Workshop
Listening for Aquatic Mammals in Latin America

Proceedings

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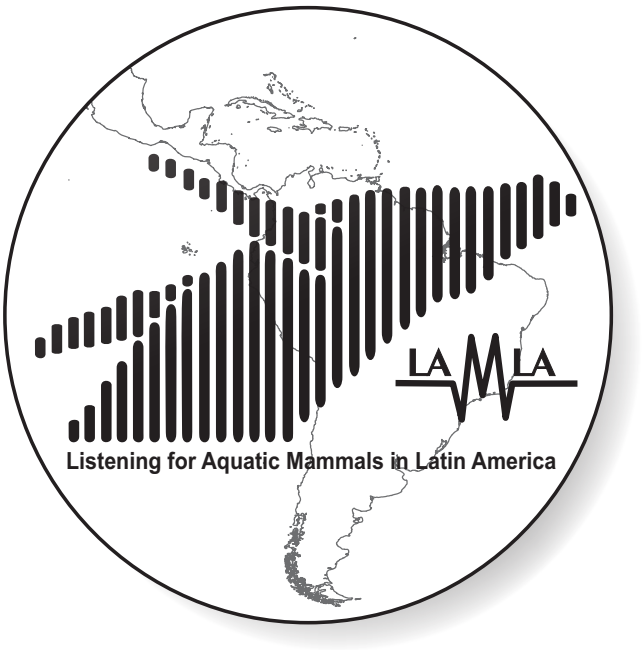

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Listening for Aquatic Mammals in Latin America

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A number of researchers in Latin America are using PAM at their study sites, but have no idea of Who, Where, What species, What methods, and over which spatial and temporal scales this research is done. Therefore, between October and December 2015, the LAMLA organizing committee conducted an online survey, sent out to the aquatic mammal community via the Marmam email list, in order to get a sense of how many researchers were working on aquatic mammal bioacoustics in Latin America, and whether there was any interest from the community for a meeting that could bring us together. We asked for one representative from each laboratory or research group to provide information of numbers of researchers and students, target species, country, their funding sources (private or public), methods, time and space scales, interest in a potential meeting, convenient dates for a meeting and what would they want to achieve out of a meeting.

Seventy-one researchers answered the survey, representing nearly 300 researchers, professionals, and students from 44 institutions working in the field. Answers came from all over Latin America, from Brazil, Mexico, Peru, Argentina, Chile, Colombia, Guatemala, Costa Rica, Panama, Ecuador and Belize. Most were part of academic institutions (62%), but also non-governmental organizations and industry.

Results on species studied and effort distribution by country is summarized in the figures. The survey revealed a clear demand for an opportunity for networking, collaboration and exchange of information at a regional level from those who answered the questionnaire, and a need to boost scientific and technological development in Latin America.

Therefore we proposed the **Workshop Listening to Aquatic Mammals in Latin America (LAMLA)**. Our aim is to bring together researchers, professionals, and students working in bioacoustics to communicate their work, network and interact with other researchers, and discuss directions for a coordinated regional bioacoustics network and collaboration. LAMLA workshops will eventually result in a compilation of bioacoustics research efforts in Latin America and in future directions for developing the field at a regional level.

A perspective on the spatial and spectral dynamics of ocean noise and its influence on marine animals

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In 1971 Roger Payne and Doug Webb hypothesized that prior to modern shipping, infrasonic songs of blue and fin whales could be heard across an ocean. In 1993, using the U.S. Navy's Sound Surveillance System with LCDR Chuck Gagnon, I had the life-changing opportunity to hear blue whales singing off the Grand Banks, Canada while listening 1600 nautical miles away. Payne & Webb's hypothesis is true, at times when an ocean area is very quiet, a singing blue whale can be heard across an ocean. Today, the aggregate noise from global commercial ship traffic and explosions from vessels using seismic airgun arrays to prospect for fossil fuels beneath the seafloor is dramatically changing the low-frequency marine acoustic environment. The spatial and temporal scales of this anthropogenic acoustic invasion have not been adequately characterized nor quantified in terms of the ecological cost to whales, fishes and invertebrates. The present paradigm to assess such costs is based on a dose-response, threshold approach that uses estimates of received level to predict impact (e.g., a received level above level X dB at an animal is an impact; below that, it is not). A new paradigm is emerging based on behavioral ecology and auditory response factors (e.g. context, masking) that models the biological cost as a result of lost acoustic opportunities (e.g. communication, foraging) due to changes in species-specific acoustic environments (i.e. acoustic habitats). The ultimate goal is a realistic mechanism to quantify and assess the biological consequences of anthropogenic sounds on marine acoustic ecosystems.

Importance of the combined used of towed arrays with visual surveys for cetacean bioacoustics

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Acoustic monitoring provides an opportunity to collect data in conditions unsuitable for visual observations such as darkness, poor visibility and high sea conditions. From 2012 to 2015, passive acoustic methods were used to investigate cetaceans and describe their distribution along the western South Atlantic shelf break. Five research cruises were performed between 29o54S and 34o06S over continental shelf break and slope. The .wav files were partially analyzed using automated detections tools and were visually and acoustically searched for species confirmation when possible. Visual positive identifications were associated to the acoustic recordings. A total of 9 cetacean species were acoustically detected and identified. Among the more frequent registered cetacean species are the sperm whales, common-dolphin, pilot whale, and bottlenose dolphin. The study has relevance collecting data in pristine area with less impact than north hemisphere where we expect to record more natural animals emissions. Future approaches are a) identify not assigned species; b) expand the study along the Brazilian coast; c) add new species to the list; d) improve automated detection systems; e) improve the analysis related to anthropogenic activities; f) organize an acoustic library.
This study was funded by BG Group and Chevron.

Studying the dolphin whistle repertoire

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.Dolphins use whistles during social interactions and feeding activities involving group cohesion, individual recognition and recruitment. My research group are studying dolphin whistles from wild and captive bottlenose dolphins, *Tursiops truncatus*, wild spinner dolphins, *Stenella longirostris*, and wild guiana dolphins, *Sotalia guianensis*, to learn about their social structure and individual recognition. We have developed a new methodology to study the whistle repertoire: 1) whistle contour extraction to classify whistles into whistle types using Matlab BELUGA and ArtWARP, 2) classification of whistle types into four general categories (high complexity, low complexity, linear long, and linear short), and 3) computing a complexity index and a proportional variability of the whistle repertoire. Results obtained showed that this very simple method is useful to describe the whistle repertoire and to compare it according to the general behavioral state of dolphins, and between species. It is necessary to implement new methodologies like this one to better understand how dolphins are using whistles, since acoustic communication is the most important sense in dolphin species. [work currently supported by PAPIIT-UNAM].

Estimating cetacean abundance from stationary passive acoustic monitoring devices.

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Oral Presentations

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- Humpback whales (*Megaptera novangliaeae*) residency in Los Cabos Region, Baja California Sur, Mexico (2003-2012).
- Humpback whale vocalizations from Trindade-Martin Vaz Archipelago detected by passive acoustic monitoring.
- Humpback whale repertoire of social sounds in a Brazilian breeding area.
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- Using two passive acoustic monitoring methods to investigate the acoustic ecology of Southern right whales (*Eubalaena australis*) off Brazil.
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- Medium and high frequency components of vessel noise in two shallow-water regions of Santa Cruz and the potential for masking of Commerson's dolphins (*Cephalorhynchus commersonii*) sounds.
- Advanced interdisciplinary bioacoustical analyses for cetacean observatories in Chile and Peru.
- High-performance computing for whale sound propagation in South American oceans based on accurate numerical techniques.
- Contributions to the Soundscape of the Brazilian Equatorial Margin based on data from Lagrangian Profilers.

Preliminary results of passive acoustic monitoring in Babitonga bay, Santa Catarina, Brazil

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The Babitonga Bay is the only known site that houses sympatric populations of franciscana (*Pontoporia blainvillei*) and Guiana dolphins (*Sotalia guianensis*). Passive acoustic monitoring (PAM) has been widely used worldwide for research on cetaceans and its distribution, habitat use, abundance, etc. The goal of this study was to test the use of C-PODs (Chelonia Limited ©) for PAM in the Babitonga Bay. C-PODs have high sensitivity and a rapid automated detection process. They monitor the range of 20-160 kHz, recording the pulsed sounds of almost all species of toothed cetaceans. Four C-PODs were used at different locations between October 2015 and January 2016. Using the C-POD.exe program specifically developed for screening and analysis of trains of click sounds, we analyzed the duration of the trains (TD), number of clicks in a train (NC), the interval between clicks (ICI) and the click center frequency (F). The program works with extreme robustness and very low rates of false positives, allowing identification of sounds in the categories: boat sonars (BS), narrow-band high frequency (NBHF = *Pontoporia*) and other dolphins (OD = *Sotalia*). Only NBHF and OD categories were analyzed. We recorded 12,600 trains, of which 8,238 were of the NBHF category and 3,454 of the OD. In the NBHF category the trains had average TD = 0.5s ± 0.523 (0.013 – 7.125), NC = 32 ± 17 (7 – 195), ICI = 15ms ± 12 (1 – 142) and F = 130KHz ± 4 (121 – 144). In the OD category the trains had average TD = 0.761s ± 0.62 (0.016 – 9.84), NC = 24 ± 15 (6 – 170), ICI = 36ms ± 22 (1 – 242) and F = 100KHz ± 31 (35 – 142). The results demonstrate the potential of C-PODs to detect and categorize the pulsed sounds of dolphins in the Babitonga Bay, allowing future studies.

Anthropogenic noise and Guiana dolphins (*Sotalia guianensis*) in Brazil: ecological and conservation concerns

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Guiana dolphin (*Sotalia guianensis*) is a coastal species inhabiting mangrove and estuarine areas from Brazil to Central America. Guiana dolphin has been susceptible of potential impacts due to human use of its habitats. It is well-known that marine activities such as boat traffic and dredging activity generate noises that can hamper cetacean's communication. This work compares anthropogenic noises and Guiana dolphin's repertoire of three brazilian populations: Cananéia Estuary/CAN (25°S), Caravelas Estuary/CVL (17°30'S) and Praia da Pipa/PIP (6°10'S). Data were collected during boat surveys, with hydrophones and audio recorders approaching the objects within 100 m distance. Sounds were analyzed and results showed that Guiana dolphin's whistles had frequencies from 2.4 to 34.7kHz and duration of 0.02 to 0.61s. Pulsed calls had frequencies from 0.25 to 17.2kHz composed by 1 to 24 harmonics and mean duration of 0.25s. Boats with inboard/diesel engines (11–260Hp) produced noise intensity from 19 to 95dB (SNR-Signal to Noise Ratio) and frequency from 0.38 to 35.71kHz, whereas boats with offboard/gasoline engines (8–150Hp) produced intensity from 7 to 90dB (SNR) and frequency from 0.84 to 46.8kHz. In CVL, a hopper dredger produced noise frequency from 0.15 to 17.3kHz and intensity from 80 to 105dB (SNR), and large wood barges produced frequency from 0.02 to 20kHz and intensity from 70 to 104dB (SNR). In PIP a water pump used to fill up a seawater swimming pool produced noise intensity from 75 to 99dB (SNR) and frequency from 0.0 to 13.1kHz. Comparing noises produced by boat traffic and dredging activity with dolphin's repertoire it is notable the occurrence of overlapping acoustic layers, thus may cause acoustic masking. Therefore, in front of the intense development of coastal areas and, consequently, higher noise levels affecting the Guiana dolphins ecology, acoustic studies are extremely relevant as a tool to its conservation.

