HUMPBACK WHALES AND OTHER MARINE MAMMALS OFF COSTA RICA, 1996-2000

REPORT OF RESEARCH DURING OCEANIC SOCIETY EXPEDITIONS IN 2000 IN COOPERATION WITH ELDERHOSTEL VOLUNTEERS

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INTRODUCTION

Cascadia Research in collaboration with Oceanic Society has conducted a long-term research effort on humpback whales and other marine mammals off the Pacific coast of Costa Rica starting in 1996. In January and February 2000, we continued this research with Elderhostel volunteer support and completed our fifth season of effort. This report summarizes the research conducted on humpback whales and other marine mammals off southern Costa Rica as part of the Oceanic Society trips in 2000. To make this report of broadest possible value, we also summarize the results from all five years of research in this region and consider the significance of the findings in relation to our research off the west coast of the U.S.. Cascadia Research, in conjunction with Oceanic Society Expeditions, and Elderhostel volunteer support, has conducted surveys based from Drake Bay, Costa Rica for two to four week periods in January and February between 1996 and 2000. Until these studies began in 1996, little information was available on humpback whales and other marine mammals that inhabit the waters off the west coast of Costa Rica.

Humpback whales make seasonal migrations between high-latitude feeding areas and low latitude wintering areas where they mate and give birth to calves. Their populations were depleted by commercial whaling and, in the North Pacific, have recently been estimated to number about 8,000 (Calambokidis *et al*. In Press). Humpback whales return annually to defined feeding areas in coastal waters, including the waters off California where about 900 humpback whales return annually to feed (Calambokidis *et al*. 1996a, 1999, 2000).

In the North Pacific, humpback whales were thought to use three primary wintering areas: the waters near Mexico, Hawaii, and Japan. It was not until research conducted in the 1990s that it became clear that some humpback from the North Pacific were also using Costa Rica as a wintering ground (Calambokidis *et al.* 1996b, 2000, Steiger *et al.* 1991, Rasmussen *et al.* 1995, Acevedo and Smultea 1995). This research has provided some of the first information available about the number and behavior of humpback whales using Costa Rican waters.

The project has several scientific objectives:

1. Determine the number of whales using Costa Rican waters as a wintering area.

2. Examine for evidence of whale preference for specific areas and habitats within the region.

3. Determine the movement patterns and migratory destinations of these whales.

4. Evaluate the annual return rate of animals to Costa Rican waters.

5. Further evaluate if humpback whales seen in Costa Rican waters are engaged in breeding behaviors similar to other North Pacific wintering grounds.

6. Document the occurrence of other marine mammals in Pacific waters off Costa Rica including the habitats and regions that they inhabit.

METHODS

Small boat surveys

Small boat surveys were conducted in all five years (1996-2000) from Drake Bay Wilderness Camp on the north side of the Osa Peninsula, Costa Rica, located in the southwestern section of the Pacific coast (Figure 1). The boats used were primarily 24 ft fiberglass boats equipped with twin 40-60 hp outboard motors and driven by experienced boat captains familiar with the local area. A total of 29 dedicated boat surveys and 1 opportunistic survey were conducted on 16 days in 2000 between 25 January and 13 February (Table 1). These surveys totaled approximately 1,736 nmi (Table 2) and encompassed much of the southwest coast of Costa Rica (Figure 1). Surveys predominately covered the area offshore from Drakes Bay to Isla del Caño, north to Dominical, and southeast into Golfo Dulce (Figure 2). Survey effort in all five years has been consistent in both the areas covered and the total effort which has involved from 18 to 27 surveys covering from 1,205 to 1,734 nmi per year (Table 2, Figure 2).

Three teams of volunteers assisted in observing for marine mammals as well as collecting the data in 2000. Each team volunteered for one week. Two boats were used each day with 6-8 observers each (including a team leader). Observation points to the front, sides, and back were divided among observers. Position information was based on a hand-held GPS (Global Positioning System) kept aboard each boat. Positions were generally recorded every 30-60 minutes as well as with each sighting. Weather conditions, including sea state, cloud cover, swell height, wind speed, and water temperature were recorded at intervals throughout the survey. Observers recorded information on each surfacing and the behavior of whales during each encounter.

In addition to the dedicated Drakes Bay effort, photographs were also obtained somewhat opportunistically from several other surveys and sources. Immediately prior to the start of the 2000 Drakes Bay work, John Calambokidis and Laura May made a trip to Northern Costa Rica (near Playa del Cocos) to look for humpback whales. One identification was obtained during two short opportunistic surveys done on 23 and 24 January 2000. The first of these surveys was prompted by the sighting of one whale from shore on the evening of 23 January.

Photographic identification

All humpback whales that seen were approached to obtain identification photographs of individual animals. We used photographic identification procedures that have been developed by us and other researchers in studies of humpback whales around the world. Whales were approached slowly from behind and followed until they made a deep dive and typically raise their flukes in the air. If the whale did not raise its flukes, dorsal fin photographs were taken for identification purposes. We used *Nikon* 35mm cameras equipped with a motor drive, databacks to print the date on each frame of film, 300mm telephoto lenses, and *Ilford* HP5+, a high-speed black-and-white film.

Acoustic monitoring

Survey boats from 1998 to 2000 utilized hydrophones to listen for and record vocalizations of humpback whales while in 1996 and 1997 only a single hydrophone was used. Several models of hydrophones have been used over the five years of research including those designed by Bev Ford (Offshore Acoustics) and Don Norris (Biomon). Both hydrophones used in 2000 were modles from Offshore Acoustics (sensitivity -154 dBV/uPa ±4 dB at 100 Hz, frequency response from 6 Hz to 14 kHz ±3 dB). One system was used with a 10m cable and the other with a 20m cable. When humpback whale songs were heard clearly, recordings of 30-60 minutes of song were generally made onto either Digital Audio Tape (DAT) with a *Sony* TCD-D7 DAT recorder (frequency response 20-14,000 Hz, 32 Hz sampling rate) or cassette tape with an *Aiwa* Super Bass HS-JS135W stereo cassette recorder.

Hydrophones were also used to help find and locate whales. Hydrophones were usually deployed every 30 minutes. If whales were heard, a more intensive search of the area was made to try and locate the whale. The relative intensity of the song was used to judge the approximate range to the singing whale. Whales were heard at distances up to 5-10 nmi.

The use of hydrophones on both boats since 1998 has allowed us to locate whales based on the time of arrival of the song to each boat. This was accomplished by having one boat transmit the song over the radio to the other boat. The boat hearing the song later was farther from the source of the song (the whale) and would reposition ahead of the other boat. This process was continued in a series of leap-frog movements until both boats were equally close to the whale and the song could be heard clearly through the boat without the hydrophone. We would then remain in position until the whale was seen.

Measuring sizes of whales

For the first time in the 2000 field season, we experimented with determining the relative sizes of humpback whales by measuring the width of the flukes of animals. In conjunction with identification photographs, the distance to the whale was measured using a *Bushnell Yardage Pro* laser range-finder (model 400 and 1000). The range finder and lens focal-length were calibrated by taking sets of measurement of known size targets on land. The range finders yielded consistent measurements of distance with relatively little error and only a slight bias that was adjusted for in the calibration equation. Measurements of whales were attempted when directly behind the whale so that the flukes were perpendicular to the photograph angle. When this was not possible, the angle off perpendicular was estimated in the field. The length of the whale was calculated based on regressions of the size of the fluke to the overall length of whales determined from stranded animals. This relationship has been found to be very close to linear in a large sample of gray whales ($n=54$, $R^2=0.88$, $p<0.000$). For humpback whales, the average ratio between fluke width and whale length was 0.336 ($n=9$, $SD=0.034$).

RESULTS AND DISCUSSION

Humpback whale sightings

The 2000 season was one of the better years for humpback whale sightings (Table 2). There were 29 sightings of 46 humpback whales (including duplicate sightings by different boats) made during the study (Tables 1-2). Humpback whales were seen on 15 of the 16 days (94%) and 22 of 30 boat surveys (73%) conducted from 26 January through 13 February 2000. On average 1.5 whales were seen per survey. These sighting rates are higher than our average for the 5-year period (Table 2).

The composition of the animals seen this season was also different than in most past years (Table 3). Sixty-nine percent of all sightings were of lone whales, higher than any past year, most of these (48% of all sightings) were of lone whales determined to be singing. This is in sharp contrast with 1999 when only 29% of sightings were of lone animals and the majority (60%) were of mothers with calves (both with and without escorts). Some of this difference was magnified by the resightings of the same animals multiple times. The larger number of humpback whale singers we saw is consistent with the higher proportion of time we heard singing whales in 2000 (see Table 4 and discussion in section on Humpback Whale Song). The reason for the difference in composition of animals from year to year is not yet clear.

