Laguna San Ignacio
ecosystem science program
a project of The Ocean Foundation

Preliminary 2011 Summary Research Report

The 2011 winter research at Laguna San Ignacio began in mid-January and continued until early-April 2011. This year's projects and researchers contributed significantly to our goals and objectives for the Laguna San Ignacio Ecosystem Science Program (LSIESP). We want to express our thanks to our sponsors, the residents of Laguna San Ignacio, and the eco-tourism operators for their support of LSIESP researchers and students.

The 2011 Gray Whale research and monitoring Team was led by Jorge Urbán (UABCS), Steven Swartz (CRA), and Alejandro Gòmez Guallardo U. (UABCS), and included six researchers and graduate students from universities in Mexico: Sergio Martínez (UABCS), Hiram Nanduca (UNAM), Anaid Lòpez Urbán (UNAM), Jessica Robles Mercado (UABCS), Erandi Calderòn Yánez (UABCS), and Mauricio Rodríguez Alvarez (UABCS). The Acoustic Team was led by Aaron Thode and Delphine Matthias (SCRIPPS Institution of Oceanography) and included additional UCSD undergraduate and graduate students.

Gray Whale Monitoring and Assessment

After four years (2007-2010) of declining counts of Eastern North Pacific gray whales within Laguna San Ignacio, Baja California, Sur, Mexico, the number of whales utilizing this lagoon during their 2011 winter breeding season was significantly higher than that seen in recent winters. Weekly census counts of the number of whales in the lagoon began on 18 January and continued until 13 April to document the number of whales utilizing the lagoon during the winter (Table 1- below). Counts of gray whales continued to increase through January and February and reached a maximum of 320 adult whales on 26 February, representing a 60% increase above the average high counts between 2007-2010 and approaching adult whales counts observed in the 1980's (Fig. 1.).

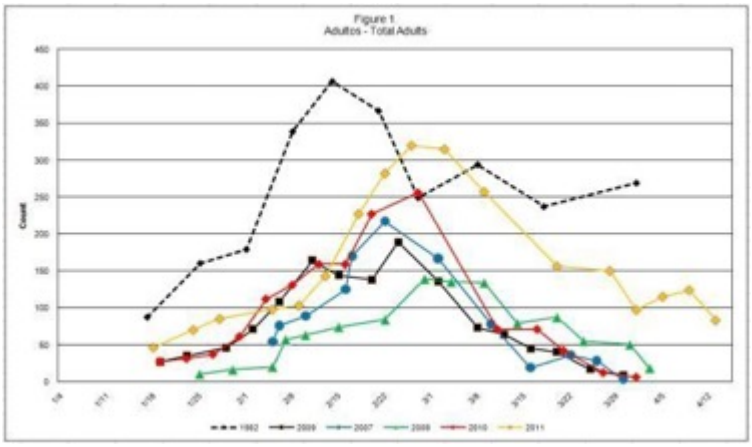

Figure 1. Counts of adult gray whales in Laguna San Ignacio from 18 January to 13 April 2011(yellow line); 1982 (black broken line); 2007 (blue line); 2008 (green line); 2009 (black line); 2010 (red line).

The number of single whales (whales not accompanied by calves) observed in 2011 reached its maximum of 261 whales on 26 February, and was similar to single whale counts obtained in the 1980's (Fig. 2.). During the period from 2007-2011 single whales do appear to arrive and to leave the lagoon 7-10 days later than during the 1980's, which corresponds to similar shifts in a later fall southward migration from the summer feeding grounds in the North Pacific and Arctic seas documented by the NOAA National Marine Fisheries Service (Laake et al. 2009).

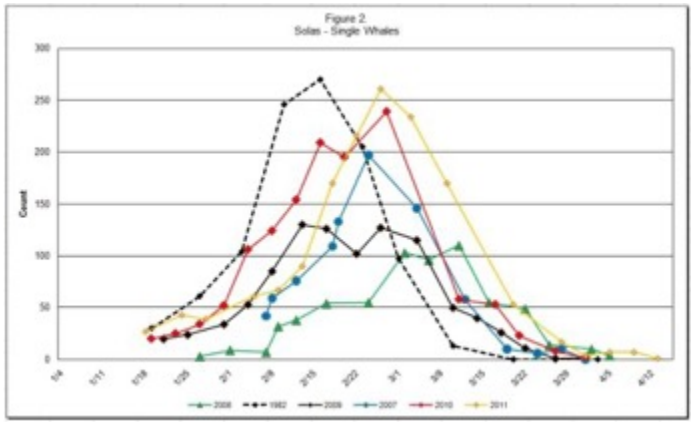

Figure 2. Counts of single (non-mother-calf pairs) gray whales in Laguna San Ignacio from 18 January to 13 April 2011(yellow line); 1982 (black broken line); 2007 (blue line); 2008 (green line); 2009 (black line); 2010 (red line).

