Report Season 2016-2017

Song occurrence and culture of humpback whales breeding off the coast of Ecuador: Acoustic-visual surveys, analysis, education and scientific collaboration.

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1. Introduction

Song repertoire is considered to be an indicator of humpback whale presence and provides relevant information of seasonal occupancy in breeding grounds (e.g. Lammers et al. 2011). Humpback whale songs have been well researched in different breeding grounds of the world oceans (Payne and Guinee, 1983). However, in breeding grounds of the Southeastern Pacific region, acoustic behavior, social behavior, and migratory movement of this specie has received little attention compared with surface activity studies (Flórez et al. 2007, Kavanag, 2017). Song patterns may help to determine connectivity among populations of humpback whales and support strategies of conservation and management in the at Southern hemisphere (Andriolo et al. 2014, Garland et al. 2015).

Song structure and patterns of song can be used to recognize subpopulations or isolated populations according to the level of song exchange within an ocean basin (intra-oceanic songs), and among ocean basins and/or hemispheres (inter-oceanic songs) (Winn et al., 1981; Payne and Guinee, 1985; Garland et al., 2015). This is due to all males within a population singing the same song at any one time, and populations within an ocean basin singing similar songs based on the distance between populations (Payne and Guinee, 1985). Songs evolve through time within a population, and changes are shared among populations within an ocean basin (e.g. Winn and Winn, 1978; Payne and Payne, 1985). Humpback whale songs were culturally transmitted in a step-wise fashion between populations causing population-wide cultural change which remains the best example to date of horizontal cultural transmission in a non-human animal (Garland et al 2011, 2013, 2015). In the Southeast Pacific song transmission is poorly understood; there is little knowledge of song evolution within and between seasons, and how this differs among the multiple breeding grounds.

In this context, specific initiatives from Colombia, Ecuador, and Peru, and other countries, have increased information with large data collections, that should be management and used adequately to effectively promote acoustic monitoring of cetaceans in the Southern hemisphere region. Relevant baseline information has been generated about acoustic presence, behavior, spatial distribution and whale watching of humpback whale populations (Group G) at Southeastern Pacific region (e.g. Felix and Hasse 2001a, 2005, Felix and Botero 2009, Pacheco et al. 2011, 2013, Guidino et al. 2014, Garcia and Pacheco 2016, Oña et al 2017, Valdivia et al 2017). However, acoustics studies in South America are still in the very beginning and training programs using new acoustic technology applications are necessary to improve research and collaborations (Sousa-Lima et al 2013).

Humpback whales breed off the coast of Ecuador from June to September each year. As part of their mating behavior, they fill our coastal waters with an extravagant song display (Oña et al., 2017). So far, in the coastal areas we have collected relevant information on the habitat preference, spatial distribution, social structure and acoustic

behavior of humpback whales during several seasons (Intriago 2015, Narvaez 2015, Oña et al., 2017) and in deep waters (off coast Esmeraldas, Manabí and Santa Elena) not commonly visited by research boats (Rubianes, 2015). Ocean noise is increasing and this is considered an important threat, especially for cetaceans which rely primarily on sound for communication (e.g. Dunlop et al., 2010, Rolland et al., 2011). To improve our understanding of song occurrence and culture in humpback whales, we need to continue research through scientific collaborations in the region. With CETACEA project, our team has worked to strengthen fieldwork techniques and acoustic analyses, which will allow to adequately define conservation priorities for humpback whales and enhance local capacity of students, young researchers and awareness of the local community. This report informs of our scientific advances concerning regional collaboration and with the community work during the 2016 humpback whale research season.

2. Study Area

Northern Ecuador is an important breeding location for humpback whales that migrate along the west coast of South America (Group G). During the 2016 season we expanded our acoustic efforts to a new field site off the coast of Quinge in the Galera-San Francisco Marine Reserve with coordinates from N0° 49' 43.9" W80° 02' 55.2" to N0° 37' 18.5" W80° 03' 17.6" (Figure 1). This breeding ground has a temperature range that varies from 24 to 26 ºC. The seabed structure is composed of areas with hard substrate, mixed bottoms formed with sand and rock and soft bottoms with muddy channels. The coastline of is approximately 12 km long, with depths ranges gradually increasing from 100 m to 500 and more than 1000 m (Denkinger et al., 2006). (Figure 1).

