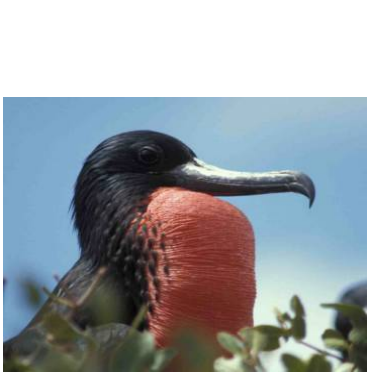
Laguna San Ignacio
Ecosystem Science Program: 2007 Report







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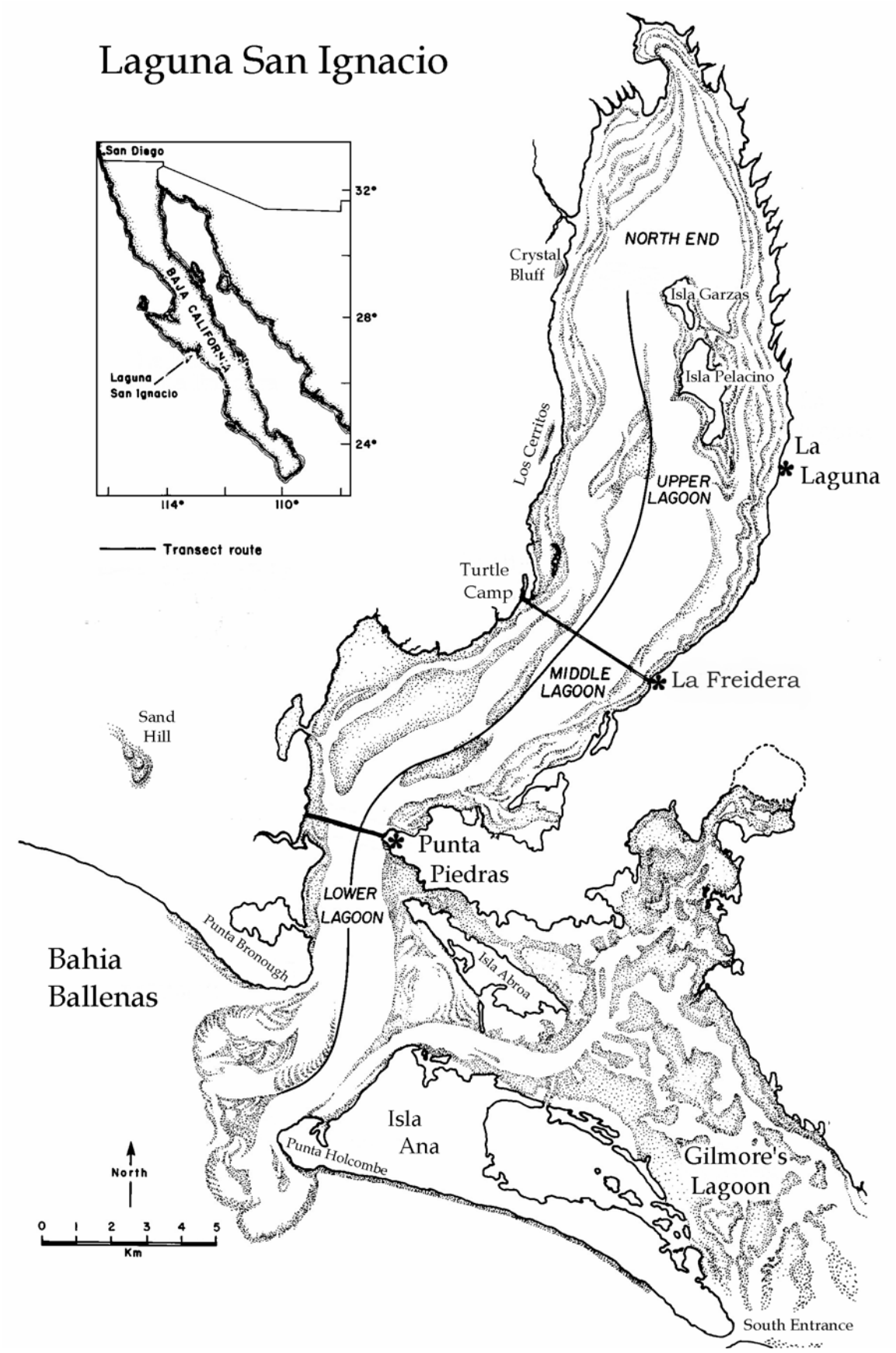
Laguna San Ignacio
San Diego
32°
28°
24°
114°
110°
BAJA CALIFORNIA
Laguna San Ignacio
Transect route
NORTH END
Crystal Bluff
Isla Garzas
Isla Pelacino
Los Cerritos
UPPER LAGOON
La Laguna
Turtle Camp
MIDDLE LAGOON
La Freidera
Sand Hill
Punta Piedras
LOWER LAGOON
Punta Bronough
Isla Abroa
Bahia Ballenas
Isla Ana
Punta Holcombe
Gilmore's Lagoon
South Entrance
North
0 1 2 3 4 5
Km