Soundscape Ecology of the Guiana dolphin (*Sotalia guianensis*) habitat in the Baia de Todos os Santos, Northeastern Brazil

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Soundscape Ecology brings a new perspective to study sounds in associative approach, integrating biological, environmental and anthropogenic sounds occurring in marine habitats. The present work aims to describe some acoustic patterns of soundscape ecology involving a resident Guiana dolphin (*Sotalia guianensis*) population in a threatened habitat such as the Baia de Todos os Santos, Bahia State, the second largest bay ecosystem in the Brazilian coast. In this area there is no systematic bioacoustics studies to date, only punctual recordings. Field surveys were conducted in order to test different boats to successfully record dolphin acoustic and surface behavior. A 10m Sailing boat was compared to a 15m wood schooner, utilized in different days. Sounds were recorded utilizing dipping hydrophones (HTI 90 min) plugged in a Tascam DR-05 digital recorder. We registered about 20 hours of the local soundscape, including dolphin sounds (whistles, burst pulsed and clicks), fish sounds, different boat noise as well as "quiet" soundscapes, composed basically of moments with no loud sounds in the acoustic environment. It was possible to note important differences in sound acquisition utilizing a sailing boat rather a wooden schooner, allowing tobetter approximation and increased approach of dolphins during recordings. Whistles recorded utilized a broad frequency bandwidth, reaching sometimes ultrasonic levels. Part of future efforts consists in creating a sound library to improve sound gathering and dissemination to the research community of bioacoustics studies. This work adds important efforts in the acoustic parameters, through descriptions and ecological relationships, for the species in this scarcely studied coastal habitat, the Todos os Santos Bay, helping to subsidize conservation of this important coastal environment.

High-frequency modulated whistles of killer whales (*Orcinus orca*) in Antarctica

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Killer whales have a diverse acoustic repertoire that includes echolocation clicks and pulsed calls and whistles. High-frequency modulated whistles (HFW) have been described in some killer whale populations, including populations in the eastern North Atlantic, western South Atlantic, and western North Pacific, as well as in the eastern North Pacific offshore ecotype. Very little is known about the acoustic repertoire of killer whales in Antarctica. Acoustic recordings were collected in Antarctic waters with both a towed hydrophone array used during a visual and acoustic survey along the western Antarctic Peninsula in austral summer 2014, and also with a bottom-moored High-frequency Acoustic Recording Package (HARP) deployed north of Elephant Island. Long-term spectral averages were examined to detect killer whale signals, including HFW. Characterization of HFW was performed using custom MATLAB-based routines. Killer whales were recorded in ten acoustic encounters, of which four contained HFW (n=130) that were highly stereotyped, showing a frequency downsweep contour without inflection points. Signals were emitted in bouts, with a mean inter-pulse interval of 2.3 s, mean start frequency of 21.6 kHz, mean end frequency of 15.7 kHz, mean -10 dB bandwidth of 5.9 kHz, mean duration of 65.2 ms, and mean sweep rate of 95.2 Hz/ms. Most of the HFW were partially modulated in the non-ultrasonic range, and compared to the previously described signals, Antarctic HFW were most similar to those recorded in the South Atlantic Ocean. It is unknown which Antarctic killer whale ecotype produced these HFW, but given the location of recordings, possible candidates are type A, B, or D killer whales. The function of these signals remains unknown. Ongoing passive acoustic monitoring near the Antarctic Peninsula will allow us to increase our understanding of the behavioral role of these signals, as well as determine which ecotype produces them.

Pulsed sounds of a Franciscana dolphin calf

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The acoustic repertoire of franciscana dolphins (*Pontoporia blainvillei*) is very little known. This study was conducted with a female calf length 82 cm, which was at the rehabilitation center in Guarujá, São Paulo state, during 79 days, from January 18 to April 6, 2015. The recordings were made between 20 and 21 February. The acoustic acquisition was performed not continuously switching between day and night and totalizing 4h50min recorded. A digital recorder Fostex FR2, with sampling rate of 0-192 kHz, connected to a Reson TC 4032 hydrophone, with a frequency response of 5 - 120 kHz (+/-3 dB), sensitivity of -170 dB re 1V/µPa, was used. The maximum frequency recorded was 96 kHz. Analyzes were performed in the program Avisoft-SAS Lab Pro 5.2. The number of pulses (NP), interval between pulses (IPI), duration of the trains (TD), bandwidth (BW) and peak frequency (PF).Two pulsed sounds categories were recorded: clicks (IPI > 0.005s) and burst-pulses (IPI < 0.005s). For the burst-pulses (N = 6), NP = 81 ± 21 (55-110), TD = 0.34s ± 0.087 (0.20-0.44) and IPI = 0.0042s ± 0.00043 (0.004-0.005), BW = 69 ± 31 (15.87-95.82) and (PF) = 84 ± 17 (52,36-94,58).For the clicks (N = 52), NP = 62 ± 45 (17-242), TD = 0.54s ± 0.41 (0.09-2.45) and IPI = 0.009s ± 0.003 (0.005-0.021), BW = 79 ± 19 (20.67-95.18) and (PF) = 74 ± 29 (15.30-95.20).The franciscana dolphins are known to be a NBHF (Narrow band high frequency) species. The results presented here indicate that the calf can use a larger bandwidth.

Enviromental factors explain tucuxi (*Sotalia fluviatilis*) whistle variation

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The tucuxi (*Sotalia fluviatilis*) is the only Delphinidae to live exclusively in freshwater and is widely distributed throughout the Amazon basin. Identifying how tucuxi use acoustic communication signals in different environments throughout their distribution helps us understand the patterns in habitat use of this specie and the level of sounds variation within the specie. The main goal of this study is to examine the variation of physical parameters in S. fluviatilis whistles in different types of water along their distribution. Variation between water types were tested using recordings conducted at river junctions: black and white water rivers in Manaus – Amazonas state and clear and white water rivers in Santarém – Pará state. Ten acoustic parameters of the fundamental frequency of whistles were extracted for analysis: start, end, minimum, maximum, 1⁄2, 1⁄4, and 3⁄4 frequencies, delta frequency, signal duration, and number of inflection points. PERMANOVA was used as test and as a post hoc. The post hoc was performed using exclusion and re-inclusion of acoustic variables. The whistles had lower frequencies in white water in both river junction areas. However, only specific acoustic parameter resulted in significant differences between white and clear water in Santarém –PA. Probably the greater amount of suspended material in white water makes that environment absorb more acoustic energy than black and clear water. Since absorption losses increase in higher frequencies, it should be advantageous for tucuxis to use lower frequencies in white waters. The efficiency of visual communication is also affected by very low visibility in white water. So, the adjustment of whistle parameters to guarantee better transmission in white water environment seems to be a likely strategy to maintain a communication efficiency.

Motivational information on Amazon river dolphins' acoustic signals

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Amazon river dolphins (*Inia* spp.) or botos are known to produce several types of sounds. However, studies on botos' phonations have not described how these animals use sounds to communicate nor in which behavioral contexts sound production occurs in the wild. Here we discuss the potential functions of acoustic signals in Amazon river dolphin' communication. Recordings were made at the Negro River with an omnidirectional HTI SSQ96 hydrophone (frequency response 20 Hz-25 kHz) coupled to a Sony PCM-D50 digital recorder (sampling rate 48 kHz, 16 bits). Acoustic analyses were performed using Raven Pro 1.5. Eleven acoustic parameters were extracted from spectrograms, oscillograms, and power spectra. Kruskal-Wallis test was used to investigate differences between behavioral contexts and measured sound parameters. A post hoc multiple pairwise comparison procedure with Bonferroni correction was used to identify differences in sound types produced between pairs of behavioral contexts. Statistical analyses indicated that acoustic variables differed among behavioral contexts. Interestingly, vocalizations emitted during aggressive behavior were significantly different from other behavioral contexts. The calls had the lowest high frequency (7.587±7.994 kHz), delta frequency (6.495±7.783 kHz), 3rd quartile frequency (3.057±3.084 kHz), initial (2.273±2.619 kHz) and final frequency (2.204±2.343 kHz) and also the lowest dominant frequency at the fundamental (1.549±1.396 kHz). By contrast, vocalizations emitted during play had the highest frequency values for high frequency (20.557±5.211 kHz), 3rd quartile frequency (8.524±4.469 kHz), initial (6.328±3.891 kHz) and final frequencies (4.685±3.506 kHz). Emissions of low-frequency sounds during aggression and high-frequency sounds associated with play corroborates with the motivation-structural rules proposed by Morton. The emission of low-frequency sounds during aggression might also convey body size information, while high-frequency emissions may elicit friendly approaches. The use of recording equipment with a higher frequency response to study botos' phonations are still necessary to uncover patterns of association of sounds and behavior.

Parameters of bottlenose dolphins (*Tursiops truncatus*) whistles respond to social structure and foraging tactics

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Whistles emitted by bottlenose dolphins (*Tursiops truncatus*) resident in Laguna, southern Brazil, were evaluated between different foraging strategies and over the modular social structure of this population. The structure of this dolphin society is coupled to a unique interactive behavior with artisanal fishermen - known as cooperative fishery – which are shared among a subset of animals that spend more time together. Recorded whistles were then evaluated regarding the foraging tactic - interacting or non-interacting with fishermen - and social modules – cooperative or non-cooperative dolphins. Whistles were classified into six classes– ascending, descending, concave, convex, multiple, and tonal – to verify possible variations in the frequency of use between foraging tactic. Descending whistles were predominant in the population (38.7% of total whistles). However, ascending whistles were more frequent during non-cooperative fishery (36.9% of total whistles emitted during non-cooperative fishery). Acoustic parameters - duration, initial frequency, final frequency, maximum frequency, minimum frequency, number of inclination points, and number of inflections - were explored by Discriminant Function Analysis (DFA) and Multivariate Analysis of Variance (MANOVA), which showed that the variation in these parameters also responds to social module and foraging tactic. It is possible to distinguish whistles emitted during the cooperative fishery ($p<0.001$) and by cooperative dolphins ($p<0.001$). Duration and number of inflexions were the determinant parameters for grouping whistles according to social modules and/or foraging tactics. These results suggest that whistles may be transmitting specific information for the cooperative foraging tactic and/or are more similar among cooperative dolphins

Comparison of whistles of rough-toothed dolphins (*Steno bredanensis*) among different social contexts in Southeastern Brazil