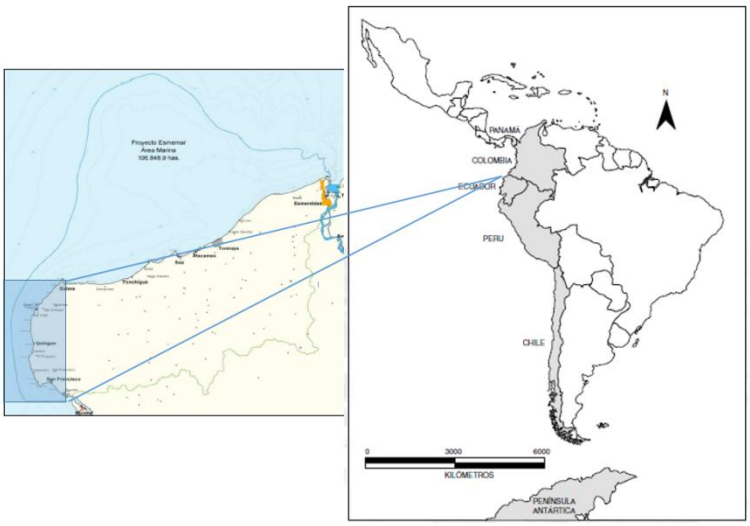

Figure 1. Study Area (Galera-San Francisco Marine Reserve). Modified from Denkinger et al., 2006 and Flórez et al., 2007.

3. Acoustic and Visual Surveys

During the breeding season 2016, acoustic sampling, direct observation (sightings) and photo-identification were performed through standardized acoustic sampling stops and dedicated visual search. Boat-based acoustic and visual surveys of humpback whales were conducted for 33 days between July to September, spending 4 to 5 hours every day covering different parts of the marine reserve. We sampled at acoustic stations with a minimum of 8 to 10 km distance between each other in order to avoid spatial autocorrelation.

During each song recording and when whales were sighted information as sea state, geographic position, group size, presence of calves, underwater sounds, and behavior was noted. Acoustic recordings were made with an omnidirectional hydrophone Dolphin ear (sensitivity of 15 Hz - 20,000 Hz +/- 3db) and a Tascam DR-40 tape recorder (WAV files, 16 bit, 44.1 kHz). If possible, underwater video recordings were performed during opportunistic encounters. Songs were recognized from the distinctive species-typical harmonic sounds, long vocalization times, and repeating patterns (Payne and McVay 1971).

4. Spatial and Acoustic Store

Songs recordings and information collected during acoustic surveys from previous years to 2016 were stored standardized. Dat- Recorder (Digital Audio Tape) and Digital Recorder sheets, including metadata were standardized (see annexes) to allow share this information through of regional scientific collaboration. This entire standard manner to store acoustic information was obtained and modified from ¨ACOUSTIC NOTES 2012¨ prepared by Ellen Garland and Mike Noad (unpublished).

5. Regional Bioacoustic Workshop

The ¨ Bioacoustic Introduction to Humpback Whales¨ workshop was carried out during from the 9th to 11th November at the University San Francisco de Quito, Ecuador. In this workshop we invited, Dr. Ellen C. Garland (University of St. Andrews) as an international bioacoustics expert from San Andrew University, Scotland. Collaborators and students from Colombia, Ecuador and Peru participated in this workshop (see annexes). Currently, we are elaborating collaborations with Colombia and Peru to gather song samples for the next season 2017 from Peru, Colombia and the Laboratory of Bioacoustics, Universidade Federal do Rio Grande do Norte, Brazil (see annexes).

6. Acoustic Analyses Advances

From analyses of humpback whale songs during the 2016 season, Ana Paula Suarez (USFQ Bachelor student) conducted her thesis on the impact of earthquakes on the acoustic behavior of humpback whales. High quality song samples were visually and acoustically explored using Raven Pro 1.4. Beta version. We coded and extracted acoustic parameters such as duration (min) frequency, max frequency, start frequency, end frequency, frequency range, frequency trends, number of inflection and peak frequency of each unit (see photo). Through collaboration, with other researches of South America we will explore song occurrence and culture of humpback whales in the Southeastern Pacific region.

7. Education strategy

Song recordings and photos were converted for education material (see annexes). Materials were used to inform about the biology and ecology of humpback whales in Ecuadorian waters. Both Caimito and Quingue communities (kids, tourists, fisherman and adult people) participated actively during all education activities (puppet show and beach cleaning) (see annexes). This kind of social strategy had an important social impact to generate awareness about marine mammals and conservation in the marine reserve.

