ANNUAL REPORT FOR 2003

RESEARCH ON LARGE WHALES
OFF CALIFORNIA, OREGON, AND WASHINGTON IN 2003

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report summarizes fieldwork conducted by Cascadia Research and collaborators in 2003 on humpback, blue, fin and gray whales off California, Oregon, and Washington and also summarizes work conducted under NMFS permit #540-1502-00 in 2003. Principal support for this research was from Southwest Fisheries Science Center to assess population size and trends (Contract # 50ABNF100065) with additional support from Office of Naval Research, Office of Naval Operations, National Marine Mammal Laboratory, and the Olympic Coast National Marine Sanctuary.

Identification photographs in 2003 came from a number of sources and survey types including 65 days of dedicated research surveys under Permit 540-1502-00 conducted by Cascadia Research off California, Oregon, and Washington. Photographic identification was also conducted on either an opportunistic basis by others who provided photographs to Cascadia or as part of collaborative research under other permits.

A total of 542 humpback whale identifications were obtained in all effort off California, Oregon, and Washington in 2003 representing 398 unique individuals. Of the 398 identified whales, 98 were seen two or more times during the year. Rates of interchange of animals were highest among adjacent years and decreased progressively with distance to the north or south. Abundance estimates of humpback whales from mark-recapture revealed a surprising jump to 1,391, about 400 animals higher than any previous estimate. Estimates of humpback abundance along the west coast from our previous work had revealed a steady increase in abundance of about 8% per year through 1998, after which there was a dramatic drop in abundance. The current high estimates appear to be the result of an influx of whales into the region that had not been seen in previous years.

Blue whale identifications were made from southern California to British Columbia in 2003 with 534 identifications of 292 unique individuals in 2003. Movements of blue whales within 2003 were fairly extensive; animals were resighted all along the California coast in 2003. A single blue whale identified off the southwest end of the Queen Charlotte Islands, British Columbia on 7 August 2003 was an animal that had been seen eight times from 1988 to 2001 off California. This is the second animal identified off British Columbia with both matching identifications off California. The only previous whale identified off British Columbia was ID# 1110, seen on 12 June 1997 and then resighted on 1 and 14 July in the Santa Barbara Channel. While 2003 data did not directly contribute to a new estimate of blue whale abundance, we were able to update our most recent estimate from mark recapture to 1,781 blue whales for 2000 to 2002.

Tagging in 2003 consisted of 41 deployments of four instrument packages on blue, fin, and humpback whales. The vast majority of the tag deployments in 2003 were of the Burgess acoustic tag. Deployments in Monterey Bay were conducted in collaboration with Scripps Institute of Oceanography, Moss Landing Marine Labs, and UC Santa Cruz and yielded dive data in conjunction with hydro-acoustic mapping of prey fields. Combined dive, pitch, and roll data from the Burgess tags have provided insights into the diving dynamics of blue whales. These tags have also contributed insights into the vocal behavior of blue whales including

indications that it is only the males that produce the long loud repeated calls generally described for blue whales but that both sexes produce the shorter more variable D-type call. Satellite tag data for the five humpback and two blue whales provided movement data on both species over only about a 2-week period.

A total of 97 skin samples were collected off California, Oregon, and Washington in 2003 under our permit. Of these, 71 were from biopsies and 26 were small pieces of skin collected from the suction-cups and other parts of the tagging apparatus. Skin samples were collected from 40 fin whales, 28 blue whales, 21 humpback whales, and 8 gray whales.

Reaction of whales to the various research activities was generally mild. Most animals that were approached for photographic identification did not exhibit any detectable behavioral reaction to the boat. A total of 51 whales were approached to attach tags and these close approaches for tagging generally resulted in some reaction from the whales, which appeared to be from the close approach of the boat. The most typical response was a suspension of the surface series (where the animal would resurface after a slightly longer surface interval) or a termination of the surface series. There were 103 approaches of animals to obtain a biopsy; a clear reaction to either the approach or the biopsy was seen in slightly less than half of these instances. Reactions were most common to biopsy hits than to misses and humpback whales showed observable reactions at a much higher rate than blue or fin whales.

INTRODUCTION

This report summarizes fieldwork conducted by Cascadia Research and collaborators in 2003 on humpback, blue, fin and gray whales off California, Oregon, and Washington. It also summarizes work conducted under NMFS permit #540-1502-00 in 2003. Cascadia Research has been conducting research on humpback and blue whales off California, Oregon, and Washington using photographic identification of individuals since 1986 under several permits (including permits #855 and 938) and since 2000 under permit #540-1502-00. The purpose of the research has been to examine distribution, abundance, movements, and population dynamics of humpback and blue whales in the eastern North Pacific (Calambokidis and Steiger 1997, Calambokidis *et al.* 1996, 2000b, 2001, 2004, Calambokidis and Barlow 2004) and to examine the use of coastal and inland waters of Washington by gray whales especially in light of proposed native takes of gray whales (Calambokidis *et al.* 2002). A central method has been photographic identification to track individual whales.

Principal support for this research was from Southwest Fisheries Science Center to assess population size and trends as well as reproductive and mortality rates (Contract # 50ABNF100065). Support for several related projects that allowed additional opportunity to obtain identifications photographs and other types of data came from several additional sources:

- Office of Naval Research provided support for some of the tag deployments including National Geographic's Crittercam, and Burgess' acoustic tag on blue whales off California under grant award No. N00014-02-1-0849.

- Support for some of the work off Southern California was provided through a subcontract from Scripps Institute of Oceanography (Purchase Order 10200451) as part of a project on ambient noise and blue whale vocalizations for the San Clemente Offshore Range (SCOR).

- The National Marine Mammal Laboratory provided partial support for some of the gray whale work in Washington and Oregon under Purchase Order #AB133F-03-SE-1058.

- Support was received from the Olympic Coast National Marine Sanctuary for some of the survey work off northern Washington under Purchase Order AB-133F-03-SE-1092

- Several private contributors provided support for conducting the research.

METHODS

Survey regions and coverage

Identification photographs in 2003 came from a number of sources and survey types. Dedicated research surveys for photographic identification and other research activities under Permit 540-1502-00 were conducted by Cascadia Research off California, Oregon, and Washington and are summarized in Table 1. These represent 65 days of effort that were broadly distributed geographically and temporally (Table 1, Figure 1). Survey coverage was most extensive in the Santa Barbara Channel, Monterey Bay, and Gulf of the Farallones. Effort was most extensive in these regions due to large concentrations of whales in these areas and the presence of opportunistic sources of effort. Photographic identification during Cascadia surveys was sometimes conducted in conjunction with other research activities described later in this report including tagging, biopsy, and acoustic tracking of whales (see description in Table 1).

Photographic identification was also conducted on either an opportunistic basis by others who provided photographs to Cascadia or as part of collaborative research under other permits. Cascadia Research conducted surveys for a variety of marine mammals including humpback and blue whales in central British Columbia in collaboration with the Canadian Department of Fisheries and Oceans (Table 2). Additional opportunistic effort was also conducted by:

1. Peggy Stapp in collaboration with Nancy Black obtained opportunistic photographic identifications of humpback and blue whales primarily in and around Monterey Bay (Table 3).
2. The Naturalist Corps organized by the Channel Island National Marine Sanctuary obtained opportunistic identification photographs of humpback and blue whales in the Santa Barbara Channel (Table 4).
3. Ski Lanowitz and Eric Martin obtained identification photographs of whales in southern California (Table 5)
4. A number of other people provided smaller numbers of opportunistic photographs including Eric Martin, Greg Tepke, John Hyde, Jeff Jacobson, and Michuru Ogino (Table 5).

The combined dedicated and opportunistic effort resulted in a fairly broad distribution of locations and months that both humpback and blue whale identifications were made (Table 6, Figures 2-3)

Photographic identification methods

Identification photographs were taken with *Nikon* 8008 35mm cameras equipped with 300mm *Nikkor* telephoto lenses and databacks that recorded date/time on the exposed film. High-speed black-and-white film (*Ilford HP-5+*) was exposed pushed 1 stop so that exposure times were generally 1/1,000 or 1/2,000 sec.

Identification photographs of humpback, blue, and gray whales were taken using standard procedures employed in past research off California and Washington since the late 1980s and early 1990s (Calambokidis *et al.* 1990a, 1990b, 1994). Both the right and left sides of blue and gray whales in the vicinity of the dorsal fin or hump were photographed as well as the ventral surface of the flukes. For humpback whales, photographs were taken of the ventral surface of the flukes.

Humpback, blue, and gray whale identification photographs taken in 2003 have been compared internally and a preliminary comparison has been made to catalogs of all humpback and blue whales identified along the West Coast. These catalogs currently consist of 1,437 different humpback whales and 1,495 different blue whales identified during annual surveys between 1986 and 2002 off the west coast (Calambokidis *et al.* 2003). Additional identifications included in these collections are whales identified in other areas such as off Central America by Cascadia and collaborators (Rasmussen et al. 1999, 2002, Chandler et al. 1999). Individual whales identified in 2003 that did not match past years and are of suitable quality will be assigned a new unique identification number and added to the catalogs.

Observations were routinely made of the feeding behavior of both humpback and blue whales. A variety of data are also recorded that were related to feeding including surface temperature, water depth, the presence and depths of any scattering layers, and bird species associated with sightings.

Tagging

Tagging in 2003 consisted of the deployment of four instrument packages on blue, fin, and humpback whales (Oleson *et al.* 2004, Calambokidis 2003, Calambokidis *et al.* 2004b). All three were attached to the whale with a suction-cup. Tags were placed on the whale using a long pole to make direct contact with the whale. The three deployed tags were:

Burgess Bio-Probe: An acoustic tag deployed developed by Bill Burgess of Greeneridge Scientific Services (with support from ONR) and deployed as part of a collaboration with Scripps Institute of Oceanography. Joe Olson of Cetacean Research helped to test the tag and develop a delivery and attachment method for the tag. The tag recorded underwater sound and dive depth. The tag was potted in resin and was much smaller than in previous tag deployments. The tag sampled acoustics with 16-bit resolution at bandwidths up to 14 kHz, as well as temperature and depth with 12-bit resolution. Constant acoustic sampling at 2 kHz fills the 576-MB solid-state flash disk in 41 hours. Low-power three-volt electronics allow a single half-AA-cell lithium battery to power the entire tag.

Crittercam: Package developed by National Geographic and termed “Crittercam”, onto blue whales (Marshall 1998, Williams *et al*. 2000, Francis *et al*. 2001). The instrument packages deployed contained a combination of the following instruments and devices:

- Hydrophone and recording system for underwater vocalizations
- Pressure sensor to record water depth
- Sensor to monitor and record water temperature
- Conductivity switch to control surface and underwater instrument activation
- VHF tag to provide local positioning information
- Underwater video camera to record behavior and encounters with prey

MANTA - The Marine Animal Tracking Apparatus: Deployments of this tag were conducted with Tom Norris, who developed the tag. Most deployments of this tag were conducted under his permit and are not reported here. We did attempt a few deployments of this tag using non-invasive, suction cup attachments as were used in the Burgess Bioacoustic probes. Since these few deployments were performed on the tagging vessel operated by Cascadia's Principle Investigator, John Calambokidis, they were performed under our permit (#540-1502-00) and are included here.

Nick Gale's satellite tags: These position-only tags were deployed in collaboration with Nick Gales of the Australian Antarctic Research Program. They were fired with a Excalibur Exomag simple recurve crossbow (200 lb. draw weight producing 330 FPS) at a range of about 3-5 m. The tags contained a stop that prevented their deep penetration past the blubber layer. Although these have similarities with those deployed in recent years on blue whales by Bruce Mate of OSU (Mate *et. al.* 1999), they represent an independent effort.

Most deployments of these tags (with the exception of some of the deployments of the Burgess bio-acoustic tags in southern California) were conducted in a collaborative effort with Moss Landing Marine Labs and UC, Santa Cruz in an effort in part supported by the TOPP program (Tagging of Pacific Pelagics).

Collection of skin samples

Biopsy methods

Skin samples were collected to examine genetic relatedness, population structure, and sex of individual whales (Baker *et al*. 1990, 1998). Biopsy samples were collected from whales using the system developed by Lambertsen (1987). The biopsy system has three integral components: a biopsy dart and punch, a projection unit, and a retrieval system. The biopsy dart consists of a crossbow bolt (arrow) affixed with a stainless steel biopsy punch. The biopsy punch has a flange or 'stop' to prevent penetration of the skin. The punch is 7 to 9 mm in diameter and 2 to 5 cm in length and is fitted with two or three internal pins to secure the sample. A hole drilled transversely through the punch and just distal of the flange prevents pressure buildup inside the punch as it penetrates the skin. The projection unit is a commercially available crossbow fitted with a 125 or 150-lb draw fiberglass prod (bow). Sample extraction occurs with the recoil of the dart when the flange strikes the skin. We used an untethered free-floating bolt retrieved by hand from small vessels or with a dip net from larger vessels.

We collected blubber from biopsy samples (when available) for pregnancy testing (in collaboration with SWFSC). Blubber was separated from the skin with a clear razor and stored in a separate small vial and frozen after return to shore. Samples of skin and blubber were submitted to SWFSC, Jolla, CA.

RESULTS AND DISCUSSION

Movements and abundance from photographic identifications

Humpback whales

A total of 542 humpback whale identifications were obtained in all effort off California, Oregon, and Washington in 2003 (Table 6). These identifications were fairly well distributed along the west coast with clusters of identifications in the Santa Barbara Channel, off Pt. Sal, Monterey to Half Moon Bay, Gulf of the Farallones to Bodega Bay, Pt St. George, and along the N Washington an S British Columbia border (Figure 2). Identifications were also taken over a broad period from April to October with largest samples (over 100) in May, July, September, and October (Table 7).

The 542 good quality identifications, once compared to each other, revealed 398 unique individuals. This is tied for the second highest number of unique animals we have identified in a year since the inception of our research in 1986 (Table 8). The geographic distribution of identification locations in 2003 was fairly consistent with past years.

Of the 398 identified whales, 98 were seen two or more times during the year (Figure 2). These animals had moved an average of 47 nmi (n=98, SD=69) and a maximum of 308 nmi between sightings. Most common movements were between the southern and central California locations or within these regions. Only limited interchange was seen between these regions and northern California, and none was seen with sightings off Oregon and northern Washington, although sample sizes in these areas were small (Figure 2).

Rates of interchange of humpback whales among regions, when data were pooled from all years, were calculated including both within and between year resightings of the same individuals (Table 9, Figure 4). Rates of interchange of animals were highest among adjacent years and decreased progressively with distance to the north or south. A dramatic drop off in resighting rates was seen moving northward to the Washington/British Columbia border, as has been noted previously (Calambokidis *et al*. 1996).

Abundance estimates of humpback whales took a surprising jump in the most recent numbers based on annual samples. Estimated abundance from Petersen capture-recapture calculations based on the 2002 and 2003 identifications for California to southern Washington was 1,391 (Table 10). This is almost 400 animals higher than any previous estimate (Table 10, Figure 5). Overall there is a statistically significant increase in abundance; log values of the Petersen annual estimates show a 6% per year increase ($r^2=0.65$, $p=0.001$).

