al., 2007).

In Tortuguero National Park, there has also been a significant decline in the hawksbill nesting population during the period from 1956 to 2003 (Bjorndal, Bolten, & Lagueux, 1993; Meylan, & Donnelly, 1993; Troeng, Dutton, & Evans, 2005). This species faces similar threats to that suffered by other marine turtles such as commercial exploitation (e.g. eggs, meat and carapace) and incidental capture in fishing gear (Meylan & Donnelly, 1993; Troeng et al., 2005). As with leatherbacks, jaguar predation of this species has been observed at irregular intervals, fitting to the sporadic nesting behaviour of this species in Tortuguero. Therefore, we consider that current predation rates do not represent a significant threat to the local nesting population. However, Troeng et al. (2005) indicated that jaguar predation may prevent population recovery of this species in Tortuguero beach. This could hold true for leatherbacks as well.

Jaguars tend to avoid human-dominated areas (Cullen, Sana, Lima, Abreu, & Uezu, 2013). Therefore, it is expected that the core areas of jaguar activity, and therefore predation, are localized away from Tortuguero village, which is located in the North end of the beach. The far South end of the beach also reported lower numbers of both predation and jaguar activity, which could be related to the presence of a small ranch, a coconut plantation and a research station located in this end of the beach, as well as the presence of Parismina village located on the other side of Jalova River mouth. A similar pattern was described by Verissimo et al. (2012).

Our data also shows that the higher predation rates occur in areas with a higher nesting density. In Tortuguero beach, turtle nesting density tended to be lower closer to Tortuguero and Jalova river mouths, which are the least stable areas of nesting habitat (Gonzales, Guerrero, & Harrison, 2013). Further, between the period from 2005 to 2013 the higher nesting levels were recorded between kilometers 6 and 22 (Haro & Troeng, 2006; Gonzales et al., 2013) corresponding with predation hotspots. Hence, the spatial distribution of nesting females along the beach could also be affecting the spatial arrangement of jaguar activity and predation hotspots. This differs from Veríssimo et al. (2012) who considered that turtle presence is not an important predictor for jaguar predation.

This study suggests that jaguar predation do not represent a threat to the population of green turtles that nest in Tortuguero National Park, and it is not the main cause for population decline for leatherbacks and hawksbills. However, there are still major gaps in our understanding of the interaction between jaguars and marine turtles (e.g. do jaguars predation influence marine turtle behavior?). Therefore, it is important to continuously monitor and evaluate this predator-prey relationship in order to understand how it will evolve in the future. Further understanding of this issue will be required for an effective management of the local jaguar population, as well as the marine turtle species that nest in Tortuguero National Park.

Our findings also stress the potential importance of Tortuguero beach to support the local jaguar population. The beach not only hosts a stable prey community (marine turtles) but also contains a known population of resident and migratory jaguars (which can facilitate gene flow and connectivity between populations) as well as being a breeding area and parenting site (I. Thomson, personal communication, October 1, 2014). The conservation of this area could be critical for the long term survival of the species in the region. Further research on the abundance of terrestrial prey species for jaguars is also essential to better understand the dynamics of this predator-prey relationship.

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Evaluating management strategies in the conservation of the critically endangered Blue-throated Macaw (*Ara glaucogularis*)

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A B S T R A C T

We model the dynamics of the remaining wild population of the Blue-throated Macaw (*Ara glaucogularis*), a critically endangered and Bolivian endemic species exposed to different management strategies. The model becomes a tool to quantify how effective management actions may be. We construct a birth-pulse, post breeding census, deterministic, stage structured projection matrix model to describe the population dynamics. The model shows that population growth is sensitive to changes in the probability of survival in the adult stage, followed by changes in fertility. We describe the long-term behavior of the population as result of the combination of the maternity function and the nestlings' survival probability. Under the scenarios of increasing population, the number of years that are necessary to double the current wild population varied between 33 and 215 years without reintroduction, and between 7 and 46 years if 50 adult macaws are reintroduced ten years later since the simulation starts. Stakeholders of the Blue-throated Macaw Conservation Project may profit from a simple graphical tool based on this model for management decision making. By knowing the adult population size and the number of hatched eggs at the beginning of each breeding season, the field team could assess the necessary effort on nestlings' management to increase the chances of a positive population growth. Evaluating beforehand the impact of management actions on Blue-throated Macaws could contribute to the improvement and effectiveness of conservation actions on the critically endangered Blue-throated Macaw population.

1. Introduction

Macaws are the most endangered group of the Psittacidae family, counting one extinct species, three critically endangered ones. Habitat loss, trade and the hunting for indigenous ornamental feathers dresses are the main causes of macaws' population decline (Snyder, 2000; Birdlife International, 2016). More than 50% of macaw species are included in the Red List as Endangered, Vulnerable, or Near Threatened species (Birdlife International, 2016). Rediscovered in the savannahs of Bolivia in 1992, the Blue-throated Macaw *Ara glaucogularis* is the last critically endangered macaw still sustaining a wild population (Birdlife International, 2016; Forshaw, 1989; Hesse and Duffield, 2000).

The wild population of the Blue-throated Macaw is unlikely to count more than 115–125 individuals (Birdlife International, 2016). A number of conservation actions aimed to recover the wild population were conducted during the last 15 years. However, our knowledge of the species' biology is limited to descriptions and estimations of range, habitat use, population size, and some basic reproductive parameters, recently described (Hesse and Duffield, 2000; Yamashita and Barros, 1997; Herrera et al., 2007; Berkunsky et al., 2014).

The conservation initiatives on the Blue-throated Macaw focus on actions aimed at providing long-term solutions (Berkunsky et al., 2014). As it occurs in many small populations, the limited number of individuals is one of the most serious threats, and all the efforts are addressed to boost the reproductive output by managing the wild population, and to reinforce it by reintroductions of captive-bred individuals. How effective these management actions will be, must be related to how precisely current threats and limiting factors, such as nest predation, nest flooding, brood reduction and nest site availability (Berkunsky et al., 2014; Kyle, 2006), can be identified. These actions include the protection of natural nests, the provision and protection of nest boxes, the use of defenses against predators and drainage systems for the boxes, and the hand-feeding of nestlings during first weeks of life (Berkunsky et al.,

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2014). Although the relative effectiveness of management actions is known, yet these were never analyzed in the global context. As part of a management strategy, knowledge of the impact and scope of each action facilitates decision-making and optimizes resources for conservation.

Modeling results in an effective tool for quantifying how effective management actions may be, and can help to better understand how accurately the current threats and limiting factors are being identified (Noon and Sauer, 1992; Simons, 1984). Strem (2008) developed a demographic model of the Blue-throated Macaw population in 2008 conducting a population viability analysis (PVA) using individual-based (VORTEX 9.72) and cohort-based (RAMAS GIS 4.0) programs. The accumulation of new data and plans for reintroduction since 2008 indicate that it is time to reassess the population and conservation projects (Berkunsky et al., 2014). Deterministic models can be a useful and simple tool for the management of endangered species (Caswell, 2001). A small number of input variable still providing good estimates of the effects of anthropogenic perturbations on species near the threshold of extinction. Also it can provide insight into the potential consequences of threatening processes and highlight the urgency with which management authorities need to act (Otway et al., 2004).

In this work we model the dynamics of the wild Blue-throated Macaw population under different management strategies. By quantifying the impact of management actions on Blue-throated Macaws we hope to contribute to the improvement and effectiveness of Blue-throated Macaw conservation projects and measures.

2. Materials and methods

2.1. Study site

The Llanos de Moxos is a 160,000 km^2 expanse of seasonally inundated savannahs in Northern Bolivia, interspersed with a complex mosaic of forest islands and riverine gallery forests, occupying the extremely flat Beni-Mamore-Itenez basin in Southwest Amazonia, located between the Precambrian Shield to the East and the Andes to the West and South (Forshaw, 1989). The lanscape is dominated by flat, low-lying areas, which are seasonally inundated and covered by completely open treeless savannah (Langstroth, 1996). Forest islands are scarce and restricted to raised areas (mounds) which are sufficiently elevated to escape annual flooding. Most forest islands are eroded relics of natural levees or terraces of abandoned river channels, and therefore constitute fragments of former gallery forest (Hanagarth and Sarmiento, 1990).

2.2. Blue-throated Macaw's biology and management

The Blue-throated Macaw is a critically endangered parrot, endemic of Llanos de Moxos (Jordan and Munn, 1993), throughout a geographic range of 2508 km^2 in Beni Department, Bolivia (Hesse and Duffield, 2000). The habitat availability is enough to support a large population of macaws, and there is no evidence of limiting resources for the species, at least at these low numbers (Hesse and Duffield, 2000; Berkunsky et al., 2014; Strem, 2008).

The species has a monogamous mating system (Snyder, 2000; Forshaw, 1989). In captivity, an individual reaches sexual maturity, on average, at the age of five years (Bueno, 2000; Voss, 2005). In the wild, the breeding season of Blue-throated Macaws begins during the dry season (August) and extends over the rainy season, lasting until February (Berkunsky et al., 2014). In the wild, clutch size varies from 1 to 3 eggs, the latter being most common. Eggs are laid at 1–2 day intervals, incubation period is 25–26 days, and nestlings fledge approximately 90 days after hatching (Berkunsky et al., 2014). Data on sex ratio in the wild are scarce; nevertheless, the sex ratio (males/females) in the Loroparque Fundación, the largest captive population in the world counting some 150 individuals, is close to 1:1 (Bueno, 2000).

Table 1
Number of counted pairs and individuals per year and median of the monitored population of Blue-throated Macaw for the period 2004–2011 by The World Parrot Trust in Beni, Bolivia.

	2004	2005	2006	2007	2008	2009	2010	2011
Pairs laying eggs	6	6	7	10	2	8	4	3
Successful pairs	3	1	6	6	2	8	4	2
Hatched eggs	3	1	8	13	4	16	10	3
Fledglings	2	1	6	10	0	9	3	2
Juveniles and adults	50	60	60	80	65	70	70	70

Currently, there is no data on the mean lifespan of Blue-throated Macaw in the wild. We took into account the value reported by Strem (2008), who estimated it to be at least 40 years. Because there is no evidence to suggest a post-reproductive stage, age of last reproduction and maximum age were assumed to be the same.

The wild Blue-throated Macaw population is estimated to fall between 115 and 125 individuals. At least 16 breeding pairs were identified and followed over 8 years. During this study period there were no new adult pairs recruited into the breeding population. Table 1 summarizes data collected during eight consecutive breeding seasons from 2004 to 2011 (Berkunsky et al., 2014; Kyle, 2006). The variables measured were: numbers of adults and juveniles, breeding and successful pairs, hatched eggs and fledglings per nest. Each year, between 2 and 10 pairs laid eggs, with a median of 6 pairs. They produced between 0 and 10 fledglings, with a median of 2.5 fledglings.

Long term conservation management is in place for the Blue-throated Macaw in Beni, Bolivia since 2000 (Hesse and Duffield, 2000). To reduce nesting failure, drainage holes or roofs were installed in all known nests prone to flooding. Other actions aimed at avoiding nest failure included passive and active anti-predator defenses. Passive defenses are metal flashing wrapped around tree trunks and branches pruned back from cavities to abate climbing predators. Active defenses involve a high level of daily monitoring by volunteers. Most of the defenses seem to be effective given that no nests have been flooded since 2008, and that 2010 was the first year since the beginning of Blue-throated Macaw nest monitoring with no recorded predation.

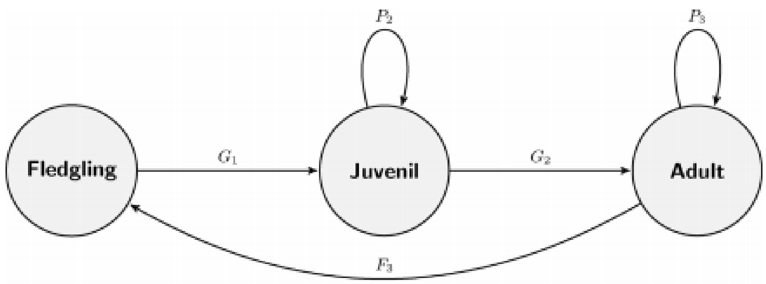
The conservation project also provided nest boxes which have a good drainage and could be placed to safer positions. However, it takes time for Macaws to get used to nest boxes, since until 2014 only five pairs had used nest-boxes in fourteen different attempts.

To avoid brood reduction, the project monitors nests in a daily basis, identifying nestlings that need a boost, and helping them by hand-feeding. Since 2007, thanks to this intervention, no nestlings have died because of brood reduction and the average number of fledglings per nest has increased from one to two.

Another management action has been moving individuals who are in captivity to a Wildlife's Custody Center in Sachojere, Beni, Bolivia. Up to date, six individuals have already been recovered, whose final destination will be their reintroduction in Llanos de Moxos to strengthen existing populations. In a first stage, at least 50 individuals are expected to be reintroduced.

2.3. Matrix model development

We used a birth-pulse, post breeding census, deterministic, stage projection matrix model to describe the dynamics of the total population of the Blue-throated Macaw as proposed by Caswell (2001). The equation describing this model is of the form: $\mathbf{n}(t+1) = A\mathbf{n}(t)$, where vector $\mathbf{n}(t)$ gives the population in each stage at time t and A is a Lefkovitch projection matrix.



$$A = \begin{pmatrix} 0 & 0 & F_3 \\ G_1 & P_2 & 0 \\ 0 & G_2 & P_3 \end{pmatrix}$$

Fig. 1. Life cycle graph and the corresponding Lefkovitch population matrix for the Blue-throated Macaw in Beni, Bolivia considering three stages: fledgling, juvenile and adult; and vital rates: permanence (P), growth (G) and fertility (F).

The Blue-throated Macaw population was modeled considering three biologically defined stages with a projection interval (time from t to $t+1$) of 1 year: (1) fledglings, (2) juveniles and (3) adults. The population projection matrix parameters (i.e. vital rates) are permanence (P), growth (G) and fertility (F). P_i is the probability that an individual in stage i (at time t) will survive and remain in stage i (at time $t+1$), G_i is the probability that an individual in stage i (at time t) will survive and grow to stage $i+1$ (at time $t+1$), and F_i is defined as the number of offspring in time $t+1$, per individual in stage i at time t. In Fig. 1 it is showed the life cycle graph and the corresponding Lefkovitch population matrix for the Blue-throated Macaw in Beni, Bolivia.

The projection matrix A is primitive (i.e. A is nonnegative and there is a k such that A^k is positive) and it satisfies the hypothesis of the Strong Ergodic Theorem since the population is ergodic, meaning that its long-term behavior is independent of its initial state (Caswell, 2001; Cohen, 1979). Considering that λ_1 is the real dominant eigenvalue of A, which existence is guaranteed by the Perron-Frobenius Theorem (Gantmacher, 1959), and $\mathbf{w}_1$ the associated eigenvector, it is obtained that $\lim_{t\to\infty} \mathbf{n}(t) = c_1\lambda_1^t \mathbf{w}_1$. Consequently, the modeled population will grow at a rate given by the dominant eigenvalue (λ_1), and, independently of the initial population vector, the stable stage distribution will be given by the right eigenvector associated ($\mathbf{w}_1$) to the dominant eigenvalue. When reaching a stable distribution, this eigenvector will give information on the proportion of the population in each of the stages.

2.3.1. *Estimation and sensitivity of the vital rates*

Parameters P_i and G_i, in a stage structured model, can be estimated from information on stage duration. Caswell (2001) proposed to separate the process of survival and growth by introducing two probabilities:

$$\sigma_i = P(\textit{survival of an individual in stage } i)$$

$$\gamma_i = P(\textit{growth from } i \textit{ to } i+1 | \textit{survival})$$

resulting

$$G_i = \sigma_i \gamma_i$$

$$P_i = \sigma_i (1-\gamma_i)$$

In each stage σ_i is constant and the age distribution within the stage is stable for a stable age distribution in each stage. The estimation of γ_i is done using:

$$\gamma_i = \frac{\left(\frac{\sigma_i}{\lambda}\right)^{T_i} - \left(\frac{\sigma_i}{\lambda}\right)^{T_i-1}}{\left(\frac{\sigma_i}{\lambda}\right)^{T_i} - 1},$$

where T_i represents the duration of stage i.

We considered that population lives until the age of forty years, the duration of fledgling stage is four years and that individuals can reproduce until they die.

The value of σ_1 was taken from Strem (2008), where it was estimated to be 0.7. The value of γ_1 is 1, since in one time step all individuals in the first stage, grow to the new stage, juvenile. The inability to distinguish juveniles from adults when censuses were taken for this population in Beni, Bolivia and since the observations of captive populations indicate no significant differences in survival of juveniles and adults, determined to assume: $\sigma_2 = \sigma_3 = \sigma$.

Fertility (F_i) is defined as the number of offspring in time $t+1$, per adult individual in time t, and it is usually described as $F_i = m_i P_i$ where m_i is the product between the expected number of hatched eggs per individual in adult stage per year, maternity function (m) and the probability of survival of these hatched eggs for the fraction of the time interval p from hatching to fledgling, ($l(p)$).

Then, the characteristic polynomial of A is

$$\chi_A(\lambda) = \begin{vmatrix} \lambda & 0 & -ml(0.25)\sigma\left(1 - \frac{\left(\frac{\sigma}{\lambda}\right)^{35} - \left(\frac{\sigma}{\lambda}\right)^{34}}{\left(\frac{\sigma}{\lambda}\right)^{35} - 1}\right) \\ -0.7 & \lambda - \sigma\left(1 - \frac{\left(\frac{\sigma}{\lambda}\right)^{4} - \left(\frac{\sigma}{\lambda}\right)^{3}}{\left(\frac{\sigma}{\lambda}\right)^{4} - 1}\right) & 0 \\ 0 & -\sigma\left(\frac{\left(\frac{\sigma}{\lambda}\right)^{4} - \left(\frac{\sigma}{\lambda}\right)^{3}}{\left(\frac{\sigma}{\lambda}\right)^{4} - 1}\right) & \lambda - \sigma\left(1 - \frac{\left(\frac{\sigma}{\lambda}\right)^{35} - \left(\frac{\sigma}{\lambda}\right)^{34}}{\left(\frac{\sigma}{\lambda}\right)^{35} - 1}\right) \end{vmatrix} \quad (1)$$

Sensitivity predicts the impact of hypothetical alterations in parameters on population growth rate (de Kroon et al., 1986). The sensitivity of λ to small changes in a model parameter a_{ij} is, as Caswell (Caswell, 2001) defined, is the partial derivative of λ with respect to a_{ij}. The sensitivity of λ to all of the a_{ij} can be calculated in a sensitivity matrix $S = (\frac{\partial\lambda}{\partial a_{ij}})$.

Table 2
Estimation of the number of adults and the values of maternity (m) and nestling survival (l) of the monitored population of Blue-throated Macaw for the period 2004–2011 by The World Parrot Trust in Beni, Bolivia.

Year	Adults	l	m
2004	43	0.6667	0.0698
2005	49	1.0000	0.0204
2006	55	0.7500	0.1455
2007	75	0.7692	0.1733
2008	56	0.0000	0.0714
2009	70	0.5625	0.2286
2010	65	0.3000	0.1538
2011	59	0.6667	0.0508
Median	57.5	0.6667	0.1084

2.4. How management actions affect parameters

The management actions can affect fertility (F) in different ways. For example, the protection of cavities results in a higher number of eggs hatched, and consequently the maternity function (m) increases its value. On the other hand, protection and hand-feeding of nestlings increase their probability of survival (l). Hence, we combined the quartiles of the maternity function (m) and the survival of nestlings for identifying which combination of their values allows population growth. We estimated the number of years needed to double the current wild population of macaws, under three reintroduction scenarios: (a) no reintroduction; (b) reintroduction of 50 adult macaws in groups of ten individuals per year during five consecutive years; and (c) reintroduction of 50 adult macaws in one single group.

3. Results

From the values in Table 1, we compute the number of hatched eggs per individual in adult stage per year (m) and the probability of survival of these hatched eggs for the fraction of the time interval p from hatching to fledgling (3 months, p = 0.25), calculated as the number of fledglings over the number of hatched eggs. The results obtained are shown in Table 2.

We used median and quartiles to estimate the parameters of the model. From the characteristic polynomial $\chi_A(1) = 0$, and suppose that the the population is stable, we have $\sigma_2 = \sigma_3 = 0.9735$ and, consequently:

$$\gamma_2 = \frac{\sigma_2^4 - \sigma_2^3}{\sigma_2^4 - 1} \simeq 0.2400$$

$$\gamma_3 = \frac{\sigma_3^{35} - \sigma_3^{34}}{\sigma_3^{35} - 1} \simeq 0.01745$$

Table 3
Values of probabilities of survival (σ_i and l), growth (γ_i), and the expected number of hatched eggs per adult per year (m) for the Blue-throated Macaw in Beni, Bolivia.

Vital rate	Description	Value
σ_1	Annual probability of survival in fledgling stage	0.7000
σ_2	Annual probability of survival in juvenile stage	0.9735
σ_3	Annual probability of survival in adult stage	0.9735
γ_1	Probability of growth from fledging to juvenile since survived	1.0000
γ_2	Annual probability of growth from juvenile to adult since survived	0.2400
$l(0.25)$	Probability of survival from hatching to fledging	0.6667
m	Annual median of hatchlings per adult	0.1084

Table 4
Sensitivity analysis (λ = 1) for vital rates of the projection matrix of the stage structured population model for the Blue-throated Macaw in the Beni, Bolivia.

Vital rate	Value	Description	Sensitivity
P_3	0.9565	Permanency in adult stage	0.8260
F_3	0.0692	Fertility of adults	0.5193
G_2	0.2337	Growth from juvenile to adult	0.1537
P_2	0.7398	Permanency in juvenile stage	0.1380
G_1	0.7000	Growth from fledgling to juvenile	0.0513

From the probabilities of survival, growth, and the expected number of hatched eggs per adult per year (Table 3), and considering that sex ratio (1:1), density-independent growth, and population closed to migration, we estimated permanence (P), growth (G) and fertility (F) of the population projection matrix for Blue-throated Macaw population in Beni, Bolivia.

The sensitivity analysis performed on the vital rates of this projection matrix showed that population growth is more sensitive to changes in the probability of surviving and remaining in the adult stage (P_3), followed by changes in fertility (F_3). Table 4 shows the sensitivity values for λ = 1.

Table 5 shows the long-term behavior of the population (decreasing, stable or increasing) as result of the combination of quartiles of the maternity function (m) and survival probability of nestlings (l). Under the four scenarios of increasing population, the number of years that are necessary to double the current wild population varied between 33 and 215 years without reintroduction and between 7 and 46 years if 50 adult macaws are reintroduced (Table 6). In terms of the dominant eigenvalue, the stable population distribution is reached within a period of 12–15 years.

Table 5
The long-term behavior of the wild Blue-throated Macaw population determined from each dominant eigenvalue (value in parenthesis) as result of the combination of quartiles of the number of hatched eggs per adult per year [m] and survival of nestlings from hatching to fledging [l]. A dominant eigenvalue higher than 1 implies the population will increase.

		Survival of nestlings from hatching to fledging l		
		Low [0.4969]	Medium [0.6667]	High [0.7548]
Number of hatched eggs per adult per year [m]	Low [0.0650]	Decreasing (0.9782)	Decreasing (0.9905)	Decreasing (0.9877)
	Medium [0.1084]	Decreasing (0.9905)	Stable (1.0000)	Increasing (1.0046)
	High [0.1587]	Increasing (1.0032)	Increasing (1.0156)	Increasing (1.0216)

Table 6
Time (in years) necessary to double the current wild population for each scenario of increasing population for the Blue-throated Macaw in Beni, Bolivia.

	Medium hatching, high survival	High hatching, low survival	High hatching, medium survival	High hatching, high survival
Without reintroduction	149	215	45	33
10 individuals per year over 5 years	32	46	10	8
50 individuals at once	31	44	9	7

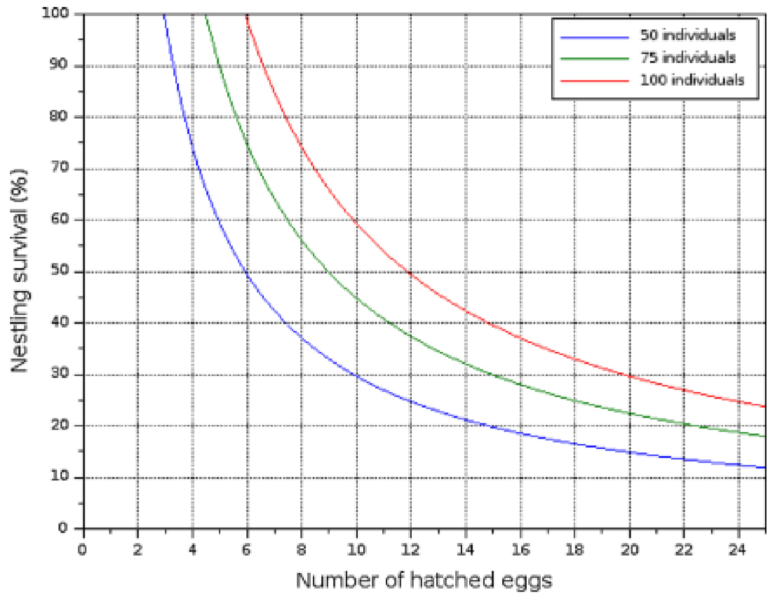


Fig. 2. Relationship between the total number of hatched eggs per year and the percentage of successful fledglings for three stable populations of 50, 75 and 100 adult Blue-throated Macaws (i.e. $\lambda = 1$). Values above the curves imply the population will increase.

4. Discussion

Here we have built a structured stage, discrete-time population model which allowed us to analyze the dynamics of the remaining wild population of Blue-throated Macaw. Our results were supported by the information gathered by monitoring this wild population during eight consecutive breeding seasons (Berkunsky et al., 2014).

The sensitivity analysis showed population growth is sensitive to the survival of adults, followed by their fertility. The priorities of management of the wild population should aim at enhancing these two parameters. Our deterministic approach reached the same conclusion as a previous stochastic approach (i.e. the Population Viability Analysis conducted by Strem (2008)) where adult mortality had a greater impact on the probability of extinction. Successful actions aimed at avoiding the hunting of adults would increase the chances of viability of the population. Meanwhile, increasing the number of fledglings will also have a positive impact on the population size.

