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Final Contract Report  
Sakhalin Marine Mammal Monitoring and Research Program  
Sakhalin Energy Investment Company

**Gray Whales off Sakhalin Island, Russia: June – October 1999  
A Joint U.S. – Russian Scientific Investigation**

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## INTRODUCTION

Numerous species of marine mammals inhabit the Sea of Okhotsk. Three of the most critically endangered populations of large whales; the Okhotsk bowhead (*Balaena mysticetus*), the western North Pacific right whale (*Eubalaena glacialis*), and the western Okhotsk-Korean gray whale (*Eschrichtius robustus*) are known to occur in this sea (Brownell *et al.* 1997, Clapham *et al.* 1999). Concerns regarding the status of these whale populations have been intensified by the recent onset of U.S.-Russian oil and gas development programs in Okhotsk waters. Anthropogenic activities related to oil and gas exploration, including geophysical seismic surveying, drilling operations, vessel and aircraft traffic, and oil spills, pose potential new threats to the marine ecosystem, and may impact populations of endangered species, including whales (for reviews see Geraci and St. Aubin 1990 and Richardson *et al.* 1995). However, a properly designed biological monitoring and Habitat Conservation Plan (U.S. Fish and Wildlife Service 1998) can provide the requisite information needed to prevent significant impacts, and help to mitigate unavoidable impacts to acceptable levels. Studies in the U.S. and Canadian arctic or near-arctic, on bowhead, white (*Delphinapterus leucas*), and gray whales have demonstrated that knowledge of habitat use and behavioral reactions can help to plan industrial activities in a fashion that allows animals and human development to coexist (summaries in Würsig 1990, Richardson and Würsig 1995, 1997). Therefore, it has been recommended by the Russian and U.S. governments that biological investigations of potential industry-related ecosystem impacts be conducted for such oil and gas development projects to proceed (Anonymous 1997a).

Detailed information on responses of marine mammals to industrial activities and noise can help to gauge potential ecosystem effects (Richardson *et al.* 1995, Richardson and Würsig 1997). Results from studies on the reactions of cetaceans to underwater noise and other human-related activities are highly variable, ranging from no apparent response to active avoidance (for review see Richardson *et al.* 1995). While many of these studies have documented no or only subtle short-term changes in behavior, it is

important to recognize that tolerance of noise does not necessarily mean that it has no deleterious effects (Richardson and Würsig 1997). Long-term effects of noise and disturbance at the individual and population levels are presently little understood. Gray whales currently provide the best example of long-term behavioral changes as a result of industrial activities. Several studies on eastern gray whales have documented behavioral changes (Malme *et al.* 1988, Würsig *et al.* 1999), and distributional shifts or complete abandonment of known wintering areas (Bryant *et al.* 1984) in relation to increased anthropogenic activity (for review see Richardson *et al.* 1995).

### **Rationale**

Oil and gas exploration and development is currently underway off the northeastern coast of Sakhalin Island, Russia (Fig. 1). High intensity 3-D geophysical surveying of a feature named “Piltun-Astokhskoye” (PA) off the northeastern Sakhalin coast (Fig. 2) was conducted during summer of 1997. The PA field overlaps in latitude with the waters adjacent to Piltun Lagoon (Fig. 3), a region recognized as a primary feeding ground of the western gray whale. In 1998, the temporary-drilling rig, *Sakhalinskaya* (located at ~52°54’ N, 143°29’ E), and permanent offshore production platform, *Molikpaq* (located at ~52°43’ N, 143°34’ E), were installed in the PA field. The Molikpaq, located approximately 24 km southeast of the entrance to Piltun Lagoon, was in operation during 1999, and by late summer began production activities including transfer of oil via seabed pipeline to a floating storage and offloading unit.

Sighting records from Russian aerial and vessel surveys in the Okhotsk Sea between 1979 and 1989 (Blokhin *et al.* 1985, Votrogov and Bogoslovskaya 1986,

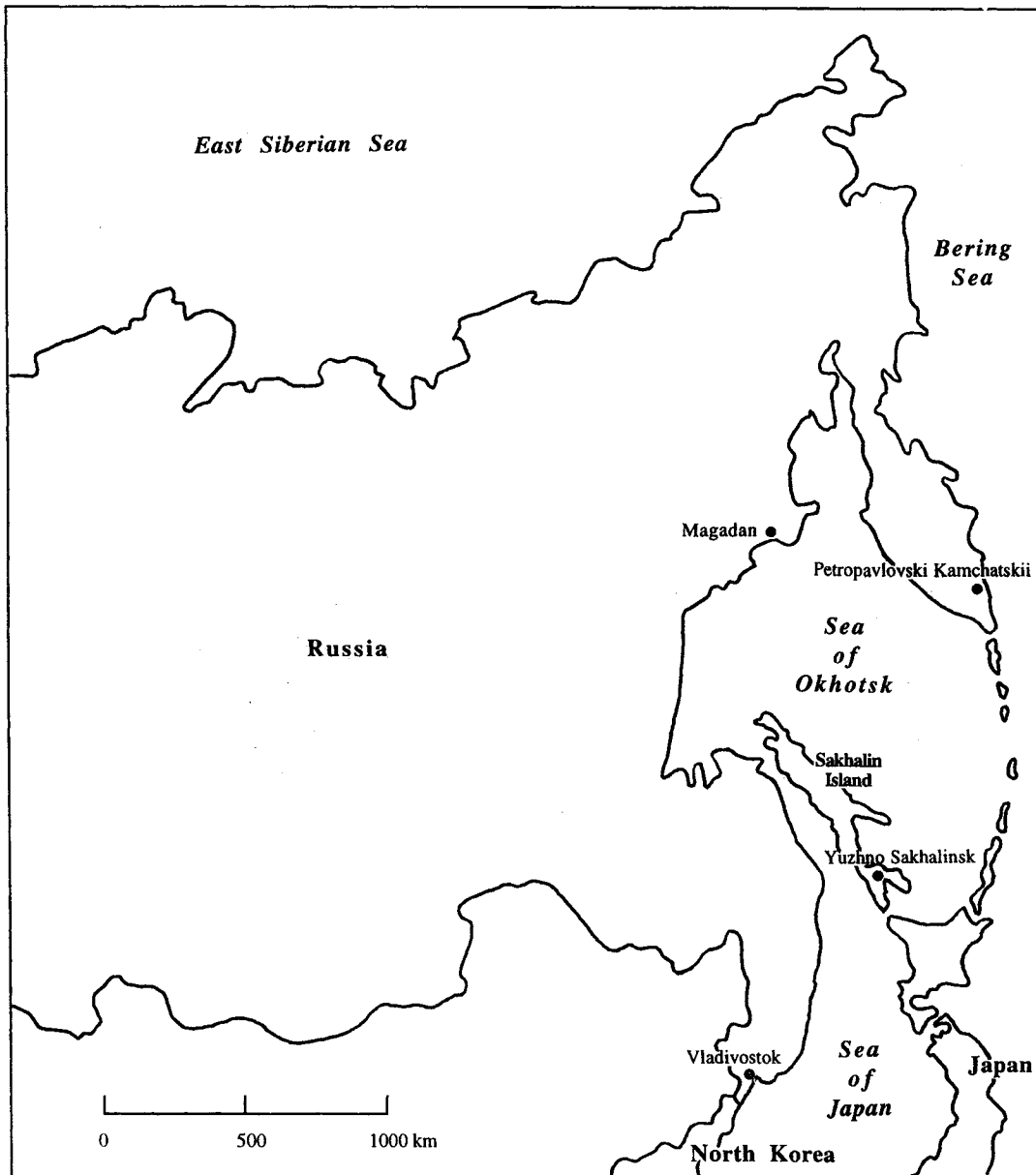


Figure 1. Far East Russia, showing the location of Sakhalin Island in the southwestern Okhotsk Sea.