8. Acknowledgments

I want to thank my tutors Ellen Garland and Judith Denkinger for their support in all training and scientific initiatives. I want to thank the team involved in the CETACEA Project, Ana Paula Suárez, Martín Narváez, Marilda Intriago, Laia Muñoz, Francisco Rubianes, and Geovanna Jácome for their assistance with data gathering and working at the ¨Caimito Scientific Station¨. My thanks go to all volunteers involved in the acoustic and visual monitoring of humpbacks: Megan, Emily, Lucy, Andrew, Heather, and Daniela Asar and tourists involved in all project activities. Puppet work ¨Elena La Ballena Jorobada¨, was written and directed by Marilda Intriago with support of Geovanna Jácome, Martín Narváez, Sara Carranco and Kelly Morales. In particular, we would like to thank Ginio, Ernesto, Leiden, dear mother and Proaño Mosquera family. In particular, we would like to thank Fabiola and Raúl Gudiño. Specially, we thank all Caimito and Quingue communities. Thank so much Rufford Foundation, Universidad San Francisco de Quito, CETACEA Project, USFQ for assistance in logistical and research resource to develop fieldwork and education activities.

9. References

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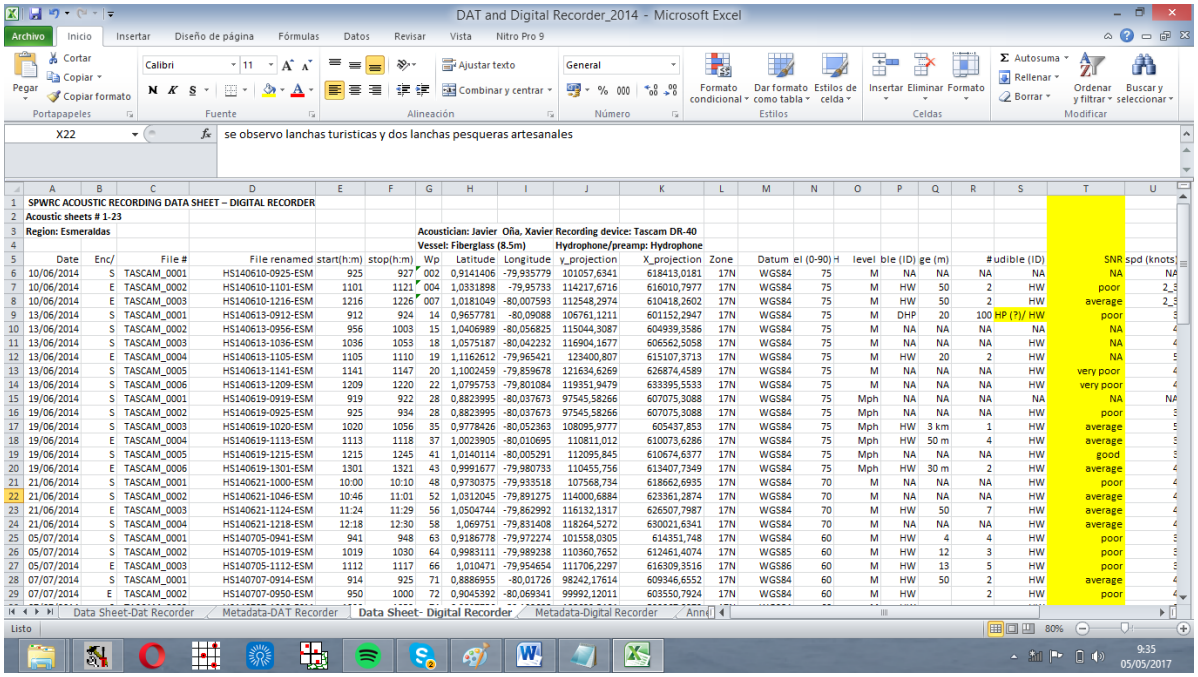
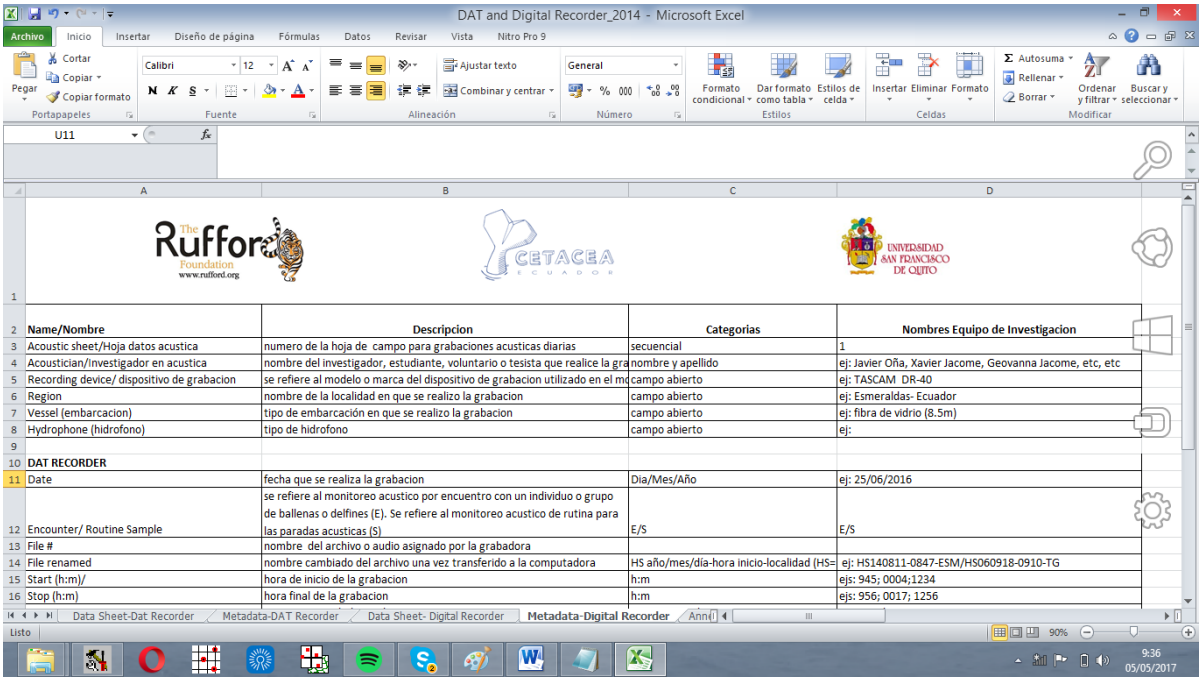
10. Annexes

