

Photographic Analysis of Eastern North Pacific
Gray Whale (*Eschrichtius robustus*)
Movements within the Breeding Grounds of
Baja California, Sur, Mexico

Mary Lou Jones and Steven L. Swartz
Cetacean Research Associates
14700 Springfield Road, Darnestown MD 20874
E-mail: Kabloona15@comcast.net

ABSTRACT

Photographs of individual gray whales taken between 1977 and 1982 in the breeding lagoons of Baja California were analyzed to document individual whale duration of stay in specific lagoons, and movements within the lagoons in the same year and across multiple years, and for breeding females, calving intervals during this time period. Results suggest the following lagoon use patterns for breeding females at Laguna San Ignacio:

1. Resident type-females that were present for long periods of time during calving years and for short periods of time in non-calving years;
2. Transient type-females that were seen for short periods of time late in the season (March) with an older calf that was born in some other area.
3. Combination type-females that were photographed with a calf throughout a season for a long period, as a single whale for a short period early in a season, and for a short period late in the season with an older calf.

Males and females in non-calving years were generally seen during the first few weeks of the winter breeding season and moved among the primary breeding lagoons of Baja California.

Key words: gray whale, breeding lagoon, duration of stay, photographic identification

INTRODUCTION

Laguna San Ignacio is located in the west coast of the Baja California Peninsula in Mexico and it is currently the only one of the four calving-breeding lagoons of the Eastern Pacific gray whale (*Eschrichtius robustus*) that remains mostly undeveloped. The lagoon lies within the Vizcaino Desert Biosphere Reserve, Mexico's largest refuge administered by Secretaria de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAT) (Fig. 1). This is a popular destination for recreational whale watching which began in the mid-1970s.

Detailed studies of demography and phenology of gray whales were conducted during the winter months from 1978 to 1982 (Jones and Swartz, 1984). These investigations included photographic identification based studies during the 1978-1982 winter breeding seasons to document the presence of individually recognizable whales in Laguna San Ignacio, and to identify breeding female whales and to document which winters they had given birth to calves. Similar photo-identification methods were also being used in other Baja breeding lagoons during this period, and included Laguna Gerrero Negro (P. Bryant and S. Lafferty), Laguna Ojo de Liebre (joint Mexican & US research program), Bahia Magdalena's Estero Soledad (S. Lawson), and at Yavaros and Bahia Reforma on the Sinaloa mainland coast inside the Gulf of California (T.L. Findley and O. Vidal) (Table 1). This information was used to document the presence and movement of individual whales within these breeding areas and to estimate the calving interval for adult females. The estimated calving interval for this period based on photographs of known females is reported in Jones 1990.

The objectives of the research reported here included:

1. Determining whether individual whales demonstrated site fidelity and returned annually to the same breeding lagoon each winter, which might be indicative of sub-populations of breeding whales in each of the lagoons.
2. Determine the use patterns of Laguna San Ignacio in terms of the number of days single and female-calf pairs utilized the lagoon each winter breeding season.
3. Determining if there was an exchange of whales between lagoons within a season

or during different years, because sequential depletion of each lagoon by early whalers suggested that each lagoon might support individual stocks that did not mix.

METHODS

Gray whales possess individually unique pigmentation and markings that can be used to identify and document the presence and to track the movements of specific individual whales. Photographs of individual whales were taken of both the left and right sides of the whales with 35 mm SLR cameras with 70-300 mm telephoto zoom lenses. When possible, photographs of both sides of the same individual were obtained. Any unique or outstanding scars or other conspicuous natural markings were also photographed. The best photographs from the right and left sides of each whale (for each sighting) were selected, assigned a unique sequential identification number, and archived into photographic database. Each photograph for an individual whale was coded according to the type of markings and their locations on the body (*e.g.*, unique pigmentation of the skin, mottling, scarring, and barnacles, scars, etc.). Photographs with similar markings were then compared to identify photographs of the same whale obtained during the same year or in other years (*i.e.*, matches).