Estimates of humpback whales based on multi-year Jolly-Seber open population models also increased with the addition of the 2003 sample (Table 11). These calculations only provide abundance estimates through 2002 but still showed the pattern of rapid and unrealistically high increases in abundance in recent years after a drop around 1999 or 2000.

Humpback whale abundance for California to Washington by both Petersen and Jolly-Seber estimates had been showing a consistent increase of about 8% per year from the early to the late 1990s (Calambokidis and Barlow 2004). Estimates by the Petersen inter-year method showed a dramatic drop in 1999 consistent with a mortality or loss of animals associated with the severe 1998 El Niño and the resulting drop in krill abundance which potentially prevented whales from obtaining adequate prey to survive through the winter (Calambokidis *et al.* 2003). The Jolly-Seber estimates also show fairly consistent abundance increases and realistic annual survival rates (0.91 to 1.0) and number of births (41 to 151) for 1991 to 1997 (Table 11). Starting in 1998, however, not only did abundance estimates dip but both annual survival rates (0.86 to 1.08) and births (-24 to 233) became erratic.

While it initially appeared that humpback whales were again recovering at a steady rate after the drop in the late 1990s, the recent estimates are more erratic and unrealistic. These suggest something more fundamental about humpback whale occurrence has changed in recent years to either cause these dramatic changes or at least violate some of the assumptions of the abundance estimates to create a new bias to the estimates.

One possible change in recent years that could explain the dramatic increase in abundance estimates would be immigration of humpback whales from other areas into the California-Washington feeding area. A dramatically increased percent of whales identified in 2003 (35%) had not been seen in any other year. From 1986 (when our photo-ID studies of humpback and blue whales began) to 2000, only 2-13% of the whales identified each year had not been seen in any other year. In 2001 and 2002, this jumped to 21% for both years and in 2003 it spiked to 34%. This finding would be consistent with immigration of a large number of individuals into this feeding area that had not used it in past years.

Regions where new animals were seen suggest that if immigration had occurred, it appeared to be from the north. There was a trend of higher proportions of humpback whales seen for the only time in 2003 in northern areas. The proportion of whales seen only in 2003 from south to north was 19% in the Santa Barbara Channel, 31% in Monterey Bay, 32% off Half-Moon Bay, 39% in the Gulf of the Farallones, 40% off Pt Arena and 45% off Pt St. George. Despite this trend, in all areas the percent new animals was still higher than it had generally been in the past.

The findings off California to southern Washington are very similar to what was observed off northern Washington and southern British Columbia in recent years (Calambokidis *et al.* 2004). This latter region appears to be a somewhat separate feeding area for humpback whales with only limited interchange with feeding areas to the south (this report and Calambokidis *et al.* 1996). In 2002, there was a dramatic increase in the number of whales seen off northern Washington, an increase in the proportion of these whales that had been seen in this region in past years, and an increase mark-recapture abundance estimates (Calambokidis *et al.* 2004). The primary suspected cause of these changes was an influx of animals from the north.

There did not appear to be anything unusual with the observations of mothers with calves in 2003. A total of 17 mothers were identified with calves representing 4.4% of the individuals identified in 2003 (excluding N Wa./S. BC). This similar to the fairly low rate we have observed in past years and is likely biased downward for the high proportion of effort we have late in the season when mothers with calves may be weaned and hard to recognize (Steiger and Calambokidis 2000). Of the 17 different mothers with calves identified, only one (6%) was a new animal not seen prior to 2003 much less than the 34% new animals seen overall. This indicates any influx of animals did not appear to include reproducing females.

Blue whales

Blue whale identifications were made from southern California to British Columbia in 2003 (Table 12). Of the 534 identifications made in 2003, 292 unique individuals were present with 242 resightings of these animals or a total of 534 identifications (Figure 3). Blue whale identifications in 2003 came disproportionably from the Monterey Bay area, which accounted for more than half the identifications (Table 12). Large number of identifications were also made in the Santa Barbara Channel, an area just SW of San Miguel Island, off Pt. Arguello, and in the Gulf of the Farallones region (Figure 3). Most identifications were made in September (Table 12).

The 292 unique blue whales identified in 2003 was the second highest number for any year since the start of our work in 1986 (Table 13, Figure 6). Only 2002 had a higher total number of animals identified (311). This was largely due to the record number of identifications from Monterey Bay (119 unique individuals). Of the 292 identified whales, 184 (63%) had been identified previously and 108 (37%) had not been identified previously in our research. Unlike humpback whales, there has not been as clear a trend in the percent of blue whales identified each year that have been that year only (Figure 6). However, the proportion of whales seen only a single year has been slightly higher in the last two years (2002 and 2003) than previous years.

Movements of blue whales within 2003 were fairly extensive; animals were resighted all along the California coast in 2003 (Figure 3). Blue whales seen furthest south near the U.S./Mexico Border demonstrated different movement patterns. Three whales showed movements to the southern and northern extents of our sampling: 1) ID# 2006, seen off San Diego on 10 July was resighted on 28 October in the Gulf of the Farallones, 2) ID# 1632, seen on 20 July off San Miguel Island was seen on 3 October near Tanner/Cortez Bank on the Mexican border, 3) ID# 1943 seen on 6 September near Pt. St. George at the Oregon border was resighted on 26 October near Cordell Bank

Another long-distance match between northern British Columbia and California was found in 2003. As part of surveys we conducted in British Columbia with DFO, a blue whale was sighted and photographed on 7 August 2003 off the southwest end of the Queen Charlotte Islands. This animal was identified as ID#233. While it was not identified again in 2003, this whale had been identified 8 previous times in 1988, 1993, 1995, 1999, and 2001. All the previous sightings had been off central and northern California from Half-Moon Bay to Pt Arena in August through October. The only previous whale identified off British Columbia was ID# 1110, seen on 12 June 1997 and then resighted on 1 and 14 July in the Santa Barbara Channel.

The 2003 data did not directly contribute to a new estimate of blue whale abundance. Since our last report, however, some late additions to the 2001 and 2002 datasets slightly modify our last reported estimates of blue whale abundance (Calambokidis et al. 2003). Unbiased blue whale abundance estimates can only be determined when we have representative samples of whales from both inshore and offshore waters. We have relied on identification photographs obtained during the SWFSC systematic surveys conducted off Mexico, California, Oregon, and Washington for these samples. This is a requirement for blue whales and not for humpback whales for two reasons: 1) a large portion of the blue whale population feeds in waters farther offshore than we are able to sample in our coastal surveys, and 2) blue whales that feed offshore and inshore do not randomly redistribute between these strata between sample periods (years). We therefore use the identifications from the SWFSC systematic surveys as a representative sample that can be compared to our larger but not representative coastal sample.

The updated samples from 2000 to 2002 slightly increase the estimates of abundance for this period (Table 14). Estimates for right and left sides were 1,585 (CV=0.32) and 1,978 (CV=0.33), respectively, averaging 1,781. This is slightly lower than estimates from 1991-93 and 1995-97 using similar procedures. The large coefficients of variation on these estimates mean they were not significantly different from those in the early and mid-1990s. They do not suggest, however, that blue whale populations were increasing over the last decade as occurred with humpback whales.

Responses to photo-ID approaches

Most animals that were approached for photographic identification (see below for reactions to tagging and biopsy) did not exhibit any detectable reaction to the boat (Table 15). For humpback whales, only six groups of nine whales showed a clear reaction to the vessel. All of these were animals that circled and approached the boat. For blue whales, 16 groups of 26 whales showed an apparent reaction to a photo-ID approach. All of these included apparent avoidance of the boat with seven groups briefly altering their activities and three groups appearing to dive prematurely. For fin whales, two groups of two whales appeared to approach the boat. None of the gray whales showed a clear reaction to photo-ID approaches.

Tagging

A total of 51 whales were approached to attach four types of tags to three different whale species (Table 16). These close approaches for tagging generally resulted in some reaction from the whales (Table 16), which appeared to be from the close approach of the boat. For blue whales the most typical response was a suspension of the surface series (where the animal would resurface after a slightly longer surface interval) or a termination of the surface series. Responses that were also commonly seen for blue whales sometimes in combination with the surface series interruption were a sink response where the whale would submerge more rapidly than normal without arching its back or an acceleration in swimming speed. Responses for fin whales were similar to blue whales with suspension of surface series being the most common response. For humpback whales, a high arch (instead of sink), sometimes accompanied by an acceleration and tail slap, was seen.

Tags were deployed on 41 occasions representing 45 tag deployments including four cases where two types of tags were applied on the same whale on the same approach (Table 17 and 18). The vast majority of the tag deployments in 2003 were of the Burgess acoustic tag (representing 33 of the 45 deployments). These were deployed on blue and fin whales. Blue whale deployments were made in several regions of southern and northern California. All the fin whale deployments were made near Tanner and Cortez Bank off southern California in association with visual and acoustic monitoring from FLIP (Wiggins *et a*l. 2004) (see below).

Burgess acoustic tag deployed on fin whale off Tanner and Cortez Bank in 2003

Analyses of the data from the tag deployments are still currently in progress so are only briefly described here. Deployments in Monterey Bay were conducted in collaboration with Scripps Institute of Oceanography, Moss Landing Marine Labs, and UC Santa Cruz yielded dive data in conjunction with hydro acoustic mapping of prey fields (Figure 7). These reveal blue whales diving to layers of krill down near 300 m. Dives to prey near or deeper than 300 m was fairly common in many of the deployments even though this is deeper than had been described for blue whales in past work off California (Croll *et al.* 2001).

Combined dive, pitch, and roll data from the Burgess tags has provided insights into the diving dynamics of blue whales (Figure 7). Blue whales were generally diving very steeply (70 degrees) downward, and as reported from previous deployments (Williams *et al.* 2000), they are typically gliding downward with few fluke strokes as revealed by oscillations in the tilt sensor. Both during upward lunges and the return to the surface they use repeated deep beats of their flukes. Lunges into prey are generally steeply upward and are accompanied by a sharp roll.

One goal of the placement of acoustic tags on blue whales has been examination of the vocal behavior in relation to sex and behavior context (McDonald *et al.* 2001, Oleson *et al.* In prep.). In 2003, loud calls were recorded on several of the blue whale tags deployed in Monterey Bay, apparently from the tagged animal. These were variable in nature and included the shorter “D-type” call. The combined tag data and the acoustic/visual monitoring of blue whales has generally revealed it is the males that are producing the long loud repeated calls generally described for blue whales but that both sexes produce the shorter, more variable D-type call.

Satellite tag data for the five humpback and two blue whales provided movement data on both species over about a 2-week period. Unfortunately, we did not receive signals from the tags past about 2 weeks. Photographs taken immediately after deployment showed the tags had generally not fully penetrated down to the stop and a photograph taken about a week later on one of the blue whales showed it was slowly retracting. We concluded the failure of longer signals from these tags was the result of their not being deployed deeply and also of the current design not preventing the tags from migrating out of the animal.

Collection of skin samples

A total of 97 skin samples were collected off California, Oregon, and Washington in 2003 under our permit (Table 19). Of these 71 from biopsies and 26 were small pieces of skin collected from the suction-cups and parts of the tagging apparatus. Skin samples were collected from 40 fin whales, 28 blue whales, 21 humpback whales, and 8 gray whales. This does not include biopsy samples of 16 humpback whales and 2 sperm whales collected in central British Columbia under permits from and during a cruise conducted with Department of Fisheries and Oceans.

There were 103 approaches of animals to obtain a biopsy and a clear reaction to either the approach or the biopsy was seen in slightly less than half of these instances (Table 20). Reactions were more common to biopsy hits than to misses (Table 20), although responses were sometimes seen to misses. Humpback whales showed detectable reactions at a much higher rate than blue or fin whales, a pattern consistent with our observations in past years. Primary response for humpback whales was an alteration in the fluking behavior with either a tail flick or wave of the fluke (Table 20).

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Tagging effort and some of the surveys off southern California were conducted in collaborations with Scripps Institute of Oceanography. Erin Oleson served as Cruise Leader for the surveys aboard the *Sproul* and worked on deploying and analyzing data from the Burgess bio-acoustic probes. John Hildebrand, Alan Sautor, Jessica Burtenshaw, Sean Wiggins, and Mark McDonald and crew and staff of the Sproul and FLIP all assisted in this effort.

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The Channel Islands Naturalist Corps collected data and photographic identifications opportunistically during whale-watch operations in the Santa Barbara Channel. Shauna Bingham and Michael Smith helped coordinate and set this up. Michuru and Yuki Ogino provided identification photographs and aided the research. Nancy Black and Peggy Stapp obtained opportunistic identifications during trips in Monterey Bay.

Jim Harvey, Don Croll, Kelly Newton, Nick Gales, Kyler Abernathy, Tom Norris, Greg Falxa, and Dan Costa all helped coordinate or conduct elements of the tagging effort in the Monterey Bay area. Bill Burgess of Greeneridge Scientific Services developed the Bio-acoustic probe and assisted in deployments. Joe Olson developed the attachment method for the acoustic tag. SIO personnel and the crew of the Sproul assisted in the work off southern California. The National Geographic Crittercam was developed by Greg Marshall of National Geographic and modifications made by Mehdi Baktiari. Nick Gales developed and deployed the satellite tags deployed on blue and humpback whales.

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LIST OF TABLES AND FIGURES

Tables

Figures

6) Number of blue whales identified and the proportion of these seen in at least one other year off California for 1986 to 2003.
7) Dive record from feeding blue whale tagged in Monterey Bay on 28 September 2003. Top figure shows dive profile superimposed on hydro-acoustic data (provided by UC Santa Cruz). Bottom figure shows detail of first dive including pitch and roll of whale.

Table 1. Summary of field effort in 2003 by Cascadia Research personnel off California, Oregon, and Washington.