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The present study characterized and compared whistles of *Steno bredanensis* recorded in different social contexts. Recordings of 15 groups were made between 2010 and 2015 in adjacent areas of Guanabara and Ilha Grande Bay, Rio de Janeiro, Brazil. Group size ranged from 8 to 44 individuals and was classified in four classes for analysis: c1 (8≤x<15); c2 (15≥x<25); c3 (25≥x<35); c4 (35≥x<45). Among the groups recorded, only three did not have calves. Whistles were recorded during feeding (N=136) and travelling (N=123) behaviors. The recording system consisted of a C54XRS hydrophone (165dB re: 1V/lPa, 0.009 to 100 kHz) and a fostex FR-2 recorder (48 kHz sample rate). Spectrograms were analyzed in Raven 1.4 (FFT and Hanning window 512 ,50% overlap) where selected whistles were measured with 12 acoustic parameters. Also, whistles were counted for whistle rate calculations (whistles/minutes/individuals). Whistle frequency ranged from 2.82 to 14.2 kHz and duration from 49 to 1037 ms. Whistles emitted during travelling were longer (442±184 ms), had higher starting (6.7±1.4 kHz) and minimum frequency (6.0±1.1 kHz) than whistles during feeding (375±192 ms , 6.1±1.5 and 5.6±1.4 kHz respectively) (Mann-Whitney U test, $p<0.05$). Delta frequency was higher during feeding (2.2±1.5 kHz) than travelling (1.8±1.6 kHz) (Mann-Whitney U test, $p<0.01$). Class c4 emitted whistles with higher ending frequency (7.6±2.2 kHz), delta frequency (2.5±1.8 kHz), number of inflection points (0.3±05) (Kruskal-Wallis $p<0.05$, Dunn-Bonferroni test $p<0.05$), and duration (461±144 ms) (Kruskal-Wallis $p<0.001$, Dunn-Bonferroni test $p<0.01$) than whistles emitted by groups in c3 (6.7±1.4 kHz, 1.6±1.2 kHz, 0.1±0.3 and 353±150 ms respectively). Groups with calves had higher whistle rate (0.3±0.4) than groups without (0.08±0.1) (Mann-Whitney U test, $p<0.05$). Whistle rate was higher for class c1 than c3 (Kruskal-Wallis $p<0.01$, Dunn-Bonferroni test $p<0.01$). Differences found in parameters and whistle rates may have important roles in whistle communication and should be further investigated.

Adults also allowed: a reassessment of the structure and function of gargling sounds in Guiana dolphins

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To our knowledge, gargling sounds are produced only by individuals of the population of Guiana dolphins (*Sotalia guianenis*) inhabiting Cananeia estuarine system, southeastern Brazil. Gargles were first described in the literature as FM sounds with up to two harmonics, lasting around 3 s but occasionally extending to 20 s, with energy around 0.3 kHz and apparently produced by calves. However, we analyzed 76 gargle samples collected between 2008 and 2014 in the vicinity of Comprida and Cardoso Islands and found a set of entirely different acoustic characteristics. Furthermore, most of our records have been done in the presence of solitary adult dolphins of unidentified sex when no calves were present. Gargles are shown in our dataset as relatively short, low-frequency pulse train sounds, with energy spanning from 0.6 to 4.9 kHz, peaking at 151 dB re: 1uPa @1m and an averaged duration of 1.8 s. Two major types of gargles could be distinguished: a so-called slow-train gargle, which presented up to six regularly spaced pseudo-harmonic bands resulting from an uniform pulse repetition rate (Hann window, 4096 pts, 90% ovlp); a fast-train gargle, presenting up to nine irregularly spaced pseudo-harmonics and a variable pulse repetition rate. Both types could be produced one at a time or in series of two and three trains. Guiana dolphins produced gargles exclusively while foraging in shallow water. Frequently, but not always, gargling sounds were followed by increasing click trains, culminating in the interception of a prey. We speculate gargles act as some kind of marker signals, indicating the onset of a foraging bout. Further research is needed in order to ascertain individual identity in gargling production.

Stenella frontalis screams record in the Southwest Atlantic Ocean

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A group of approximate 200 Atlantic spotted dolphins, *Stenella frontalis* was recorded through an one-element hydrophone array at 96 kHz/24 bits while navigating at the Brazilian continental shelf break. The preliminary results demonstrated 155 scream emissions. This specific whistle type is characterized by the presence of a blurring, in either a segment or the entire normally narrow-band frequency-modulated tone. Previous work report that the possible cause of the blurring is that 5 or 6 overlapping FM whistles are produced simultaneously by multiple animals. Other cause may be the aeration of the whistle during its production. We found both isolated emissions and synchronized bouts of scream comprising 6 different contour shapes. Minimum frequencies ranged from 4.33 to 13.21 kHz (median = 6.95 kHz); maximum frequencies ranged from 6.23 to 20.42 kHz (median = 13.84 kHz) and whistle duration ranged from 0.07 to 2.45 s (median = 0.46 s). The most associated behavioral context with this emission hitherto was agonistic related with intra & and interspecific aggression. Screams have also been previously linked to play and inquisitive activities and less associated with forage or travel activities. Screams have been registered for Atlantic spotted dolphins in the Bahama Islands, West Atlantic southeast of Florida. This is the first record of this type of emission in the Southwest Atlantic Ocean. This study was funded by BG Group and Chevron.

The marine mammals of French Guiana and the impacts of the anthropogenic activities on their biology, their populations and their environment.

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In French Guiana waters, aerial surveys and boat based surveys have been conducted since the last ten years only and data about the occurrence and abundance of marine mammals are very limited. The manatee,*Trichechus manatus*, is observed near the coast and in estuaries on a regular basis. About cetaceans, the Guiana dolphin, *Sotalia guianensis*, is observed regularly near the coast. Among large species of cetaceans, the sperm whale, *Physeter macrocephalus*, the humpback whale, *Megaptera novaeangliae*, and even the blue whale, *Balaenoptera musculus*, have been observed offshore. Medium size whales have also been observed: the false killer whale, *Pseudorca crassidens*, and the pilot whale, *Globicephala macrorhyncus*. Small cetaceans species have also been observed such as the bottlenose dolphin, *Tursiops truncatus*, the Atlantic spotted dolphin, *Stenella frontalis*, and the melon-head whale, *Peponcephala electra*, among other species. Very few is know about the trends of marine mammals' populations as well as the movements of migrating species and the status of residency in other species. Among the techniques used to better understand the biology of these species in French Guiana waters and to measure the impacts of the anthropogenic activities on them and their populations, acoustic techniques and equipment can be used in parallel with other techniques such as photo ID, telemetry and genetics. The aim of this work is to evaluate the best techniques are useful to increase knowledge about the marine mammals of French Guiana and to establish collaborations with research groups in Latin America. Seismic surveys for oil exploration seem to be a major threat for those marine mammals species and a common problematic to be discussed about to better measure with appropriate techniques the impact of antropogenic sounds on marine mammals species and their biology as well as their populations and their natural environment.

Overview of projects bioacoustics-related on cetaceans conducted in Argentina and Antarctica

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The development of research using bioacoustics in Argentina has been limited because of resource limitations. Since 2011, Fundación Cethus in collaboration with the Scripps Institution of Oceanography and Whale and Dolphin Conservation has been undertaking several projects on cetaceans implementing acoustics or developing necessary tools to record sounds. Some of them are listed below: - Exploration of alternatives aiming to design and build a hydrophone suitable for recordings of cetaceans in Argentina. - Description of sounds emitted by Franciscana dolphins (*Pontoporia blainvillei*), the creation of a semi-automatic tool available to everybody at http://www.cethus.org/ to detect Franciscana dolphins acoustically, and trying to understand noise impact on the species. - Acoustic discrimation of sympatric Commerson's dolphins (*Cephalorhynchus commersonii*) and Peale's dolphins (*Lagenorhynchus australis*) in Argentina. - A 10-years project is underway in the western Antarctic Peninsula, combining visual and acoustic surveys of cetaceans to assess species presence and relative abundance in the region. Additionally, PAM is implemented throughout the year to understand seasonality of cetaceans and other patterns.

Spatial and acoustic overlap of humpback whale singers and vessels in the Abrolhos Bank

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Humpback whales are a cosmopolitan migratory species that are constantly in contact with human vessel-based activities. In regard to the growing number of vessels, researchers are constantly gathering more information on humpback whales' distribution, behavior and especially the effects of human activities on these animals. The purpose of this study is to characterize spatial and acoustic interactions of vocally active humpback whales and vessel traffic in the Abrolhos National Marine Park (Brazil). Vessel based surveys were conducted in 2004 (52 days) and 2005 (43 days) in order to register humpback whale group behavior, acoustic activity and geographical position. ArcGIS was used to create maps to identify the main areas where the vessel navigation corridor overlaps with humpback whale singers' distribution. Raven Pro 1.4 was used to analyze sound data. The vessels' frequency band that contains 50% of the sound energy was measured to verify any overlaps with the low-frequency band with most energy produced by humpbacks in Abrolhos (70-350 Hz). In order to characterize noise from different vessel or engine type, 3 dB bandwidths and source levels were measured for each vessel. From the humpback whale singing activity and vessel density maps, it was found that areas with higher density of singing activity overlap with higher density of vessel traffic. All vessels generated noise that overlapped with the frequency band of humpback whale sounds in Abrolhos. It was possible to identify areas most used by humpback whale singers around the Abrolhos Bank and how they overlapped with vessel traffic. This study provides data that emphasize the need to continue monitoring the overlap between humpback whales and vessel traffic activity to inform adaptive management plans for the species in Brazil.

Humpback whales (*Megaptera novangliaeae*) residency in Los Cabos Region, Baja California Sur, Mexico (2003-2012)

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Notwithstanding the conservation status of the humpback whale population that goes to wintering grounds in the Mexican Pacific is under consideration of being out of risk according with the Endangered Species Act (NOAA, 2015), its migratory dynamic is still a matter of interest. For that reason, this research shows how their residence times in Los Cabos Region have been changing during ten years. This data was collected mostly in cruises and field work trips performed by researchers of the Marine Mammal Research Program (PRIMMA) between December and April in the Gulf of California Peninsula and from the SPLASH project (Structure of Populations, Level of abundance and Status of Humpback whales). Considering that the residency is the time among the first and the last photography of each individual, 2763 humpback whales were photo-identified and their residence time average was estimated at approximately 12.7 days. Besides, the analysis of photographic data revealed that 34.3% of the humpback whales were recaptured in 2004, 28.9% in 2005 and 27.9% in 2006; whereas in 2010 the percentage of recapture was 9.7% in 2011 and 2.1% and 0% in 2012. Despite the effort was not homogeneous in some years; results indicate humpback whales have stayed between 10 and 15 days in Los Cabos almost all the seasons but due to the low rates of recaptures it may not be the same population size than ten years ago. This tendency shows how important is to keep improving conservation programs to protect areas that are part of the migratory routes of this species.

