

FINAL REPORT

**RESEARCH ON HUMPBACK AND BLUE WHALES
OFF CALIFORNIA, OREGON AND WASHINGTON IN 2000**

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TABLE OF CONTENTS

EXECUTIVE SUMMARY	3
INTRODUCTION.....	4
METHODS	5
Photographic identification methods	5
Biopsy sample collection	5
Tagging	6
Measurements of the sizes of whales.....	6
Acoustic monitoring.....	6
Survey regions and coverage.....	7
Dedicated Surveys off Washington and Oregon.....	7
Opportunistic effort off Oregon and Washington.....	7
Dedicated photographic identification surveys off California.....	8
Surveys conducted on the <i>Sprout</i> in collaboration with Scripps Institute of Oceanography.....	8
Monterey Bay surveys conducted in collaboration with Nancy Black and Oceanic Society.....	9
Additional opportunistic photographic identifications made off California.....	9
RESULTS	10
Photographic identification.....	10
Humpback whales.....	10
Blue whales.....	10
Gray whales.....	11
Abundance estimates	11
Cittercam deployments	11
Number of animals disturbed by approaches.....	12
Collection of fecal and skin samples	13
Measurements of the sizes of whales.....	14
ACKNOWLEDGMENTS	15
REFERENCES	16
TABLES AND FIGURES	19

EXECUTIVE SUMMARY

Surveys were conducted in 2000 to continue long-term research studies of humpback and blue whales off California, Oregon, and Washington. Primary objectives of this work include examining the abundance and trends of these two species, movement and migration patterns, and reproduction and mortality rates. This research has also been conducted in association with studies on gray whales and incidental observations of other large whales. Although photographic identification was the primary method used, we also collected skin and fecal samples, made behavioral observations, measured sizes of whales, and deployed an underwater video/instrument package (Critttercam) on blue whales. Support for different aspects of this research in 2000 came from Southwest Fisheries Science Center, Olympic Coast National Marine Sanctuary, Office of Naval Research, Scripps Institute of Oceanography, National Marine Mammal Laboratory, and several individual contributors.

Photographic identification studies of humpback and blue whales were conducted off California, Oregon, and Washington April to December 2000. Dedicated surveys were conducted using Cascadia's 5.3m RHIBs and on a few occasions other boats. Collaborating researchers and work from opportunistic platforms provided additional effort and identification photographs especially in Monterey Bay. Identification photographs were taken using standard procedures employed in past research (Calambokidis *et al.* 1990a, 1990b, 2000a). Both sides of blue whales in the vicinity of the dorsal fin were photographed as well as the ventral surface of the flukes. For humpback whales, photographs were taken of the ventral surface of the flukes.

Dedicated and opportunistic effort results in 646 identifications of 254 unique humpback whales. Photographic identification of blue whales conducted in 2000 yielded 335 identifications of 168 unique individuals. Locations of sightings in 2000 were more clumped than in past years due to more limited support for field effort. More than half the humpback and blue whale identifications were made in the Monterey Bay area due to the steady concentrations of whales in this area and a high research effort in this area. The 2000 identifications provided updated abundance estimates for humpback whales of 715 (CV= 0.17), considerably lower than estimates in recent years and counter to the increasing trend seen since the early 1990s. The lower estimate appears to be at least partly an artifact of the lack of representative coverage in 2000. The unusually high proportion of the identifications coming from Monterey Bay in 2000 (66%) and in 1999 (50%) would likely cause heterogeneity in capture probabilities some which would bias the estimate downward. Mark-recapture estimates using the 2000 sample and the 1998 dataset which was not as geographically biased yielded an estimate of 856 (CV=0.12).

Several other components of the research proved successful in 2000. We attached (and recovered) a second Critttercam instrument to a blue whale in Monterey Bay in September in collaboration with National Geographic. The animal was feeding and yielded both images and the dive record of the animal's underwater behavior. Estimated sizes of humpback whales were determined using a laser range-finder and calibrated camera system. We also obtained biopsy samples of humpback and blue whales for determination of gender and genetic patterns.

INTRODUCTION

Cascadia Research has been conducting research on humpback and blue whales off California, Oregon, and Washington using photographic identification of individuals since 1986. This report summarizes research conducted by Cascadia Research and collaborators in 2000 on primarily humpback and blue whales off California, Oregon, and Washington and updates a number of parameters for this population including estimates of abundance, mortality and natality. 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. A central method has been photographic identification to track individual whales.

Support for this research has come from a number of sources in 2000:

- Primary support for the overall research effort aimed at assessing population size and trends as well as reproductive and mortality rates came from Southwest Fisheries Science Center under Purchase Order #40ABNF901105.
- The Olympic Coast National Marine Sanctuary provided support for surveys off Washington and provided space for a researcher on their annual surveys in sanctuary waters under Purchase Order #40ABNC004848.
- National Geographic provided in-kind support for deploying instrument packages that included video, acoustic, depth, and temperature (Cittercams) onto blue whales.
- Office of Naval Research provided support for the Cittercam deployments under grant award No. N00014-00-1-0942.
- Support for some of the work off Southern California was provided through a subcontract from Scripps Institute of Oceanography (Purchase Order 10189516) 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 #40BANF0S1644.
- Several private contributors provided support for conducting the research.

METHODS

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 (Calambokidis *et al.* 1990a, 1990b, 1994, 1996, 2000a, 2000b). 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 2000 were compared internally and then compared to catalogs of all humpback and blue whales identified along the West Coast. These catalogs currently consist of 1,173 different humpback whales and 1,213 different blue whales identified during annual surveys between 1986 and 1999 off the west coast (Calambokidis *et al.* 2000a). Also included in these collections are whales identified in other areas such as off Central America by Cascadia and collaborators (Rasmussen *et al.* 1999, 2000, Chandler *et al.* 1999). Individual whales identified in 2000 that did not match past years and are of suitable quality were 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 are related to feeding including surface temperature, water depth, the presence and depths of any scattering layers, and bird species associated with sightings.

Biopsy sample collection

Skin samples were collected from humpback and blue whales to examine genetic relatedness, population structure, and sex of individual whales (Baker *et al.* 1990, 1998). Samples were collected from sloughed skin taken from the Crittercam tags (see next section) and by biopsy sampling. These will be used to examine genetic information including sex determination, mtDNA haplotypes, and nuclear DNA patterns. All samples will be submitted to SWFSC .

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.

Tagging

Tagging in 2000 consisted of deployment of an instrument package, developed by National Geographic and termed “Cittercam”, onto blue whales (Marshall 1998, Williams *et al.* 2000). A suction-cup was used for attachment to blue whales. Attachment was achieved by close approach and attachment using a long pole to make direct contact with the whale. 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 prey

Following pilot efforts in 1998 and 1999, we worked in collaboration with National Geographic Television in 2000 to attach one instrument package to blue whales. All attempts in 2000 were made in Monterey Bay from 13 to 18 September.