VISION, MISSION, & STRATEGY

It is the ***Vision*** of the Laguna San Ignacio ecosystem science program to support the maintenance of a marine protected area that hosts sustained, low-impact, environmentally friendly eco-tourism and fishing operations for the economic and social benefit of the local communities, Mexico, and to benefit the wildlife that depend on this unique coastal marine ecosystem. Achieving this vision requires a scientific basis for management.

It is the ***Mission*** and long-term ***Goal*** of the Laguna San Ignacio ecosystem science program to develop and implement a multi-year, sustained ecosystem science program that provides wildlife and land managers and developers with information on the status and trends of the Laguna San Ignacio Wetlands Complex (LSIWC). Research and monitoring projects provide information to address complex ecosystem issues at scales appropriate to management questions, and that recognize the natural and human-related mechanisms affecting the ecosystem. Such science based information is fundamental to evaluate development and conservation alternatives and options, and to assess the outcome of management and conservation measures implemented to determine if they achieve their intended purposes.

The ***Strategy*** for the Laguna San Ignacio ecosystem science program begins with pilot studies that build on the results of former and existing research and monitoring programs (*e.g.*, gray whale monitoring); expands the program to include biological and physical components of the ecosystem (*e.g.*, turtles, fisheries, whale-watching, water quality & productivity, *etc*.); provides academic employment and training for graduate students interested in careers in wildlife conservation science; and provides a forum for local fishermen, businesses, and residents to contribute their observations and information to the overall knowledge base for the lagoon and surrounding region. Research findings and information are made available in published reports, at workshops and symposia, and on the Program's internet web-site.

INTRODUCTION

This report presents the initial findings and conclusions from the 2007 winter monitoring and assessment activities at Laguna San Ignacio in three chapters: 1. Research and monitoring for gray whales during their winter breeding season, 2. the first ever benthic fauna surveys and inventory development, and 3. acoustic studies of gray whale sounds and ambient natural and human made noise in the lagoon.

The Ecosystem Science Program for the Laguna San Ignacio Wetland Complex (LSIWC) is based on fundamental environmental monitoring requirements, principles, needs, and approaches over the long-term (Swartz and Hofman 1991). Research and monitoring activities address the specific information requirements of the LSIWC resource managers to provide information relevant to concerns about the long-term status of the San Ignacio wetlands ecosystem and its ability to support sustained eco-tourism, fishing, and local habitation, while continuing to provide a viable habitat for the marine species that occupy the lagoon. Scientific activities build on existing baseline information and, where none exists, establishes observing programs that will develop baseline values for comparative analysis in future years.

The Program's content, findings, and conclusions are presented each year to independent subject experts at peer review workshops held after each field season. These experts provide feedback and recommendations on the: (a) appropriateness of research and monitoring methods; (b) adequacy of the planned monitoring

effort; (c) reliability of survey and behavioral observation data; (d) appropriateness of statistical and other procedures used to analyze data; and (e) validity of the Program's results and conclusions drawn from them. Representatives of the responsible regulatory agencies, affected industry, resident groups, and interested environmental organizations (e.g., stakeholders) participate in these workshops.