The combination of quartiles of the maternity function and the survival probability of nestlings allowed us to identify which combination of values result in population growth. In current wild adult populations, when maternity is close to the median value (i.e. six hatched eggs per year, Table 1), a survival of at least 67% of nestlings (i.e. 4 fledglings) is necessary for a positive population growth; which implies large efforts in feeding and protection of nestlings coinciding with the conclusions of Strem (2008). On the other hand, nine hatched eggs increase the chances of a positive population growth in all three scenarios of nestling survival. The number of hatched eggs could be raised by increasing the availability and protection of cavities, and/or by introducing adult macaws into the wild population.

The model allowed us to simulate different options of reintroduction. The reintroduction of 50 adult macaws would reduce between 4 and 5 times the number of years that are necessary to double the wild population under current management conditions. The 50-adult macaw reintroduction in the best management scenario would double the wild population in less than 10 years. On the other hand, without reintroduction and keeping current management actions, between 33 and 215 years would be necessary to double the wild population. Both reintroduction strategies, all individual in a single group or five groups of ten individuals each introduced in consecutive years, showed similar times needed to double the current wild population.

We believe that this model can be an effective tool to quantify the effect of management actions as these actions can be translated into changes in the vital parameters. Stakeholders of the Blue-throated Macaw Conservation Project may have a simple graphical tool for management decision making (Fig. 2). By knowing the adult population size and the number of hatched eggs at the beginning of each breeding season, the field team may be able to assess the necessary effort on nestlings' management to increase the chances of a positive population growth. By quantifying the impact of management actions on Blue-throated Macaws, we hope contribute to the improvement and effectiveness of conservation actions in the critically endangered species.

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Reproductive Parameters in the Critically Endangered Blue-Throated Macaw: Limits to the Recovery of a Parrot under Intensive Management

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Abstract

Rediscovered in the wild twenty years ago, the breeding biology of wild Blue-throated Macaws remains largely unexplored, yet is essential to its effective conservation and recovery. Here, we analyse reproductive parameters in an intensively managed wild population of Blue-throated Macaws, providing the first data on the breeding biology of this critically endangered species. During the six-year study period, 2007–2012, the number of active breeding pairs either remained constant or decreased, depending on the site, and no new breeding pairs were discovered despite extensive searching. We documented nesting attempts in natural cavities in dead palms or live hardwoods, and artificial nest boxes. Egg-laying was concentrated during the end of dry season and the beginning of the wet season, August through December. Hatching failure was the greatest cause of egg losses. Half of the breeding attempts of Blue-throated Macaws produced at least one fledging, on average two, after a 85 days nestling period. An average of 4.3 nestlings per year fledged from all known wild nests combined. Each pair lost roughly 65% of its initial reproductive investment at each nesting attempt. In most successful nesting attempts of individualized pairs, a new nesting attempt was not detected the following year. All monitored breeding pairs showed high nest site fidelity, reusing hardwood-tree cavities and nest boxes. Our findings will aid conservation efforts by refining current actions and prompting new approaches towards the conservation and recovery of the Blue-throated Macaw.

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Introduction

Nearly half of the 152 species of Neotropical parrots are threatened or near-threatened with extinction, and most of the remaining species are declining due to exploitation for the pet trade, hunting for food and feathers, and/or habitat destruction [1–3]. Although extensive parrot research and conservation work is on-going in the Neotropics, we still lack basic biological data for many taxa, hampering the identification of specific threats, the effective monitoring of populations, and the implementation of effective conservation actions.

Macaws are the most endangered group of the Psittacidae family with at least five extinct species, three critically endangered (one possibly extinct [*Anodorhynchus glaucus*], and one species [*Cyanopsitta spixii*] surviving only in captivity), and seven of the 15 species that remain in the wild occur on the Red List as Endangered, Vulnerable, or Near Threatened [3,4]. The Blue-throated Macaw *Ara glaucogularis* is an Bolivian endemic, and one of the two critically endangered macaw species that still exists in the wild (as *A. glaucus* is possibly extinct and *C. spixii* can only be found in captivity) [5,6]. In the wild, this macaw is unlikely to number more than 115–125 individuals divided in two subpopulations [7]. A number of conservation actions aimed to recover the wild population of Blue-throated Macaw were conducted during the last 10 years; however our knowledge of the species' biology is limited to descriptions and estimations of range, habitat use and population size [6,8–10]. Basic reproductive parameters for wild Blue-throated Macaws remain unavailable, yet are fundamental to their conservation and recovery.

Here, we analyze a variety of reproductive parameters such as clutch size, hatching success, fledging success and nest success, in an intensively managed wild population of Blue throated Macaws. Our research provides the first published data about the breeding biology of this critically endangered species. Our observations were made concurrently to our intensive hands-on conservation program, with the primary purpose of maximizing these same reproductive parameters. Our findings will aid conservation efforts by refining current actions and prompting new approaches towards the conservation and recovery of the Blue-throated Macaw and other parrots facing similar threats.

Methods

Study site

We conducted surveys in the Llanos de Moxos, Beni Department, northern Bolivia (Fig. 1). The Llanos de Moxos is a 160,000 km^2 expanse of seasonally inundated savannahs, interspersed with a complex mosaic of forest islands and riverine gallery forests, occupying the extremely flat Beni–Mamoré–Iténez basin in southwest Amazonia, situated between the Precambrian Shield to the east and the Andes to the west and south [11]. Numerous white-water rivers and hundreds of shallow, flat-bottomed lakes cover the landscape. Mean annual precipitation varies from 1,300 to 2,000 mm across the region, occurring mostly between September and May [12].

The landscape is dominated by flat, low-lying areas, which are seasonally inundated and covered by completely open, treeless savannah [13]. Conversely, forest islands are scarce and restricted to raised areas (mounds), which are sufficiently elevated to escape annual flooding. Most of forest islands are eroded relics of natural levees or terraces of abandoned river channels, and therefore constitute fragments of former gallery forest [14]. The study region maintains a high diversity and abundance of parrots, including large macaws (*Ara choropterus* and *Ara ararauna*) [8]. Most parrot populations in the area appear healthy, with the Blue-throated Macaw being the only highly threatened species.

Human presence in the study area occurs at low densities (1.4 people per square kilometre), with 43 settlements spanning the municipalities of Trinidad, San Javier, San Ramón, Santa Ana de Yacuma, San Andrés and Loreto. The primary occupation of the residents is cattle ranching [11] as has been the case for several hundred years.

Data collection

Data were collected from early August up to late March during five consecutive breeding seasons (2007–2008 to 2011–2012). Each breeding season we searched intensively for Blue-throated Macaw nests throughout the season, visiting all known nesting areas for the species covering approximately 5200 Km^2 of the Beni. We identified some individuals by photographing their distinctive facial feather tracts (enabling confirmation of site fidelity). We found nests mainly by observing the behaviour of breeding pairs, and after locating a potential nest (a tree with a cavity and macaw activity) we reached the entrance hole using modified single-rope ascending techniques [15]. For each nest we noted the following: tree species, diameter at breast height (DBH), diameter at entrance-hole height (DEH), height of the entrance

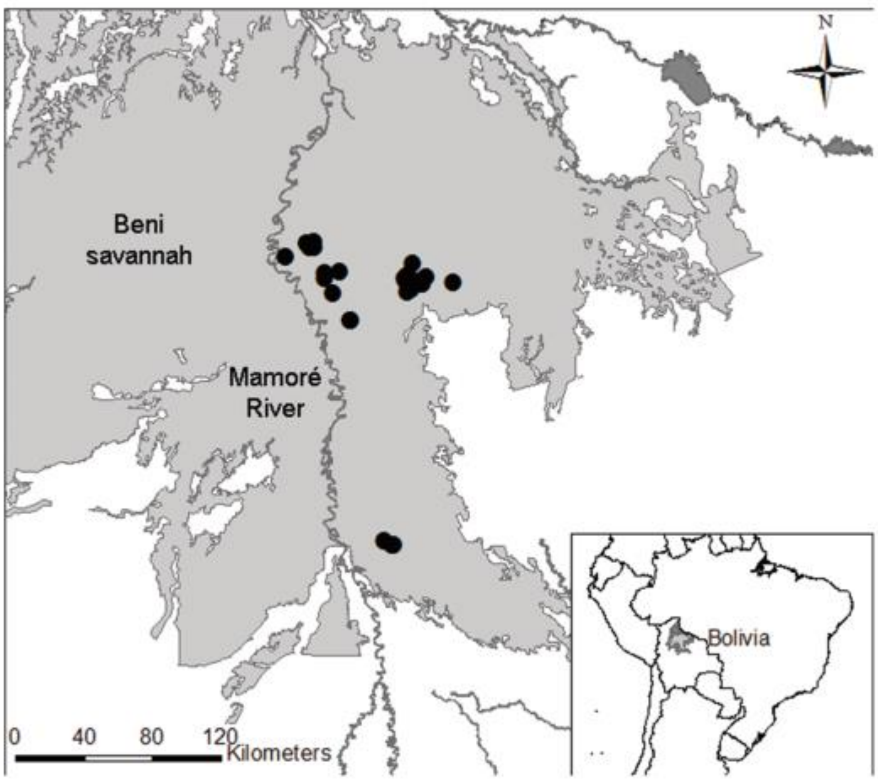

Figure 1. Location of active breeding pairs. Map showing all active breeding pairs of Blue-throated Macaw (black dots) during the 2007–2012 period.
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hole, minimum and maximum diameter of the entrance hole, internal diameter and depth of the cavity.

We assigned a start date to each nest based upon the date of the first egg was laid in each nest. We defined as nesting attempt when at least one egg was laid in a nest. The start date of nests found before or during the laying stage was determined directly. The start date of nests found during incubation or nestling stages was determined by back-counting from the hatching date of the first egg and assuming a 25-day incubation (based upon eggs of known lay and hatch dates). We estimated the duration of the laying stage as the number of days between the first and the last laying event of the season.

In some cases, nests were observed from blinds between 25 and 40 m from nest trees. Daily observations were concentrated during the morning (dawn to 10:00) and the afternoon (15:00 to dusk). The frequency of nest visits by adult macaws was variable and it was related to the nest location and nest stage. For monitored nests, we climbed trees once a week during incubation; every day or every other day during the first three weeks of nestling development; and twice a week until the nestlings fledged. We recorded nest content each time we inspected a nest.

For each nest, we defined the duration of 1) the incubation period as the difference in days between the laying date and the hatching date of the last egg and 2) nestling period as the difference in days between the hatching date and the nest abandon date of the first nestling [16].

In order to calculate clutch and brood sizes we counted eggs and nestlings at four stages of the breeding period: a) at the end of the laying period (Total clutch laid), b) at the end of the incubation (Clutch size at hatching), c) immediately after the hatching (Brood size hatched) and d) immediately before nestlings' fledge (Brood size at fledgling). For each nest we also estimated the egg survival, as the proportion of eggs that complete the incubation period; the hatching success, as the proportion of the eggs at hatching that produced nestlings; and the nestling survival, as the proportion of the hatched nestlings that successfully fledged from the nest (i.e. fledglings). A nest was deemed successful if it produced at least one fledgling.

When loses occurred, we recorded the most probable cause as: a) predation (i.e. missing or broken eggs without any apparent cause, or eggs or nestlings gone from the nest with egg shells or feathers in the nest interior); b) unknown disease (dead nestlings in the nest without any external sign that allowed us to determine the cause of death), c) failure during hatching (eggs that had not hatched one week to ten days after the expected hatching date), d) adverse weather (e.g. a flooded cavity, a cavity broken open by wind), e) nest abandoned during incubation, f) nest poaching and g) starvation. Most unhatched eggs were left inside the nests. In some cases, we removed those eggs and we examined the egg content.

Fledging was confirmed by at least two of the following criteria: fully feathered young seen in the nest; new fledglings seen or heard nearby; nest undisturbed and in good condition in combination with one other of the criteria. Descriptive statistics are presented as averages ± SE. We performed all statistical analyses with significance accepted at $P<0.05$.

Observations were made concurrent to our intensive conservation program, which included a range of actions designed to enhance nesting success. 25 hardwood and 12 PVC nest boxes (for details see [17,18]) were installed at sites where they were likely to be adopted by known pairs. We protected most occupied nest trees each year from predators with metal flashing, by pruning branches, and by actively defending nest sites from blinds during daylight hours. We manipulated tree cavities to keep them dry and safe by redirecting water away from the cavity entrance, placing drains in the cavity, or both. Finally, in some cases nestlings received supplemental food until their growth rates caught up with age-appropriate levels. The study involved a critically endangered and protected species and our field protocol was approved by the Dirección General de Biodiversidad, Viceministerio de Medio Ambiente of Bolivia (Permit Number: 1239-11, Project Name: Proyecto de Conservación de la Paraba Barba Azul: Manejo poblacional). The study was carried out on private lands (owner names are mentioned in acknowledgments).

Results

During the 2007–2012 period we identified 64 individuals in the study area, of which at least 32 were active breeding birds, specifically 16 distinct pairs that laid at least one egg (Fig. 1). During our study, the number of active breeding pairs in a given area either remained constant or decreased, depending on the site.

We followed 31 nesting attempts (n = 12 in 2007–2008, n = 2 in 2008–2009, n = 8 in 2009–2010, n = 4 in 2010–2011, and n = 5 in 2011–2012). These nesting attempts occurred in 19 different natural cavities and six wooden nest boxes and one PVC nest box. Twelve natural cavities were in dead palms: 11 in *Attalea phalerata* and one in *Acrocomia aculeata*; and six in live hardwood trees: four *Gallesia integrifolia*, two *Anaedanthera colubrina;* and one in *Sterculia apetala*. Table 1 shows tree and cavity characteristics. Most cavities in hardwood trees and in nest-boxes were reused by Blue-throated Macaws at least once during the study period, while cavities in dead palms were never reused due to rapid degradation. All pairs that accepted nest boxes had nested in the same tree or in a tree no greater than a few meters from where the pair had bred in previous seasons.

Egg-laying was generally concentrated during the end of dry season (i.e. September and October) in the northern population and during the beginning of the wet season in the southern population, resulting in a large laying interval from August to May (Fig. 2).

The average clutch size was 2.53±0.10 eggs per clutch (n = 29), with a range of one to three and a mode of three eggs per clutch. Clutch replacement was observed twice and only in nests that failed during incubation. No eggs from second clutches hatched.

The precise duration of incubation was clearly documented for one nest and lasted 25 days for each egg. During egg-laying and incubation, females spent most of their time inside the nest or perched nearby, and males were rarely seen entering the nest cavity, although they often remained perched nearby. Partial losses during incubation were low: two cracked eggs were removed by parents before hatching date.

The average clutch size at hatching was 2.10±0.18 eggs per clutch (range: 1–3; n = 21). Hatching success was 72±7% (n = 23) and hatching failure was the greatest cause of egg losses (28/30 eggs). In most nests all eggs hatched (52%, n = 12), and in some nests one egg (30%, n = 9) failed to hatch and in two nest none of eggs hatched (9%, n = 2). Two of four (50%) of non-hatched eggs that were removed had a partially developed embryo. The average date of hatch for the first nestling in a nest was October 23rd (from May 3rd to January 15th, n = 21).

The average clutch size at fledgling was 2.00±0.25 fledglings per clutch (range: 1–3; n = 13 nests). In successful nests, the survival of nestlings was 100% (n = 25 nestlings).

The nestling period lasted approximately three months (85 days).

If we pool all nests, of 74 eggs (n = 29 nests), 30 eggs were lost during the incubation period and 18 nestlings were lost during the

Table 1. Main characteristics (mean ± SE) of natural cavities used as nest by Blue-throated Macaws.

Tree and cavity characteristics	Mean ± SE (n)	Range
DBH (cm)	65.7±12.2 (7)	30–107
Diameter at entrance (cm)	57.5±2.1 (4)	52–62
Height of entrance hole (m)	8.60±0.79 (17)	2.5–14.0
Depth of cavity (cm)	52.3±7.9 (11)	25–110
Maximum diameter of entrance hole (cm)	24.1±2.5 (8)	13–33
Minimum diameter of entrance hole (cm)	17.9±3.6 (8)	9–33
Internal diameter of cavity (cm)	28.8±1.0 (6)	26–33

Sample sizes (number of trees) are indicated between parentheses.
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nestling rearing period (59% of overall survival of hatchlings). Between 2007 and 2012, a total of 26 nestlings of Blue-throated Macaw successfully fledged, meaning an average of 4.3 nestlings per year fledged from all known nests during the study period. Given that the average total clutch was 2.5 eggs per nesting attempt, and the average of 0.89 fledglings per nesting attempt, each pair is losing on average 65% of its initial reproductive investment at each nesting attempt.

From 30 breeding attempts of Blue-throated Macaws, 77% of theses ($n = 23$) would complete the incubation stage and 45% ($n = 13$) would produce at least one fledging (i.e. nesting success).

Fifty-seven per cent of 30 monitored nests failed. Most failures occurred during the incubation stage (Fig.3). Causes of nest failure were diverse (Table 2). All evidence of predator identity was indirect. In two cases the evidence suggested predation by snakes. An unknown disease appears to be affecting breeding success in one breeding pair and was responsible for the death of all nestlings in the clutch, in three nesting attempts in sequential years. Nest abandonment as a result of adverse weather included nest-tree falls and broken and flooded cavities.

In seven of eight successful nesting attempts of individualized pairs, a new nesting attempt was not detected the following year (Table 3). All monitored breeding pairs showed a high nest site fidelity reusing hardwood-tree cavities and nest boxes.

Discussion

During the study period, no new adult pairs were recruited into the breeding population. This lack of recruitment of breeding pairs could be a consequence of a low survival rate of juveniles and pre-breeding birds, and/or an extremely low density impeding effective pair formation. We have no information about survival of pre-breeding birds, and the density of breeding pairs is of 0.003 pairs/Km^2 (i.e. 16 breeding pairs in 5200 km^2). Failure to recruit new breeding pairs into the population, will of course severely constrain the potential for this critically endangered species to once again thrive in the wild.

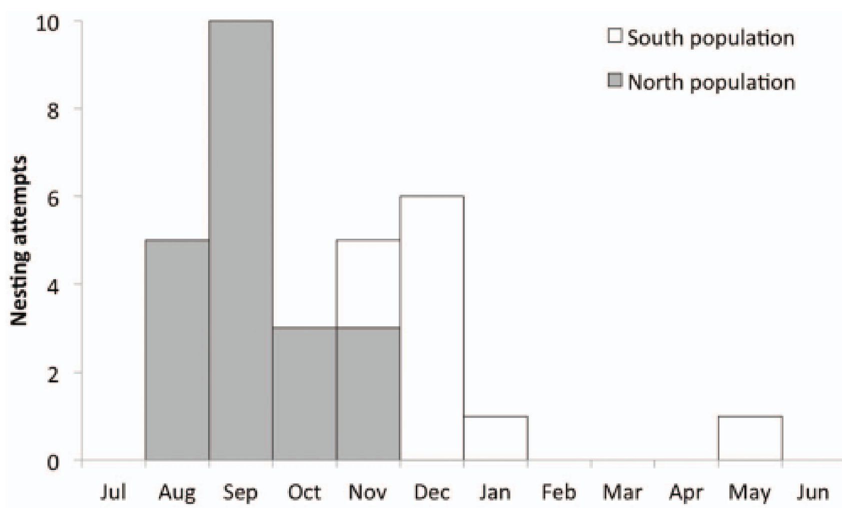

Figure 2. Clutch initiation. Phenology of clutch initiation for 31 nesting attempts of Blue-throated Macaw during five consecutive breeding seasons (2007–2008 to 2011–2012).
doi:10.1371/journal.pone.0099941.g002

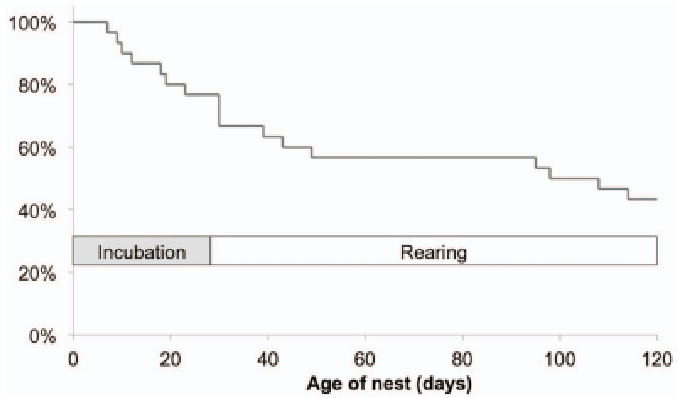

Figure 3. Nest survival curve. Kaplan-Meir survival curve for Blue-throated Macaw nests ($N = 30$ nesting attempts) in Beni savannahs.
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Clutch sizes were similar to reported values in captive and wild pairs where the mode of three eggs is also common [18,19,21,22]. The average clutch size for wild large macaws (*A. macao*, *A. chloropterus*, and *A. ararauna*; body mass 1015–1250 g) is 2.5–2.8, slightly higher than the average of 2.1 reported for the Blue-throated Macaw in this study [17,18]. Hatching success of Blue – throated Macaw (72%) was similar to other macaw species reported from Peruvian rainforest where usually one egg does not hatch; 77% of hatching success in Red-and-Green Macaw (*Ara chloropterus*) and 50% in Scarlet Macaw (*Ara macao*); and considerably higher than the 36% of hatching success reported in Blue-and-Yellow Macaw (*Ara ararauna*) [17,18]. In addition, as was found in large macaws of Peruvian rainforest, all eggs hatched in 61% of occupied nests [18]. Because inbreeding depression (or loss of heterozygosis) in birds is often indicated by depressed hatching success, our observations suggest that these birds have not yet suffered a significant genetic bottleneck, presumably because their population decline was so recent [21].

Clutch replacement was not observed in nests that failed during the rearing of nestlings. We observed a replacement clutch only on two occasions, and in both cases nests failed during first days of incubation. Second clutches are not common in wild parrots, in fact, in macaws they have been documented only in Scarlet Macaws [15,22,23]. The decision of some pairs of macaws to initiate a second clutch may be related to good body condition of the female or abundant food during the breeding period, or both.

Nesting attempts and nesting success varied between years. In some years, up to 10 pairs nested and in some years only two attempts were made. Nesting success of Blue-throated Macaw (45%) was similar to other macaw species where usually half of nesting attempts succeed: 54% in Blue-and-Yellow Macaws (*Ara ararauna*), 44% in Scarlet Macaws (*Ara macao*) and 41% in Red-and-Green Macaws (*Ara chloropterus*); but our value was lower than the 70% reported for Hyacinth Macaws (*Anodorhynchus hyacinthinus*) [18,24,25]. However, the number of fledgling per initiated nest (0.89) in Blue-throats was higher than the reported values for macaw species in Peruvian rainforest (between 0.55 and 0.65) and similar to the 0.98 reported value in Hyacinth Macaws [24,25]. Differences in those indices are a consequence of the number of fledglings per successful nest. We observed two fledglings per successful pair, a value 38% higher than the maximum reported value for a large macaw in the wild (i.e. 1.44 fledglings/successful nest in *Ara macao*) [18]. This high nestling survival (100%) in successful pairs is probably a consequence of our intensive conservation management program.

Two thirds of natural cavities were in dead palms. Most cavities in hardwood trees were reused by Blue-throated Macaws at least once during the study period, while cavities in dead palms of *Attalea phalerata* were never reused before they fell naturally. Like

Table 2. Failed nesting attempts and causes of nest failure of Blue-throated Macaw pairs per breeding season.

Cause of nest failure	Breeding season				
	2007-08 (12)	2008-09 (2)	2009-10 (8)	2010-11 (4)	2011-12 (5)
Predated	4	1	-	-	-
Apparent disease	-	1	1	-	1
Failure to hatch	1	-	1	-	-
Adverse weather	2	-	-	-	-
Abandoned	-	-	-	1	1
Poached	-	-	2	1	-

In parenthesis the number of nesting attempts.
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Table 3. Breeding attempt histories of seven Blue-throated Macaw pairs.

Pair	2007	2008	2009	2010	2011
A	S	NN	S	NN	S
B	S	NN	S	NN	Fa
C	Fp	NN	S	NN	S
D	1ST Fw - 2nd Fp	NN	S	NN	U
E	1ST Fp - 2nd Fh	NN	Fh	NN	U
F	S	Fp	-	-	-
G	U	Fu	Fu	Fa	Fu

S (successful), NN (no nesting attempt detected), U (unknown fate) and F (failed nest). Causes of failure were: Fa (failed by nest abandon), Fh (failed by hatching failure), Fp (failed by predation), Fu (Nestling's die or did not fledge for undiagnosed reasons) and Fw (failed by adverse weather).
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other macaws [17,18,26], Blue-throats were willing to nest in various kinds of nest boxes, but in all cases, they selected boxes placed in the same tree or in a tree few meters from where the pair had bred in previous seasons.

We now have a better idea about the characteristics of cavities selected by Blue-throated Macaw to breed. Our findings on the dimensions suggested nothing unusual about these macaws, but the results are useful for future nest box design, which can be more carefully tailored to the species' needs and preferences. Future studies of nest site selection should assess the availability of similar cavities in the region.

Our results suggest that successful breeding pairs are unlikely to breed the following year; if true, this factor dramatically constrains this species' ability to recover from its current critically endangered status. In some years we observed breeding pairs accompanied with their fledglings of previous year, and they were not showing breeding behavior. Parents appear to attend to their fledglings (i.e. providing food, social learning, etc.) for an extended period, possibly through the subsequent breeding season in some cases. Further studies are needed to understand post-breeding relationships between adults and their dependent juveniles. This factor has potentially dramatic consequences for the reproductive output of the most productive and attentive breeding pairs. Our data also suggest that breeding pairs that failed in a given year are unlikely to make a breeding attempt the following year, or in some cases they may have separated and/or moved to different undiscovered breeding areas. Expectations of population dynamics and recovery potential for the species must integrate these natural limitations to be accurate and useful for conservation planning.

We fully recognize there are trade-offs to conducting research and applied conservation simultaneously on the same individuals in the wild. For a critically endangered species like the Blue-throated Macaw, with typically fewer than ten pairs attempting to breed in a given year, we feel a balanced approach putting conservation first, data gathering second, is appropriate. This approach has aided the species recovery while simultaneously generating biological findings, which inform ongoing and future conservation and management options. We cannot know how unmanaged populations would fare in terms of nesting attempts, rates of predation, hatching success, and recruitment of fledglings as all such parameters have been directly influenced by our actions. As this macaw's numbers improve in future years, we may have the opportunity to make direct comparisons between managed and unmanaged pairs, but with annual recruitment still averaging in the single digits, we do not yet have the luxury of taking such a hands-off approach.

