

**HUMPBACK WHALES AND OTHER MARINE MAMMALS OFF COSTA RICA AND
SURROUNDING WATERS, 1996-2001**

**REPORT OF THE OCEANIC SOCIETY 2001 FIELD SEASON
IN COOPERATION WITH ELDERHOSTEL VOLUNTEERS**

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INTRODUCTION

Since 1996, Cascadia Research has been conducting research on humpback whales and other marine mammals off the Pacific coast of Costa Rica and surrounding areas of Central America. In January and February 2001, we continued this research for the sixth field season in collaboration with the Oceanic Society and with Elderhostel volunteer support. 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 2001 and also includes some of the closely related effort we conducted before and after these trips in northern Costa Rica and Panama. To make this report of broadest possible value, we also summarize the results from all six years of research in this region and consider the significance of the findings in relation to our research off the west coast of the United States.

The primary effort in conjunction with Oceanic Society Expeditions, and Elderhostel volunteer support, consisted of boat surveys based from Drake Bay, Costa Rica for three weeks in 2001 (effort in 1996 to 2000 have ranged from two to four week-long programs each year). All of these have been conducted in January and February. 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 was conducted in the 1990s that it became clear that some humpback whales from the North Pacific were also using Costa Rican waters 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

The primary small boat surveys in all six years (1996-2001) were conducted from Drake Bay Wilderness Camp on the north side of the Osa Peninsula, Costa Rica, located in the southwestern section of the Pacific coast (Figures 1 and 2). The boats used were 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 24 dedicated boat surveys and 1 opportunistic survey were conducted on 13 days in 2001 between 24 January and 11 February (Tables 1 and 2). Additionally, 3 days of surveys were conducted in the Gulf of Papagayo in northern Costa Rica on 19-21 January and 4 days of surveys were conducted in Panama on 14-17 February (Figure 1). The Drake Bay surveys covered 1,990 nmi and all surveys covered 2,374 nmi of effort (Table 2) and encompassed much of the southwest coast of Costa Rica in addition to coverage in northern Costa Rica and northern Panama (Figure 1). Surveys out of Drake Bay predominately covered the area offshore from Drake Bay to Isla del Caño, north to Dominical, and southeast into Golfo Dulce (Figure 2). Survey effort in past years in southern Costa Rica 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 1, Figure 2). Although a similar number of surveys were conducted in 2001, slightly more distance was covered in the surveys than past years. This was due to our success in completing all the long range trips planned and also our new procedure of having one boat make two trips on some days (see below).

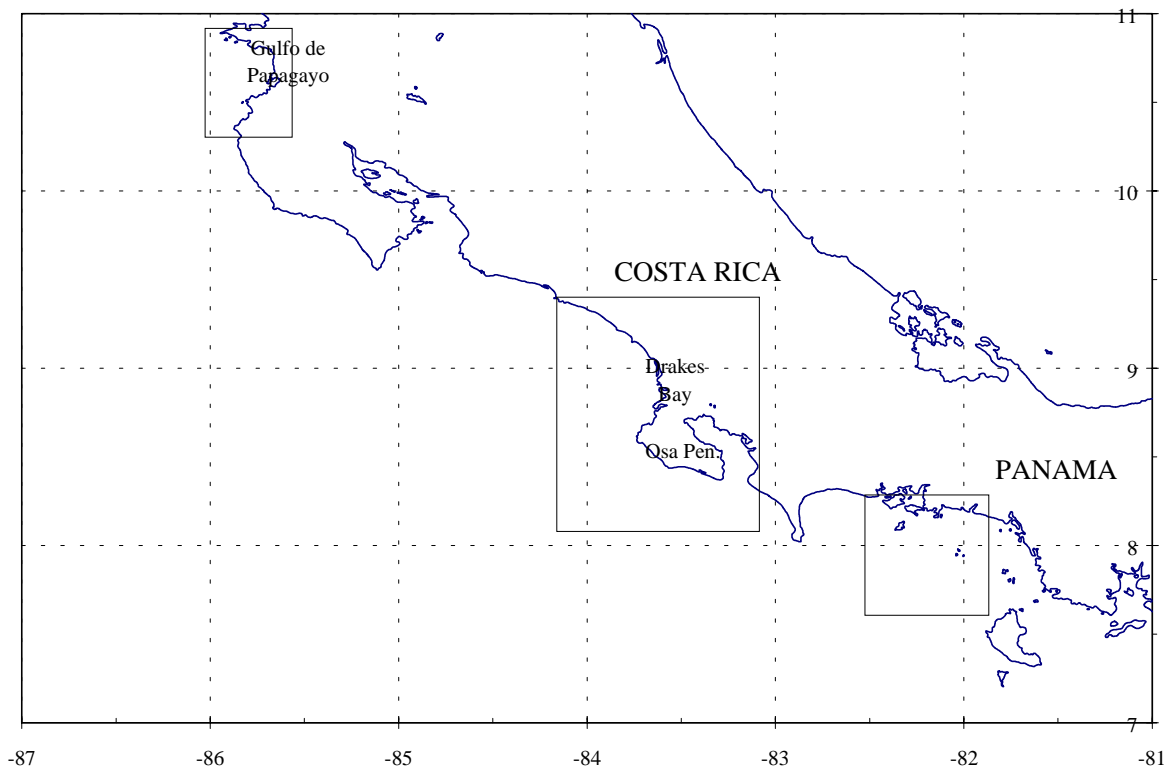


Figure 1. Study areas in Central America in northern and southern Costa Rica and Panama.