Measurements of the sizes of whales

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

Acoustic monitoring

Acoustic monitoring of blue whales was conducted in 2000 primarily in collaboration with cruises conducted by Scripps Institute of Oceanography (SIO) or in association with Cittercam deployments. The primary objectives have been examining the vocal behavior of blue whales and the relationship to gender (McDonald *et al.* 2001). Acoustic monitoring in association with Cittercam deployments utilized a single hydrophone from Offshore Acoustics (sensitivity -154

dBV/uPa ± 4 dB at 100 Hz, frequency response from 6 Hz to 14 kHz ± 3 dB). One system was used with a 10m cable and the other with a 20m cable. We made recordings onto Digital Audio Tape (DAT) with a *Sony* TCD-D7 or D8 DAT recorder (frequency response 20-14,000 Hz, 32 Hz sampling rate).

Survey regions and coverage

Dedicated Surveys off Washington and Oregon

We conducted 18 days of dedicated surveys off Washington and Oregon between 15 March and 15 November 2000. These included surveys of coastal waters (incl. Puget Sound) for seasonal resident gray whales and surveys of offshore waters west of Cape Flattery and Newport, Oregon for humpback whales (Table 1). Components of this effort in and around Washington and Oregon included:

- Photographic identification of humpback and gray whales conducted off the northern Washington coast including to the British Columbia border on 10 days from 20 May to 4 October. Half these surveys were conducted using Cascadia's rigid-hull inflatable boats (RHIB) in surveys conducted out of La Push or Neah Bay. Cascadia also participated in surveys sponsored by the Olympic Coast National Marine Sanctuary using a chartered Navy boat *Agate Pass*. Cascadia personnel were on board the *Agate Pass* for surveys 16-19 June and additional photographic identifications were obtained on 21 June by biologist Richard Rowlett.
- Dedicated surveys were conducted on 17 August and 15 November to identify gray and humpback whales off Oregon. This included surveys in more offshore waters searching for humpback whales off Newport.
- Photographic identification of gray whales conducted in and around Puget Sound and Grays Harbor primarily from April to August. Including five surveys from 15 March to 17 May in and around northern Puget Sound, two surveys on 22 May and 21 June in Grays Harbor. There were also seven days of effort making shore-observations of gray whales in southern Puget Sound from 4 April to 4 July 2001.

Opportunistic effort off Oregon and Washington

Identification photographs of humpback and gray whales off Oregon and Washington were also provided to us from a number of opportunistic sources including whale-watch trips (opportunistic effort and not conducted under our research permit). This effort included:

- Cascadia personnel and interns obtained photo-identifications of gray whales aboard 11 trips on 9 days between 30 March and 19 May in Grays Harbor, Washington aboard whale-watch vessels *Lucky Pierre*, *Mr. Magu*, *Mac's Effort*, and *Angela C*. These were arranged through Ocean Charters.

- Additional opportunistic identification photographs of gray whales in northern Puget Sound were obtained by Cascadia personnel aboard several boats operating out of Everett and Bellingham on 7 days between 8 April and 19 May 2000. These included the *St. Nicholas* (operated by Mosquito Fleet), *Puget* (during disposal of gray whale), *Red Head* (operated by Marc Goodman of San Juan Shuttle), and the *Snow Goose* (educational expedition out of Bellingham).
- Photographic identifications of gray whales were obtained off Oregon on 9 whale-watch trips between 4 August and 12 September. Anne Nelson conducted these trips out of Newport and Depoe Bay aboard the *Discovery* (operated by Marine Discovery Tours) and the *Seastar* (operated by Jim Sinnott of Zodiac Adventures).
- Photographic identification of a single humpback whale was made opportunistically during 11 trips conducted between 26 April and 26 May 2001 by Heather Harding aboard the *Glacier Spirit*, a whale-watch boat operating out of Port Townsend.
- Mark Sears provided identification photographs of gray whales near Seattle from 25 March and 24 July 2000.
- Dave Ellifrit provided photographs of two gray whales near Sydney, Vancouver Islands on 7 June and 23 August 2000.

Dedicated photographic identification surveys off California

Dedicated photographic identification surveys for humpback and blue whales were conducted off California by Cascadia personnel on 30 days between 6 May and 17 November 2000 (Table 1). These were conducted using one of Cascadia's two 5.3m RHIBs and, on a few occasions, a larger boat. This survey effort had several components including:

- Surveys on 4 days from 27 August to 17 November in the Gulf of the Farallones (out of Bodega Bay or Half Moon Bay) using Cascadia's RHIB
- Surveys on 16 days from 6 May to 12 November in the Monterey Bay area, mostly out of Moss Landing using Cascadia's RHIB. This included photo-ID effort conducted in conjunction with Crittercam deployments (see next section) but not the surveys conducted by Nancy Black (see following section).
- Surveys on 5 days from 11 July to 26 August in the area from Pt. Arguello to north of Morro Bay (from Port San Luis or Morro Bay) using Cascadia's RHIB.
- Surveys conducted on 4 days off southern California with Cascadia's RHIB deployed from Scripps vessel *Sproul* (see next section).

Surveys conducted on the *Sproul* in collaboration with Scripps Institute of Oceanography

Three surveys were conducted in collaboration with Scripps Institute of Oceanography (SIO) as part of a project on ambient noise and blue whale vocalizations for the San Clemente Offshore Range (SCOR). All three cruises were aboard the *Sproul*, two of them with a Cascadia RHIB aboard which was deployed during the surveys. The three surveys were 28-30 June, 19-24 August, and 15-19 October 2000 (Table 2). Surveys in June and August were conducted between San Diego and Tanner/Cortez Bank. In October the survey included coverage north to off Point Conception. While many whales were sighted from this platform only a few groups were approached directly. Most photographic identification was conducted from Cascadia's RHIB which was deployed when conditions allowed.

Monterey Bay surveys conducted in collaboration with Nancy Black and Oceanic Society

A collaborative research program with Nancy Black and the Oceanic Society yielded additional dedicated photographic identification surveys in the Monterey Bay area on 15 days between from 7 August and 29 September 2000 (Table 3). These surveys were conducted aboard the *Sea Wolf II* out of Monterey and were directed by Nancy Black with Peggy Stapp taking identification photographs. Additional identification photographs were also obtained more opportunistically during killer whale research and whale-watch trips by Nancy Black, Peggy Stapp, and Todd Chandler in Monterey Bay.

Additional opportunistic photographic identifications made off California

A number of researchers and members of the public provided us with identification photographs of humpback or blue whales taken off California. These were obtained either opportunistically or under other research permits. These included:

- Identification photographs of humpback and blue whales collected by Tom Kieckhefer in the Monterey Bay area
- Identification photographs of blue whales taken by Bruce Mate and colleagues in conjunction with their efforts to attach satellite tags to blue whales of California.
- Photographs of blue whales were taken in the Santa Barbara Channel by Michuru and Yuki Ogino from the *Solera* on 1, 2, 3, 4, and 8 August 2000.
- Photographs of humpback and blue whales taken aboard Oceanic Society natural history trips to the Farallon Islands on 25 June and 16 July 2000.

RESULTS

Photographic identification

Photographic identifications of humpback, blue, and gray whales were conducted over a range of months and locations in 2000 (Tables 4-7). Sections below summarize the results of this effort by species.

Humpback whales

During dedicated surveys a total 271 groups totaling 575 humpback whales were approached for photographic identification 2000 off California, Oregon, and Washington. Combined with opportunistic efforts, especially in Monterey Bay, 646 identifications made of 254 different individuals (Table 4, 5, 8).