Despite the inter-year variation, the overall group composition for humpback whales off Costa Rica for all five years is not very different than has been reported in other wintering areas. The overall proportion of single animals (singers and non-singers for all five years) in our study through 2000 has been 48%. In the North Atlantic, 42% of sightings on Samana Bank (Mattila *et al.* 1994) and 49% of sightings on Virgin Bank were singletons (Matilla and Clapham 1989). Along the Hawaiian Island chain, only 30% of animals were reported to be single whales (Mizroch *et al.* 1996). In all wintering areas it has generally been found that more males are present than females.

Although we did not see as many mothers and calves in 2000 as in 1999, the proportion of groups containing a newborn calf (20%) was still higher in 2000 than in the years previous to 1999. Prior to 1999, the proportion of mothers with calves seen had been low. Along with the sightings of mother-calf pairs, there may have been additional pregnant females present that had not yet given birth. In past years we have documented pregnant females as well as calves that appeared to have been born very recently and which still had folds in their skin. In both 1996 and 1997, we sighted an adult whale traveling without a calf and later that year saw the same whale off California with a calf (ID #10233 and 10988). In both these cases, the adult animal was seen in Costa Rica traveling with another whale that was either known or suspected to be a male. These findings of pregnant females and newborn calves confirms that females use these waters to give birth.

Water temperatures in 2000 were generally low, just above the temperatures seen in 1999 (Table 4). Water temperatures were significantly different between years from 1996 to 2000 (ANOVA, $p<0.001$) and temperature in 2000 (27.9°C, n=202, SD=0.9) was significantly lower than three of the four previous years (except 1999). The two years with lowest temperatures (1999 and 2000) have had the highest sighting rates of whales while the 1998 warm-water year had one of

our lowest sighting rates. This could mean that in warm-water years, fewer humpback whales are choosing to travel as far south to their wintering grounds. Temperature readings we took in the field were somewhat crude due to rudimentary instruments used but so far appear to be providing readings consistent with those from satellites for broader regions.

Sighting locations of humpback whales were more broadly distributed in 2000 (Figure 3) than in previous years (Figure 4). Humpback whales were seen between Isla del Caño and the mainland areas where they have been common in past years. Sightings in 2000, however, were also made north of Drakes Bay including north of Dominical and also in the Golfo Dulce to the south. The sighting (and identification) in Golfo Dulce is particularly valuable because we have received reports of whales in this area in the past but not found whales there in past surveys.

Photo-identification

Humpback whales were identified on 26 occasions representing 12 different individual humpback whales in 2000 (Tables 5 and 6). This includes one identification obtained off northern Costa Rica prior to the start of our Drakes Bay trips. Of these 12 individuals identified in 2000, 5 had been seen previously off Costa Rica and 7 were new identifications for this area. The proportion of whales seen previously off Costa Rica (5 of 12 or 42%) is the highest we have observed so far in our research.

A high proportion of the whales identified in 2000 had also been seen previously off California (Tables 4 and 5). All but 1 of the 12 whales identified in Costa Rica had been seen previously off California between 1988 and 1999. Most of these whales had been seen off southern and central California in either the Santa Barbara Channel, Port San Luis, Monterey Bay, or Gulf of the Farallones, off San Francisco (Table 5). Two whales had been seen off northern California off Fort Bragg or off Pt. St. George (near the Oregon border). Four of the matches to California were of whales seen the previous feeding season (1999) off California. Although we did not have extensive late-season effort off California in 1999 to allow examination of transit times, two whales were seen in October 1999 off California and then photographed off Costa Rica in January and February 2000 (Table 5).

The total number of different individuals that has been identified off Costa Rica (including one from Panama) in winter months now is 41 (Table 6). The rate with which we have matched whales identified off Costa Rica to those we know from our research off California remains high (Table 6). Of the total of 41 different humpback whales off Costa Rica, 35 (85%) have been seen previously off California. Because we have not identified all California whales (we typically find that 15-20% of whales we see off California have not been identified previously) the match rate of Costa Rica whales to California indicates Costa Rican waters are almost exclusively used by humpback whales that migrate to California. This overall rate is higher than has been documented between any other winter and feeding regions that scientists have examined. The exclusive use of a wintering area by animals from a single feeding area is different than has been documented for other humpback whale wintering areas that have been studied in the North Pacific and North Atlantic. At other wintering areas, humpback whales have been documented traveling to multiple

different feeding areas. This may be the result of Costa Rica being the farthest south wintering area for North Pacific humpback whales and California being the most southern feeding area.

A surprising finding was that whales identified in different wintering areas showed a preference for where they were seen feeding off California. Whales identified in Costa Rica were more likely to feed off southern California then northern California while whales that were known to have wintered in Mexico were more likely to be seen feeding off northern California than southern California. This pattern was apparent in our overall matches (Calambokidis *et al.* 2000) as well as from the 2000 sample where only 2 of the 11 whales matching California had been seen north of the Gulf of the Farallones. Although humpback whales are clearly capable of extremely long migrations, it appears that those wintering off Costa Rica, the southern-most wintering areas for North Pacific humpback whales, are more likely to seek feeding areas that are farther south and do not require as long a migration.

The two transits of whales between California in fall 1999 and the following winter (2000) in Costa Rica, add to a growing set of data on migration distances and timing. The farthest north a Costa Rica whale was seen (ID#10583) was off Newport, Oregon in October 1999, 5,524 km north of where it was seen in Costa Rica in February 1998. Since these sightings are more than a year apart they do not represent a direct transit. The longest documented transit distance (same season) for a whale seen in Costa Rica was ID#11243 seen on 6 October 1998 off Pt. St. George at the Oregon/California border and resighted in Costa Rica on 6 February 1999, a minimum straight-line distance of 5,427 km in 4 months. This more impressive given that the distance traveled was likely much greater and the interval probably much shorter than we documented. The shortest transit time we have documented in any year was a whale we saw off northern California on 1 December 1995 (one of our last surveys of the season) that we saw a mere 56 days later on 26 January 1996 during our first survey off Costa Rica. The straight-line distance between these two points is 5,200 km. Even in this case the actual transit was probably shorter in time and longer in distance than this indicates; this whale likely stayed longer off California, arrived earlier off Costa Rica, and may have traveled other areas than revealed by our observations. As coincidental as this pair of sightings seems, we have had several other resightings of the same whale thousands of miles away just a few months apart.

Humpback whale song and gender differences

We obtained a number of excellent recordings (onto Digital Audio Tape) of humpback whale song in 2000; we frequently heard humpback whale singing and obtained recordings on 11 occasions (Table 11). Humpback whales are known for their complex songs, heard primarily on the breeding grounds. Only the males sing the songs, which tend to vary from year to year. We heard singing on 193 of the 455 (42%) times we deployed the hydrophone in 2000 (Table 4). This is a much higher proportion of the time compared to past years. The higher proportion of time whales were heard singing is consistent with: 1) the more whales seen in 2000 than most years, 2) the higher proportion of singing whales, and 3) the wider geographic distribution of whales in 2000. The locations where singing was heard in 2000 agreed with the locations of sightings (Figure 5) and in most cases detecting song served as a key tool in eventually finding the singer.

Seven of the whales we identified in 2000 were determined to be singing. These are therefore likely males and their presumed sex will help in interpreting their behavior in the future. Sex can also be determined when a mother is seen with a calf or skin samples are collected for genetic analysis. Prior to this year, all the known sex animals we have positively documented returning multiple years have been males. This year one known female (ID#9046) was seen which had also been in seen in Costa Rica in 1996 as well. In 2000 off Costa Rica, she was with a calf (part of a cow/calf/escort threesome seen multiple times) and she had also been seen with a calf off California in 1993. During her previous sighting in Costa Rica in 1996 she was also in a group of three animals, although without a calf.

Sizes of whales

Nine measurements of six different whales were obtained using a combination of photography and distance measurements from the laser range finder (Table 8). Two whales were measured multiple times and showed fairly good agreement among duplicate estimates; 12.6-13.2 m for two measurements of ID# 11243 and 12.6-13.4 m for three measurements of ID# 10762. This agreement is good considering not all of these photographs were taken when the whale was judged to be completely perpendicular (up to about 20 degrees off).

Length estimates for most whales were fairly reasonable or slightly low compared with what would be expected for mature individuals. All measurements of the two singers were between 12.6 and 13.4 m falling above the 11-12 m size when males are estimated to become sexually mature but below the maximum size of 15 m for males. Two animals that were not singers or cows, one seen alone and the other in a group of four, yielded measurement of 11.6 and 13.5 m. The single measurement of a cow and an escort yielded unreasonably low sizes. The cow was estimated to be 11.2 m long, a little low for the estimate size of sexual maturity of females of 11.4 to 12.4 m. The lone measurement of an escort animal, came out unreasonably low (8.4 m) and suggests there was an error in the distance measurement for this animal. This was a problem noted in our California work, where occasionally the range-finder would get a reading on the water between the boat and the whale and yield an unreasonably short distance which would bias the length estimate downward.