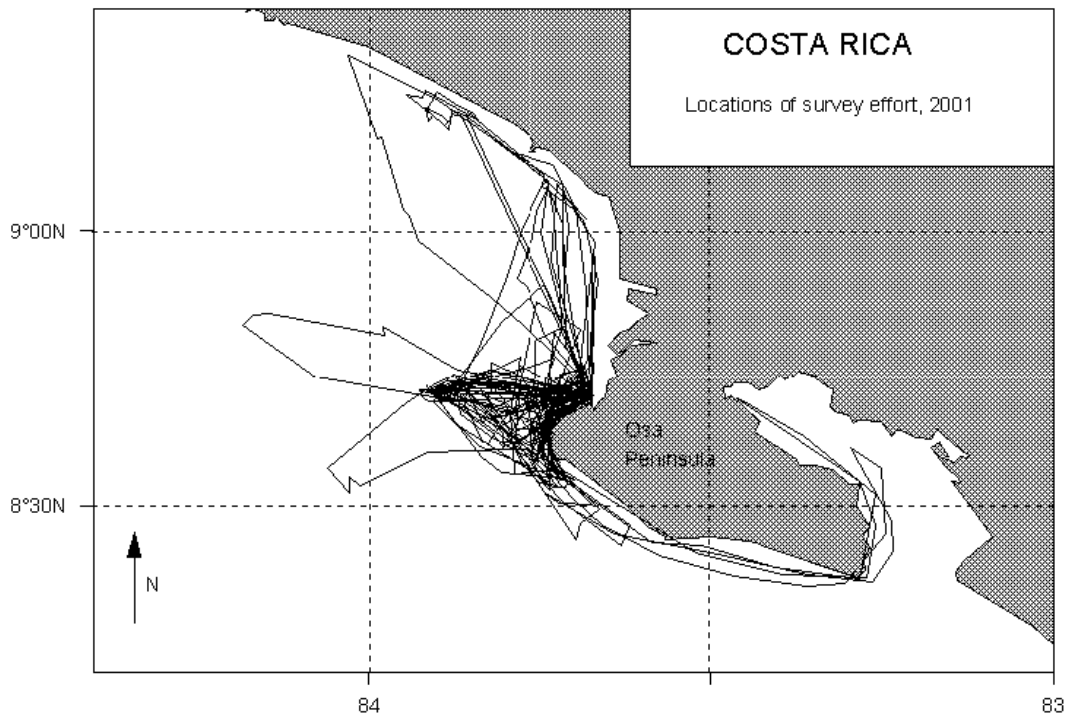


Figure 2. Detail of survey effort in 2001 out of Drake Bay in southern Costa Rica.

Table 1. Summary of survey effort and humpback whale sightings off southern Costa Rica.

	Year								Total
	1996	1997	1998	1999	2000	2001			
						Drakes	Other	Total	
Survey effort									
Start date	26-Jan	31-Jan	24-Jan	27-Jan	25-Jan	23-Jan	19-Jan	19-Jan	
End date	16-Feb	14-Feb	18-Feb	7-Feb	13-Feb	11-Feb	17-Feb	17-Feb	
Days with surveys	15	10	15	10	16	13	7	20	86
Total boat surveys	26	18	27	18	30	25	7	32	151
Survey nmi	1,581	1,205	1,734	1,249	1,738	1,990	384	2,374	9,880
Humpback sightings									
Sightings	15	27	18	32	29	28	5	33	154
Animals	19	45	25	60	46	59	8	67	262
Days whales seen	10	10	8	10	15	10	2	12	65
Surveys whales seen	13	14	12	15	22	16	2	18	94
Sighting rates									
Percent of days whales seen	67%	100%	53%	100%	94%	77%	29%	60%	76%
Percent of surveys whales seen	50%	78%	44%	83%	73%	64%	29%	56%	62%
Whales/survey	0.73	2.50	0.93	3.33	1.53	2.36	1.14	2.09	1.74
Whales per nmi	0.012	0.037	0.014	0.048	0.026	0.030	0.021	0.028	0.027

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

Other effort in 2001 includes 3 days effort in northern Costa Rica (19-21 January) and 4 days in Panama (14-17 February)

Table 2. Summary of survey effort, sightings, and identifications in Costa Rica and Panama in 2001.