Identifications were from a wide range of months and regions but were not well as well distributed geographically as in past years. The largest sample of humpback whales came from Monterey Bay were a combination of effort during dedicated surveys by Cascadia and Oceanic Society and opportunistic effort in conjunction with whale watching trips (by Nancy Black and Peggy Stapp), research surveys by Tom Kieckhefer, and tagging effort by Cascadia yielded 424 identifications of 146 whales from April through December (Table 5). A total of 139 identifications were made off southern California mostly between Point Sal and in the Morro Bay in July and August. Close to 50 identifications were made in the Gulf of the Farallones in August to November with most of these from a single day just west of the Farallon Islands.

Identifications of humpback whales in the Pacific Northwest were productive again in 2000. Nine identifications were made during surveys covering waters offshore of Newport, Oregon in August. A total of 31 identifications were made off the northern Washington coast and near the BC border. These came from surveys done using Cascadia's RHIB on two days in June and two days in October and the June Olympic Coast National Marine Sanctuary survey. One humpback whale was seen on 9 occasions near Smith Island in the Strait of Juan de Fuca in April and May but only poor identifications photographs could be obtained.

Blue whales

Photographic identification of blue whales off California in 2000 resulted in 335 identifications of 168 individual blue whales (Tables 6 and 9). Whales were identified in two primary locations in 2000. The largest number of identifications (184) were made from June to December in the Monterey Bay area where we had the heaviest combination of effort and whales. We also obtained nearly 100 identifications in just a few surveys in the Gulf of the Farallones in August, October, and November. Identifications of smaller numbers of blue whales were obtained just off Point Arguello in July, in the Tanner/Cortez Bank area in the southern California Bight in August, and in the Santa Barbara Channel in August..

Photographic identifications of blue whales were also made by SWFSC in the ETP in summer and fall 2000. While these identification photographs are still being compared to those in our collections from 2000 and previous years, one initial match from this comparison is intriguing. ID#1505 is a whale SWFSC identified on 1 November 2000 (S#1651) west of the Costa Rican Dome and matched a blue whale identified on 13 March 1999 by Cascadia in the same area. Although these are in different years, they suggest some animals may spend extended periods in this region from at least late fall to early spring. This whale has not as yet been identified off California.

Gray whales

Gray whales were also identified in the course of the research off Oregon and Washington in 2000. During dedicated surveys, 68 sightings of 85 whales were approached (Table 4). Combined with opportunistic effort from whale-watch trips, 139 identifications were made in areas of the Pacific Northwest (Table 7) from Oregon (14 identifications) to southern Vancouver Island (17 identifications). Early season identifications were made regularly in Northern Puget Sound from March to May and in Grays Harbor from March to July. Occasional sightings of gray whales were made in southern and central Puget Sound with 7 identifications from April to July. We also identified 6 gray whales along the northern Washington coast just north of La Push on 20 May 2000.

Abundance estimates

The 2000 identifications were used to generate updated abundance estimates for humpback whales (Table 10). The abundance estimate using 1999 and 2000 data was 715, considerably lower than estimates in past years. Through 1999, annual estimates of abundance have consistently increased averaging a rate of 8% of year. The sharp drop with the 2000 data is surprising.

The lower estimate appears to be at least partly an artifact of the lack of representative coverage in 2000. Funding constraints limited the scope of our coverage in 2000 and resulted in an unusually high proportion of the identifications coming from one area, Monterey Bay. In 2000, 66% of the humpback whale identifications along the entire coast were from the Monterey Bay area. While coverage in 1999 was more complete, close to 50% of the identifications in that year were in the Monterey Bay area. The high proportion of identifications from Monterey Bay in the two years, especially 2000, would likely cause heterogeneity in capture probabilities (the tendency for some animals to be captured in both samples and others to be missed in both). This would bias the estimate downward. Mark-recapture estimates using the 2000 sample and the 1998 dataset which was not as skewed toward samples from Monterey Bay yielded an estimate of 856 (CV 0.12).

Crittercam deployments

Crittercam deployment and recoveries in 2000 were made in Monterey Bay from 12 to 19 September 2000. We made close approaches to blue whales in an attempt to attach the tag on six

occasions (Table 11). In three of these approaches we made physical contact with one resulting in a successful deployment (Table 11). Our success in getting close to whales was higher this year as we have improved our strategy for approaching whales. Most unsuccessful deployments where there was no contact were due to the whale diving prior to our reaching the proper location to attempt attachment. The two occasions where we made contact but there was no attachment were the result of the difficulty of getting a tight enough seal for a long enough period to allow the suction cup to fully attach.

The successful deployment was made on the lead whale of a pair of whales on 14 September at 0947 at 36°48.02N and 121°57.40W (see Figure 1). The crittercam stayed on the whale throughout that day's observations even though we expected the corroding magnesium to result in breaking the vacuum holding the suction cup on to occur in about three hours. We were able to stay with the two whales through 1949 after which deteriorating weather and light resulted in our losing the whales. The whales did not appear to change their milling behavior immediately after tag attachment. We did lose track of the whales for over one hour in the morning. The whales were tracked as they traveled south for almost an hour before resuming milling at a new location (Figure 1).

Recovering the Crittercam proved challenging but was eventually achieved 3 days later on 17 September. By this time the combination of movement on the whale and drift after release had taken the tag to 36°31.57N and 122°17.80W or 23.2 nmi (43 km) from the location of attachment. It was not clear exactly when the tag had detached from the whale but several potential distant signals that were picked up the day after it was tagged and that evening from high locations on land indicated the whale had probably left Monterey Bay sometime during the first night after it was tagged and the Crittercam had likely released shortly thereafter somewhere offshore, then begun drifting southward. The long time between tagging and recovery caused a small amount of moisture to leak or condense in the Crittercam casing resulting in a loss of the dive and temperature data that were stored in memory.

Both the lead animal that was tagged and the trailing animal in the pair were previously identified whales with long sighting histories. The animal on which the tag was deployed was ID# 111 and had been first identified in 1987 in the Gulf of the Farallones. It has been seen since then in 1990 in the Gulf of the Farallones and in 1992 off both Fort Bragg and Point Arena. The trailing animal in this pair was also a known older animal (ID# 283) first identified in 1988 in the Gulf of the Farallones and seen in 1989 in Mexico and in 1992 in both Santa Barbara Channel and the Gulf of the Farallones.

Number of animals disturbed by approaches

Most animals that were approached for photographic identification did not exhibit any overt change in behavior that we could attribute to reaction to the boat (Table 12). Responses to photo-ID approaches may be occurring and not noted because either they were not obvious or we could not link them to our approach. One easy to detect reaction occurred for three groups of five humpback whales which circled and approached the boat. Humpback whales approaching the boat closely under their own control and apparently out of curiosity (apparently "friendly"

behavior) became increasingly common through the 1990s off California, however, this type of approach was less frequent in 1999 and again in 2000 than in some previous years. For blue whales 10 groups of 13 whales showed an apparent reaction to a photo-ID approach, all but one of these was avoidance (whales turning away from the boat in a manner that appeared in response to the boat's presence) and one was a closer approach initiated by the whale. The only other reaction to a photo-ID approach was a single gray whale that appeared to avoid the boat.