									Blue whale			Fin whale			Gray whale			Humpback			Killer whale		
Date	**VES**	**Launch site**	**Pers**	**Activity**	**Beg**	**End**	**Hours**	**Nmi**	**S#**	**Tot**	**IDs**	**S#**	**Tot**	**IDs**	**S#**	**Tot**	**IDs**	**S#**	**Tot**	**IDs**	**S#**	**Tot**	**IDs**
24-Mar-03	N1	Everett	JAC		10:15	17:05	6.8	52							3	6	3						
18-Apr-03	N1	Everett	JAC		11:45	19:20	7.6	39							5	6	5						
18-May-03	N1	Everett	JAC		12:45	20:25	7.7	41							4	4	4						
27-May-03	N2	S.B.C.	TEC		6:26	18:58	12.5	117										6	14	9			
27-May-03	WDFW	Neah Bay	JRE	WDFW survey														3	3	3			
28-May-03	N2	S.B.C.	TEC		6:48	18:41	11.9	107										18	34	23			
26-Jun-03	N1	Sedro Woolley	TEC	ER upriver	15:37	19:33	3.9	13							1	1	1						
29-Jun-03	N1	La Push	TEC		8:16	18:10	9.9	81										1	1	1			
01-Jul-03	ZOD	Newport	TEC		6:21	19:55	13.6	171										2	3	1			
02-Jul-03	ZOD	C.C./Pt. St. George	TEC		10:06	16:05	6.0	65															
03-Jul-03	ZOD	H.M.B.	TEC		11:14	19:00	7.8	86	1	1	1							3	4	3			
13-Jul-03	N1	Bellingham	JAC	Smith Is	9:00	16:00	7.0																
19-Jul-03	N1	Pt. San Louis O.	JAC		5:30	16:00	10.5	84	11	18	11							12	20	13			
20-Jul-03	N1	S.B.	JAC		7:00	17:45	10.8	113	29	37	29							4	13	13			
22-Jul-03	N1	At sea from Sproul	JAC		9:49	20:15	10.4	30				13	28	13									
23-Jul-03	N1	At sea from Sproul	JAC	Tagging	7:55	20:00	12.1	78				9	16	9				1	1	0			
23-Jul-03	N2	H.M.B.	TEC		7:28	18:48	11.3	73	4	5	2							17	38	25			
24-Jul-03	N1	At sea from Sproul	JAC	Tagging	8:16	20:05	11.8	44	8	12	7	1	1	1									
25-Jul-03	N1	At sea from Sproul	JAC	search/Tag	7:55	20:15	12.3	96	8	13	8	1	1	1									
25-Jul-03	ZOD	Moss Landing	TEC		6:43	19:58	13.3	112	12	19	17							28	61	32			
27-Jul-03	ZOD	Channel Isl.	TEC	search/Tag	7:28	22:00	14.5	142															
30-Jul-03	ZOD	Channel Isl.	TEC	search/Tag	6:11	12:19	6.1	68															
20-Aug-03	N2	At sea off FLIP	JAC	Tag	9:45	19:30	9.8	20				9	23	9									
21-Aug-03	N2	At sea off FLIP	JAC	Tag	8:00	19:40	11.7	38	1	1	1	19	46	19									
22-Aug-03	N2	At sea off FLIP	JAC	Tag	8:10	19:00	10.8	28	1	1	1	4	8	4									
23-Aug-03	N2	At sea off FLIP	JAC	Tag	8:50	16:30	7.7	13	1	1	0	6	13	6									
24-Aug-03	N2	At sea off FLIP	JAC	Tag	9:00	14:30	5.5	9				10	22	10									
25-Aug-03	N2	At sea off FLIP	JAC	Tag	7:53	19:20	11.5	34	3	4	0	18	47	18									
26-Aug-03	N2	At sea off FLIP	JAC	Tag	9:48	17:20	7.5	12				12	39	12									
27-Aug-03	N2	At sea off FLIP	JAC	Tag	8:53	15:15	6.4	18				12	26	12									
31-Aug-03	N2	Pt San Luis	JAC		7:15	17:00	9.8	97	23	36	31							2	3	1			
01-Sep-03	N2	H.M.B.	JAC		8:05	21:00	12.9	103	9	14	7	1	2	2				16	39	28			
02-Sep-03	ZOD	La Push	TEC		7:15	18:05	10.8	108										4	8	6			
03-Sep-03	ZOD	La Push	TEC		6:52	17:40	10.8	142															
05-Sep-03	ZOD	Port Orford	TEC	ER	11:00	17:39	6.7								34	45	40						
06-Sep-03	ZOD	Pt. St. George	TEC		7:09	19:34	12.4		6	9	10							20	45	24			
07-Sep-03	ZOD	Fort Bragg	TEC		10:48	18:55	8.1	102	1	1	0							11	21	10			
15-Sep-03	ZOD	Moss Landing	TEC		7:06	18:53	11.8	114	9	21	11							13	21	13			
17-Sep-03	ZOD	Moss Landing	TEC		8:24	9:57	1.6	23															
22-Sep-03	N2	Monterey	JAC	Fog	8:53	11:30	2.6	24															
22-Sep-03	ZOD	Moss Landing	TEC	Fog	7:07	11:28	4.4	28	1	1	1							3	8	5			
23-Sep-03	N2	Moss Landing	JAC	Tag	8:05	20:00	11.9	119	3	5	5	1	3	1				7	19	9			
23-Sep-03	ZOD	H.M.B.-Moss Landing	TEC		7:16	19:40	12.4	102	9	15	12							13	23	19			
24-Sep-03	N2	Moss Landing	JAC	Tag	8:17	19:56	11.7	45	11	28	4												
24-Sep-03	ZOD	Moss Landing	TEC		7:19	19:45	12.4	69	16	26	21							2	5	2			
25-Sep-03	N2	Moss Landing	TEC	Tag	7:13	18:10	11.0	46	21	38	28												
26-Sep-03	N2	Moss Landing	JAC	Tag	7:24	18:45	11.4	57	9	14	2												
26-Sep-03	ZOD	Moss Landing	TEC		7:26	18:30	11.1	81	5	9	8							1	1	0	1	3	1
27-Sep-03	ZOD	H.M.B.	TEC		9:15	19:33	10.3	75	8	14	11	1	2	1				11	22	11			
28-Sep-03	N2	Moss Landing	JAC	Tag	7:20	19:30	12.2	44	8	11	4												
28-Sep-03	ZOD	Moss Landing	TEC		8:34	16:01	7.5	67	4	6	4												
29-Sep-03	N2	Moss Landing	JAC	Tag	7:30	16:15	8.8	31	3	5	3												
29-Sep-03	ZOD	Moss Landing	TEC		7:42	15:30	7.8	26	5	6	3												
30-Sep-03	N2	Moss Landing	JAC	Tag	7:20	20:15	12.9	59	2	3	2							1	3	2			
30-Sep-03	ZOD	Moss Landing	TEC		7:18	19:24	12.1	66	3	5	2							1	2	2			
01-Oct-03	N2	Moss Landing	JAC		7:25	16:30	9.1	53	7	15	7												
01-Oct-03	ZOD	Moss Landing	TEC		7:33	17:18	9.8	90	3	4	3							6	18	12			
21-Oct-03	ZOD	Half-Moon Bay	TEC	Fog	8:12	16:36	8.4		1	2	0												
22-Oct-03	ZOD	Bodega Bay	TEC	Fog	8:14	18:10	9.9		6	7	7												
25-Oct-03	ZOD	Pt Arena - Bodega	TEC		8:00	18:53	10.9		14	22	16							1	5	5			
26-Oct-03	ZOD	Bodega	TEC		7:29	17:47	10.3		30	48	44	1	1	1				14	29	22			
27-Oct-03	ZOD	Bodega	TEC		6:41	17:59	11.3		24	44	39							25	54	36	1	7	1
28-Oct-03	ZOD	Bodega-HMB	TEC		6:37	17:35	11.0		11	18	16	1	2	0				59	123	80			
09-Nov-03	ZOD	Pt St. George	TEC	Pr weather	9:30	12:50	3.3								7	15	15						
Total	64 days						608	3558	331	539	378	119	280	119	54	77	68	305	641	410	2	10	2

Table 2. Summary of field effort in 2003 off central British Columbia by Cascadia in collaboration with Department of Fisheries and Oceans. Effort was based off the vessel *Curve of Time* . Humpback whale identifications are being compiled by DFO.

							Blue whale			**Fin whale**			**Gray whale**			**Humpback**			**Killer whale**			**Sperm whale**		
Date	**VES**	**Pers**	**Beg**	**End**	**Hours**	**Nmi**	**S#**	**Tot**	**IDs**	**S#**	**Tot**	**IDs**	**S#**	**Tot**	**IDs**	**S#**	**Tot**	**IDs**	**S#**	**Tot**	**IDs**	**S#**	**Tot**	**IDs**
02-Aug-03	N2	JAC	10:46	17:05	6.3	34							10	11	10	1	1	1						
04-Aug-03	N2	JAC	10:00	14:55	4.9	23										1	1	1				5	6	5
05-Aug-03	N2	JAC	15:27	21:46	6.3	46										8	16	8						
06-Aug-03	N2	JAC	8:53	20:40	11.8	53				1	1	1				41	94	41						
06-Aug-03	TEN	MO	9:00	20:00	11.0	76										5	42	5	1	2	1			
07-Aug-03	N2	JAC	7:05	21:55	14.8	117	1	1	1	2	5	2				15	22	15				6	6	6
07-Aug-03	TEN	MO	9:15	12:30	3.3	20	1	1	1							2	6	2	2	9	2			
08-Aug-03	N2	JAC	10:26	18:00	7.6	96							15	22	15	1	1	1						
08-Aug-03	TEN	MO	10:33	15:30	5.0								4	6	4									
Total	9	days			71	465	2	2	2	3	6	3	29	39	29	74	183	74	3	11	3	11	12	11

Table 3. Daily summary of opportunistic effort to identify humpback and blue whales in Monterey Bay in 2003 conducted by Peggy Stapp incollaboration with Nancy Black.

							Blue whale			Fin whale			Humpback whale		
Date	**Group**	**VES**	**Start**	**End**	**Hours**	**nmi**	**S#**	**Tot**	**IDs**	**S#**	**Tot**	**IDs**	**S#**	**Tot**	**IDs**
08-Apr-03	P. Stapp/ N. Black	SW2	10:10	13:40	3.5	17									
22-Apr-03	P. Stapp/ N. Black	SW2	10:12	13:50	3.6	30							1	2	1
29-Apr-03	P. Stapp/ N. Black	SW2	10:10	12:58	2.8	10							1	4	2
01-May-03	P. Stapp/ N. Black	INF	7:25	14:05	6.7	55							1	3	2
03-May-03	P. Stapp/ N. Black	SW2	9:02	13:40	4.6	33							2	5	2
04-May-03	P. Stapp/ N. Black	INF	7:35	17:30	9.9	48							8	16	9
06-May-03	P. Stapp/ N. Black	INF	7:45	14:00	6.3	51							1	1	1
07-May-03	P. Stapp/ N. Black	INF	8:21	15:40	7.3	48							1	6	4
08-May-03	P. Stapp/ N. Black	INF	8:00	11:20	3.3	24							3	6	4
10-May-03	P. Stapp/ N. Black	INF	7:10	15:25	8.3	62							2	9	5
20-Jul-03	P. Stapp/ N. Black	SW2	9:10	17:15	8.1	42	5	9	1				7	16	3
03-Aug-03	P. Stapp/ N. Black	SW2	9:10	13:00	3.8	27	2	5	2				3	11	3
04-Aug-03	P. Stapp/ N. Black	SW2	9:00	13:40	4.7	23	2	4	2				2	4	1
05-Aug-03	P. Stapp/ N. Black	SW2	9:02	16:45	7.7	43	6	11	8				12	31	8
06-Aug-03	P. Stapp/ N. Black	SW2	9:00	15:21	6.4	31	7	38	13				6	28	7
07-Aug-03	P. Stapp/ N. Black	PSC	9:02	13:02	4.0	14	1	7	7				1	9	2
29-Aug-03	P. Stapp/ N. Black	SW2	9:06	16:58	7.9	37	18	70	6				1	2	0
30-Aug-03	P. Stapp/ N. Black	SW2	9:06	17:15	8.2	35	12	51	5						
31-Aug-03	P. Stapp/ N. Black	SW2	9:06	17:15	8.2	42	6	17	3				1	1	0
01-Sep-03	P. Stapp/ N. Black	SW2	9:05	13:40	4.6	23	4	13	3	1	2	0			
03-Sep-03	P. Stapp/ N. Black	ZAN	9:17	18:59	9.7	51	6	26	4				1	6	4
05-Sep-03	P. Stapp/ N. Black	SW2	9:03	17:25	8.4	40	8	56	8	6	20	0			
06-Sep-03	P. Stapp/ N. Black	SW2	9:04	17:00	7.9	38	8	60	7	4	21	0			
07-Sep-03	P. Stapp/ N. Black	SW2	9:06	17:10	8.1	42	7	25	9	2	7	0			
08-Sep-03	P. Stapp/ N. Black	SW2	9:03	12:55	3.9	18	7	30	5						
09-Sep-03	P. Stapp/ N. Black	SW2	9:03	13:15	4.2	24	5	25	1						
10-Sep-03	P. Stapp/ N. Black	SW2	9:10	13:15	4.1	21	3	26	4						
11-Sep-03	P. Stapp/ N. Black	SW2	9:02	13:05	4.1	16	3	15	2				1	2	1
12-Sep-03	P. Stapp/ N. Black	SW2	9:05	12:59	3.9	20	4	17	6	1	2	0			
13-Sep-03	P. Stapp/ N. Black	PSC	9:02	12:45	3.7	21	3	22	2						
16-Sep-03	P. Stapp/ N. Black	BD	9:52	14:45	4.9	33	3	5	2				2	4	1
17-Sep-03	P. Stapp/ N. Black	BD	8:16	16:08	7.9	44	4	6	4				1	3	0
18-Sep-03	P. Stapp/ N. Black	BD	7:31	16:10	8.7	33	14	21	13				2	4	3
19-Sep-03	P. Stapp/ N. Black	SW2	9:06	13:00	3.9	21	3	28	7				1	1	0
20-Sep-03	P. Stapp/ N. Black	BD	8:51	17:02	8.2	36	6	11	7				2	2	1
21-Sep-03	P. Stapp/ N. Black	SW2	5:40	17:20	11.7	109	2	5	1				1	5	1
23-Sep-03	P. Stapp/ N. Black	PSC	8:35	12:53	4.3	10	5	24	11						
24-Sep-03	P. Stapp/ N. Black	PSC	10:24	11:06	0.7	1	2	4	1						
25-Sep-03	P. Stapp/ N. Black	BD	8:30	12:40	4.2	20	2	3	3				1	1	0
27-Sep-03	P. Stapp/ N. Black	BD	9:14	13:44	4.5	24	6	11	1				2	4	1
28-Sep-03	P. Stapp/ N. Black	SW2	9:46	13:22	3.6	18	4	11	1				1	1	0
01-Oct-03	P. Stapp/ N. Black	ZAN	8:59	16:05	7.1	42							3	10	7
03-Oct-03	P. Stapp/ N. Black	SW2	9:06	17:08	8.0	51	2	24	5				3	3	0
04-Oct-03	P. Stapp/ N. Black	BD	7:14	15:57	8.7	26	3	3	1						
05-Oct-03	P. Stapp/ N. Black	SW2	9:06	17:12	8.1	47	3	11	3				1	1	0
06-Oct-03	P. Stapp/ N. Black	SW2	9:08	14:57	5.8	34									
08-Oct-03	P. Stapp/ N. Black	BD	8:20	16:11	7.9	34							3	5	2
10-Oct-03	P. Stapp/ N. Black	SW2	9:06	13:25	4.3	25	1	1	0				3	5	0
11-Oct-03	P. Stapp/ N. Black	BD	6:50	16:15	9.4	29							2	4	2
14-Oct-03	P. Stapp/ N. Black	BD	8:03	16:11	8.1	24							7	16	7
15-Oct-03	P. Stapp/ N. Black	SW2	9:10	13:11	4.0	26							5	7	4
16-Oct-03	P. Stapp/ N. Black	BD	7:59	16:13	8.2	48							4	9	0
17-Oct-03	P. Stapp/ N. Black	BD	9:00	17:16	8.3	50							4	7	5
18-Oct-03	P. Stapp/ N. Black	SW2	9:08	17:20	8.2	60									
19-Oct-03	P. Stapp/ N. Black	SW2	9:13	18:05	8.9	66							2	3	0
20-Oct-03	P. Stapp/ N. Black	SW2	9:05	14:22	5.3	46									
21-Oct-03	P. Stapp/ N. Black	SW2	9:03	14:02	5.0	49									
24-Oct-03	P. Stapp/ N. Black	SW2	9:06	15:14	6.1	47							1	0	0
Total		58 days			361	2037	177	695	158	14	52	0	106	257	93

Table 4. Daily summary of opportunistic effort to identify humpback and blue whales off California conducted by the Channel Islands National Marine Sanctuary Naturalist Corps in 2003.