Date	Leader	Time Start	Time End	Duration (h)	nmi	Humpbacks sight.	#	#ID	ID's	Other species	Comments
Northern Costa Rica											
19-Jan	John	7:10	15:52	8.7	55.8	3	4	0		Sa	Vessel Felussi
20-Jan	John	7:30	11:15	3.8	43.5	0	0	0		Sa	Vessel Felussi
21-Jan	John	7:39	12:00	4.4	18.8	0	0	0		Sa	With OTS group
Drake Bay											
23-Jan	John	8:45	8:45	0.0	Air	1	3	0			Flying into Drake Bay
24-Jan	John	8:00	17:12	9.2	33.0	3	5	2	11408, 12001	Sa	Singer heard
24-Jan	Frank	8:00	17:00	9.0	69.7	0	0	0		Sa	Singer heard
25-Jan	John	7:40	17:35	9.9	88.4	2	5	4	11447, 11449, 10213, 9042	Sa	Singer, song recorded
25-Jan	Frank	8:16	17:15	9.0	73.5	0	0	0		Sa	
26-Jan	John	7:45	9:45	2.0	27.5	0	0	0			Survey from Corcovado to Drake Bay
27-Jan	John	7:16	17:39	10.4	99.1	0	0	0		Sa, Pc	
27-Jan	Frank	7:13	17:05	9.9	134.3	0	0	0		Sa	Survey Golfo Dulce
28-Jan	John	7:30	16:45	9.3	68.8	2	3	2	9042, 10941	Sa, Tt	Also Unident. whale
28-Jan	Frank	7:35	17:36	10.0	28.6	2	3	2	9042, 10941		Singer
31-Jan	Kristin	7:43	16:58	9.3	63.1	2	2	2	10213(sing?), 0520 (sing?), 1	Sa, Pc	Pseudorca w/ humpback, 2 singers
31-Jan	Frank	7:48	17:20	9.5	50.2	3	5	1	11445 (cow)	Sa	one mother calf pair
1-Feb	Kristin	7:54	16:36	8.7	68.0	2	6	2	10825 (esc.), 10213 (esc.)	Sa	2 mother/calf groups, 1 w/ 2 escorts
1-Feb	Frank	7:48	17:15	9.5	84.8	3	5	0		Sa, Tt	2 singers, 1 mother/calf/escort trio
3-Feb	Kristin	7:31	17:40	10.2	141.5	1	3	0		Sa, Tt	Mother/calf/escort, to Golfo Dulce
3-Feb	Frank	7:38	16:55	9.3	100.6	0	0	0			
4-Feb	Kristin	7:42	16:36	8.9	90.1	0	0	0		Sa	
4-Feb	Frank	7:44	16:32	8.8	90.0	0	0	0		Sa, Tt	Survey Isla Ballena
7-Feb	Kristin	7:58	17:35	9.6	63.4	2	6	2	10731 (esc.), 10213 (esc.)	Sa, Tt	One mother calf escort trio
7-Feb	Frank	7:55	17:13	9.3	96.3	1	3	0		Sa, Tt	Two mother calf escort groups
8-Feb	Frank	7:56	16:54	9.0	81.6	1	2	0			Mother calf pair
8-Feb	Kristin	7:52	16:58	9.1	91.6	0	0	0		Sa, Ud	
10-Feb	Kristin	7:44	16:55	9.2	80.6	1	2	0		Sa, Tt	Mother calf pair
10-Feb	Frank	7:38	16:52	9.2	96.1	1	3	2	10547 (cow), 10557 (esc.)	Sa, Tt	Mother/calf.escort group
11-Feb	Kristin	7:54	17:15	9.4	83.9	1	3	2	10213 (esc.), 11446 (calf)	Sa, Tt	Mother calf escort group
11-Feb	Frank	7:52	17:15	9.4	85.2	1	3	2	10213 (esc.), 11446 (calf)	Sa	Same as Kristin's sighting
Panama											
14-Feb	Kristin	8:44	15:00	6.3	55.4	0	0	0		Tt	Singer heard
15-Feb	Kristin	7:12	14:50	7.6	72.0	0	0	0		Tt	
16-Feb	Kristin	7:12	15:05	7.9	64.7	2	4	2	10143 (esc.), 11448 (single)	Sa	Mother/calf/escort trio
17-Feb	Kristin	8:29	14:51	6.4	73.8	0	0	0		Sa, Tt	
S Costa Rica surveys			25	227	1990	28	59	23			
All effort			33	272	2374	34	70	25			

Sa-spotted dolphin (*Stenella attenuata*), Tt-bottlenose dolphin (*Tursiops truncatus*), Pc-False killer whale (*Pseudorca crassidens*)

Three teams of volunteers assisted in observing for marine mammals as well as collecting the data in 2001. 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.

One boat would generally attempt to survey more distant regions and one boat would work more locally. Destinations for the longer trips included Dominical to the north, Golfo Dulce to the south, and a number of offshore areas to the northwest and west. For the first time in 2001 the boat operating in more local waters would often come in midday and go back out a second time in the afternoon, allowing a change of personnel. This allowed this boat to cover more ground than was possible without a personnel change.

Photographic identification

All humpback whales 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 raised 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

Acoustic monitoring and recording has been conducted as part of our surveys, although there have been some changes over the years. Survey boats from 1998 to 2001 each had a hydrophone to listen for and record vocalizations of humpback whales while in 1996 and 1997 only a single hydrophone was available. The primary hydrophones used over the last few years (incl. 2001) were those designed by Bev Ford (Offshore Acoustics). These hydrophones from Offshore Acoustics had a sensitivity of $-154 \text{ dBV/uPa} \pm 4 \text{ dB}$ at 100 Hz, and frequency response from 6 Hz to 14 kHz of $\pm 3 \text{ dB}$. 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 or D8 DAT recorder (frequency response 20-14,000 Hz, 32 Hz sampling rate). A few recordings in past years were made on 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.