Reactions were more frequently observed to approaches for tagging and biopsy. Some type of reaction to biopsy approaches or the dart was observed in 5 of 11 approaches of humpback whales and 9 of 31 approaches of blue whales (Table 12 and 13). Many of these reactions appeared to be to the closer approach of the boat required for biopsy attempt than necessarily to the dart. Reactions by humpback whales consisted of tail slaps (or flicks), quick dives, or longer dive before the next surface in the series. In one case a "friendly" whale that was circling the boat was biopsied and the whale temporarily stopped circling the boat before resuming this behavior. For blue whales, reactions consisted most frequently of boat avoidance or turning away from the boat or acceleration in swimming speed.

We noted reactions of blue whales to approaches made for Crittercam attachments. These tagging approaches required a closer approach than biopsy and once again most of the reactions appeared to be to the close approach of the boat rather than to the contact made with the tag. Six approaches to closer than one body length were made to attempt Crittercam attachment on 13 and 14 September in Monterey Bay (Table 11). In three cases we either did not get close enough or the orientation was wrong and we broke off the approach without touching the whale. In two other cases we attempted to attach the Crittercam but it did not attach to the animal. In the final case we succeeded in approaching and attaching the Crittercam. Short-term reactions to our approach were noted in all six close approaches with the most common reaction being a quick dive or sink where the animal appeared to more rapidly submerge without showing as much of its body as it would in a normal surfacing.

We did not see longer term changes in behavior in reaction to the tagging attempts. In most cases the animals continued the milling behavior they were engaged in prior to approach. Our longest observation was of the traveling animals to which a tag was applied and which is described in detail above. Once contact was made with an animal, it was generally harder to get close to in the next few attempts.

Collection of fecal and skin samples

Skin samples of humpback and blue whales were collected from biopsies and also when available from tagging attempts (Table 14). A total of 15 skin samples were obtained in 2000, 6 were biopsy samples from humpback whales near the Washington/British Columbia border, 6 were biopsy samples of blue whales off southern California that were being monitored acoustically, and 3 were biopsies or skin from tags related to crittercam deployments in Monterey Bay. Genetics from humpback whales near the Washington and British Columbia border have been collected in recent years including 2000 to help determine the number and boundaries of humpback whale feeding aggregations from California to Alaska. The samples collected in association with acoustic

monitoring will aid in examining the vocal behavior of blue whales in relation to behavior and gender. The samples obtained during the Crittercam deployments will allow assessment of the gender of the animal which was tagged and the whale it was associated with. All samples have been given to SWFSC.

Only a single fecal sample was collected in 2000. This was a brick-red feces of a single blue whale on 27 August 2000 in the Gulf of the Farallones. This sample was preserved in alcohol for later analysis.

Measurements of the sizes of whales

During field effort in 2000 we continued to use a new technique we started in 1999 to determine 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 laser range-finder. 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 in the calibration (Calambokidis *et al.* 2000a). Measurements of whales were only made when directly behind the whale so that the flukes were perpendicular to the photograph angle.

A total of 54 usable images and measurements were obtained in 2000 off California. Most of these (48) were of humpback whales, but measurements were also obtained of five gray whales and one blue whale. We are currently examining repeat measurements of the same individual to test consistency of the results. This method appears promising for determining the relative size-classes of identified whales and combined with data gathered in 1999 off California, Oregon, and Washington as well as samples from Costa Rica should allow an assessment of the size distribution of animals and additional data relative to the sighting, movement, and reproductive histories of specific animals.

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Numerous collaborating researchers provided photographs of humpback and blue whales from California in 2000 that were obtained incidental to their research activities. These are listed in the Methods sections. We especially appreciate Nancy Black and Peggy Stapp who provided photographs of humpback and blue whales from Monterey Bay conducted both as part of Oceanic Society Expeditions trips and whale watching trips. Michuru Ogino provided valuable support and assistance in the field. Erin Olesson and John Hildebrand organized the research trips aboard the *Sproul*. We thank the observers and crew from these surveys. John Francis and Mehdi Baktiari conducted the Crittercam deployments. Mark McDonald examined the acoustic data from the Crittercam tapes.

We thank the operators of the boats that allowed us to gather data from their boats including the *Lucky Pierre*, *Mr. Magu*, *Mac's Effort*, and *Angela C* in Grays Harbor (through Ocean Charters) and the *St. Nicholas* (operated by Mosquito Fleet), *Puget* (during disposal of gray whale), *Red Head* (operated by Marc Goodman of San Juan Shuttle), and the *Snow Goose* (educational expedition out of Bellingham) in northern Puget Sound. We thank the Oregon whale watch boats that allowed Anne Nelson to conduct observations on their trips out of Newport and Depoe Bay including the *Discovery* (operated by Marine Discovery Tours) and the *Seastar* (operated by Jim Sinnott of Zodiac Adventures).

A number of people assisted in the field effort and in the printing and matching of photographs. We thank our volunteers and interns whose assistance in the field and in the processing of the photographic identifications was invaluable. They include Hannah Smith, Katy Siegel, Jane Truman, Eileen Kelly, Danielle Osborne, Kristine Endsley, J.R. Veldink, Celva Boon, Heidi Faken, Randy Lumper, Alyssa Ferrell, Moira Morel, Nathan Donley, Beth Phillips, and Amanda Kaplan. In addition to helping in the field and matching, Beth Phillips and Julia Erickson also assisted in the measurements of humpback whale flukes. Annie Douglas assisted in field work and in the photographic matching and analysis. Anne Nelson assisted in matching and conducted surveys off Washington and Oregon.

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TABLES AND FIGURES

Tables

- 1 List of surveys conducted by Cascadia Research with summary of identifications in 2000
- 2 Surveys conducted from SIO ship *Sproul*
- 3 Surveys and approaches conducted in Monterey Bay during Oceanic Society expeditions
- 4 Summary of sightings and photo-ID approaches
- 5 Identifications of humpback whales by month and region
- 6 Identifications of blue whales by month and region
- 7 Estimated identifications of gray whales by month and region
- 8 Identifications of humpback whales by year and region
- 9 Identifications of blue whales by year and region
- 10 Abundance estimates of humpback whales
- 11 List of approaches and reactions to Crittercam deployment attempts
- 12 Reactions of whales to photo-ID, biopsy, and tag approaches
- 13 List of approaches and reactions to biopsy attempts
- 14 List of skin samples collected

Figure

- 1 Track of blue whale with Crittercam attached 14 September 2000 in Monterey Bay.

Table 1. Summary of field effort by Cascadia Research personnel off California, Oregon and Washington in 2000 including number of groups and animals seen, and estimated number of successful identifications.