Photographic effort was concentrated on whales with distinctive markings, which were easily recognized with the naked eye. Specifically, whales bearing white pigmentation or scars on the back, dorsal ridge, or the anterior portion of the peduncle were preferred because these areas were consistently visible each time the whale surfaced. Other distinctive features utilized included broken backs, wounds, and missing flukes. Fluke patterns were not photographed because the whales do not usually raise their flukes above the water surface while they are in the breeding lagoons.

Single whales included known males, females in years they were not accompanied by a calf, and immature whales. Breeding females are females known to be reproductively mature as evidenced by their being accompanied by a calf in

one or more years, although they may have been also re-sighted (matched) as single female whales in years they were in estrus and seeking mates and had not given birth to a calf.

RESULTS

Individual Whales Identified:

A total of 434 individual whales were identified from an analysis of 5,630 photographs. Of the 434 whales individual whales, 116 were re-sighted (matched) in Laguna San Ignacio in one or more years.

Of the 116 whales, 45 were matched in Laguna San Ignacio for 2-6 years; 30 were known females by the presence of a calf in one or more years; and 15 were either males, non-breeding females, or immature individuals.

Re-sightings in other lagoons:

Eighteen of the whales photographed in Laguna San Ignacio were matched with photographs taken in other breeding lagoons of Guerrero Negro, Ojo de Liebre or Baha Magdalena indicating that whales circulated among the breeding lagoons of Baja California (Table 3).

Some breeding females with were seen with calves in multiple years within Laguna San Ignacio and then were seen with calves in a different lagoon for one or more years (Table 3, Whales Nos. 4 and 5). Some breeding females visited more that one breeding lagoon with their calves within the same year (Table 3, whales Nos 11 and 12). Sightings of two known male whales were made within Laguna Ojo de Liebre and then within Laguna San Ignacio within a few days of each other, suggesting these animals were spending little time in any specific breeding area (Table 3, whales Nos. 16 and 18). Finally, one immature female was seen as a single whale in Laguna San Ignacio for five years (1977-1981) and then with a calf in Laguna Guerrero Negro (1982) indicating she had reached reproductive maturity between

1981 and 1982 at a minimum age of 6-7 years (Table 3, Whale No. 1).

Minimum Duration of Stay:

The minimum duration of stay (in days) in Laguna San Ignacio was determined from the first and last sighting/re-sighting of a whale.

Single whales: The minimum duration of stay in Laguna San Ignacio for 15 single whales (*i.e.*, males and females without calves) as determined from the first and last sighting/resighting ranged from 21-32 days. During the 6-year study period, there were 28 instances of these 15 matched single whales remaining in the lagoon at least one-week, 7 instances of staying two-weeks, one instance of a three and four-week stay, and one instance of a five-week stay in the lagoon (Fig. 2). The one-week stays in Laguna San Ignacio peaked around 1 February each year, which is consistent with the transient behavior of single whales (males and females in non-calving years) to arrive early in the breeding season and not to stay more than a week or two.

Breeding Females: The minimum duration of stay in Laguna San Ignacio for breeding females with calves ranged from 22-87 days.

The patterns of residency for breeding females in Laguna San were more complex depending on whether they were single whales (during breeding years) or accompanied by a calf (in calving years). There were three distinct peaks of re-sightings of 30 matched breeding females in Laguna San Ignacio during the 6-year study period (Fig 3).

First there were 20 instances of female whales remaining in the lagoon at least one-week (12 for one-week stays as mother-calf pairs and 8 as single whales). These stays peaked on 19 March for females with calves, and 3 February for females as singles.

There were 8 instances of 5-week stays for females peaking around 25 February, and another peak for 9-week stays around 15 February. The longest stay for a female with a calf was 13 weeks (Fig.3).