Obtaining length estimates of humpback whales will allow us to evaluate a number of key elements of humpback whale use of Costa Rican waters as well as examine some areas of whale behavior. As our sample size increases with this method, we hope to achieve the following:

1. Fully evaluate this new method for obtaining length estimates of humpback whales. Researchers have sought ways to obtain estimates of size of whales in the field and we may have found a method that would be useful in many settings.

2. Evaluate whether the size of humpback whales that use Costa Rican waters is different than at the primary breeding grounds in Hawaii or Mexico (is this area selectively used by younger or older males or females?).

3. Examine aspects of the behavior of animals in relation to their size.

Other marine mammals

Besides humpback whales, four other species of marine mammals were documented during the surveys in 2000 (Table 9). These sightings were particularly valuable because of the limited information available on marine mammals off Costa Rica. In total, we have documented 11 different species of marine mammals in our study area from 1996 to 2000 (Table 8). A brief summary from the data from all years for each species is provided below.

Large baleen whale sighting

No large baleen other than humpback whale was seen in 2000. A single Bryde's whale was seen on 26 January 1998. It was observed along the south side of the Osa Peninsula and was swimming south. This medium-size whale is in the same family (Balaenopteridae) as humpback whales. Unlike most other baleen whales, it is generally confined to warmer tropical and temperate waters. It was identified by its streamlined shape, smaller size (30-40 ft), and three head ridges. This was our first sighting of this species in our research, although its occurrence in this region is not surprising. The only other species of baleen whale, besides humpback and Brydes whales, seen in our research, was a single sighting of a likely fin whale in 1997.

Toothed whales

We had one sighting of a group of 12 false killer whales near Isla Ballaena in 2000. These supplement sightings of this species in 1996 and 1998 (Table 9). During one of the sightings in 1998, one whale dove down out of our sight, and then resurfaced with a red rockfish in its mouth. It carried the fish around in its mouth and passed it to another animal nearby. Two of the sightings (one in 1996 and one in 1998) were made on the west side of Isla del Caño while the other sighting (in 1998) was off Drakes Bay. This species has been reported frequently in Golfo Dulce and off Isla de Coco in Costa Rica (Acevedo-Gutierrez *et al.* 1997). Local naturalists reported frequently sighting pilot whales in the study area. We never encountered pilot whales in our surveys and suspect at least some sightings of false killer whales may be mistakenly identified as pilot whales.

Sperm whales and killer whales were seen in 1996 and 1997 (Table 9). Sperm whales primarily inhabit deeper offshore waters, where we saw them in 1996. Our surveys are usually in shallower waters with the exception of a few segments just barely off the shelf edge so the infrequent sightings of this species are to be expected.

Dolphin species

Five dolphin species have been seen during the study (not including the false killer whale or killer whale which are in the delphinid family), three of them in 2000. Spotted dolphins remained by far the most frequently seen marine mammal species in our surveys accounting for 83 sightings of 1,868 animals in 2000 alone. The number of sightings and animals seen in 2000 was higher than previous years. The distribution of spotted dolphin sightings reveals they were seen throughout the

area we surveyed. Highest concentrations of sightings were surrounding Isla del Caño and off the west edge of the Osa Peninsula.

Bottlenose dolphins were seen three times in 2000 and have been seen all five years of the study and throughout the study area (Table 9). They were not as commonly seen around Isla del Caño and many of our sightings came around the periphery of our primary survey area. A quarter of the sightings of bottlenose dolphins were made during our few surveys out to the shelf edge northwest of our primary study area suggesting this is a better habitat for this species than the principal areas we surveyed. Bottlenose dolphins were also seen in Golfo Dulce during some of the trips we made there. Group sizes were generally smaller than for other dolphin species (about 15 animals).

We had our second sighting of rough-toothed dolphins in 2000. These dolphins do not have a crease between the melon and beak, indicative of this species. Rough-toothed dolphins are considered relatively uncommon throughout most of their tropical range (Leatherwood and Reeves 1983).

Two other species of dolphin have only been sighted in single years (Table 9). Spinner dolphins, were seen for the first time in our study in 1999. This is a fairly common dolphin known to occur in this region but we had been unable to positively identify it in past surveys. A group of approximately 50 common dolphins were seen during one of our few surveys off the continental shelf edge at the northwest tip of our survey coverage on 12 February 1998. This species is relatively common in offshore waters of the eastern tropical Pacific but had not been seen in the areas of our surveys.

CONCLUSIONS

Principal findings of the research have included:

- Humpback whales regularly use Costa Rican waters as a calving and breeding area with sightings of mother-calf pairs, pregnant females, and singing males.

- The number of animals and their composition varied among years. Both 1999 and 2000 have been years with high numbers of sightings, especially mothers and calves in 1999 and singletons (mostly singers) in 2000.

- North Pacific humpback whales migrate farther south than previously known.

- Our study area is used by a small group of humpback whales many of which return in multiple years to this area.

- Humpback whales from this region are almost exclusively animals that use the California feeding area.

- A total of 11 marine mammal species were documented in Costa Rican coastal waters and provided some of the first details of these species in these waters.

This information will be valuable in protecting managing marine mammals in Costa Rica. Tourism in Costa Rica has increased dramatically over the last 20 years, especially with visitors interested in terrestrial and marine wildlife. An expansion of resorts and tourist activities in Drake Bay has occurred over the four years of this research. With these increasing activities and interest in whales and marine mammals, it is important we learn more about the populations of many of these species to be better to protect them and educate people.

The findings of the research off southern Costa Rica have gained a particular value in the context of our larger survey of Central American waters conducted with the schooner *Russamee*. That study revealed that large portions of the Central American coast are used as a wintering ground for humpback whales. This could mean this area collectively represents a wintering ground for far more humpback whales than we have suspected in the past. Detailed information in this broader region has only been gathered off southern Costa Rica, so this information provides an important insight into how whales use this larger area.

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LIST OF TABLES AND FIGURES

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FIGURES

Table 1. Dates and times boat surveys were conducted out of Drake Bay, Costa Rica, with number of humpbacks and other species seen in 2000.

		Time		Humpback's		Other	
Date	**Leader**	**Start**	**End**	**seen**	**# ID**	**species**	**Comments**
23-Jan-00	John	15:36	17:30	1	1	Sa	survey in Northern Costa Rica
24-Jan-00	John	6:05	10:00	0	0	Sa	survey in Northern Costa Rica, singing heard
25-Jan-00	John	11:26	14:43	3	2		cow, calf, escort trio
26-Jan-00	John	8:15	15:13	6	2	Sa	same cow, calf, escort trio seen on 25 January
26-Jan-00	Frank	8:15	14:48	4	2	Sa, Tt	same cow, calf, escort trio seen on 25 January
27-Jan-00	John	8:15	16:25	3	2	Sa, Pc	same cow, calf, escort trio seen on 25 and 26 Januai
27-Jan-00	Frank	8:16	14:17	0	0	Sa	
28-Jan-00	John	8:15	15:45	2	0		breaching and pec slapping seen from land
29-Jan-00	Frank	8:23	15:30	1	0	Sa	singing whale, recording made
29-Jan-00	John	8:23	16:54	3	2	Sa	cow, calf, escort trio, escort is singing
30-Jan-00	John	8:22	17:05	3	1	Sa	singing whale, recording made
30-Jan-00	Frank	8:22	18:00	1	1	Sa	singing heard
01-Feb-00	Kristin	11:03	13:49	1	1		song heard
01-Feb-00	Izzy	11:09	13:50	1	0		same as Kristin's sighting
02-Feb-00	Kristin	8:07	15:44	1	1	Sa	singing heard, spotted dolphins accompanying whal
02-Feb-00	Izzy	8:19	15:55	0	0	Sa	5 turtles and a sailfish seen
03-Feb-00	Kristin	8:01	15:54	4	4	Sa	one group of four, spy hops and underwater blows
03-Feb-00	Izzy	8:20	17:45	1	0	Sa	song heard
05-Feb-00	Kristin	7:46	16:32	1	1	Sa, Sb	singing heard, same whale heard by Kristin 2 Febru
05-Feb-00	Izzy	7:35	16:10	0	0	Sa, Tt	Golfo Dulce
06-Feb-00	Kristin	7:56	16:06	1	1	Sa	Boats work together to find singer, mating sea turtle
06-Feb-00	Izzy	8:06	16:00	2	1	Sa	Spotted dolphins bowriding whale
08-Feb-00	Kristin	14:33	16:19	0	0	Sa	
08-Feb-00	Izzy	14:33	16:01	0	0	Sa	
09-Feb-00	Kristin	8:08	16:41	4	2	Sa	singing heard and recorded, pec slaps and breaches
09-Feb-00	Izzy	8:17	15:50	2	2	Sa	same sighting as above, people hear singing
10-Feb-00	Kristin	7:34	16:32	0	0	Sa, Tt	Golfo Dulce
10-Feb-00	Izzy	7:52	15:45	1	1	Sa	singing heard, dead turtle found
12-Feb-00	Kristin	7:57	16:28	0	0	Sa	
12-Feb-00	Izzy	8:01	16:05	2	0	Sa	Cow/calf humpback seen, group of 250 spotted dolphins feeding, boobies, pelicans, frigates, and tu
13-Feb-00	Kristin	8:03	15:53	2-3	1	Sa	singing heard, possible cow/calf pair seen
13-Feb-00	Izzy	8:03	13:18	0	0	Sa	47 Olive Ridley's seen