Date	Vessel	State	Region	Time			Dist nmi	Latitude		Gray whale			Humpback whale			Blue whale		
				Start	End	Durat		South	North	Sit #	An #	Pho #	Sit #	An #	Pho #	Sit #	An #	Pho #
15-Mar	HAR	WA	NPS	9:10	16:31	7.4	55.51	47.98	48.17	5	10	8						
11-Apr	N2	WA	NPS	7:00	14:40	7.7	62.22	47.99	48.17	8	8	4						
17-Apr	DS	WA	NPS	14:15	16:00	1.8	2	47.95	47.95	1	1	1						
6-May	N1	CA	MB	7:02	12:43	5.7	41.13	36.59	36.8				11	26	23			
7-May	N1	CA	MB	7:11	15:27	8.3	58.43	36.63	36.87				18	46	30			
14-May	N2	WA	NPS	13:05	17:39	4.6	18.29	48.69	48.76	2	3	2						
17-May	N2	WA	NPS	10:35	18:36	8.0	89.03	47.86	48.17	13	16	12						
20-May	N2	WA	NWA	12:10	16:45	4.6	28.19	47.86	48.04	7	7	6						
22-May	N2	WA	GH	15:41	17:35	1.9	11.26	46.9	46.97	5	5	5						
1-Jun	N2	WA	WSJF &	12:00	21:35	9.6	95.49	48.16	48.49	1	1	1						
2-Jun	N1	CA	MB	7:26	16:00	8.6	52.81	36.66	36.87				14	23	18			
2-Jun	N2	WA	WSJF &	6:40	19:05	12.4	129.7	48.3	48.49	2	2	2	6	8	7			
4-Jun	N1	CA	MB	12:10	14:45	2.6	7.43	36.78	36.82				9	17	13			
16-Jun	AP	WA	WA/BC	12:16	20:33	8.3	74.76	48.37	48.5				1	2	2			
17-Jun	AP	WA	WA/BC	7:05	16:42	9.6	91.42	48.22	48.33				2	3	0			
18-Jun	AP	WA	WA/BC	6:20	16:30	10.2	84.03	48.06	48.17				5	7	5			
19-Jun	AP	WA	WA/BC	9:41	18:40	9.0	78.53	47.9	47.99				7	11	3			
21-Jun	AP	WA	WA/BC	7:10	11:11	4.0		47.78	47.82				2	4	3			
21-Jun	N2	WA	GH	12:45	15:10	2.4	19.38	46.9	46.98	2	2	2						
11-Jul	N1	CA	SCA	6:05	17:31	11.4	103.4	34.48	35.17				32	74	51	15	19	17
12-Jul	N1	CA	SCA	6:17	17:10	10.9	110.6	34.5	35.17				24	51	34	10	11	11
13-Jul	N1	CA	SCA	6:10	17:20	11.2	99.57	35.12	35.64				11	18	13	4	5	5
14-Jul	N1	CA	SCA	6:09	15:15	9.1	50.22	34.93	35.17				25	48	35			
29-Jul	N1	CA	MB	6:40	11:38	5.0	57.61	36.57	36.85							2	2	2
17-Aug	N2	OR	OR	7:38	20:23	12.8	122.3	44.4	45.07	3	4	4	10	13	11			
21-Aug	N1	CA	SCA	8:10	19:20	11.2	69.5	32.33	32.85							9	10	6
22-Aug	N1	CA	SCA	11:50	19:10	7.3	31.94	32.38	32.63							4	5	5
23-Aug	N1	CA	SCA	10:05	19:20	9.3	23.65	32.61	32.71							11	12	7
26-Aug	N1	CA	SCA	8:10	17:45	9.6	51.95	34.92	35.17				30	60	42			
27-Aug	N1	CA	GF	9:20	20:48	11.5	87.78	37.47	37.75				16	54	33	24	41	36
28-Aug	N1	CA	PSG	12:20	17:33	5.2	51.98	41.6	41.95									
5-Sep	N2	CA	MB	6:21	16:15	9.9	35.01	36.74	36.81							7	7	6
5-Sep	SW2	CA	MB	7:47	16:30	8.7	8.727	36.61	36.67									
7-Sep	N2	CA	GF	7:15	16:08	8.9	94.02	37.98	38.32									
12-Sep	N2	CA	MB	15:26	19:18	3.9	40.86	36.65	36.8				1	2	0	4	8	5
13-Sep	N2	CA	MB	8:00	19:55	11.9	74.41	36.62	36.81							6	15	4
14-Sep	N2	CA	MB	7:30	22:23	14.9	31.72	36.75	36.81				1	2	0	6	10	5
15-Sep	N2	CA	MB	8:20	15:00	6.7	43.39	36.68	36.81							6	6	4
16-Sep	N2	CA	MB	7:13	16:48	9.6	50.16	36.65	36.8							1	2	0
17-Sep	N2	CA	MB	6:20	18:35	12.3	86.34	36.52	36.86							1	2	0
18-Sep	N2	CA	MB	7:30	18:20	10.8	56.26	36.67	36.85				5	7	6	5	7	3
19-Sep	N2	CA	MB	7:55	13:40	5.8	44.08	36.62	36.81				1	1	1	5	10	2
3-Oct	N1	WA	WSJF &	9:50	21:30	11.7	114.3	48.25	48.39	4	5	4	7	20	16			
4-Oct	N1	WA	WSJF &	7:50	18:30	10.7	89.61	48.29	48.79	16	22	22	1	2	2			
5-Oct	RD	CA	MB	11:00	14:00	3.0	25	36.8	36.87				1	2	2			
6-Oct	RD	CA	MB	10:28	14:20	3.9	48	36.68	36.92									
8-Oct	RD	CA	MB	10:22	14:00	3.6	30	36.6	36.84									
16-Oct	N1	CA	SCA	12:22	17:33	5.2	56.57	32.9	33.5									
23-Oct	N2	CA	MB	11:51	13:29	1.6	7	36.79	36.81				1	2	2			
24-Oct	N2	CA	GF	7:48	17:40	9.9	76.91	37.48	37.68				7	13	9	8	13	8
12-Nov	N2	CA	MB	7:28	16:28	9.0	84.46	36.59	36.9				20	43	41			
15-Nov	N1	OR	OR	8:15	18:00	9.8	97.97	44.45	44.95									
17-Nov	N2	CA	GF	7:09	17:18	10.2	91.91	37.48	37.76				3	4	3	33	58	55
53 days										69	86	73	271	563	405	161	243	181

Table 3. Summary of sightings and approaches conducted during Oceanic Society-sponsored research trips in Monterey Bay in 2000. Additional identifications were also obtained opportunistically in conjunction with other research and whale watching.

Date	Times		Humpback whale					Blue whale				
	Start	End	Sightings		Approaches			Sightings		Approaches		
			# Grps	# Ind	# Grps	# Ind	# Pho	# Grps	# Ind	# Grps	# Ind	# Pho
8/7/2000	8:00	14:55	3	6	2	4	3	1	2	1	2	2
8/8/2000	8:15	15:00	1	1	0	0	0	9	16	5	9	8
8/9/2000	7:40	15:00	8	31	3	14	14	4	7	1	2	2
8/10/2000	7:45	15:00	7	10	3	3	3	8	28	1	1	1
8/11/2000	7:40	14:00	1	2	0	0	0					
9/11/2000	8:00	14:32						7	13	6	12	10
9/12/2000	7:42	15:20	4	7	3	6	6	11	17	6	12	11
9/13/2000	7:35	15:00						6	9	5	8	7
9/14/2000	7:45	15:10						3	5	2	3	3
9/15/2000	7:40	14:45						5	6	3	4	4
9/25/2000	8:00	15:15						2	3	2	3	3
9/26/2000	7:50	15:00	1	1	1	1	1	5	7	4	6	6
9/27/2000	7:37	15:00						1	1	0	0	0
9/28/2000	7:55	14:00	2	3	2	3	3	2	2	1	1	1
9/29/2000	7:55	15:00	1	1	0	0	0	2	2	0	0	0
Totals			28	62	14	31	30	66	118	37	63	58

Table 4. Summary of photographic identification approaches made under permit 540-1502-00 in 2000.