The one-week stays for "single" females peaking around 3 February each year are

consistent with the transient behavior of single-females (without calves) that arrive early in the breeding season to find mates and do not to stay more than a few weeks. The second peak of one-week stays centered around 19 March is indicative of the late-season influx of females with calves from other areas that move into Laguna San Ignacio late in the winter season and mix with females with calves that have resided in Laguna San Ignacio for most of the season. Earlier peaks of 5-week to 9-week stays are consistent with the end of the annual birthing period for gray whales and likely indicate those females that have remained within Laguna San Ignacio for most of the winter.

Durations of one-week stays for 71 breeding females with calves showed a peak of eight re-sightings during the fourth week in January, and a second greater peak of 18 re-sightings during the 3rd week of March (Fig. 4). This pattern of re-sightings indicates the initial build-up of females with calves early in the season as the calves are being born (late January -to early February), and the late season (March) increase in the number of females sighted for the first time in Laguna San Ignacio with previously born calves that moved into Laguna San Ignacio from other areas.

DISCUSSION

The re-sightings of both single whales and female whales with calves suggest that each group have different lagoon use patterns, and for breeding females their use pattern depends upon whether they are seeking mates in non-calving years or have given to a calf during the winter.

Single whales generally visit the lagoon early each winter breeding season and stay for a few days to a few weeks while they seek mating opportunities. Some singles whales, especially males, appear to circulate among the various breeding lagoons during the winter presumably looking for mating opportunities.

Breeding females generally follow the single whale pattern in non-calving years but in calving years they generally arrive at the lagoon early in the winter and remain there for up to

three months. We term this pattern as the "resident-type" where a breeding females remains with her calf in Laguna San Ignacio for several weeks but is seen in the lagoon for only a few days in non-calving years.

Some breeding females move into Laguna San Ignacio in the last weeks of the winter season with their calves which were born in other areas. We term this pattern the "transient-type." In this regard, Laguna San Ignacio seems to serve as a "staging area" prior to females beginning the spring northward migration with their calves to their summer range.

Other breeding females with calves may visit Laguna San Ignacio and then move on to other breeding lagoons, and/or circulate among different breeding lagoons among and within different years. We term this pattern as a "combination-type".

These findings do not support the suggestion that eastern North Pacific gray whales may include separate breeding sub-stocks or sub-populations that are unique to specific breeding lagoons. Future studies of the gray whales' utilization of its breeding range will need to investigate the importance of sub-regions within the breeding range, whether various areas are used at random or in succession, and what proportion of the whales return regularly to specific locations within the breeding range. Future research should investigate which use-strategy is most successful for a female's reproduction: returning to the same area in which conception has been successful, or moving about as changing environmental conditions may dictate to ensure successful reproduction and the best opportunities for calf survival.

LITERATURE CITED

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FIGURE CAPTIONS

Figure 1. Study site: San Ignacio Lagoon and El Vizcaino Biosphere Reserve.

Figure 2. Durations of stay in weeks for 15 re-sighted single whales in Laguna San Ignacio. Date indicates the average date for those durations.

Figure 3. Durations of stay in weeks for 30 re-sighted breeding female whales in Laguna San Ignacio during calving years (white bars) and as single whales in non-calving years (black bars). Dates indicate the average dates for those durations.

Figure 4. Durations of stay of one week or less by month for 71 identified breeding females with calves.

Figure 1. Location of Laguna San Ignacio in the Vizcaino Biosphere Reserve of Baja California, Sur., Mexico.