Humpback whale vocalizations from Trindade-Martin Vaz Archipelago detected by passive acoustic monitoring

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Information about cetacean occurrence in oceanic islands from South Atlantic Ocean is scarce. Trindade-Martin Vaz Archipelago (20º30'S 29º20'W) is located 1150 km from Brazilian coast and cetacean information have been limited to a few surveys in last years. In order to investigate whale and dolphin presence in the archipelago passive acoustic monitoring (PAM) was conducted during 26 days in August-September 2014. One SM2M+ device (Wildlife Acoustic Inc) was deployed at 20 meters depth. The equipment recorded at a 66% duty cycle at sample of 48 kHz and 16 bits, which provided us with 400 recordings. The audio files were downsampled to 6 kHz and acoustic parameters of vocalizations were measured using Raven 1.4 (Cornell Lab of Ornithology, NY) in a 512 Hann window, 75% overlap. Humpback whale songs were visualized in all recordings, therefore recordings from five random days of deployment period were chosen to run Band Limited Energy Detector in Raven 1.4 to see if vocalization behavior varied with hour of the day. A total of 36 926 humpback whale song signals were detected. Acoustic parameters of vocalizations were highly variable, their duration ranged from 196 to 2299 ms (mean of 1187.8 ± 557.6 ms), with minimum frequency ranging from 66.2 to 1095.6 Hz (mean of 317.2 ± 232.9) and maximum frequency ranging from 117.6 to 2102.9 Hz (mean of 570.5 ± 368.5). Singing occurred in all hours of the day without a clear pattern, but recordings made at 14:00-15:00 had the lowest mean number of detected vocalizations (272.4 ± 303.3) while 18:30-19:30 had the highest mean (642.6 ± 290.5). Humpback whale presence in Trindade island is known, but the high number of hours of songs recorded suggest that the archipelago may be an important area for species during migration to breeding grounds in the South Atlantic Ocean.

Humpback whale repertoire of social sounds in a Brazilian breeding area

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Humpback whales (*Megaptera novaeangliae*) migrate to the Brazilian coast during the winter and spring to breed and calve. During this time, the males sing complex songs related to mating. Although most of the studies on acoustic communication of the species are focused on song, humpback whales also use other "social sounds" to communicate. Non-song acoustic signals are vocalizations and percussive sounds produced on the surface of the water resulting from aerial behaviors such as breaching, flipper, and tail slapping. Non-song sounds have been recorded in feeding, migration and reproduction areas and are produced by males, females and calves. As the name implies, these types of sounds may have specific social functions depending on the group composition and behavioral context as means to mediate interactions between different individuals in the group and among groups in the vicinity. The objectives of this study are to catalogue and categorize social sounds produced by the humpback whales that pass by the Serra Grande region (Bahia, Brazil) during the reproductive period, and verify if the pattern of emission changes throughout the season and between day and night time periods. Passive acoustic monitoring was conducted in collaboration with LADIN-USP, by using Oceanpods (autonomous underwater sound recorder developed by Ladin-USP) deployed on the seabed at depths of 16 to 22 m, at a distance of 3.4 km to the coast between July and October, in 2014 and 2015. Recording efforts were approximately 2,100 hours at a sampling rate of 11.025 kHz (single channel) using two or three Oceanpod units simultaneously deployed. Measured sounds were initially analyzed by means of long duration spectrograms, using software developed by Ladin. They will also be investigated manually using spectrograms generated in Raven Pro 1.4 (Cornell Lab of Ornithology). Statistical analyzes will be used to support human classification of recorded sounds.

Humpback whale songs were identified and characterized based on the definition of the subunits

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Humpback whale songs were identified and classified based on their subunits. While these subunits vary somewhat , they were important for the identification of the species using the Autonomic Passive Acoustic Monitoring System. The recordings were obtained by the Humpback Whale Institute team between 2006 and 2013, in the Abrolhos region off eastern Brazil. The parameters analyzed for the subunits were: Energy; Mean power; High, Center and Maximum frequency; and Delta time and frequency. The mean and standard deviation, and minimum and maximum values were calculated for all seven parameters. A multivariate analysis of variance with a post-hoc test was run, where $p>0.05$ represented a lack of significant variation among years. The recordings from 2006, 2007, 2009 and 2011 (14% of the samples) were of adequate quality for analysis. Subunits A, B and C were identified. Subunit A (18% of the recordings) has been recorded at feeding grounds northeast of Iceland (in 2011) and off Alaska (2012). Subunit B (24%) was also recorded in feeding grounds off Iceland (2000) and Alaska (2012), and breeding grounds off Hawaii (1991). Subunit C (51%) was recorded in breeding grounds off Madagascar (2009), Hawaii (1989 and 1991), Mexico (2006), Australia (2009) and New Caledonia (2010), as well as in Antarctic feeding grounds (2010). The subunits have been well preserved over time, especially in their frequencies (high, center and maximum), and delta time and frequency. Delta time presented a more uniform average and standard deviation. Comparisons with subunits found in the literature indicate that they are suitable bio-acoustic markers for humpbacks in the context of the MAPA approach. The data obtained in this study will be used to establish a sound database for the marine mammals of the South Atlantic

Using two passive acoustic monitoring methods to investigate the acoustic ecology of Southern right whales (*Eubalaena australis*) off Brazil

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Currently, numerous passive acoustic monitoring (PAM) instruments and procedures are available fulfilling the needs and aims of a great variety of applications, study areas and target species. Each PAM method has advantages and limitations and for that reason, the use of complementary approaches is recommended in order to maximize the comprehension of different aspects of a species acoustic ecology. To investigate the vocal behaviour Southern right whales (*Eubalaena australis*) off the state of Santa Catarina, Brazil, two PAM methods were used. Autonomous archival devices were fixed 1.5 meters above the sea floor in two locations and were set to continuously sample at a rate of 8 kHz and 16-bit resolution. Over 720 hours of recordings were obtained and distinct analysis techniques were used with the purpose of gathering information on the whale´s vocal repertoire, the temporal pattern of vocal activity and the vocal plasticity of whales in different background noise conditions. Nevertheless, a significant limitation of our long-term recordings was that inferences about behavioural context of vocalizations were unfeasible. Hence, to link surface and vocal behaviour, synchronized behavioural observations and acoustic recordings were conducted. Behaviour was continuously sampled through group-focal observations. Recordings were done using a dipping two-unit linear array plugged into a portable digital recorder. The array was deployed from the side of small vessel and was sustained on the water column by a buoy set. From a total of 542 minutes of synched recordings and observations, calling rate and call usage information was obtained accordingly to the whales´ behavioural state. The use of complementary PAM methods allowed us to obtain important baseline information on the acoustic ecology right whales off Brazil, contributing to increase the utility of passive acoustic monitoring as a tool for conservation and research of the species.

Babitonga Bay underwater acoustic environment, South Brazil

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The underwater noise is becoming a major concern in marine environments, threatening directly populations of cetaceans. The goal of this study was to characterize the underwater acoustic environment of Babitonga Bay, SC, south Brazil. This area represents an important refuge for franciscana dolphins (*Pontoporia blainvillei*) and Guiana dolphins (*Sotalia guianensis*). For the characterization of underwater noise, 37 sampling points for acoustic recordings were defined, that were replicated twice each season between September 2012 and September 2013. The acquisition system allowed the record of sounds in the range of 5 Hz to 96 kHz. Using the resources of Avisoft-SAS Lab Pro 5.2 program were selected 5 periods of 10 seconds from each sample. There was a decline in sound intensity with the increased frequency, with a significant difference between the lower (<10 kHz) and higher frequencies (>10 kHz) ($H = 18218.75$, $p < 0.01$). The highest intensity was recorded below 1 kHz, with a high noise band up to 10 kHz. The innermost region of the Babitonga Bay has a lower intensity of noise, increasing towards the mouth of the bay, which coincides with the proximity of the harbors ($H = 8999.06$, $p < 0.01$). All seasons differed significantly in noise intensity, with the highest noise in spring and the lowest noise in winter ($H = 4634.709$, $p < 0.01$). The highest average sound intensity was recorded near harbors. The highest sound intensity (161.99 dB re 1uPa), at the frequency of 375 Hz, was recorded during the maneuver of two tugboats and a ship close to the Itapoá harbor. Further analysis are necessary to understand the interaction of acoustic noise and dolphins habitat use patterns. Information about the underwater acoustic environment of the Bay Babitonga can provide essential aid in the development of management actions and conservation for the cetaceans.

Medium and high frequency components of vessel noise in two shallow-water regions of Santa Cruz and the potential for masking of Commerson's dolphins (*Cephalorhynchus commersonii*) sounds

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Ship noise is the most widespread anthropogenic noise source over the oceans and dominates the spectrum levels at low frequencies (LF). Most studies have considered the potential impacts of such increased noise levels on baleen whales, which produce LF sounds and are believed to have the highest sensitivity at LF. However, less attention has been paid to the medium (MF) and high frequency (HF) components of vessel noise and their potential impacts on cetaceans, especially HF specialists. Broadband acoustic recordings for different types of vessels were obtained using an omnidirectional hydrophone in two coastal areas of southern Patagonia Argentina: Ría Deseado and San Julián Bay. Both areas are inhabited by Commerson's dolphins, especially during spring and summer seasons where they are exposed to recreational nautical activities, whale watching and, especially in the case of Ría Deseado, to the ship traffic of the harbor located there. The potential range reduction for communication of Commerson's dolphins was calculated for third-octave bands of 1, 10 and 125 kHz for each single vessel. Ship noise from a range of different vessel types substantially elevated median ambient noise levels across the entire recording band from 0.2 to 250 kHz at ranges between 10 and 1000 m. Vessel noise is able to produce about 90% hearing range reductions within a distance of 500 m in the third-octave bands of 1 and 10 kHz and increase noise levels by 18 dB at a range of 100 m from the recording platform. Our results show that several types of vessels produce substantial noise at MF and HF, where toothed whale hearing is most sensitive, and thus have the potential to mask relevant sounds used by small cetaceans. This is consistent with findings in harbor porpoises (*Phocoena phocoena*) off Denmark.

Advanced interdisciplinary bioacoustical analyses for cetacean observatories in Chile and Peru

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Advanced investigations in bioacoustics involve interdisciplinary teams to include computer science, machine learning, feature learning, physics, mathematics and biology. We propose forming a net of scientists in Chile, Peru and France (i.e. computer scientists, physicists, mathematicians, oceanographers, psychobiologists, and ecologists) that will exchange technologies, data, theoretical models, field experiences, and other information. We plan to install innovative, low-cost, multi-channel recording equipment from 2016 through 2018 capable of high sampling rates at real time (1,000,000 Hz: JASON DAQ – developed by the Université of Toulon) in conjunction with other equipment already in place to acoustically monitor marine mammals over long periods of time. These acoustic surveys will occur in South American hot spots: Carlos III Island in the Magellan Strait, Corcovado Gulf near Chiloe Island, Chanaral Island in northern Chile, and the Peruvian Amazon. Innovative techniques that are currently being developed will be applied to the collected data, such as:
-Automatic decomposition of cetacean songs in units (humpback whales, blue whales, Amazon River dolphins, as in [1]).
-Finite element wave propagation models ([2] Patris et al., in this workshop).
-Wavelet or Scattering representations ([3] Trone et al., [4] Balestriero et al.).

[1] 2015, M. Bartcus, F. Chamroukhi, H. Glotin « Hierarchical Dirichlet Process Hidden Markov Model for unsupervised bioacoustic analysis », International Joint Conference on Neural Networks (IJCNN).