Summary	All sightings		Approached		
	Sight	Anim	Sight	Anim	Photog.
Humpback whales					
CRC	271	5633	257	544	406
Sproul	1	1	0	0	0
NB-OS	28	62	14	31	30
			271	575	436
Gray whales - CA					
CRC			68	85	72
Blue whales - CA					
CRC	161	243	149	219	181
Sproul	37	44	3	4	3
NB-OS	66	118	37	63	58
			189	286	242
Fin whales					
CRC			4	5	2
Sproul	18	21	10	12	3
			14	17	5

Table 5. Number of humpback whales photographed off California, Oregon, and Washington in 2000 during dedicated and opportunistic effort.

Region	Code	Month										Total	
		4	5	6	7	8	9	10	11	12			
Santa Barbara Channel	33			1									1
Off San Luis	41				90	43							133
Pt. Buchon to Sur	42				5								5
Monterey Bay area	51	28	105	54	18	23		25	13	152	6		424
G. Farallones to Bodega	53					32			8	3			43
central Oregon	72					9							9
WA/BC border	76			17					14				31
All areas		28	105	72	113	107		25	35	155	6		646

Table 6. Estimated number of blue whales photographed off California, Oregon, and Washington in 2000. Includes some opportunistic effort.

Region	Code	Month								Total
		6	7	8	9	10	11	12		
S. California Bight	31			12		1				13
Santa Barbara Channel	33	3		17						20
Off San Luis	41		33							33
Pt. Buchon to Sur	42		3							3
Monterey Bay area	51	2	21	39	76	39	3	4		184
G. Farallones to Bodega	53			20		7	55			82
All areas		5	57	88	76	47	58	4		335

Table 7. Estimated number of gray whales photographed off Oregon and Washington in 2000. Includes some opportunistic effort.

Region	Month									Total
	3	4	5	6	7	8	9	10		
Southern Vancouver Island								17		17
N Washington coast			6					7		13
Strait of Juan de Fuca				3				2		5
Northern Puget Sound	8	14	21							43
Southern Puget Sound		3	3		1					7
Grays Harbor	2	22	14		2					40
central Oregon						9		5		14
Grand Total	10	39	44	3	3	9		5	26	139

Table 8. Number of unique humpback whales identified by Cascadia and collaborators by year and region for California, Oregon and Washington through 2000.

REGION	Code	Number of individuals identified																All
		>86	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	
S Ca. Bight (south)	31	0	0	0	0	0	0	1	0	5	3	0	0	4	0	0	0	12
S. Ca. Bight (north outside SBC)	32	0	0	0	1	0	1	0	3	1	6	18	0	0	5	0	0	33
Santa Barbara Channel	33	0	0	0	4	0	6	15	97	9	13	136	22	27	101	18	1	254
S. California (offshore)	39	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4
Pt Concpetion to Buchon	41	0	0	8	58	0	0	78	4	1	14	20	0	23	3	2	69	203
Pt Buchon to Pt. Sur	42	0	0	0	2	0	2	12	0	0	0	0	8	13	16	9	5	65
S Monterey Bay Sanc.	51	3	0	4	15	2	13	13	65	45	59	33	89	90	146	175	146	532
N Monterey Bay Sanc.	52	0	0	0	2	0	20	0	0	26	4	42	82	47	30	12	0	225
Farallones/Cordell	53	16	90	140	133	110	161	89	172	181	164	127	168	34	89	117	33	708
Bodega Bay to Pt. Arena	54	0	1	0	5	0	0	0	63	6	0	0	4	5	22	2	0	104
C. California offshore	59	0	0	0	0	0	0	0	0	3	1	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	119
C Mend. to Klamath Riv.	62	1	0	0	8	0	0	4	0	4	0	12	8	26	6	0	0	61
N California to Oregon	63	0	0	0	3	0	0	85	50	16	0	1	0	14	69	6	0	185
S Oregon	71	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
C. Oregon	72	0	0	0	0	0	22	0	0	0	0	0	7	0	0	30	9	65
N Oregon	73	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	6
Washington	75	0	0	0	0	0	5	0	0	0	0	0	0	0	1	0	0	6
Wash/BC border	76	0	0	0	1	1	10	13	0	3	16	34	34	22	29	21	22	114
Puget Sound	79	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
All		20	91	150	213	111	218	282	398	257	260	364	366	287	418	349	254	1219

Table 9. Number of unique blue whales identified by Cascadia and collaborators by year and region for California through 2000.

REGION	Code	Number of individuals identified																
		>86	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	All
S Ca. Bight (south)	31	1	0	0	0	0	5	17	0	7	1	33	16	11	43	0	9	137
S. Ca. Bight (north outside SBC)	32	2	2	0	0	0	0	1	19	5	34	91	9	22	0	0	0	177
Santa Barbara Channel	33	0	0	0	0	0	0	0	106	0	145	102	77	102	77	122	16	541
S. California (offshore)	39	3	1	0	0	0	0	20	0	32	0	0	8	0	0	0	0	64
Pt Concpetion to Buchon	41	0	0	0	0	0	0	4	0	2	6	5	2	8	0	0	18	45
Pt Buchon to Pt. Sur	42	0	0	0	0	0	0	0	0	2	0	0	7	0	0	6	3	18
S Monterey Bay Sanc.	51	13	42	62	25	15	0	0	6	18	18	8	21	10	84	16	93	356
N Monterey Bay Sanc.	52	0	0	0	0	0	2	0	1	45	0	3	4	4	1	5	0	64
Farallones/Cordell	53	9	36	74	95	64	102	27	109	25	29	7	26	40	22	42	46	416
Bodega Bay to Pt. Arena	54	0	0	0	17	1	0	0	20	0	1	0	4	5	0	3	0	47
C. California offshore	59	0	0	0	0	0	0	3	0	9	0	0	2	0	0	0	0	14
Pt. Arena to C. Mendocino	61	0	0	0	0	0	0	2	93	0	0	0	0	4	7	0	0	103
C Mend. to Klamath Riv.	62	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4
N California to Oregon	63	0	0	0	0	0	0	4	4	0	0	0	0	0	7	0	0	15
All		28	79	129	122	77	109	76	280	126	209	231	168	182	226	178	168	1272

Table 10. Humpback whale abundance off California, Oregon, and Washington using Peterson mark-recapture estimates with samples based on annual samples.

Period	Sample 1			Sample 2			Match	Est.	CV1	CV2		
	Year	Subs. Ident.	n	Year	Subs. Ident.	n						
Annual samples using all data												
1991-92	1991	7	668	269	1992	8	1,023	398	188	569	0.03	0.051
1992-93	1992	8	1,023	398	1993	6	512	254	173	584	0.03	0.057
1993-94	1993	6	512	254	1994	6	402	244	108	572	0.05	0.148
1994-95	1994	6	402	244	1995	9	661	331	100	804	0.06	0.166
1995-96	1995	9	661	331	1996	7	564	331	144	759	0.05	0.078
1996-97	1996	7	564	331	1997	7	382	264	104	837	0.06	0.164
1997-98	1997	7	382	265	1998	8	854	389	117	878	0.06	0.132
1998-99	1998	8	854	389	1999	6	613	331	125	1,027	0.06	0.097
1999-2000	1999	6	613	331	2000	8	615	232	107	715	0.06	0.172
1998-2000	1998	8	854	389	2000	8	615	232	105	856	0.06	0.12

Ident.-Number of identifications during period

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

Est.-Estimated abundance

CV1-Coefficient of variation based on Chapman

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

Table 11. Approaches to place Crittercam tags on blue whales in Monterey Bay in 2000.