PROJECT BACKGROUND

Eastern North Pacific gray whales are the "charismatic mega-fauna" that attract thousands of whale-watchers to Laguna San Ignacio, Baja California Sur, Mexico each winter, and it is the gray whales that form the basis of a thriving eco-tourism industry in this coastal lagoon along the Pacific coast of Baja California. Following their depletion from the whaling industry in the nineteenth century, the eastern North Pacific population of gray whales recovered from a few thousand whales (Reilly, 1984) to an estimated 26,000 animals by the mid 1990's, and currently are estimated to number 18,000 (Rugh *et al*. 2005).

Eastern North Pacific gray whales were removed from the Endangered Species List in 1997, and as such, they represent a conservation success for a previously endangered species. However, with the gray whales' recovery and popularity come new challenges and potential threats from natural (e.g., climate change) and human sources (e.g., ecotourism and development) (Wild Coast, 2006). Detecting and evaluating changes in the gray whales' and other marine wildlife's use of their lagoon habitat requires an understanding of factors that affect these species both inside and outside of the LSIWC and that are insufficiently monitored currently.

For example, from 1978 to 1982, approximately 300-400 adult gray whales were counted each February compared to an average of 204 whales for the period 1996 to 2001, suggesting a 30% decrease (Urban, *et al*. 2001). This trend of declining winter whale counts have continued through 2007 (S. Swartz, *pers. comm*.). Unfortunately there are no data available on gray whale abundance in Laguna San

Ignacio for the period from 1983 to 1995 to suggest likely causes of this decline. No field studies were conducted during those years, although levels of whale-watching tourism and commercial fishing continued to increase within the lagoon. While there is no direct explanation for the decrease in the use of the lagoon by the gray whales, physical changes in the lagoon's characteristics and increased levels of human activities within the lagoon may provide some clues.

Commercial fisheries for fin-fish, lobster, and shellfish grew un-restrained in the 1970′s and 1980′s only to economically collapse in the 1990′s with the depletion of the primary shell-fish species being harvested (Young, 1999). During this period significant amounts of shellfish e.g., Pacific calico scallops (*Argopecten circularis*), pismo clams (*Tivela stultorum*), hatchet clams (*Pinna spp. & Atrina spp.*), and other bivalves were commercially harvested from the lagoon's eel-grass beds (e.g., *Zostera marina*) and sand flats (Young, 1999). Before they collapsed, these

fisheries removed millions of tons of bivalves from the lagoon as evidenced by acres and acres of shell piles (middens) that liter the desert shore of the lagoon today. These filter feeding bi-valves excrete nitrogen and phosphorous which are nutrients for marine plants from the smallest phytoplankton that form the basis of the marine food chain, to the macro-algae and marine grasses (Peterson and Heck, 1999; Ganter, 2000). The removal of these suspension feeders also removed this source of nutrients from the lagoon's waters, nutrients utilized by the lagoon's marine plants. Before the bi-valve fisheries collapsed, the dominant marine plant in the lagoon was eel-grass. But today eel-grass density is noticeably reduced, along with reductions of Pacific black brant geese (*Branta bernicla*) and surf scoters (*Melanitta perspicillata*) that migrate to the lagoon to feed on the eel-grass (Gantner 2000; S. Swartz; *pers.observation*). One can only wonder if the reduction in water-fowl is linked to the reduction in eelgrass, and that possibly linked to the reduction of the lagoon's bi-valve communities.