Of particular significance was the number of female whales with newborn calves utilizing the lagoon in 2011. From 2007 to 2010 between 20 and 40 mother-calf pairs were consistently counted in Laguna San Ignacio, and numbers declined by April until no female-calf pairs remained in the lagoon. However, during the 2011 winter the number of mother-calf pairs began to increase early in the winter season, continued to increase after the maximum adult counts in late February, and reached a maximum count of 133 mother-calf pairs on 28 March. This late-season increase after the birthing period suggests that mother-calf pairs were entering the Laguna San Ignacio late in the season from other areas to the south or to the north of Laguna San Ignacio (e.g., Bahia Magdalena, Ojo de Liebre), perhaps as they begin their migration to the summer feeding range. While the overall number of mother-calf pairs in 2011 is less than the numbers observed 30-years ago, this trend of increasing counts throughout the winter represents a return to the previous pattern of late-season lagoon use by mother-calf pairs originally observed during the 1978-1982 studies conducted by Mary Lou Jones and Steven Swartz (Jones and Swartz 1984) (Fig. 3.). Preliminary discussions with the researchers that monitor gray whale abundance in the larger Laguna Ojo de Liebre to the north of Laguna San Ignacio indicate that similar increases in the number of whales, and mother-calf pairs also occurred in that lagoon during the 2011 winter (Urban et al. 2011).

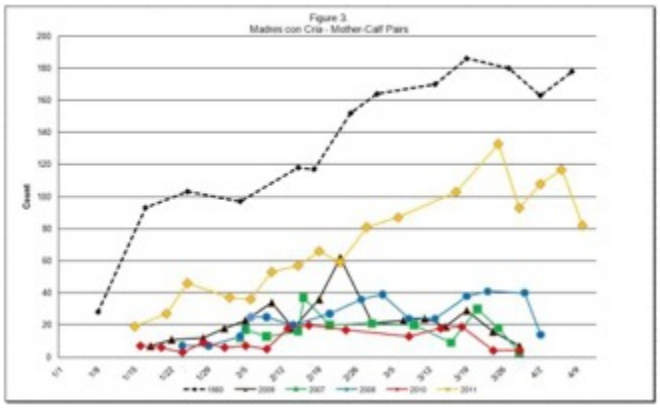

Figure 3. Counts of gray whale mother-calf pairs in Laguna San Ignacio from 18 January to 13 April 2011(yellow line); 1982 (black broken line); 2007 (blue line); 2008 (green line); 2009 (black line); 2010 (red line).

In recent years (2007-2010) most gray whales were distributed in the areas nearest to the lagoon's entrance and in the middle lagoon area, with few whales occupying the innermost northern areas of the lagoon furthest from the sea. However, in 2011 gray whales were distributed throughout the entire lagoon during the winter. Mother-calf pairs were frequently observed in the shallow areas next to Isla Garzas and Isla Pelícano in the northern portion of the lagoon, where they have not been seen in numbers in recent years. The use of the northern portion of the lagoon by mother-calf pairs in 2011 resembles the whales' distribution patterns observed during the 1978-1982 time period.

It is not clear at this time why more gray whales utilized Laguna San Ignacio in 2011 than in previous years. In general water temperature was 16-17 degrees C during most of the winter,

compared to 18-19 degrees C in a warm water year. These colder than the average temperatures or a "La Ninia" conditions, may have influenced the number of whales that entered and spent time in Laguna San Ignacio. It is possible that new breeding females are replacing those mature females that were lost during the range-wide die-off that occurred between 1998-2000 (Le Boeuf et al. 2000) and we are now seeing the increase in calf production 10 years later. LSIESP researchers also noted that the condition of the newborn calves looked very "fat", with few "skinny" whales observed during the 2011 winter (see Photo-ID below), which suggests that gray whales may be recovering from the nutritional stress that was observed following the range-wide die-off of 1998-2000.

Table 1. Counts of gray whales in Laguna San Ignacio from 18 January to 13 April 2011.