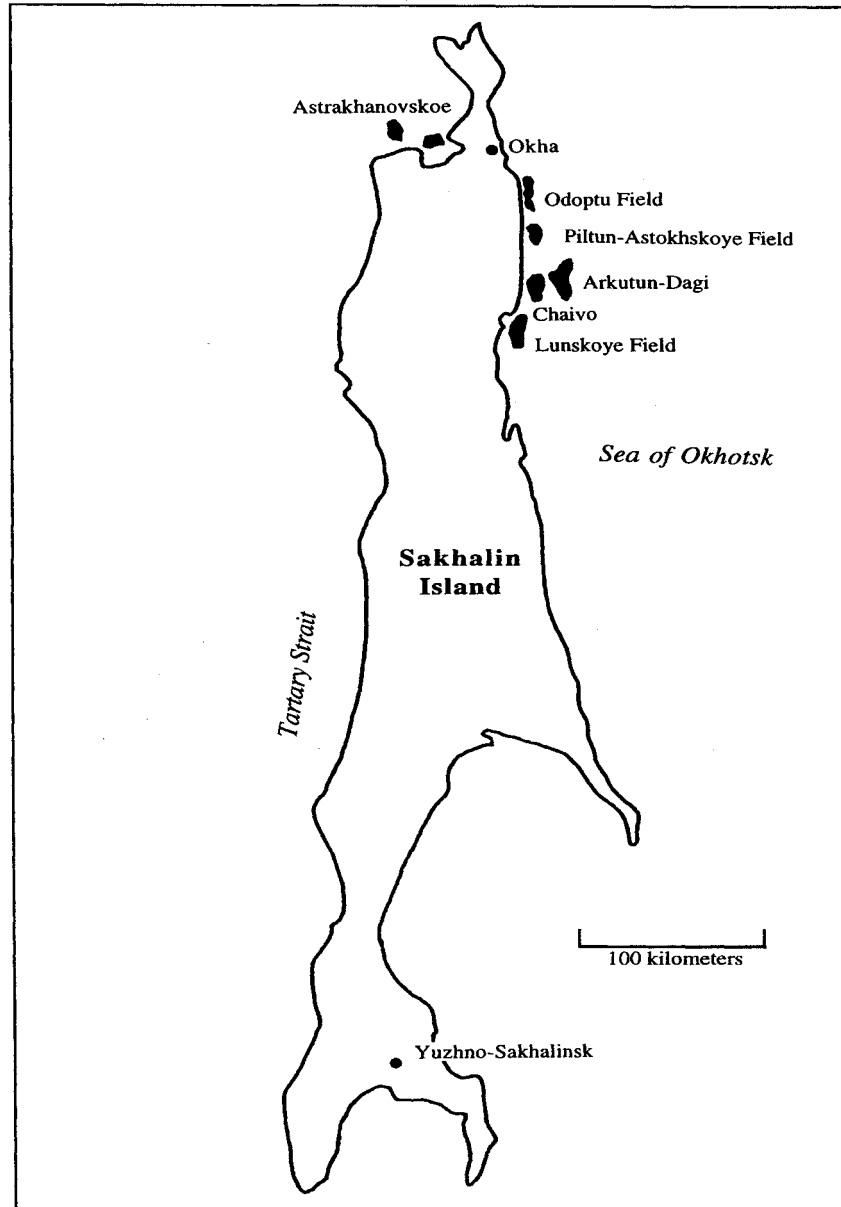


Figure 2. Sakhalin Island, showing major oceanic oil fields along the northeastern coast.



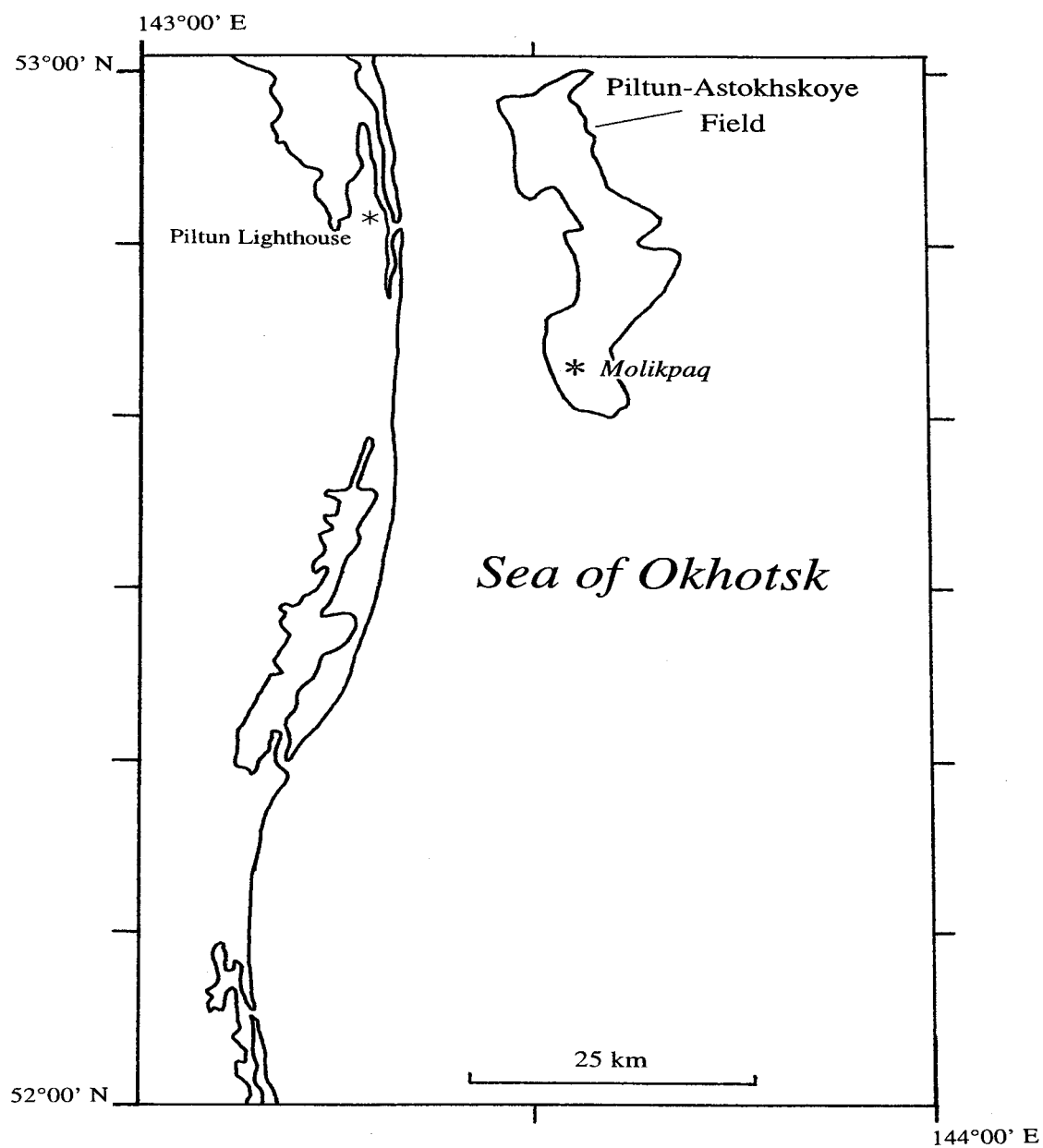


Figure 3. Location of the Piltun-Astokhskoye oil field in relation to the Piltun Lighthouse at the inner entrance channel of Piltun Lagoon.