Sa-spotted dolphin (Stenella attenuata), Tt-bottlenose dolphin (Tursipos truncatus), Sb-Rough toothed dolphin (Steno bredanensis), Pc-False killer whale (Pseudorca crassidens)

Table 2. Summary of survey effort and humpback whale sightings off southern Costa Rica.

	Year					Total
	1996	**1997**	**1998**	**1999**	**2000**	
Survey effort						
Start date	26-Jan	31-Jan	24-Jan	27-Jan	25-Jan	
End date	16-Feb	14-Feb	18-Feb	7-Feb	13-Feb	
Days with surveys	15	10	15	10	16	**66**
Total boat surveys	26	18	27	18	30	**119**
Survey nmi	1,581	1,205	1,734	1,249	1,738	**7,506**
Humpback sightings						
Sightings	15	27	18	32	29	**121**
Animals	19	45	25	60	46	**195**
Days whales seen	10	10	8	10	15	**53**
Surveys whales seen	13	14	12	15	22	**76**
Sighting rates						
Percent of days whales seen	67%	100%	53%	100%	94%	**80%**
Percent of surveys whales seen	50%	78%	44%	83%	73%	**64%**
Whales/survey	0.73	2.50	0.93	3.33	1.53	**0.45**
Whales per nmi	0.012	0.037	0.014	0.048	0.026	**0.026**

In 2000, 6 hours of effort on 23-24 January covering 31 nmi was conducted off N Costa Rica

Table 3. Group composition of humpback whale sightings in study area off Costa Rica, 1996-2000.

	1996		1997		1998		1999		2000		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Lone singers	5	33%	2	7%	7	39%	5	16%	14	48%	33	27%
Singles	5	33%	6	22%	4	22%	4	13%	6	21%	25	21%
Pairs	3	20%	15	56%	5	28%	4	13%	2	7%	29	24%
Mother/calf	0	0%	3	11%	2	11%	14	44%	1	3%	20	17%
Mother/calf/escort	0	0%	0	0%	0	0%	5	16%	5	17%	10	8%
Groups larger than 2	2	13%	0	0%	0	0%	0	0	1	3%	3	2%
Undetermined	0	0%	1	4%	0	0%	0	0	0		1	1%
Total	15		27		18		32		29		121	

Table 4. Water temperatures (degrees C) observed during surveys off Costa Rica and the proportion of hydrophone deployments in which humpback whales were heard singing by year.

	Water temperature (C)			Hydrophone deployments		
Year	**n**	**Mean**	**SD**	**n**	**Song heard**	**%**
1996	135	28.3	0.8	79	19	24%
1997	111	28.2	0.8	82	13	16%
1998	205	29.1	0.9	255	54	21%
1999	242	27.7	1.1	238	52	22%
2000	202	27.9	0.9	455	193	42%

Table 5. Sighting histories of humpback whales identified off Costa Rica in 2000. Sightings off Costa Rica in 2000 are shaded.

ID	Date	Time	Latitude	Longitude	Region	Num	Calf	Behavior	Comments
9044	14-Jul-88	16 48	35 01.3	120 48.8	San Luis, CA	1		Unknown	
9044	24-Oct-91	13 15	35 02.5	120 49.6	San Luis, CA	6	0	Milling	
9044	25-Oct-91	14 50	35 03.6	120 51.1	San Luis, CA	3	0	Milling	
9044	25-Aug-91	16 30	35 05.0	120 48.5	San Luis, CA	6	1	Milling	
9044	11-Aug-91	13 13	35 08.0	120 51.0	San Luis, CA	1	0	Unknown	
9044	12-Jun-92		34 08.2	119 49.9	Santa Barbara Channel, CA				
9044	24-Jun-92		34 05.5	119 46.8	Santa Barbara Channel, CA				
9044	27-Oct-93	11 51	36 51.2	121 57.7	Monterey Bay, CA	5	0		
9044	27-Sep-95	12 30	34 08.2	120 04.5	Santa Barbara Channel, CA	10	1	Slow travel, tail lobbing, fluke swish, pec slap, spyhop	
9044	08-Aug-96	17 50	36 32.9	122 00.1	Monterey Bay, CA	4	0	Milling	
9044	16-Sep-96	14 24	37 40.9	122 58.4	Monterey Bay, CA	4	0		
9044	23-Sep-98	10 10	36 40.4	122 00.4	Monterey Bay, CA	3			
9044	22-Sep-98	12 48	36 45.0	122 00.7	Monterey Bay, CA	2			
9044	28-Sep-98	09 20	36 46.9	121 57.6	Monterey Bay, CA	1			
9044	29-Sep-98		36 48	122 08	Monterey Bay, CA	0			
9044	30-Jan-00	13 14	8 24.95	83 15.21	Costa Rica	0			
								Slow travel	
9046	17-Jul-88	17 04	35 01.5	120 49.7	San Luis, CA	4			
9046	24-Jul-88	11 30	35 06.6	120 47.9	San Luis, CA				
9046	26-Sep-93	13 18	37 39.3	123 02.0	Gulf of Farallones, CA	3	0	Surface lunge feed	scat sample collected
9046	24-Sep-93	14 30	37 38.2	123 02.8	Gulf of Farallones, CA	6	0	Milling	
9046	24-Sep-93	14 40	37 38.2	123 03.2	Gulf of Farallones, CA	4	1	Milling	
9046	24-Aug-93	11 26	36 48.9	122 04.3	Monterey Bay, CA	6	0		
9046	09-Aug-93	12 10	36 49.2	122 05.4	Monterey Bay, CA	6	0		
9046	09-Aug-93	12 04	36 47.7	122 00.6	Monterey Bay, CA	2	1		
9046	12-Aug-93	10 25	36 49.4	122 01.7	Monterey Bay, CA	2	1		
9046	13-Aug-93	11 12	36 52.4	122 12.6	Monterey Bay, CA	2	1	Surface lunge feed	
9046	15-Jun-95	13 31	34 20.0	120 21.4	Santa Barbara Channel, CA	9		Milling, breaching, playing in kelp	
9046	25-Nov-95	13 15	38 00.7	123 29.6	Gulf of Farallones, CA	3	0	Milling	
9046	07-Nov-95	13 23	38 00.6	123 29.5	Gulf of Farallones, CA	3	0	Milling, head lunge	California sea lion nearb
9046	07-Nov-95	13 35	38 00.4	123 29.1	Gulf of Farallones, CA	3	0	Milling	
9046	07-Nov-95	13 55	38 00.3	123 28.9	Gulf of Farallones, CA	2	0	Slow travel	
9046	07-Jul-95		34 06.0	120 10	Santa Barbara Channel, CA	0			
9046	24-Jul-95		34 06.0	120 10	Santa Barbara Channel, CA	0			
9046	24-Feb-96	10 17	09 03.8	83 41.9	Costa Rica	3	0	Milling	
9046	06-Feb-96	13 30	09 06.9	83 46.4	Costa Rica	3	0	Slow travel	
9046	06-Jul-98	10 30	34 11.5	119 59.2	Santa Barbara Channel, CA	7	0	Stationary	
9046	04-Jul-98	11 38	34 11.0	119 59.6	Santa Barbara Channel, CA	3	0	Slow travel	
9046	04-Jul-98	11 58	34 11.2	119 59.6	Santa Barbara Channel, CA	3	0	Milling	
9046	20-Jul-99				Santa Cruz, CA				
9046	25-Jan-00	12 10	8 44.58	83 41.37	Costa Rica	3	1	Milling,Slow travel,Breaching,	Cow
9046	26-Jan-00	08 54	8 42.49	83 41.91	Costa Rica	3	1	Slow travel,Breaching	Cow
9046	26-Jan-00	13 50	8 43.82	83 43.38	Costa Rica	3	1	Tail-lobbing,	Cow
9046	27-Jan-00	12 00	9 07.93	83 45.30	Costa Rica	3	1	Milling,Breaching,Close approach to boa	Cow
9046	29-Jan-00	14 21	8 47.49	83 41.57	Costa Rica	3	1	Milling,Breaching	Cow
10307	31-Aug-89	17 31	37 45.6	123 12.1	Gulf of Farallones, CA	5	0		
10307	25-Oct-90		36 19.6	121 59.7	Pt Sur, CA	2			
10307	01-Aug-91	10 40	35 05.0	120 47.5	San Luis, CA	2	0		
10307	12-Aug-96	07 50	37 26.1	122 55.2	Half Moon Bay, CA	2	0	Milling	
10307	27-May-97	16 51	37 27.6	122 49.6	Half Moon Bay, CA	2	0	Slow travel	
10307	08-Oct-99				Monterey Bay, CA				
10307	03-Feb-00	09 59	8 45.22	83 49.61	Costa Rica	4	0	Slow travel,Bubbles seen,Spy hop	
10523	26-Oct-91	10 15	35 00.7	120 48.0	San Luis, CA	6	0	Milling	
10523	25-Oct-91	14 35	35 03.1	120 51.1	San Luis, CA	5	0	Milling	
10523	25-Nov-91	10 20	34 55.5	120 46.0	San Luis, CA	2			
10523	02-Nov-91	11 11	34 55.6	120 46.3	San Luis, CA	2		Milling	
10523	02-Aug-91	15 45	35 06.0	120 48.0	San Luis, CA	2	0	Milling	
10523	11-Sep-93	13 18	37 39.3	123 02.0	Gulf of Farallones, CA	3	0	Surface lunge feed	scat sample taken
10523	24-Sep-93	14 36	37 39.1	123 01.2	Gulf of Farallones, CA	4	0	Slow travel	
10523	26-Sep-93	16 20	37 29.6	122 49.4	Half Moon Bay, CA	2	0		
10523	15-Aug-94	19 29	37 40.8	123 05.8	Gulf of Farallones, CA	9	1	Milling	
10523	26-Aug-94	12 30	37 42.1	123 07.2	Gulf of Farallones, CA	5	0	Milling	
10523	27-Sep-96	13 47	37 33.4	122 58.6	Gulf of Farallones, CA	6	0	Milling	
10523	24-Jun-96	10 06	34 09.6	120 20.5	Santa Barbara Channel, CA	2	1	Slow travel	
10523	04-Feb-97	09 31	08 35.5	083 44.8	Costa Rica	2	0	Fast travel	
10523	19-Jul-99				Monterey Bay, CA				
10523	09-Feb-00	10 46	8 44.29	83 50.18	Costa Rica	1	0	Slow travel	