Date	Mother-Calf Pairs	Single Whales	Total Adults	Total Whales
18 Jan	19	27	46	65
24 Jan	27	43	70	97
28 Jan	46	39	85	131
5 Feb	37	61	98	135
9 Feb	36	67	103	139
13 Feb	53	90	143	196
18 Feb	57	170	227	284
22 Feb	66	215	281	347
26 Feb	59	261	320	379
3 Mar	81	234	315	396
9 Mar	87	170	257	344
20 Mar	103	53	156	259
28 Mar	133	17	150	283
1 Apr	93	4	97	190
5 Apr	108	7	115	223
13 Apr	82	1	83	165

Photographic Identification and the Archiving and Management

Photographs of individual gray whales were obtained throughout the 2011 winter season and included the left and right sides of single whales, females with calves, and calves that accompanied female whales. Individual whales were photographed during the 2011 winter season, and these included single whales and female-calf pairs. The average minimum duration of stay within the Laguna San Ignacio area was estimated from the first and last time individual whales were photographed, for singles whales for females with calves. (Results to be presented this summer).

Photographs of single whales and females with calves from 2006 to 2011 are being analyzed to estimate female calving-interval, the number of years between births of calves by a female gray whale. Calving interval is a key indicator of the reproductive health of the population. The

interval estimate from 2006-2011 data will be compared with previous estimates developed from photographs obtained during the 1978-1982 and 1996-2005 time periods to evaluate changes in the number of calves produced by female whales over time. UABCS Master's student Jessica Robles is leading this research for her Master's thesis.

Approximate 7,000 digital images of individual gray whales obtained from 2006-2010 were archived into digital catalogs. LSIESP researcher Sergio Martinez developed separate catalogs for single whales and females with their calves for each year that the photographs were obtained. Catalogs were posted on the LSIESP website (http://lsiecosystem.org/photography-id-catalogs/) to allow other researchers to review and look for matches with photographs of gray whales from other portions of the species range (e.g., Arctic, Pacific Northwest of North America, Western Pacific, etc.). Matching of photographs of whales that visited Laguna San Ignacio with photographs of the same individuals obtained from other areas will improve understanding of the migratory movements and distribution of Eastern North Pacific gray whales.

Acoustic Research

Aaron Thode and Delphine Matthias of SCRIPPS Institution of Oceanography led the gray whales acoustics research. They were assisted by Anaid Lopez U. and additional UCSD undergraduate and graduate students. In 2011 digital recording arrays were placed on the lagoon bottom at three locations to gather baseline ambient noise measurements and gray whale calls: one recorder was placed within the lower lagoon whale-watching zone, the second in a deep channel in the interior "closed" zone where no whale-watching activity occurs, and a third in the upper inner lagoon adjacent to Isla Pelícano. Recordings of gray whale calls will be analyzed for call types, and trends in calling rate that may correlate with naturally occurring biological and non-biological noise (e.g., tides, winds, snapping shrimp, & fish) and boat activity in the lagoon.

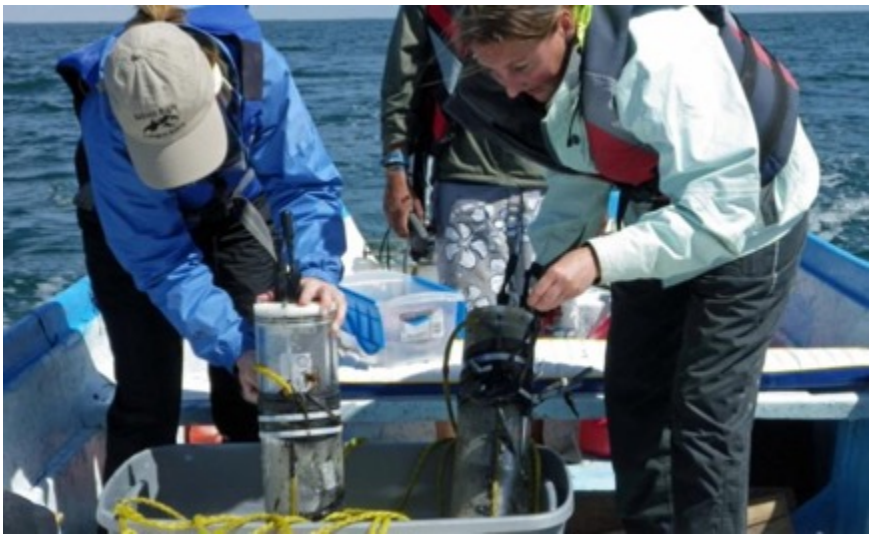

Figure 5. Acoustic Team members recover two acoustic recorders from the bottom of Laguna San Ignacio.