Berzin *et al.* 1988, 1990, 1991, Blokhin 1996, Berzin in press), and results from aerial surveys in 1998 (Würsig *et al.* 2000, Weller *et al.* in review) indicate that gray whales aggregate predominantly along the shallow-water shelf region located off Piltun Lagoon. This region of the Okhotsk Sea is characterized by high benthic biomass densities of 1,000,000 kg/km<sup>2</sup> (Koblikov 1986), and is the only currently known feeding ground for western gray whales (Blokhin *et al.* 1985, Brownell *et al.* 1997, Weller *et al.* 1999, Würsig *et al.* 1999, Würsig *et al.* 2000). Given the endangered status of the western gray whale population (Anonymous 1997b, Clapham *et al.* 1999), and the new potential for increased industry-related disturbance on their feeding grounds, a joint U.S.-Russian multi-year research, monitoring, and mitigation program on gray whales (and other marine mammals) off the northeastern Sakhalin coast was initiated in 1997 by Sakhalin Energy Investment Company and Exxon Neftegas.

Oil development involves industrial activities that could pose threats to western gray whales, as has been documented for marine mammals elsewhere (review by Geraci and St. Aubin 1990). Potential problems include those associated with oil spills, ship strikes, entanglements in cables or lines, pollution from drilling muds or similar materials, and physical habitat changes such as those caused by dredging (review by Richardson *et al.* 1989, and Clapham *et al.* 1999). For example, on 27 September 1999 a rupture in the pipeline used for transferring oil from the Molikpaq to the floating storage unit resulted in approximately 2.0 liters of oil being released into the marine environment. While the influence of this small spill was thought to be negligible (personal communication Marathon Upstream Sakhalin Services, Ltd., 19 May 2000), the impact of a larger spill on the surrounding marine flora and fauna is poorly understood. In addition, displacement of whales from critical feeding and migratory habitat is possible due to the disturbance from seismic surveys, or other industrial noise and activity. For example, strong acoustic sources such as the open-water seismic exploration conducted in the PA field during 1997 were probably audible to gray whales at distances exceeding 100 km (Richardson *et al.* 1995). Acoustic monitoring during 1997 in the PA field revealed nearshore received sound levels from seismic pulses of approximately 153 dB re 1 µPa, zero-to-peak; 159 dB re 1 µPa, peak-to-peak; and 139 dB re 1 µPa, averaged over one second, while the seismic survey vessel was 30-35 km from shore (Würsig *et al.*

1999). These findings indicated that even at relatively large distances, seismic noise was detectable within the near-shore area where gray whales were typically located. Intra-seasonal shifts in pod distribution indicated that whales moved into deeper water as the summer season progressed. This distributional change suggested that pods may have remained closer to shore during seismic periods (July to mid-August) and shifted to more offshore waters (late-August to early-September) once seismic surveying was terminated (Würsig *et al.* 1999). However, in that case, other potential natural causes of the distributional shift cannot be ruled out

### **Background and Previous Research Summary**

Gray whales are known to occur as two separate populations along the eastern and western margins of the north Pacific (Rice and Wolman 1971). While both populations were hunted to near-extinction, only the eastern North Pacific or California-Chukchi gray whale has returned to pre-exploitation population levels (Reilly 1992, Clapham *et al.* 1999). The western North Pacific or Korean-Okhotsk gray whale was thought to be extinct as recently as the early 1970's (Bowen 1974), but is known to survive today as a remnant population (Brownell and Chun 1977, Blokhin *et al.* 1985, Berzin *et al.* 1990). This western population is presently considered one of the most endangered and little-known large whale species in the world (Berzin *et al.* 1995, Brownell *et al.* 1997, Brownell 1999, Clapham *et al.* 1999). The current population size has been reported as 100-250 whales (Vladimirov 1994, Blokhin 1996, Berzin in press); however, no quantitative data were used generate these assessments.

Basic information regarding the life history and biology of western gray whales is sparse, and only recently has this population come under concerted study (Brownell *et al.* 1997, Weller *et al.* 1999, Würsig *et al.* 1999, Würsig *et al.* 2000, Weller *et al.* in review). Historic sighting data and whaling records suggest that summer feeding grounds for this population are in the Okhotsk Sea, and that they migrate to presently unknown breeding grounds suspected to be along the coast of southern China (Henderson 1972, 1984, 1990; Yablokov and Bogoslovskaya 1984; Kato and Kasuya in press). Sighting records from aerial and vessel surveys in the Okhotsk Sea between 1979 and 1989 indicated that feeding gray whales aggregated predominately along the shallow-water shelf of northeastern Sakhalin Island, Russia, and were particularly abundant off the southern

portion of Piltun Lagoon (Blokhin *et al.* 1985; Berzin *et al.* 1988, 1990, 1991, Blokhin 1996, Berzin in press). More recent photographic identification studies between 1994-1998 (Brownell *et al.* 1997, Weller *et al.* 1999, Würsig *et al.* 1999, Würsig *et al.* 2000) and aerial surveys conducted during 1998 (Würsig *et al.* 2000, Weller *et al.* in review) have corroborated the earlier Russian finding.

Concerns regarding the status of western gray whales have intensified as a result of continued low-level human-related mortality south of the Okhotsk Sea (Brownell 1999), and the onset of relatively large-scale U.S.-Russian oil and gas development programs along the migratory pathway and near the only known gray whale feeding ground within Okhotsk waters (Brownell *et al.* 1997, Würsig *et al.* 1999). In response to these concerns, a 1995 feasibility study designed to examine the conservation status, occurrence, distribution, behavior, and potential human-related disturbance of gray whales off the northeastern coast of Sakhalin Island was initiated by the National Marine Fisheries Service under the U.S.-Russian Environmental Agreement (Marine Mammal Project).

In 1997 and 1998, gray whale studies sponsored by Sakhalin Energy Investment Company and Exxon Neftegas were conducted by Texas A&M University and Kamchatka Institute of Ecology and Nature Management in the near-shore waters off Piltun Lagoon (Würsig *et al.* 1999, Würsig *et al.* 2000). These collaborative studies included: 1) shore-based observations to describe general behavior and near-shore movement patterns in relation to industrial activity and noise (1997-1998); 2) photo-identification of individual whales to examine occurrence patterns, site fidelity, and habitat use (1997-1998); 3) acoustic monitoring of the ambient environment, industrial/seismic sounds, and gray whale vocalizations (1997); and 4) aerial surveys of the near-shore area to describe basic distribution patterns (1998). Summaries of major results and mitigation recommendations for 1997 (Würsig *et al.* 1999) and 1998 (Würsig *et al.* 2000) are presented in Appendix 1.

The scope of work for the 1999 research effort (Appendix 2) was to conduct photo-identification surveys to examine occurrence patterns, site fidelity, and habitat use of gray whales occurring near the PA field off northeastern Sakhalin Island. This report represents third-year findings from a research program designed to: 1) determine the

occurrence, annual return, site fidelity, and habitat use patterns of whales in the area; and 2) develop potential mitigation policies allowing oil and gas development activities and marine mammals to coexist.

## METHODS

Photo-identification research methodologies employed during the 1999 field study were identical to those employed during the 1997 and 1998 field studies. The overall consistency in research design, data collection, and analysis maintained in 1999 permits inter-annual comparisons to be made. Additional, information collected during independent surveys off Piltun in 1994 and 1995 (Brownell *et al.* 1997, Weller *et al.* 1999) are also presented here to better describe interannual trends and facilitate a long-term interpretation for some of the results. Data from these independent studies include gray whale photographs obtained between 7-12 September 1994 during the filming of a wildlife documentary by H. Minakuchi (for description see Weller *et al.* 1999), and from 14-20 August 1995 during a pilot study to determine the feasibility of conducting boat- and shore-based research in the Piltun area (Brownell *et al.* 1997).