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Author Contributions

Conceived and designed the experiments: IB GD FPK JADL RMA JDG. Performed the experiments: IB GD FPK JADL CPSF. Analyzed the data: IB GD FPK JADL RMA JDG. Contributed reagents/materials/analysis tools: IB. Wrote the paper: IB GD FPK JADL CPSF RMA JDG.

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Conservation in human-dominated landscapes: Lessons from the distribution of the Central American squirrel monkey

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ABSTRACT

It is becoming increasingly evident that many species can tolerate different degrees of habitat perturbation and that we often underestimate the capacity of some human-modified landscapes to support populations of declining species. We provide new insights into the distribution of the endangered Central American squirrel monkey and habitat changed over the last 20 years. The species has shown an approximate 60% decrease between the historic and the present extent of occurrence, with an area of occupancy of also about 60% of the present extent of occurrence. Despite the large habitat alteration, our results show surprisingly that this endangered monkey can persist in highly perturbed landscapes. This offers opportunities to improve its long-term chances of survival through conservation actions to protect and restore its habitat on the one hand, and to reduce the monkey's direct mortality on the other. Surprisingly we found several troops in 16 localities in a large area along the Rio Coto Brus where the Central American squirrel monkey was previously unrecorded. Some of our observations were made in cloud forests at a record high altitude for this species. We speculate the monkeys are using these highland areas as a corridor between suitable lowland habitats in the Coto Brus and the Rio Sierpe-Osa Peninsula regions. In response, we suggest strategies to help in the monkey's long-term conservation, that can be used as an example for other endangered species.

1. Introduction

Earth is currently experiencing a major loss of biodiversity, one unparalleled in the history of humanity. The sixth mass extinction has already seen the disappearance of thousands of species and billions of populations, and the current high rate of extinction seems doomed to increase (Ceballos et al., 2015, 2017; IUCN, 2019). At least 35 species of mammals have become extinct since 1600, and around 30% of all mammal species are at risk of extinction in one conservative estimate (Ceballos et al., 2015; IUCN, 2019). Primates are particularly vulnerable to human impacts, most are tightly tied to forest habitats that are being fragmented or are disappearing entirely. The rapid loss of tropical forests has already caused the extirpation of many of their populations throughout the world (Oates et al., 2000; Estrada et al., 2017). Many primate species, such as the recently discovered Tapanuli orangutan (*Pongo tapanuliensis*) in lowlands forests of northwestern Sumatra (Nater et al., 2017), the kipunji or highland mangabey (*Rungwecebus kipunji*), a new genus and species from the tropical forest of the Mount Rungwe mountains in Tanzania (Davenport et al., 2008), and the Myanmar snub-nosed monkey (*Rhinopithecus strykeri*) of rainforest in Myanmar and China (Geissmann et al., 2011; Long et al., 2012), have populations of < 1000 individuals. Primates are favorite targets for those hunting for bush-meat, zoo exhibits, pharmaceutical testing, or pets. Many also have low reproductive rates. As result of the impacts of those factors, approximately 60% of the > 500 recognized species are in danger of extinction (Jernvall and Wright, 1998; Cowlishaw, 1999; Wong et al., 2008). Nevertheless, the clear logistic inability to gain the necessary level of understanding for the conservation of the vast majority of billions of endangered species and populations dictates we must try to deal with two fundamental questions. First, how can we deal with the global drivers of biodiversity loss: human overpopulation, overconsumption (especially by the rich)? And second, how through standard and novel approaches, greatly increase efforts to protect refuges for biodiversity, expand them, and modify our impacts on human-dominated landscapes to make them more hospitable to our indispensable fellow creatures?

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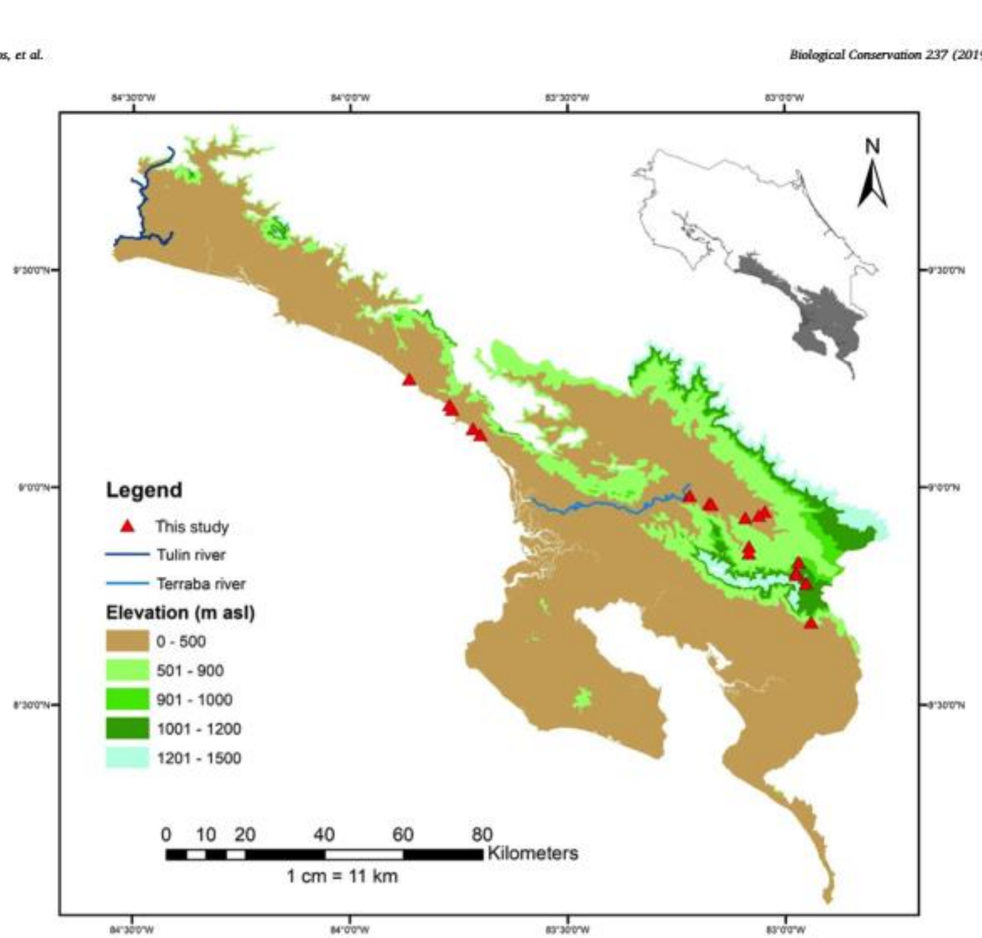

Fig. 1. Observation localities of the Central American squirrel monkey (*Saimiri oerstedii*) reported in this research along the regional altitudinal gradient on the southern end of the Pacific slope, Costa Rica.

Conservation of the endangered mammals, primates in particular, and other vertebrates in general, is increasingly requiring the use of both, traditional and novel methods in response to the diverse and dynamic causes of decline. Setting aside protected areas and biological corridors, encouraging local land owners to maintain habitat through conservation incentives, reintroduction of target species in suitable habitats, and developing economic activities such as ecotourism to incentivize local people to do protect forests, should be methods to promote their long-term conservation (see also Caughley and Gunn, 1996; Goehring et al., 2007). More unusual, sometimes bolder approaches, such as translocations to previously unoccupied suitable habitat, should be more widely tested now.

Primates are particularly important to conserve as they are charismatic, conspicuous, and informative because of their evolutionary relationship to us. Many species, including large ones such as howler monkeys (*Alloutta* spp.), are able to persist in human-dominated landscapes under certain circumstances. Additionally, because many mammal species have relatively extensive geographic ranges, they can serve as "umbrella species," protecting populations of many other less-charismatic organisms. Careful determining of geographic ranges using two broad measurements (sensu Gaston, 2003): the *extent of occurrence*, which is the area defined by the outer limits of the range, and the *area of occupancy*, which is the area used by the species within the extent of occurrence, is important. Understanding an endangered taxon's geographic range is critical to the development and application of effective adaptive management strategies (Holling, 2005; Blair et al., 2013a). The extent of occurrence of a population or species may differ significantly from the area of occupancy because organisms rarely occupy all the habitats or regions within their range (Gaston, 1994; Brown and Lomolino, 1998; Hurlbert and White, 2005; Goehring et al., 2007). Underestimating the area of occupancy of an endangered species may lead to oversight when developing protection strategies for it, thus reducing the chances for long-term conservation of populations or increasing implementation costs (Thomas and Abery, 1995; Caughley and Gunn, 1996). Conversely, assuming that the entire extent of occurrence is fully occupied by a taxon can lead to underestimates of extinction vulnerability, as has previously been observed in many terrestrial mammals (Ceballos and Ehrlich, 2002).

There is abundant evidence of the capacity of mammals and other vertebrates to persist in human – dominated landscapes. For example, in the same area where we studied the squirrel monkeys, our research program on the capacity of agricultural landscapes to support biodiversity has showed that a tropical mixed forest-patch and agriculture landscape can support a substantial sample of the biodiversity of regional undisturbed forest. We found, for example, that within a 23,600 ha study area, the small ribbons of forest weaving through farmland collectively increased the effective size of a 326-ha local forest reserve up to 16-fold for vertebrates and invertebrates (Daily et al., 2003; Pacheco et al., 2006; Mendenhall et al., 2014). Many species of primates as diverse as orangutans, chimpanzees, gibbons, howler monkeys, lorises, and squirrel monkeys are able to persist in human-dominated landscapes too (Estrada et al., 2017).

Several species of squirrel monkeys are relatively widespread in tropical regions of South America (Rylands et al., 2013; Lynch Alfaro et al., 2015). The Central American squirrel monkey (*Saimiri oerstedii*) has, however, a small historic geographic range disjunct from other species of squirrel monkeys, and restricted to the Pacific lowlands of southern Costa Rica and northern Panama (Reid, 2009; Rylands et al., 2013). It is categorized as an endangered species due to habitat loss, population fragmentation, and hunting (Boinski and Siwt, 1997; Boinski et al., 1998; Sierra et al., 2003; Reid, 2009). It has been almost completely eradicated from Panama (Rylands et al., 2006), and habitat destruction has divided its historic geographic range in Costa Rica into two separate areas (Boinski et al., 1998). It survives in human dominated habitats and because of that can serve as a conservation model.

We discovered a relatively large population of squirrel monkeys in the region of Coto Brus in southern Costa Rica. That prompted us carry out an analysis of the current geographic range of the species. The new information on the distribution of *S. oerstedii* can help improve efforts to restore the habitat and protect this charismatic primate, as well as provide insights for the conservation of other primate species. In this paper, we address the following issues: i) analyze the current extent of occurrence and area of occupancy of the squirrel monkey; ii) document habitat change over the last 20 years; and iii) identify land conservation strategies for preservation of the species.

2. Methods

2.1. Study area

Our study was carried out in the Pacific lowlands of central and southern Costa Rica from the Carara National Park to the Panama border (Fig. 1). We covered all the known geographic range of the species and nearby areas. We conducted most of our fieldwork between February and May 1999, with additional survey periods in March 2001, 2002, 2014 and 2015. We surveyed in an area of approximately 140,000 ha in the Rio Coto Brus region, located just north of the Golfo Dulce in southern Costa Rica. We selected our survey area based on interviews with local people who observed squirrel monkeys in the region. We interviewed informally peasants, ranchers, and hunters who had good knowledge of the local fauna. One of them was hired as our main guide. In the interviews, we showed them pictures of spider, howler, and squirrel monkeys to let them identify the species present. Additionally, we carried out seven, one-day line transects to determine the presence of squirrel monkey troops in different localities in the districts of San Vito, Aguabuena, Limoncito, Pittier, Changuena, Potrero Grande, and Corredor (Table 1). With the exception of the steep, isolated forests adjacent to the study site, we surveyed most of the accessible areas. However, it is likely that some groups of squirrel monkeys were not recorded. Each time squirrel monkeys were observed, their GPS location, altitude, and vegetation type were recorded. During our 2014 and 2015 return visits to previously surveyed localities, we reaffirmed the presence of *S. oerstedii* troops in the Rio Coto Brus region. We also observed *S. oerstedii* in localities around the Marino Ballena National Park during our surveys in the Costa Rican central-south Pacific region.

2.2. Historical range of *S. oerstedii*

We determined the historic and present distribution of squirrel monkeys in Costa Rica from reviews of published information, primarily Boinski et al. (1998), Morera-Avila (2000, 2002), Sierra et al. (2003), Solano-Rojas (2007), Blair et al. (2013b), and from our own data. We used the IUCN range data (Wong et al., 2008) to determine the historical extent of occurrence of *S. oerstedii*. All the records used are from forested localities at elevations below 500 masl in an area along the Pacific coast, between the Tulín River in the north to the southern border of Costa Rica in the Burica Peninsula. To calculate the forest area within the historical extent of occurrence, we assumed an 85% forest cover for the year 1900 (Keogh, 1984). The present extent of occurrence was defined as the sum of all forest patches larger than 3 ha within a polygon delimited by the localities where *S. oerstedii* presence has been reported since 1998 until the present day. The forest area was computed from the maps of the National Forest Inventory (SINAC, 2013). Each locality consisted of a 5 km radius around the reported observation points (Boinski et al., 1998; Morera-Avila, 2000, 2002; Sierra et al., 2003; Solano-Rojas, 2007; Blair et al., 2013b, and our own data). The 5 km radius was defined by the daily movement of troops of *S. oerstedii* reported by Baldwin and Baldwin (1972). We excluded those regions where the species have been lost according to Boinski et al. (1998).

We considered two scenarios to calculate the area of occupancy (Gaston, 2003). The *conservative* scenario considered the area of occupancy as the sum of all forest fragments larger than 15 ha within a 5 km radius from each observation point, and the *less conservative* scenario included all forest fragments larger than 5 ha within 5 km radius from each observation point. We used the National Forest Inventory map (SINAC, 2013) to compute the forest area for both scenarios; the selection of both fragment values was based on the minimum area considered as forest (5 ha) by the Costa Rican legislation, and the minimum fragment size (15 ha) required by the species for long term survival (Sáenz and Sáenz, 2008).

2.3. Remote sensing of the change to *S. oerstedii* habitat

We used the Costa Rica Land Use map of 1992 (MAG, 2008) and the 2012 National Forest Inventory map to identify changes in the location and extent of forest cover of the *S. oerstedii* distribution range. We analyzed the data with ArcGIS 10 (ESRI, 2011) and the Patch Analyst extension (Rempel et al., 2012). The Costa Rican land use map of 1992 was generated from Landsat 5 images and others not specified in the metadata map; the resolution is 30 × 30 m. The 2012 National forest inventory map was generated with RapidEye images, which has finer resolution. We then edited and re-classified both maps to make them comparable for the landscape analysis and defined a patch of habitat as any mature or secondary forest, or mangrove segment larger than 3 ha.

We determined the habitat change that occurred within the present-day extent of occurrence by computing four landscape metrics: area, number of patches, mean patch size, and mean shape index for 1992 and 2012 and for each habitat type (i.e. forest, secondary forest, and mangrove). By area we are referring to the Class Area metric, which indicates the sum of areas of all patches within a coverage class. In this case, the class corresponds to forest area (in the landscape). All data layers were analyzed under the Projected Coordinate System for Costa Rica (CRTM05/WGS84). Using these data and the formula employed by Puyravaud (2003), we estimated the annual rate of change in habitat, number of patches, and mean patch size using the following formula: $= \frac{1}{t2 - t1} \times \ln \frac{A2}{A1}$, where A1 and A2 are the forest cover at t1 and t2, respectively; the unit could be per year or percentage per year.

3. Results

3.1. New details on the distribution of *S. oerstedii*

We found direct and indirect (i.e. interview) evidence of squirrel monkeys in 16 localities along the rivers and forest fragments in the Coto Brus region (Table 1). The majority of localities were below 700 masl, in remnants of tropical lowland and riparian forests surrounded

Table 1

Field observations of the Central American squirrel monkeys (*Saimiri oerstedii*) in Costa Rica. All records are based on observations (O), interviews (I), or photograph (P). Localities in bold represent new, upper altitudinal records for the species.

District	Locality	Coordinates (DD)	Altitude (masl)	Plant association	Type of record
Potrero Grande	Coto Brus river (Minae Reserve)	8.9319444, −83.0922220	300	Lowland forest	O
Potrero Grande	Chocoacos lagoon	8.9644444, −83.1747220	430	Lowland forest	I
Potrero Grande	Las Vueltas	8.9627778, −83.1697220	430	Lowland forest	O
Pittier	Rio Coto Brus (Bonanza I)	8.9463889, −83.0469444	400	Riparian forest	O[a]
Changuena	Rio Limon y Rio Terraba	8.9833333, −83.2200000	300	Riparian forest	I
Limoncito	San Luis (Rio Limon)	8.8661111, −83.0838880	580	Riparian forest	I
San Vito	Quebrada Pavo (San Vito)	8.8297222, −82.9688880	780	Lowland forest	P[b]
San Vito	**Finca Gamboa**	**8.8063889, −82.9750000**	**930**	**Premontane wet forest**	**O**
Aguabuena	**Copal**	**8.7805556, −82.9525000**	**930**	**Premontane wet forest**	**O**
Corredor	Fila de Cal	8.6922222, −82.9408330	800	Lowland forest	I
San Vito	**Finca Gamboa (1.7 km S San Vito)**	**8.8008333, −82.9750000**	**1014**	**Secondary Forest**	**P**
San Vito	**Quebrada Pavo (1 km NE San Vito)**	**8.8297222, −82.9688889**	**960**	**Non-Forest**	**P**
Aguabuena	**Copal**	**8.7805556, −82.9525000**	**1145**	**Secondary Forest**	**O**
Limoncito	Rio Limon (3 km SE San Luis)	8.8505556, −83.0838889	764	Secondary Forest	O
Pittier	Rio Coto Brus (Bonanza II)	8.9463889, −83.0469444	315	Forest	O
Potrero Grande	Rio Coto Brus (3.5 km El Jabillo)	8.9369444, −83.0611111	331	Riparian forest	F
Bahía Ballena	Playa Hermosa	9.1816100, −83.7659000	0	Secondary forest	O
Bahía Ballena	Queb Grande - Ballena	9.1367420, −83.7175400	100	Secondary forest	O
Bahía Ballena	Ballena	9.1233280, −83.7009990	35	Secondary forest	O
Bahía Ballena	Dominical	9.2519444, −83.8641660	23	Non-Forest	O
Bahía Ballena	Rancho Reno	9.1915900, −83.7718800	55	Forest	O
Bahía Ballena	La Cuzinga	9.1367430, −83.7177540	79	Non-Forest	O

[a] Observed by Jorge Pérez.

[b] Photograph provided by Sr. Enrique Laurent from San Vito.

Fig. 2. A Central American squirrel monkey (*Saimiri oerstedii*) crossing a pasture through a fence to reach the Wilson Botanical Garden in the San Vito region in southern Costa Rica. (Photo: Gerardo Ceballos).

by pastures. However, we recorded the presence of *S. oerstedii* at five localities above 900 masl in the premontane wet forests of the Java River near the Las Cruces Reserve, including two above 1000 masl (Figs. 1 and 2, see Daily et al., 2003 and Pacheco et al., 2006 for a description of this region and its mammalian fauna). These are the first reported observations of *S. oerstedii* at this elevation in Costa Rica and the first ones in the Las Cruces forests. We photographed a squirrel monkey troop crossing a pasture to the Wilson Botanical Garden through a cattle fence in Finca Gamboa in 1999 (Fig. 2; Table 1); the local owners of the farm adjacent to the Garden told us they had begun occasionally to observe squirrel monkeys in the region that year. Additionally, we recorded squirrel monkeys in six localities around the Bahía Ballena area (south-central Pacific slope), totaling 22 localities in this study (Table 1).

Based on our reviews and field work, we estimated the historical extent of occurrence of *S. oerstedii* in Costa Rica to be about 550,000 ha (5500 km^2) and the current extent of occurrence about 225,000 ha (2.250 km^2), suggesting a decrease of about 60% between 1900 and

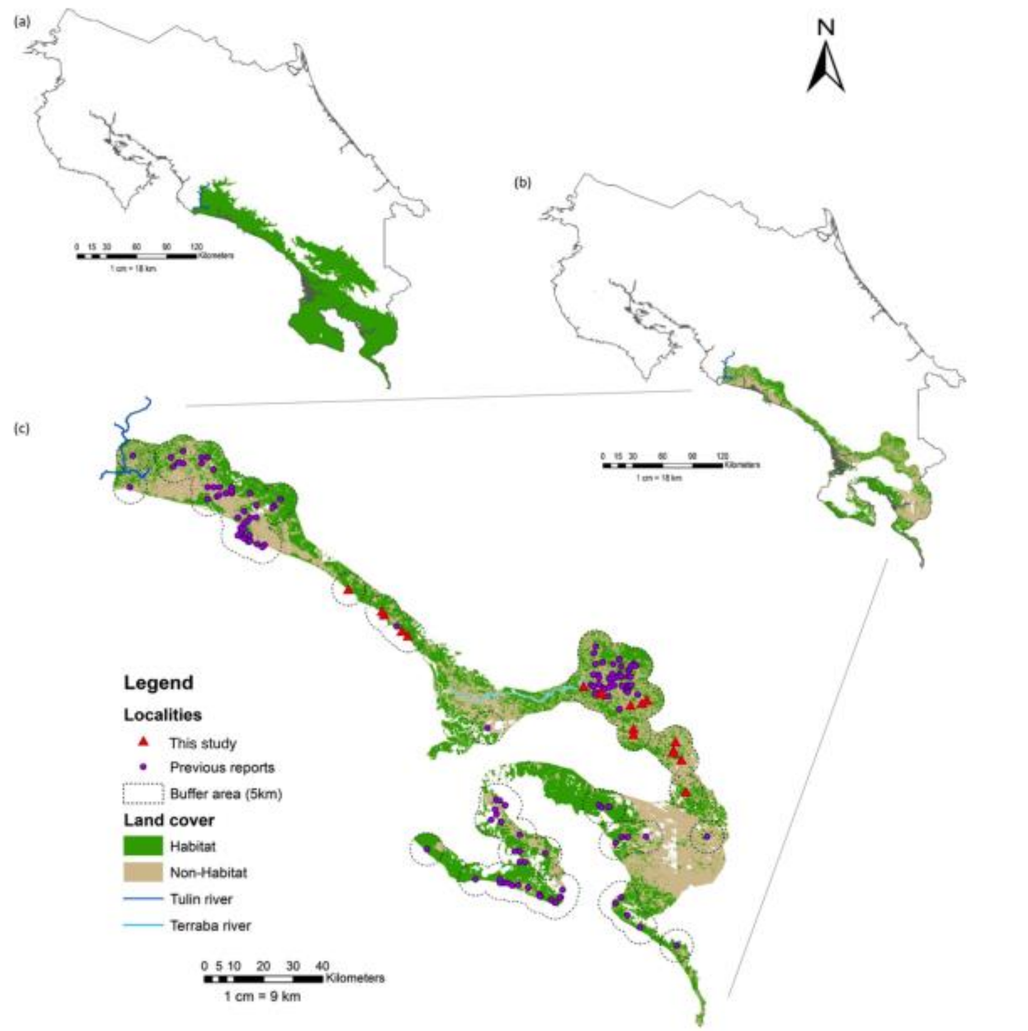

Fig. 3. Central American squirrel monkey (*Saimiri oerstedii*) distribution in Costa Rica: (a) historical extent of occurrence; (b) present extent of occurrence; and (c) present extent of occurrence showing the localities and their buffer areas.

Table 2
Total habitat available in the present area of occupancy of the Central American squirrel monkey (*Saimir oerstedii*) in conservative and less conservative scenarios.

Scenario	Forest (km^2)	Secondary forest (km^2)	Mangrove (km^2)	Total habitat (km^2)
Conservative ($P \geq 0.15\,km^2$)	800	428	53	1281
Less conservative ($P \geq 0.05\,km^2$)	842	490	55	1387

2012 (Fig. 3). We also estimated the present area of occupancy to be 57–62% of the present extent of occurrence, meaning that the species occupies an area of about 128,00–138,700 ha (1280–1387 km^2) in Costa Rica, including mature forest, secondary forest, and mangrove. Mature forest was the dominant forest type in the area of occupancy (Table 2). In relation to the status of habitat protection, the squirrel monkeys are surviving in forest patches in and near the Manuel Antonio, the Marino Ballena, and the Corcovado National Parks. In contrast, the troops present in the Coto Brus - Golfito and Puriscal-Parrita regions are not protected.

3.2. Habitat change along the present extent of occurrence of *S. oerstedii*

We found important differences in landscape structure across the years studied (Table 3). The area covered by suitable squirrel monkey habitat did not show drastic changes over the study period, but the

Table 3
Changes in the habitat of the Central American squirrel monkey (*S. oerstedii*) along its present extent of occurrence in Costa Rica from 1992 to 2012.

Land cover by habitat	Year 1992				Year 2012				Annual rate of change (%)		
	Area (km^2)	Number of patches	Mean patch size (km^2)	Mean shape index	Area (km^2)	Number of patches	Mean patch size (km^2)	Mean shape index	Habitat area	Patch size	Mean patch size
Forest	1100	97	11	1.73	1225.34	1978	0.62	4.38	0.54	15.08	−14.54
Secondary forest	856	164	5	1.69	838.96	2588	0.32	4.72	−0.10	13.79	−13.90
Mangrove	213	217	1	1.76	179.34	227	0.79	2.74	−0.87	0.23	−1.10

number of patches was higher and their average size smaller in 2012 than in 1992. The mean shape index over the study period suggests that the patches were not only smaller but more irregular at its end. This pattern of spatial change was consistent across the three habitat categories, but the most significant variation occurred in the mature and secondary forested areas which showed annual rates of change between 13 and 15% in the number of fragments and their mean size. In contrast, the mangrove area showed annual rates of change around 1%, which denote virtually no change in this habitat category during the period of study. Although mean fragment size has decreased, it is still adequate for the survival of *S. oerstedii* troops (Boinski and Siwt, 1997; Sáenz and Sáenz, 2008). Suitable habitat outside the protected areas is, however, more fragmented and isolated from large areas of continuous forest cover, such as in Coto Brus region, rendering them largely unsuitable for troops of squirrel monkeys.