10523	13-Feb-00	10 01	8 57.29	83 42.10	Costa Rica	1	0	Slow travel	Singer
10649	10-Sep-92	09 30	39 27.8	123 57.0	Fort Bragg, CA	1	0	Unknown	
10649	23-Oct-92	12 36	39 30.0	123 53.9	Fort Bragg, CA	1	0	Slow travel	
10649	07-Sep-94	13 20	37 56.9	123 24.0	Gulf of Farallones, CA	6	0?	Slow travel	
10649	28-Sep-94	15 12	37 53.2	123 25.9	Gulf of Farallones, CA	1	0	Slow travel	
10649	28-Aug-95	14 57	34 09.6	120 02.5	Santa Barbara Channel, CA	2	0	Milling	
10649	29-Jan-98	12 57	08 30.4	083 40.3	Costa Rica	2	0	Slow travel	
10649	29-Jan-98	08 36	08 40.4	083 45.1	Costa Rica	2	0	Fast travel	
10649	02-Feb-00	10 50	9 00.01	83 41.27	Costa Rica	1	0	Slow travel	Singer
10649	05-Feb-00	10 45	8 57	83 40	Costa Rica	1	0	Slow travel	Singer
10649	09-Feb-00	09 04	8 40.01	83 44.70	Costa Rica	1	0	Stationary,Breaching,Slow travel,	
10649	09-Feb-00	09 05	8 40.19	83 44.82	Costa Rica	1	0	Slow travel,Stationary,Tail-lobbing,	Singer
10649	10-Feb-00	08 24	8 44.91	83 41.50	Costa Rica	1	0	Milling	Singer
10703	29-Jun-92	08 02	34 26.3	120 15.5	Santa Barbara Channel, CA	1	0	Slow travel	
10703	10-Oct-95	16 40	37 39.9	123 04.9	Gulf of Farallones, CA	3	0	Unknown	
10703	03-Feb-00	09 59	8 45.22	83 49.61	Costa Rica	4	0	Slow travel,Bubbles seen,Spy hop	
10762	02-Oct-93				Monterey Bay, CA	5	0		
10762	19-Oct-93	11 15	36 50.3	122 0.1	Monterey Bay, CA	5	0		
10762	21-Sep-93	16 14	37 42.2	123 07.6	Gulf of Farallones, CA	2	0	Slow travel	
10762	06-Sep-93	16 10	37 38.1	123 00.6	Gulf of Farallones, CA	2	0	Slow travel	
10762	23-Jun-95	13 31	34 20.0	120 21.4	Santa Barbara Channel, CA	9		Milling	
10762	25-Feb-96	09 22	08 25.5	83 34.2	Costa Rica	1	0	Fast travel	
10762	13-Feb-98	08 34	08 41.6	083 46.5	Costa Rica	1	0	Fast travel	
10762	09-Feb-98	09 30	08 44.7	083 46.3	Costa Rica	1	0	Slow travel	
10762	03-Feb-00	09 59	8 45.22	83 49.61	Costa Rica	4	0	Slow travel,Bubbles seen,Spy hop	
10762	09-Feb-00	14 40	8 43.59	83 51.75	Costa Rica	1	0	Slow travel	Singer
10995	09-Aug-97	1245	36 38.95	122 03.50	Monterey Bay, CA	1	0	Friendly	
10995	05-Jun-98		34 08	119 53	Santa Barbara Channel, CA	40			
10995	23-Jan-00	16 30	10 33.4	85 44.78	Costa Rica	1	0	Milling	
11141	06-Oct-99				Monterey Bay, CA				
11141	03-Feb-00	09 59	8 45.22	83 49.61	Costa Rica	4	0	Slow travel,Bubbles seen,Spy hop	
11243	14-Oct-98	15 30	41 53.1	124 25.5	Pt St. George, CA	4	0	Milling	
11243	06-Oct-98	15 45	41 53.0	124 25.2	Pt St. George, CA	7	0	Milling	
11243	06-Oct-98	16 34	41 53.4	124 25.1	Pt St. George, CA	4	0	Milling	
11243	06-Feb-99	08 39	08 36.2	083 44.9	Costa Rica	1	0	Slow travel	
11243	30-Jan-00	15 48	8 41.11	83 42.99	Costa Rica	1	0	Slow travel,Milling,	SINGER
11285	06-Jun-98		34 08	119 53	Santa Barbara Channel, CA				
11285	25-Jan-00	12 10	8 44.58	83 41.37	Costa Rica	3	1	Milling,Slow travel,Breaching,	Escort
11285	26-Jan-00	08 54	8 42.49	83 41.91	Costa Rica	3	1	Slow travel,Breaching	Escort
11285	26-Jan-00	13 50	8 43.82	83 43.38	Costa Rica	3	1	Tail-lobbing	Escort
11285	27-Jan-00	12 00	9 07.93	83 45.30	Costa Rica	3	1	Milling,Breaching,Close approach to boa	Escort
11285	29-Jan-00	14 21	8 47.49	83 41.57	Costa Rica	3	1	Milling,Breaching	Escort
11285	06-Feb-00	11 13	8 41.53	83 43.18	Costa Rica	1	0	Stationary	Singer
11285	06-Feb-00	09 33	8 38.41	83 45.31	Costa Rica	1	0		Singer
11392	01-Feb-00	11 50	8 40.81	83 43.74	Costa Rica	1	0	Stationary	Singer?

Table 6. Results of photographic identification research of humpback whales in Costa Rica during winter through 2000.