### *Study Area*

Zaliv Pil'tun (referred to here as Piltun Lagoon) is located on the northeastern shore of Sakhalin Island, Russia (Fig. 4). The lagoon is approximately 90 km long and 15 km across at its widest point. A single channel connects the inner lagoon with waters of the Okhotsk Sea occurs at 52°50' N 143°20' E, and appears to have considerable biological influence on the surrounding coastal waters. This channel, approximately 18 km north of the lagoon's southern boundary, served as the base from which studies reported here were conducted. The near-shore marine environment of the study site is predominately sand substrate, characterized by a gradually sloping and broad continental shelf. Water depths within 5 km of shore are almost uniformly less than 20 m deep. Sea surface temperature and salinity, as measured from our research vessel during sea state conditions  $\leq 3$  on the Beaufort scale (winds of 7-10 kts), ranged from 1.6-16.1 °C and 18-38 ppt, respectively (Table 1). Periods free of sea ice occur mainly between May and December; however, significant inter-annual variability exists.

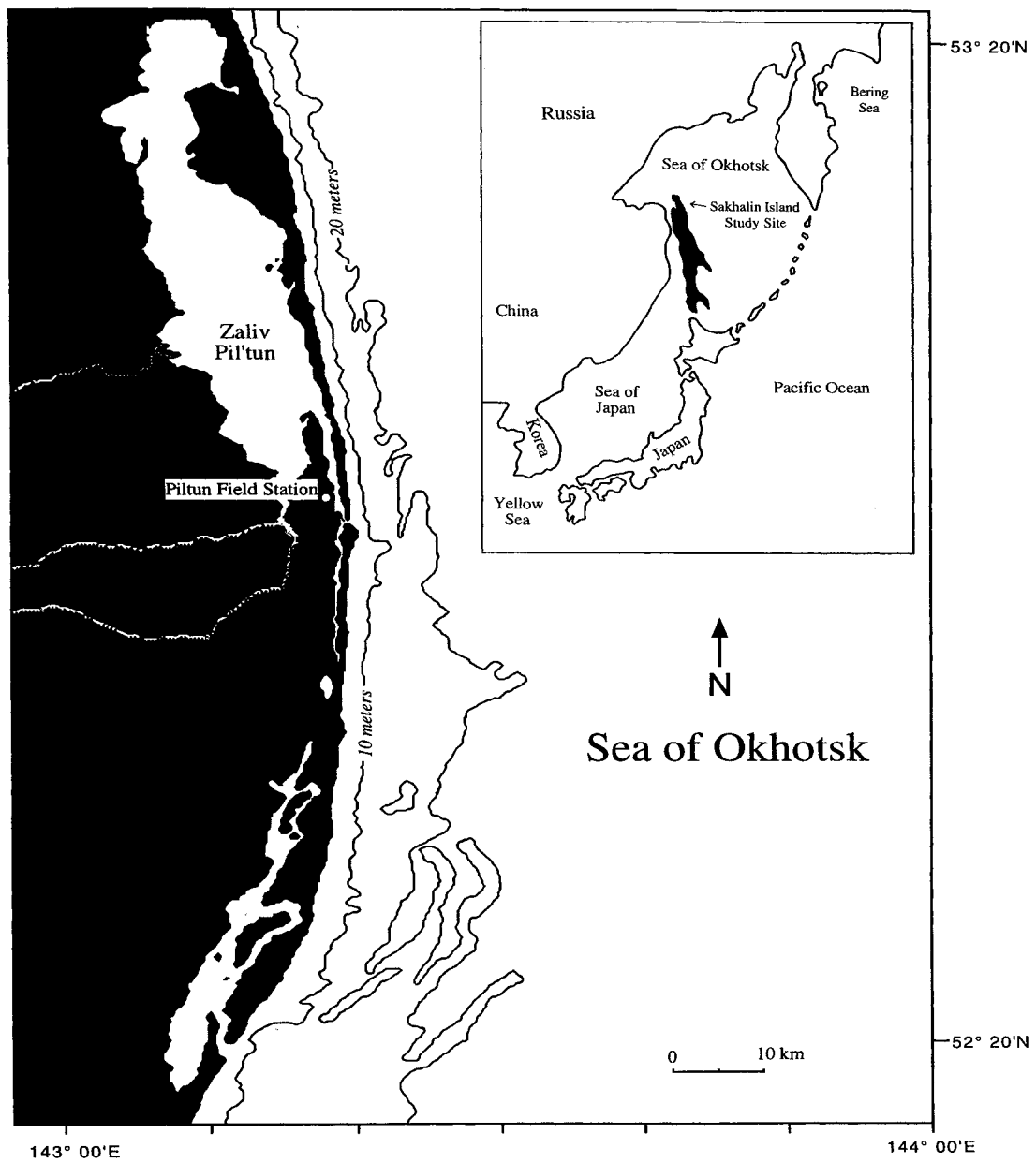


Figure 4. Map of the Piltun study area. Inset shows relative location of Sakhalin Island in the Sea of Okhotsk.

Table 1. Temperature and salinity summary statistics associated with pod sighting locations, 1999.

| Variable         | Sample Size | Mean | SD   | Median | Mode | Range    |
|------------------|-------------|------|------|--------|------|----------|
| Temperature (°C) | 77          | 9.0  | 3.74 | 9.2    | 7.8  | 1.6-16.1 |
| Salinity (ppt)   | 75          | 31.3 | 3.67 | 32     | 32   | 18-38    |

### ***Photo-Identification Surveys***

Photo-identification methods have proven extremely useful for gray whale studies (Darling 1984, Jones 1990, Weller *et al.* 1999), as individuals are particularly well marked along their sides, backs, and flukes (Fig. 5). Boat-based photo-identification surveys were conducted on all good weather days during the 1999 study period. Identical methodology was employed during each survey, with the primary objective of encountering and photographically identifying as many whales as possible. Previous photo-identification data gathered in the Piltun area in 1994-1998 used mainly right-side dorsal flank markings for identification (Brownell *et al.* 1997, Weller *et al.* 1999, Würsig *et al.* 1999, Würsig *et al.* 2000), and for the sake of intra- and inter-annual reliability, we continued this methodological approach.

Photographic surveys involved slow travel in a 4.5-m outboard-powered inflatable boat. The research team consisted of a boat driver, data recorder, digital video camera operator, and 35-mm camera photographer. Systematic search from the survey vessel was maintained until a whale sighting was made. Upon initial sighting of a pod, the survey vessel slowed to idle speed, and maneuvered to a vantage point approximately 50 m from the whale(s). From this position, observations on pod location (as determined by Global Positioning System) time, behavior, and number of whales were recorded.

The research vessel was then moved within 3-12 m of the whale pod and individuals were photographed. During the photographic effort, a running commentary regarding the film frame and video counter number as related to particular whales was recorded onto data sheets. Measures of water depth (as determined by digital depth sounder), location (as determined by GPS), and environmental conditions were recorded on average every 3-5 min throughout each photographic session. In all cases, attempts were made to simultaneously photograph and videotape the right dorsal flank of each whale, followed then by photos of the left dorsal flank and flukes. Photographs were

taken with a Nikon F5 35-mm camera equipped with a 100-300 mm zoom telephoto lens, high-speed motordrive, and databack. Video footage was recorded on a Sony DCR-VX1000 digital video camera. Two 35-mm film types were used: Kodachrome 200 ISO color slide film, and Fujichrome 400 ISO color slide film.

Contact with whale pods was maintained until all individuals encountered had been photographed. The boat was then motored away from the pod, where initial estimates of pod size and composition were revised if necessary, and all film and written records reviewed for completeness. These procedures were repeated as the research vessel resumed travel and additional whale pods were encountered.