3.3. Land conservation strategies

Based on our results, we suggest conservation strategies to consolidate the squirrel monkey distribution, that include protected areas, biological corridors, environmental payments for land owners of critical unprotected parcels, and introductions into new areas (Fig. 4). It is fundamentally important to expand and improve the connectivity among the Manuel Antonio, Marino Ballena, and Corcovado National Parks. There are biological corridors already established in those regions, such as Paso de las Lapas, Paso de la Danta, Fila Langusiana, and Osa but it is necessary to enhance their protection and functionality. Indigenous reserves could have a critical role as connecting patches among corridors and protected areas, while involving these communities in conservation of charismatic species, and thus potentially generating social benefits. In addition where possible, new protected areas should be created in the Rio Terraba, Rio Coto Brus and the Terraba-Sierpe regions that have squirrel monkey populations; these areas can also act as corridors. It is particularly important to set aside protected areas in the Ciudad Neily valley, where most habitat is gone, and the few remnant native forests are not in any protection category. The federal government conservation payment program in private lands should be expanded to encompass all habitat identified in our study (Fig. 4). Those habitats include indigenous reserves, private ranches, and peasant lands. In addition, it is essential to try novel approaches such as introducing squirrel monkeys into the Carara National Park and the lowlands of the Paso de la Danta Biological Corridor. Such regions are adjacent to the squirrel monkeys' historic geographic range and have very similar habitat to the present areas occupied by the species.

4. Discussion

4.1. New details on the distribution of S. oerstedii

Our observations of *S. oerstedii* at higher elevations than previously reported show that the altitudinal range of the species has been expanding upwards for at least the past two decades. In the Coto Brus region, this range now extends up to ~1200 masl. Although some reports of occurrence identified 800 masl as the upward limit (Morera-Avila, 2000, 2002; Pacheco et al., 2006), historically, and even in recent publications (Sierra et al., 2003; Wong et al., 2008; Blair et al., 2013b), the limit of *S. oerstedii* distribution was stated as being below 500 masl. Our observations of *S. oerstedii* at significantly higher elevations suggest we have identified a relatively large addition to its known extent of occurrence geographic range in a fairly accessible and biologically well-studied region (Daily et al., 2003; Pacheco et al., 2006). Additionally, our information indicates that there may be other localities at high elevations with squirrel monkeys in the vicinity of Las Alturas in the Cordillera de Talamanca, along the Costa Rica - Panama border. Although our findings are novel for this Central American species, squirrel monkeys in South America have frequently established populations at high altitudes. It is likely, considering the South American center of evolution of the group, that *S. orestedii* is pre-adapted to move upward (Lynch Alfaro et al., 2015; Ruiz-García et al., 2015).

The San Vito region has lost most of its natural vegetation due to extensive deforestation that occurred four decades ago (Hughes et al., 2002; Daily et al., 2003). Recent observations of squirrel monkeys at Finca Gamboa and Copal may suggest that as suitable, lower-elevation habitat is destroyed, *S. oerstedii* have been forced to seek new habitat patches at higher elevations. It is, of course, possible that gradual global warming has facilitated this. Deforestation and changes in land use may cause negative impacts to the local fauna, including local extinctions, changes in abundance, and invasion of exotic species (Ceballos and Ehrlich, 2002; Daily et al., 2003). Shifts in range size can be used as an index of the impact of these changes in environmental conditions (Gaston, 1994). At this point, we do not know if *S. oerstedii* will be able to use higher elevation forests in the long term. This may depend on whether climate change actually makes the higher altitude forests more hospitable (Chen et al., 2011).

It is important for conservation purposes to note that a species usually will not occupy its entire extent of occurrence. The area of occupancy of *S. oerstedii* covers a maximum of 60% of its extent of occurrence, which is currently less than half of its historical value despite the addition of the Coto Brus region to the area of geographic distribution. Effective conservation planning requires determining critical areas for *S. oerstedii*. While we believe that *S. oerstedii* occurs at least throughout its entire available habitat, we need to confirm its presence in areas where there are sampling gaps. These areas include the Terraba-Sierpe region, mid-altitude lands near its historic extent of occupancy (800–1500 masl), and the Corcovado and Piedras Blancas National Parks.

4.2. Habitat change along the present extent of occurrence of S. oerstedii

Our research has demonstrated a marked change in the extent of occurrence of *S. oerstedii* since 1992. While the forest patches have maintained their canopy cover, they currently have decreased connectivity, because they are smaller and more irregularly shaped. This in turn has reduced the suitability of the landscape for *S. oerstedii* (Fahrig, 2003; Cushman et al., 2008; Magle et al., 2009). Remaining forests are also not increasing in area or connectivity (Pagiola, 2011; Arriagada et al., 2012; Programa Estado de la Nación, 2014). Despite significant efforts to support local owners to maintain forest cover through programs for environmental services, competing land uses, such as growing crops, cattle ranching, and urban expansion, have had a strong impact

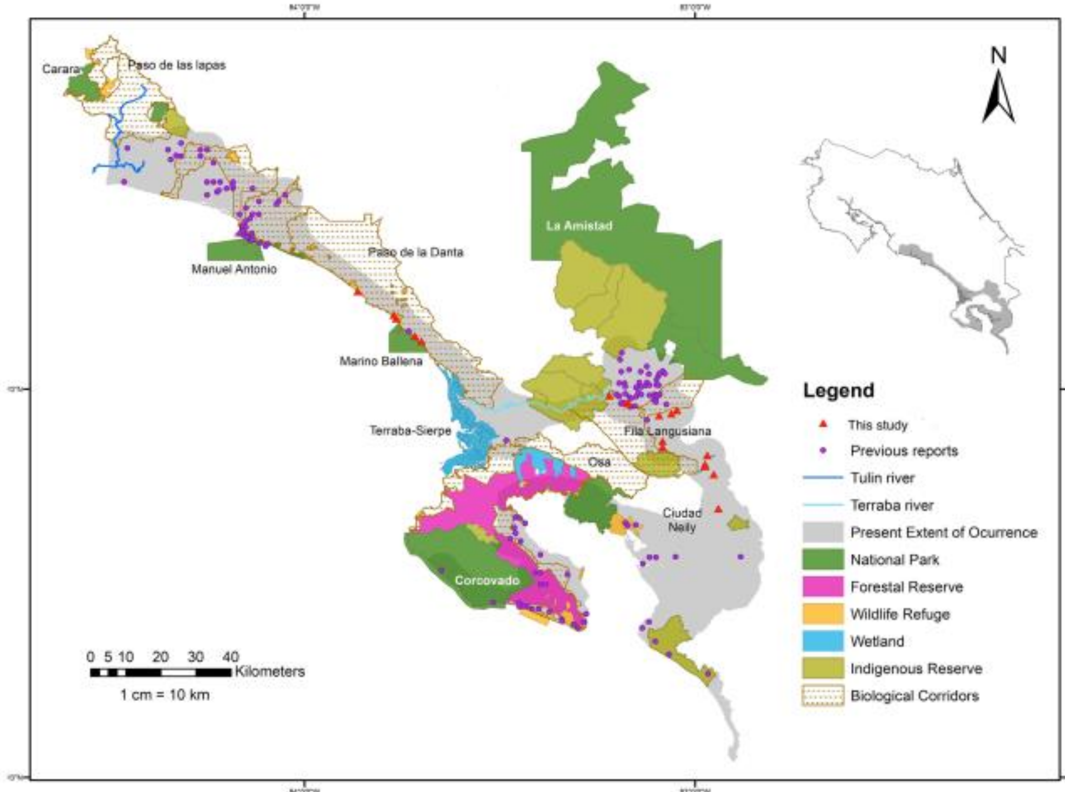

Fig. 4. Priority areas for conservation of the Central American squirrel monkey (*Saimiri oerstedii*) in Costa Rica. Although there are no records in the region where the Carara National Park is located, the habitat is practically the same where the species is found, so it can be introduced to have a larger protected population.

in land used by *S. oerstedii*. So, in addition to environmental services incentives, constant vigilance is required to ensure the survival of the species. Furthermore, tourism, concentrated along the coastal and lowland areas, places additional pressure on primate populations in the fragmented habitats there (Wong, 2002; Picón-Cruz and Baltodano-Zúñiga, 2006; Baltodano, 2007; Calvo-Alvarado et al., 2009).

Primate populations can persist in fragmented landscapes if the remnant patches provide sufficient resources, are allowed to regenerate, and maintain good connectivity to larger patches (Estrada et al., 2006; Sáenz and Sáenz, 2008). We have demonstrated that the squirrel monkey's extent of occurrence is likely expanding. This, together with the ability of its populations to survive in highly fragmented habitat, offers new possibilities for ensuring long-term preservation.

4.3. *S. oerstedii as a conservation model*

The results of our research illustrate a basic challenge facing conservation biology, providing sufficiently detailed information to make required conservation decisions for endangered and threatened species. Additionally, our research highlights several important, take-home conservation messages which may offer guidance for reducing the threats to other species. First, even very conspicuous organisms such as the Central American squirrel monkey, which are under tremendous pressure from habitat destruction, persecution as pests and capture as pets for trade, may attain relatively stable populations in a highly-fragmented, human-dominated landscape, if properly protected. Other primates that are good examples of such flexibility are orangutans, howler monkeys, and lorises (Estrada et al., 2017). Second, the benefits of protecting habitat to maintain stable *S. oerstedii* populations in Coto Brus will also benefit many other populations of vertebrates and other organisms (Daily et al., 2003; Pacheco et al., 2006; Mendenhall et al., 2014). Third, expanding and enhancing protected areas, and promoting benefits for local owners of unprotected habitat will also help populations of many other species. Four, as our squirrel monkey study has shown, critical information for conservation can now be acquired relatively simply and inexpensively in light of the powerful satellite technologies now increasingly available. But, of course, such effort will likely remain logistically impossible for the vast majority of populations and species.

It is easy to underestimate the capacity of some human-modified landscapes to support vulnerable faunal populations. Our research shows that the population of a threatened primate species and a wide range of other associated mammal species, can survive in an area significantly modified by agriculture, primarily because of the presence of remnant forest patches of suitable size and connectivity. Patches of secondary and riparian forests serve as buffers that increase landscape connectivity are critical for the conservation of many threatened species (Marsh, 2013; Newbold et al., 2015). An improved protection status of this landscape, framed on coherent and ecologically-based policies, is essential to ensuring that its ecological functionality is not further compromised (Baltodano, 2007). This concept reinforces the view that key contributions of conservation biologists are the development and application of techniques used to accurately diagnose a landscape's capacity to maintain wildlife populations (Daily et al., 2003), and recommending actions that will enhance this capacity.

This study of squirrel money conservation illustrates another extremely important point about global conservation of biodiversity. A very large amount of effort by many investigators has been required to illuminate the situation of *S. oerstedii*, even though it is a relatively large, attractive, and easily-observed animal. This tells us that there is no hope of attaining similar understanding of the many millions of species and billions of populations of most organisms. That's why modern conservation biology recognizes that the global level of biodiversity, the status of humanity's life-support system, is strongly linked with a wide range of human disturbances, such as habitat destruction, climate disruption and toxification (Ceballos et al., 2015). Finding ways to deal with the rapid increase of the global human population and its unrelenting efforts to expand consumption by the rich and middle class are among the greatest conservation challenges in a world addicted to mindless economic growth. On the positive side, our study shows that despite these trends, there can be great value in efforts to preserve protected areas, establish new ones, and enhance the quality of human-dominated landscapes from the viewpoint of their non-human occupants.

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Text in Spanish 1

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ABSTRACT

Ecotourism can be defined as tourism based on nature and its protection. It represents a small share of tourism but has made great progress recently. This progress is closely associated with a progressive generalized environmental awareness. Costa Rica has an exuberant natural heritage and biodiversity, its main source of income is tourism, and has been a pioneer in the development of ecotourism for over thirty years. It is important to review this development to see what aspects can be improved. Since its birth in Costa Rica, there are certain aspects that must be corrected to prevent to exhaust this model. In this article, the question of whether ecotourism is inexhaustible will be answered; several reasons are given in the following lines. A deep review of the academic literature on ecotourism has been done, multiple ecotourism projects have been studied in Costa Rica and elsewhere in Latin America to know about their recent status, and their main concerns and difficulties. This paper concludes with some recommendations to improve ecotourism's sustainability.

Keywords: **Ecotourism, wealth, Costa Rica, Latin America, sustainability.**

RESUMEN

El ecoturismo se puede definir como aquel turismo que se fundamenta en la naturaleza y su protección. Supone una pequeña porción del turismo, aunque ha tenido un gran desarrollo recientemente y su auge está íntimamente asociado a una progresiva concienciación medioambiental generalizada. Costa Rica tiene una herencia natural y una biodiversidad exuberante, su principal fuente de riqueza es el turismo y es, además, pionero en el desarrollo del ecoturismo desde hace más de treinta años. Es interesante aprender desde la propia experiencia y echar la vista atrás para comprobar cómo ha sido este desarrollo y qué aspectos pueden mejorarse. Desde su nacimiento en Costa Rica, han aparecido ciertos aspectos necesarios de corregir para que no se agote dicho modelo. En este artículo se plantea la pregunta de si el ecoturismo es inagotable y se darán razones al respecto en las líneas siguientes. Para ello se hace una revisión de la literatura académica sobre ecoturismo, se estudian múltiples proyectos ecoturísticos en Costa Rica y en otros lugares de América Latina para conocer cuál es su estado actual, sus principales preocupaciones y dificultades, para así poder concluir con algunas recomendaciones para que se pueda mejorar la sostenibilidad del ecoturismo.

Palabras clave: **Ecoturismo, riqueza, Costa Rica, América Latina, sostenibilidad.**

>>

» INTRODUCCIÓN

El turismo tiene un papel fundamental como generador de desarrollo (Artesi, 2002) y es una de las actividades económicas con mayor crecimiento a nivel global. El turismo es importante para prácticamente todos los países, pero incluso lo es todavía más para los países en desarrollo, ya que gracias a él se produce la mayor cantidad de llegadas de vuelos internacionales (Arrieta y Rivera, 2006). En América Latina se ha incrementado la competencia en el sector del turismo, debido, entre otras razones, a la aparición de nuevos destinos turísticos y a la llegada de operadores turísticos internacionales como consecuencia del proceso de globalización. Es por ello por lo que interesa mucho analizar los factores que pueden influir en su competitividad (Arrieta y Rivera, 2006).

Se pueden encontrar diferentes definiciones de ecoturismo en la literatura académica; por ejemplo, se puede definir el ecoturismo como el turismo basado en la protección de áreas naturales, una alternativa de turismo que permite la obtención de beneficios fundamentándose en la preservación del entorno natural (Smith, 2010). Según Sánchez y Ramírez (2011), ecoturismo se denomina a los viajes cuyo principal propósito es la contemplación de la naturaleza, aumentar su conocimiento y la participación y promoción de su conservación, y cuyo destino son áreas poco modificadas por la acción humana. Asimismo, se podría definir el ecoturismo como la modalidad turística ambientalmente responsable, consistente en visitar áreas naturales con el fin de apreciar, disfrutar y estudiar el paisaje, la flora o la fauna autóctona. Se distingue del simple turismo de naturaleza por su énfasis en la educación y la conservación medioambiental (Alvarado, 2010; Molina, 2011). A este tipo de turismo se le conoce con varios nombres, como por ejemplo, bio turismo, turismo ambiental, verde, académico… según la faceta en la que se enfoque.

El ecoturismo todavía no representa una gran parte del total del turismo mundial, aunque su alcance ha sido ascendente en los últimos años, y sus tasas de crecimiento superan a las del turismo convencional (Schulte, 2003). Concretamente en América Latina, su potencial de desarrollo es considerable debido a su gran abundancia y diversidad biológica (Torres, González, Martín y Kirkby, 2011).

Muchos autores consideran claramente probada la relación existente entre la mejor conservación de la naturaleza allí donde se da el ecoturismo, especialmente en áreas naturales protegidas, que es donde se manifiestan más frecuentemente (Álvarez, Segura y Campos, 2012).

Asimismo, es evidente la correspondencia entre la educación ambiental y la existencia de áreas naturales protegidas, puesto que es fundamental la creación de proyectos que ayuden a la conservación de dichas áreas protegidas y que, a su vez, generen mejoras en las condiciones de vida (Reyes y Castro, 2008). El ecoturismo estimula la educación ambiental y los valores ecológicos que ayudan a mejorar la relación de las personas con el medioambiente (Lee y Moscardo, 2005). Esta relación innegable se aprecia claramente entre el ecoturismo y la educación ambiental, a diferencia de otros tipos de turismo (Álvarez et al., 2012).

Habitualmente los lugares para la práctica del ecoturismo suelen ser los asentamientos rurales en las cercanías de áreas naturales protegidas, ya que estas ejercen una acción de atracción importante

El ecoturismo se puede definir como aquel turismo que se fundamenta en la naturaleza y su protección. Supone una pequeña porción del turismo, aunque ha tenido un gran desarrollo recientemente

sobre los turistas (Sánchez y Ramírez, 2011). El ecoturismo cercano a zonas protegidas aumenta las posibilidades de empleo para las personas que viven en zonas adyacentes (Palacio, 2010).

Muchos autores contemplan el ecoturismo cada vez más como una herramienta que, al mismo tiempo que promueve la conservación de la naturaleza, es capaz de contribuir al desarrollo local rural (Torres et al., 2011; Casas, Soler y Jaime, 2012, Alvarado, 2010). Otros autores nombran este hecho como turismo comunitario, basado en las comunidades locales y encargado de reforzar la relación del turismo con la naturaleza; este turismo comunitario posibilita la mejora del nivel de vida de regiones rurales al involucrar a la población local y permitir que también ellos reciban su parte de beneficios económicos asociados (Casas et al., 2012; Coria y Calfucura, 2012)

Algunos autores discrepan en algunos aspectos y cuestionan en cierta medida los resultados de algunos proyectos ecoturísticos, sobre todo en lo referido a la supuesta mejora de las condiciones de las áreas naturales que las alojan (Álvarez et al., 2012). Un ejemplo de esta discrepancia es la disminución de la superficie de algunas áreas naturales protegidas (Alvarado, 2010). También otros autores alertan sobre los efectos del ecoturismo en las islas Galápagos, famosas por alojar especies animales endémicas muy atractivas pues, según González-Pérez y Cubero-Pardo (2010), aunque se intente respetar al máximo el entorno de dicha fauna, la mera presencia humana provoca reacciones directas en el comportamiento de estas especies que sí pueden afectar a la biodiversidad.

Los aspectos positivos del ecoturismo son muchos, claros y muy valiosos de promover. Aunque los autores de este artículo consideran todavía más interesante el hecho de conocer cuáles son sus rasgos mejorables, los cuales aparecen una vez que se concreta su implementación. Es por esto totalmente necesario el análisis objetivo de los cambios asociados al ecoturismo, para evaluar su impacto real (Alvarado, 2010).

Se han desarrollado, en los últimos años, numerosas iniciativas enfocadas hacia el ecoturismo en varios países de América Latina. Vamos a estudiar algunas de ellas para analizar sus efectos, observar sus beneficios y analizar sus posibilidades de mejora.

El objetivo principal de este artículo es profundizar en el conocimiento del ecoturismo a través del análisis de varios de los proyectos ecoturísticos que recientemente se han llevado a cabo en diferentes lugares. El mejor conocimiento permite maximizar el potencial del ecoturismo como una herramienta muy válida que promueve la conservación de la naturaleza en conjunción con la mejora de las condiciones de vida de las zonas donde se practica (Torres et al., 2011). Mejorar algo bueno no es fácil, es más fácil mejorar algo malo. Este es el caso del ecoturismo, ya que para mejorarlo se debe incidir en aumentar sus ventajas e intentar disminuir sus inconvenientes asociados al mínimo posible.

METODOLOGÍA

La metodología seguida para la elaboración de este artículo es la revisión de la literatura académica actual en ecoturismo, particularmente en Costa Rica y en sus países vecinos. Este estudio intenta averiguar cuál es el estado actual del ecoturismo estudiando distintos proyectos ecoturísticos que se han podido observar, y analizar las posibilidades de mejora.

Entre la literatura académica estudiada, destaca el interés por diferentes estudios de caso realizados en distintos países y entornos de Costa Rica y de otros países de América Latina. Al compararlos entre ellos se encuentran similitudes y diferencias, pero sobre todo lo más interesante es que permite el desarrollo de ideas de mejora que pueden ser de gran utilidad para todos.

COSTA RICA, PARAÍSO DEL ECOTURISMO

Costa Rica es un país eminentemente turístico, por lo tanto, la industria turística es la mayor fuente de riqueza del país. Costa Rica es, además, un país pionero en el desarrollo del ecoturismo, se dio a conocer como tal en la década de los 90, aunque desde bastante antes se manifestaban inquietudes de conservación de sus riquezas naturales. La belleza exótica de su medio natural lo hace ser uno >>

>> de los paraísos más cotizados. A pesar de su pequeña extensión contiene más variedad de fauna y flora que Estados Unidos y Canadá (Alvarado, 2010). Sin embargo, no todo su turismo es ecológico, pues existe mucho turismo de sol y playa, aunque es el ecoturismo el que es utilizado como elemento diferenciador (Barrado, 2001) y todo el conjunto del país se agrupa como imagen de destino natural (Alvarado, 2010). Costa Rica es considerado un país líder en el desarrollo del ecoturismo a nivel mundial (Chen y García, 2011).

Costa Rica posee una gran cantidad de atractivos naturales, esto ha permitido el desarrollo de una muy amplia oferta de ecoturismo, como visitar un parque nacional, el paseo por sus distintos tipos de bosques, la observación de aves, caimanes y animales exóticos, visitar sus dos costas en el Caribe y en el Océano Pacífico, donde se puede disfrutar del buceo y la observación de arrecifes, delfines, tiburones, distintos tipos de peces y del desove de las tortugas. Se pueden recorrer senderos entre vegetación exuberante, visitar cataratas, atravesar ríos, subir a volcanes…

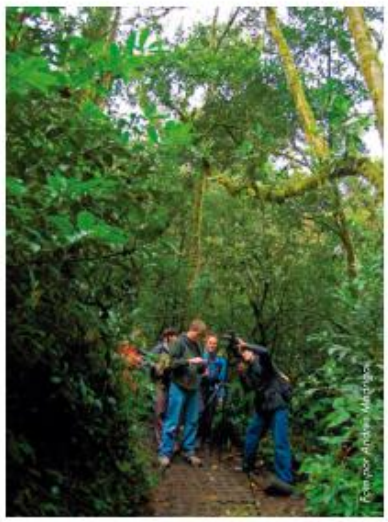
También se puede disfrutar del etnoturismo; según Pilquiman y Skewes (2009), el etnoturismo es el turismo que centra su interés hacia las culturas indígenas. Existe la posibilidad de visitar poblados autóctonos para apreciar sus costumbres, los turistas pueden convivir unos días para realizar distintas actividades agrícolas, culturales, gastronómicas, artesanales, etc., para así conocer sus tradiciones ancestrales, por ejemplo, la observación de la cultura y el arte de las etnias bribrí o guaymí en Puntarenas (Chen y García, 2011).

Es recomendable la visita y hospedaje en comunidades rurales donde se puede participar de sus actividades diarias. Estas tareas en comunidades rurales son generalmente impulsadas por diferentes asociaciones comunitarias. El gobierno del país patrocina la creación de agrupaciones locales ya que es consciente de sus beneficios y promueve la creación de agrupaciones locales de apoyo al sector ecoturístico, como las cooperativas, asociaciones de desarrollo local, grupos de apoyo a la conservación, grupos de mujeres, etc. Algunos ejemplos de este hecho son la formación de asociaciones como la Asociación de Talamanca para el Ecoturismo y la Conservación (ATEC) creada para el fomento del ecoturismo en la zona protegida del Parque Nacional Cahuita, la reserva Indígena de Kè Koldi y el Refugio de Vida Silvestre de Manzanillo (Palacio, 2010). Se pueden nombrar más ejemplos: ASEPALECO, los buzos de Paquera, el asentamiento de campesinos de Los Planes de Drake, los grupos organizados de Playa Grande o la asociación de damas ecoturísticas de la isla de Chira. Estas asociaciones nacieron para desarrollar diferentes actividades de carácter medioambiental (Chen y García, 2011). La existencia de estas asociaciones y el trabajo conjunto de ellas permiten facilitar el desarrollo de sus capacidades y mejora el aprovechamiento de su entorno de una forma más eficiente (Chen y García, 2011).


Foto por Andrei Madrigal

Estas asociaciones se dan por todo el país y se observa que a través de ellas se beneficia a la población local, y a la vez se es capaz de reducir el impacto negativo del turismo (Matarrita-Cascante, Brennan y Luloff, 2010). Otro ejemplo muy interesante se halla en La Fortuna, donde se promueve la mejora de los productos locales a través del aumento de la competencia hacia ellos, aumentando, de este modo, su calidad y provocando que la economía local crezca en calidad y cantidad (Matarrita-Cascante et al., 2010). Otra de las características de estas asociaciones es que las personas locales mantienen la propiedad de las tierras, incluso muchos de sus habitantes mantienen sus actividades agrícolas paralelamente a su actividad turística, diversificando de este modo sus ingresos (Matarrita-Cascante et al., 2010).

A pesar de esto, no todo son ventajas, ya que algunas comunidades locales costarricenses no siempre obtienen los beneficios que se esperaban del ecoturismo (Coria y Calfucura, 2012), lo cual provoca reacciones de oposición y rechazo al no verse igualitariamente incluidas en el reparto de beneficios. Reyes, Feria y Aguilar (2013) indican que, en el caso de Caño Negro, existe un proyecto cuyos resultados son pobres, puesto que su degradación ha aumentado y, además, el desarrollo de la población local ha sido muy escaso. Este hecho no ocurre únicamente en Costa Rica, se dan más casos en América Latina, por ejemplo, en Perú: en la declaración de Lima se anima a los indígenas a participar en el ecoturismo porque ayuda al desarrollo de sus comunidades, sin embargo, el foro de turismo indígena lo rechazó porque ellos no se sienten respetados (Dachary y Arnaiz, 2009).



Es interesante destacar los casos de éxito en la colaboración entre tour operadores y comunidades indígenas, como es el caso de Posada Amazonas, en donde se da una colaboración positiva entre ambos actores, ya que firmaron un acuerdo para trabajar juntos y para compartir los beneficios de forma igualitaria (Coria y Calfucura, 2012). Se puede observar otro caso de éxito en Ecuador: la comunidad Achuar conduce el proyecto prácticamente sola después de que una compañía privada financiara el proyecto; trabajaron conjuntamente durante 10 años hasta que fue transferido a la comunidad local cuando ya habían adquirido habilidades de gestión (Stronza y Gordillo, 2008).