On the initial trips in 2001 we experimented with use of a DIFAR sonobuoy to determine direction to a singing whale using this single hydrophone. We used a modified DIFAR sonobuoy (adapted for multiple deployment and direct recording of signal into a DAT) and several software programs and code developed by Mark McDonald of Whale Acoustics. While we obtained good recordings of whales with this system, we were not successful getting accurate readings to the calling whale (see results).

Measuring sizes of whales

In 2001 we continued an effort began in 2000 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

Overall we had good success sighting and identifying whales in 2001 compared to previous years (Tables 1 and 2). The number of sightings during the surveys out of Drake Bay (28 sightings of 59 whales) was higher than in most past years. Even adjusting for our increased effort in 2001, the rate at which we saw whales (sightings on 77% of days and an average of 2.4 whales per survey or 0.03 whales per nmi) were slightly higher than the average for all years (Table 2).

The distribution of whale sightings in 2001 was similar to past years in that most whales were found between the mainland and Isla del Caño (Figure 3). One difference from past years was the larger number of sightings off Isla Ballena and Dominical to the north. Whales were regularly seen in these more northern areas despite our more limited effort there.

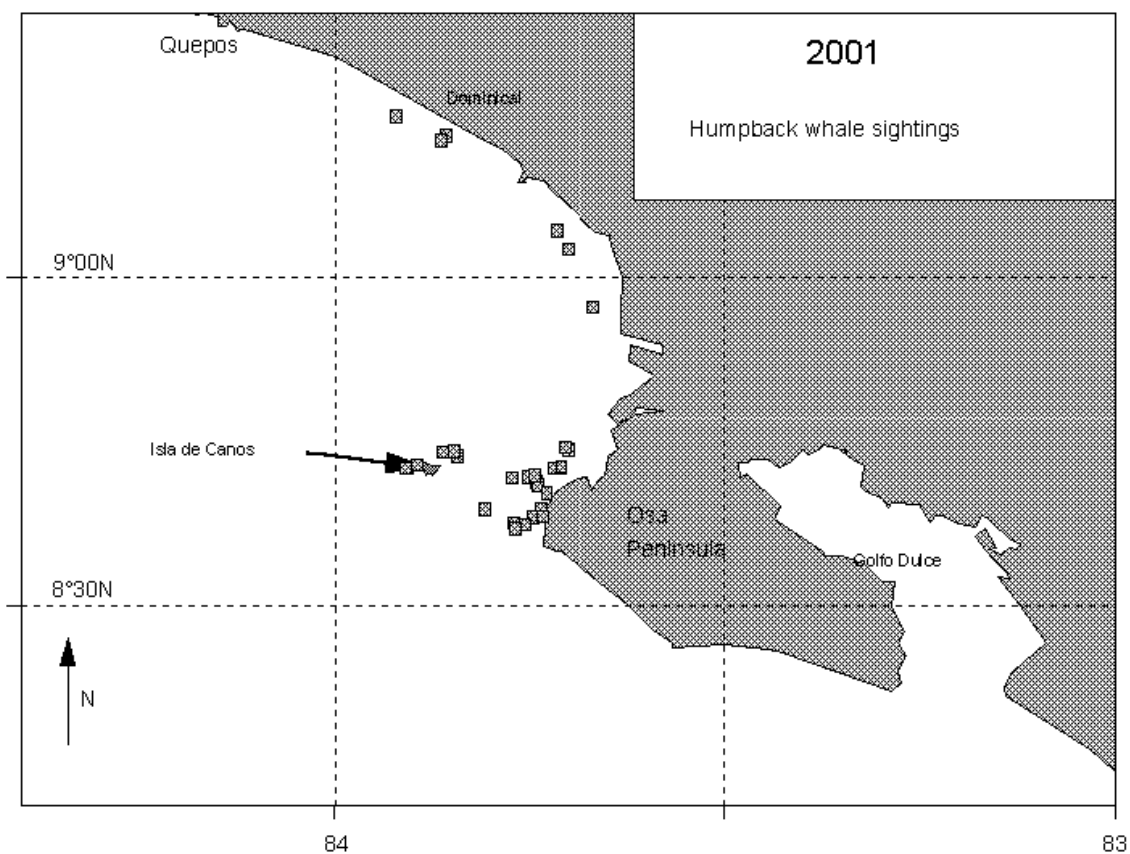


Figure 3. Locations humpback whales were seen in 2001 off southern Costa Rica.

Our success in finding whales in northern Costa Rica and Panama during our scouting trips in 2001 was not as high as off Drake Bay. We had success finding whales in both northern Costa Rica and in Panama but only on a minority of the days we searched (2 of 7 days). These areas do show promise, however, because when we found whales we had numerous sightings. Our lower

success rate in these initial scouting trips was likely more a function of logistical limitations in the boats we used and also in not having yet determined the best areas to search for whales.

A good mix of group types was seen in 2001 including single singing whales, and cows with calves (sometimes with one or two escorts). The composition of the animals seen in 2001 consisted more heavily of mother/calf/escort groups (10 of 33 or 30%) than had been common in past years (Table 3). Single singing and non-singing whales were also common accounting for a combined 33% of sightings, just slightly lower than the average for past years. Although the proportion of sightings that were mothers with calves was slightly lower than past years, the inclusion of cow/calf groups containing escorts, The proportion of groups containing a cow and calf (42%) was higher in 2001 than past years although more of these were groups also contained an escort than had been typical. The proportion of cows may be underestimated because some females may have been pregnant but 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.