							Blue whale			Humpback whale		
Date	**Group**	**VES**	**Start**	**End**	**Hours**	**nmi**	**S#**	**Tot**	**IDs**	**S#**	**Tot**	**IDs**
17-May-03	Ch. Is. Natur. Corps	CON	9:40	15:10	5.5		1	2	0	6	14	8
14-Jun-03	Ch. Is. Natur. Corps	CON	8:25	15:22	7.0		3	6	4	3	7	3
20-Jun-03	Ch. Is. Natur. Corps	CON	8:10	12:37	4.5	40				2	4	1
22-Jun-03	Ch. Is. Natur. Corps	CON	8:00	11:45	3.8	37				2	4	0
23-Jun-03	Ch. Is. Natur. Corps	CON	7:55	12:10	4.3	52						
30-Jun-03	Ch. Is. Natur. Corps	CON	8:05	12:30	4.4	58	1	2	0	1	2	0
02-Jul-03	Ch. Is. Natur. Corps	CON	8:30	12:30	4.0	36				1	1	1
05-Jul-03	Ch. Is. Natur. Corps	CON	13:15	16:37	3.4	29	1	1	0	2	2	0
08-Jul-03	Ch. Is. Natur. Corps	CON	9:10	11:20	2.2	6	2	14	1	2	5	4
18-Jul-03	Ch. Is. Natur. Corps	CON	8:58	16:05	7.1	42	4	9	1	1	1	0
20-Jul-03	Ch. Is. Natur. Corps	CON	8:00	17:04	9.1	100	2	2	0	2	6	3
21-Jul-03	Ch. Is. Natur. Corps	CON	9:00	11:45	2.8	25	1	3	0	2	2	0
22-Jul-03	Ch. Is. Natur. Corps	CON	8:10	13:00	4.8	73	2	3	1	1	2	1
25-Jul-03	Ch. Is. Natur. Corps	CON	8:13	16:00	7.8	79	5	14	3	2	5	0
26-Jul-03	Ch. Is. Natur. Corps	CON	13:00	17:00	4.0	58	1	2	1			
27-Jul-03	Ch. Is. Natur. Corps	CON	8:15	11:30	3.3	41	4	6	1	2	7	1
02-Aug-03	Ch. Is. Natur. Corps	CON	13:02	16:30	3.5	45	6	16	4			
03-Aug-03	Ch. Is. Natur. Corps	CON	8:15	12:10	3.9	55	2	48	2			
06-Aug-03	Ch. Is. Natur. Corps	CON	8:10	12:35	4.4	58	2	10	1			
07-Aug-03	Ch. Is. Natur. Corps	CON	13:05	17:00	3.9	56	1	8	0			
17-Aug-03	Ch. Is. Natur. Corps	CON	13:15	17:45	4.5	62						
20-Aug-03	Ch. Is. Natur. Corps	CON	8:05	12:15	4.2	50				1	3	2
21-Aug-03	Ch. Is. Natur. Corps	CON	8:00	12:46	4.8	95	2	4	0			
24-Aug-03	Ch. Is. Natur. Corps	CON	8:11	17:05	8.9	105				3	4	2
26-Aug-03	Ch. Is. Natur. Corps	CON	8:00	12:40	4.7	60				1	3	0
30-Aug-03	Ch. Is. Natur. Corps	CON	13:00	16:55	3.9	58						
31-Aug-03	Ch. Is. Natur. Corps	CON	13:15	17:10	3.9	47				2	2	2
01-Sep-03	Ch. Is. Natur. Corps	CON	13:16	17:40	4.4	75						
19-Sep-03	Ch. Is. Natur. Corps	CON	8:00	12:15	4.3	39				1	2	0
24-Sep-03	Ch. Is. Natur. Corps	CON	8:03	12:13	4.2	29				1	1	0
28-Sep-03	Ch. Is. Natur. Corps	CON	9:34	9:34	0.0	0	1	1	0			
03-Oct-03	Ch. Is. Natur. Corps	CON	8:10	12:00	3.8	51				1	2	1
Total	32	days			145	1560	41	151	19	39	79	29

Table 5. Daily summary of opportunistic effort to identify humpback and blue whales off California in 2003.

				Blue whale			Humpback whale	
Date	**Group**	**VES**	**S#**	**Tot**	**IDs**	**S#**	**Tot**	**IDs**
13-May-03	D. Lanowitz	SOL				1	2	2
17-May-03	D. Lanowitz	SOL				1	2	1
17-May-03	E. Martin	EM				1	2	2
25-May-03	D. Lanowitz	SOL				1	2	2
01-Jun-03	D. Lanowitz	SOL				1	1	1
09-Jun-03	D. Lanowitz	SOL				4	4	1
10-Jul-03	J. Jacobsen	JJ				2	2	1
10-Jul-03	J. Hyde	JH	1	1	1			
26-Jul-03	E. Martin	EM	1	10	4			
21-Aug-03	M Ogino	MO	1	1	0			
25-Aug-03	G. Tepke	GT	1	2	2			
Total		11 days	4	14	7	11	15	10

Table 6. Summary of field effort in 2003.

Group	Region	Days	Hours	Nmi	Blue whale S#	Blue whale Tot	Blue whale IDs	Fin whale S#	Fin whale Tot	Fin whale IDs	Humpback S#	Humpback Tot	Humpback IDs
Cascadia Research	California, Oregon, Washington	64	608	3558	331	539	378	119	280	119	305	641	410
Cascadia Research / Dept. Fisheries and Oceans	British Columbia	9	71	465	2	2	2	3	6	3	74	183	*
P. Stapp	Monterey Bay	58	361	2037	177	695	158	14	52	0	106	257	93
Channel Islands Nat. Marine Sanc. Naturalist Corps	Santa Barbara Channel	32	145	1560	41	151	19				39	79	29
Other	California	11			4	14	7						
Total		174	1185	7619	555	1401	564	136	338	122	524	1160	532

* Identifications being handled by DFO

Table 7. Humpback whales identified by month and region in 2003. Circles show subsamples used in bootstrap variance.

		Month							
Region	**Code**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**Total**
Santa Barbara Channel	33		47	6	23	6		1	83
Pt Conception to Buchon	41				13	1			14
Big Sur Coast	43				1				1
Monterey Bay	51	3	27		35	21	45	39	170
Half-Moon Bay	52				25		58		83
Gulf of the Farallones	53				3			138	141
Bodega to Pt Arena	54							5	5
Pt. Arena to Mendocino	61						10		10
N California	63						24		24
S Oregon	72				1				1
N Washington/BC	76		3	1			6		10
Total		3	77	7	101	28	143	183	542

Table 8. Number of unique humpback whales identified by Cascadia and collaborators by year and region for California, Oregon and Washington through 2003.

		Number of individuals identified																			
REGION	**Code**	**>86**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**All**
S Ca. Bight (south)	31	0	0	0	0	0	0	1	0	5	3	0	0	4	0	0	0	0	3	0	15
S. Ca. Bight (north outside SBC)	32	0	0	0	1	0	1	0	3	1	6	18	0	0	5	0	0	4	1	0	38
Santa Barbara Channel	33	0	0	0	4	0	6	15	97	9	13	136	22	27	101	18	1	3	71	63	305
S. California (offshore)	39	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	4
Pt Conception to Buchon	41	0	0	8	58	0	0	78	4	1	14	20	0	23	3	2	69	13	34	13	238
Pt Buchon to Pt. Sur	42	0	0	0	2	0	2	12	0	0	0	0	8	13	16	9	5	4	0	1	70
S Monterey Bay Sanc.	51	3	0	4	15	2	13	13	65	45	59	33	89	92	145	175	143	70	40	118	616
N Monterey Bay Sanc.	52	0	0	0	2	0	20	0	0	26	4	42	82	47	30	12	0	115	31	68	381
Farallones/Cordell	53	16	90	140	133	110	161	89	172	181	164	127	168	34	89	116	33	83	109	127	859
Bodega Bay to Pt. Arena	54	0	1	0	5	0	0	0	63	6	0	0	4	5	22	2	0	0	0	5	109
C. California offshore	59	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	4
Pt. Arena to C. Mendocino	61	0	0	0	0	0	0	4	73	2	0	0	0	23	22	0	0	0	20	10	148
C Mend. to Klamath Riv.	62	1	0	0	8	0	0	4	0	4	0	12	8	26	6	0	0	0	0	0	61
N California to Oregon	63	0	0	0	3	0	0	85	50	16	0	1	0	14	69	6	0	3	9	22	207
S Oregon	71	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	5	2	0	9
C. Oregon	72	0	0	0	0	0	22	0	0	0	0	0	7	0	0	30	9	2	30	1	92
N Oregon	73	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	1	0	0	7
Washington	75	0	0	0	0	0	5	0	0	0	0	0	0	0	1	0	0	5	0	0	11
Wash/BC border	76	0	0	0	1	1	10	13	0	3	14	35	34	22	47	60	40	36	32	10	185
Puget Sound	79	0	0	0	2	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	5
All		20	91	150	213	111	218	282	398	257	260	365	366	290	435	388	269	308	346	398	1,565

Table 9.Interchange among regions with pooling for 1988-2003. Total of 1,233 unique whales

Region	**Codes**	**n**	**30-39**	**40-49**	**51**	**52**	**53-54**	**61-62**	**63**	**70-75**	**76-79**
			264	**235**	**525**	**225**	**707**	**169**	**185**	**74**	**155**
<u>Numbers of individuals seen across regions</u>											
S California Bight	30-39	264		132	162	49	162	21	13	1	0
S central California	40-49	235	132		152	52	142	24	14	0	1
Monterey Bay area	51	525	162	152		123	311	54	33	11	1
Farallones to Monterey	52	225	49	52	123		171	34	24	7	4
Gulf of the Farallones to Pt Arena	53-54	707	162	142	311	171		133	130	37	9
Pt Arena to Trinidad	61-62	169	21	24	54	34	133		65	20	6
Pt St. George area	63	185	13	14	33	24	130	65		32	5
Oregon and S Washington	70-75	74	1	0	11	7	37	20	32		8
N Washington and S BC	76-79	155	0	1	1	4	9	6	5	8	
<u>Percent of animals in each region listed along the left margin that had been seen in each other region</u>											
S California Bight	30-39	264		50%	61%	19%	61%	8%	5%	0%	0%
S central California	40-49	235	56%		65%	22%	60%	10%	6%	0%	0%
Monterey Bay area	51	525	31%	29%		23%	59%	10%	6%	2%	0%
Farallones to Monterey	52	225	22%	23%	55%		76%	15%	11%	3%	2%
Gulf of the Farallones to Pt Arena	53-54	707	23%	20%	44%	24%		19%	18%	5%	1%
Pt Arena to Trinidad	61-62	169	12%	14%	32%	20%	79%		38%	12%	4%
Pt St. George area	63	185	7%	8%	18%	13%	70%	35%		17%	3%
Oregon and S Washington	70-75	74	1%	0%	15%	9%	50%	27%	43%		11%
N Washington and S BC	76-79	155	0%	1%	1%	3%	6%	4%	3%	5%	

Table 10. Humpback whale abundance off California, Oregon, and Washington using Petersen mark-recapture estimates with annual samples. Coefficients of variation (CV1 and CV2) are based on analytical formulae and jackknife (respectively).

	Sample 1				Sample 2							
Period	**Year**	**Subs.**	**Ident.**	**n**	**Year**	**Subs.**	**Ident.**	**n**	**Match**	**Est.**	**CV1**	**CV2**
Annual samples using all data												
1991-92	1991	7	668	269	1992	8	1,023	398	188	**569**	0.03	0.05
1992-93	1992	8	1,023	398	1993	6	512	254	173	**584**	0.03	0.06
1993-94	1993	6	512	254	1994	6	402	244	108	**572**	0.05	0.15
1994-95	1994	6	402	244	1995	9	662	331	100	**804**	0.06	0.17
1995-96	1995	9	662	331	1996	7	565	332	145	**756**	0.05	0.08
1996-97	1996	7	565	332	1997	7	385	267	105	**841**	0.06	0.16
1997-98	1997	7	385	267	1998	8	854	388	119	**868**	0.06	0.13
1998-99	1998	8	854	388	1999	6	613	331	127	**1,008**	0.06	0.10
1999-2000	1999	6	613	331	2000	8	615	229	107	**706**	0.06	0.17
2000-01	2000	8	615	229	2001	8	488	272	81	**765**	0.07	0.16
2001-02	2001	8	488	272	2002	8	489	314	86	**987**	0.07	0.11
2002-03	2002	8	489	314	2003	9	532	388	87	**1,391**	0.08	0.22

n-Number of unique individuals in sample used in mark-recapture estimate

Est.-Estimated abundance

CV1-Coeficient of variation based on Chapman

CV2-Alternate estimate of coefficient of variation using Jackknife procedure (see Methods)

Table 11. Model parameters and population estimates for humpback whales from Jolly-Seber mark-recapture method using California,Oregon, and Washington (not incl. WA/BC border) for 1991-2003.

Year	**IDs**	**Prev IDs**	**r**	**z**	**Surv**	**Births**	**Marked available**	**Popul. estimate**	**SE**
1991	269	0	254	0	0.97				
1992	398	188	364	66	0.97	49	260	549	16
1993	254	199	227	231	0.95	80	457	583	18
1994	244	187	221	271	0.98	151	486	633	21
1995	331	228	285	264	1.00	61	534	775	26
1996	332	253	256	296	0.91	41	637	835	29
1997	267	217	205	335	0.92	115	653	803	30
1998	388	294	269	246	0.89	169	648	855	29
1999	331	235	216	280	0.86	-24	663	933	42
2000	229	192	151	304	1.08	233	652	777	37
2001	272	189	131	266	1.00	52	741	1069	72
2002	314	231	87	166			825	1120	96
2003	388	253	0	0					
Mean	309	205	205	210	0.96	93	596	812	
SD	58	69	94	115	0.06	75	154	183	

Table 12. Number of blue whales identified by month and region in 2003.

Region	Code	Month						Total
		06	07	08	09	10	11	
S Ca. Bight (south)	31		15	2			1	18
S. Ca. Bight (north outside SBC)	32						1	1
Santa Barbara Channel	33	4	42	7				53
Pt Conception to Buchon	41		11	31				42
Monterey Bay	51		18	48	200	12		278
Half-Moon Bay	52		2		30			32
Gulf of the Farallones	53		1			86		87
Bodega to Pt Arena	54					11		11
N California	63				10			10
British Columbia	82			2				2
Total		4	89	90	240	109	2	534

Table 13. Number of unique blue whales identified by Cascadia and collaborators by year and region for the west coast of the US and Canada through 2003.