a. Dat- Recorder (Digital Audio Tape), Digital Recorder sheets, and standardized metadata





b. Scientific Regional Collaboration

Memorandum of Understanding for Scientific Cooperation between UFRN Laboratory of Bioacoustics, Brazil and Ecuador CETACEA Project.

the four following criteria according to ¨Best Practice Guidelines on Publishing Ethics¨:

1. Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; and
2. Drafting the work or revising it critically for important intellectual content; and
3. Final approval of the version to be published; and
4. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

FOURTH - DURATION AND RENEWAL OF MOU

a. The agreement shall come into effect on April **2017**. Changes to this agreement shall be made by mutual consent between both parties. In cases of disagreement, the University wishing to depart from the agreement shall, wherever possible, give three months' notice of its intention to do so.
b. In order to promote future scientific exchanges both parties shall actively evaluated the success of scientific products during the PhD program.
c. Correspondence about this agreement shall be conducted between the representatives of CETACEA Project, Ecuador, and UFRN Laboratory of Bioacoustics, Brazil

Quito, Ecuador, 01/04/2017

Sincerely,

MSc. Javier Oña
Affiliate Researcher and Coordinator
Bioacoustic Program
CETACEA Ecuador Project
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MSc. Divna Djokic
PhD Candidate
UFRN PhD program on Psychobiology, Brazil

Dr. Judith Denkinger
Director CETACEA Ecuador Project
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Dr. Renata Sousa-Lima
Professor of Animal Behavior
Laboratory of Bioacoustics
Universidade Federal do Rio Grande do Norte

Doc ID: 19cd58d9eb0a786fe3999c09ecb8462f460cb55a

Acuerdo de entendimiento para cooperación científica entre representantes del Grupo Mastozoología, Universidad de Antioquia, Colombia, y el proyecto CETACEA Ecuador.