La educación es un factor de éxito muy importante a tener en cuenta, ya que fundamenta los proyectos ecoturísticos, aumenta la concienciación hacia la conservación y la actitud positiva hacia el medio ambiente. El caso de Rara Avis, que integra el conocimiento bilateral entre los visitantes y los locales, es un buen ejemplo de ello (Sander, 2012). También el ecoturismo forestal tiene una influencia positiva en el desarrollo social y ambiental en Costa Rica, como afirma Bien (2010) en su estudio.

El apoyo del gobierno al ecoturismo a nivel estatal es también considerable, se han creado varias instituciones que se ocupan del seguimiento de las cuestiones medioambientales asociadas al ecoturismo: El Instituto Costarricense de Turismo (ICT), el Ministerio del Ambiente (MINAE), el Sistema Nacional de Áreas de Conservación, el Tribunal Ambiental, la Secretaría Técnica Nacional Ambiental y el Tribunal Ambiental (Alvarado, 2010).

En Costa Rica se puede estudiar incluso la carrera de Ecoturismo en la Universidad de Costa Rica, con sede en Guanacaste. Es pionera en América Latina. Se impartió por primera vez en 1991 con el objetivo de la creación de profesionales especialistas en dicho campo (Arrieta y Rivera, 2006). Su tarea fundamental es contribuir al desarrollo ecoturístico local y del país en general, su objetivo principal es la promoción de la investigación ecoturística, para poder identificar los cambios que se producen con el ecoturismo y así poder mejorar la eficiencia de las explotaciones intentando evitar la alteración del medio ambiente. Esta carrera cuenta con programas de intercambio con la Escuela Superior Politécnica de Chimborazo (Ecuador), la Universidad de Guadalajara (México) y la Universidad de >>

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Bremen (Alemania). Además, recientemente se ha creado el Observatorio del Turismo Sostenible para Guanacaste, encargado de apoyar la creación de nuevos proyectos.

Por otra parte, en Costa Rica algunos autores manifiestan la existencia de alguna contradicción entre el ecoturismo teórico y el real, pues se observa que, por ejemplo, algunas áreas protegidas están perdiendo terreno, poniendo en peligro la biodiversidad (Alvarado, 2010). Precisamente, debido a que la economía costarricense depende directamente del turismo, se intenta atraer cada vez más visitantes; recientemente, cadenas hoteleras internacionales que se han instalado en el país están fomentando un turismo de sol y playa, con un perfil de visitantes que genera mayor cantidad de desechos con un mayor impacto ambiental que amenaza ciertas especies, como, por ejemplo, la amenaza al sapo dorado en Monteverde (Chen y García, 2011).

Este mismo hecho es denunciado en otras zonas de América Latina por otros autores; por ejemplo, Torres et al. (2011) alertan acerca de la sobre explotación por el excesivo número de visitantes que sufre Machu Picchu, y recomiendan aumentar el control y reducir su número. En las Islas Galápagos, según González-Pérez y Cubero-Pardo (2010), el exceso de visitantes afecta de forma negativa la relación de las numerosas especies endémicas y únicas que allí habitan.

Estas contradicciones entre ecoturismo teórico y su implementación real deberían tenerse en cuenta, evaluarse y corregirse adecuadamente, pues podría llegar el punto en que la imagen de Costa Rica se viese dañada y perdiese su valor fundamental de paraíso medioambiental.

Otra cuestión destacable es que el enfoque del ecoturismo es mayoritariamente hacia turistas extranjeros con alto poder adquisitivo, sobre todo europeos y norteamericanos; paradójicamente, los costarricenses suelen estar fuera de la experiencia ecoturística (Alvarado, 2010), lo cual debería evaluarse, pues se trata de una ironía que los propios habitantes no disfruten del mismo modo las bondades de la naturaleza como lo hacen los turistas extranjeros.

CONCLUSIONES

Iniciamos las conclusiones con la pregunta que se formuló en el título de este artículo: ¿es el ecoturismo una fuente inagotable de riqueza? Se podría contestar que depende. Depende de la gestión que se lleve a cabo de las áreas naturales protegidas de Costa Rica, de una riqueza excepcional, con el objetivo de conseguir un mejor desarrollo económico sostenible con el tiempo.

El perfil del ecoturista ha cambiado en los últimos años, ya que en sus inicios el turista disfrutaba recorriendo caminos difíciles para acceder al lugar del destino y esto formaba parte de la experiencia, sin embargo, ahora demanda unas mejores condiciones de vida en su estancia (Alvarado, 2010). Este hecho se ha transformado en presión para la construcción de infraestructuras que puede suponer una irreversible degradación del hábitat.

La capacidad para la obtención de rentabilidad del ecoturismo depende de la estrategia seguida. Un factor esencial a tener en cuenta es lograr mayor concienciación y participación local. Muchas de estas explotaciones son dadas a concesiones extranjeras, por lo que sería más recomendable la unión entre las comunidades nativas y empresas turísticas especializadas que doten de conocimiento, experiencia y concienciación, para así desarrollar mejor los proyectos de ecoturismo y que, de este modo, sus beneficios lleguen igualmente a las comunidades locales.

Las concesiones extranjeras disponen habitualmente de mayor capital y habilidades de gestión, mientras que las comunidades locales poseen un mayor conocimiento de su entorno y un mayor interés en su conservación, puesto que es su hogar. Es abundante la literatura que indica que la combinación sinérgica de ambos actores muestra los mejores resultados a largo plazo (Coria y Calfucura, 2012; Carrascosa-Lopez, Segarra-Oña, Peiró-Signes y De-Miguel-Moli-

La capacidad para la obtención de rentabilidad del ecoturismo depende de la estrategia seguida. Un factor esencial a tener en cuenta es lograr mayor concienciación y participación local

na, 2015; Stronza y Gordillo, 2008; Li, 2013; Elliot, 2014).

Sería necesario debatir cuál es modelo de desarrollo turístico más adecuado desde el punto de vista de su impacto social y medioambiental, así como evaluar cuál es el mejor para el desarrollo de la economía local. En este debate deberían estar representados todos los miembros implicados, desde las autoridades públicas hasta el sector privado y la población local en general (Chen y García, 2011). La combinación de las habilidades locales junto a las de las empresas turísticas contribuye a una mejor distribución de la riqueza (Matarrita-Cascante et al., 2010).

Posteriormente, sería recomendable la elaboración de un plan de acción articulado según las ventajas competitivas del territorio y de sus habitantes. El objetivo sería el desarrollo de un cluster ecoturístico, que aprovechase los atractivos turísticos locales, fomentara su conservación y que permita y promueva la competitividad favorable para su desarrollo, sin perder de vista cuál es el factor diferenciador principal, la naturaleza, con el fin de mantener su esencia fundamental (Chen y García, 2011). Se debe mantener la conciencia de que es la naturaleza quien atrae el turismo (Matarrita-Cascante et al., 2010), y debe evitarse a toda costa cualquier duda al respecto. Por ejemplo, sería totalmente necesario redimensionar algunas de las explotaciones para poder asegurar la sostenibilidad del ecoturismo (González-Pérez y Cubero-Pardo, 2010; Torres et al., 2011), así como reforzar la legislación medioambiental para asegurar que el desarrollo del ecoturismo no dañe el medio ambiente.

Otra cuestión destacable es que el enfoque del ecoturismo es mayoritariamente hacia turistas extranjeros con alto poder adquisitivo, por lo que, irónicamente, los costarricenses suelen estar fuera de la experiencia ecoturística (Alvarado, 2010). Para el desarrollo de clusters es fundamental el fomento de una demanda local exigente (Porter, 2000). Por eso sería recomendable la promoción de los valores del ecoturismo a todos los niveles de la sociedad, sobre todo partiendo de la base de la educación, para que este mayor conocimiento presione a la sociedad hacia el aumento del disfrute por parte de todos los ciudadanos. Incluso Sander (2012) habla de la necesidad de desarrollar el concepto de "orgullo ecoturístico" en Costa Rica.

Como conclusión final, se podrían añadir tres recomendaciones generales que ayuden a que los proyectos ecoturísticos sean sostenibles en el tiempo y que mantengan su esencia:

1.- Debe haber un mínimo impacto en la interacción con el medio ambiente.

2.- El control y los beneficios económicos deben contentar razonablemente a las comunidades locales, para que, de esta forma, se den al mismo tiempo sostenibilidad medioambiental, cultural y económica.

3.- Debe ser creada una atmósfera de aprendizaje e investigación, para lo cual la educación es el factor básico sobre el que se apoye.

El principal peligro que debe evitarse es que el ecoturismo pierda su esencia, no debe mostrarse ningún género de duda en que el ecoturismo conserve su naturaleza intrínseca, que sea modelo de sostenibilidad, que preserve los ecosistemas y satisfaga a los habitantes locales, con la mejora de sus condiciones de vida.

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Text in Spanish 2

ARTÍCULOS

Consideraciones éticas y ambientales en el proceso de acidificación oceánica

ETHICAL AND ENVIRONMENTAL CONSIDERATIONS IN THE PROCESS OF OCEAN ACIDIFICATION

CONSIDERAÇÕES ÉTICAS E AMBIENTAIS NO PROCESSO DE ACIDIFICAÇÃO OCEÂNICA

Nelson de Jesús Gil-Luna*

Resumen

La acidificación oceánica es un problema creciente que afecta el medio ambiente global, cuyas repercusiones son detectables ahora, que ponen en riesgo el recurso hídrico más extenso del planeta e influyen en los cambios climáticos que se pueden documentar en todo el planeta. El presente artículo analiza la protección del medio marino como una medida para asegurar a las generaciones futuras un ambiente sano, que les garantice una mejor forma de vida. Se exponen los diferentes principios que rigen a la bioética, y se establece su relación con los procesos de desarrollo sostenible y el incremento de la acidificación que ocurre en el océano y que afecta a una gran cantidad de comunidades de escasos recursos a nivel mundial.

Palabras clave: bioética; cambio climático; acidificación oceánica; desarrollo sostenible; ambiente; principios bioéticos (Fuente: DeCS).

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Abstract

Ocean acidification is a growing problem that affects global environment. Its effects are detectable now, putting the most extensive water resource on the planet at risk and influencing the climate changes that can be documented across the globe. This paper analyzes the protection of the sea as a measure to ensure a healthy environment for future generations, guaranteeing a better way of life for them. We present the different principles governing bioethics, and we establish their relationship with the processes of sustainable development and the increase of acidification in the ocean, which affects a large number of communities of scarce resources in the world.

Key words: Bioethics; climate change; ocean acidification; sustainable development; environment; bioethical principles (Source: DeCS).

Resumo

A acidificação oceânica, cujas repercussões são detectáveis agora, é um problema crescente que afeta o meio ambiente global, que coloca em risco o recurso hídrico mais extenso do planeta e influencia nas mudanças climáticas que podem ser documentadas em todo o mundo. O presente artigo analisa a proteção do meio marinho como uma medida para assegurar um ambiente saudável às futuras gerações, que lhes garanta uma melhor forma de vida. Os diferentes princípios que regem a bioética são expostos e é estabelecida sua relação com os processos de desenvolvimento sustentável e o aumento da acidificação que ocorre no oceano e que afeta grande quantidade de comunidades com recursos escassos.

Palavras-chave: acidificação oceânica; ambiente; bioética; desenvolvimento sustentável; mudança climática; princípios bioéticos (Fonte: DeCS, Bireme).

INTRODUCCIÓN

A partir de la primera reunión que se efectuó en octubre de 1984, donde se crea la Comisión Mundial sobre Medio Ambiente y Desarrollo (World Commission on Environment and Development) el planeta dirigió la mirada al ambiente y comenzó a prestar más atención al cuidado del mismo. Sin embargo, los procesos industriales y domésticos han afectado al ambiente de tal manera que es necesario intervenirlo para intentar llevarlo a un estado de menor afección (1).

El cambio climático global es considerado una de las amenazas más graves a los ecosistemas en todo el mundo. Este es, sin lugar a dudas, uno de los problemas ambientales más importantes a los que se ha enfrentado el ser humano (2). La acidificación oceánica (AO) ha empezado también a reconocerse, desde al menos cinco años atrás, como "el otro problema del CO_2", puesto que este gas tiene la característica de ser un gas de efecto invernadero (GEI), situación que lo hace responsable, en parte, del proceso actual de calentamiento global (3). Este hecho ha afectado al medio de tal manera que ahora podemos observar cambios en la química de océano y el clima de la tierra.

A MODO DE INICIO

Los ecosistemas marinos proporcionan bienes y servicios a la humanidad, incluido el de servir como fuente de alimento a muchas naciones y miles de millones de personas que dependen de ese ecosistema como de fuente principal para la obtención de proteínas de origen animal a bajo costo. La investigación reciente ha puesto de manifiesto otros factores que pueden subyacer a la variabilidad en la sensibilidad entre y dentro de grupos taxonómicos.

LAS TEMPERATURAS ELEVADAS PUEDEN AUMENTAR LA TASA METABÓLICA DE LOS ORGANISMOS DENTRO DE SU RANGO DE TOLERANCIA TÉRMICA, PERO CAUSAN UN RÁPIDO DETERIORO DE LOS PROCESOS CELULARES Y DE RENDIMIENTO MÁS ALLÁ DE LOS LÍMITES DE TOLERANCIA.

Por ejemplo, el aumento de alimentos o nutrientes podría compensar las reducciones en la calcificación y el crecimiento asociado a la acidificación en los corales, así como en mejillones (4, 5), los cuales se ven afectados por la disminución del pH y la disponibilidad de aragonita en el medio marino para producir sus exoesqueletos y conchas (6, 7).

Además, la adaptación puede hacer a una población más o menos sensible que a otra de la misma especie. Algunas especies pueden ser capaces de aclimatarse a la acidificación por plazos más largos (8).

También, los niveles crecientes de CO_2 atmosférico están impulsando simultáneamente un calentamiento oceánico, y un creciente número de experimentos ha probado el efecto combinado de acidificación y calentamiento. Las temperaturas elevadas pueden aumentar la tasa metabólica de los organismos dentro de su rango de tolerancia térmica, pero causan un rápido deterioro de los procesos celulares y de rendimiento más allá de los límites de tolerancia (9). Por tanto, predecir los efectos combinados del calentamiento y la acidificación es difícil, así como también es muy complejo indicar que el calentamiento tampoco podría contrarrestar los efectos de la acidificación del océano (10), o agravarlo a través de una acumulación de efectos de estrés térmico (11). Debido a lo anterior, la ciencia se ha abocado a evaluar la respuesta de los tres principales reservorios planetarios (terrestre, oceánico y atmosférico) ante el aumento en las emisiones de CO_2 hacia la atmósfera y la acumulación de gases de efecto invernadero, junto con la identificación de las perturbaciones que genera en el ciclo global del carbono y el clima (12)

No es necesario aclarar que los problemas ambientales tienen su origen antropogénico, generado posiblemente por una sensación de superioridad de la especie humana frente al ambiente pues este es "un ser que no entendemos, con el que no sabemos entablar un diálogo" (13). Si bien el Génesis[1] plantea que el hombre fue hecho "para que domine sobre toda la tierra y sobre todo animal", este elemento —que parece evidente para la mayoría de la sociedad occidental— pasa a generar un intento de dominio del ambiente. En Venezuela, Simón Bolívar, nuestro Libertador, lo demuestra con su famosa frase "¡Si la naturaleza se opone, lucharemos contra ella y haremos que nos obedezca!" En este aspecto algunas personas pudieran presumir que por mandato divino el hombre "civilizado" es amo y señor de todo lo que le rodea, y ha hecho creer a la especie humana que puede hacer lo que quiera con el ambiente, y tal como lo plantea Quiñones Colarte (14), la especie humana no ha entendido que el planeta afronta las consecuencias de un cambio climático sin precedentes, producto —entre otras cosas— de su propia acción.

1 Cfr. Gn. 1, 26

Sin embargo, creencias consideradas en algún momento "primitivas" o ancestrales (denominadas sabidurías ancestrales) permitían a los indígenas de diversas zonas del mundo aprender a vivir en equilibrio con el ambiente, tomando de la naturaleza lo necesario para su subsistencia, y como "pago" por este servicio ambiental le procuraban vida y evitaban, a través de diferentes prácticas, alterar los ciclos naturales ya que habían formado parte de sus vidas y permitían su sustentabilidad; por esto transmitían, y aún lo hacen, estas enseñanzas sustentables de generación en generación.

Se puede plantear hasta la saciedad por qué ocurre esto y quizás todas las respuestas posibles nos lleven a un lugar común. Por ejemplo, la falta de formación e información de los jóvenes, y no tan jóvenes, en aspectos ecológicos de totalidad, de conocer plenamente el sistema ecológico dentro del cual viven, así como analizar al individuo, al grupo y a la comunidad como relación ecológica y mantener los equilibrios en los ecosistemas creados por el hombre (15) pudiera ser una de las posibles respuestas, pero es harto demostrado que factores como el crecimiento indiscriminado de la población y el desarrollo social y tecnológico producido en los últimos años han dado como resultado un incremento importante en la acumulación de dióxido de carbono (CO_2) en la atmósfera y los océanos, situación que tiene el potencial para reestructurar los ecosistemas marinos (16). Este escenario hace que el aumento del CO_2 atmosférico a niveles atribuibles a la actividad humana haya reducido el pH del océano en aproximadamente 0,1 unidades. De igual manera, la modernidad en el uso de nuevas formas de energía contaminante o de sistemas político-económicos que van de la mano con la depredación ambiental tienen responsabilidad en estos hechos.

ACTUALMENTE, LOS ESTUDIOS QUE SE HAN REALIZADO PARA ESTIMAR EL INTERCAMBIO DE CO_2 ENTRE LA ATMÓSFERA Y LOS OCÉANOS COSTEROS DAN RESULTADOS INCIERTOS. LOS POCOS ESTUDIOS DISPONIBLES REPORTAN ÁREAS DE INTENSO INTERCAMBIO DE CO_2 EN LA INTERFACE AIRE-AGUA, LAS CUÁLES ACTÚAN EN AMBOS SENTIDOS: COMO FUENTES O SUMIDEROS CON RESPECTO A LA ATMÓSFERA.

EL CO_2 EN EL MAR

Se conoce que la corteza terrestre y el océano son los grandes reservorios de carbono (12). El océano costero contiene algunas de las áreas más productivas biológicamente de los océanos mundiales (17). Estas regiones costeras soportan gran parte de los recursos marinos capturados por el hombre (18), a pesar de que cubren solo una estrecha franja del área superficial total de los océanos. Es de esperarse que estas regiones actúen como fuertes sumideros de dióxido de carbono (CO_2) antropogénico debido a sus altas tasas de fijación de carbono fotosintético (17).

El ciclo del carbono de los mares a nivel de la plataforma continental ha sido fuertemente perturbado por actividades antropogénicas desde el inicio de la revolución industrial (19). El caso del dióxido de carbono (CO_2) presente en la atmósfera constituye solamente ~0,038 % del total de la combinación de gases existentes (380 ppm o µatm en unidades de presión parcial). Sin embargo, su solubilidad en el agua de mar es mayor que la del nitrógeno y la del oxígeno debido a que este gas disuelto reacciona con el agua para formar ácido carbónico y sus productos de disociación, bicarbonato y carbonato, tal y como se muestra en la siguiente ecuación (20):

$$CO_2\,(gas) + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^- \leftrightarrow 2H^+ + CO_3^{2-} \quad (A)$$

Las especies resultantes de la reacción (A) y su relación con el rango de pH del agua de mar, hacen que la presencia de CO_2 como gas disuelto se encuentre en cantidades muy pequeñas en el agua de mar (~0,23 ml l^{-1} o < 0,23 ppm), es decir, no llega al 2 % del TCO_2, en contraposición al bicarbonato, el cual es la especie química más abundante y se consume por efecto de la fotosíntesis (20), lo que genera cambios importantes en el ciclo del carbono tanto orgánico como inorgánico en ríos y humedales (21, 22), así como por las alteraciones en la intensidad del intercambio de CO_2 en la interfase aire-agua de los océanos costeros (1).

Actualmente, los estudios que se han realizado para estimar el intercambio de CO_2 entre la atmósfera y los océanos costeros dan resultados inciertos (19). Los pocos estudios disponibles reportan áreas de intenso intercambio de CO_2 en la interface aire-agua, las cuáles actúan en ambos sentidos: como fuentes (22-24) o sumideros (25-27) con respecto a la atmósfera.

En la década, pasada diversos estudios estimaron la asimilación de CO_2 atmosférico por parte de los océanos costeros entre 0,18 y 0,45 Pg C y^{-1}. Sin embargo, Laruelle, Lauerwald, Pfeil y Regnier (28) estimaron que los océanos costeros actúan como débiles sumideros de

CO_2 atmosférico, y fijan en promedio -0,19 Pg C y^{-1}. Estos resultados son consistentes con los obtenidos por Wanninkhof *et al*. (29), quienes estimaron la fijación de CO_2 atmosférico por parte de los océanos costeros en -0,18 Pg C y^{-1}.

EL PH EN EL MEDIO MARINO Y SU RELACIÓN CON EL CO_2

En el océano, el pH ha mostrado cambios no solo en tiempo y espacio debido a procesos de advección, sino también como resultado del incremento en la absorción de CO_2 de origen antropogénico (30). Este incremento de CO_2 en el océano ha provocado cambios en la profundidad de los horizontes de saturación de aragonita (HSΩA) (31, 32).

La acidificación del océano como resultante de la variabilidad del pH provoca cambios en los ecosistemas y en la biodiversidad marina. Este proceso puede afectar la seguridad alimentaria y limita la capacidad del océano de absorber el CO_2 procedente de las emisiones antropogénicas. Las repercusiones económicas de la acidificación del océano podrían ser considerables (33).

Se ha indicado que la absorción oceánica de CO_2 atmosférico proveniente de la quema de combustibles fósiles podría generar grandes cambios del pH en el agua de mar en los próximos siglos (34, 5).

De acuerdo con el Intergovernmental Panel on Climate Change (IPCC) (35), el pH ha disminuido en 0,1 unidades desde la revolución industrial, tendencia que en los últimos decenios se ha mantenido a un ritmo de -0,0014 a -0,0024 por año, y Marsh (36) plantea que el pH podría disminuir en 0,5 unidades hacia el 2100, aun cuando otras investigaciones también señalan que tal reducción podría estar entre 0,065 y 0,31 unidades (16).

ACIDIFICACIÓN OCEÁNICA, DISPONIBILIDAD DE ARAGONITA E IMPACTO EN LOS ECOSISTEMAS MARINOS Y SUS ORGANISMOS CALCÁREOS

La acidificación del océano ha tenido impacto en los ecosistemas marinos, que incluyen los corales tropicales constructores de arrecifes, corales de agua fría, algas coralinas incrustantes y pastos marinos, entre otros, lo que ha ocasionado cambios en sus funciones (36, 37) y en los arrecifes coralinos, y causa la reducción de su biodiversidad, blanqueamiento y, en algunas ocasiones, su muerte (38, 39).

En la bibliografía son ampliamente comentados los efectos perjudiciales que el cambio de pH en el océano ha tenido en los corales, tales como disminución del crecimiento del esqueleto, reducción de la densidad de las zooxantelas, disminución de la calcificación y variaciones en las comunidades marinas asociadas (40-43).

La acidificación del océano también afecta a las comunidades de macroalgas, con la disminución de la riqueza de algunas especies y la alteración de sus hábitats (44). Los llamados "pastos marinos", que son poblaciones de macrófitas acuáticas (plantas vasculares como *Thallasia testudinum* o *Poisodonia oceánica*), también pueden verse afectados por esta disminución de pH, cuyo impacto varía según la especie y las condiciones ambientales. Estas perturbaciones se evidencian en la distribución al alterar la competencia entre las especies de pastos marinos y sus poblaciones y las de algas (45, 46).

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Investigaciones indican que aunque durante el siglo pasado el pH disminuyó en 0,1 unidades, las tasas de calcificación de los corales han aumentado, al igual que la temperatura y la concentración de CO2, por tanto, la disminución potencial del pH oceánico no parece haber causado un detrimento en los corales y otras formas de vida marina, lo que genera resultados controversiales.

Esta acidificación afecta igualmente a los ecosistemas de manglares, ya que la reducción del pH incide en la solubilidad química, la disponibilidad de nutrientes, la descomposición de la materia orgánica, la mineralización diagenética de la materia orgánica, y ocasiona alteraciones en la cadena trófica de los estuarios asociados a este ecosistema (47, 48).

Sin embargo, investigaciones indican que aunque durante el siglo pasado el pH disminuyó en 0,1 unidades, las tasas de calcificación de los corales han aumentado, al igual que la temperatura y la concentración de CO_2, por tanto, la disminución potencial del pH oceánico no parece haber causado un detrimento en los corales y otras formas de vida marina, lo que genera resultados controversiales (49).

Para la zona del Caribe existen pocas investigaciones en las cuales se relacione la variación del pH marino con la absorción de CO_2, y cómo esta variación impacta en la disponibilidad de aragonita que se encuentra en el medio marino, para generar la cobertura de carbonato de calcio ($CaCO_3$) en organismos fotosintéticos marinos calcáreos.

Desde la bioética ¿qué principios se violan o se fortalecen? A la luz de lo expuesto la bioética, o más aún una ética ambiental o ecobioética, se muestra como la indicada para responder las principales preguntas que nos hacemos con relación con esta situación. Este es el punto central de este escrito: tratar de ver, desde una perspectiva bioética, cómo el hombre puede disminuir los procesos de acidificación, o por lo menos mitigar este punto tomando en cuenta estos diferentes principios, a fin de generar conciencia por un ambiente sostenible y garantizar los principios propuestos en el informe Brundtland: "Garantizar las necesidades del presente sin comprometer las posibilidades de las generaciones futuras para satisfacer sus propias necesidades".

Es necesario recordar en qué consisten la ética y la bioética. Inicialmente la ética, desde una concepción inicial más simple, la griega, se define como la ciencia de las costumbres (50), pero ya en la actualidad se la define como "la ciencia de la conducta, ya sea derivada de la naturaleza del hombre en razón del fin a que debe conformarse y de los medios ordenados a conseguirlo, ya sea en razón del impulso motor de la conducta humana y de los actos que la determinan" (50). La bioética es una disciplina iniciada por van Rensselaer Potter, que plantea el estudio sistemático de la conducta humana en el área de las ciencias de la vida y del cuidado de la salud, analizada a la luz de los valores y de los principios morales (51), lo que permite hacer juicios de valor sobre lo biológico, en el sentido más amplio del término, y obrar en consecuencia.