		Number of individuals identified																			
REGION	**Code**	**>86**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**All**
S Ca. Bight (south)	31	1	0	0	0	0	5	17	0	7	1	33	16	11	43	0	9	19	6	13	172
S. Ca. Bight (north outside Sl	32	2	2	0	0	0	0	1	19	5	34	90	9	22	0	0	0	171	44	22	364
Santa Barbara Channel	33	0	0	0	0	0	0	0	106	0	145	102	77	102	77	120	16	9	175	25	663
S. California (offshore)	39	3	1	0	0	0	0	20	0	32	0	0	8	0	0	0	0	0	2	0	66
Pt Conception to Buchon	41	452	0	0	0	0	0	474	0	2	6	5	2	8	0	0	18	6	39	31	116
Pt Buchon to Pt. Sur	42	0	0	0	0	0	0	0	0	2	0	0	7	0	0	6	3	9	0	0	27
S Monterey Bay Sanc.	51	9	42	61	25	15	0	0	6	18	18	8	29	10	84	16	95	41	32	119	496
N Monterey Bay Sanc.	52	0	0	0	0	0	2	0	1	45	0	3	4	4	1	5	0	20	4	23	106
Farallones/Cordell	53	9	36	74	95	64	102	27	109	25	29	7	34	40	22	42	46	21	36	70	488
Bodega Bay to Pt. Arena	54	0	0	0	17	1	0	0	20	0	1	0	4	5	0	3	0	0	6	11	62
C. California offshore	59	0	0	0	0	0	0	3	0	9	0	0	2	0	0	0	0	0	0	0	14
Pt. Arena to C. Mendocino	61	0	0	0	0	0	0	2	92	0	0	0	0	4	7	0	0	2	1	0	104
C Mend. to Klamath Riv.	62	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	4
N California to Oregon	63	0	0	0	0	0	0	4	4	0	0	0	0	0	7	0	0	2	0	8	25
Oregon	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
British Columbia	82	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2
ALL		24	79	128	122	77	109	76	279	126	209	229	184	181	226	176	170	284	311	292	1,604

Table 14. Summary of Petersen mark-recapture estimates for blue whales off California and W. Baja Mexico. Sample n1 is the number of unique identified whales from SWFSC systematic ship surveys and n2 is from coastal small-boat work. The number of matches or recaptures (m) are indicated. Coefficients of variation (CV) are based on analytical formulae.

Samples used	Left sides					Right sides					Mean
	n1	**n2**	**m**	**Est.**	**CV1**	**n1**	**n2**	**m**	**Est.**	**CV1**	
Pooled years using survey type as samples											
1991-93 all qualities	61	293	8	**2,024**	0.29	74	289	10	**1,976**	0.26	**2,000**
1995-97 all qualities	43	350	7	**1,930**	0.30	34	361	7	**1,583**	0.29	**1,756**
2000-2002 all qualities	20	452	5	**1,585**	0.32	24	474	5	**1,978**	0.33	**1,781**

Table 15. Summary of number of animals approached and showing a reaction or alteration in behavior in response to photo-ID approaches in 2003.

Species	**Approaches**		**Showing reaction**		**Types of reactions seen**			
	Sight	**Tot**	**Sight**	**Total**	**Approach**	**Avoid**	**Alter**	**Quick dive**
Blue whales	376	602	16	26		16	7	3
Fin whales	116	119	2	2	2			
Humpback whales	351	738	6	9	6			
Gray whales	54	79	0	0				
Total	897	1538	24	37	8	16	7	3

Reaction numbers include animals making friendly close approach to the vessel.

Table 16. Summary of reactions of humpback and blue whales to tagging approaches in 2003.

Action	All	Blue whale	Fin whale	Humpback
Total approaches	51	31	14	6
Tag deployments (incl 4 double tags)	41	21	14	6
Reactions to approaches				
None	10	6	3	1
Change in behavior				
Accelerate	11	7	3	1
Extend or temporarily interrupt surface se	23	15	8	
Terminate surface series	6	5	1	
Startle	1		1	
Tail slap	1			1
High arch	4			4
Sink or quick dive	11	11		

* 3 attempts and 2 tagging of blue whales were under Tom Norris permit

Table 17. Tag types deployed by species in 2003

Tag type	All	Blue whale	Fin whale	Humpback
Bioacoustic Probe	33	19	14	
Crittercam	3	3		
Nick Gale's satellite tag	7	2		5
Norris MANTA tag	2	1		1
Grand Total	45	25	14	6

Table 18. Tag deployments conducted in 2003. 1/7/00 0:00

Code	Deploy Date/time	Type	Tag	VHF Ch	Sp	Region	Deployment Latitude	Deployment Longitud	Detach Time	Hours on	Recovery Time	Num	SN#	Beh	Desc of deployment	Size	Track	Data	Photos	Skin	Reaction
Tag	7/24/03 11:17	BP	B006	Argos, 11 164.105	BM	SN	33 30.25	119 36.72	7/28/2003?		7/30/03 10:43	1	SP113	Mill	Left side		Yes	~1.2 h Depth,tilt, roll, & acoustics then	JAC 12/ 8-12, 19-29		NR
Tag	7/24/03 15:45	BP	B005	Hobbs Sat, VHF 2	BM	SN	33 29.81	119 35.80	7/24/03 16:38	0.9	7/24/03 16:45	1	SP131	Mill	Right side		Seen 1615	Depth & acoustic	JAC 13/4	Sl030724-2	Suspend/Resume SS
Tag	8/20/03 12:30	BP	B004	Argos, 4 164.305	BP	T/C	32 41.15	119 16.71	8/20/03 12:43	0.2	8/20/03 12:45	3	4	Mill	Middle L of 3	Med	No	No	No		Accel
Tag	8/20/03 13:27	BP	B007	2 164.015	BP	T/C	32 41.28	119 18.11	8/20/03 15:55	2.5	8/20/03 16:50	4	5	Mill	2nd of 4 lg whales	Med	Seen 14:35,15:07	Depth, tilt, roll, acoustics	SC1/16-7,2/10-1	B030820-3A&B	Suspend SS
Tag	8/20/03 14:10	BP	B006	11 164.105	BP	T/C	32 41.31	119 17.68	8/20/03 14:19	0.1	8/20/03 14:23	2			one of two			No	SC 1/26	Sl 030820-1	Suspend SS
Tag	8/21/03 9:05	BP	B006	2 164.015	BP	T/C	32 41.04	119 18.34	8/21/03 9:19	0.2	8/21/03 9:26	4	2	Mill	single near 4+4	Med	No	No	JAC C/8	Sl 030821-1?	Suspend SS
Tag	8/21/03 10:40	BP	B006	2 164.015	BP	T/C	32 41.04	119 18.34	8/21/03 13:52	3.2	8/21/03 13:52	1	8	Mill	Single	Lg	until 11:28	No	JAC C/12-43	Sl030821-2 030821-6A&B	Suspend SS
Tag	8/21/03 11:40	BP	B007	11 164.105	BP	T/C	32 40.08	119 18.25	8/21/03 11:57	0.3	8/21/03 11:59	4	9	Mill	One of four	Med	No	Depth, tilt, roll, acoustics		Sl 030821-4	NR
Tag	8/21/03 12:50	BP	B007	11 164.105	BP	T/C	32 39.99	119 18.19	8/21/03 13:17	0.5	8/21/03 13:22	4	12	Mill	2nd from lead	Med	No	Depth, tilt, roll, acoustics		Sl 030821-5	Accel, Suspend SS
Tag	8/21/03 16:27	BP	B004	Argos, 2 164.015	BP	T/C	32 39.89	119 18.56	8/21/03 16:36	0.1	8/21/03 16:39	2	19	Mill	Left lead	Med	No	Not recov	JAC C/67-9		Suspend SS
Tag	8/21/03 17:16	BP	B004	Argos, 2 164.015	BM	T/C	32 37.78	119 17.76	?		Not recovered	1	20	Trav	Single caller	Lg	Yes	Not recov	JAC C/70-8	Sl030821-7, B030821-8A&B	Term SS
Tag	8/22/03 8:30	BP	B007	11 164.105	BP	T/C	32 41.03	119 18.84	8/22/03 17:00	8.5	8/22/03 17:47	2	2	Mill	Trail, then lead, then solo	M-Lg	to 0919	75 min Depth, tilt, roll,	JAC C/1-5,11-6	B030822-1A&B	NR
Tag	8/22/03 12:59	BP	B006	2 164.015	BM	T/C	32 48.86	119 22.53	8/22/03 13:22	0.4	8/22/03 13:22	1	6	Mill	Solo Suspected caller	Lg	Yes	No	JAC C/17-26	Sl030822-2	Suspend SS
Tag	8/22/03 15:48	BP	B006	2 164.015	BM	T/C	32 48.68	119 22.50	8/22/03 16:35	0.8	8/22/03 16:43	1	6	Mill	Redeploy on Susp. caller	Lg	Yes	Depth, tilt, roll, acoustics	Same	Same	Sink
Tag	8/23/03 11:35	BP	B006	2 164.015	BP	T/C	32 41.24	119 17.70	8/23/03 11:56	0.3	8/23/03 13:20	1	5	Mill	Single	Med	No	Depth, tilt, roll, acoustics	No	Sl030823-2	Accel
Tag	8/25/03 9:09	BP	B007	2 164.015	BP	T/C	32 38.38	119 20.59	8/25/03 11:21	2.2	8/25/03 11:32	3	5	Mill	Lead	Med	No	Depth, tilt, roll, acoustics	JAC C/4-5	Sl030825-3	Suspend SS
Tag	8/25/03 9:28	BP	B006	16 164.154	BM	T/C	32 37.62	119 21.10	8/25/03 9:35	0.1	8/25/03 9:45	1	6	Mill	Single	Lg	No	Yes but does not look right		Sl030825-2	Sink, Suspend SS
Tag	8/25/03 15:00	BP	B006	16 164.154	BP	T/C	32 38.56	119 20.44	8/25/03 15:05	0.1	8/25/03 15:09	3	17	Mill	Single	Med	No	Depth, tilt, roll, acoustics		Sl030825-6	NR
Tag	8/26/03 12:25	BP	B007	16 164.154	BP	T/C	32 37.74	119 21.68	8/26/03 13:43	1.3	8/26/03 13:46	2	6	Mill	Trail of 2 then 3	M-Lg	Yes	Depth, tilt, roll, acoustics	JAC C/15-20	B030826-1	Flinch, Term SS
Tag	8/26/03 16:04	BP	B006	2 164.015	BP	T/C	32 38.91	119 19.71	8/26/03 16:50	0.8	8/26/03 16:54	3	12	Mill	Middle of 3	Lg	No	Depth, tilt, roll, acoustics		Sl030826-4	Suspend SS
Tag	9/23/03 15:01	GST	Gales, 2-blade	PTT 43563	MN	MB	37 00.40	122 24.35				2	N2-11	Mill				Gales	JAC C/26	B030923-2	Fluke wave/slap
Tag	9/23/03 17:42	GST	Gales, 2-blade	PTT 43566	MN	HMB	37 14.73	122 43.22				2	N2-12	Feeding				Gales			Light tail lift, calm imm. After
Tag	9/23/03 18:31	GST	Gales, 2-b	PTT 43565	MN	HMB	37 15.45	122 42.89				4	N2-14	Surface Lunge feeding				Gales	JAC C/62-64		Back arch. Calm afterwards. Continued feeding, stayed w/
Tag	9/23/03 17:38	GST	Gales, 2-b	PTT 43564	MN	HMB	37 14.39	122 43.07				3	N2-13	Surface lunge feed				Gales	JAC C/46	030923-3A&B	None
Tag	9/23/03 18:31	GST	Gales, 2-b	PTT 43565	MN	HMB	37 15.45	122 42.89				4	N2-14	Surface Lunge feeding				Gales	JAC C/62-64		Back arch. Calm afterwards. Continued feeding, stayed w/
Tag	9/24/03 9:55	BP	B006	16 164.154	BM	MB	36 43.65	121 59.10	9/24/03 11:07	1.2	9/24/03 11:14	1	N2-4		Deploy on single		Martin w/ HA	Depth, tilt, roll, acoustics	JAC C/1-5	TS 030924-1	Suspend SS
Tag	9/24/03 13:00	BP	B007		BM	MB	36 43.59	122 01.42	9/24/03 13:01	0.0	9/24/03 13:01	1	N2-6				too brief	No	No	TS 030924-2	
Dual Tag	9/24/03 16:42	CC	CC		BM	MB	36 41.23	121 59.92	9/24/03 16:42	0.0	9/24/03 16:43	2	N2-10		Deploy both tags on lead		too brief	No	No	TS 030924-3	Sink and Accelerate
Dual Tag	9/24/03 16:42	BP	B007?		BM	MB	36 41.23	121 59.92	9/24/03 16:44	0.0	9/24/03 16:44	2	N2-10		Deploy both tags on lead		too brief	No	No	TS 030924-3	Sink and Accelerate

Code	Deploy Date/time	Type	Tag	VHF Ch	Sp	Region	Deployment Latitude	Longitud	Detach Time	Hours on	Recovery Time	Num	SN#	Beh	Desc of deployment	Size	Track	Data	Photos	Skin	Reaction
Tag	9/24/03 17:33	GST	Gales, 4-l	PTT 43562	BM	MB	36 40.87	121 58.33				2	N2-11	Mill	Lead			Gales	JAC C/10		None
Tag	9/24/03 18:52	GST	Gales, 4-l	PTT 43561	BM	MB	36 41.15	121 58.88				2	N2-12	Mill	Trail			Gales	JAC C/15-22		Accelerate, Terminate SS
Tag	9/26/03 8:35	BP	B007		BM	MB	36 41.37	122 00.84	9/26/03 8:36	0.0	9/25/03 8:37	2	N2-1	Slow Travel	Deployment		too brief	Brief Depth, tilt, roll, & acoustic			Sink and Accelerate, Suspend SS
Dual Tag	9/26/03 11:06	BP	B007		BM	MB	36 46.59	121 57.00	9/26/03 11:20	0.2	9/26/03 11:24	1	N2-6		Dual Deployment			Brief Depth, tilt, roll, & acoustic		TS 030926-1	Accelerate and Suspend SS
Dual Tag	9/26/03 11:06	CC	CC		BM	MB	36 46.59	121 57.00	9/26/03 11:12	0.1	9/26/03 11:13	1	N2-6		Dual Deployment			Depth, temp, image		TS 030926-1	Accelerate and Suspend SS
Tag	9/26/03 11:35	BP	B007		BM	MB	36 46.80	121 58.10	9/26/03 14:56	3.3	9/26/03 15:02	1	N2-7		Deployment		Martin w/ HA >12:14	Depth, tilt, roll, & acoustic	JAC C/1-6	B 030926-2	Sink, Suspend SS
Tag	9/26/03 15:14	BP	B006	11 164.105	BM	MB	36 41.52	122 01.69	9/26/03 16:45	1.5	9/26/03 16:58	2	N2-10		Deploy on lead		Yes	Depth, tilt, roll, & acoustic	JAC C/10-14 (sighting)	B 030926-3AB	Temporary Suspend SS
Tag	9/28/03 13:43	BP	B007	11 164.105	BM	MB	36 44.52	121 58.70	9/28/03 17:20	3.6	9/28/03 0:00	2	N2-6		Deployment		Martin w/ HA >13:53	Depth, tilt, roll, & acoustic	JAC C/2-7	B 030928-1AB	Temporary Suspend SS
Tag	9/28/03 17:00	BP	B006	16 164.154	BM	MB	36 45.11	121 58.63	9/28/03 17:20	0.3	9/28/03 17:29	1	N2-8		Deployment		No	No		TS 030928-2	Suspend SS
Tag	9/29/03 12:00	BP	B007	16 164.154	BM	MB	36 41.70	122 00.24	9/29/03 12:01	0.0	9/29/03 12:02	2	N2-3	Mill	Deploy on trail			No	JAC D/1-7 (sighting)	TS 030929-1	
Dual Tag	9/29/03 11:18	BP	B006		BM	MB	36 45.83	121 58.07	9/29/03 ~11:28		9/29/03 11:28	1	Z-3	Mill	Dual deployment, ARTT slid almost perpendicular to lateral		Martin w/ HA	No	TEC 48/22-27 (sighting)	TS 030929-2	
Dual Tag	9/29/03 11:18	MANTA	ARTT		BM	MB	36 45.83	121 58.07	9/29/03 13:10	1.9	9/29/03 0:00	1	Z-3	Mill	Dual deployment, Bioprobe slid almost off top of whale		Yes	Tom	TEC 48/22-27 (sighting)	TS 030929-2	
Tag	9/30/03 11:26	MANTA	ARTT		MN	MB	36 44.38	121 55.86	9/30/03 ~11:28		9/30/03 11:35	2	N2-1	Fast Mill, travel	Deployment			Tom	JAC D/11-16 (sighting)		Small tail flick, accelerate
Dual Tag	9/30/03 15:45	CC	CC	1150.88	BM	MB	36 33.54	121 58.65	9/30/03 16:00	0.2	9/30/03 16:00	2	N2-3	Mill	Deploy on trail		Yes, TEC	Depth, temp, image	TEC 49/3-7	TS 030930-1	
Dual Tag	9/30/03 15:45	BP	B006	11 164.105	BM	MB	36 33.54	121 58.65	9/30/03 16:31	0.8	9/30/03 16:31	2	N2-3	Mill	Deploy on trail		Yes, TEC	Depth &acoustics only, prob >16:12	TEC 49/3-8		
Tag	9/30/03 17:08	BP	B007		BM	MB	36 33.28	121 59.64	9/30/03 17:50	0.7	9/30/03 17:57	2	N2-3	Mill	Deploy on lead		Yes, TEC	No	TEC 49/1-2, 9-11	TS 030930-2	

Table 19. List of skin samples collected in 2003 off California, Oregon, and Washington from biopsy and skin from tag suction cups.