Description	**pre 1996**	**1996**	**1997**	**1998**	**1999**	**2000**	**All Years**
Number of identifications from Oceanic Society trips	0	12	19	12	5	25	48
Number of identifications contributed by others	5 [1]	4 [2]	0	0	0	1 [3]	10
Total identifications	5	16	19	12	5	26	57
Unique animals for period	5	13	11	7	4	12	41
New whales (not seen a previous year)	5	12	10	4	3	7	
Number matching California	4	11	8	6	4	11	35
Total percent matching California	80%	85%	73%	86%	100%	92%	85%

[1] Two identifications contributed by Richard Sears, two contributed by Carol Henderson, two contributed by Marco Saborio and Marenco Biological Reserve

[2] Two identifications contributed by Herbert Michaud and Drake Bay Wilderness Camp, one identification contributed by Bill Muraco while visiting Drake Bay, one identification from Panama contributed by Jack Swenson

[3] One idenfication by John Calambokidis from Northern Costa Rica

Table 7. Times and locations of recordings of humpback whale songs, 1996-2000.

Date	Time	Latitude	Longitude	Tape track	Comments
1996					
29-Jan-96	13 30	08 43.49	083 44.01	Tape 96-1 Pr. 5	ID-10541
07-Feb-96	10 02	08 56.2	083 40.1	Tape 96-2 Pr. 1	
12-Feb-96	09 35	08 40.99	083 47.16	Tape 96-2 Pr. 2-3	ID-10731
12-Feb-96	09 33	08 40.89	083 46.57	Tape 96-2 Pr. 4	ID-10731
15-Feb-96	10 40	08 42.13	083 50.51	Tape 96-3 Pr.1	
15-Feb-96	12 54	08 44.4	083 48.48	Tape 96-3 Pr.2	
1997					
13-Feb-97	10 17	09 05.7	083 43.5	Tape 97-1	ID-9047
13-Feb-97	11 33	09 06.9	083 45.5	Tape 97-1	ID-9047
1998					
02-Feb-98	08 50	08 45.9	083 41.9	Tape 98-1 Pr.1	
02-Feb-98	15 16	08 41.06	083 43.65	Tape 98-1 Pr.3	ID-10753?
02-Feb-98	13 15	08 41.2	083 45.9	Cassette	ID-10753
10-Feb-98	11 27	08 42.8	083 45.1	Tape 98-2 Pr.1	ID-10753
10-Feb-98	13 35	08 43.9	083 42.8	Tape 98-2 Pr.2	ID-10753
10-Feb-98	14 24	08 44.5	083 42.6	Cassette	ID-10753
13-Feb-98	09 41	08 38.9	083 49.3	Tape 98-2 Pr.3	ID-9003
16-Feb-98	12 33	08 46.2	083 49.6	Tape 98-3 Pr.1	ID-9003?
1999					
27-Jan-99	10 17	08 40.5	083 44.1	Tape 99-1 Pr.1	ID-10525
27-Jan-99	15 39	08 44.0	083 45.0	Cassette	
28-Jan-99	16 54	08 27.7	083 38.1	Tape 99-1 Pr.2	
30-Jan-99	09 32	08 40.9	083 43.84	Cassette	
30-Jan-99	12 06	08 41.7	083 43.5	Tape 99-1 Pr.3	
31-Jan-99	14 10	08 40.15	083 45.27	Cassette	ID-10520
2000					
26-Jan-00	09 58	08 44.94	83 42.19	Tape00-1 Pr.2	
27-Jan-00	10 30	09 05.80	83 44.41	Tape00-1 Pr.3	False killer whales w/Mn in background
27-Jan-00	12 05	08 07.95	83 45.30	Tape00-1 Pr.4	ID-11285, cow/calf/escort, escort singing
29-Jan-00	14 10	08 29.55	83 44.11	Tape00-2 Pr.1	poor recording
30-Jan-00	13 14	08 24.95	83 15.21	Tape00-1 Pr.5-6	ID-9044
02-Feb-00	12 18	09 02.80	83 42.52	Tape 00-2 Pr.2	ID-10649
05-Feb-00	11 20	8 57.24	83 40.09	Tape00-2 Pr.3	ID-10649
06-Feb-00	11 33	08 41.77	83 43.23	Tape00-2?	
06-Feb-00	14 15	08 41.22	83 43.39	Tape00-2?	ID-11285?
09-Feb-00	09 34	8 40.50	83 45.12	Tape 00-3 Pr.1	ID-10649
09-Feb-00	14 40	08 43.59	83 51.75	Tape00-3 Pr.2	ID-10762

Table 8. Measurements of fluke sizes of humpback whales in Costa Rica.

							Dist.	Fluke size on negative (cm)			Calculated size (m)	
Date	**Snum**	**Pho**	**Roll**	**Fr. #**	**ID**	**Role**	**m**	**L lobe**	**R Lobe**	**Total**	**Width**	**Length**
01/23/00	2	JAC	1	3	10995	Single	116	5.3	4.5	9.8	3.91	11.6
01/25/00	1	JAC	1	32	11285	Escort	70	5.7	5.8	11.5	2.78	8.3
01/26/00	1	JAC	2	6A	9046	Cow	60	8.4	9.7	18.1	3.75	11.2
01/30/00	2	FGA	1	17	11243	Singer	96			13.7	4.44	13.2
01/30/00	2	FGA	1	18	11243	Singer	80	8.5	7.1	15.6	4.22	12.6
02/03/00	3	KR	1	19	10703	Grp of 4	87	7.5	7.6	15.1	4.52	13.5
02/03/00	3	KR	1	21	10762	Singer	71	9	9.3	18.3	4.48	13.3
02/03/00	3	KR	1	32	10762	Singer	90			13.7	4.25	12.6
02/03/00	3	KR	2	2A	10762	Singer	94	7.1	6.8	13.9	4.50	13.4

All photos taken with Nikon M90 w/ 300 f4 Nikor lens.

LRF 1000 used for all measurements except 1/30/00

Table 9. Summary of sightings of all species identified in study area off Costa Rica, 1996-2000.

	1996		1997		1998		1999		2000		Total	
Species	**sightings**	**animals**	**sightings**	**animals**	**sightings**	**animals**	**sightings**	**animals**	**sightings**	**animals**	**sightings**	**animals**
Baleen whales												
Humpback whale	15	19	27	45	18	25	32	60	29	46	121	195
Fin/Sei whale			1	1							1	1
Bryde's whale					1	1					1	1
Toothed whales											0	0
Sperm whale	2	5									2	5
False killer whale	1	40			2	35			1	12	4	87
Killer whale			2	8							2	8
Dolphins											0	0
Spotted dolphin	20	448	36	358	35	614	63	948	83	1868	237	4,236
Bottlenose dolphin	8	53	2	7	7	203	2	11	3	35	22	309
Common dolphin					1	50					1	50
Rough-toothed dolphin					1	20			1	8	2	28
Spinner dolphin							1	150			1	150
Unidentifed dolphin	26	120	8	33	12	33	1	10	2	3	49	199