Table 3. Group composition of humpback whale sightings in study area off Costa Rica, 1996-2001.

	1996		1997		1998		1999		2000		2001		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Lone singers	5	33%	2	7%	7	39%	5	16%	14	48%	8	24%	41	27%
Singles	5	33%	6	22%	4	22%	4	13%	6	21%	3	9%	28	18%
Pairs	3	20%	15	56%	5	28%	4	13%	2	7%	7	21%	36	23%
Mother/calf	0	0%	3	11%	2	11%	14	44%	1	3%	4	12%	24	16%
Mother/calf/escort	0	0%	0	0%	0	0%	5	16%	5	17%	10	30%	20	13%
Groups larger than 2	2	13%	0	0%	0	0%	0	0%	1	3%	1	3%	4	3%
Undetermined	0	0%	1	4%	0	0%	0	0%	0	0%	0	0%	1	1%
Total	15		27		18		32		29		33		154	

We have often had a difficult time getting good identification photographs of cows and especially calves, but we had some success with this in 2001. In one of our sightings of a female and calf in 2001 in Costa Rica we were only able to identify the cow (ID#11445) but not the calf. We resighted this pair on 24 June off California (near Pt Buchon) and both whales were identified (calf id#11446) and a size measurement determined.

The overall group composition for humpback whales off Costa Rica is not very different than has been reported in other wintering areas (Table 3). The overall proportion of single animals (singers and non-singers for all five years) in our study through 2001 has been 45%. 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.

Measured water temperatures in 2001 were slightly higher than in past years averaging 29.6°C (n=369, SD=0.6) (Table 4). This difference may not be real since we switched in 2001 to calibrated digital thermometers, and the slight increased readings could be an artifact of this change. The current instruments are more accurate and reliable than those used in the past. Data from other sources will need to be used to verify if temperatures were higher. In 1998, when water temperature readings were also high, our sighting rates of humpback whales were low, something that did not occur in 2001. Water temperatures in Panama were slightly lower than off southern Costa Rica (n=17, mean=29.0, SD=0.3).

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

Year	Water temperature (C)		
	n	Mean	SD
1996	135	28.3	0.8
1997	111	28.2	0.8
1998	205	29.1	0.9
1999	242	27.7	1.1
2000	202	27.9	0.9
2001 N CR		NA	
2001 S CR ¹	369	29.6	0.6
2001 Panama ¹	17	29.0	0.3

¹Instruments used to measure water temperature were changed in 2001 (see text)

Photo-identification

Humpback whales were identified on 25 occasions representing 16 different individual humpback whales in 2001 (Tables 2 and 5). This includes two whales identified off Panama after the end of our Drake Bay surveys. Of these 16 individuals identified in 2001, 4 had been seen previously off Costa Rica and 12 were new identifications for this area.

Table 5. Results of photographic identification research of humpback whales in Costa Rica during winter through 2001.

Description	pre-1996	1996	1997	1998	1999	2000	2001	All Yrs
IDs from OS trips	0	12	19	12	5	25	23	96
Other IDs	5 ¹	4 ²	0	0	23 ⁵	1 ³	2 ⁴	35
Total IDs	5	16	19	12	28	26	25	131
Unique whales	5	13	11	7	27	12	16	76
New whales (not seen prev.)	5	12	10	4	26	7	12	-
No. matching California	4	11	8	6	23	11	13	62
% matching California	80%	85%	73%	86%	85%	92%	81%	82%

¹ Includes 2 IDs by Richard Sears, 2 by Carol Henderson, 2 by Marco Saborio

² Incl. 2 IDs by Herbert Michaud of Drake Bay Wilderness Camp, 1 ID by Bill Muraco, and 1 ID from Panama by Jack Swenson

³ Incl. 1 ID by John Calambokidis from Northern Costa Rica

⁴ Incl. 2 IDs by Kristin Rasmussen from Panama

⁵ Incl. 19 IDs from *Russamee* Central American survey and 2 IDs each from Laura May and Andre Koenig, both in Northern Costa Rica

A high proportion of the whales identified in 2001 had also been seen previously off California (Tables 5 and 6). Out of 16 different whales identified in 2001, 13 (81%) had been seen previously off California between 1988 and 2001. Two of these matches are of the mom with calf (11445 and 11446) first identified in Costa Rica in 2001 that were also seen as a mom and calf off Port San Luis in southern California in June 2001. We have not yet completed analysis and matching of our summer and fall 2001 identifications from California, so this match was found incidentally and we may find additional matches once we complete comparison of the California 2001 photographs.

Table 6. Humpback whales identified in 2001 in Costa Rica in January and February 2001 with summary of sighting histories.