A pod was defined as either a solitary individual, or two or more whales observed in close spatial proximity (within several body lengths of each other), and swimming in close association and generally coordinating their diving or direction of movement (see Clapham 1993). Pod size estimates were based on field observations, and represented the product of a consensus among observers on the survey vessel. The term “calf” is used here to refer to young of the year. In all cases calves were initially identified by their small body size (about one-third that of a mature adult), and constant association with a particular adult whale. Calves documented to disaffiliate from their mothers at some point during the field season were termed “newly-independent calves”.

### ***Photo and Video Analysis***

A total of 160 rolls of film were taken during the 1999 field season. Images of individual gray whales consisted of various aspects of the body, including head, back, dorsal flanks, and flukes. Based on the photographic methodology employed during 1995-1998 field efforts in the Piltun area (Brownell *et al.* 1997, Weller *et al.* 1999, Würsig *et al.* 1999, Würsig *et al.* 2000), the 1999 research team also targeted the right dorsal flank of each whale as the primary body aspect for identification purposes. Attempts were made in all cases to follow this standard approach; however, it was not always possible. Therefore, to maximize the collection of data, whales were photographed sequentially from head to fluke on either the left or right side, and the top and bottom of their flukes. Written observations and video footage collected at the time of each photographic session were used to link inter-individual aspects whenever



possible. Photographic images were first examined on a light table using an 8x loupe. To prevent cataloging different sides and aspects of the same whale as more than one individual, the right flank was always used as the basis for initial identification. A whale was not given a permanent subject identification number unless its right dorsal flank was photographed at some point during the field season. Additional aspects of the body were used as identification tools only if they were first matched with their respective right flank. In an effort to identify as many whales as possible, all images of acceptable quality (even if unmatched) were archived for subsequent identification purposes.

Photographic “matching” was done by comparing a “new” individual to all images of already-cataloged whales. If a prospective match was determined, the current image was repeatedly compared to previous images, and was required to match before being confirmed as a reidentification of a known individual. If a photograph could not be matched, then photographs of remaining individuals were inspected. Although labor intensive, this systematic search process increased the probability that most, if not all, previously-sighted whales would be resighted. If a match was not found after this comprehensive inspection, the individual was considered a new sighting. Upon completion of the 1999 photo-identification catalog, comparisons were made with whales first identified in the Piltun study area between 1994-1998, and a database containing information on each whale identified between 1994-1999 was established (Appendix 3).

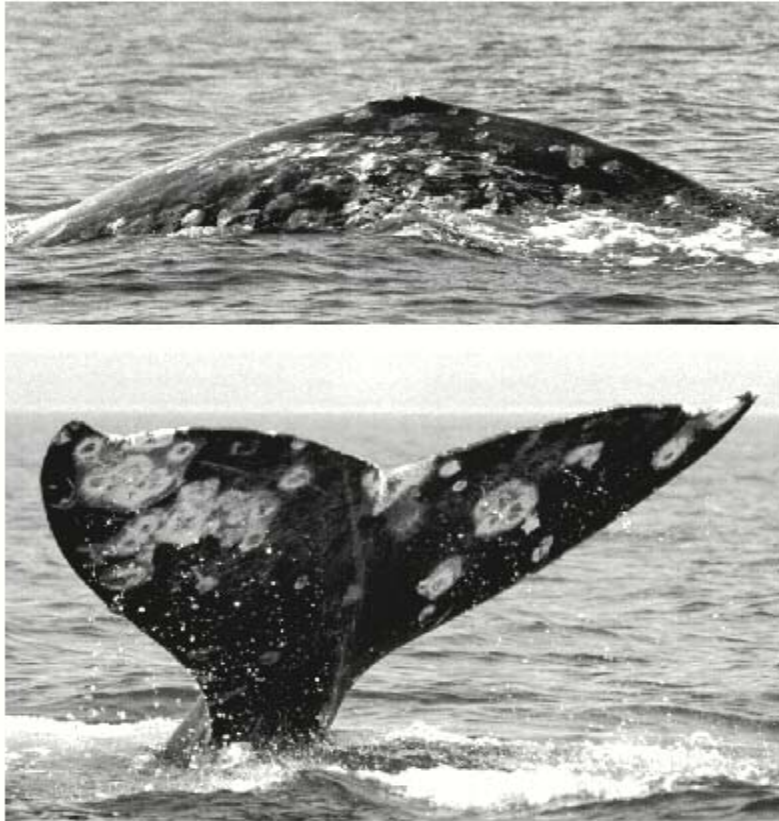


Figure 5. Pigmentation and other patterns used to photographically identify individual whales.

Digital video footage was collected simultaneously to still photography during photo-identification surveys. A total of 4 hrs of digital video footage, acquired at 30 frames per second, were obtained during the 1999 research effort. Each video session was subsequently reviewed frame by frame to verify and enhance the already established 35-mm photographic catalog. A data code containing date and running time information allowed easy separation of whale pods. When analyzing each pod session, video frames of marked whales were compared to the corresponding 35-mm images for that group. If the video image(s) matched a whale already cataloged, a note was made in the video log and the next surfacing sequence was examined. If the video images did not match a previously known whale, then a print was made on a digital video color printer. Such prints were set aside for later comparison with the 35-mm photographic catalogs. If the videographer recorded a previously unphotographed aspect of an identified whale, then a print was made of that aspect. The print was labeled with the appropriate identification number and added to the identification catalogs.

After all digital video footage was analyzed and necessary prints made, images of whales not accounted for by 35-mm photographs were systematically “matched” following the same procedure as that described for photo-identification analysis. The use of digital video proved to be a valuable tool in creating the photo-identification catalogs. Although the quality of the video images was generally slightly lower than the 35-mm photographic images, the resulting footage nevertheless provided additional identification information for individual whales.

## RESULTS

### *Survey Effort*

Fifty-six photo-identification surveys were conducted between 29 June and 13 October 1999. Approximately 300 hrs of survey effort was conducted during which 122 hrs were spent in direct observation of 434 whale groups. A total of 160 rolls of film and 4 hrs of digital videotape were used for individual identification purposes. Summary numbers for 1994-1999 annual survey effort, number of pods encountered, and the number of whales identified are presented in Table 2.

Table 2. Annual survey effort, number of pods encountered, and whales identified, 1994-1999. Time is represented in decimal hours.

| Year              | Sampling period (mo, d) | Number of surveys | Hours of observation | Rolls of film used | Pods encountered | Whales identified |
|-------------------|-------------------------|-------------------|----------------------|--------------------|------------------|-------------------|
| 1994 <sup>1</sup> | 09/07 - 09/12           | -                 | -                    | -                  | -                | 10                |
| 1995              | 08/15 - 08/19           | 5                 | 10.1                 | 15                 | 23               | 27                |
| 1997              | 07/09 - 09/08           | 22                | 33.4                 | 72                 | 114              | 47                |
| 1998              | 07/06 - 09/29           | 35                | 50.5                 | 91                 | 125              | 54                |
| 1999              | 6/29 – 10/13            | 56                | 122.0                | 160                | 434              | 70                |
| Overall           |                         | 118               | 216.0                | 338                | 696              | 88 <sup>2</sup>   |

<sup>1</sup> Opportunistic photographs were collected during several days in mid-September, 1994. Information other than the number of whales identified was not recorded.

<sup>2</sup> The number of whales identified annually includes resightings of individuals from previous years, resulting in a total of 88 known individuals.