Sin embargo, no solo se puede analizar esto desde esa perspectiva, es necesario incluir a la ecología como ciencia que, unida a la bioética, no solo haga que esta última analice los principios y valores morales sobre la vida, sino que también aporte el sentido de globalidad en torno a la vida y a la naturaleza como sistema. Este es el punto básico de la ecobioética. El poder entender cómo valoramos tanto la vida de organismos marinos como el equilibrio del ambiente y, de forma colateral, la disminución de la calidad de vida de las comunidades adyacentes a las zonas marinas y a toda la comunidad mundial, pues estas alteraciones afectan de manera global nuestro planeta.

Los principios bioéticos universalmente conocidos y planteados por Beauchamp y Childres (52) son insuficientes para este tipo de problemas. Por eso, de acuerdo con lo planteado anteriormente sobre la diferencia entre la bioética y la ecobioética surgen otros principios que se relacionan directamente con la manera de abordar y de apropiarse del problema ambiental desde otras perspectivas, no solamente ecológicas, sino también desde un trípode económico, social y cultural, que representa los principales compartimientos o dimensiones del desarrollo sustentable. Con base en estas apreciaciones, entonces, se discutirán y se incluirán los principios de sostenibilidad, el principio precautorio, de progresividad, de responsabilidad diferenciada y concertación, de solidaridad y de conservación.

El ser humano siempre tiende y aspira a la prosperidad. El ser sostenible se puede definir desde la capacidad de satisfacer las necesidades de la actual generación sin sacrificar la capacidad de futuras generaciones de satisfacer sus propias necesidades.

A continuación se realiza un análisis de estos principios afectados.

Principio de sostenibilidad

El ser humano siempre tiende y aspira a la prosperidad. El ser sostenible se puede definir desde la capacidad de satisfacer las necesidades de la actual generación sin sacrificar la capacidad de futuras generaciones de satisfacer sus propias necesidades (53). Si un sistema destruye su propia base biofísica resulta insostenible (54); para ello, el desarrollo económico y social, y el aprovechamiento de los recursos naturales debe realizarse con una gestión adecuada; es decir, canalizar o pensar en dos aspectos que son de suma importancia: el respeto a los límites biológicos (*input* y *output* de elementos en el ambiente) y el pensar en el futuro (54). Estos dos aspectos o dimensiones del principio de sustentabilidad pareciera que no están planteados en estos momentos, pues el incremento de los gases invernadero (principalmente el CO_2) producto de la combustión incompleta en chimeneas industriales, y la quema de combustibles fósiles por parte de los vehículos automotores, sin que haya un proceso avanzado de investigación en energías alternativas, tanto para las casas como para los carros (los que existen son, hasta ahora, procesos exiguos), no garantizan una disminución de las cantidades de carbono presentes en el ambiente y, por consiguiente, un mantenimiento estable en los niveles de pH en el ambiente marino.

Principios de libertad y autonomía

Este principio determina la libertad y la autonomía que tiene el hombre para obrar en función de aspectos positivos para el ambiente, y de manera concurrente para con él. No obstante, se observa que un gran número de personas malinterpretan este principio y plantean que pueden hacer lo que quieran. Es la idea del libre albedrío, que es básicamente la potestad que el ser humano tiene de obrar según considere y elija. Pero, desde una perspectiva ética, ¿todo lo que el hombre hace en el ambiente, lo hace a favor de este? En los últimos años se ha visto cómo el ambiente marino es presa de la contaminación por plástico. De acuerdo con la Agencia Europea del Medio Ambiente, aproximadamente 10 millones de toneladas de basura van a parar a los mares y océanos del mundo, y la forma principal de estos desechos es plástico, tales como las botellas de bebidas y las bolsas desechables.

El hombre, de acuerdo con este principio, debe tender a obrar de manera positiva, a hacer el bien en favor del ambiente y en favor de él mismo. Este hecho mejoraría el proceso de desarrollo sostenible, lo que garantizaría a las generaciones futuras un ambiente en condiciones adecuadas y una sostenibilidad "económica" que permitiría no comprometer los recursos actuales ni los futuros en este momento.

Principio de precaución o principio precautorio

El no tener información científica sobre un daño grave o irreversible al ambiente no implica postergar la adopción de medidas eficaces para impedirlo. En este caso, las investigaciones que se han realizado sobre los procesos de acidificación oceánica no dan resultados conclusivos, pues dependen del paradigma de investigación que el científico adopte. Sin embargo, los efectos corrosivos planteados, y que pueden ser observados, obligan de forma inmediata a tomar en cuenta este principio y a actuar de la manera más responsable en favor del ambiente. Tal y como lo plantea Gudynas (55), la ciencia contemporánea se ha convertido en una pieza clave en la dominación y apropiación de la naturaleza y carga con una tradición que es positivista. Se presenta a sí misma como una unidad objetiva, materialista, universal y racional. Su finalidad es buscar la verdad y apela a procedimientos conocidos como "método científico" que es único, experimental y fáctico. Esta posición, muy simplista por demás, le ha costado fuertes críticas a los procesos científicos que tratan de explicar los fenómenos que ocurren en el planeta desde el punto de vista ambiental, debido a que legitima el dominio sobre el ambiente. En este aspecto, el propio Gudynas plantea que "se parte de la premisa de que todo es conocible y, por tanto, es controlable y manipulable. La naturaleza, los demás seres vivos, y el entorno inorgánico, están al servicio de los seres humanos y no poseen valores propios. Por tanto, esta ciencia es profundamente antropocéntrica" (55).

La ciencia contemporánea se ha convertido en una pieza clave en la dominación y apropiación de la naturaleza y carga con una tradición que es positivista. Se presenta a sí misma como una unidad objetiva, materialista, universal y racional.

EL PRINCIPIO DE BENEFICENCIA SE BASA EN LA OBLIGACIÓN MORAL DE ACTUAR EN BENEFICIO DE LOS DEMÁS Y DEL AMBIENTE QUE NOS RODEA. UNO DE LOS ELEMENTOS MÁS IMPACTANTES EN EL PROCESO DE ACIDIFICACIÓN OCEÁNICA, Y QUE ENVÍA UNA CANTIDAD CONSIDERABLE DE CO_2 AL AMBIENTE ES LA TALA DE ÁRBOLES, TANTO EN ZONAS COSTERAS COMO EN SELVAS.

Principios de beneficencia y de no maleficencia

El principio de beneficencia se basa en la obligación moral de actuar en beneficio de los demás y del ambiente que nos rodea. Uno de los elementos más impactantes en el proceso de acidificación oceánica, y que envía una cantidad considerable de CO_2 al ambiente es la tala de árboles, tanto en zonas costeras como en selvas. Esta tala en zonas costeras está relacionada con desarrollos urbanísticos. Es posible pensar que se mejora la vida de las comunidades, pero al final se degrada al océano y se actúa en beneficio de los demás, pero no en beneficio del ambiente. Lo que implica que el principio de beneficencia se logra a la mitad. Esto se encuentra asociado al paradigma desarrollista, que plantea un progreso material ilimitado que fija las siguientes pautas: "lo importante es acumular gran número de medios de vida, de riquezas materiales, de bienes y servicios, a fin de poder disfrutar nuestro corto paso por la Tierra" (15).

Al degradar el océano también se viola el principio de no maleficencia, que se refiere a no producir daño al ambiente y prevenirlo. Cuando se contamina o se disminuye el pH de los mares, se afecta la biota marina, es decir, se afectan formas de vida. La ética convierte a la ecología en la conciencia. Esto hace que se traduzcan conclusiones científicas y se transformen en imperativos de comportamiento que permitan el cuidado del ambiente. No dañar o perjudicar es diferente de no producir beneficios: si bien estamos obligados a no perjudicar a otros, no estamos obligados en la misma medida a beneficiarlos, pero nunca podremos tener certeza —o al menos, seguridad— de no perjudicar a otros con nuestras acciones e intervenciones (sean estas en la humanidad, en la naturaleza, en otros seres vivos, entre otros).

Principio de progresividad

El principio de progresividad plantea que los objetivos ambientales deben ser logrados de forma gradual, con metas a corto, mediano y largo plazo, para facilitar el cumplimiento de las actividades y disminuir el impacto ambiental que puedan conllevar. La Organización de las Naciones Unidas (ONU), en su informe de 2015, planteó los objetivos logrados para ese año, los cuales, trazados en 2000 se denominaron Objetivos de Desarrollo del Milenio. En su objetivo 7 se planteaba "garantizar la sostenibilidad del medio ambiente", y aunque en el informe presentado se indica que "prácticamente se han eliminado las sustancias que agotan la capa de ozono y se espera que la capa de ozono se recupere a mediados de este siglo", también se informa que "las emisiones de dióxido de carbono han aumentado en más de 50 % desde 1990 en todo el mundo".

Desde esta perspectiva, el objetivo principal —mantener el pH neutral del mar, para evitar los efectos de acidificación— no se ha logrado, y el impacto sobre las comunidades marino-costeras y sobre los habitantes de las mismas sigue siendo un peligro latente. La degradación de este medio afectará de forma progresiva los derechos humanos de estas comunidades, y ¿quién levantará la voz por las personas más pobres del planeta? ¿Qué Gobierno de los países industrializados se atreverá, con elementos de defensa éticos, a levantar la voz y defender los derechos de los países más pobres, afectados principalmente por la industrialización y la negación de ellos mismos a invertir en tecnologías más limpias y que sean más amigables con el ambiente? Todas estas preguntas quedan en el aire para el debate en su momento.

Principio de responsabilidad diferenciada y concertación

Este principio bioético es de suma importancia pues plantea que quien genera efectos degradantes al ambiente debe ser responsable de los costos de las acciones de prevención y corrección para mitigar los impactos causados actuales o futuros, es decir, "el que rompe, paga". Acá puede surgir la pregunta básica, ¿quién asume el costo de esta acidificación? ¿Quién responde por los daños causados a miles de habitantes de zonas deprimidas económicamente que viven a lo largo de zonas costeras? Pero más allá de todas esas preguntas, ¿quién puede dar la cara por los animales y por el propio ambiente afectado, que al final nos afectará a todos los que vivimos en esta isla sideral llamada planeta Tierra? Si se toman en cuenta ideas del derecho ambiental internacional y se indica "lo que es y no lo que debe ser", es necesario abordar la protección ambiental consistente en bienes comunes o intereses generales de la humanidad desde dos perspectivas, una negativa y otra positiva. La primera consiste en que la creencia de que "los bienes protegidos son patrimonio común de la Humanidad ha traído aparejado evanescencia en los deberes y derechos internacionales de los sujetos del derecho internacional" (56).

La segunda señala la proclamación por parte de las Naciones Unidas de que "el ambiente es patrimonio común de la humanidad otorgándole al individuo, a la persona humana, derechos para reclamar protección internacional como miembro de esa humanidad, pero en cuanto a quién es el titular de la legitimación, todos y ninguno, es decir todos son responsables y ninguno a la vez" (56). Es decir, al mismo momento todos y nadie pueden hacerse responsables de los impactos ambientales que ocurren en el planeta, y esto hace de suma importancia construir y poner en marcha un sistema que pueda generar protección de manera internacional en el ambiente para administrar los bienes comunes. Sin embargo, de forma ética esto choca directamente con el principio de autonomía, puesto que la soberanía estatal funciona como un principio básico del derecho internacional, en el cual los Estados plantean una lógica negativa a ceder sus competencias ambientales aunque solo fuera para resolver los problemas globales (57). No obstante, frente al mar estamos como en un inmenso conjunto residencial con una inmensa área común. La pregunta obligatoria es: ¿cómo administramos ese espacio?

Principio de justicia

Los responsables de la protección ambiental deben vigilar el uso del ambiente para garantizar que las generaciones presentes y futuras puedan gozarlo, pero desde esta perspectiva, ¿quiénes son los responsables de la protección ambiental? Los responsables son todos aquellos que viven en el planeta, pues este hecho de vigilar el uso del ambiente para garantizar el goce y disfrute de generaciones presentes y futuras es transversal a la vida. La raza humana, como culmen de la evolución, tiene como principio de justicia el cuidado del ambiente tanto para las generaciones presentes como las futuras.

De acuerdo con Gudynas (55), los principios de una sociedad sostenible (que atañen directamente al principio de justicia) serían: a) El respeto y cuidado de la comunidad de los seres vivientes, b) la mejora en la calidad de la vida humana, c) la conservación de la vitalidad y diversidad de la Tierra, d) la reducción al mínimo del agotamiento de los recursos no renovables, e) la modificación de las actitudes y prácticas personales y f) el forjamiento de una alianza mundial. Todos estos elementos permiten establecer un patrón de conducta ambientalmente sostenible, y de justicia y equidad que facilitaría el cuidado del ambiente y principalmente el cuidado de las comunidades humanas más sensibles.

Principio de solidaridad y cooperación

Este principio es manejado principalmente por entes del Estado pues le otorga al Gobierno nacional, por intermedio de todos los departamentos de la administración pública nacional y regional que tengan que ver con el ambiente, la responsabilidad de los efectos ambientales y de las medidas de mitigación de riesgos sobre los sistemas ecológicos compartidos con países fronterizos, con medidas desarrolladas en forma conjunta, y la utilización de los recursos naturales y los sistemas ecológicos compartidos de forma equitativa y racional. Sin embargo, a nivel marino no es sencillo plantear dicha solidaridad, pues los límites son muy difusos en cuanto a la forma de mitigar los impactos que dan inicio a la acidificación oceánica. Generalmente, estos impactos provienen de tierra firme y están referidos a los grandes procesos de industrialización y de manejo de tecnologías no adecuadas que impactan gravemente el ambiente, basados en la premisa del desarrollo nacional.

Los pocos mecanismos de control pasan por el consenso internacional y la adhesión a propuestas, protocolos (p. ej., el Protocolo de Kyoto) que muchas veces son firmados y quedan como letra muerta.

Como se puede apreciar a lo largo de esta disertación, los planteamientos éticos ambientales frente a un problema determinado son amplios y los límites son muy difusos. Todo lo que hagamos en favor del ambiente en un determinado lugar repercutirá de forma favorable en una de las regiones más extensas del planeta, el mar, el cual fue nuestra cuna y puede volverse nuestra tumba.

CONCLUSIONES

Los procesos asociados a la acidificación oceánica (AO) son complejos así como sus impactos. Después del somero análisis realizado podemos sacar algunas conclusiones. El principal evento contaminante es la cantidad de CO_2 enviado a la atmósfera por las grandes empresas generado por la quema, bien de combustibles fósiles o de elementos orgánicos. Esto evidencia el alcance que tiene este problema al no ser un problema puntual sino global. El océano funciona como un elemento *buffer* que absorbe las emisiones de CO_2, pero ese hecho disminuye su pH natural, se estima que para el año 2100 el valor de este será de 7,7, lo que generará grandes daños a los organismos marinos calcáreos.

LAS COMUNIDADES DEPENDIENTES DEL TURISMO, EMPRESA QUE A NIVEL MUNDIAL MUEVE MILLONES DE DÓLARES, SE VERÁN AFECTADAS POR LA PÉRDIDA DE BELLEZAS NATURALES ATACADAS POR LA ACIDEZ OCEÁNICA, LO QUE INCIDIRÁ EN LA CALIDAD DE VIDA DE ESTOS HABITANTES.

De mantenerse las emisiones de CO_2 al nivel actual se producirán grandes pérdidas en la biodiversidad y serán afectadas las grandes empresas de pesca y mariscos a nivel mundial.

Como acción colateral, las poblaciones más pobres del planeta sufrirán la falta de estos alimentos pues es la forma de obtener proteína animal más barata o de manera artesanal.

Las comunidades dependientes del turismo, empresa que a nivel mundial mueve millones de dólares, se verán afectadas por la pérdida de bellezas naturales atacadas por la acidez oceánica, lo que incidirá en la calidad de vida de estos habitantes.

La AO no es un problema fácil de analizar y no está completamente entendido, por lo que los modelos actuales no muestran una relación clara entre el problema y las posibles causas de mitigación.

El estudio de la AO requiere de una base ética y filosófica pragmática, y que a nivel internacional no sea simplemente una aproximación discursiva y retórica; exige de estrategias, planes, acciones, inversiones y presupuestos que poco a poco, y de manera coherente y consistente, sirvan de insumo a un nuevo paradigma, por supuesto, con el cumplimiento de todos los principios de bioética.

El futuro del planeta depende del concepto de ambiente y de cómo nos vemos inmersos en este proceso. Son las generaciones futuras las que pueden terminar de ayudar o hundir a nuestro ecosistema.

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Text in Spanish 3

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¿POR QUÉ ES NECESARIO ESTUDIAR EL COMPORTAMIENTO ANIMAL?

WHY IS NECESSARY TO STUDY ANIMAL BEHAVIOR?

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RESUMEN

Palabras clave: *comportamiento animal; evolución; lógica; teoría de la conducta*

Se examinan varias razones por las que es necesaria la investigación con animales y del comportamiento animal en la formulación (y aplicación) de una teoría general de la conducta. Entre ellas se destacan razones de naturaleza evolutiva, de tipo epistemológico, de carácter lógico, de utilidad experimental y de índole ética.

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ABSTRACT

Keywords: *animal behavior; evolution; logics; behavior theory*

Several arguments are examined in order to support the need of animal behavior research for the formulation (and application) of a general behavior theory. Among them, arguments related to evolution, epistemology, logics, experimental utility, and ethics are emphasized.

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La mayor parte de los legos considera que la psicología es una ciencia "humana", es decir, que su objeto de conocimiento se centra exclusivamente en la especie *Homo sapiens sapiens*; sin embargo, esta suposición no es correcta. Es mi propósito examinar varias razones por las que, no sólo se justifica, sino que es indispensable que la psicología estudie el comportamiento animal. Estas razones no son todas del mismo nivel, sin embargo, apuntan a la importancia del comportamiento animal para la comprensión de los fenómenos psicológicos. Este trabajo hará un breve recorrido por cada una de ellas.

El Comportamiento Humano como Resultado Evolutivo

A pesar de los embates creacionistas en los Estados Unidos, ya nadie pone en duda el hecho de que el hombre (para referirme a la especie *Homo sapiens sapiens,* sin ningún ánimo discriminatorio de las diferencias sexuales, ni de género, en la propia especie) es el resultado de la evolución biológica en el planeta Tierra y que, en esa medida, comparte procesos y características con muchos de sus ancestros. La especie humana es, en sentido estricto, un animal. Obviamente, nadie puede cuestionar que se trata de un animal muy especial y singular, no sólo en sus características biológicas, sino principalmente en relación con su comportamiento. Se trata del único animal cuyo origen como especie fue posible y está enraizada en la creación de un medio social, estructurado a partir de la división del trabajo y el intercambio diferido de los productos del trabajo. Es también la única especie que desarrolló el lenguaje en una diversidad de lenguas naturales y lenguajes técnicos, como condición necesaria para la división social del trabajo. Finalmente, en lo biológico, es quizá una especie más vulnerable que otras en muchos aspectos, pero posee el sistema nervioso más desarrollado en la evolución y un sistema motriz de locomoción y manipulación fina altamente diferenciado. Por estas razones, entre otras, es indudable que las características psicológicas del ser humano son especiales. Sin embargo, ello no significa que otras especies en la evolución estén privadas de manifestaciones psicológicas.

¿Cómo saber si se pueden atribuir procesos psicológicos a otras especies en los distintos reinos biológicos? El problema central radica en la forma en que concebimos y definimos a los fenómenos psicológicos. En el caso del ser humano, los fenómenos psicológicos se identifican a partir y en la forma de *prácticas* del lenguaje ordinario identificables por medio (aunque no exclusivamente) de términos y expresiones "mentales" (emociones, sentimientos, recuerdos, pensamientos, etc.). Sin embargo, dado que el ser humano es la única especie que se comporta lingüísticamente, no es posible restringir a este criterio la identificación de los procesos psicológicos en la escala zoológica del reino de los animales (dando por descontado que en los otros reinos no tienen dichos procesos: procariotas, hongos, plantas y protistas). Lo anterior, no impide que, de manera no sistemática, atribuyamos a los animales fenómenos psicológicos con base en lo que Darwin denominó reacciones vestigiales que compartimos con ellos.

La cuestión está en los criterios para distinguir al comportamiento estrictamente biológico del comportamiento psicológico, aunque parezca extraño que utilicemos el término *comportamiento* en dos contextos con significados diferentes. De hecho, este término no es exclusivo de la psicología, pues se emplea no sólo en el lenguaje ordinario sino también en todas las disciplinas científicas como la física, química, biología, sociología, economía y otras; cuando se habla, por ejemplo del comportamiento de las partículas, de las moléculas, de las células, de las instituciones, y de los mercados, respectivamente.

El comportamiento biológico puede ser identificado en términos de la reactividad, filogenéticamente determinada, propia de cada especie y, en esa medida, es invariante en el ciclo vital de los organismos individuales. En contraste, el comportamiento psicológico consiste en el desarrollo de funciones en la ontogenia, en la que se diferencian, reorganizan y diversifican las relaciones con los objetos, acontecimientos y otros organismos en el ambiente, más allá de las reacciones fijas vinculadas a la nutrición, la reproducción y la defensa. La diferenciación y flexibilidad reactiva es una característica del comportamiento psicológico y, por consiguiente, sólo puede tener lugar cuando la especie dispone de sistemas reactivos diferenciados para cada una de las funciones biológicas de supervivencia antes mencionadas. Los hongos, plantas y protistas carecen de estas características, de modo que el comportamiento psicológico aparece vinculado a la emergencia filogenética del tejido nervioso, cuya función es coordinar los sistemas reactivos diferenciales y especializados. Es el paso de la irritabilidad a la sensibilidad y motricidad. La propia evolución del tejido nervioso, de los ganglios a la compleja estructura que presenta en los homínidos, es resultado de una sutil interacción con la diferenciación de los sistemas reactivos (sensoriales y motrices, principalmente) y las contingencias de supervivencia y ajuste del nicho ecológico correspondiente. Siguiendo este criterio podemos extender el objeto de conocimiento de la psicología a todas aquellas especies animales con tejido nervioso y, por consiguiente, con distintos niveles de diferenciación reactiva. Esta es la primera razón por la que la psicología debe estudiar la conducta animal.

El Estudio Comparado del Comportamiento

Después de establecer que el comportamiento psicológico tiene lugar en un sinnúmero de especies animales, además del hombre, y que se puede identificar el comportamiento psicológico a partir de la diferenciación reactiva (sensibilidad y motricidad) que auspicia la emergencia del tejido nervioso en la filogenia, un paso natural es asumir que la psicología, entre otros objetivos, debe plantearse el estudio comparado del comportamiento (psicológico, obviamente), y además que la psicología comparada es una rama legítima de conocimiento científico.

La psicología comparada, en un sentido amplio, contempla varias ramas de igual importancia:

1. El estudio comparado de los procesos psicológicos en la diferentes especies, y de la forma particular en que se organizan considerando su medio ecológico y su medio sociocultural, este último en el caso del hombre. La identificación de procesos compartidos por diversas o todas las especies, así como de los procesos exclusivos de sólo algunas o de una sola especie (nuevamente el caso del hombre) no sólo es de primordial importancia para la validación externa de la teoría general de la conducta, sino que constituye un campo multidisciplinario excepcionalmente rico entre la psicología, la prehistoria humana y paleontología, y la biología de la evolución. La evolución de las funciones psicológicas es un proceso de naturaleza ontogenético. Sin embargo, no se le puede separar de la evolución filogenética y de cómo a partir de las diversas convergencias y divergencias evolutivas emergieron especies compartiendo y/o repartiendo diferentes potencias y funciones biológicas que, dependiendo de los hábitats y demandas ecológicas auspiciaron a su vez el surgimiento de distintas formas de organización funcional del comportamiento psicológico. Lo mismo puede aplicarse en el caso del hombre a su evolución a partir de los primates superiores y la creación progresiva de medios sociales de convivencia de complejidad organizativa creciente. Aunque el comportamiento psicológico no tiene filogenia en sentido estricto, ni es función directa de las variables socioculturales, su evolución (aún inconclusa, creo yo) no puede entenderse sin comprender la evolución biológica y la historia de las formaciones sociales;
2. El estudio comparado de un mismo tipo de comportamiento en distintas especies, conduce a plantearse inevitablemente los criterios de comparabilidad del comportamiento. Son diversos los criterios con base en los que se puede comparar el comportamiento de distintas especies. Sin embargo, la cuestión fundamental radica en *qué* es lo que se compara: la forma de la conducta, el tipo de aparato o preparación experimental, las características del hábitat, la función biológica implicada, las características de los estímulos empleados, las respuestas consumatorias pertinentes, formas de organización funcional del comportamiento,

significación del comportamiento como patrón de la especie, procesos subyacentes, y otras más. En el caso de la psicología el objeto de interés fundamental es la compleja interacción evolutiva entre comportamiento eficaz para la supervivencia, estructura reactiva del organismo, contingencias ecológicas, y modificaciones progresivas de la biología de la especie. No se debe olvidar que la selección natural planteada por Darwin no es la razón, sino el resultado de la evolución, y que las especies, como poblaciones de organismos especiales, representan en última instancia colectivos de individuos que interactúan en un nicho ecológico con sus coespecíficos, así también con individuos de otras especies y con las variaciones de los distintos componentes que integran su nicho ecológico. Ese fue el motivo histórico de los primeros estudios sobre la inteligencia animal, que dieron lugar a lo que posteriormente se llamó teorías del aprendizaje; y

3. El estudio comparado de las etapas del desarrollo psicológico en diferentes especies, y de una misma especie en diferentes nichos, este último es un equivalente de los estudios comparados del desarrollo psicológico humano en distintas culturas. El análisis del desarrollo del comportamiento y sus procesos involucra una metodología longitudinal con el individuo como eje de observación respecto de las contingencias progresivas de un medio específico; en el caso humano, un determinado grupo cultural, mientras que en los animales el medio se define en términos de nichos ecológicos específicos. El estudio comparado del desarrollo del comportamiento no consiste solamente en el establecimiento de paralelismos entre distintas especies y nichos en lo que se refiere a la secuencia de "etapas", "ciclos" o "momentos" y sus estados terminales, sino que permite el análisis transversal de una misma condición o circunstancia del desarrollo en distintas especies y en distintos nichos. Este análisis transversal puede incluir tanto estudios etológicos, como estudios observacionales restringidos así como estudios experimentales. La riqueza potencial de estos análisis no ha sido explorada, lamentablemente.