ID	CR 2001 dates	Role	Yrs seen C. Amer.	Sightings in California			Comments
				#	Locations	Years	
9042	25,28 Jan	singer & pair	No	11	SCB SBC SL	88 95 97 00	Size in Calif.
10143	16 Feb	Escort	CR 99	20	MB GF PSG	87 90-3 95 99	Panama
10213	25,31 Jan 1,7,11 Feb	Escort, grp., singer?	MX 85,86,90	16	MB GF FB PSG	88 90-2 94 96 99 00	
10520	31 Jan	Singer?	CR 99	18	SBC SL HM GF NC	91-3 95 98-00	Mom in 95
10547	10 Feb	Cow	No	7	SL MB HM GF	91 93 97 98	
10557	10 Feb	Escort	CR 98	12	SL GF	91-5 98	Friendly in 95
10731	7 Feb	Escort	CR 96	14	MB HM GF	93 95-00	Calf? in 93, singer 96
10825	1 Feb	Escort	No	4	SBC GF	95 98	Calf of 10184 in 95
10941	28 Jan	Single to pair	No	13	SBC MB	96 98-00	
11408	24 Jan	Pair	No	1	MB	00	
12001	24 Jan	pair	No	6	GF FB NC OR	90 92 94 98	
11445	31 Jan, 11 Feb	Cow	No	1	SL	01	Cow of 11446, size from CA
11446	31 Jan, 11 Feb	Calf	No	1	SL	01	Calf of 11445, size from CA
11447	25 Jan	grp of 4	No	0			
11448	16 Feb	single	No	0			Panama
11449	25 Jan	grp of 4	No	0			

Locations (from south to north): SCB-S California Bight, SBC-Santa Barbara Channel, SL-San Luis, MB-Monterey Bay, HM-Half Moon Bay, GF-Gulf of Farallones, FB-Fort Bragg, NC-N California, PSG-Pt. St. George, OR-Oregon.

A pattern we had noted in the past was that whales that winter off Costa Rica are more likely to be seen feeding off southern California and those wintering off Mexico were more likely to be seen feeding off northern California, Oregon, and Washington. A number of the whales identified off Costa Rica in 2001, however, do not follow this pattern. Four of the whales we saw in

Costa Rica in 2001 have been seen farther north than typical including off northern California (from Cape Mendocino to Pt. St. George) and Oregon (Table 6). Areas off southern California were still common feeding areas for these whales with eight of them seen in the southern California Bight (especially the Santa Barbara Channel) or off Port San Luis. The most common feeding area for these whales remained off central California (Monterey Bay to the Gulf of the Farallones) where 10 of them had been seen (Table 6).

The 2001 field season also provided additional data on migratory transits of these whales. Six of the whales we identified in Costa Rica had been identified off California the previous feeding season (summer-fall 2000) and at least two (likely more when matching is completed) were seen in California early in summer of 2001. These transits add to a growing set of data on migration distances and timing. The farthest north Costa Rica whales have been seen (ID#10583 and 12001) is near Newport, Oregon, 5,524 km north of where they were seen in Costa Rica. 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 is 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 (Calambokidis *et al.* 2000). 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.

The total number of different individuals that has been identified off Central America (primarily S Costa Rica but including some from S. Mexico to Panama) in winter months now is 76 (Table 5). The rate with which we have matched these whales to those we know from our research off California remains high (Table 5). Of the total of 76 different humpback whales off Costa Rica, 62 (82%) have been seen 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.

Humpback whale song and gender differences

We obtained a number of recordings of humpback whale song in 2001 during both the winter field season as well as the summer field season (Tables 7 and 8). Humpback song was heard

frequently during the limited field effort off northern Costa Rica in January 2001. Singing was heard less often during our Drake Bay field effort off southern Costa Rica in 2001 compared to other areas and years (Table 7). Singing was heard often during in late January 2001 but the overall proportion of the time song was heard was low because singing was relatively infrequent during the first and second weeks in February 2001. Song was frequently heard during the field effort in late February 2001 in Panama as well (Table 7). 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.

Table 7. Proportion of hydrophone deployments in which humpback whales were heard. Results are biased upwards by more frequent deployments when locating a singing whale.

Year	Hydrophone deployments		
	n	Song heard	%
1996	79	19	24%
1997	82	13	16%
1998	255	54	21%
1999	238	52	22%
2000	455	193	42%
2001 N CR	30	17	57%
2001 S CR ¹	368	48	13%
2001 Panama ¹	57	18	32%

Table 8. Times and locations of recordings of humpback whale songs, 2001.

Date	Time	Latitude	Longitude	Tape track	Comments
19-Jan-01	10 13-10 50	10 48.00	85 55.77	Tape 01-1 Pr.1	No ID
24-Jan-01	11 36-11 38	8 42.50	85 43.18	Tape 01-1	No ID
25-Jan-01	13 06-13 14	8 13.09	83 52.60	Tape 01-1	DIFAR ID 9042
25-Jan-01	15 06-15 29	8 12.64	83 51.40	Tape 01-1	ID-9042
25-Jan-01	15 30-15 33	8 12.64	83 51.40	Tape 01-1	DIFAR ID-9042
31-Jan-01	10 14-10 34	8 40.0	83 45.1	Tape 01-2 Pr. 1	Likely ID 10213
01-Feb-01	13 02-13 29	9 14.54	83 56.63	Tape 01-2 Pr. 2	No ID
16-Aug-01	08 12-08 35	8 40.33	83 45.37	Tape 01-08-1 Pr. 2	
16-Aug-01	12 52-13 22	8 40.73	83 44.90	Tape 01-08-1 Pr. 5	
17-Aug-01	09 08-09 33	8 37.69	83 45.54	Tape 01-08-2 Pr.1	
17-Aug-01	13 51-14 21	8 39.65	83 49.43	Tape 01-08-2 Pr.2	
20-Aug-01	09 38-10 40	8 42.88	83 47.28	Tape 01-08-2 Pr.3	

The lower occurrence of humpback songs made it harder to positively identify singers in 2001. One singer was identified (9042) and in another case we thought we had likely identified the singer (10213). 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.