[2] 2016, J. Patris, H. Glotin, D. Komatish, E. Van't Wout, F. Malige, M. Asch « High Performance Computing for whale sound propagation by Finite Element Methods : SPECFEM and BEM++, applied in South America »

[3] 2015, M. Trone, H. Glotin, R. Balestriero, D.E. Bonnett. « Enhanced feature extraction using the Morlet transform on 1 MHz recordings reveals the complex nature of Amazon River dolphin (Inia geoffrensis) clicks. Journal of the Acoustical Society of America, 138, 1904. http://dx.doi.org/10.1121/1.4933985 »

[4] 2015, R. Balestriero, H. Glotin, "Scattering Decomposition for Massive Signal Classification: From Theory to Fast Algorithm and Implementation with Validation on International Bioacoustic Benchmark", In: 2015, IEEE ICDM Workshops

High-performance computing for whale sound propagation in South American oceans based on accurate numerical techniques

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The oceans are complex environments for the study of wave propagation. Due to the changes in the wave velocity, complex bathymetry and ground structure, the propagation of cetacean sounds is known to be difficult to analyze with computational methods. So far, little effort has been made to model the propagation of a bioacoustic signal in such an environment.
Can the knowledge of the bioacoustic sound propagation help in obtaining data, such as quantity, position, movement, behavior, and communication of whales? To answer this question, we investigatetwo accurate full-waveform numerical methods, namely a finite-element method (FEM) and a boundary-element method (BEM)
Finite-element methods can accurately model wave propagation in complex environments. However, due to their computational cost, the domain under study is currently limited to moderate sizes (simulation box of around 100 wavelengths in each direction). SPECFEM is a spectral-element software package initially developed for seismic waves. We are adapting this tool in order to simulate whale signals in the time domain.
The boundary-element method is potentially faster to compute wave propagation, because only the interfaces and boundaries of homogeneous regions are being discretized. To this end, we use the open-source BEM++ library (BEM++, Smigaj, 2015), which provides frequency-domain acoustic models.
We will present these numerical methods and our first results on simulated data, which show how the signal can interact with the local environment. We'll also present how we will apply this techniques to real data, obtained from our "bioacoustic observatory in South America" project (see abstract from Franck Malige et al. « Advanced interdisciplinary bioacoustical analyses for cetacean observatories in Chile and Peru »).

Contributions to the Brazilian Equatorial Margin soundscape based on data from Lagrangian Profilers

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In order to collect data on the soundscape of the Brazilian Equatorial Margin, lagrangian profilers are being deployed in the Continental Shelf Break of Pará-Maranhão and Barreirinhas basins. Equipped with a temperature sensor and an acoustic package, the profilers perform daily dives down to 1000 meters' depth while being carried by ocean currents. During the ascent phase of each dive, the profiler is able to register and process up to 5 acoustic windows in different depths. Once the equipment reaches the surface, it transmits standard acoustics metrics such as: SPL RMS, Peak-to-Peak and SPL histograms of 30 1/3 octave bands between 10 Hz and 7.94 kHz. In this work, we analyze data collected by 3 profilers, accounting for 219 dives and 997 acoustic windows. Higher SPL in the lower frequencies were observed in the region adjacent to São Marcos bay, where bigger vessels are frequently present. SPL values observed in this regions are between 120 and 128 dB re 1µPa while values between 108 and 122 dB re 1µPa are more frequent outside this area. No evident spatial distribution was observed for Peak-to-Peak values but the maximum values observed are spatially coincident with the maximum values observed for SPL RMS. Next analysis will try to estimate vessel contributions to the SPL values based on AIS data history on the region.

LAMLA

Listening for Aquatic Mammals in Latin America

23 de junho de 2016

Assunto: Dados provenientes dos registros de PAM

Diretoria de Licenciamento Ambiental (DILIC)

Coordenadoria Especial de Petróleo e Gás (CGPEG)

Instituto Brasileiro do Meio Ambiente (IBAMA)

Rio de Janeiro, RJ

Prezados,

O grupo de pesquisadores reunidos no *1st Listening for Aquatic Mammals in Latin America* – LAMLA, realizado no Centro de Biociências na cidade do Natal, entre os dias 21-23 de junho de 2016, vem apresentar seu interesse em colaborar com os esforços dessa Diretoria para a conservação do ecossistema marinho.

Cientes de que os mamíferos marinhos são carismáticos representantes da riqueza e da complexidade biológica desse ecossistema, externamos nossa preocupação com o avanço e a expansão crescentes das atividades de exploração de recursos nesse ambiente sem que esse avanço seja acompanhado proporcionalmente de pesquisas de base e caracterização ambiental que antecedam as atividade licenciadas, bem como o monitoramento de seus potenciais impactos.

LAMLA

Listening for Aquatic Mammals in Latin America

As atividades de prospecção sísmica são foco internacional de atenção quanto a potenciais prejuízos que essa atividade possa produzir no ecossistema marinho, especialmente quanto à qualidade de vida dos mamíferos marinhos. Estamos cientes que para que essa atividade seja licenciada, e possam ser mitigados efeitos sobre os mamíferos marinhos, as empresas devem realizar o monitoramento acústico passivo (PAM) no qual são feitos registros acústicos de sons emitidos pelos animais e sons do ambiente onde a atividade é realizada. Nesse cenário o grupo de pesquisadores vem fortemente recomendar que essa diretoria torne obrigatório para as empresas a gravação, o armazenamento e a disponibilização para pesquisa dos registros de PAM realizados durante as atividades resultantes de processo de licenciamento.

Os pesquisadores concordam que explorar esses dados não substitui a necessidade de realização de pesquisa sistematizada e de caracterização básica dos fenômenos biológicos, que por sua vez, devem ser de interesse de Estado, ainda sim as informações registradas são de grande valor para a ampliação do conhecimento da própria atividade, bem como dos animais.

Sem mais para o momento colocamo-nos a disposição para colaborar com passos futuros para a implementação dessa proposta cientes que atuamos conjuntamente com os órgãos públicos para a conservação da natureza.

Atenciosamente,

Renata Sousa-Lima
Presidente

Artur Andriolo
Coordenador Científico

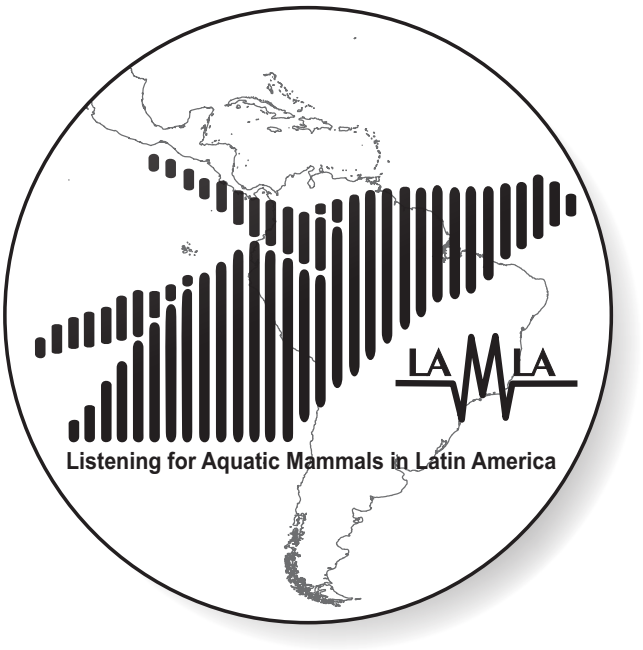
Comissão Organizadora do 1st LAMLA Workshop

2nd Workshop
Listening for Aquatic Mammals in Latin America

November 26-27, 2016 | Valparaiso, Chile | RT17

LA LA

2nd Workshop
Listening for Aquatic Mammals in Latin America
Valparaíso, Chile, 26-27 November 2016



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Plenary talk

- What can Listening reveal about humpback whales?
- Understanding noise impact to advocate for quieter waters in Latin America.

What can Listening reveal about humpback whales?

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Humpback whale bahavior can only be studied in nature, and observing their underwater lives becomes a challenge. The wide distribution, large size, and aquatic life style of these leviathans constrain our ability to observe and understand the context of our observations and limits our inferences. Humpbacks are known for using long distance acoustic communication to coordinate social interactions, during reproduction and feeding, as well as during migration. Therefore, we rely on sound to help us "see" beyond the surface. We eavesdrop on their underwater lives by listening. Studies developed in the past 17 years in the Abrolhos Bank aimed to understand the lives of this large marine mammal species using different passive acoustic technology. We focused on male singing behavior to understand their culture, social dynamics, their movement, spatial and temporal activity patterns, and how male singing activity has been affected by noise. Funding has been provided by Fundação O Boticário de Proteção à Natureza / MacArthur Foundation, Society for Marine Mammalogy CAPES, The Canon National Parks Science Scholars Program, Animal Behavior Society, Cornell University, Projeto Baleia Jubarte and Petróleo Brasileiro S. A. (PETROBRAS).

Understanding noise impact to advocate for quieter waters in Latin America.

Malcon, Mariana

Oral Presentations

- Forty-four years of using bioacoustics to study aquatic mammals in Latin America: state of art of a growing research area.
- Bioacoustical Research in Latin America Aquatic Mammals (BRILAM) Preliminary Report.
- Adquisición de registros sonoros de cetáceos a partir de hidrofonos de bajo costo.
- Integrative acoustic discrimination of delphinids in the Western South Atlantic.
- Acoustic behaviour of Tucuxi (*Sotalia fluviatilis*) whistles in two different types of amazonian waters.
- Clustering of echolocation signals of Commerson's dolphins (*Cephalorhynchus commersonii*) in Ría Deseado, Argentina.
- Variations in calls of Killer Whales (*Orcinus Orca*) from the Western South Atlantic.
- First description of a behaviour-related vocalization in two independent Blue Whale populations and automatic detection possibilities.
- Evolución en los patrones de canto de ballenas jorobadas (*Megaptera novaeangliae*) en las costas de Esmeraldas y Manabí Ecuador.
- Patrón circadiano de actividad acústica del delfín chileno (*Cephalorhynchus eutropia*), utilizando un monitoreo de acústica pasiva, en una zona con intensa actividad acuícola.
- Efectos de pirotecnia de año nuevo en el comportamiento del lobo marino común (*Otaria Flavescens*) en el santuario de la naturaleza de Cobquecura, centro Súr de Chile.
- A work in progress: Understanding the temporal variation in blue whale acoustic presence, prey abundance and oceanographic variables in the Corcovado Gulf, Patagonia, Chile.
- Temporal variation in whistles of Guyana Dolphins in Babitonga Bay, Santa Catarina, Brazil.
- Automated whistle categorization of Short-beaked Common Dolphins (*Delphinus Delphis*) in Western South Atlantic.
- Description of echolocation clicks produced by Amazon River Dolphin (*Inia Geoffrensis*) in Xingu River, Pará, Brazil.