El Estudio Controlado de los Procesos Conductuales

El comportamiento psicológico es función de una diversidad de factores, entre los que se destacan la propia historia interactiva de los individuos, la complejidad de las contingencias ambientales, los criterios o demandas de ajuste del medio, así como distintos tipos de variables situacionales y organísmicas, muchas de ellas de difícil o imposible manipulación práctica. En el caso de los seres humanos, por razones obvias, no es posible estudiar el comportamiento bajo condiciones experimentales rigurosas en las que se restrinjan condiciones y circunstancias que son garantes de los derechos humanos consagrados por las distintas leyes, ni tampoco realizar estudios observacionales prolongados, tanto por razones de privacidad de los observados como de la complejidad misma de las situaciones en que tienen lugar las interacciones humanas.

¿Qué es posible estudiar en el comportamiento animal que nos informe acerca del comportamiento humano? En la medida en que el comportamiento psicológico es resultado de la evolución biológica y de los medios que la propician, auspician y estimulan, se hace patente la pertinencia de la investigación del comportamiento animal para una mejor comprensión del comportamiento humano. En primer lugar, la investigación en animales nos permite estudiar experimentalmente bajo condiciones de restricción los procesos psicológicos que compartimos humanos y subhumanos, sin las limitaciones ya señaladas que imponen las legislaciones y, considerando, algunas normativas recientes de salvaguarda y buen trato de las especies animales (restricciones ambientales y de movimiento, demandas excesivas de esfuerzo, privación de agua y alimento, estímulos aversivos, administración de drogas, preparaciones crónicas, aislamiento, y otras más). En segundo lugar, dicha investigación no sólo facilita analizar de manera más rigurosa y paramétrica las variables involucradas en procesos básicos del comportamiento, sino que también permite distinguir las diferencias de organización de dichos procesos entre distintas especies y el hombre, dada la preeminencia del medio social y cultural en este último caso y el papel central que tiene el lenguaje tanto como sistema reactivo, como componente de las interacciones psicológicas, y como parte funcional inherente de todos los objetos y contingencias en el medio y el ambiente. En tercer lugar, se pueden "construir" historias funcionales pertinentes para evaluar el efecto de la experiencia en distintos tipos de situaciones. Finalmente, se pueden diseñar ambientes complejos de vida en los que sea posible experimentar y observar sistemáticamente acerca de los procesos que regulan el comportamiento.

El Valor Formativo y Lógico de la Investigación con Animales

La investigación del comportamiento animal tiene un valor agregado en su impacto formativo en los estudiosos del comportamiento en general. Se pueden destacar tres contribuciones importantes en este aspecto:

En primer lugar, la investigación con animales –aunque no siempre con éxito dadas las teorías antropomórficas en boga actualmente– fomenta explicaciones que no se basen en ficciones causales internas de diversa índole: estimaciones y cálculos, asociaciones complejas, representaciones, codificaciones y otras más. En la medida en que el Canon de Morgan obliga a buscar las interpretaciones más sencillas y elegantes lógicamente de los fenómenos, los iniciados en el estudio del comportamiento, por lo general, se percatan de la vaguedad y ambigüedad de las explicaciones basadas en atribuciones coloquiales del lenguaje ordinario, empleadas normalmente en la vida cotidiana, pero sin un sentido técnico. En contraste, se estimula el empleo de conceptos y explicaciones que tengan un carácter técnico y que se orienten al análisis funcional, paramétrico y abstracto de los fenómenos observados como producto de manipulaciones, observaciones y registros escrupulosos.

En segundo lugar, el estudioso del comportamiento animal, en la medida en que tiene que justificar y diseñar preparaciones experimentales especiales, se ve obligado a tener consistencia en relación con los planteamientos teóricos que orientan su indagación, las características de la situación experimental empleada, la naturaleza de los registros y datos a ser considerados, y la forma en que se van a interpretar. Las interpretaciones ad hoc y a posteriori son poco apreciadas y se aprende paulatinamente a desechar el modus operandi hermenéutico tan bien acogido por la mayoría de los psicólogos. Se aprende que lo fácil no es necesariamente lo correcto.

Finalmente, y en congruencia con lo anterior, las preguntas que guían el estudio del comportamiento animal, además de regirse por la prudencia de los procesos que pueden colegirse de los fenómenos observados, tienen que ser coherentes con los criterios teóricos que establecen cómo pueden relacionarse dichos procesos con los fenómenos más complejos característicos del comportamiento humano. Esta necesidad de coherencia lógica entre los diversos niveles de explicación del comportamiento, obliga a ubicar lo que se estudia en el marco de un campo de fenómenos general, previniendo en cierto grado la tendencia a la compartimentalización de los fenómenos y campos de investigación, y al fraccionamiento teórico de la psicología.

El Diseño de Modelos Experimentales

La investigación del comportamiento animal tiene una utilidad muy amplia en el campo de la colaboración multidisciplinaria e interdisciplinaria. En ambos casos, se pueden diseñar preparaciones experimentales con base en el conocimiento sobre los procesos conductuales en animales, a fin de emplearlas como modelos para el estudio de fenómenos de interés teórico o aplicado para otras disciplinas.

Un modelo experimental consiste en un análogo de un fenómeno o condición general que va a ser evaluada experimentalmente de manera sistemática. No hay modelos experimentales para sólo unos cuantos estudios y, de ocurrir así, significa que el modelo en cuestión resultó inadecuado para los propósitos que se planteaban. En tanto un modelo constituye un análogo bajo condiciones controladas de observación, manipulación y registro de variables, requiere satisfacer dos criterios. El primero tiene que ver con la validez ecológica de la preparación experimental, es decir, dicha preparación debe contemplar las circunstancias y variables que definen a un fenómeno determinado, Por ejemplo, si se pretende desarrollar un modelo experimental de la búsqueda de alimento en una especie dada, se deben incluir las características funcionales que definen a dicho fenómeno, como puede ser el número de individuos de la misma especie que compiten por, o que buscan el alimento, la presencia o ausencia de predadores, la diversidad de alimentos que componen la dieta de dicha especie, las propiedades espaciales del hábitat pertinente, los ciclos de alimentación, la disponibilidad espacial y temporal del alimento y otras más. De no tomarse en consideración estos aspectos, el modelo deja de ser un análogo válido del fenómeno y puede simplificar en exceso la condición estudiada. El segundo criterio tiene que ver con la selección de las variables y parámetros a ser evaluados de manera sistemática, y la manera en que, en este caso, la teoría de la conducta puede interpretar los procesos individuales que subyacen al fenómeno bajo análisis.

Los modelos experimentales empleando comportamiento animal pueden ser de utilidad en el estudio de fenómenos etológicos y ecológicos, de correlaciones entre sistemas fisiológicos (especialmente del sistema nervioso, pero no exclusivamente) y el comportamiento, de alteraciones clínicas, de evaluación farmacológica y adicciones, así como en estudios de biología y psicología evolutiva, de comportamiento parasocial en animales, y de comportamiento pre y paralingüístico en animales. En todos estos casos, la teoría y metodología experimental de la psicología puede contribuir con preparaciones experimentales pertinentes para el estudio de fenómenos de otras disciplinas o profesiones, que constituyen la esencia de la colaboración multidisciplinaria e interdisciplinaria.

El Valor Sistemático y Heurístico de la Investigación Animal

La investigación científica tiene como fin primordial la comprensión de los fenómenos naturales y sociales desde dos perspectivas: una de carácter sistemático y otra de carácter heurístico. En ambos casos, la investigación del comportamiento en animales es de fundamental importancia en el proceso continuo de construcción de una teoría general de la conducta.

La teoría científica avanza en la medida en que es capaz de clasificar, relacionar y, en esa medida, explicar todos aquellos fenómenos que forman parte de su campo de estudio. Dicha tarea se realiza con base en una lógica coherente que permite distinguir o identificar estos fenómenos en términos de propiedades y funciones abstraídas por la teoría. Desde esta perspectiva, una teoría es más robusta y poderosa en la medida en que puede considerar una mayor cantidad de fenómenos, distinguir sus propiedades, relacionarlos y explicarlos mediante una sola lógica categorial. Esta es la función sistemática de la teoría científica, que incluye tanto la clasificación como la explicación de los fenómenos. La investigación animal pone a prueba la lógica de cualquier teoría general respecto de la ubicación categorial de los distintos tipos de datos obtenidos y de su relación con los obtenidos con humanos. En esa medida, una teoría general de la conducta debe disponer de categorías que puedan ubicar lógicamente los procesos observados en animales y humanos, y establecer los criterios de comparabilidad, de equivalencia, y de divergencia.

Por otra parte, la función heurística de la teoría científica tiene que ver con el horizonte de observabilidad que su lógica de análisis abre a la indagación empírica. Este horizonte de observabilidad no es independiente de las posibilidades experimentales y de representación de los datos y fenómenos que auspicia y permite la investigación de la conducta animal y la investigación con animales y, en esa medida, también está relacionado con el poder sistematizador de sus categorías. Toda observación en ciencia es una observación determinada teóricamente. Por esta razón, los hechos a observar son los que una teoría contempla desde su lógica. Mientras más estrecha (e indiferenciada) sea esa lógica, menor será lo que se puede "ver" con dicha teoría. Las teorías que incluyen a la investigación animal como un dominio legítimo de observación, se plantean a su vez los criterios de relación de las medidas de la conducta animal con las del comportamiento humano. La posibilidad de observar y representar relaciones funcionales nuevas a partir de las observadas en el comportamiento animal es un agregado heurístico que sólo poseen las teorías que contemplan a la investigación animal como parte necesaria de su hacer indagatorio. Parafraseando al filósofo inglés J. L. Austin, "La investigación del comportamiento animal no es el final pero sí es el principio".

Text in Spanish 4

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Industrias de fundición: aspectos ambientales e indicadores de condición ambiental[(•)]

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Resumen El empleo de indicadores ambientales es, actualmente, una herramienta que colabora en el proceso de toma de decisiones en la gestión de la administración pública y privada. La falta de antecedentes de Indicadores de Condición Ambiental (ICA) en lo regional y local, la información asociada a la generación de residuos, efluentes y emisiones gaseosas provenientes de la industria de fundición, y la particularidad de encontrar a estas industrias en el ámbito urbano en la ciudad de Tandil, Argentina, orientan el principal objetivo del presente trabajo: la construcción de un conjunto de ICA que proporcionen información sobre el estado del ambiente en relación a este tipo de actividad. El campo de la investigación comprendió el total de industrias de fundición de la ciudad en el periodo marzo – abril de 2010. Se generaron ICA para el recurso, aire (9), suelo (5) y agua (1) con metodología adaptada a cada caso particular.

Palabras clave Indicadores de Condición Ambiental (ICA); Emisiones; Contaminación ambiental urbana;Tandil; Argentina; Gestión ambiental.

Foundry industries: environmental aspects and environmental condition indicators

Abstract Nowadays, environmental indicators are widely used as effective tools to assist decision-making in both public and private sectors. The lack of literature and research about local and regional Environmental Condition Indicators (ECI), the poor knowledge regarding solid waste generation, effluents and gas emissions from foundry industries, and their particular location in the urban area of Tandil, Argentina are the main reasons for this investigation, aiming to develop a set a of ECI to provide information about the environment in relation to the foundry industry. The study involves all the foundries located in the city between March and April 2010. The set of ECI developed includes 9 indicators for air, 5 for soil and 1 for water. Specific methodology was used for each indicator.

Keywords Environmental Condition Indicators (ECI); Emissions; Urban environmental pollution; Tandil; Argentina; Environmental management.

1. INTRODUCCIÓN

El rápido crecimiento económico e industrial de las últimas décadas ha traído consigo serios problemas de contaminación ambiental, como la polución del aire, agua y suelo. Paralelamente las exigencias y controles respecto de la relación actividad / entorno, por organismos de fiscalización, ha propiciado la creación de herramientas que sirven a la evaluación del estado del ambiente. Los indicadores ambientales son ejemplo de ello.

Los antecedentes en utilización de indicadores de condición ambiental (ICA) se corresponden, en general, con empresas de gran magnitud, que poseen sistema de gestión medioambiental (SGMA), y evaluación del desempeño ambiental de la empresa de acuerdo con la ISO 14031. La ISO 14032 ejemplifica el desarrollo de ICA a nivel internacional (cítese el caso de Iran Khodro Co, fábricas de automóviles iraníes), donde se encuentran empresas radicadas en Argentina, cítese el caso de Envases Alvher, División Industrial de Dinan

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S.A, envases flexibles laminados, YPF Refinería Lujan de Cuyo, una refinería de una petrolera multinacional y Petroquímica Cuyo S. A. I. C., una petroquímica[1].

En referencia a industrias que son específicas de fundición (mucho menos en la escala que se considera Pyme) no se hallan antecedentes de ICA aunque sí de indicadores de sustentabilidad ambiental. El trabajo "Worldsteel Sustainability Indicator Methodogy" define y calcula una metodología para indicadores de sustentabilidad de las industrias del Hierro y el Acero[2]. En lo nacional, la empresa Acindar Grupo Arcelor Mital, en su planta de Villa Constitución tiene desarrollado el índice de desempeño ambiental donde, mediante indicadores de gestión ambiental, se controlan emisiones a la atmósfera, se evalúa la contaminación de los efluentes líquidos y la generación de residuos[3].

En cuanto a las condiciones del estado del ambiente la información disponible se encuentra referida como "reportes del estado del ambiente" en cuestiones que se relacionan con problemáticas globales e indicadores de seguimiento (ej. concentración de gases de efecto invernadero), pero no están asociados y/o determinados por una actividad en particular (véase p. ej. la Iniciativa Latinoamericana y Caribeña para el Desarrollo Sostenible[4]; GEO América Latina y el Caribe[5]; Primer Compendio de Estadísticas Ambientales, República Argentina[6]).

Si bien la relación empresa/entorno tiene características propias de cada lugar donde ésta se desarrolla, hay aspectos ambientales que se pueden recuperar y generalizar para una actividad en particular. Es de interés por tanto desarrollar herramientas capaces de prevenir problemas ambientales consecuentes de la interacción elemento de la actividad/entorno. La dificultad de acceso a antecedentes de investigación que desarrollen indicadores de desempeño ambiental en industrias de fundición, y más aún la ausencia de los ICA que forman parte de este grupo, es lo que da motivo a su construcción en esta investigación, y constituye el objetivo del presente trabajo. Se espera entonces que estas herramientas permitan hacer el seguimiento y control del estado del ambiente en el entorno de las fundiciones.

Se adelanta brevemente que (hay un apartado metodológico específico para ello) las decisiones metodológicas que se llevan a cabo para la selección de los ICA se basan en criterios de relevancia, es decir, de pertinencia del indicador para los problemas o decisiones en que se requiere el uso y la relación que éstos tienen con normas específicas que existen en el país o en otras escalas territoriales, lo que lo sitúa en la realidad en términos de políticas públicas e información ciudadana.

2. DESCRIPCIÓN DE LA ZONA DE ESTUDIO

El proceso de industrialización desde el punto de vista espacial en la Argentina, se produjo de forma diferencial y en relación con ciertos factores de localización como los medios de transporte, la localización de la materia prima, el mercado, las fuentes de energía, la infraestructura y por supuesto, las facilidades impositivas de cada lugar[7].

En la ciudad de Tandil, a partir de la década de 1920 y hasta la primera década del siglo XXI, las industrias metalúrgicas y en específico las de fundición han sido motores de crecimiento económico y generación de empleo[8]. Este proceso paralelo de desarrollo industrial y urbano, algo desordenado, ha generado que con el paso del tiempo las industrias quedaran inmersas en zonas urbanas y periurbanas (Fig. 1).

Según normativa local y provincial vigente (Ordenanza Municipal Nº 9865/05, Decreto Municipal Nº 3085/07, Decreto Ley Provincial Nº 11.459/93, Decreto Provincial Nº 8912/77, Decreto Reglamentario Provincial Nº 1741/96), las industrias de fundición están localizadas en las Zonas de Regulación General. Es decir, se ubican en sectores con características homogéneas en cuanto a sus aspectos socio-económicos, paisajísticos y ambientales, en relación a los usos y ocupación del suelo, en lo referido al patrimonio urbano-arquitectónico y, en particular, en el rol que cumplen en la estructuración general y en la dinámica funcional del espacio territorial de Tandil. En dicha zona no está permitida la instalación de industrias de segunda (Ley 11.459, Art 15 inciso "b") y tercera (Ley 11.459, Art 15 inciso "c") categoría, a pesar de que las industrias de fundición, por las características que reúnen, pertenecen a estas categorías [8].

Estudios previos describen las fundiciones según sus condiciones productivas, operativas y ambientales. De las 30 industrias existentes, el 80 % se dedican a la producción de piezas de un solo tipo de material. El 20 % restante se distribuye entre fundiciones de Al/Fe, AL/Fe/Cu+Sn (bronce), y Al/Cu+Sn. Del 80 %, el 60 % se dedica al hierro y sus aleaciones, y el 40 % al aluminio. De acuerdo a estimaciones correspondientes al año 2010, la producción en toneladas (t) de piezas fundidas en esta localidad asciende a 3.011 t por mes, de las cuales 2.978,5 t corresponden a hierro gris y aleaciones de hierro, 30,5 t constituyen aluminio y 2 t pertenecen a bronce[9]; es de destacar que sólo una industria concentra el 80 % de la producción mensual.

Respecto de las condiciones operativas, a partir de la clasificación de la OCDE del año 2001, que atiende las intensidades de I+D (se calcula a partir de dos medidas de la producción: valor de producción y valor agregado), y de las denominaciones y códigos ISIC Rev 3

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Figura 1. Distribución de industrias de fundición. Los puntos representan las industrias. Los polígonos indican: (A) área urbana, (B) complementaria, (C) rural y (D) zona de uso industrial.

Figure 1. Distribution of foundry industries. Points represent industries. Polygons represent: (A) urban areas, (B) complementary areas, (C) rural areas and (D) near industrial use.

(International Standard Industrial Classification), Argentina identifica a la industria manufactura de metales básicos como *de* media baja tecnología[10]. Estudios locales indican además, que estas industrias son en su mayoría pequeñas en tamaño (de acuerdo con la cantidad de empleados por empresa), siendo las condiciones operativas y de cumplimiento de la legislación vigente preocupantes en relación al control de los efluentes[9].

En este sentido las condiciones ambientales señalan problemas como falta de chimeneas o de tratamientos de efluentes gaseosos que se agravan con el uso, aún significativo, de hornos cubilotes en empresas que funden hierro gris. Los hornos que funden aluminio (crisol y reverbero) en general poseen campanas de extracción de gases, sin tratamiento y con chimeneas de baja altura. En esta actividad, sólo se cuenta con chimeneas para evacuar los gases captados en el ambiente laboral, desatendiendo las obligaciones normativas (Tabla I).

A excepción de los efluentes sanitarios, el volumen de aguas residuales industriales de las fundiciones

Tabla I. Sistemas de tratamiento de efluentes gaseosos en hornos de fusión correspondientes a las 30 industrias locales

Table I. Emission control systems in furnaces of the 30 local foundries

Horno de fusión	Cubilote	Eléctrico	Crisol	Reverbero
Hornos totales	13	12	14	3
Hornos con ausencia de tratamiento de efluentes gaseosos	6	5	14	3

es poco significativo. El principal problema puede darse por el contacto del agua de escorrentía con materias primas de fundición, escorias, lodos, cenizas y otros residuos[11]. Veintiuna industrias vierten los efluentes líquidos del proceso al sistema de alcantarillado sanitario. Dos quedan por fuera de este servicio y disponen las aguas residuales en pozos absorbentes, y otras siete restantes se radican en el Parque Industrial Tandil (PIT) cuya infraestructura cuenta con un canal de desagüe (del año 1970) que sirve a todas las empresas en el parque y descarga aguas abajo en el arroyo Langueyú. No obstante, como ya se mencionara, la gran mayoría de estas industrias se encuentra en zonas con sistema de alcantarillado por lo que no representaría un problema ambiental significativo si se considera que las aguas colectadas por dicho sistema son posteriormente tratadas.

De acuerdo con lo expuesto se hace necesario abordar las situaciones de incompatibilidad de usos de suelo y problemáticas ambientales propias de las emisiones que la actividad genera.

3. PROCESOS Y ASPECTOS AMBIENTALES TÍPICOS EN INDUSTRIAS DE FUNDICIÓN

Las industrias de fundición son establecimientos que obtienen como resultado de su proceso piezas de metal que no podrían ser producidas por procesos de laminación forja o soldadura.

Los procesos que se llevan a cabo en cada fundición presentan variantes que dependen del tipo de metal a fundir (fundición de metales ferrosos como el hierro gris, hierro nodular, aceros y no ferrosos como el aluminio, bronce, cobre, zinc, plomo y níquel entre otros), de los métodos y de las tecnologías aplicadas.

Los diferentes métodos para la obtención de las piezas dependerán del tipo de pieza y cantidad a producir. Las etapas en general involucran: manipulación y almacenamiento de materiales, fabricación de moldes y noyos, fusión del metal, colada y limpieza de piezas fundidas. A continuación (Tabla II) se presentan las etapas que se desarrollan en el ámbito de la fundición y los aspectos ambientales asociados. Se entiende por aspecto ambiental a aquel elemento de la actividad capaz de interactuar con el entorno y producir un impacto[12].

De acuerdo a los aspectos ambientales identificados en las distintas etapas del proceso, los ICA se relacionarían primordialmente con las emisiones gaseosas (material particulado y otros contaminantes atmosféricos) y con residuos sólidos, fundamentalmente arenas de descarte y escorias. Teniendo en cuenta factores tales como las tecnologías actuales de los hornos de fundición que superan las viejas tecnologías que tenían un consumo significativo de agua, asimismo el tamaño, mediano a pequeño, de las industrias de fundición de la zona de estudio, el acceso de la mayoría al sistema de alcantarillado sanitario y la generación de volúmenes poco significativos de efluentes líquidos (ver apartado 2), se considera a estos efluentes como un aspecto poco relevante para la actividad. Sin embargo, el recurso hídrico será igualmente abordado ya que se identifica un riesgo de contaminación al recurso hídrico subterráneo debido a las disposiciones de residuos de arenas de fundición en cavas originadas por la extracción de granito y actualmente abandonadas, características de esta zona de estudio.

Otros aspectos ambientales a tener en cuenta en esta actividad, con carácter secundario, son la generación de emisiones difusas, olores y humos que causan molestias de diversa índole (olor durante las horas de fusión, degradación de las fachadas de las construcciones vecinas por humos y emisión de material particulado, en especial por fundición de hierro gris en hornos cubilotes) y el ruido proveniente del funcionamiento de la fábrica, de la movilidad de vehículos de carga y descarga de materiales, residuos y piezas fundidas.

4. METODOLOGÍA

El campo bajo investigación comprendió el total de industrias de fundición de la ciudad de Tandil, involucrando 30 establecimientos identificados durante el relevamiento realizado en el periodo marzo – abril de 2010. Debe destacarse aquí, que existe la posibilidad de que establecimientos no declarados funcionen en fondos de viviendas o galpones sin autorización.

El conjunto sometido a análisis quedó definido por los cinco tipos de procesos productivos existentes en el área de estudio que corresponden a los siguientes metales: aluminio (Al), aluminio/hierro (Al/Fe), aluminio/bronce (Al/Cu+Sn), aluminio/hierro/bronce (Al /Fe /Cu+Sn), hierro (Fe).

Los pasos metodológicos seguidos en la construcción de los indicadores están tomados y adaptados de la metodología propuesta por Jane Barr (2006)[8 y 15], donde: a) se identifican los puntos de interacción entre el entorno y la actividad, para lo cual se hizo una revisión bibliográfica obteniendo los aspectos ambientales recopilados en la tabla II; b) se describen los factores ambientales afectados, se identificaron temas prioritarios en relación a problemáticas ambientales locales y la actividad en

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Tabla II. Aspectos ambientales asociados a cada etapa del proceso

Table II. Environmental aspects related to each process stage

Etapa del proceso	Recurso con potencial impacto	Aspecto ambiental asociado	Efluente
Manipulación y almacenamiento de materiales e insumos	Aire	Descarga, almacenaje y transporte de materias primas (metales, chatarra) e insumos (arenas, combustibles sólidos y líquidos, resinas, fundentes, solventes, etc.).	Material particulado, hidrocarburos, COV, Cu, Ni, Zn, C.
	Agua		Aguas residuales con solventes, ácidos varios, metales, fenoles.
	Suelo		Residuos industriales sólidos: arenas, restos de combustibles, bidones.
Producción de moldes y noyos	Aire	Manipulación de materias primas.	Material particulado. Metales. Compuestos orgánicos volátiles (COV).
	Agua	Lavado de cajas de noyos y bateas de pinturas de sección noyería y rebabado. Lodos.	Kerosene, gasoil, soda caústica, pinturas y restos de pinturas. Lodos con contenidos de metales.
	Suelo	Manipulación de materias primas.	Polvo y barridos con contenidos de metales.
Proceso de fusión	Aire	Emisiones controladas: focos estacionarios con sistemas tradicionales de limpieza de gases. Emisiones fugitivas: aperturas de tapas o puertas para cargar, recargar, alear, inyectar oxígeno, remover la escoria y al colar.	Material particulado, metales, monóxido de carbono (CO), compuestos orgánicos volátiles (COV), óxidos de azufre, óxidos de nitrógeno, humos inorgánicos, dioxinas.
	Agua	Sistemas de tratamientos de efluentes gaseosos (ej. lavador de gases).	Carbonilla, óxidos de manganeso, óxidos de hierro y otras impurezas. Carga térmica importante. Metales.
	Suelo	Sistema de tratamiento de efluentes gaseosos.	Metales en polvo y lodos de filtros.
Colada y enfriamiento	Aire	Llenado de moldes y enfriamiento.	Material particulado. Monóxido de carbono (CO), compuestos orgánicos volátiles (COV)
	Agua	Enfriamiento y arrastre de la escoria.	Metales.
	Suelo	Residuos de escorias.	Escorias de hierro y acero. Escoria de aluminio, plomo, cobre, estaño, zinc y aleaciones como zamak, latón y bronce. Dioxinas.