Sizes of whales

A total of 14 measurements of at least six different whales were obtained using a combination of photography and distance measurements from the laser range finder (Table 9). Six duplicate measurements were obtained of one whale (ID#10213) and despite some variation in the

angle of perpendicular showed fairly good agreement (3.77 to 4.66 m). A mother and calf seen Costa Rica were both measured when they were resighted in California on 24 June 2001.

Table 9. Summary of fluke measurements made during Costa Rica surveys in 2001.

Date	Ves	SN	Pho	Roll	Fr.	ID	Behavior	Dist	Caveat	Meas fluke	Fluke width	Deg off Perp.	Side off
24-Jan-01	R	3	JAC	1	27	12001	non-singing pair	84		9.8	2.84	40	L
24-Jan-01	R	3	JAC	1	33	PQ	non-singing pair	57	R tip est	20.5	4.04	10	L
24-Jan-01	R	3	JAC	1	34	PQ	non-singing pair	104		9.9	3.54	30	R
28-Jan-01	R	2	JAC	2	32a	10941	Non-singer in pair	164	distant	4	2.25	0	
25-Jan-01	R	2	JAC	2	9a	10213	1 of 4	96		12.6	4.16	10	L
25-Jan-01	R	2	JAC	2	10a	11449	1 of 4	84		7.9	2.29	20?	L
25-Jan-01	R	2	JAC	2	12a	10213	1 of 4	200		5.5	3.77	10	R
25-Jan-01	R	2	JAC	2	26a	11447	1 of 4	164		7.5	4.22	15	L
25-Jan-01	R	2	JAC	2	28a	11447	1 of 4	83		12.3	3.52	10	R
31-Jan-01	K	5	KR	1	15	10520	singer	117	Chp R	10.6	4.26	10	R
1-Feb-01	K	1	KR	1	34	10213	escort (M/C/E/E)	127		9.4	4.10		
1-Feb-01	K	1	KR	1	35	10213	escort (M/C/E/E)	119		11.4	4.66		
1-Feb-01	K	1	KR	2	4	10213	escort (M/C/E/E)	118		10.7	4.34		
7-Feb-01	A	6	KR	2	32	10213	escort	82		16	4.52		
Resightings off California													
24-Jun-01	N2	162	JAC	22	28a	New	calf	44		19.3	2.94	10	R
24-Jun-01	N2	162	JAC	22	29a	11445	cow	50		25.2	4.36	0	

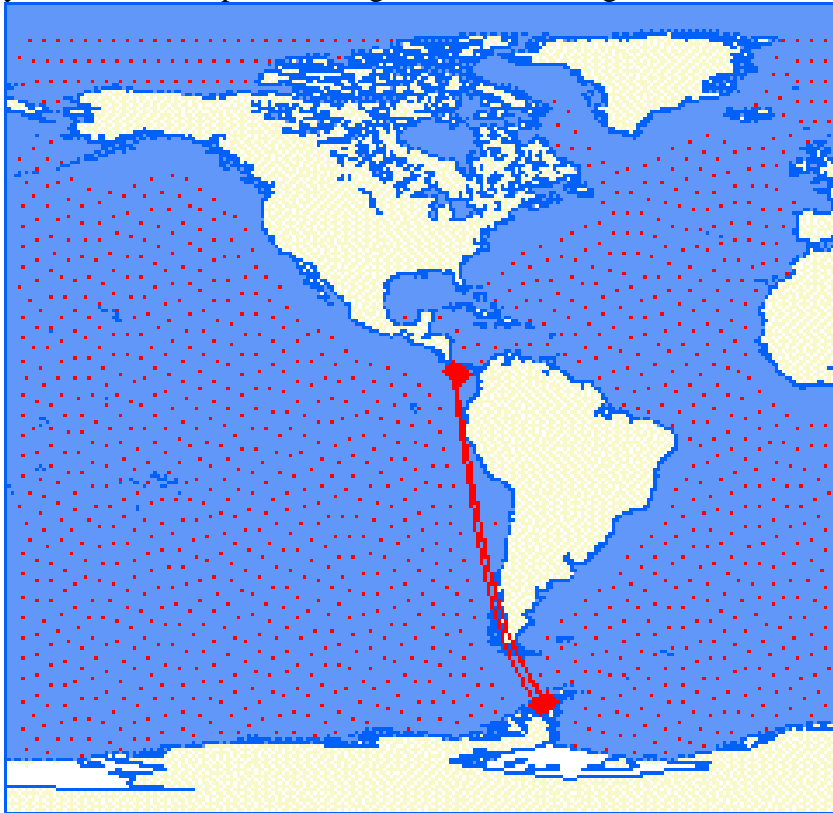
There were several measurements that suggested problems with the distances obtained in the field or unusual fluke sizes. A distant photograph of ID#10941 yielded a very low measurement suggestive of a calf even though this is an animal who has been seen multiple times. Another measurement of a whale in a group of four (ID#11449) also came out very low but there was some uncertainty of the angle off perpendicular and this was thought to be 20° or more off potentially biasing the measurement. This information along with measurements obtained off California indicates there are often problems with measurements taken at ranges of greater than 80m and also that angle off perpendicular is often greater than estimated in the field (Calambokidis et al. 2001).