### ***Pod Size and Distribution Patterns***

Mean pod size for the 434 pods encountered during 1999 was 1.8 ( $\pm$  s.d. 1.03) with a range of 1-7 whales per pod (Table 3). A majority of pods (97.0%) were composed of four whales or less (Fig. 6). The mean water depth in which pods were encountered was 12.9 m ( $\pm$  s.d. 3.63,  $n = 423$ ) with a range of 2.9 – 24.0 m. Ninety-four percent of all pod locations were distributed in waters < 18 m deep (Fig. 7). GPS determined pod locations (Appendix 3) were generally inside 5 km of shore, and within 10 km north or south of the lagoon channel mouth (Fig. 8). On several occasions, exceptional sea conditions allowed us to expand our more typical survey coverage (usually within 20 km of the lagoon mouth) to include areas 50 km north and up to 25 km south of the entrance to Piltun Lagoon. In all cases, whales photographed to the north and south were individuals known to also occur off the lagoon channel mouth. Many surveys documented individual whales moving distances of 50 km or more in less than 24 hours, while other whales demonstrated strong site fidelity (sometimes over days) to regions less than 500 m<sup>2</sup>. In general, the 1999 season was seemingly characterized by a more northern distribution of pods than had been detected during previous studies in 1997 and 1998 (Würsig *et al.* 1999, Würsig *et al.* 2000). This finding is supported by data collected during several hundred counts from the Piltun lighthouse between May and November of 1999 (Blokhin *et al.* unpublished data, Weller and Würsig unpublished data), and the encounter data from photo-identification surveys reported here.

Table 3. Pod size summary statistics, 1995-1999.

| Year    | Number of pods | Mean pod size | Median pod size | Mode pod size | ± S.D. pod size | Range in pod size |
|---------|----------------|---------------|-----------------|---------------|-----------------|-------------------|
| 1995    | 23             | 2.3           | 2               | 2             | ± 1.18          | 1-6               |
| 1997    | 114            | 1.8           | 1               | 1             | ± 1.33          | 1-9               |
| 1998    | 125            | 2.0           | 2               | 2             | ± 1.02          | 1-6               |
| 1999    | 434            | 1.8           | 1               | 1             | ± 1.03          | 1-7               |
| Overall | 696            | 2.0           | 1.5             | 1.5           | ± 1.14          | 1-9               |

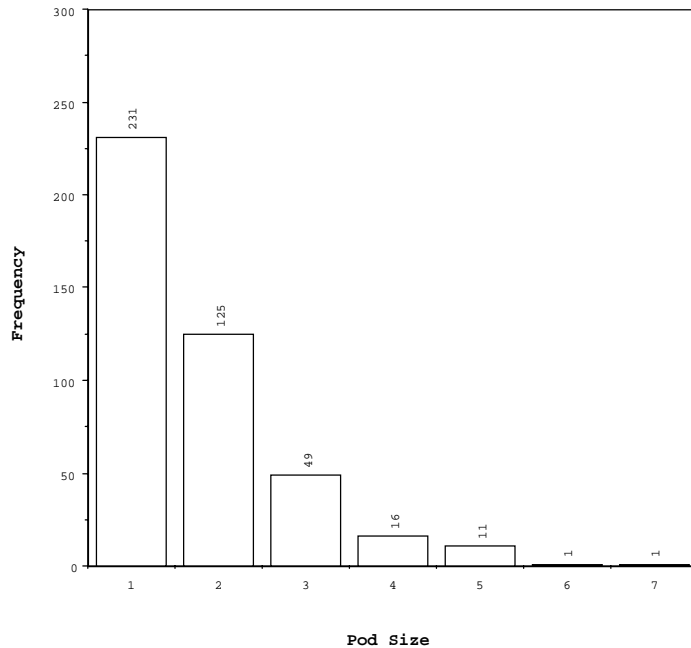


Figure 6. Distribution of pod sizes encountered during photo-identification surveys in 1999.

***Individual Recognition and Sighting Patterns***

A total of 70 naturally marked individual whales, including two calves, were identified during 1999. The rate at which individual whales were first identified during each field season between 1994-1999 is presented in Fig. 9. This figure displays the cumulative number of whales identified over time. The rapid increase in the slope of the curve during 1994-1997 represents the initial identification of unrecognized whales. Sightings of new animals, however, leveled dramatically early in 1998. The rate of increase in this function was relatively limited in 1999, with only 14 additional non-calves identified. The leveling in the slope of the discovery curve at the end of the 1998 and 1999 field efforts suggests that all whales present in the search area during each respective year had been identified. This trend was particularly apparent in 1998 when only two new individuals were identified during the final 26 photo-identification surveys, and in 1999 when only three new individuals were identified in the final 28 surveys.

Figure 7

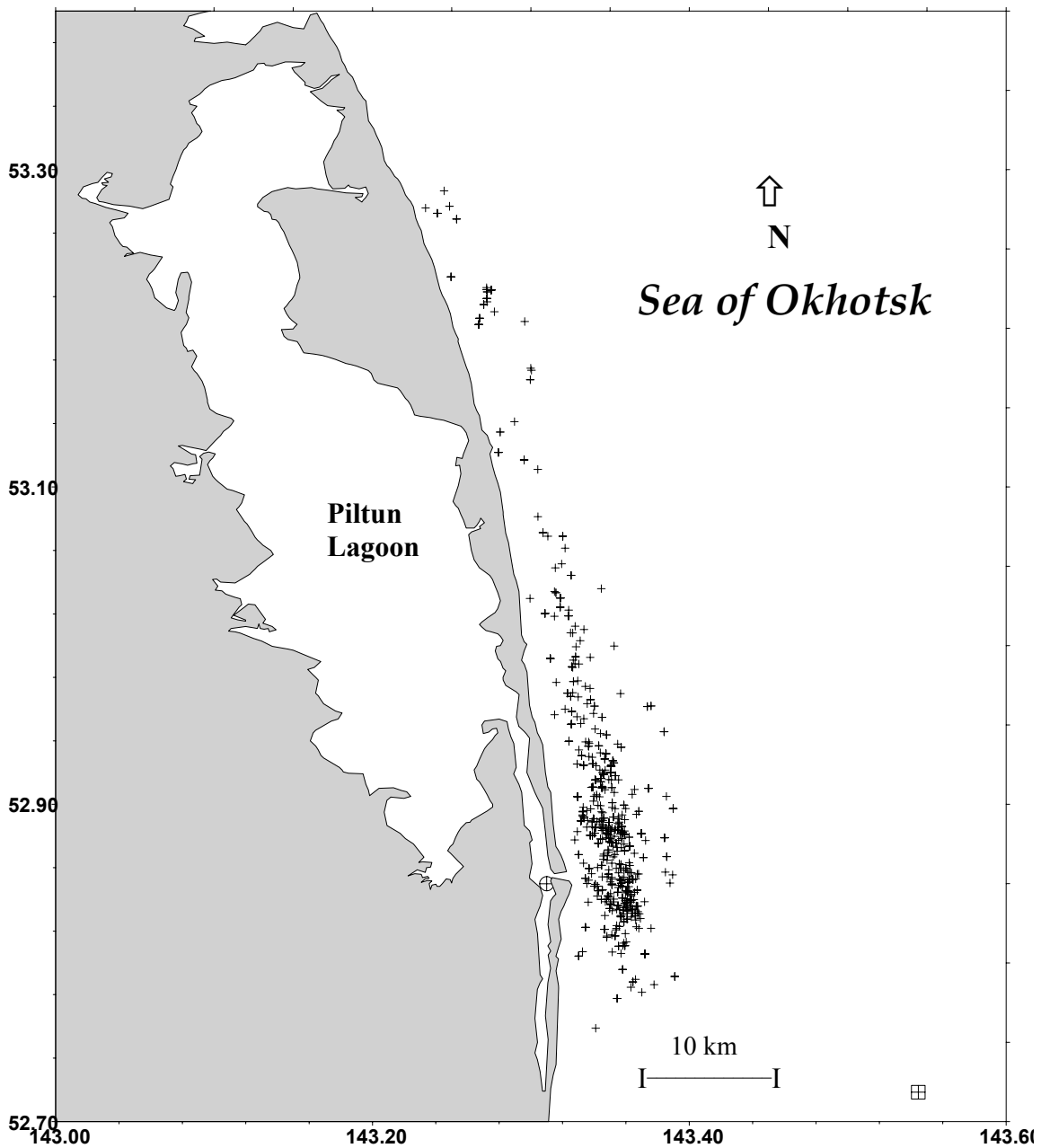


Figure 8. Spatial distribution of pods encountered during photo-identification surveys in 1999. The Molikpaq location is denoted by a square at the lower right side of the chart. Latitude and longitude are displayed in decimal degrees.