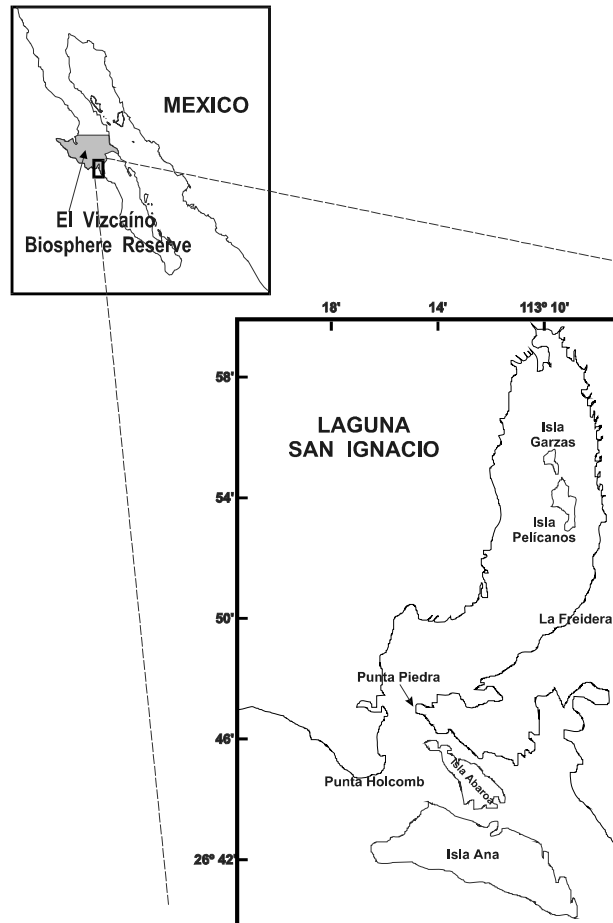


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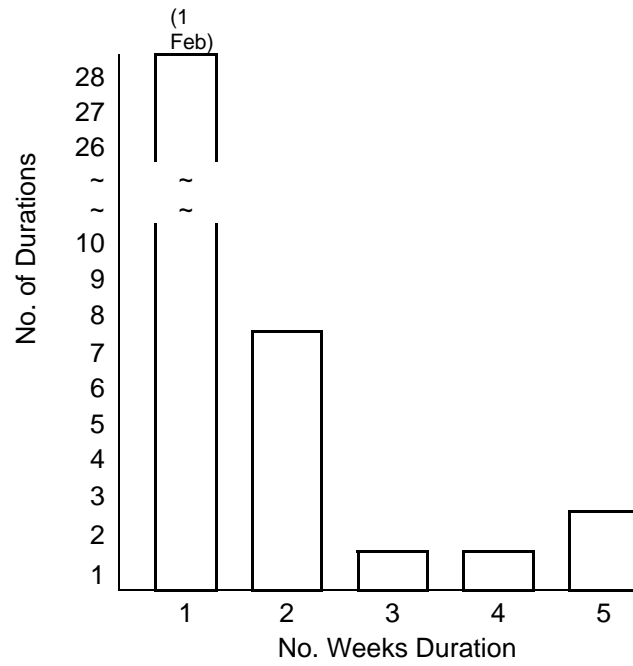


Figure 3. Durations of stay in weeks for 30 re-sighted breeding female whales in Laguna San Ignacio during calving years (white bars) and as single whales in non-calving years (black bars). Dates indicate the average dates for those durations.