Date	Time	Ves	Latitude	Longitude	Num	SN#	Prim beh.	Activity	Reaction
13-Sep	9:30	N2	36 44.47	121 58.36	1	1a	Milling	Approach but no contact	Quick dive
13-Sep	9:43	N2	36 44.47	121 58.36	1	1b	Milling	Approach and contact but to attachment	Interups surface series then resumes
13-Sep	9:57	N2	36 44.47	121 58.36	1	1c	Milling	Approach and contact but to attachment	Terminates surface series
13-Sep	10:25	N2	36 44.29	121 59.53	1	1a	Milling	Approach but no contact	Quick dive
14-Sep	9:35	N2	36 47.91	121 56.37	2	2	Traveling	Approach but no contact	Accelerates
14-Sep	9:47	N2	36 48.02	121 57.40	2	4	Milling	Approach and deployment for all day	Quick dive but continues surface seri

Table 12. Summary of reactions to approaches of gray whales made under permit 540-1502-00 in 2000.

Species/type of approach	Groups	Whales	Approaches Reacted	Comments
Humpback whale				
Photo-ID	271	575	271	5 3 groups, all friendly approaches
Biopsy	7	11	11	5 Each approach treated separately
Blue whale				
Photo-ID	189	286	189	13 10 grps, boat avoidance except one friendly approach
Tagging	5	7	6	6
Biopsy	14	18	31	9
Gray whale				
Photo-ID	68	85	68	1
Fin whale				
Photo-ID	14	17	14	0

Table 13. Summary of approaches to obtain biopsy skin samples in 2000.

Date	Time	Ves	Sn#	Latitude	Longitude	Num	Sp.	Beh	Obeh	Region	Action	Reaction
2-Jun	10:50	N2	4	48 22.78	125 42.66	1	MN	2		WA/BC	Biopsy shot and miss	No reaction
2-Jun	11:25	N2	4	48 22.78	125 42.66	1	MN	2		WA/BC	Biopsy 00-06-02#1	Tailslap
2-Jun	12:20	N2	5	48 22.84	125 44.64	1+1	MN	1	2,9,19	WA/BC	Biopsy shot and miss	No reaction
2-Jun	14:57	N2	6	48 28.78	125 26.93	1	MN	9	31,33	WA/BC	Biopsy 00-06-02#2	Tail flick
2-Jun	15:07	N2	7	48 28.31	125 27.39	1	MN	9	33	WA/BC	Biopsy shot and miss	No reaction
2-Jun	15:07	N2	7	48 28.31	125 27.39	1	MN	9	33	WA/BC	Biopsy shot and miss	No reaction
2-Jun	15:07	N2	7	48 28.31	125 27.39	1	MN	9	33	WA/BC	Biopsy 00-06-02#3	Quick dive
2-Jun	15:37	N2	8	48 28.97	125 28.45	1	MN	9	31	WA/BC	Biopsy shot and miss	No reaction
21-Aug	15:47	N1	2	32 21.19	118 14.44	1	BM	9	1	SCA	Biopsy shot and miss	Turned away from boat and extended dive
21-Aug	15:53	N1	2	32 21.36	118 14.60	1	BM	9	1	SCA	Biopsy BM-00-01	No reaction
21-Aug	18:09	N1	7	32 21.26	118 14.87	1	BM	9		SCA	Biopsy shot and miss	No reaction
21-Aug	18:40	N1	7	32 21.79	118 15.36	1	BM	9		SCA	Biopsy BM-00-02	Accelerate, high fluke dive
21-Aug	19:06	N1	10	32 21.3	118 15.4	1	BM	9		SCA	Biopsy BM-00-03	Tail flick, quick dive
22-Aug	12:37	N1	1	32 36.03	118 27.12	2	BM	1	31	SCA	Biopsy shot and miss	No reaction
22-Aug	12:50	N1	1	32 36.39	118 27.29	2	BM	1	31	SCA	Biopsy BM-00-04, larger	No reaction
22-Aug	12:57	N1	1	32 36.67	118 27.72	2	BM	1	31	SCA	Biopsy shot and miss, smaller	Accelerates
22-Aug	17:28	N1	3	32 25.02	118 17.85	1	BM	1		SCA	Biopsy shot and miss	No reaction
22-Aug	17:53	N1	3	32 25.38	118 19.23	1	BM	1		SCA	Biopsy BM-00-05	No reaction
22-Aug	18:33	N1	4	32 24.05	118 18.95	1	BM			SCA	Biopsy attempt and miss	Avoidance of boat
22-Aug	18:40	N1	4	32 23.82	118 18.91	1	BM			SCA	Biopsy attempt and miss	Avoids boat
23-Aug	12:32	N1	1	32 37.95	119 13.13	1	BM	1		SCA	Biopsy attempt and miss	No reaction
23-Aug	13:13	N1	1	32 39.46	119 14.25	1	BM	1		SCA	Biopsy attempt and miss	No reaction
23-Aug	13:43	N1	1	32 40.36	119 14.88	1	BM	1		SCA	Biopsy attempt and miss	No reaction
23-Aug	14:05	N1	1	32 40.94	119 16.00	1	BM	1		SCA	Biopsy attempt and miss	No reaction
23-Aug	14:08	N1	1	32 41.13	119 16.00	1	BM	1		SCA	Biopsy attempt and miss	No reaction
23-Aug	14:40	N1	3	32 41.92	119 17.08	1	BM	9		SCA	Biopsy BM-00-06	No reaction
23-Aug	17:10	N1	6	32 42.16	119 16.30	1	BM	9		SCA	Biopsy attempt and miss	No reaction
23-Aug	17:20	N1	6	32 42.25	119 16.33	1	BM	9		SCA	Biopsy attempt and miss	No reaction
23-Aug	17:30	N1	7	32 42.28	119 16.11	2	BM	9		SCA	Biopsy attempt and miss	Avoidance of boat
23-Aug	18:46	N1	11	32 42.57	119 16.32	1	BM	9		SCA	Biopsy attempt and miss	No reaction
23-Aug	19:00	N1	13	32 42.16	119 16.07	1	BM	9		SCA	Biopsy attempt and miss	No reaction
27-Aug	17:30	N1	32	37 45.23	123 02.88	2	BM	9		GF	Biopsy attempt and miss	No reaction
14-Sep	13:12	N2	4	36 45.92	121 54.08	2	BM	9	1	MB	Biopsy attempt lead and miss	Accelerates
14-Sep	13:27	N2	4	36 45.92	121 54.08	2	BM	9	1	MB	Biopsy lead BM-00-11	No reaction
14-Sep	13:42	N2	4	36 45.59	121 55.29	2	BM	9	1	MB	Biopsy attempt trail and miss	Accelerates
14-Sep	14:34	N2	4	36 45.58	121 55.54	2	BM	9	1	MB	Biopsy attempt trail and miss	No reaction
14-Sep	14:44	N2	4	36 45.92	121 55.58	2	BM	9	1	MB	Biopsy trail BM-00-12	No reaction
14-Sep	14:58	N2	4	36 45.88	121 55.58	2	BM	9	1	MB	Biopsy attempt trail and miss	No reaction
14-Sep	18:40	N2	4	36 45.64	121 55.96	2	BM	9	1	MB	Biopsy hit but no recovery	No reaction
3-Oct	15:55	N1	12	48 18.18	125 43.14	3	MN	9	20,21,22	WA/BC	Biopsy 00-10-03#1	Temporarily stops circling boat
4-Oct	15:30	N1	18	48 30.62	124 58.26	2	MN	1	9	WA/BC	Biopsy smaller 00-10-04#1	No reaction
4-Oct	15:13	N1	18	48 30.62	124 58.26	2	MN	1	9	WA/BC	Biopsy 00-10-04#2	Longer dive in surface series

Table 14. Details on skin samples collected from 6 humpback whales and 9 blue whales in 2000.