Forty-four years of using bioacoustics to study aquatic mammals in Latin America: state of art of a growing research area

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Bioacoustics is a useful tool with application at a wide range of research areas, and its use in studies with aquatic mammals has been increasingly explored in Latin America. Here we present a review of what has been done with bioacoustics and aquatic mammals in Latin America. We conducted an exhaustive search on the Web of Science database to obtain all published research articles until 2015, using a combination of keywords and selecting those papers related to Latin America. In order to evaluate tendencies, progress and possible deficiencies in the use of bioacoustics to study aquatic mammals, we extracted the following information: year of publication, bioacoustics method used (i.e. active or passive method), studied species, country, and category (e.g. review or research) and aims of the article. We were able to retrieve 95 research articles using bioacoustics to study aquatic mammals in Latin America, since 1971. Our review shows that, since the first publication, the use of bioacoustics has experienced a considerable growth, mainly in 2014 and 2015, which together account for 30% of the total number of articles. The majority of the papers were related to Brazil, with a great discrepancy between the number of articles of this country and the others. Eight Latin American countries lack publications. Regarding the species, more than 80% of the articles focused on just one species, and most of them (71%) studied cetacean species. Among the cetacean species included in the bioacoustics studies, most articles studied Sotalia guianensis and Balaenoptera musculus. Despite the bioacoustics' potential to be helpful in answering a great variety of scientific questions, Latin America studies have been using it mainly to solve behavior issues and for repertoire descriptions. Nevertheless, the range of questions that have been answered with bioacoustics have increased in recent years, possibly indicating an expansion in the use of these tools. We expect that this review highlights the importance and potential ofbioacoustics to improve our knowledge on aquatic mammals and encourage its use, alone or in conjunction with other methods, to answer interesting scientific questions.

Bioacoustical Research in Latin America Aquatic Mammals (BRILAM) Preliminary Report

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In May 2016, a collaboration between France, Chile and Peru ensued with the submission of a grant to the STIC-South America program (STICAmSud). The objective of this program is to facilitate research and development in the field of Information and Communication Science and Technology (ICT) through joint projects between at least two South American countries and France (http://www.sticamsud.org/index.php/en/news/95-call-for-proposals-2015). Researchers from France, Chile, Peru and the United States formed the Bioacoustical Research in Latin America Aquatic Mammals (BRILAM) research group as a result of this collaboration. The scientists from this working group united their efforts recently in the Peruvian Amazon to address the lack of information regarding the acoustical emanations and natural history of both cetacean species encountered in the Amazon River watershed (*Inia geoffrensis* and *Sotalia fluviatilis*). Indeed, these species have been listed as "data deficient" by the International Union for the Conservation of Nature (IUCN) (*Inia*: http://www.iucnredlist.org/details/10831/0; *Sotalia*: http://www.iucnredlist.org/details/190871/0). As such, one of the primary goals of BRILAM is to develop acoustical methods to count dolphins, and if possible, to expand this work so that individual dolphins can be identified by their acoustic signals in order to assess populations. To this end, researchers were in the field from June 9 – August 20, 2016. A fixed array containing up to 8 ultra-high frequency hydrophones sampling at 1 MHz each was used in conjunction with a prototypical analog-to-digital converter, referred to as JASON, to record both cetacean species, although efforts were focused on *I. geoffrensis*. Behavior observations and video were also collected and synchronized with the audio recordings. Hydrophone positions on the array were modified throughout the season to optimize data in our attempt to concretely identify the lobe of an on-axis click. In addition, a HumminBird 997c side scan imaging system was employed with the array at times to verify the dolphin positions relative to the hydrophone and the direction of the rostrum. Some measurements of dolphin lengths have been derived from these HumminBird recordings, data which can be used to explore correlation possibilities of animal size and frequency production. Currently we are in the process of data analysis, although preliminary results are presented, along with some of the challenges we encountered and how we solved these issues. In addition, we organized a mini-symposium hosted by the Instituto de Investigaciones de la Amazonía Peruana (IIAP) in Iquitos. Details from this collaboration are shared. We would also like to report on the establishment of the Amazon Dolphin Acoustics Laboratory (ADAL) with the help of Explorama Lodges. Finally, we would like to share information regarding the development of an Android application to be used during field operations and an open source website with audio recordings and analysis software.

Adquisición de registros sonoros de cetáceos a partir de hidrofonos de bajo costo

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En el medio acuático, el sonido recorre grandes distancias en un escaso periodo de tiempo. La acústica pasiva (grabación de sonidos mediante la utilización de hidrófonos), permite recibir o escuchar los sonidos del medio circundante, y puede utilizarse para identificar la fuente emisora del sonido. La gran mayoría de los delfines generan emisiones sonoras tanto para la localización de objetos como para la comunicación entre individuos. Los delfines nariz de botella (*Tursiops truncatus*) solían ser frecuentes en la Provincia de Buenos Aires pero hace décadas su frecuencia de ocurrencia es cada vez menor, por causas desconocidas. Por tales motivos, se plantea evaluar la instalación de hidrófonos en el arte de pesca que permitan monitorear sinópticamente la presencia de estos cetáceos. Sin embargo, una de las principales limitantes son los altos costos de estos dispositivos y la alta tasa de extravío de las redes. Por tales motivos, se diseñaron hidrófonos caseros de bajo costo, los cuales constan de um compartimiento estanco que contiene sensores piezoeléctricos conectados a un grabador digital. Los desempeños de los hidrófonos fueron evaluados registrando los sonidos de los delfines nariz de botella en un ambiente controlado (Mar del Plata Aquarium). Durante las 3 horas de grabación, fue posible adquirir tanto registros de ecolocalización como vocalizaciones del tipo “silbidos” con diferentes características. Los resultados obtenidos han demostrado que dichos dispositivos podrían ser una herramienta muy potente para determinar la presencia de estos individuos a partir de los sonidos que estos generan.

Integrative acoustic discrimination of delphinids in the western south atlantic

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This study presents an integrative bioacoustics approach to classify eight species of odontocetes in the Western South Atlantic. Spinner, Atlantic spotted, rough-toothed, Risso's, bottlenose, short-beaked common dolphins, killer and long-finned pilot whales were visually confirmed during recordings with a 3-element omnidirectional hydrophone array. Spectral and time parameters of whistles and echolocation clicks were used in a discriminant function analysis (DFA) and a classification tree model. As a first step, whistles and clicks were analyzed separately; a further analysis consisted of both vocalizations combined. Receiver Operating Characteristic (ROC) curves were created in order to verify the classifying efficiency of the model by its area, and the Likelihood-ratio Chi-square (G^2) categorical statistics was computed to inspect the contribution of each input parameter to the model. All species show species-specific properties in their vocalizations. The DFA showed that the whistle classification had higher number of false classifications (47.8%, N=526), these numbers decreased when only clicks were taken into account (25.0%, N=158). The discrimination result improved with the combined analysis presenting a misclassification percentage of 4.8% (N=24). The optimal classification whistle tree consisted of 28 splits and a misclassification rate of 0.606. The optimal click tree consisted of 60 splits and a misclassification rate of 0.260. When whistles and clicks were combined, the optimal tree consisted of 90 splits and a false classification of 0.188. The contribution parameter analysis showed that for whistles, the maximum frequency contributed greatly to the model (G^2=1524.89), for clicks the 3 dB bandwidth was the parameter that most contributed (G^2=5065.64) and in the combination step, the 3 dB bandwidth still contributed the most to discrimination (G^2=4977.24). Furthermore, the ROC curves resulting from the tree algorithm analysis exhibit better model efficiency for all species when whistles and clicks were combined (Areas>0.936). The results demonstrated that an integrative bioacoustics approach potentially improves the classification process, once it considers the different signals produced by the species as part of a whole communication system employed in different ecological contexts.

The project was funded by BG Group and Chevron.

Acoustic behavior of tucuxi (*Sotalia fluviatilis*) whistles in two different types of amazonian waters

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Sound carries many important information for the survival of cetaceans. However, enrivonmental features may affect the transmission, sound quality and, consequently, the communication of these animals. Amazon rivers present differences in physical characteristics: a) white water: turbid water with high level of suspended material and b) black water: brownish with low level of suspended material. Thus, we aimed to compare the acoustic behavior of *Sotalia fluviatilis* whistles between white and black waters at the Juami-Japurá Ecological Station, Amazon. Vocalizations were recorded using a system consisting of a Cetacean Research™ C54XRS hydrophone (frequency response: 0.006 a 203kHz, +3/- 20 dB, - 185 dB re: 1V/µPa) coupled to the Fostex FR-2 LE digital recorder (sampling rate of 96 kHz/24 bits). Whistles were manually analyzed using Raven Pro 1.5 (Cornell Laboratory of Ornithology, Cornell University, NY, USA) with DFT 2048 points, overlap of 80% and Hann window of 1024 points. The following acoustic parameters were extracted from the fundamental frequency: duration; minimum, maximum, delta, peak, center, beginning and ending frequencies. The descriptive statistics for all measured acoustic parameters includes minimum and maximum values, mean, standard deviation and coefficient of variation. Fundamental frequency whistles parameters emitted in white and black waters were compared through Wilcoxon test, considering a level of significance equal to 0.05. Tucuxi whistles were significantly different in most of the analyzed acoustic parameters. White water whistles (N=238) presented greater duration (0.362±0.30s, $p<0.05$) and lower frequency parameters (except for the minimum and beginning frequencies) than those produced in the black water (N=238, duration: 0.283±0.23s). Delta frequency showed larger significant difference ($p<0.001$) between the two types of waters. The differences in white and black waters whistles seems to be an acoustic behavior of *S. fluviatilis* to minimize the attenuation of sound. This capacity ensures an efficient transmission of the acoustic signal and, therefore, it is relevant for the survival of tucuxi.

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Clustering of echolocation signals of Commerson's dolphins (*Cephalorhynchus commersonii*) in Ría Deseado, Argentina

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Commerson's dolphins (*Cephalorhynchus commersonii*) inhabit coastal waters of Southern Patagonia, Argentina. Recently, Reyes et al. (2015) described different echolocation signals, including on- and off-axis signals, recorded from Commerson's dolphins in the wild in Bahía San Julián, Santa Cruz province, Argentina. This study describes echolocation signals from free-ranging Commerson's dolphins in Ría Deseado, Santa Cruz province, Argentina. Signal parameters were calculated and a k-means cluster analysis was made on 4,917 regular narrow-band high- frequency (NBHF) clicks. Three clusters were obtained based on peak frequency (129, 135, and 168 kHz) and 3 dB bandwidth (10, 8, and 8 kHz), similar to previous findings in Bahía San Julián (Reyes et al. 2015). We found a ratio of 1:8 of NBHF clicks with peak frequency higher than 150 kHz related to clicks with peak frequency below 150 kHz (HF/LF ratio), which did not differ significantly with the ratio in Bahía San Julián ($\chi 2=2.6719$, $p=0.1$). Although the observed variability in echolocation signals may be a result of animals at several distances and orientations to the recording device, consistency in clusters and HF/LF ratios between the two study areas, suggests that this information could be useful while doing passive acoustic monitoring on this species in Argentina. However, the distribution of clusters varied among recordings with different noise levels, with the HF/LF ratio in recordings with higher noise levels being doubled the HF/LF ratio in recordings with lower noise levels. This could be a result of animals trying to avoid masking of clicks when noise levels increase.