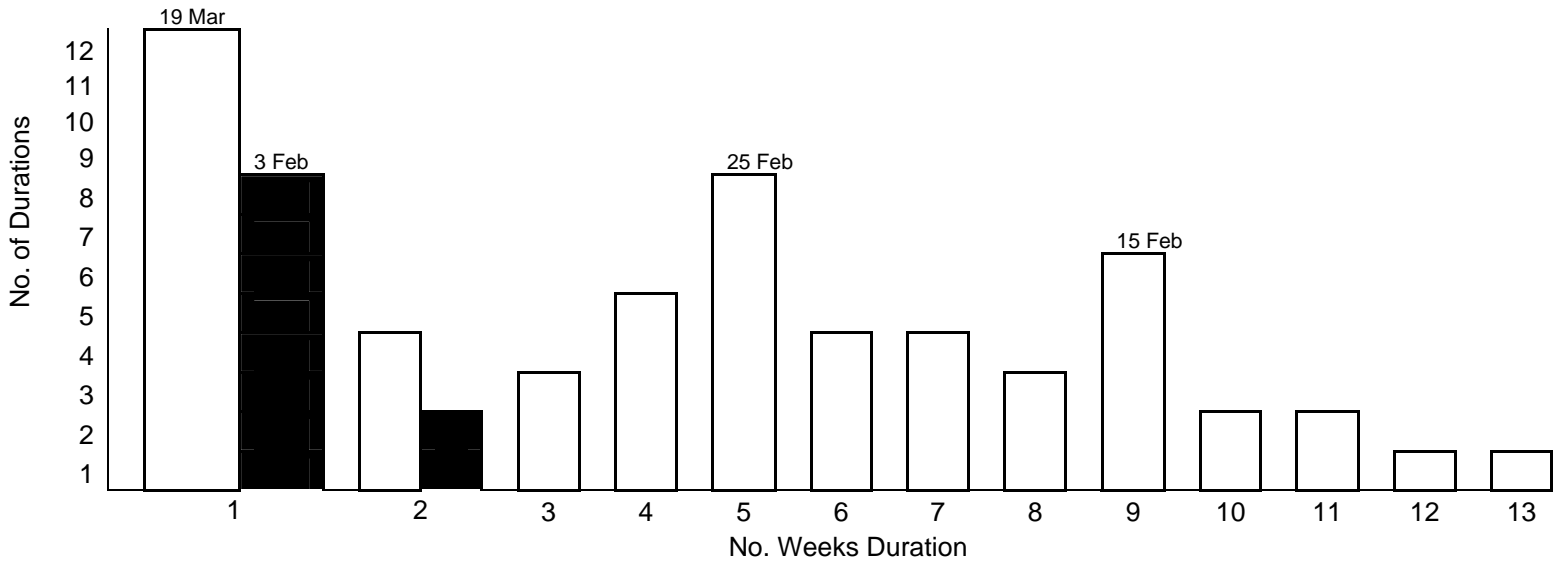
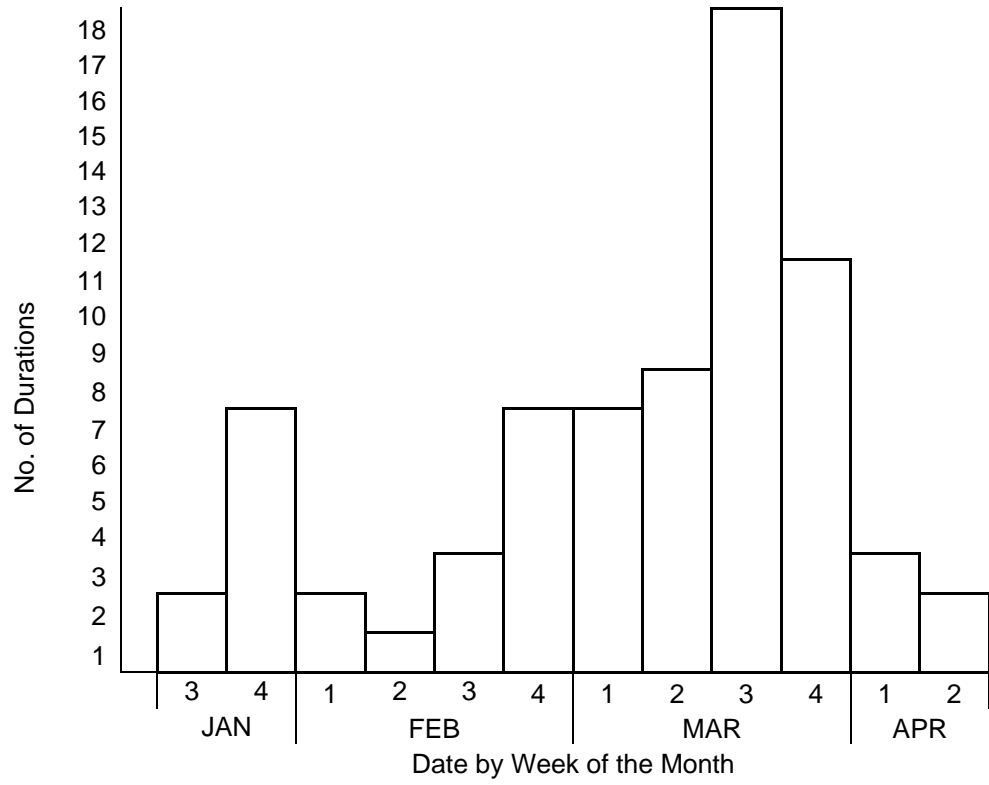


Figure 4. Durations of stay of one week or less by month for 71 identified breeding females with calves.