### ***Occurrence Patterns***

The monthly presence or absence of identified whales during 1999, and for the previous 1994-1998 photographic efforts, are presented in Fig. 10. The mean number of months in which whales were identified during 1999 was 2.7 ( $\pm$  s.d. 1.06) with a range of 1-5 months. Eleven whales (15.7%) were sighted in only one month, 18 (25.7%) were sighted in two months, 25 whales (35.7%) were sighted in three months, 14 whales (20.0%) were sighted in four months, and two whales (3.0%) were sighted in all five months of the study (Fig. 11). Only one survey was conducted in June, therefore greatly diminishing the opportunity for more whales to be sighted in the five month category. Of the eleven whales sighted in only one month, 54.5% ( $n = 6$ ) were identified in July, while 18.2% ( $n = 2$ ) were sighted in either August or October, and 27.3% ( $n = 3$ ) in September.

### ***Resighting and Site Fidelity Patterns***

The 70 whales identified during the 1999 field season were composed of 68 non-calves (i.e. adults or subadults) and two young of the year calves. Three whales (070, 075, 081) first photographed in 1994-1998, but lacking the right-side photograph required to be included in the photo-identification catalog, were properly identified during 1999. Therefore, the reference of 69 whales identified during 1994-1998 presented in earlier summaries of our work (Weller *et al.* 1999, Würsig *et al.* 1999, Würsig *et al.* 2000) can now be increased to 72. Thus, when the 16 whales first identified in 1999 are combined with the 72 individuals identified between 1994-1998 a total of 88 whales have been photographically identified (Table 4).

Table 4. Annual sighting trends and resighting percentages of whales photo-identified, 1994-1999.

| Year | Number of whales identified | Number of calves | Number of new whales identified | Percentage of non-calves identified from previous years | Number of whales seen only in that year |
|------|-----------------------------|------------------|---------------------------------|---------------------------------------------------------|-----------------------------------------|
| 1994 | 10                          | -                | 10                              | N/A                                                     | 0                                       |
| 1995 | 27                          | 2                | 22                              | 20.0% ( $n = 5$ )                                       | 2                                       |
| 1997 | 47                          | 2                | 27                              | 44.4% ( $n = 20$ )                                      | 4                                       |
| 1998 | 54                          | 7                | 13                              | 87.2% ( $n = 41$ )                                      | 6                                       |
| 1999 | 70                          | 2                | 16                              | 79.4% ( $n = 54$ )                                      | 16 <sup>1</sup>                         |

<sup>1</sup> Two of these 16 whales were “young of the year” calves, and therefore could not have been sighted in any other sampling period.

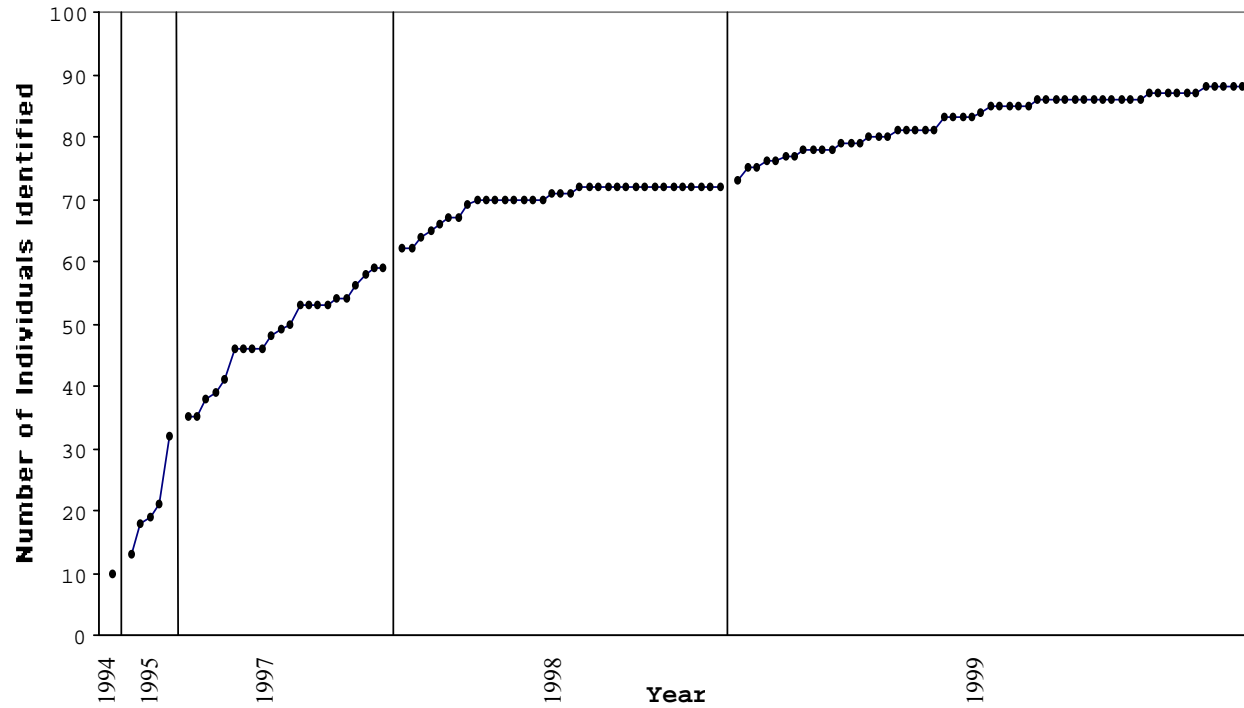


Figure 9. Rate of discovery curve for whales identified between 1994-1999. A black circle represents each survey date, and a vertical line separates each survey year.