Samples	Date/time	Type	Sp	Region	Pers	Latitude	Longitude	Num	Ves	SN#	Reaction
B030324-1	3/24/03 1346	B	ER	PS	JAC	47 53.07	122 24.43	2	N1	2	slight startle
B030324-2	3/24/03 1435	B	ER	PS	JAC	47 52.21	122 24.29	4	N1	3	sink response
B030324-3	3/24/03 1510	B	ER	PS	JAC	47 52.83	122 24.13	4	N1	3	sink response
B030324-4	3/24/03 1529	B	ER	PS	JAC	47 52.81	122 23.97	4	N1	3	tail flinch
B030418-1A&B	4/18/03 1435	B	ER	PS	JAC	48 03.95	122 24.88	2	N1	3	Sink, Long dive
B030418-2A&B	4/18/03 1435	B	ER	PS	JAC	48 03.95	122 24.88	2	N1	3	Fluke swish, Accel.
B030418-3A&B	4/18/03 1627	B	ER	PS	JAC	48 07.22	122 28.92	1	N1	4	Tail Slap
B030518-1A&B	5/18/03 1900	B	ER	PS	JAC	48 01.95	122 20.66	1	N1	5	Flinch
B030527-1A&B	5/27/03 1156	B	MN	SBC	TEC	34 06.28	120 04.59	2	Z2	5	Soft flick
B030527-2A&B	5/27/03 1225	B	MN	SBC	TEC	34 06.40	120 05.64	2	Z2	6	Soft flick
B030527-3	5/27/03 1740	B	MN	SBC	TEC	34 09.27	119 42.21	2	Z2	9	Soft flick
B030719-1A&B	7/19/2003 1012	B	MN	SL	JAC	34 53.69	120 48.58	1	N1	9	NR
B030722-1	7/22/03 11:36	B	BP	T/C	JAC	32 36.86	119 21.30	2	N1	5	NR
B030722-2A&B	7/22/03 11:50	B	BP	T/C	JAC/MM	32 37.31	119 21.00	1	N1	6	NR
B030722-3A&B	7/22/03 12:10	B	BP	T/C	JAC/MM	32 37.24	119 20.64	5	N1	7	NR
B030722-4	7/22/03 12:49	B	BP	T/C	JAC/MM	32 37.34	119 20.81	4	N1	7	NR
B030722-5A&B	7/22/03 14:17	B	BP	T/C	JAC/MM	32 36.32	119 21.85	5	N1	9	NR
B030722-6A&B	7/22/03 14:37	B	BP	T/C	JAC/MM	32 38.83	119. 20.38	1	N1	10	NR
B030722-7A&B	7/22/03 15:45	B	BP	T/C	JAC/MM	32 41.31	119 17.42	2+1	N1	12	NR
B030722-8A&B	7/22/03 15:45	B	BP	T/C	JAC/MM	32 41.31	119 17.42	2+1	N1	12	Accelerate
B030722-9A&B	7/22/03 16:30	B	BP	T/C	JAC/MM	32 39.89	119 18.48	2	N1	13	NR
B030722-10A	7/22/03 16:30	B	BP	T/C	JAC/MM	32 39.89	119 18.48	2	N1	13	Accelerate
B030722-11A&B	7/22/03 16:54	B	BP	T/C	JAC/MM	32 41.42	119 16.93	2	N1	14	NR
B030723-1A&B	7/23/03 11:05	B	BP	T/C	JAC/MM	32 39.09	119 11.91	1	N1	2	Suspend SS/Resume
B030723-2A&B	7/23/03 11:22	B	BP	T/C	JAC/MM	32 39.33	119 11.58	1	N1	3	Accelerate
B030723-3A&B	7/23/03 11:57	B	BP	T/C	JAC/MM	32 39.33	119 11.62	2+2	N1	4	NR
B030723-4A&B	7/23/03 12:32	B	BP	T/C	JAC/MM	32 39.13	119 11.53	2	N1	5	NR
B030723-5A&B	7/23/03 12:32	B	BP	T/C	JAC/MM	32 39.13	119 11.53	2	N1	5	NR
B030723-6	7/23/03 14:15	B	BP	T/C	JAC/MM	32 37.42	119 15.97	1+1	N1	SP-93	NR
B030723-7A&B	7/23/03 14:30	B	BP	T/C	JAC/MM	32 32.49	119 15.84	2	N1	7	Accelerate
B030724-1	7/24/03 12:57	B	BM	San Nic	JAC/MM	33 30.06	119 35.92	1	N1	SP-113	NR
Sl030724-2	7/24/03 16:45	Sl-tag	BM	San Nic	JAC/MM	33 30.57	119 34.18	1	N1	SP-131	Susp/Resume SS
B030725-1A&B	7/25/03 1120	B	MN	Santa Cruz	TEC	36 59.59	122 19.86	2	Z2	17	Moderate Flick
B030725-2A&B	7/25/03 1120	B	MN	Santa Cruz	TEC	37 00.52	122 21.76	2	Z2	18	NR
B030725-1A&B	7/25/03 17:10	B	BM	San Nic	JAC/MM	33 29.61	119 52.33	2	N1	1B	Suspend/Resume/SS
B030725-2	7/25/03 18:13	B	BM	San Nic	JAC/MM	33 30.37	119 51.99	2	N1	3	NR
B030725-3A&B	7/25/03 18:13	B	BM	San Nic	JAC/MM	33 30.37	119 51.99	2	N1	3	Accelerate, term SS
Sl030820-1	8/20/03 14:23	Sl-tag	BP	T/C	JAC/MM	32 41.21	119 17.59	4	N2	5B	Susp SS
B030820-2	8/20/03 14:50	B	BP	T/C	JAC/MM	33 41.21	120 17.59	3	N2	5A	Susp/Resume SS
B030820-3A&B	8/20/03 15:30	B	BP	T/C	JAC/MM	33 41 40	120 17 87	3	N2	5A	Susp SS
Sl030821-1	8/21/03 9:05	Sl-tag	BP	T/C	JAC/MM	32 41.04	119 18.34	1	N2	2	Susp SS
Sl030821-2	8/21/03 10:40	Sl-tag	BP	T/C	JAC/MM	32 41.33	119 18.68	1	N2	8	Susp/resume SS
B030821-3	8/21/03 1140	B	BP	T/C	JAC/MM	32 40.08	119 18.25	4	N2	9	NR
Sl 030821-4	8/21/03 11:40	Sl-tag	BP	T/C	JAC/MM	32 40.08	119 18.25	4	N2	9	NR
Sl 030821-5	8/21/03 12:50	Sl-tag	BP	T/C	JAC/MM	32 39.99	119 18.19	4	N2	12	Accel, Susp SS
B030821-6A&B	8/21/03 1420	B	BP	T/C	JAC/MM	32 39.72	119 18.42	2	N2	?	NR
Sl030821-7	8/21/03 17:16	Sl-tag	BM	T/C	JAC/MM	32 37.78	119 16.76	1	N2	20	Term SS
B030821-8A&B	8/21/03 1736	B	BM	T/C	JAC/MM	32 37.78	119 17.76	1	N2	20	NR
B030822-1A&B	8/22/03 8:30	Sl-tag	BP	T/C	JAC/MM	32 40.81	119 18.87	2	N2	2	NR
Sl030822-2	8/22/03 12:59	Sl-tag	BM	T/C	JAC/MM	32 48.86	119 22.53	1	N2	6	Susp SS
B030823-1A&B	8/23/2003 0930	B	BP	T/C	JAC/MM	32 41 91	119 18 67	1	N2	2	NR
Sl030823-2	8/23/03 11:35	Sl-tag	BP	T/C	JAC/MM	32 41.24	119 17.70	1	N2	5	Accel
B030825-1A&B	8/25/03 9:09	B	BP	T/C	JAC/MM	32 38.38	119 20.59	3	N2	5	NR
Sl030825-2	8/25/03 9:28	Sl-tag	BM	T/C	JAC/MM	32 37.62	119 21.10	1	N2	6	Sink, Susp SS
Sl030825-3	8/25/2003 1132	Sl-tag	BP	T/C	JAC/MM	32 37.67	119 20.54	3	N2	5	Susp SS
B030825-4A&B	8/25/2003 1330	B	BP	T/C	JAC/MM	32 37.55	119 21.92	3+2+2	N2	12	Quick Dive
B030825-5A&B	8/25/2003 1340	B	BP	T/C	JAC/MM	32 37.37	119 21.82	2	N2	13	Flinch, Term SS
Sl030825-6	8/25/2003 1524	Sl-tag	BP	T/C	JAC/MM	32 38.90	119 20.71	4	N2	18	Susp SS
B030826-1	8/26/03 12:42	Sl-tag	BP	T/C	JAC/MM	32 37.68	119 21.63	3	N2	6	Flinch, Term SS
B030826-2	8/26/2003 1248	B	BP	T/C	JAC/MM	32 37.59	119 21.59	2	N2	7	
B030826-3A&B	8/26/2003 1330	B	BP	T/C	JAC/MM	32 37.75	119 21.71	5	N2	6	NR
Sl030826-4	8/26/03 16:04	Sl-tag	BP	T/C	JAC/MM	32 38.91	119 19.71	3	N2	12	Susp SS
B030831-1	8/31/2003 1439	B	BM	Port San Luis	JAC/RNL	34 34.40	120 49.13	1	N2	21	
B030901-1	9/01/2003 1029	B	BM	HMB	JAC/RNL	37 36.30	122 58.63	3	N2	2	NR

Samples	Date/time	Type	Sp	Region	Pers	Latitude	Longitude	Num	Ves	SN#	Reaction
B030901-2	9/01/2003 1259	B	BM	HMB	JAC/RNL	37 37.24	123 04.25	2	N2	6	
B030901-3	9/01/2003 1259	B	BM	HMB	JAC/RNL	37 37.24	123 04.25	2	N2	6	
B030901-4	9/01/2003 1330	B	BP	HMB	JAC/RNL	37 40.73	123 05.32	2	N2	7	
B030906-1	9/06/2003 1820	B	MN	Pt. St. G.	TEC	41 49.53	124 23.47	2+1	Z2	36	Hard Flick
B030906-2	9/06/2003 1839	B	MN	Pt. St. G.	TEC	41 50.03	124 24.11	1	Z2	37	Hard Flick
B030907-1	9/07/2003 1414	B	MN	FB	TEC	39 58.47	123 54.05	4	Z2	4	Hard Flick
B030907-2	9/07/2003 1414	B	MN	FB	TEC	39 58.47	123 54.05	4	Z2	4	Soft Flick
B030907-3	9/07/2003 1414	B	MN	FB	TEC	39 58.47	123 54.05	4	Z2	4	Soft Flick
B030915-1	9/15/2003 1510	B	MN	Santa Cruz	TEC	37 10.13	122 34.67	2	Z2	19	Hard Flick
B030915-2A&B	9/15/2003 1510	B	MN	Santa Cruz	TEC	37 10.13	122 34.67	2	Z2	19	Soft Flick
B030923-1A&B	9/23/2003 1345	B	MN	Santa Cruz	TEC	36 59.68	122 25.44	2+1	Z2	21	Moderate Flick
B030923-2A&B	9/23/2003 1519	B	MN	Santa Cruz	JAC	37 00.03	122 24.20	2+1	N2	11	Mild - raised arch
B030923-3A&B	9/23/2003 1805	B	MN	Pescadero	JAC	37 15.20	122 42.89	3	N2	13	NR
Sl030924-1	9/24/2003 1114	Sl-tag	BM	Monterey	JAC	36 44.69	121 58.85	1	N2	4	Susp SS
Sl030924-2	9/24/2003 1300	Sl-tag	BM	Monterey	JAC	36 43.59	122 01.42	1	N2	6	
Sl030924-3	9/24/2003 1642	Sl-tag	BM	Monterey	JAC	36 41.23	121 59.92	2	N2	10	Sink, Accelerate
Sl030925-1	9/25/2003 1151	Sl-tag	BM	Monterey	TEC	36 40.99	122 00.69	2	N2	13	Accelerate/term SS
B030925-2	9/25/2003 1334	B	BM	Monterey	TEC	36 43.09	121 57.42	2	N2	15	Term SS
Sl030925-3	9/25/2003 1649	Sl-tag	BM	Monterey	TEC	36 40.95	122 00.50	2	N2	19	Part. Sink response
Sl030926-1	9/26/2003 1106	Sl-tag	BM	Monterey	JAC	36 46.54	121 57.00	1	N2	7	Accelerate/susp SS
B030926-2	9/26/2003 1251	B	BM	Monterey	JAC	36 44.16	121 58.47	1	N2	7	NR
B030926-3A&B	9/26/2003 1530	B	BM	Monterey	JAC	36 41.62	122 01.54	2	N2	10	NR
B030926-4	9/26/2003 1542	B	MN	Monterey	TEC/RB	36 34.29	122 02.14	1	Z2	14	Soft Flick
B030927-1A&B	9/27/2003 1612	B	MN	HMB	TEC	36 37.49	122 01.76	3	Z2	16	NR
B030927-2A&B	9/27/2003 1612	B	MN	HMB	TEC	36 37.49	122 01.76	3	Z2	16	Tail wave/no slap
B030927-3	9/27/2003 1612	B	MN	HMB	TEC	36 37.49	122 01.76	3	Z2	16	Very soft flick
B030928-1A&B	9/28/2003 1437	B	BM	Monterey	JAC	36 45.03	122 58.79	2	N2	6	Tail Slap
Sl030928-2	9/28/2003 1728	Sl-tag	BM	Monterey	JAC	36 45.14	121 58.68	1	N2	8	Susp SS
Sl030929-1	9/29/2003 1202	Sl-tag	BM	Monterey	JAC	36 41.70	122 00.05	2	N2	3	
Sl030929-2	9/29/2003 1310	Sl-tag	BM	Monterey	TEC	36 46.56	121 58.09	1	Z2	3	NR
Sl030930-1	9/30/2003 1600	Sl-tag	BM	Monterey	JAC	36 33.69	121 59.69	2	N2	3	
Sl030930-2	9/30/2003 1757	Sl-tag	BM	Monterey	JAC	36 32.71	121 59.58	2	N2	3	
B031001-1	10/01/2003 1339	B	MN	Santa Cruz	TEC	36 53.83	122 20.26	2	Z2	8	Soft Flick

Table 20. Biopsy and biopsy attempts conducted in 2003 under Permit 540-1502-00 off California, Oregon, and Washington.