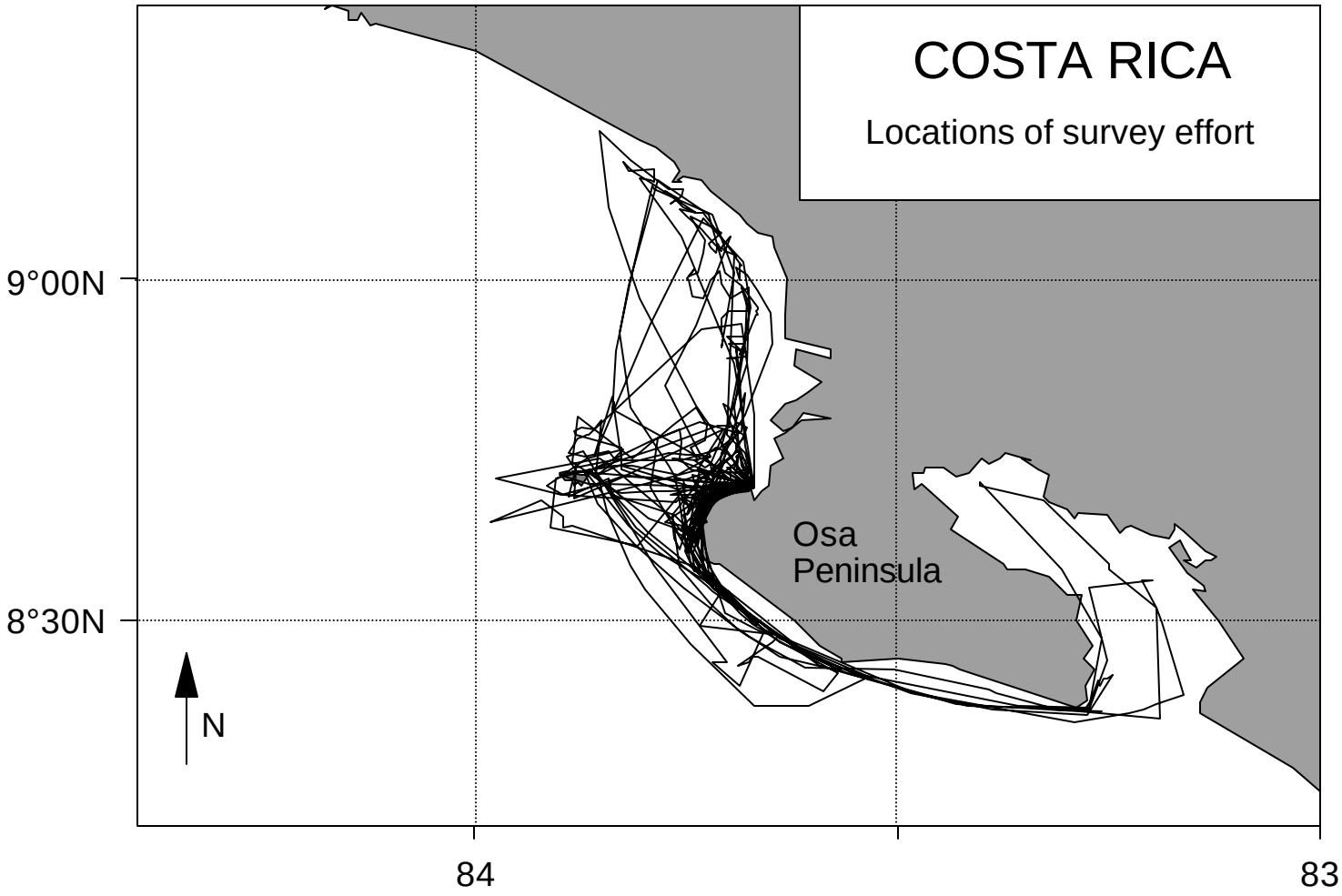

Figure 1. Tracklines of dedicated survey effort off S Costa Rica in 2000.

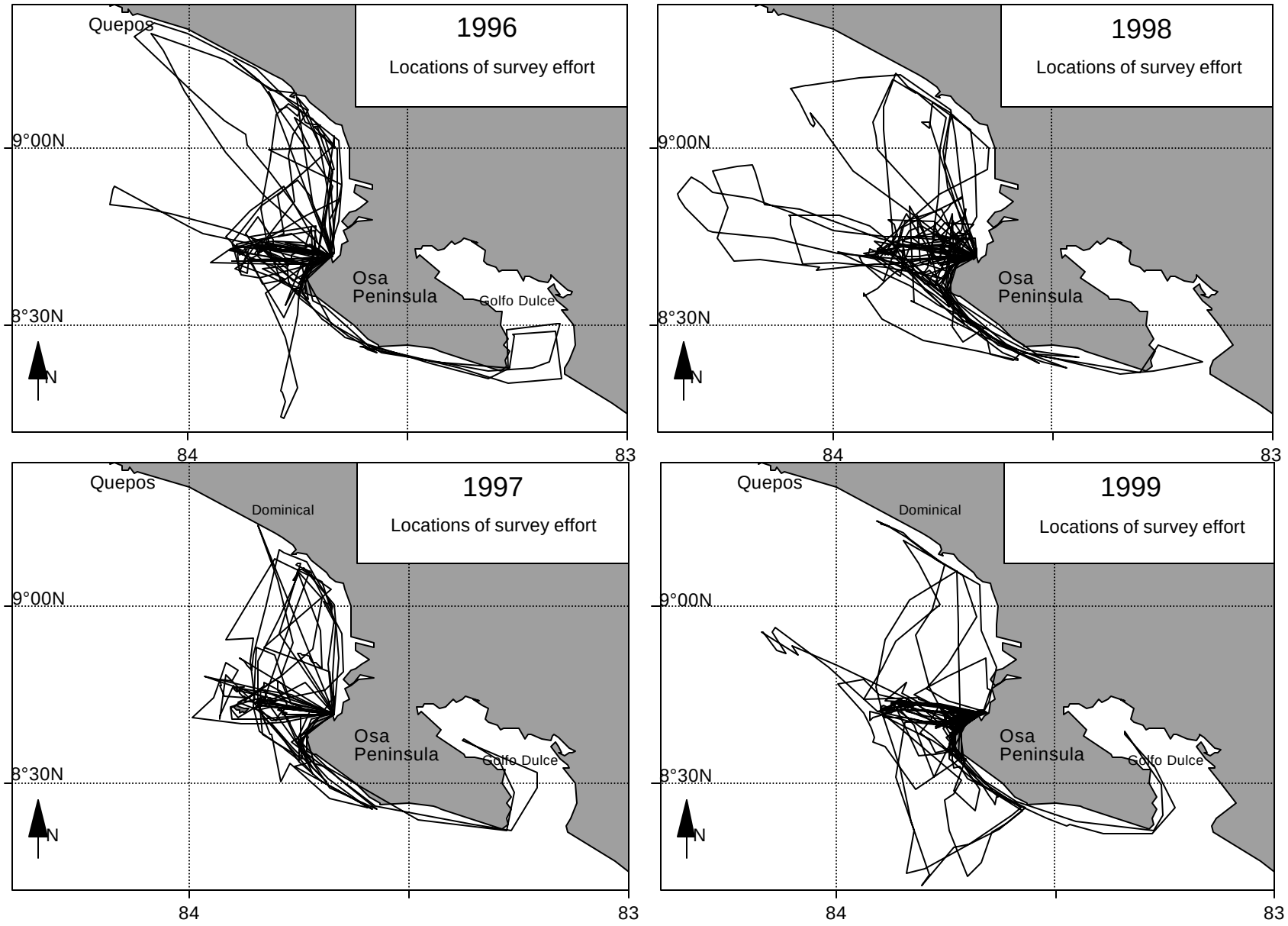

Figure 2. Locations of survey effort by year, 1996-99.

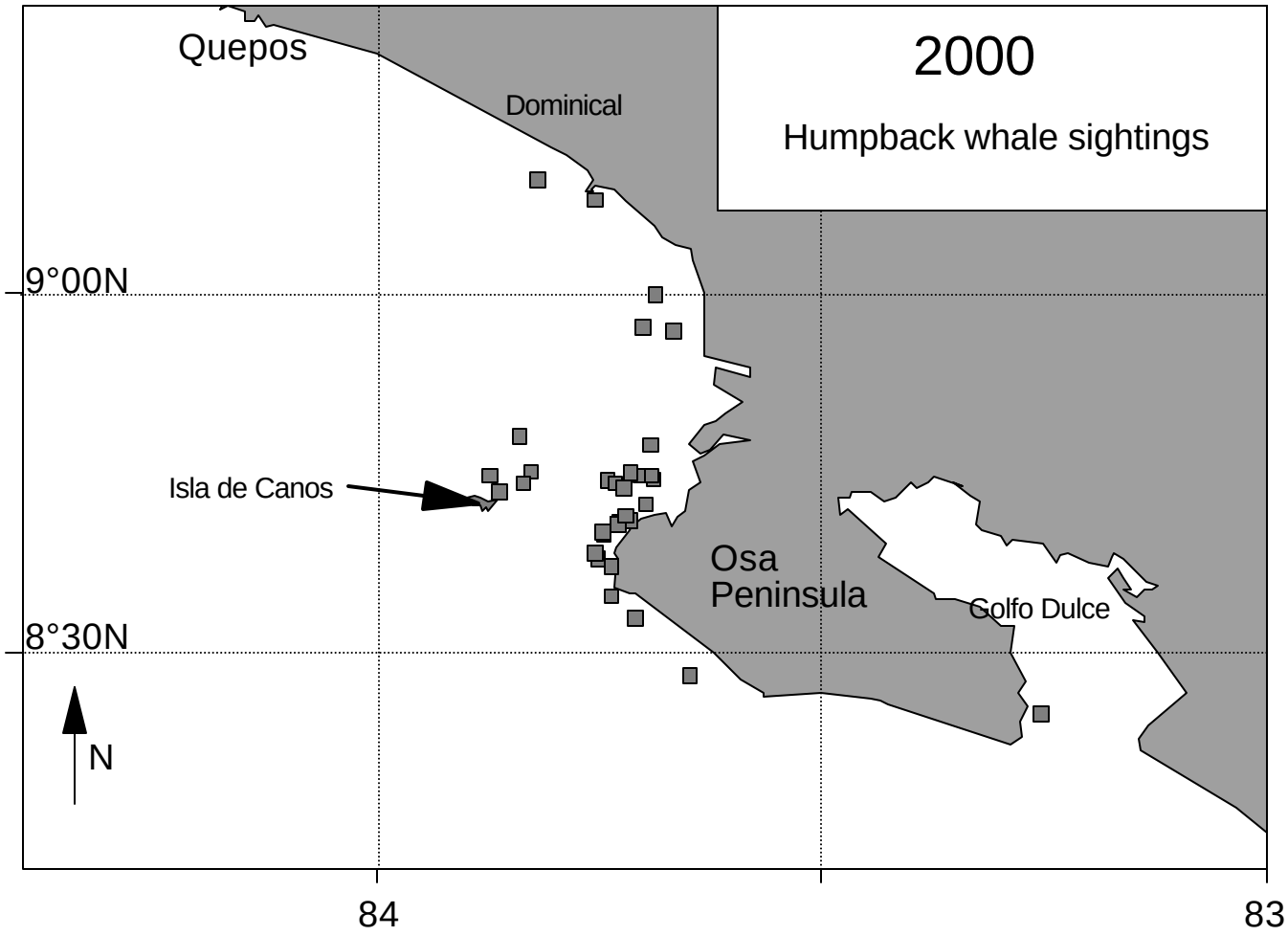

Figure 3. Locations where humpback whales were sighted in S Costa Rica in 2000.