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 (and age class) 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.

Southern Hemisphere surveys

Some of the most exciting findings from this past year have come from our new efforts to document use of Central American waters by Southern Hemisphere whales. These included findings of a new record for mammalian migration that we reported at the recent Biennial Conference on the Biology of Marine Mammals (Rasmussen et al. 2001). While we had been keeping track of sightings during this period obtained by collaborators in Costa Rica, this year we added dedicated surveys during the Southern Hemisphere wintering season (N Hemisphere summer). We conducted three surveys out of Golfo Dulce, 4 surveys out of Drake's Bay, 3 surveys at Isla Ballena, and 3 surveys in northern Costa Rica in three-week period in August 2001. In the Southern hemisphere, humpback whales feed in Antarctic waters during their summertime (December-April), and travel north to warmer waters during their wintertime (July-October). Since we started doing research in Costa Rica we were aware that whales were seen year round, with peaks during the two wintering seasons for both hemispheres.



We now have a total of 15 identification photographs taken off of Costa Rica during the southern hemisphere wintering season. Ten of these were collected this year, and 5 were collected from previous years by collaborator Marco Saborío. Of these 15, we have found three whales that have also been photographed off the Antarctic Peninsula (Figure 4). Not only does it firmly establish that whales seen during this season off of Costa Rica are migrating from Antarctica, but it also sets a new record for the longest migration by an

individual mammal. The one-way migration between these two places is approximately 8,400 kilometers.

We have also been able to describe the geographic area of overlap that whales from both hemispheres are using as a wintering area off of Central America. Along with our collaborators, we have documented whales from both hemispheres throughout the coasts of Costa Rica and Panama. This area of overlap is much bigger than was previously thought, and is the only area known in the world where whales from both hemispheres inhabit the same area during their wintering season.

Although there are two distinct peaks of sightings that correspond with the two different wintering seasons, sightings of humpback whales have been reported year round off of Costa Rica. Although the chances are slim, it is possible that whales from the two hemispheres could encounter each other. Genetic research has shown that there has been some interchange between these two populations sometime in the past, and it's likely that this wintering area off of Costa Rica is where this genetic interchange occurred.

Other marine mammals

Sightings of other species besides humpback whales were not as varied in 2001 as most past years (Table 10). Only three other species were confirmed during our surveys in 2001. These sightings are still 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 2001 and a brief summary from the data from all years for each species is provided below.

Table 10. Summary of sightings of marine mammals in 2001.

Species	Sightings		Photo-identified	
	number	animals	sightings	animals
Humpback whale	36	71	18	26
Unidentified whale	1	1		
False killer whale	3	66		
Spotted dolphin	74	1393		
Bottlenose dolphin	17	177		
Unidentified dolphin	10	33		
All species	141	1741	18	26

Large baleen whale sighting

Although no large baleen whales other than humpback whales were seen in 2001 there have been sightings in past years. 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 three sightings of a total of 66 false killer whales in 2001. This species has been seen in past years with sightings in 1996, 1998, and 2000. 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 Drake 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. 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), two of them in 2001. Spotted dolphins remained by far the most frequently seen marine mammal species in our surveys accounting for 74 sightings of 1,393 animals in 2001 alone. This is similar to most past years although slightly lower than the record number seen in 2000. 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 17 times (total of 177 animals) in 2001 and have been seen all years of the study and throughout the study area. Many of our sightings of this species over the years have come from more peripheral areas of our effort suggesting they are not as common around Isla del Caño as in some other areas. Bottlenose dolphins were often sighted 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).

Rough-toothed dolphins were not seen in 2001 but have been seen occasionally in past years. 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 but not in 2001. 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 over the years 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. In 2001 we saw a wide mix of animals with singers common early in the season but less so later. In contrast, both 1999 and 2000 were been years with high numbers of sightings, especially mothers and calves in 1999 and singletons (mostly singers) in 2000.
- North Pacific humpback whales inhabit a broad region of Central America extending south from the wintering grounds previously described in Mexico all the way to Panama. There is also some evidence of site preferences with some whales returning in multiple years to the Drake Bay area.
- Humpback whales from this region are almost exclusively animals that use the California, Oregon, and Washington feeding area with some tendency for animals from Central America to feed in the more southern portions of this 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 five 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.

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Team 1

January 22-29, 2001

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Marge Caldwell
Harriet Chapman
Barbara Hutchens
Jan Johnson
Tom and Cynthia Langan
Michael and Jane Marsh
Richard and Beverly
Radcliffe
Freja Wagner
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January 29-February 5

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Frank Garita- Leader
David and Vicky Beatty
Willard and Leanne Bruss
Edward Bzowski
Jean Danz
Jim and Nathalie Diener
Adrienne Greenstein
Mary Ann Gruber
Lynn Shyevitch
Bob Stenard

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February 5-12

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Frank Garita- Leader
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Janet David
Benita Galer
Karen Lenz
Margaret Murray
Elizabeth Nelson
Larry Richman
Michael and Maureen
Samson
Jerry and Ruth Vurek
Bernie Wides

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