Acoustic recording tags were placed on individual whales using suction-cups to record underwater sounds heard by the whales (natural and man-made) and the calls made by the

whales themselves. The recorders also obtain continuous information on each whale's depth in the water, and their movements and behavior underwater. Analyses of these data will allow documentation of the noise levels within the lagoon, sounds heard by the whales, and the whale's response to underwater noise. UNAM student Anaid Lopez U. completed her Master's degree in 2010 which described gray whale call types recorded in Laguna San Ignacio, and she is continuing her research on gray whale calls in 2011-2012.

Whale-Watching Analysis

UABCS researcher Ana Liria Del Monte M. continues her studies of Eco-Tourism whale-watching for her Master's Degree. Her analysis investigates the trends of whale-watching activity in Laguna San Ignacio during the past decade in comparison with the number of gray whales that visited the lagoon each winter. When completed, her thesis will provide a historical context for assessing trends in the number of whale-watching boats that have operated in Laguna San Ignacio since 2006, and the numbers and distribution of gray whales within the lagoon during that same time period. This information will be useful for the evaluation of current whale-watching regulations and operational practices in Laguna San Ignacio. e whale-watching operations.

Ecological Function of Seagrasses in Laguna San Ignacio

Rafael Riosmena-Rodríguez, Ph.D. of the Programa de Investigación en Botánica Marina at UABCS and his students completed surveys to document and evaluate the distribution and ecological status of seagrass meadows (*Zostera marina* and *Gracilaria vermicullophyla*) and invertebrates that that occur in the lagoon. (Fig. 4 - Left).

By sampling the marine plants throughout the year, Rafael and his team have identified seasons of rapid growth of seagrass communites during the summer months and their declines during the winter months, and periods of intensive seed production during the long summer days. The specific sampling sites include representative areas within the primary lagoon and in Estero de Pitahaya south of Isla Abroa. They have also identified and documented the distribution of an invasive species (*Rupia maritime*) which is more tolerant of changes in sea temperature and salinity, and could displace the native seagrass meadows over time. By comparing historical satellite images of the lagoon with recent photos and sampling specific locations, they have determined the extent of the decline of seagrass meadows in Laguna San Ignacio over several decades.

Dr. Riosmena has researched seagrass restoration in several areas in Baja California. He is proposing to initiate some pilot seagrass restoration experiments within specific areas of Laguna San Ignacio to evaluate the potential for restoring seagrass habitats and associated invertebrate fauna in areas where these communities have declined. If funding is obtained, these pilot restoration experiments will begin in 2012.

Sea Lion Ecology in the Lagoon

Ranulfo Mayoral completed the first season of photographic-identification and monitoring of California sea lions (*Zalophus californianus*) that haul out on Isla Pelícano within the lagoon. Weekly counts of male and female sealions were made from September to December 2010 (Table 2). Sealions began to arrive on the island during the last week of September, and counts increased to a high of 123 animals (81 males and 42 females) by the end of October. Counts of sealions then declined until the animals were absent from the island by the end of November. No sealions were observed on the island after December (Table 2 - bottom).

No pups or breeding activity were observed. Ranulfo will begin investigation of diet by analyzing scats to identify specific food items and to determine if the sealions are utilizing fish and other food resources within the lagoon. Analysis of photographs of individual animals will allow the estimation of the minimum number of individual sealions that are utilizing the island as a haul-out site and that occupy the lagoon during the summer and fall each year.

Table 2. Weekly counts of sealions ((*Zalophus californianus*) on Isla Pelícano in Laguna San Ignacio.

Week	Males	Females	Total
19-25 September	0	1	1
26 Sept – 2 Oct	1	1	2
3-9 October	11	2	13
10-16 October	31	7	38
17-23 October	46	8	54
24-30 October	81	42	123
31 Oct – 6 Nov	37	12	49
7-13 November	20	6	26
14-20 November	8	1	9
21-27 November	0	0	0
28 Nov – 4 Dec	0	0	0

Avian Research and Monitoring Project

Following the discovery in 2010 that coyotes have gained access to and were killing the marine bird breeding colonies on Isla Garzas and Isla Pelícano in the lagoon, LSIESP researchers wrote and distributed a report outlining the status of the marine bird colonies and evidence for coyote predation (http://lsiecosystem.org/category/research/avian-research/).