Jones & Swartz - Gray Whale Photo-ID - Movement

Table 1. Photographic identification collections which were compared to the Laguna San Ignacio catalogue of 434 whales to determine if gray whales change assembly areas in the winter ground in successive years and within the same year.

Locality	No. Whales Identified ^a	No. Matches with San Ignacio Whales	Years Photos Were Taken	Reference and Holder of Photo Collection
Laguna Guerrero Negro	403 to 701	3	1980-1982	Bryant & Lafferty U.C. Irvine ^b
Laguna Ojo de Liebre	56 to 112	4	1980, 1981	Anonymous, NMFS National Marine Mammal Laboratory
Bhaia magdalena (Estero Soledad)	200	11	1982	Lawson, U.C. Irvine ^c
Yavaros, Sonora & Bahia Reforma, Sinaloa, Mexico	8	0	1981-1982	Findley & Vidal, Inst. Tech. Super. De Monterey, Guaymas, Mexico ^d

a. Range of total number of whales identified depending on how many unassigned sides represent left and right views of the same animal.

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Table 2. Summary of six-year photographic identification effort at Laguna San Ignacio.

	Year						Combined Total ^a
	1977	1978 ^b	1979	1980	1981	1982	
A. No. Photos Taken	1,100	500	600	1,080	1,150	1,200	5,630
B. No. Whales Identified	52	72	35	85	66	124	434
C. No. Whales Matched (re-sighted) from the Previous Year	0	4	10	19	17	21	---
D. No. Whale Matches in Other Years	10	19	22	24	20	21	116
E. No. Re-sightings of Matched Whales within a Year ^a	68	89	83	ND	76	74	---
F. No. Days Between First & Last Sightings:							
1. Cow-Calf pair	22	71	68	81	63	87	---
2. Single Whale	24	32	25	29	21	26	---

a. Totals include one photographic sighting of a known animal per day. However, a whale may have been sighted more than once per day.

b. In 1978 50% of the photographs were lost due to a processing malfunction.

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Table 3. Photographic sightings of 18 identified gray whales showing location with the winter range from 1977 to 1982. Dates of sightings are given for whales seen in two locations with the same year.

No.	Sex	Year Photographed					
		1977	1978	1979	1980	1981	1982
1	F	LSI	LSI	LSI	LSI	LSI	LGN ©
2	F	LSI ©			LGN ©		LGN ©
3	F	LSI ©				BM ©	
4	F		LSI ©		LSI ©		MB ©
5	F		LSI ©		LGN ©		MB ©
6	F				LSI ©		MB ©
7	F				LSI ©		MB ©
8	F				LSI ©		MB ©
9	F				LSI ©		MB ©
10	F				LSI ©		MB ©
11	F				LSI ©		LGN © 18 & 25 FEB LSI © 5-6 MAR
12	F				LSI ©		BM © 19 FEB LSI © 12-20 MAR
13	F				LOL ©		LSI ©
14	F					LSI ©	BM
15	F					LSI ©	BM
16	M		LSI ©		LOL 1 FEB LSI 8 FEB		
17	M				LOL	LSI	
18	?				LOL 31 JAN LSI 3 FEB		

© = Calf Present

LSI = Laguna San Ignacio

LGN = Laguna Guerrero Negro

LOL = Laguna Ojo de Liebre (Scammon's Lagoon)

BM = Bahia Magdalena (Estero Soledad)