Firman en señal de lo acordado,

Quito, Ecuador, 01/03/2017
Medellín, Colombia, 01/04/2017

M.Sc. Javier Oña
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CETACEA Ecuador Project

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Dr. Judith Denkinger
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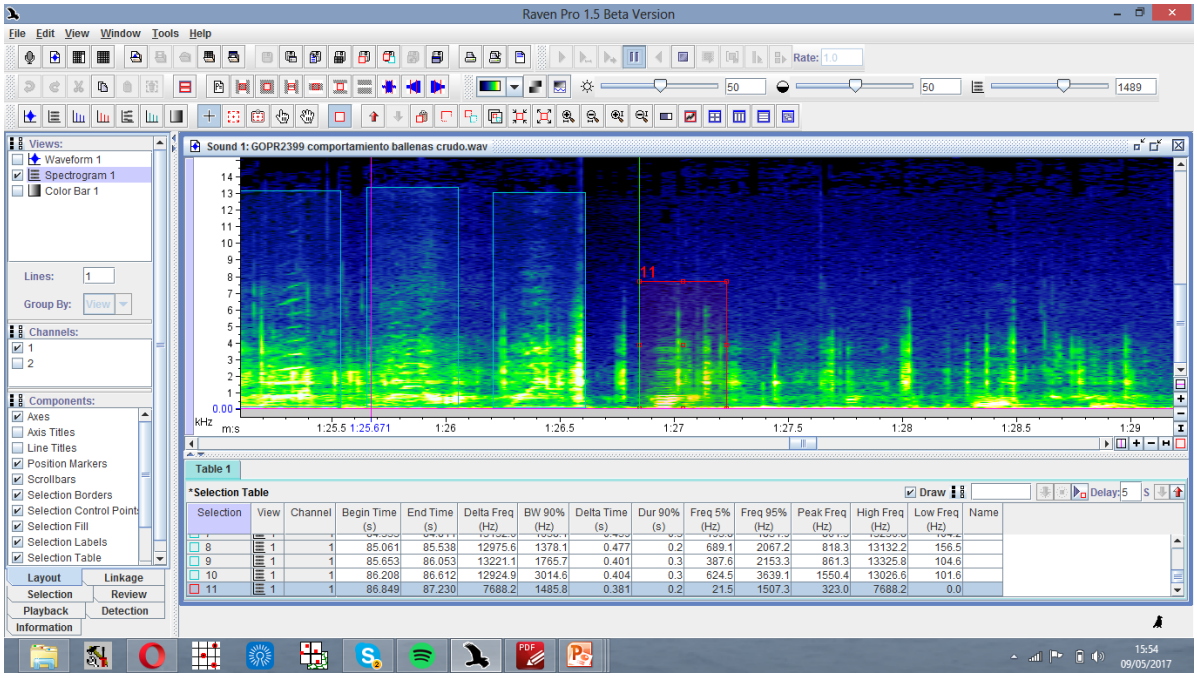
Universidad San Francisco de Quito, Ecuador

Dr. Sergio Solari
Tutor Principal
Profesor, Coordinador del Grupo Mastozoología
Universidad de Antioquia, Colombia