In collaboration with The Ocean Foundation and Pro-Peninsula, LSIESP convened a special one-day "experts workshop" to discuss and evaluate options for addressing bird predation on the islands at the "Conservation Science Symposium" held in Loreto, B.C.S., Mexico from 25-28 May 2011. Invited experts included wildlife managers from Mexican government and non-government organizations and academic institutions in

Mexico and the United States. The experts discussions resulted in several recommendations for research t better understand the size and behavior of coyotes at the lagoon. Recommendations included community involvement to not encourage coyotes to visit the campgrounds, village, and the islands. See the report of this workshop on the LSIESP website this summer.

Local School Outreach and Classroom Presentations

LSIESP researchers continued their ongoing collaboration with school teachers at the Ejido Luis Echeverria School to plan classroom presentations about Laguna San Ignacio's marine life and, the importance of conserving the lagoon habitat, and the natural history of gray whales. LSIESP researchers Jessica Robles Mercado, Erandi Calderòn Yánez, and Mauricio Rodríguez Alvarez developed several classroom presentations for primary and secondary students. These included wildlife puzzles, cross-word games, and power-point presentations on various aspects of marine life and conservation of the lagoon's habitats. Following power-point presentations, the students were grouped into teams to complete puzzles and word games based on the information presented in the lectures.

In March LSIESP researchers collaborated with Ecology Project International (EPI) to host two high school groups from the town of San Ignacio to visit the lagoon, and to learn about gray whales and the methods researchers use to study them. Each group of students received background on the natural history of the gray whale, and participated in a photo-identification project to learn how individual whales can be identified by their natural markings, and to learn the methods researchers use to analyze these photographs. Students went out with LSIESP researchers to photograph gray whales. Upon returning to their camp each afternoon, LSIESP researchers worked with the students to categorize, sort and analyze their photographs, and from these data to determine the number of individual whales identified, the number of re-identifications, the number of females with calves of the year, and other information that can be derived from photo-identification data. LSIESP will continue to collaborate with EPI to develop this program for high school students and to expand the program to include students from other local communities in Baja California.

2011 Community Reunion at Laguna San Ignacio: On 5 March LSIESP researchers hosted a mini-symposium at the Kuyimeta Campground Palapa to present brief talks on the research underway at the lagoon and to discuss local concerns and issues relating to the conservation of the lagoon. There were five science presentations; "Sataus of Seagrass Communities" by Rafael Riosmena-Rodríguez; "Increases in gray whale counts in 2011" by Hiram Nanduca; "Sealion Monitoring on Isla Pelicano" by Ranulfo Mayoral; "Ecology Project International Program at Laguna San Ignacio" by Brant Warren; and "Feeding Physiology of Gray Whales" by Javier Caraveo Patiño. Approximately 70 attendees included members of the Eco-Tourism Operator's Association, Philanthropiece, the International Community Foundation, The Ocean Foundation; the Natural Resources Defense Council, the Vizcaino Biosphere Reserve, Pronatura-Noroeste, University of Siena-Italy, local school teachers and interested public.

Public Relations and Outreach: The LSIESP researchers met and discussed conservation issues and cooperation with the new Director of the Vizcaino Biosphere reserve Dra. Irma Gonzalez and her staff, and agreed to collaborate on gray whale and ecosystem monitoring and research in the future. S. Swartz was invited by NRDC to serve as the lead naturalist for Prince Albert II of Monaco during his visit to the lagoon; the Prince's interests included efforts to balance ecological stability with local development at the lagoon. LSIESP researchers met with World Wildife Fund International (WWF-International) program managers visiting the lagoon to discuss conservation of this marine protected area and the larger Vizcaino Biosphere Reserve. Interviews were conducted with Mexican television, Al Jazeera Television, and the United

Kingdom's BBC World News. LSIESP researchers provided lectures (in Spanish and English) on lagoon ecology and gray whales to several visiting Eco-Tourism groups and high school groups from Punta Abreojos and San Ignacio. J. Urban and S. Swartz convened an "experts workshop" on coyote predation of ground nesting marine bird colonies in the lagoon at the May 25-28, 2011 "Conservation Science Symposium" in Loreto, B.C.S., Mexico. Academic presentations on gray whales and other aspects of the LSIESP will be made in 2011at meetings of the Mexican Marine Mammal Society (SOMEMMA), the International Whaling Commission (May 2011), and The Society for Marine Mammalogy (November 2011). The LSIESP web-site (www.lsiecosystem.org) will be updated with 2011 project research reports. Feature articles on LSIESP research projects were featured in the publication "Mysterios, Laguna Baja Mysteries", "Pastos Marinos" by R. Riosmena in Biodiversitas, No. 93, November 2010; and "Spyhopper" Journal of the American Cetacean Society December 2010. A 1-page flyer on the LSIESP its vision and mission was produced in English and Spanish and distribute to eco-tourism visitors to the lagoon.