Variations in calls of killer whales (*Orcinus orca*) from the western south atlantic

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Killer whales are known to produce discrete call types and differences in the detailed structure of shared call types. Here we investigate and compare call parameters of two killer whale groups. Calls were recorded in two occasions during cetacean surveys aboard the R/V Atlântico Sul of the Universidade Federal do Rio Grande conducted off southern Brazil. The first encounter (BR1 group) occurred on 16th December 2012 at 30°28'S - 47°40'W, when a group of four killer whales (no adult male present) was observed harassing a group of twelve sperm whale (including at least one calf). The recording system was composed by a Cetacean Research™ C54XRS hydrophone (sampling range of 0,006 to 203kHz, +3/- 20 dB, - 185 dB re: 1V/µPa). The second encounter (BR2 group) occurred on 21st November 2014 at 32°12'S, 49°41'W, when a group of 8–9 killer whales (including 2 adult males and at least 1 juvenile) was spotted. In this case, the recording system was composed by a towed array with 3 elements Auset® (frequency response of 499Hz to 83kHz, -161dB re: 1V/µPa). Both systems were coupled to a digital Fostex® FR-2 (sampling rate of 96kHz/24bits). Spectral parameters of call lower component contour, side band and duration were extracted using Raven software. A discriminant function analysis (JMP 12 software) of the calls was performed separating the BR1 (N = 72) and BR2 (N = 32) groups (correct classification rate BR1 = 95.77% and BR2 = 91.17%) with a misclassification of 5.71%. The low frequency component of the calls was extracted using the Sound Pro routine in Matlab. Contours were compared and categorized using dynamic time-warping algorithm (vigilance = 65%) and an adaptive resonance theory (ART) neural network resulting in seven categories. The category 7 was exclusive of BR1 group (6 calls) and category 3 was exclusive of BR2 group (2 calls). Although behavioral context could influence the call types produced by the killer whales, preliminary analysis of these parameters indicate that BR1 and BR2 groups have a relative independent social structure.

BG Group And Chevron

The project was funded by BG Group and Chevron.

First description of a behavior-related vocalization in two independent blue whale populations and automatic detection possibilities

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Besides different types of songs, blue whales also produce non-song vocalizations. In some cases non-song vocalizations in other baleen whale species are related to specific behaviours. One non-song blue whale vocalization has been described for almost all blue whale populations and various interpretations on its function exist. These non-song vocalizations in blue whales are known under various names, such as; 'D' calls, 'S' calls, contact calls, downsweeps, FM downsweeps or arch sounds (herein referred to as downsweeps). Here, we describe this specific non-song vocalization for two independent blue whale populations in the context of simultaneous visual observation of behaviour. The vocalizations were recorded on the 19th of September 2001 and the 4th of September 2004 in the Gulf of St. Lawrence (Canada) and the 15th of April 2015 in the Gulf of Ancud (Chile). In all three cases groups of three blue whales close to the recording locations exhibited vigorous surface displays and chasing behaviour, while simultaneously producing variants of the non-song downsweeps (average duration of 2 seconds, frequency range of 23.6 to 96.5 Hz, average maximum power of 70.01 dB re 1 µPa). Although the southeastern Pacific and northwestern Atlantic blue whale population are genetically distinct and differ strongly in song characteristics, these populations share the described non-song vocalizations in their repertoire. This suggests that a different evolutionary process has acted on this vocalization compared to songs. Additionally, both populations seem to use the described non-song vocalizations in a similar social context. We hypothesize this type of vocalization is used for short-range social interaction between two or more individuals and compare the vocalization's characteristics with contact-calls in other species.

Further we discuss automatic detection methods, which have potential to correctly identify blue whale downsweeps in long-term passive acoustic monitoring data. Evaluating the performance of three different detection algorithms (spectrogram cross-correlation, binary point matching and contour tracking) and additional density filters, a combination of a binary point matching detection algorithm with a density filter seems to outperform alternative analysis methods (contour tracking: low efficiency at slow computation speed; spectrogram cross-correlation: medium efficiency).

Evolución en los patrones de canto de ballenas jorobadas (*Megaptera novaeangliae*) en las costas de Esmeraldas y Manabí Ecuador

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Evolución en los patrones de canto de ballenas jorobadas (*Megaptera novaeangliae*) en las costas de Esmeraldas y Manabí EcuadorEvolution in humpback whale (*Megaptera novaeangliae*) song patterns off the coasts of Esmeraldas and Manabí, Ecuador. Intriago, M1., Denkinger, Judith1., Garland , Ellen 2., Oña, Javier1.,1Colegio de Ciencias Biológicas y Ambientales , COCIBA, Universidad San Francisco de Quito .2School of Biology , School of Biology , University of St Andrews . Las ballenas jorobadas del Pacífico tropical este realizan migraciones anuales desde las zonas de alimentación en aguas polares a las zonas de cría y reproducción en aguas tropicales. Durante esta época de reproducción, las ballenas jorobadas machos (*Megaptera novaeangliae*) producen una demostración vocal sexual repetitiva o canto. La canción consiste en la repetición de patrones jerárquicamente organizados, que van desde sonidos cortos o unidades hasta patrones reconocibles como frases y temas.La característica más singular de la canción es que cambia gradualmente durante la época de reproducción; unidades individuales cambian en frecuencia, posición y la forma que se organizan para formar frases. Las frases cambian en la cantidad, tipo de unidades que contienen y en su patrón rítmico. A un nivel mas alto, inserción u omisión de temas enteros. En el Pacífico tropical este, pocos son los estudios realizados en bioacústica de ballenas de barbas (*Megaptera novaeangliae*). La presente investigación da a conocer la primera descripción de frases y temas de tres tipos de cantos registrados en las costas centro y norte del Ecuador y tiene como objetivo demostrar la utilidad y el valor del uso de patrones vocales como una forma de entender la transmisión cultural que existe entre diferentes poblaciones.La transcripción de cada canto fue realizada de manera auditiva y visual, a través de espectrogramas acústicos generados por Adobe Audition CC 2014 . Todas las unidades fueron codificadas y la naturaleza repetitivita de la canción permitió identificar las frases y temas. Las canciones se agruparon en base a la similitud cualitativa de sus temas y a cada tipo de canción se le asigno un color representativo para su identificación. Los tres cantos registrados en las áreas presentaron una estructura acústica con ciertas similitudes y cambios graduales a través de cada temporada reproductiva en los años 2012, 2013, 2015.

Patrón circadiano de actividad acústica del delfín chileno (*Cephalorhynchus eutropia*), utilizando un monitoreo de acústica pasiva, en una zona con intensa actividad acuícola

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El monitoreo de acústica pasiva (PAM) es una metodología no invasiva y automatizada, la cual es capaz de registrar la presencia de cetáceos a través de sus vocalizaciones, permitiendo monitorear diferentes sitios de manera simultánea, durante día y noche abarcando una amplia escala temporal. Se utilizaron detectores acústicos C-PODs, capaces de identificar clicks de ecolocalización de alta frecuencia (NBHF), como posee el delfín chileno para investigar su presencia temporal y espacial en la zona sur de la isla de Chiloé, (43°08'S 73°44'W). Cinco sitios de monitoreo fueron elegidos basado en la presencia conocida de delfines chilenos en una zona con extensos cultivos de mitílidos y salmones. El objetivo de nuestro estudio fue caracterizar el patrón de ocurrencia del delfín chileno en relación a los ritmos circadianos estacionales y varios niveles de presencia de cultivos acuícolas. Los C-PODs fueron instalados a profundidades de 12-18m en distancias entre 10 y 2000m de cultivos acuícolas para un monitoreo continuo entre Abril 2013 y 2014. Mantención de los dispositivos y recuperación de las grabaciones acústicas fueron realizados cada 3-5 meses. El programa CPOD.exe fue utilizado para identificar detecciones de trenes de clicks NBHF. Se comparó detecciones positivas por cada hora a lo largo del tiempo de estudio entre cada sitio de monitoreo utilizando modelos aditivos generalizados mixtos. Los resultados muestran que los delfines chilenos mantuvieron presencia en todos los sitios de estudio a lo largo del año pero los sitios varían en su intensidad de uso y en el ritmo acústico circadiano. Sitios con cercanía a cultivos acuícolas mostraron más presencia de delfines durante periodos de noche que de día, un patrón no observado en sitios alejados a cultivos. Es la primera vez que se ha demostrado un patrón circadiano y estacional en el uso espacial de delfín chileno y en relación a la presencia de instalaciones acuícolas. Estas observaciones tienen implicancias para el manejo espacial en relación a identificar zonas de alta importancia para pequeños cetáceos y para investigar sus interacciones con cultivos acuícolas. PAM parece una técnica poderosa para el monitoreo de pequeños cetáceos en el sur de Chile.

Efectos de pirotecnia de año nuevo en el comportamiento del lobo marino común (*Otaria flavescens*) en el santuario de la naturaleza de cobquecura, centro sur de chile

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El uso de fuegos artificiales ha aumentado explosivamente en el mundo entero en los últimos años. No obstante, los efectos a corto y a largo plazo sobre la fauna silvestre han sido escasamente documentados. En particular, aunque focas y lobos marinos utilizan frecuentemente el borde costero para descansar, reproducirse y cuidar y alimentar a sus crías, los efectos y potenciales impactos de los fuegos artificiales en este grupo de animales no han sido evaluados. En este estudio se documentó y evaluó el potencial impacto de los fuegos artificiales en la noche de año nuevo del 2015 sobre el comportamiento y abundancia del lobo marino común (*otaria flavescens*) en la lobera reproductiva islote lobería de Cobquecura, zona centro-sur de chile. Se realizaron censos poblacionales los días 30 de diciembre a 02 de enero. asimismo, se registraron las vocalizaciones de los animales antes, durante y una vez finalizados los fuegos artificiales. Se registró una disminución marcada de la abundancia de animales, de un total de 636 individuos el 31 de diciembre a un total de 229 el 01 de enero. Asimismo, se registró un cese total de las vocalizaciones durante el evento, acompañado por un cambio brusco de comportamiento por parte de los animales. Sólo a partir de las 03:30 se registraron nuevas vocalizaciones por parte de algunos animales. Este estudio entrega la primera evidencia de un impacto de los fuegos artificiales sobre la conducta del lobo marino común. La disminución de las vocalizaciones, y particularmente el abandono de la colonia pueden tener consecuencias negativas para los animales, principalmente ocasionando quiebres de la estructura reproductiva y perturbaciones en el cuidado de las crías. Se requieren de mayores estudios para determinar si el impacto de los fuegos artificiales puede traer consecuencias negativas sobre los animales, o si estos han desarrollado mecanismos conductuales que les permitan lidiar con este tipo de perturbaciones de corto plazo.

A work in progress: Understanding the temporal variation in blue whale acoustic presence, prey abundance and oceanographic variables in the Corcovado Gulf, Patagonia, Chile

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Understanding the distribution of large whales in space and time and how their distribution is driven by environmental factors (for example, prey abundance and water masses), is fundamental for developing conservation management approaches. This understanding also provides insights into the functioning of mid- and high-latitude productive marine ecosystems where whales feed. In the mega-estuarine system of the northern Patagonian Archipelago Inner Sea, blue whales (*Balaenoptera musculus*) are known to feed seasonally (approx. January to June) on dense swarms of krill (*Euphausia vallentini*). In this area, however, the environmental factors that explain blue whale distribution are poorly understood. This study aims to tackle this knowledge gap by examining the interactions between the temporal variation in blue whales, prey abundance and oceanographic variables at a monitoring station in the Corcovado Gulf, Northern Patagonia.
Continuous data collection started in January 2016 and is projected to run until January 2017, with 3 month instrument turnovers. Passive Acoustic Monitoring (PAM) is being collected with a Wildlife Acoustics SM3M Deep Water Songmeter. Relative abundance of zooplankton was detected using the backscatter signal from a moored Acoustic Doppler Current Profiler of 307 KHz. Stratified *in situ* sampling of zooplankton is performed to validate acoustic data. Hydrographic data was registered with a Seabird CTD-25 to describe water masses structure. Preliminary observations revealed high zooplankton biomass and with vertical diurnal migration that spanned the entire water column during late March and April (ADCP data). *In situ* sampling of zooplankton highlighted the presence of euphausiids, copepods, and siphonophores. This appeared to coincide with high southeast Pacific blue whales song rates from the PAM data. We present preliminary results on coupling three months (January-April) of PAM data with environmental time series data in order to understand the factors that drive blue whale temporal (e.g. synoptic period) distribution of blue whales in the Corcovado Gulf.