Number	Date	Time	Ves	Sn#	Latitude	Longitude	Num	Sp.	Beh	Obeh	NOPHO	NOID	ID1	ID2	Region	Type
00-06-02#1	2-Jun	11:25	N2	4	48 22.78	125 42.66	1	MN	2		1	1	13505		WA/BC	Biopsy
00-06-02#2	2-Jun	14:57	N2	6	48 28.78	125 26.93	1	MN	9	31,33	1	1	13575		WA/BC	Biopsy
00-06-02#3	2-Jun	15:07	N2	7	48 28.31	125 27.39	1	MN	9	33	1	1	13604		WA/BC	Biopsy
BM-00-01	21-Aug	15:53	N1	2	32 21.36	118 14.60	1	BM	9	1	1				SCA	Biopsy
BM-00-02	21-Aug	18:40	N1	7	32 21.79	118 15.36	1	BM	9			1			SCA	Biopsy
BM-00-03	21-Aug	19:06	N1	10	32 21.3	118 15.4	1	BM	9		1				SCA	Biopsy
BM-00-04	22-Aug	12:50	N1	1	32 36.39	118 27.29	2	BM	1	31	2				SCA	Biopsy, larger
BM-00-05	22-Aug	17:53	N1	3	32 25.38	118 19.23	1	BM	1		1				SCA	Biopsy
BM-00-06	23-Aug	14:40	N1	3	32 41.92	119 17.08	1	BM	9		1				SCA	Biopsy
BM-00-10	13-Sep	9:57	N2	1	36 44.47	121 58.36	3	BM	9						MB	Suction cup skin
BM-00-11	14-Sep	13:27	N2	4	36 45.92	121 54.08	2	BM	9	1		2			MB	Biopsy
BM-00-12	14-Sep	14:44	N2	4	36 45.92	121 55.58	2	BM	9	1		2			MB	Biopsy
BM-00-13	17-Sep	9:45	N2	1	36 31.57	122 17.80	2	BM				2			MB	Sm. skin from CC depl. 9/14
00-10-04#1	4-Oct	15:30	N1	18	48 30.62	124 58.26	2	MN	1	9	2?	1	14024		WA/BC	Biopsy, smaller
00-10-04#2	4-Oct	15:13	N1	18	48 30.62	124 58.26	2	MN	1	9	2?	1	14024		WA/BC	Biopsy

Movements of blue whale with Crittercam on 14 Sept. 2000

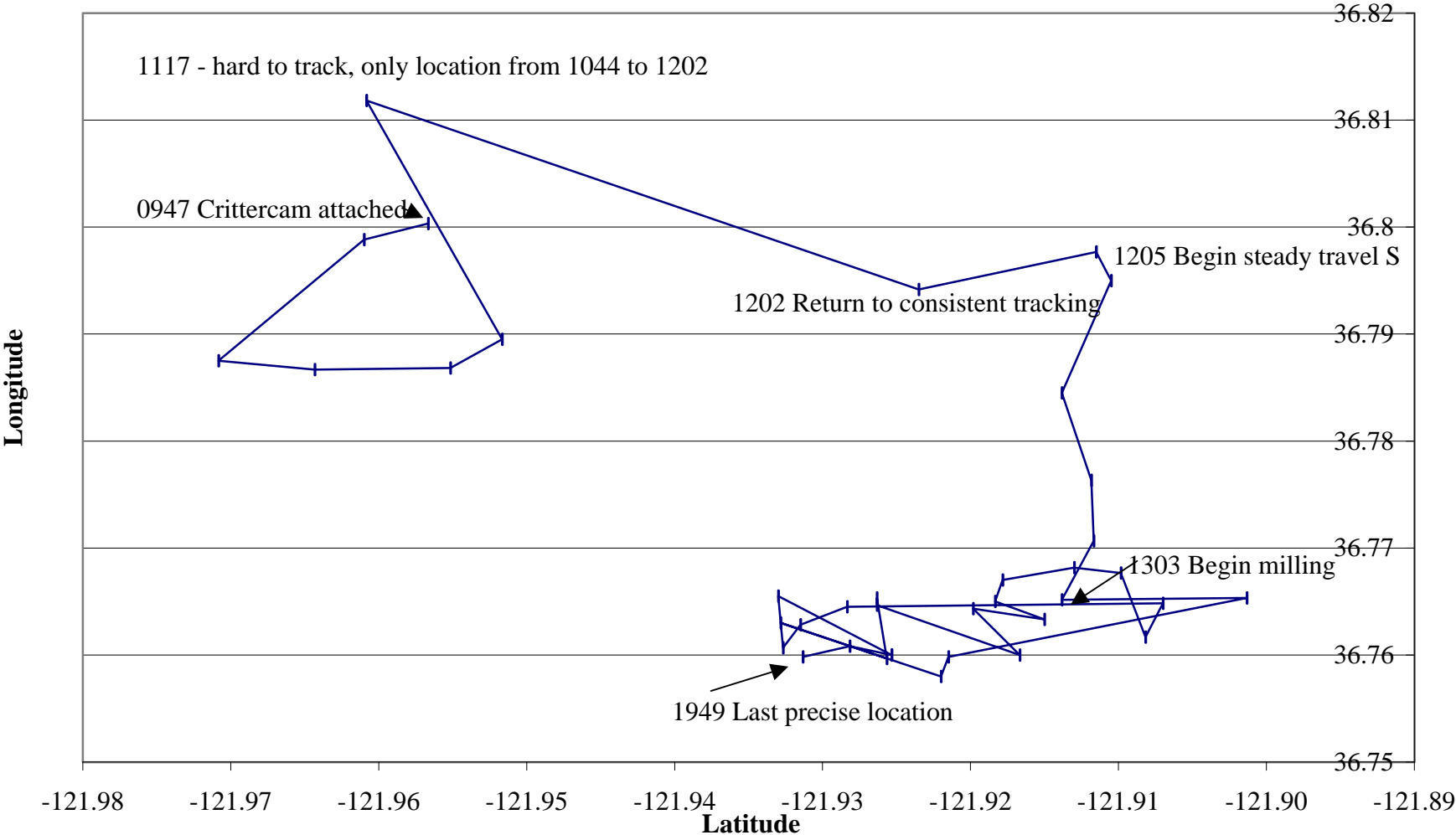


Figure 1. Track and events during deployment of Crittercam on a blue whale in Monterey Bay on 14 September 2000.

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