Tabla II (continuación). Aspectos ambientales asociados a cada etapa del proceso

Table II (continuation). Environmental aspects related to each process stage

Etapa del proceso	Recurso con potencial impacto	Aspecto ambiental asociado	Efluente
Desmoldeo	Aire	Desmolde	Material particulado
	Agua		Aceites, solventes, ácidos.
	Suelo		Arenas de descarte o desechadas con contenidos de resinas y catalizadores, pinturas, pastinas, endurecedores y partículas de metales fundidos. Desmoldantes. Elastizantes en tierra de moldeo.
Limpieza y terminación	Aire	Limpieza de productos fundidos.	Material particulado. Polvo de granalla.
	Agua	Limpieza de maquinarias. Limpieza de las piezas producidas. Tareas de lavado de material y desechos de reactivos de laboratorio.	Residuos líquidos: solventes, ácidos, álcalis. Aguas residuales con solventes y grasas. Ácidos varios y otras drogas de laboratorio.
	Suelo	Materiales gastados.	Piedra caliza, material refractario del horno, ladrillos y arenas de crisoles. Materiales impregnados en aceite.

Fuente: Elaboración propia. Adaptado de Asimet - Consejo Nacional de Producción Limpia[13], Ministerio de Medio Ambiente - Documento BREF[14] y ODES[11].

cuestión sobre la base de entrevistas a informantes calificados del Sistema de Gestión Ambiental de la Dirección de Medio Ambiente del Municipio de Tandil, del sector privado, y de bibliografía específica sobre las condiciones naturales del medio, y c) se construyen indicadores de condición para dichos factores[15 y 16]. En este último paso, además de cumplir con los criterios comunes a todo indicador (disponibilidad de información estadística de calidad, simplicidad, precisión y claridad, consistencia interna de la hoja metodológica, etc.)[16], se contempla a quién va destinado, cuáles son las fuentes y carencias de datos, y se evalúa su fortaleza y debilidad. Al mismo tiempo, y con motivo de hacer más claro los campos descriptivos que hacen al indicador, se anexaron para su desarrollo campos sugeridos por Quiroga Martínez (2009)[16]: descripción del indicador, periodicidad de los datos (periodo de tiempo en que se actualiza) y la fórmula de cálculo del indicador.

Los indicadores de condición ambiental propuestos son agrupados de acuerdo al recurso con potencial de afectación. Así se tienen tres grupos de ICA para las industrias de fundición de Tandil: ICA para el recurso aire, suelo y agua, según orden de importancia.

El marco analítico para la selección de los indicadores se basa en la importancia del aspecto ambiental identificado en el contexto de las problemáticas ambientales que la actividad genera. Por tanto el criterio de selección aplicado a cada indicador responde a su pertinencia en los problemas o decisiones en que se quiere utilizar dicho indicador y a la relación que tiene con normas específicas que existen en el país o en otras escalas territoriales, lo que lo sitúa en la realidad en términos de políticas

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públicas e información ciudadana[16]. En este sentido se utilizó una metodología adecuada a cada caso particular, la cual se explica durante el desarrollo del trabajo.

5. INDICADORES DE CONDICIÓN AMBIENTAL

A continuación se desarrollan ICA para el recurso aire, suelo y agua.

5.1. ICA para aspectos ambientales que impactan el recurso aire

En la construcción de los indicadores a medir se trabajó sobre la base de las Guías Técnicas para la Medición, Estimación y Cálculo de las Emisiones al Aire, IHOBE [17-19]. En estos documentos técnicos se detallan contaminantes provenientes del horno de fusión usando como variables el tipo de horno y la materia prima, sin necesidad de describir la capacidad de los hornos o el tipo de combustibles, entre otros. Este método no considera para la estimación de emisiones la aplicación de sistemas de tratamiento de efluentes gaseosos, contemplando de esta forma la peor situación posible. Por ello, resulta apropiado su aplicación para este estudio donde la mayoría de las industrias no tienen sistemas de tratamiento (ver apartado 2). Se generó una tabla donde se recopilaron los datos relacionados con las características operativas locales, es decir, tipo de horno (hornos cubilotes, eléctricos, reverbero) y materia prima (hierro, aluminio y cobre).

La lista de contaminantes obtenidos se comparó con los considerados en las normas nacionales (Ley Provincial N° 5.965, Decreto Reglamentario N° 3.395/96, Resolución N° 242/97 [20]) e internacionales (National Ambient Air Quality Standards (NAAQS) [21] y Guías de Calidad de Aire de la OMS 2005 [22]) que consideran criterios de salud humana y el cuidado de los bienes materiales.

La creación de los niveles guías de la calidad de aire ambiente, y de los niveles guías de emisión, es decir, de los límites legales (obligatorios y sugeridos) correspondientes a contaminantes atmosféricos se fundamentan en estos criterios.

Durante el análisis se consideraron tanto contaminantes primarios -aquellos emitidos por una fuente directamente a la atmósfera sin sufrir transformación química desde el momento que salen de su punto de emisión- (SO_2, NO_x, CO, etc.), como contaminantes secundarios, es decir una vez que han evolucionado en el medio y han reaccionado química o fotoquímicamente (formaldehido).

En este contexto se proponen ICA para el caso de inmisión de efluentes gaseosos de las fundiciones (Tabla III). La periodicidad propuesta surge de los antecedentes vinculados a los programas de monitoreo y control de las industrias locales de fundición aprobados por el organismo de aplicación (OPDS) en el marco de la legislación provincial vigente: –Ley 5965/58 de protección a las fuentes de provisión, cursos y cuerpos receptores de agua y de la atmósfera; Decretos reglamentarios 3395/96; Resolución Nº 242/97; Complementario Decreto 3395/96; Resolución Nº 279/96; Presentación de la Declaración Jurada de Efluentes Gaseosos Industriales–.

5.2. ICA para aspectos ambientales que impactan el recurso suelo

Los principales residuos sólidos generados son las arenas de descarte, escorias, escombros (virutas y chatarras), polvos y arenas retenidos en filtros de mangas. En fundiciones no ferrosas además se pueden generar residuos peligrosos y contaminados con plomo, cobre, níquel y zinc, con frecuencia en elevadas concentraciones totales y extraíbles, provenientes principalmente de la escoria[5].

Las arenas de descarte son, en el proceso en general y en los residuos sólidos en particular, uno de los efluentes más abundantes generados por esta actividad, y por tanto objeto de atención.

Si consideramos las toneladas de arenas de descarte generadas respecto de las toneladas de pieza producida, tenemos que en las aleaciones de hierro y acero la relación es 1:1, mientras que en las de aluminio es 4:1[11]. En base a estos datos, actualmente se disponen en algún lugar unas 2.978,5 t de residuos de arenas por mes provenientes de fundiciones ferrosas, y al menos unas 122 t de residuos de arenas provenientes de fundiciones no ferrosas.

En Tandil, el municipio ha prohibido su disposición en el relleno sanitario de la ciudad, aduciendo que existe desconocimiento sobre si se trata de residuos especiales o no, tal como lo establece la Ley Provincial 11 720 de Residuos Especiales y su Decreto Reglamentario 806/97 [23]. Actualmente (e históricamente), los residuos de las fundiciones son depositados en cavas de canteras, ladrilleras y terrenos bajos, situados dentro o en cercanías del casco urbano sin ningún tipo de control[24].

Asimismo, un estudio antecedente ha podido localizar un total de 39 sitios relevados, de los cuales 8

Tabla III. Determinación de ICA para efluentes gaseosos de fundiciones

Table III. ECI determination for foundry gas effluents

Aspecto Ambiental/ Recurso	Efluentes gaseosos/aire								
Indicador	**PM10 (metales)**	**Xileno (COVNM)**	**Tolueno (COVNM)**	**Formaldehido (COVNM)**	**Benceno (COV)**	**Naftaleno (HAP)**	**Monóxido de carbono (CO)**	**Oxidos de nitrógeno (NO_x)**	**Dióxido de axufre (SO_2)**
Descripción	Cr, Pb y Cd adsorbidos en partículas en suspensión con diámetro menor a 10 µm	Compuesto orgánico volátil no metálico. Se producen principalmente por la evaporación de sustancias orgánicas que presentan una baja tensión de vapor.				Hidrocarburo aromático policíclico. Son compuestos orgánicos semivolátiles provenientes de la combustión incompleta.	Gas generado a partir de la combustión incompleta de hidrocarburos y sustancias que contienen carbono.	Oxido nítrico emitido por fuentes puntuales, dióxido de nitrógeno y óxido nitroso resultantes de su transformación en atmósfera.	Gas resultante de la mezcla de oxígeno con el azufre presente en los combustibles sólidos y líquidos.
Valor de base (máx. permitido)	**PM10**:0,150 (NC)* **Cr**: 1,67 E-8 (NG)*; **Pb**: 0,0015 (NC)*; **Cd**: 1,1E-7 (NG)*	5,2 (NG)*	1,4 (NG)*	6,2 E-5 (NG)*	9,6 E-5 (NG)*	1,2 E-1 (NG)*	10 (NC)*	0,10 (NC)*	0,365 (NC)*
Unidad de medición	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3
Periodo de promedio/ Norma aplicable	**PM10**: 24h. Res Nº242 Prov. de Bs. As ; **Cr y Cd**: 1 año Decr 3395/96 Prov. de Bs. As. **Pb**: 3 meses Res Nº242 Prov. de Bs. As.	8h. Decreto 3395/96 Prov. de Bs. As.	8h. Decreto 3395/96 Prov. de Bs. As.	1 año. Decreto 3395/96 Prov. de Bs. As.	8h. Decreto 3395/96 Prov. de Bs. As.	8h. Decreto 3395/96 Prov. de Bs. As.	8h. Decreto 3395/96 Prov. de Bs. As.	1 año. Res Nº242 Prov. de Bs. As.	24h. Res Nº242 Prov. de Bs. As.
Periodicidad	1 año	1 año	1 año	1 año	1 año	1 año	1 año	1 año	1 año
Destinatario	Gestión pública/privada								
Fuentes y Carencias de Datos	No se cuenta con estudios que versen sobre el estado de la calidad del aire respecto de estos indicadores en el área de estudio.								
Fortalezas y Debilidades	F: Los indicadores propuestos son resultantes del estudio de las emisiones de las fundiciones en cuestión, por tanto permiten conocer el estado de la atmósfera respecto de esta actividad y los cambios producidos en ella a partir de su comparación en distintos periodos de tiempos. D: No hay diseñada una red de monitoreo. Los costos de muestreo y análisis son importantes.								

* NC: Norma de calidad del aire ambiente; * NG: Nivel Guía de calidad de aire ambiente.

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pertenecen a disposiciones actuales, 19 a sitios con cese de actividad y 7 a sitios con disposiciones parciales de residuos de arenas de fundición (RAF)[24] (Fig. 2).

Si bien los organismos de control y las industrias de fundición tienden a considerar estos residuos como especiales o peligrosos, gran parte de la literatura disponible expresa que los RAF son mayormente residuos no peligrosos[25 y 26]. Antecedentes locales evidencian la necesidad e importancia del monitoreo de fenoles y de metales pesados como el cadmio, cobre, cromo, plomo y zinc debido a la utilización de resinas fenólicas[27]. Siempre que los valores de estos elementos estén por debajo de lo estipulado por la legislación (Decreto 831/93[28], EPA SW 846 1311[29]), los RAF pueden ser considerados como residuos no peligrosos en el marco de la Ley de Residuos Peligrosos 24.051[28]. Por tanto, se proponen los ICA que figuran en la tabla IV.

En base a lo expuesto, se considera de importancia realizar también el monitoreo de los volúmenes de residuos que se generan en las fundiciones y de los sitios que actualmente son receptores de los mismos. Por tal motivo los ICA para el control de este aspecto ambiental son los que se presentan en la tabla V.

La disposición de estos residuos de arenas representa una amenaza porque la población de Tandil se abastece del acuífero subterráneo local. R. E. Miguel[24], afirma que los variados sectores de disposición final de RAF y otros residuos de fundición constituyen focos multipuntuales que en mayor o menor medida impactan al sistema hídrico subterráneo local. En este sentido, la contaminación del agua del acuífero se produce por el contacto de las arenas con el agua de lluvia cuyo recorrido (proceso de infiltración) termina en la napa freática (lixiviación)[30], significando ello un peligro permanente.

En este contexto, resulta complejo elaborar un indicador que monitoree dicha situación por la falta de disponibilidad de instrumental específico capaz de aportar la información sobre el funcionamiento de este sistema, que contiene múltiples y complejas variables. Si bien este trabajo se limita a construir indicadores aplicables al área de estudio, se considera que de poder contar con estos datos, el indicador debería construirse a partir del concepto de peligro de contaminación del acuífero propuesto por Foster e Hirata (2002)[31] - el uso de la expresión "peligro de contaminación del agua subterránea" tiene exactamente el mismo significado que "riesgo (medido en términos pro-

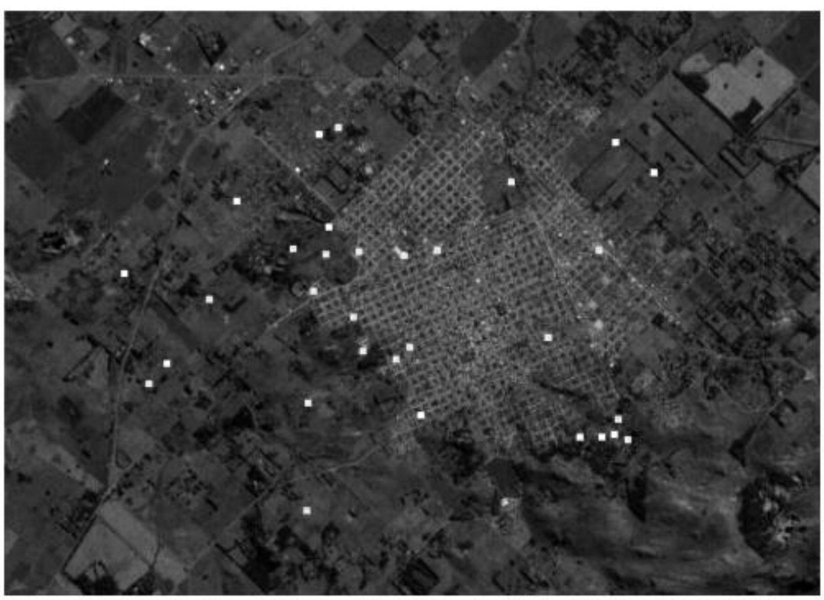

Figura 2. Sitios de disposición final de RAF, extraído de E. Miguel (2009)[24].

Figure 2. Disposal sites for foundry sand wastes, source E. Miguel (2009)[24].

Tabla IV. Determinación de ICA para la caracterización química de residuos sólidos de fundiciones

Table IV. ECI determination for chemical characterization of foundry solid wastes

Aspecto ambiental/Recurso	**Arenas de descarte/Suelo**	
Indicador	Determinación de fenoles	Determinación de metales pesados
Descripción	Informa sobre la presencia de fenoles en las arenas	Informa sobre la presencia de metales pesados
Valor de base (máx. permitido)	2	Cd: 5 Cu: 1.000 Cr: 50 Zn: 5.000 Pb: 50
Unidad de medición	ug/l	ug/l
Periodo de promedio/ Norma aplicable	24 h Decreto 831/93	24 h Decreto 831/93
Periodicidad	Debe realizarse la determinación antes de su disposición final o reutilización.	
Destinatario	Gestión pública (ej.: municipio). Gestión privada (empresa de fundición).	
Fuentes y Carencias de Datos	Se cuenta con estudios locales antecedentes con valores para el seguimiento de estos compuestos.	
Fortalezas y Debilidades	F: Los indicadores propuestos pueden utilizarse como herramienta de gestión para la toma de decisiones en la reutilización de las arenas. D: pueden presentarse dificultades técnicas y económicas para su aplicación.	

babilísticos) de contaminación del agua subterránea" en S. Foster y R. Hirata[30 y 31] 1998.

5.3. ICA para aspectos ambientales que impactan el recurso agua

A partir de la descripción realizada en el apartado 2 sobre las características que definen los efluentes líquidos y debido al análisis realizado en el apartado 5.2, se cree que la disposición de los RAF es el principal aspecto ambiental preocupante en relación al recurso hídrico subterráneo, agravándose debido a cómo son actualmente dispuestos porque las áreas utilizadas como relleno para estas arenas no están estructuralmente preparadas para la protección del recurso hídrico subterráneo.

Ante esta situación, y dadas las limitaciones antes mencionadas, se ha pensado en un indicador que considere las características intrínsecas del medio, como es la vulnerabilidad del acuífero (S. Foster[31] (2002)) en los diferentes sectores destinados a relleno y la cantidad de residuo allí depositado.

Es decir, si la vulnerabilidad es la consecuencia de las características naturales de los estratos que separan al acuífero de la superficie del suelo[31], se la puede vincular con la cantidad de residuo depositado, como un primer estado de alerta que amerite indagar a posteriori sobre el peligro de contaminación a través de la metodología antes mencionada (S. Foster[31]).

Tabla V. Determinación de ICA para residuos sólidos de fundiciones

Table V. ECI determination for foundry solid wastes

Aspecto ambiental/ Recurso	**Arenas de descarte/Suelo**		
Indicador	**Sitios con disposición final de arenas en funcionamiento**	**Residuos de arena de fundición**	**Capacidad total de almacenamiento**
Descripción	Informa sobre el aumento o disminución de los sitios con disposición final de RAF en un año	Informa sobre la cantidad de residuo de arena generada en cada empresa de acuerdo al material que funde	Informa sobre el espacio total disponible, expresado en volumen, de los sitios con disposición de RAF en funcionamiento.
Valor de base (Vb)	15 sitios (año 2008)	Coeficiente de generación de residuo de arena: 1 t de arena = 1 t de Fe; C_{Fe}= 1:1 4 t de arena = 1 t Al; C_{Al} = 4:1	Es la capacidad del sitio en la primera aplicación del indicador (se contempla de esta forma la incorporación de valores de base de nuevos sitios al indicador).
Valor absoluto	Nº de sitios	t de RAF	M^3
Valor del indicador	Positivo = aumento de sitios Negativo = disminución de sitios Cero = mantenimiento	Toneladas de residuos de arena de Al y Fe.	Positivo = mayor capacidad (puede estar dada por nuevos sitios, limpieza de sitios). Negativo = disminución de la capacidad por acumulación de RAF Cero = no hay variación.
Fórmula	$SF = Sa – Vb$ Donde SF = variación del número de sitios; Sa = número de sitios actuales; Vb = valor de base	$RAF_t = \sum P_r \times C_r$ Donde RAF_t = arena desechada en el total de las fundiciones; P_r = producción del rubro; C_r = Coef. del rubro	$Csf_i = C_i - Cvb_i$ Donde Csf_i = Variación de la capacidad del sitio i ; C_i = capacidad actual Cvb_i = valor de base de capacidad del sitio i
Valor relativo	% de variación de sitios en funcionamiento respecto de un valor de referencia.	% de arenas del rubro X respecto al total	% de variación de la capacidad de los sitios de disposición de residuos respecto del valor de referencia
Fórmula	$SFr = \frac{Sa – Vb}{Vb} \times 100$ Donde SFr = valor relativo de los sitios en funcionamiento; Sa = número de sitios actuales; Vb = valor de base.	$RA\ Rel_r = \frac{P_r \times C_r}{RAF} \times 100$ Donde $RARel_r$ = residuo de arena relativo por rubro; r = rubro considerado (Al; Fe)	$Csf = \sum \frac{C_i - Cvb_i}{Cvb_s} \times 100$ Donde Csf = valor relativo de la capacidad de los sitios en funcionamiento; C_i = Capacidad del sitio *i* ; Cvb_i = valor de base de capacidad del sitio i; Cvb_s = valor de base de capacidad de todos los sitios

Tabla V (continuación). Determinación de ICA para residuos sólidos de fundiciones

Table V (continuation). ECI determination for foundry solid wastes

Aspecto ambiental/ Recurso	**Arenas de descarte/Suelo**		
Indicador	**Sitios con disposición final de arenas en funcionamiento**	**Residuos de arena de fundición**	**Capacidad total de almacenamiento**
Periodicidad	anual	anual	anual
Destinatario	Gestión pública (ej.: municipio).	Gestión privada (empresa de fundición).	Gestión pública y privada
Fuentes y Carencias de Datos	Se cuenta con antecedentes sobre la dinámica de sitios de disposición final de RAF	Se conoce la producción de las empresas.	Se conoce la ubicación y capacidad de los sitios actuales con disposición de RAF.
Fortalezas y Debilidades	F: El monitoreo sólo requiere de un observador. D: No permite inferir la cantidad de RAF depositado.	F: no requiere de ningún costo ya que la empresa es la propia fuente de datos y el cálculo es simple. D: sólo se conoce el coef. de Al y Fe	F: permite valorar el impacto ambiental consecuente de la acumulación de RAF en inmediaciones de las industrias. D: No permite saber la relación del volumen acumulado con la carga contaminante.

En vista de lo expresado recientemente, y de acuerdo al conocimiento que se tiene de la operatividad de las industrias locales en cuanto a su tamaño, producción y distribución en el área de estudio[9], no se proponen ICA para el monitoreo de los efluentes líquidos de estas industrias, aunque sí para la posibilidad de contaminación del recurso hídrico por disposición de RAF y RIF (Tabla VI).

6. CONCLUSIONES

En el trabajo se proponen un total de quince ICA, nueve indicadores para el monitoreo del estado o condición del recurso aire, cinco para el recurso suelo, y uno para el recurso agua.

— Los indicadores en su conjunto permiten determinar la situación ambiental en el entorno de industrias de fundición porque aportan datos técnicos de emisiones de la actividad sobre los recursos que la sustentan, lo que hasta el momento se desconoce.

— La adaptación de metodología, para la construcción de indicadores, aplicada al caso particular de las industrias de fundición permite que en cada momento metodológico se tomen decisiones tendentes a seleccionar los aspectos ambientales cuyas emisiones contaminantes son de importancia, pudiendo replicarse este antecedente metodológico en otros procesos industriales y/o para otras situaciones regionales.

— Los indicadores que representan el estado o condición del recurso aire contemplan en su criterio de selección el cuidado de la salud y de los efectos adversos en el medio ambiente, debido a que en la metodología se utiliza legislación de referencia nacional e internacional que se establece según estos criterios. Por consiguiente, son representativos de los temas ambientales prioritarios en estos niveles. Asimismo las frecuencias de medición son acordes a los programas de control y monitoreo aplicados en estas industrias y aprobados por el organismo provincial de aplicación (OPDS).

— La existencia de un trabajo antecedente, de relevamiento de los sitios de disposición final de residuos de industrias de fundición, facilitó la crea-

Tabla VI. Determinación de ICA para lixiviados de RAF y RIF

Table V. ECI determination for Waste Foundry Sand (WFS) and Foundry Industry Wastes (FIW)

Aspecto ambiental/ Recurso	RAF y RIF / Acuífero
Indicador	**Posibilidad de contaminación del acuífero por lixiviados de RAF y RIF**
Descripción	Informa sobre el estado de alerta que representa la disposición de residuos en relación al peligro de contaminación del recurso hídrico subterráneo.
Valor de la vulnerabilidad	medio: 0,35; medio/alto: 0,45; alto: 0,55; alto/extremo: 0,8; extremo: 1.
Valor del indicador	Bajo: < 0,3; medio: 0,3 a 0,4; medio/alto: 0,4 a 0,5; alto: 0,5 a 0,7; alto extremo: 0,7 a 0,9; extremo: 1
Fórmula	$A = \sum \frac{V_i}{P_T} \times P_i$ Donde: A = Alerta; V_i = Vulnerabilidad (valor de la vulnerabilidad considerada); P_i = peso o cantidad de residuo en un sitio; P_T = peso total correspondiente a los residuos de todos los rellenos del área
Periodicidad	Anual
Destinatario	Gestión pública y privada
Fuentes y Carencias de Datos	Existen datos antecedentes de la cantidad de rellenos existentes y del volumen acumulado, además se conoce el valor de la densidad para este tipo de residuo por tanto, es posible obtener el peso para cada sitio de disposición. Como carencia se identifica la falta de un mapa completo de vulnerabilidades de la zona de estudio.
Fortalezas y Debilidades	F: es un indicador simple y económico ya que sólo precisa recorrer los sitios y estimar el peso de los residuos acumulados. Como herramienta de gestión permite conocer en qué medida la acumulación de RAF y RIF en los distintos sitios incrementa o disminuye el estado de alerta en referencia al peligro de contaminación del acuífero en el área. D: el estado de alerta a la contaminación del acuífero respecto de los RAF y RIF esta sólo en función de la vulnerabilidad del medio y de la distribución de la cantidad de los residuos en ellos; no se consideran variables como el tiempo de permanencia del residuo o la carga contaminante.

ción de indicadores que versan sobre los cambios en la disposición de estos residuos partiendo de una situación conocida. Los indicadores propuestos tienen la ventaja de ser muy simples en su cálculo y accesibles para la obtención del dato. De la lectura de los indicadores se obtiene información valiosa sobre la evolución de los sitios de disposición de residuos de estas industrias en tres aspectos que se relacionan: en el avance o disminución de basurales dentro de la ciudad (los sitios se encuentran dentro del área urbana), en la relación que hay entre el crecimiento productivo de la industria y la generación de RAF y en los cambios de las capacidades de almacenamiento de los sitios preexistentes, lo que puede anticipar la aparición de nuevos sitios.

— Se concluye además, que el recurso hídrico puede ser afectado por la lixiviación de los RAF y RIF (residuos de industrias de fundición). Se ha logrado un indicador conformado por la sumatoria de subindicadores o indicadores parciales (términos) que responden a los diferentes sectores con su vulnerabilidad intrínseca conocida, afectados por la disposición de residuos en diferente intensidad en cuanto a la carga (peso), y que permite una aproximación de alerta e indica la urgencia de estudios de detalle que estimen el peligro de contaminación del acuífero.

— Si bien el indicador general presentará las variaciones considerando la ponderación de los diferentes aportes (términos) es de destacar la importancia de evaluar en forma particular cada término (subindicador o indicador parcial) y considerar su variación, la cual ofrecerá información de la urgencia de estudios de mayor detalle en cada sector.

— Para finalizar, importa destacar que los ICA propuestos sirven de base de información para la gestión tanto pública como privada. Si estos sectores utilizan el mismo indicador se facilita el diálogo entre las partes, y la búsqueda de solución conjunta del problema que monitorea, y se alcanza el fin principal por el cual se construyen estos indicadores: que sean una herramienta en la toma de decisiones.

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La suscrita **Natalia Alvarado Mata**, número de carné: 305030705 graduada del grado de Licenciatura de la Universidad Internacional de las Américas, se compromete a cumplir, durante el ejercicio profesional, con el Código de Ética de la Institución, que se rige por los siguientes principios:

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