LSIESP Supported Students and Graduates: Anaid Lopez U. (UNAM) successfully defended her Master's Thesis on gray whale calls and lagoon acoustics in September 2010. Ana Liria Del Monte M. (UABCS) continues with her Master's studies at UABCS and is expected to graduate in 2012. Jessica Robles M. (UABCS) continues her analysis of female gray whale calving intervals by analyzing the extensive photographic data catalogs from 2007-2011 for her Master's degree at UABCS. Sergio Martinez will defend his Master's Thesis at UABCS during summer of 2011 and desires to pursue research on gray whales for a Ph.D degree. Mauricio Rodríguez Álvarez continues his analysis of changes in the distribution of gray whales for three time periods: 1978-82, 1996-2000 and 2007-2011. Hirma Nanduca completed his Ph.D. at Universidad Nacional Autonoma de Mexico (UNAM) in May 2011.

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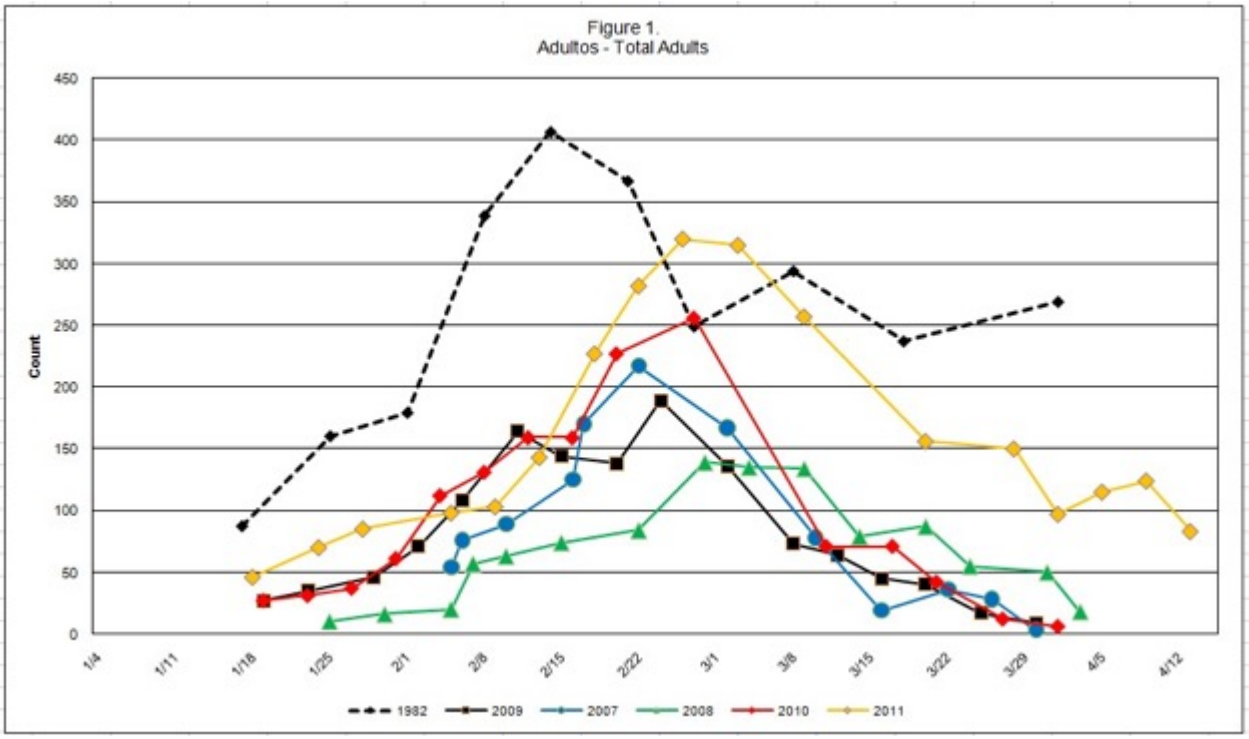