c. ¨Introduction Bioacoustic of Humpback Whale¨ workshop

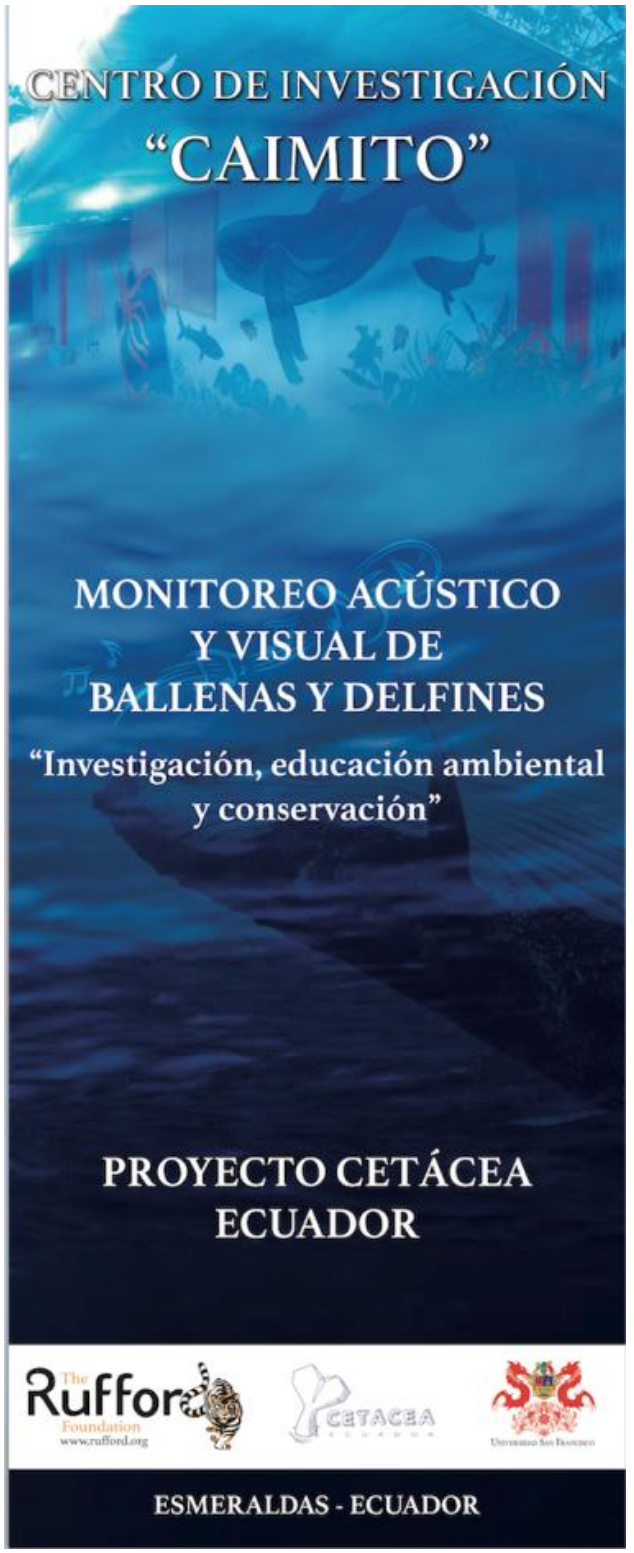
d. Spectrogram and acoustic parameter extraction

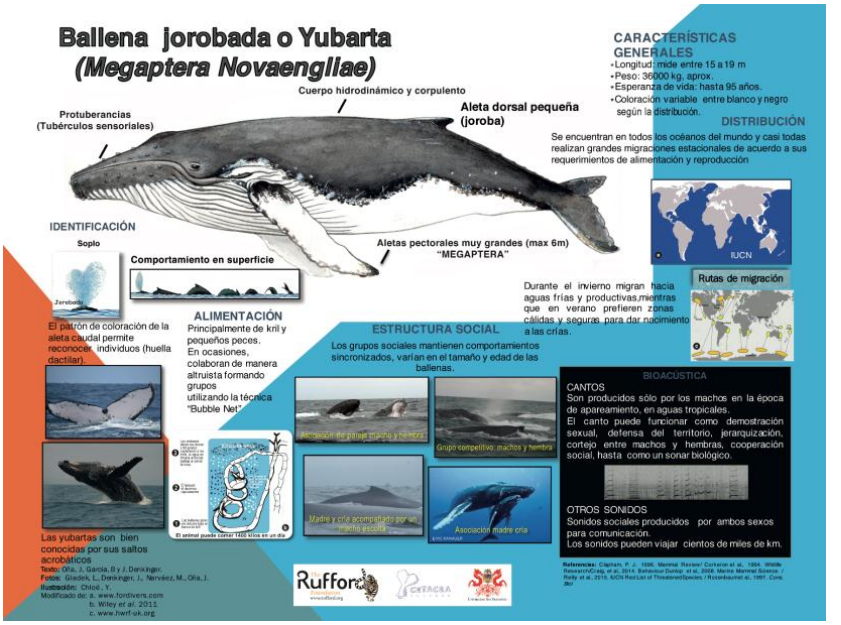
e.



f. Cleaning beach and drawing concourse

g. Spreading and educational products





Ejemplo catálogo de foto-identificación de ballenas jorobadas en las costas ecuatorianas.
Caimito, Esmeraldas.
Proyecto Cetacea Ecuador 2015

Créditos: Martin Narváez

h. International Congress: Scientific presentations CETACEA team

Oral presentation. Evolution in song patterns of humpback whales (*Megaptera novaeangliae*) during the breeding season 2012, 2013, and 2015 off the coast of Esmeraldas, Ecuador. Workshop "2nd Listening for Aquatic Mammals in Latin America" (LAMLA). Valparaiso, Chile 26th and 27th November 2016.

Oral Presentation. Occurrence of humpback whale songs (*Megaptera novaengliae*) in breeding grounds off the coast north of Ecuador. SOLAMAC Conference-Valparaiso-Chile 28 November to 01 December 2016.