Changes in the regular patterns of marine life using Laguna San Ignacio as a winter habitat appear linked to larger climatic changes taking place in the Pacific basin. Most dramatic are ocean warming associated with "El Niño Southern Oscillation" (ENSO) and ocean cooling of "La Niña" events (Dever and Winant ,2002). ENSO events have occurred on 2 to 7 year periods and have had a variety of effects on feeding and reproduction in marine wildlife populations (Fiedler, 2002), and on the gray whales' migration and survival (Urban R.J., Gómez-Gallardo U. and Ludwig, 2003). A significant warming trend occurred in the North Pacific between 1997 and 1998. The following year began a two year period of unusually high mortality of gray whale calves and adults throughout their range, which was believed to be associated with lack of sufficient food (Le Boeuf *et al*. 2000). Significant changes in the timing of the whales' occupation of its winter breeding

lagoons and abundance in Baja California were associated with this mortality event (Urban R., Gómez-Gallardo U. and Ludwig, 2003).

Perhaps the most noticeable human activity in the lagoon each winter is whale-watching tourism. Driven in part by the "Friendly Whale" phenomenon, the whale-watching tourism industry has grown in the lagoon since the mid-1980´s and offer visitors a wildlife experience that is unique in the world. Laguna San Ignacio now hosts eight commercial whale-watching "camps" on its shores that operate from January through April each year. These programs strive to be examples of "sustainable eco-tourism" that strike a balance between human visitation and ecosystem conservation. Visitors receive educational information on the lagoon and on gray whales, and the number of whale-watching boats allowed on the lagoon at any one time is limited by permit.

Despite these positive attributes, the water-borne noise and disturbance associated with whale-watching must be considered with regard to the gray whales' continued use of the lagoon as a habitat necessary for breeding, giving birth to and rearing their calves at this critical time in their life-cycle. Like the commercial fisheries, eco-tourism operators are feeling competition for "whale

resources" (Young, 1999). There is an ongoing concern about the impact of whale-watching activities on the whales. Local tour-boat operators and lagoon resource managers need to address questions such as: what is the number of whale-watching excursions that can be tolerated by the whales?; what are the best approach methods and speeds that minimize disturbance to the whales?; and what constitutes harassment from whale-watching boats? Without information to address these and other concerns the continued growth of the eco-tourism industry in response to public demand and competition could cause the whales to abandon the lagoon, and diminish the lagoon habitat and the quality of the "wilderness experience" that is the foundation for eco-tourism in the lagoon.

For the time being, the management efforts and programs at Laguna San Ignacio are demonstrating to the world that eco-tourism can be self-sustaining, has tangible social and economic value to the local community, contributes to

protection of environmental quality, and provides society with a unique wildlife experience through "hands-on" education.

It is the intent of the Laguna San Ignacio Ecosystem Science Program to provide an interpretation of changing trends in the numbers of whales and other marine life that use the lagoon during periods of environmental change, commercial fishing, and the development of ecotourism based whale-watching. Analysis of the factors and mechanisms that influence the winter-time use of Laguna San Ignacio needs to be based on reliable scientific information gathered within the LSIWC. The conclusions drawn from the science must consider the context of external factors that affect migratory species such as gray whales in other portions of their range (e.g., reduction of arctic sea-ice and warming of the Bering Sea: Grebmeir *et al*. 2006), and include the insight of local knowledge from fishermen, eco-tour panga operators, and the local community that work and reside at the lagoon all year.

The Ecosystem Science Program monitors relevant indicators of the status of the Laguna San Ignacio ecosystem. These indicators include:

- Trends in the seasonal use of the lagoon by gray whales and other living marine resources (*e.g*., other apex predators like bottlenose dolphin (*Tursiops truncatus*), sea turtles, and sealions (*Zalophus californianus*));
- The dynamics of the lagoon's oceanographic characteristics (e.g., water quality, salinity, temperature, mixing and tidal exchange); and
- Human activities (e.g., eco-tourism and fishing) that occur within and outside the lagoon.

Analyses of future changes within the Laguna San Ignacio ecosystem are fundamental to the management of human activities if they are to continue on a

sustained basis without resulting in long-term irreversible impacts on the flora and fauna of the LSIWC. And, fundamental to these analyses are ongoing scientific monitoring of natural and anthropogenic events within the complex.