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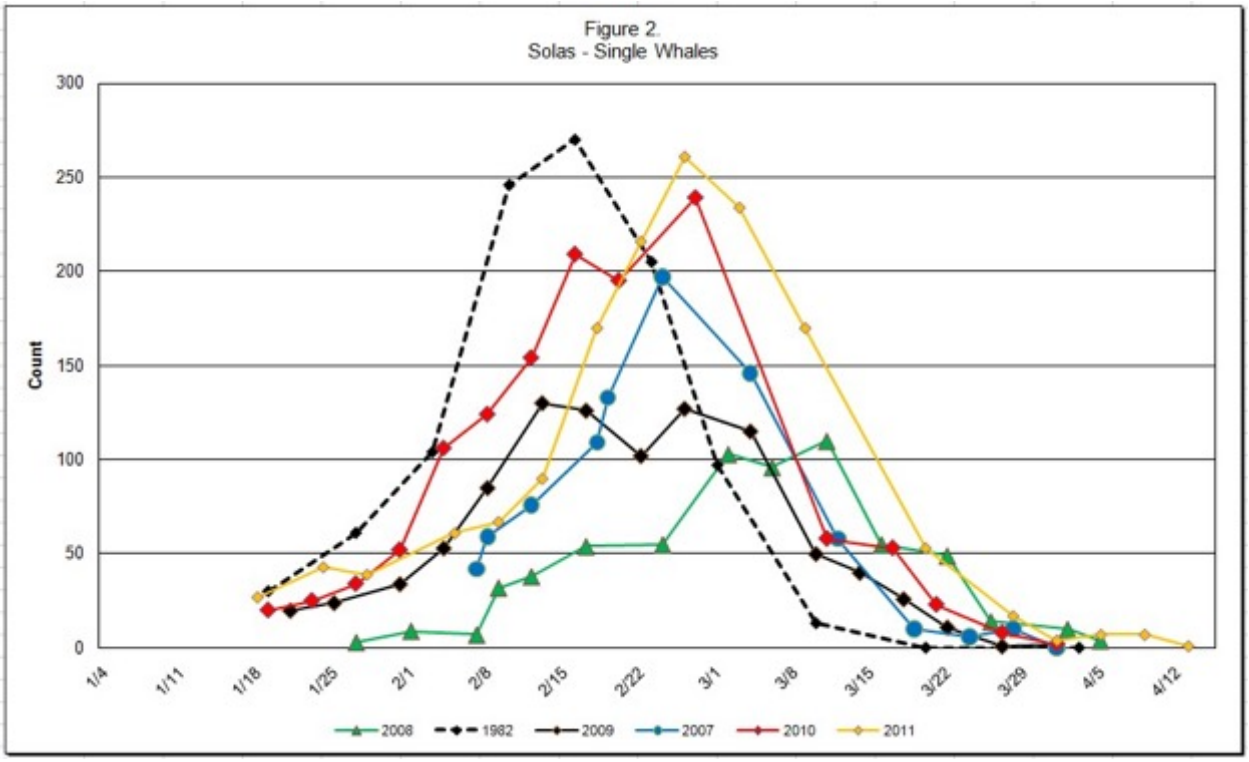

Figure 3. Counts of gray whale mother-calf pairs in Laguna San Ignacio from 18 January to 13 April 2011(yellow line); 1982 (black broken line); 2007 (blue line); 2008 (green line); 2009 (black line); 2010 (red line).