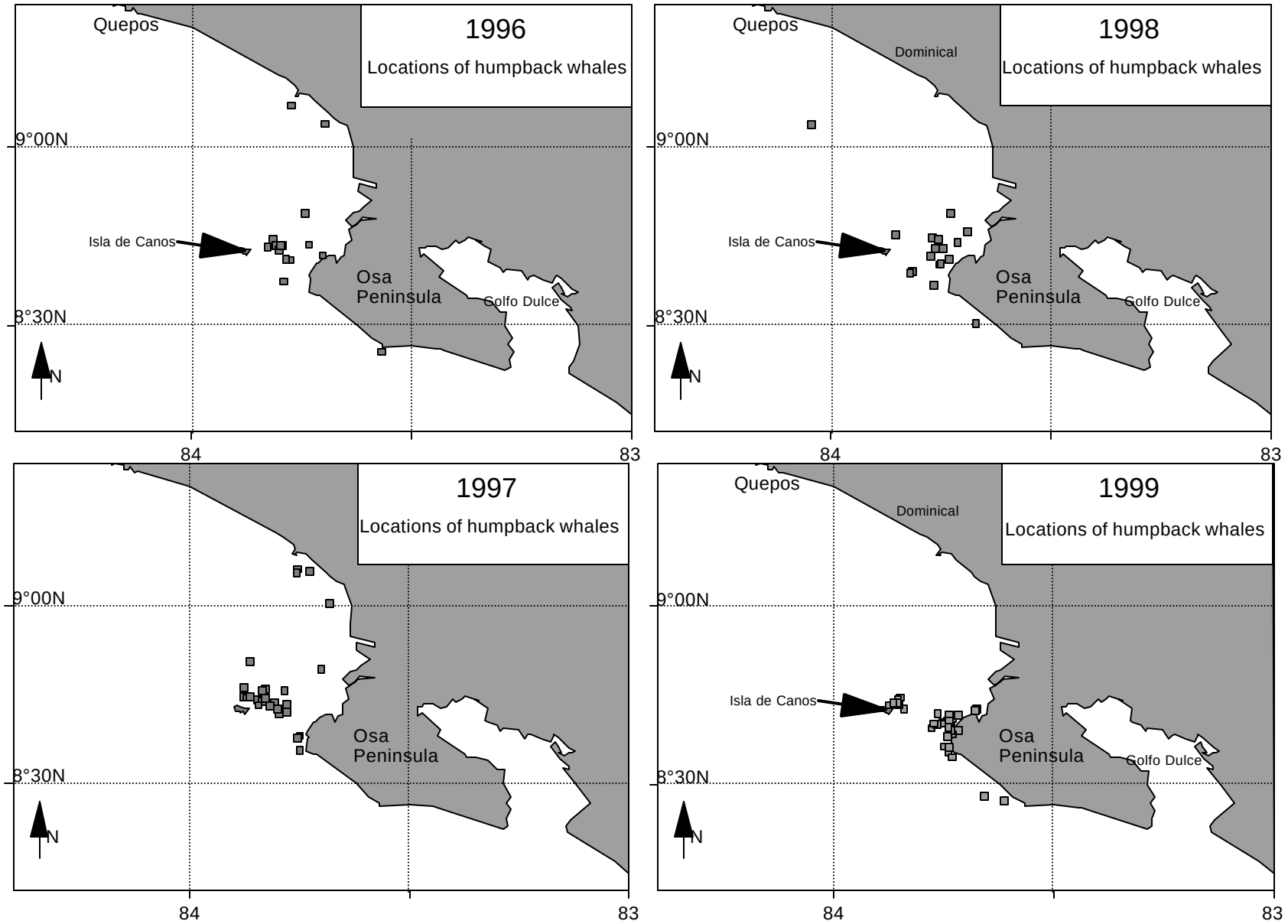

Figure 4. Locations of humpback whale sightings by year, 1996-99.

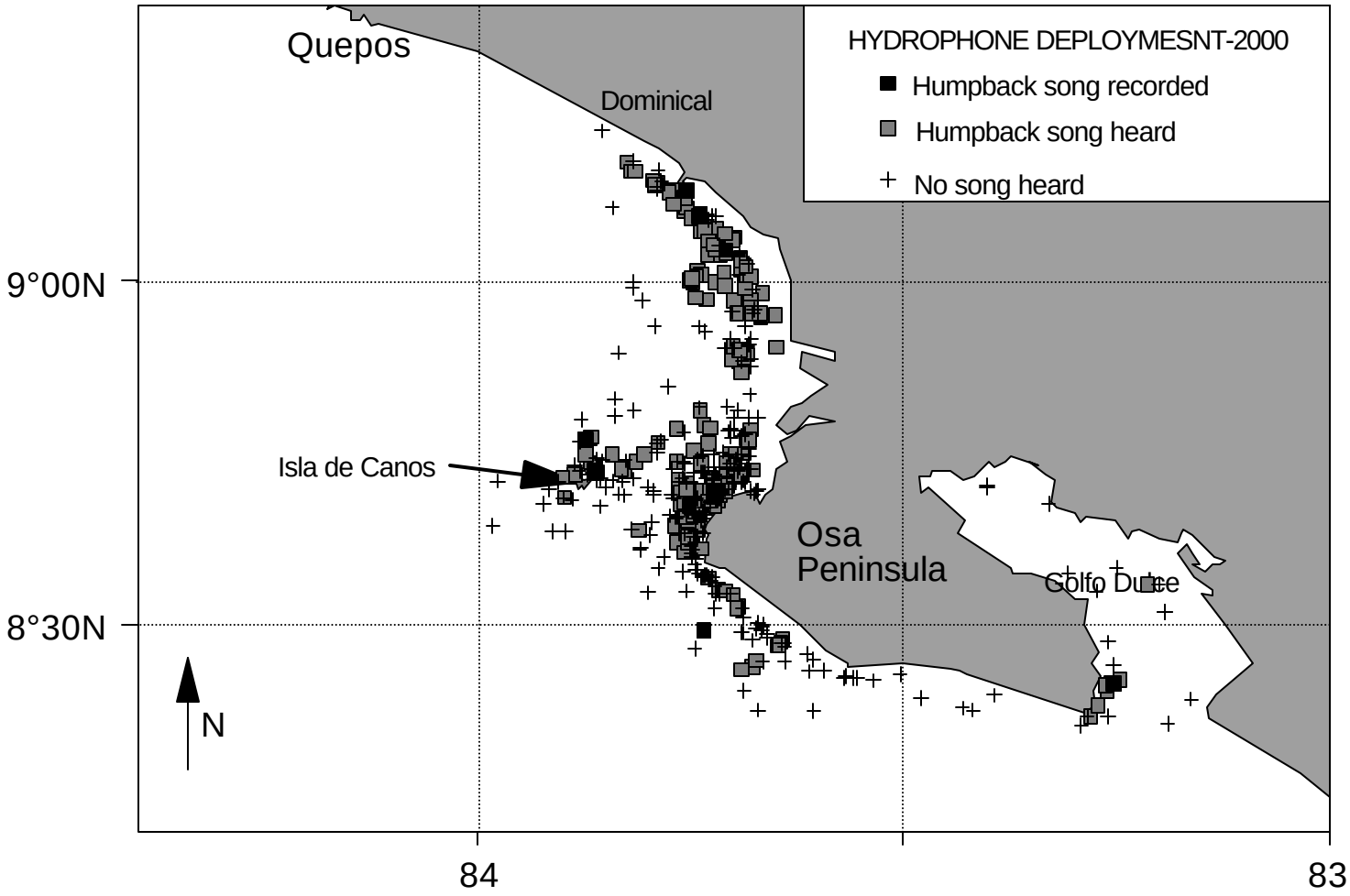

Figure 5. Locations where hydrophones were deployed and results in 2000.