OBJETIVES

Winter 2007

A range of scientific research and monitoring field activities were pursued during the 2007 winter season in Laguna San Ignacio. These activities continued to build upon previous research and monitoring of specific species (e.g., gray whales) in the lagoon, and also brought additional investigations that complement ongoing studies. The 2007 scientific activities included counts of gray whales and other marine mammals (*e.g.*, bottlenose dolphin and sealions), surveys and inventory of the benthic invertebrate faunal communities within the lagoon, and research on gray whale sounds and the ambient natural and human made underwater noise within the lagoon.

Long-Term Objective

It is hoped that each winter additional scientific investigations will be added to the program to broaden the scope and duration of the studies that will make up the *"**ecosystem approach**"* for studying and monitoring this unique wildlife area. While this program will initially center on the winter occupation of the lagoon by gray whales, it is the intent of the investigators that over time the science program will include monitoring of a range of marine wildlife throughout the year-winter, spring, summer, and fall. The LSIWC science program is expected to grow incrementally in phases as funding and scientific expertise in specific ecological disciplines becomes

available. Future investigations will include sea turtle monitoring and assessment, marine birds and waterfowl population and habitat evaluation, and documenting the oceanographic characteristics of the lagoon (e.g., water quality and primary productivity).

CHAPTER ONE:
GRAY WHALES STUDIES

REPORT OF THE 2007 GRAY WHALE STUDIES AT LAGUNA SAN IGNACIO B.C.S. MEXICO

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ABSTRACT

Laguna San Ignacio is located in the west coast of Mexico's Baja California Peninsula and it is one of the four main calving-breeding lagoons of the eastern North Pacific gray whale (*Eschrichtius robustus*). First results are presented for the 2007 gray whale winter research season, and include: abundance estimates, density and distribution of the whales within this lagoon, photographic identification studies, and observations of "skinny" whales. Twelve complete census surveys of the lagoon were conducted from February 5 to March 30, 2007. These boat surveys followed a standard survey transect and methodology to determine minimum whale abundance and distribution, and to allow comparisons with historical surveys conducted during the periods of peak whale abundance in February between 1978 to 2006. The maximum count of adult whales was 217 on 22 February (197 "single" whales and 20 cows with calves). The highest count of single whales was 197 and occurred on 22 February, and the highest cow-calf pairs count was 37 on 17 February. The high count of adult whales was 46% less than the highest recorded count of 407 adult whales on 14 February 1982, and occurred later in the season than 10 of the previous February highest count surveys suggesting a continuing decline in the number of whales utilizing this lagoon and a delay and shortening of the winter occupation of the lagoon by whales. Counts of female calf pairs also demonstrated declines from 137 pairs counted on 14 February 1982 to 37 pairs on 17 February 2007, or a decline of 73%. These findings could reflect the overall decline in the eastern North Pacific population and/or a differential use of the San Ignacio lagoon compared to other breeding lagoons and coastal areas during the winter. The distribution of whales within the lagoon at the time of the maximum adult whale count was: 63% in the lower zone nearest the entrance, 30% in the middle zone and 7% in the upper zone furthest from the entrance. This represents a change in the utilization of the lagoon since the highest historical count in 1982 when 50% of the whale utilized the lower zone, 16% used the middle zone, and 34% utilized the

upper zone. This change in distribution is largely the result of fewer females with calves observed in the lagoon at the peak of the season. From 615 photo-identified whales, 453 were single whales, 137 cows with calves, and 25 undetermined; there were 200 recaptured whales, 111 of cows with calves and only 80 of solitary whales. The longest period between re-captures was 37 days from a cow with calve. A calving interval of 2.48 $\pm$ SD 0.607 years was estimated for females during the period 1996 to 2000 from photographic identification data, and suggests that females are reproducing less frequently than in the past. Of those 615 individual whales photographed, 12.35% showed evidence of the "skinny whale" syndrome.

See the attached full report.

CHAPTER TWO:
BENTIC ENVIRONMENT STUDIES

PRELIMINARY REPORT OF THE EPIBENTHIC AND BENTHIC ENVIRONMENT OF SAN IGNACIO LAGOON.