Species / Type	Number	No visible reaction	Some reaction	Types of reaction							
				Flick or flinch	Sink	Accel	Slap	Startle	Long dive	Susp. Surface series	Term. Surface series
Blue whale											
Biopsy sample	13	9	4			1	1			1	2
Biopsy miss	5	5									
Biopsy hit no sample	1	1									
Total blue whale	19	15	4	0	0	1	1	0	0	1	2
Fin whale											
Biopsy sample	29	20	9	1		4				4	1
Biopsy miss	9	9									
Biopsy hit no sample	1		1							1	
Total fin whale	39	29	10	1	0	4	0	0	0	5	1
Gray whale											
Biopsy sample	8		8	2	3	1	2	1	1		
Biopsy miss	2	2									
Biopsy hit no sample	2	2									
Total gray whale	12	4	8	2	3	1	2	1	1	0	0
Humpback whale											
Biopsy sample	21	4	17	17							
Biopsy miss	6	5	1	1							
Biopsy hit no sample	6	2	4	4							
Total humpback wha	33	11	22	22	0	0	0	0	0	0	0
All species											
Biopsy sample	71	33	38	20	3	6	3	1	1	5	3
Biopsy miss	22	21	1	1	0	0	0	0	0	0	0
Biopsy hit no sample	10	5	5	4	0	0	0	0	0	1	0
Total all species	103	59	44	25	3	6	3	1	1	6	3

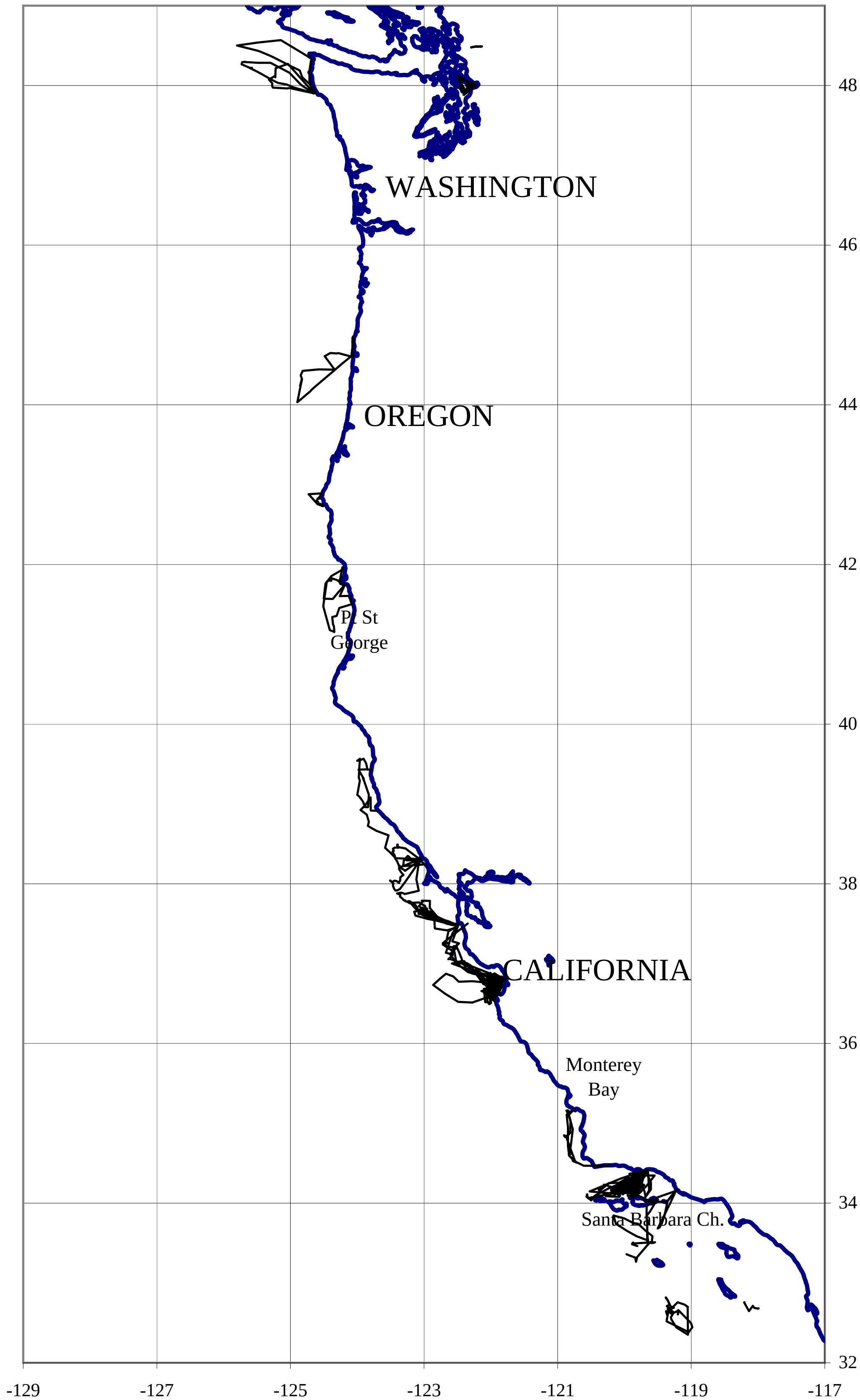

Figure 1. Photo-ID survey effort along the coast of California, Oregon, Washington in 2003.

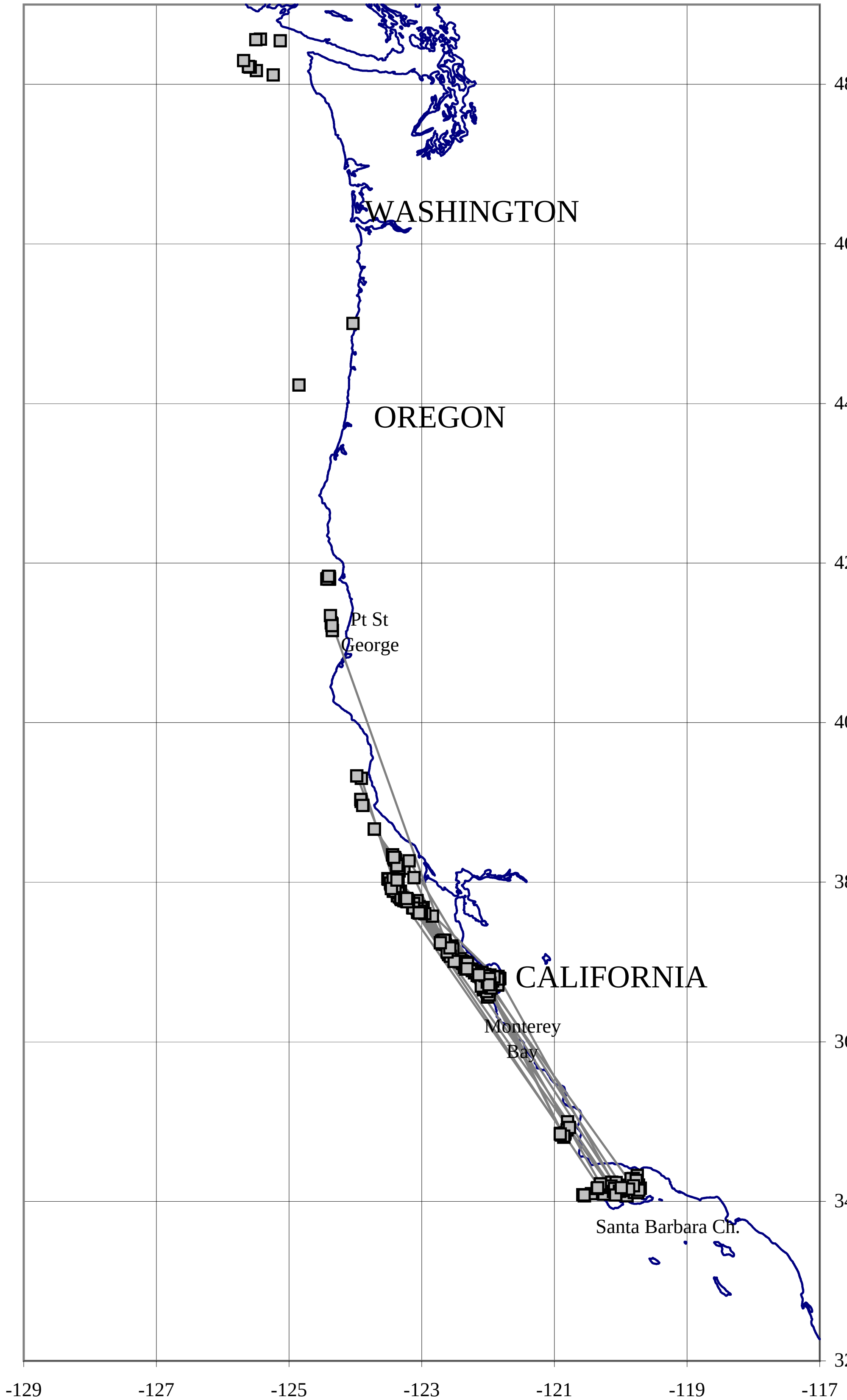

Figure 2. Locations of humpback whale identifications in 2003. Light lines connect multiple sightings of the same individual in that year.

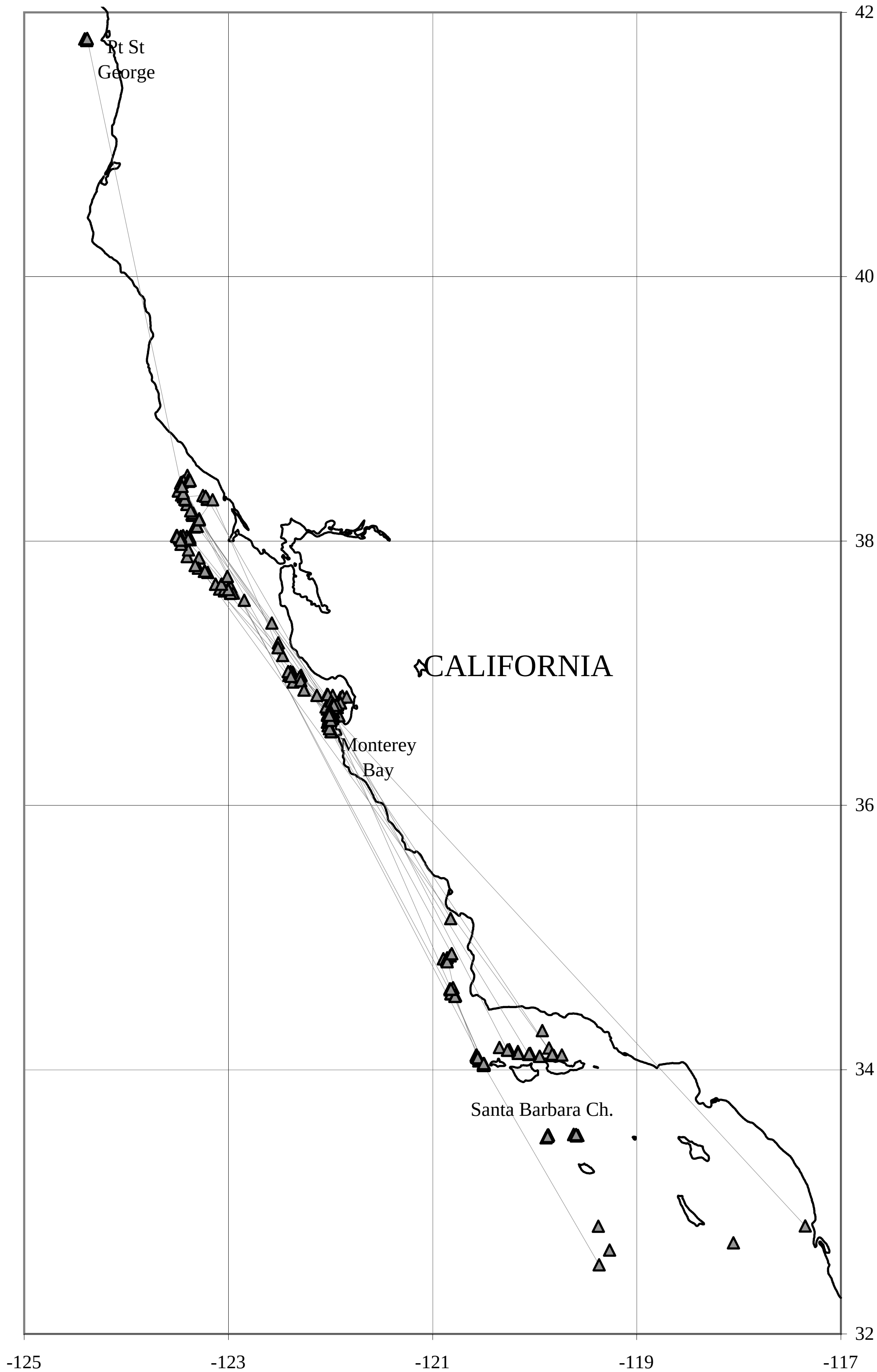

Figure 3. Locations blue whales were identified in 2003 along the California coast showing connections between resightings of the same individual.