Temporal variation in whistles of guyana dolhins in babitonga bay, santa catarina, brazil

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The acoustic communication is key to several cetacean species, assisting in group cohesion and maintenance of social networks. The noise pollution of aquatic environments can cause changes in the repertoire of the species, and the consequences for the population dynamics are still poorly understood. The Guyana dolphin, *Sotalia guianensis*, has a large acoustic repertoire, especially of tonal sounds of whistling type. In the Babitonga Bay there is a resident population of this species, that is considered endangered. The aim of this study was to evaluate the existence of temporal variation in the frequency of whistles of Guyana dolphin in Babitonga Bay over ten years. The acoustic acquisition was made in the years 2007, 2008, 2009 and 2016 with different digital recorders and hydrophones. Were only considered whistles up to 60000 Hz. Sonograms were generated in Avisoft- SAS Lab Pro 4.4 program and whistles were separated into two categories based on their contour (with inflections, n = 294; and uninflected, n = 2299) and analyzed the average frequency. Were performed temporal analysis considering three sets of data: A = 2007 and 2008 (n = 536); B = 2009 (n = 1301); and C = 2016 (n = 462). An average frequency of 22847 Hz to whistles with inflections was observed, with no temporal variation between years (Friedman chi-squared = 48.404, df = 2, p-value = 0.515). Moreover, the uninflected whistles presented temporal variation of average frequency among the three data sets (Friedman chi-squared = 499.832, df = 2, p-value < 0.01). The average frequencies observed were of 19177 Hz for the group A, 17375 Hz for the group B and 24892 Hz for the group C. The results show that there was increase in the average frequency of whistles of the Guyana dolphin in the last decade. Possibly this is due to the increased of the noise intensity caused by human activities, which are concentrated in the lower frequency bands.

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Automated whistle categorization of short-beaked common dolphins (*Delphinus delphis*) in western south atlantic

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The vocal repertoire of short-beaked common dolphins includes narrowband tonal whistles used mainly for communication. There is great inconsistency in relation to the categorization of whistles. Commonly, this categorization is carried manually by acousticians who group whistles in general broad categories based on the slope of the whistle fundamental frequency and the number of inflection points resulting in categories according to their perceived similarity. This method can be subjective and difficult to compare studies. Here, we propose an automated categorization of whistles contours of short-beaked common dolphins. Whistles were recorded opportunistically during cetacean surveys aboard R/V Atlântico Sul of the Universidade Federal do Rio Grande, in the South Brazilian continental shelf break. The encounter with approximately seven animals occurred on 14th May 2013 at 33°34'04.8"S – 50°54'00.0"W. The recording system was consisted of a 3-element omnidirectional hydrophone array coupled to a digital recorder (Fostex® FR-2 LE). As a first step, whistles were visually and aurally detected using Raven Pro 1.5 (DFT 1024 points, 80% overlap and Hann window 512 points) in order to create subset files containing good quality whistles (N=94). Further analysis consisted of marking up the contours with Sound Pro routine in MatLab R2013b. Then, a dynamic time-warping combined with an Adaptive Resonance Theory (ART) neural network algorithm (vigilance = 20%) was applied through ARTwarp custom routine in MatLab R2013b resulting in eight categories of which five were composed by at least 11 whistles. The category with the lowest and the greatest number of grouped whistles contained three and 21 contours respectively. Considering the wide variety of whistles types of *Delphinus delphis*, preliminary analysis shows that there are similar levels among the whistles that allow grouping them into well-defined and distinct categories.

The project was funded by BG Group and Chevron.

Description of echolocation clicks produced by amazon river dolphin (*Inia geoffrensis*) in xingu river, pará, brazil

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Inia geoffrensis is considered "endangered" by IBAMA (in Portuguese: Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis) and yet little is known about its acoustic behavior. The Xingu River, in Mato Grosso and Pará states, Brazil, is a major Amazonian rivers. The populations of Amazon river dolphin living there have never been studied and are threatened by several hydroelectric that occur in the river. Here, we describe echolocation clicks parameters recorded with a hydrophone Cetacean Research ™ C54XRS (+ 3 / - 20 dB - 185 dB re: 1V / Pa) and a digitizer board Daq/3000 Series with frequency response of 200 kHz/24 bits. As a first step, individual echolocation trains that had not overlapped were assigned to a vocalizing animal by visual inspection and detection of spectrograms using Raven Pro 1.4 (Cornell Laboratory of Ornithology), configured as DFT of 2048 samples, 60% overlap and Hamming window of 1024 points. The parameters peak frequency (PF), 3 and 10 dB bandwidth (BW3dB and BW10dB) and inter-click interval (ICI) were extracted using a custom routine in Matlab R2014a. The descriptive statistic (mean, standard deviation, maximum and minimum values) for 681 clicks analyzed was: mean PF of 45.76 ± 10.37 kHz (100.45 – 10.58 kHz), mean BW3dB of 22.35 ± 13.58 kHz (81.56 – 7.1), mean BW10dB of 62.08 ± 28.98 kHz (346.21 – 11.08 kHz) and mean ICI of 65.40 ± 34.82 ms (202.13 – 15.05 ms). The inter-click interval is dependent of the scanning behavior, since it reflects the approximate search distance of an animal and its target. Except the mean of ICI, all values were lower when compared to previous studies of Amazon river dolphin from other locations. This information is important to contribute more knowledge for this species so little studied.

LAMLA

Listening for Aquatic Mammals in Latin America

Sr. Subsecretario de Pesca y Acuicultura
Bellavista 168, piso 16, Valparaíso.

Santiago, enero 2017

Estimado Sr. Subsecretario de Pesca y Acuicultura:

En atención a que según la legislación sectorial vigente, el ámbito de la conservación y manejo de los recursos hidrobiológicos, y en particular los mamíferos marinos, se encuentra radicado en el ámbito de acción de la Subsecretaría de Pesca y Acuicultura, los que suscribimos la presente carta nos dirigimos a Ud. con la finalidad de presentarnos y ofrecer nuestra colaboración en temas de alta relevancia nacional y mutuo interés.

Somos un grupo de expertos en bioacústica de mamíferos marinos en Latinoamérica, reunidos durante un taller de especialistas llamado "Listening to Aquatic Mammals in Latin America" (LAMLA), que ocurrió a fines de noviembre del 2016 en Valparaíso durante el Congreso de la Sociedad Latín Americana de Expertos en Mamíferos Acuáticos (SOLAMAC). Nuestro enfoque de trabajo a nivel regional está dirigido al fomento de esta área de investigación desde una óptica que incluye la biología, la física, las matemáticas y la oceanografía.

En la literatura científica, se documenta un sostenido incremento en la contaminación acústica, particularmente debida al tráfico marítimo global, el que durante los últimos 50 años experimenta una tasa de crecimiento anual del 7%. En términos netos, hoy día existen tres veces más embarcaciones que hace 50 años, cuyo tonelaje es seis veces mayor.

Los mamíferos marinos habitan dentro de un paisaje sonoro, y el uso del sonido es comparable a nuestro uso del sentido de la visión. Estos animales dependen del sonido para desarrollar todos los aspectos de su ciclo de vida como la navegación, la caza, la sociabilización y la reproducción.

En el sector de Cape Cod (EEUU), se estima que durante los últimos años el espacio de comunicación de ballenas francas se ha reducido en un 80% debido al ruido de embarcaciones mayores. Así, en la literatura científica, hay cada vez más estudios que muestren un impacto negativo de altos niveles de ruido por tráfico marino sobre el comportamiento, distribución y estado de salud (medido a través de los niveles de hormonas de estrés) de los mamíferos marinos.

En este contexto, la contaminación acústica crónica que persiste en el tiempo, y sobretodo aquella proveniente de bajas frecuencias generadas por los motores de las embarcaciones mayores, puede llegar a afectar a animales que se encuentran distancias considerables de la zona de paso de tráfico. Sin embargo, ninguno de estos efectos ha sido evaluado en Chile.

En vista de lo que se sabe a nivel mundial, como grupo de expertos en bioacústica, queremos expresar nuestra preocupación sobre el proyecto de megapuerto Dominga en la Región de Coquimbo, dado el impacto que tendrá sobre el hábitat acústico de una de las zonas de mayor importancia ecológica para las ballenas y delfines, y probablemente el lugar donde más se proyecta el turismo de avistamiento de cetáceos, que atrae cada vez más visitantes nacionales e internacionales

Entendemos que la última adenda de este proyecto sufrió varios cambios y ya no contempla el uso de redes de burbujas como medida de mitigación durante la fase de construcción del megapuerto, una medida que estaba considerada inicialmente en el proyecto para mitigar el impacto acústico en los cetáceos. Por otro lado la fase operacional de este proyecto considerara el tránsito de decenas de barcos de tonelaje mayor y no existe ninguna medida para mitigar el impacto de la degradación crónica del hábitat acústico durante la fase operativa del proyecto. Conforme a lo anterior nuestro grupo considera que la cuantificación, monitoreo y diseño de

medidas de mitigación son aspectos claves que deben ser considerados para abordar los efectos de la degradación del hábitat acústico y espacio de comunicación de los cetáceos de Punta de Choros y de Chañaral de Aceituno, particularmente sobre la ballena fin, la ballena azul y el delfín nariz de botella, entre otras especies de cetáceos emblemáticos y vulnerables.

Las características particulares de la zona, así como la trayectoria actual y las proyecciones de la actividad de avistamiento de cetáceos en Punta de Choros y Chañaral de Aceituno indica que este sector podría transformarse en uno de los mejores sitios turísticos de "whale watching" en el mundo, tales como Puerto Madryn en Argentina y Kaikoura en Nueva Zelanda.

En el contexto anterior, nos permitimos manifestar a Ud. nuestro interés en colaborar de forma concreta con nuestros conocimientos y experiencia, para desarrollar capacidades de respuesta en el diseño de recomendaciones que propendan hacia la mitigación de los efectos de este tipo de proyectos sobre sobre el medio marino costero y en particular sobre la conservación de los cetáceos. Como grupo, estaremos muy dispuestos a prestar esta colaboración de la forma en que Ud. estime pertinente.

Delegamos a la Dra. Susannah Buchan, la vocera de nuestro grupo LAMLA y presidenta de la reunión de noviembre (lista de participantes adjunta), para efectos de las coordinaciones y acercamientos que sean necesarios sostener.

Muy atentamente,

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