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ABSTRACT

Monitoring of invertebrate species composition and spatial patterns in the epibenthic vegetation can help to detect and mitigate impacts anthropogenic activities and large-scale environmental change. Here we present the preliminary results of an initial assessment of the epibenthic and benthic community in San Ignacio Lagoon, within the Vizcaino Biosphere Reserve. In 2006 and 2007 we obtained benthic ponar grab samples from 44 and 67 sites and also recorded video clips of the epibenthic environment at 44 and 255 sites using an underwater camera throughout the lagoon. Seagrass (*Zostera marina*), algae and sea pens (Order: Pennatulacea) were detected in 34, 55 and 15 % of the 255 epibenthic videos in 2007. However in both years we observed few correlations between physical parameters, epibenthic vegetation and invertebrate densities. Non-parametric, univariate statistical analyses indicated that mollusk density was higher in areas with eel grass in 2006 and mollusks were more abundant in northern sections of the lagoon. In 2006 annelid density appeared to be higher in substrates with a high proportion of shells and in 2007 worms and echinoderms were more likely to be observed in muddy substrate. When we conducted a multivariate principle components analysis, three components were extracted from our twelve variables that characterized the physical and biological conditions at the sea floor. These three components accounted for 73 and 58 % of the overall variability in twelve variables in 2006 and 2007. In 2006 a total of 11 different phyla were found in invertebrate samples and the most numerous taxa were echinoderms. Future areas of research and approaches to improve our methods are discussed.

See the attached full report.

CHAPTER THREE: ACOUSTIC STUDIES

Summary Report of Acoustic Measurements in San Ignacio Lagoon, Winter Season, 2007

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ABSTRACT

Continuing the successful collaboration of the past two years, scientists from Scripps Institution of Oceanography (SIO) at the University of California San Diego (UCSD) participated in this year's scientific field season at Laguna San Ignacio, Baja California Sur, Mexico. Complementing the work performed by our partners, the focus of our study remains the acoustics of gray whales and the propagation of these sounds in the lagoon waters. During 2005 and 2006, procedures were developed and tested to create underwater acoustic stations using autonomous sensors. These instruments are based on Greeneridge Inc.'s "Bio-probe" tags. The core electronics' motherboard, four AAA batteries and a 1Gb flash memory chip are fitted inside a transparent acrylic pressure casing of dimensions 25cm in length and 5cm in radius. Sealing is applied by two greased O-rings around a Delrin plug, connected to an HTI-96-MIN hydrophone. Data collected includes channels for acoustics, local pressure, temperature, acceleration in two axes and a file log. Communication with the instrument is achieved through infrared transfer from a handheld PDA. Custom commanding software called BProber allows the selection of sampling frequency (between 100Hz and 20kHz) and parameters such as duty cycle, gain and wake time. Using these building blocks, array stations were assembled by attaching a number of the recorders to propyl rope in particular spacing intervals, as to target specific frequencies, creating an "insta-array". Each array station is positioned horizontally on the lagoon bottom, under a water column of about 10m by means of mushroom anchors and grapple hooks on the extremes and a recovery line of length twice the water column connects to a marker buoy on the surface. From February 12th, we were able to deploy our equipment on four occasions. The first deployment was a 4-day dummy-test, where no instruments were attached to the buoy line, though located at the precise experimental site. This test allowed us to observe general current and wind behaviors; a precaution in case of loss of sight with the station. The remaining three deployments included one instrument labeled "Lucy". Because only one instrument was available, no tracking/localization work will be performed with this dataset, but it will serve to monitor vocal cycles and changes in background noise. The station was visited by boat daily and asked the driver to perform circular patters around the buoy, as to generate a known,

directional sound. This exercise allows us to correct the internal clock for drift when the data analysis stage comes. Upon arrival into San Diego, the instrument's memory was downloaded and backed-up. All three instrument deployments proved successful. A total of 145:14:57 hours was recorded. Preliminary analysis of the dataset has been performed and histograms of vocal activity in time have been created and compared to previous years.

See the attached full report.

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