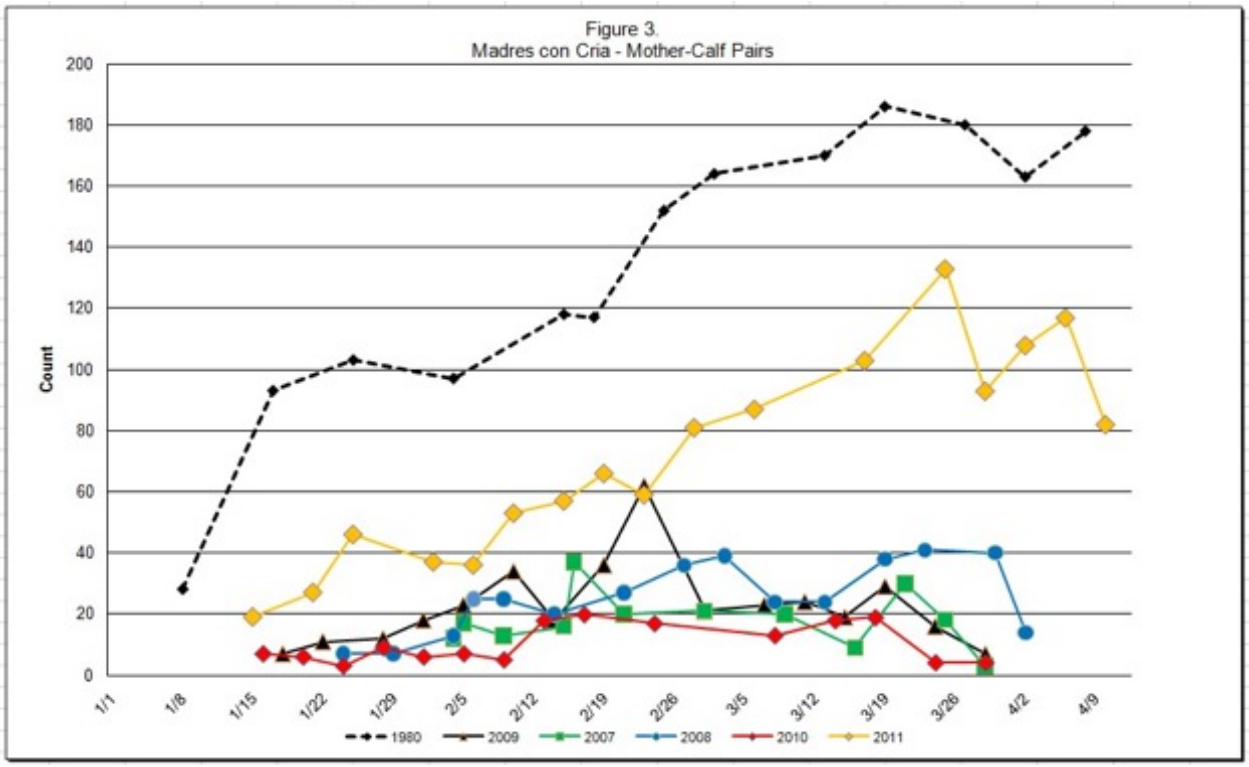
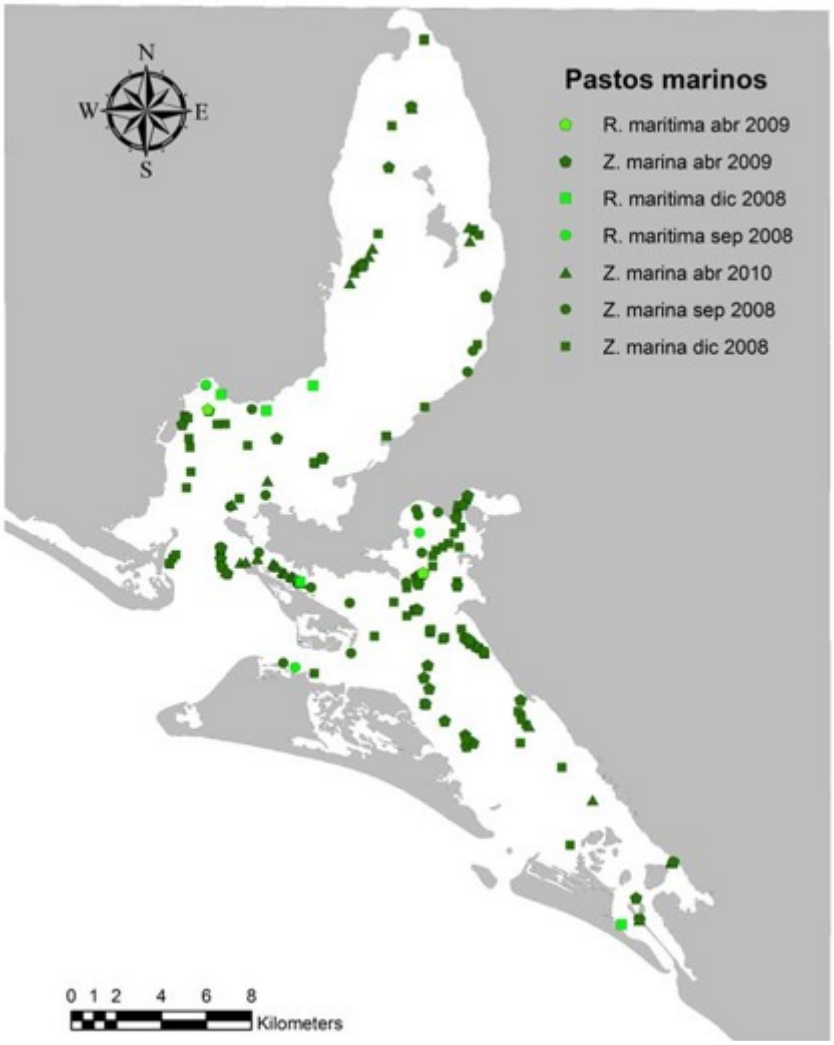
Figure 4. Distribution of seagrass meadows in Laguna San Ignacio and in Estero de Pitahaya in 2008-2009.