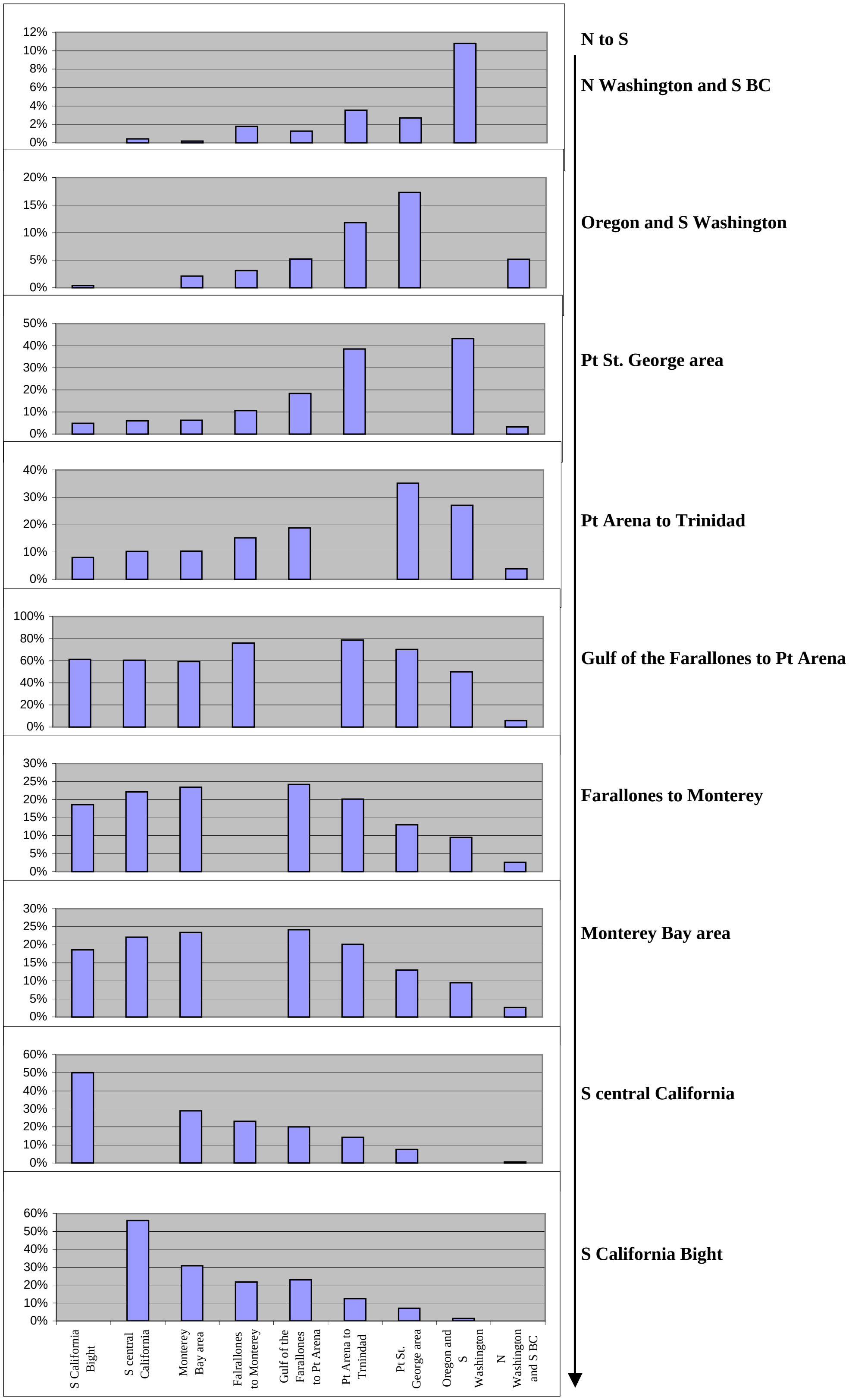

Figure 4. Interchange rates of humpback whales among regions. For each region from north to south the graph shows the percent of animals in each other region that had also been seen in the selected area. Resightings both within and between years are included.

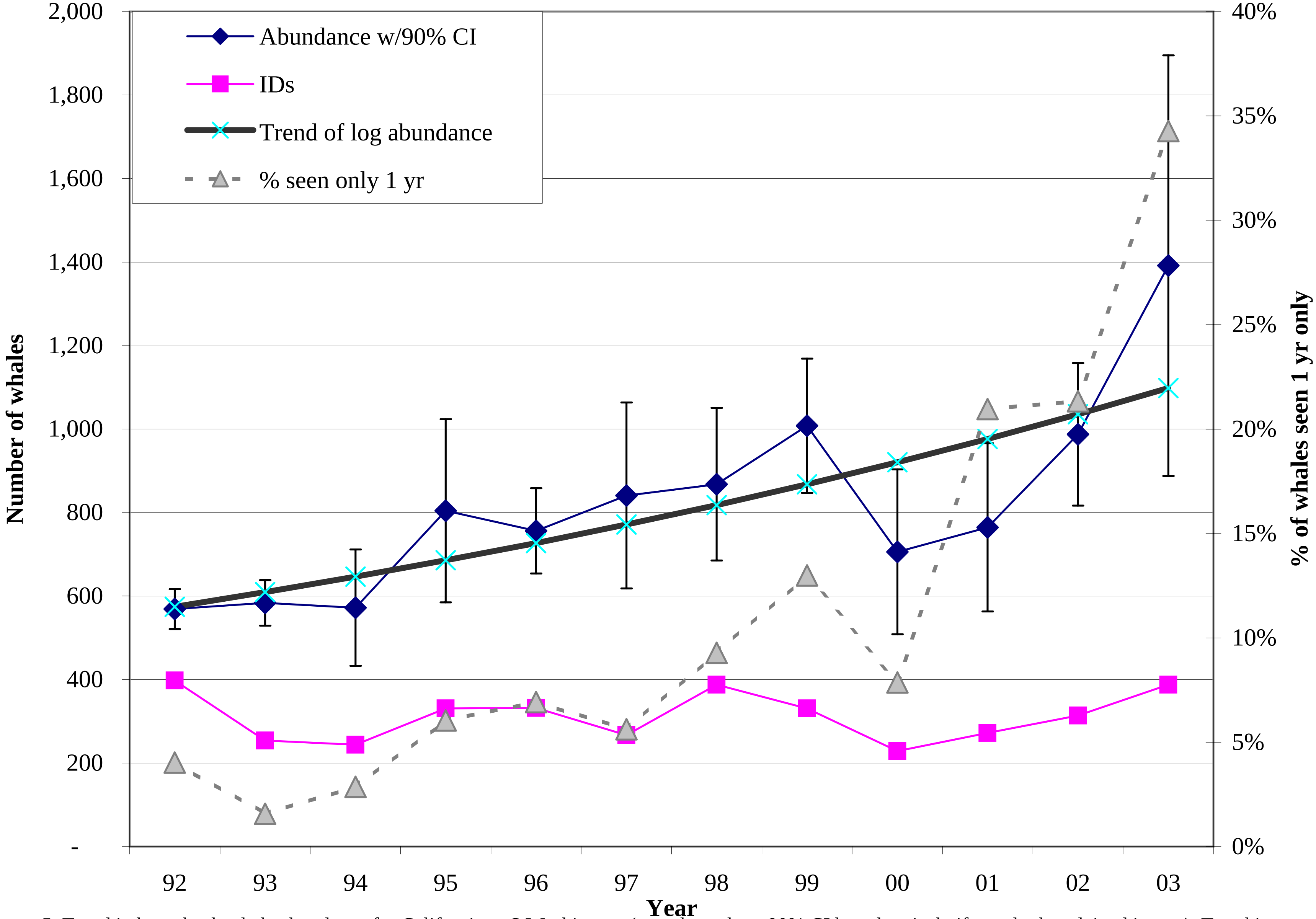

Figure 5. Trend in humpback whale abundance for California to S Washington (error bars show 90% CI based on jacknife method explained in text). Trend is based on regression of log values (r^2=0.65, slope reflects 6% per year increase). Also shown is the number of individuals identified each year and the percent that had been seen in at least one other year (scale on left).

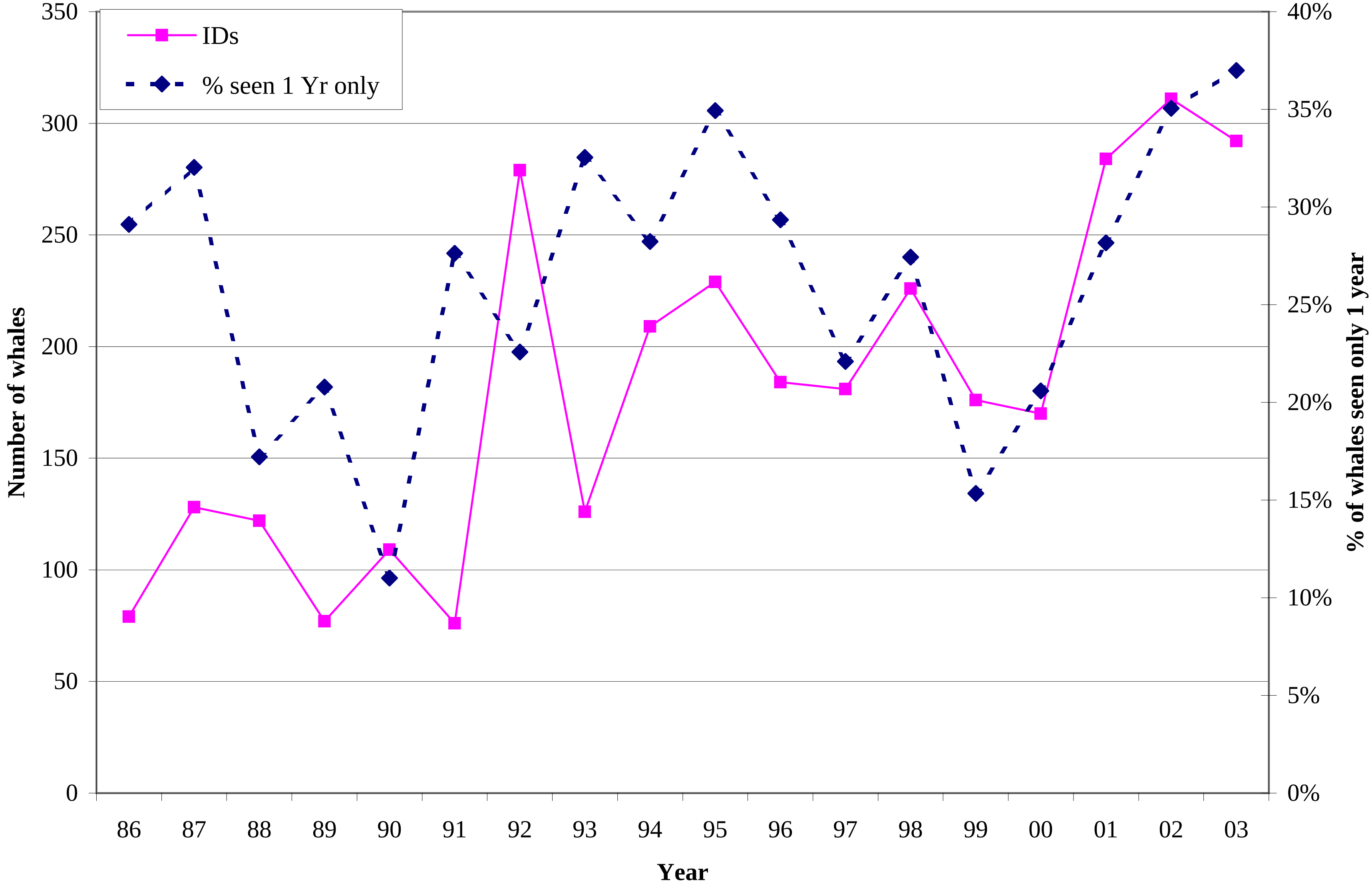

Figure 6. Number of blue whales identified and the proportion of these seen only one other year for 1986 to 2003.

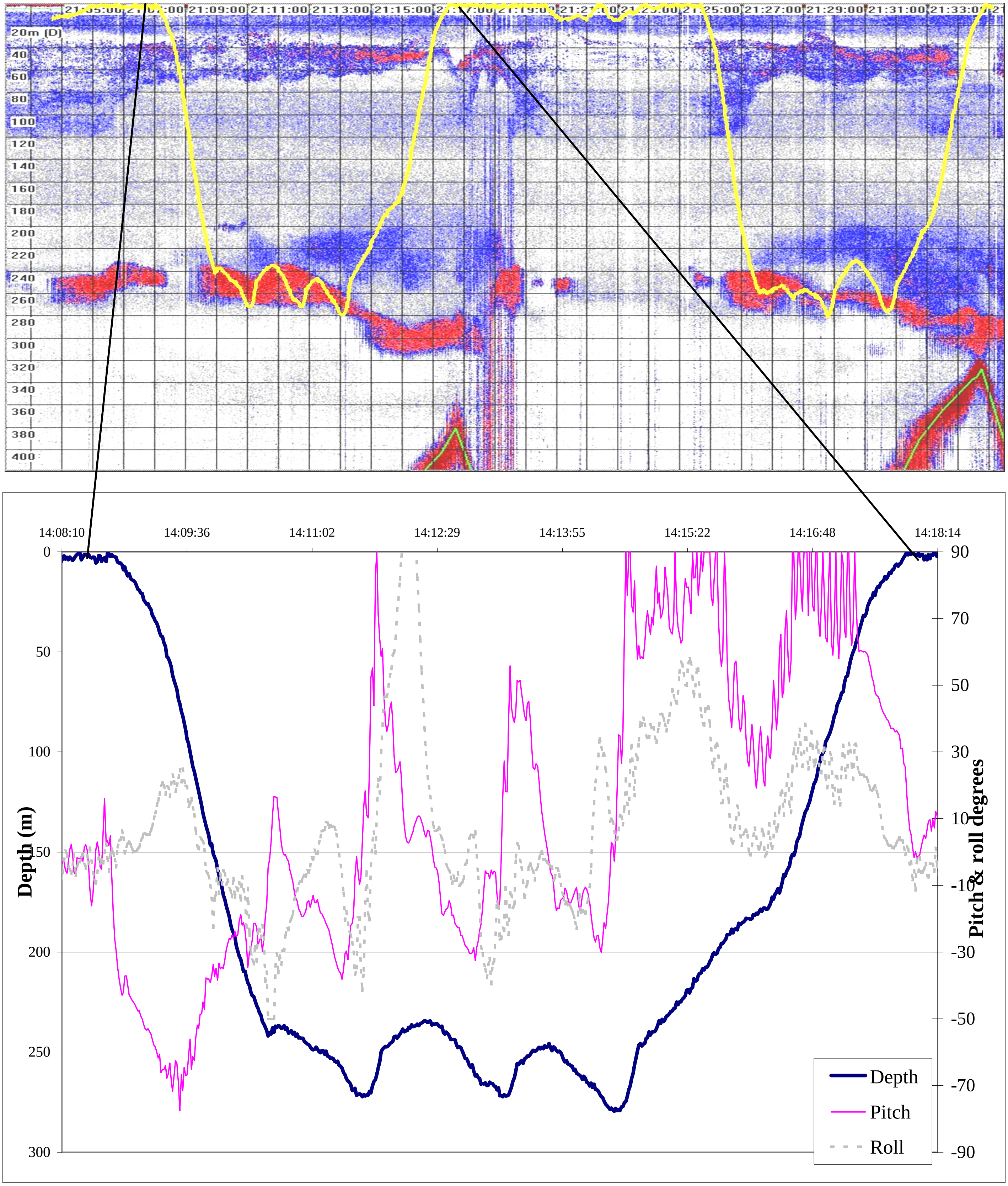

Figure 7. Dive record from feeding blue whale tagged in Monterey Bay on 28 September 2003. Top figure shows dive profile superimposed on hydroacoustic data (provided by UC Santa Cruz). Bottom figure shows detail of first dive including pitch and roll of whale.