| Whale ID number | 1994 | Aug-95 | Jul-97 | Aug-97 | Sep-97 | Jul-98 | Aug-98 | Sep-98 | Jun-99 | Jul-99 | Aug-99 | Sep-99 |
|-----------------|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 001             |      |        |        |        |        |        |        |        |        |        |        |        |
| 002             |      |        |        |        |        |        |        |        |        |        |        |        |
| 003             |      |        |        |        |        |        |        |        |        |        |        |        |
| 004             |      |        |        |        |        |        |        |        |        |        |        |        |
| 005             |      |        |        |        |        | M      | M      |        |        |        |        |        |
| 006             |      |        |        |        |        |        |        |        |        |        |        |        |
| 007             |      |        |        |        |        |        |        |        |        |        |        |        |
| 008             |      |        |        |        |        |        |        |        |        |        |        |        |
| 009             |      |        |        |        |        | M      | M      |        |        |        |        |        |
| 010             |      |        |        |        |        |        |        |        |        |        |        |        |
| 011             |      |        |        |        |        |        |        |        |        |        |        |        |
| 012             |      |        |        |        |        |        |        |        |        |        |        |        |
| 013             |      |        |        |        |        |        |        |        |        |        |        |        |
| 014             |      |        |        |        |        |        |        |        |        |        |        |        |
| 015             |      |        |        |        |        | M      | M      | M      |        |        |        |        |
| 016             |      |        |        |        |        |        |        |        |        |        |        |        |
| 017             |      |        |        |        |        |        |        |        |        |        |        |        |
| 018             |      | M      |        |        |        | M      | M      | M      |        |        |        |        |
| 019             |      | M      | M      | M      |        |        |        |        |        |        |        |        |
| 020             |      |        | C      | C      | C      |        |        |        |        |        |        |        |
| 021             |      |        |        |        |        |        |        |        |        |        |        |        |
| 022             |      |        |        |        |        |        |        |        |        |        |        |        |
| 023             |      |        |        |        |        |        |        |        |        |        |        |        |
| 024             |      |        |        |        |        |        |        |        |        |        |        |        |
| 025             |      |        |        |        |        |        |        |        |        |        |        |        |
| 026             |      |        |        |        |        |        |        |        |        |        |        |        |
| 027             |      |        |        |        |        |        |        |        |        |        |        |        |
| 028             |      |        |        |        |        |        |        |        |        |        |        |        |
| 029             |      |        |        |        |        |        |        |        |        |        |        |        |
| 030             |      |        |        |        |        |        |        |        |        |        |        |        |
| 031             |      |        | M      | M      | M      |        |        |        |        |        |        |        |
| 032             |      |        | C      | C      | C      |        |        |        |        |        |        |        |
| 033             |      |        |        |        |        |        |        |        |        |        |        |        |
| 034             |      |        |        |        |        |        |        |        |        |        |        |        |
| 035             |      |        |        |        |        |        |        |        |        |        |        |        |
| 036             |      |        |        |        |        | M      | M      | M      |        |        |        |        |
| 037             |      |        |        |        |        |        |        |        |        |        |        |        |
| 038             |      |        |        |        |        |        |        |        | M      | M      | M      |        |
| 039             |      |        |        |        |        |        |        |        |        |        |        |        |
| 040             |      |        |        |        |        |        |        |        |        | M      | M      | M      |
| 041             |      |        |        |        |        |        |        |        |        |        |        |        |
| 042             |      |        |        |        |        |        |        |        |        |        |        |        |
| 043             |      |        |        |        |        |        |        |        |        |        |        |        |
| 044             |      |        |        |        |        |        |        |        |        |        |        |        |
| 045             |      | C      |        |        |        |        |        |        |        |        |        |        |
| 046             |      | C      |        |        |        |        |        |        |        |        |        |        |
| 047             |      |        |        |        |        |        |        |        |        |        |        |        |
| 048             |      |        |        |        |        |        |        |        |        |        |        |        |
| 049             |      |        |        |        |        |        |        |        |        |        |        |        |
| 050             |      |        |        |        |        |        |        |        |        |        |        |        |
| 051             |      |        |        |        |        |        |        |        |        |        |        |        |
| 052             |      |        |        |        |        |        |        |        |        |        |        |        |
| 053             |      |        |        |        |        |        |        |        |        |        |        |        |
| 054             |      |        |        |        |        |        |        |        |        |        |        |        |
| 055             |      |        |        |        |        | M      | M      | M      |        |        |        |        |
| 056             |      |        |        |        |        | C      | C      |        |        |        |        |        |

Figure 10. Occurrence patterns for whales identified 1994-1999. M = mother, C = Calf.

| Whale ID number | 1994 | Aug-95 | Jul-97 | Aug-97 | Sep-97 | Jul-98 | Aug-98 | Sep-98 | Jun-99 | Jul-99 | Aug-99 | Sep-99 |
|-----------------|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 057             |      |        |        |        |        | C      | C      | C      |        |        |        |        |
| 058             |      |        |        |        |        | C      | C      |        |        |        |        |        |
| 059             |      |        |        |        |        |        |        |        |        |        |        |        |
| 060             |      |        |        |        |        | C      | C      |        |        |        |        |        |
| 061             |      |        |        |        |        | C      | C      |        |        |        |        |        |
| 062             |      |        |        |        |        | C      | C      | C      |        |        |        |        |
| 063             |      |        |        |        |        |        | M      |        |        |        |        |        |
| 064             |      |        |        |        |        |        | C      |        |        |        |        |        |
| 065             |      |        |        |        |        |        |        |        |        |        |        |        |
| 066             |      |        |        |        |        |        |        |        |        |        |        |        |
| 067             |      |        |        |        |        |        |        |        |        |        |        |        |
| 068             |      |        |        |        |        |        |        |        |        |        |        |        |
| 069             |      |        |        |        |        |        |        |        |        |        |        |        |
| 070             |      |        |        |        |        |        |        |        |        |        |        |        |
| 071             |      |        |        |        |        |        |        |        | C      | C      | C      | C      |
| 072             |      |        |        |        |        |        |        |        |        |        |        |        |
| 073             |      |        |        |        |        |        |        |        |        |        |        |        |
| 074             |      |        |        |        |        |        |        |        |        |        |        |        |
| 075             |      |        |        |        |        |        |        |        |        |        |        |        |
| 076             |      |        |        |        |        |        |        |        |        |        |        |        |
| 077             |      |        |        |        |        |        |        |        |        | C      | C      | C      |
| 078             |      |        |        |        |        |        |        |        |        |        |        |        |
| 079             |      |        |        |        |        |        |        |        |        |        |        |        |
| 080             |      |        |        |        |        |        |        |        |        |        |        |        |
| 081             |      |        |        |        |        |        |        |        |        |        |        |        |
| 082             |      |        |        |        |        |        |        |        |        |        |        |        |
| 083             |      |        |        |        |        |        |        |        |        |        |        |        |
| 084             |      |        |        |        |        |        |        |        |        |        |        |        |
| 085             |      |        |        |        |        |        |        |        |        |        |        |        |
| 086             |      |        |        |        |        |        |        |        |        |        |        |        |
| 087             |      |        |        |        |        |        |        |        |        |        |        |        |
| 088             |      |        |        |        |        |        |        |        |        |        |        |        |

Figure 10. Continued.

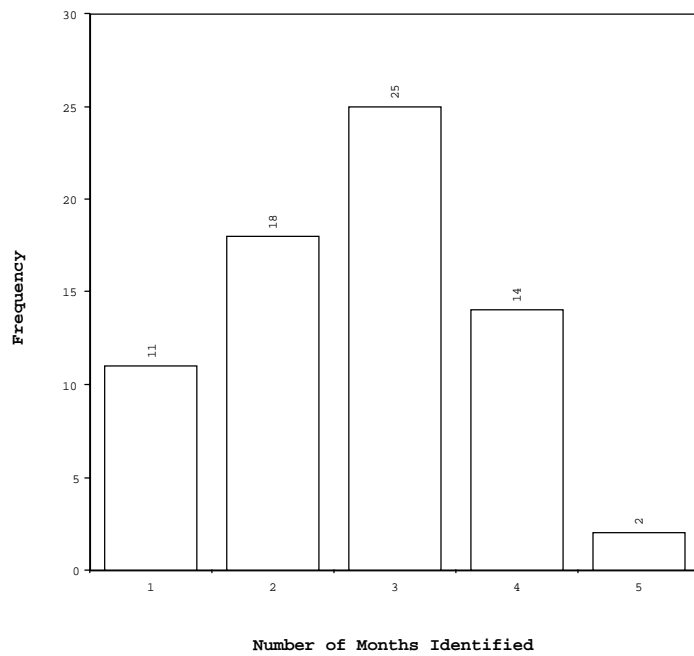


Figure 11. Number of months that whales identified between June-October 1999 were photographed.

Of the 68 non-calves identified during 1999, 79.4% ( $n = 54$ ) had been previously identified in Piltun during 1994-1998 photographic efforts. Sighting frequencies for recognized individuals, based on a one-sighting-per-day criterion, ranged between 1-30 with an overall mean of 8.1 ( $\pm$  s.d. 5.92) sighting per whale (Fig. 12). The period between the first and last sighting for individual whales ranged from 2 to 105 days with a mean of 57.2 days ( $\pm$  SD 25.60). This measure was calculated for 63 whales photographed on two or more days, and does not assume that the individual was absent from or present in the study area for the period between sightings (see Seipt *et al.* 1990, Clapham *et al.* 1993).

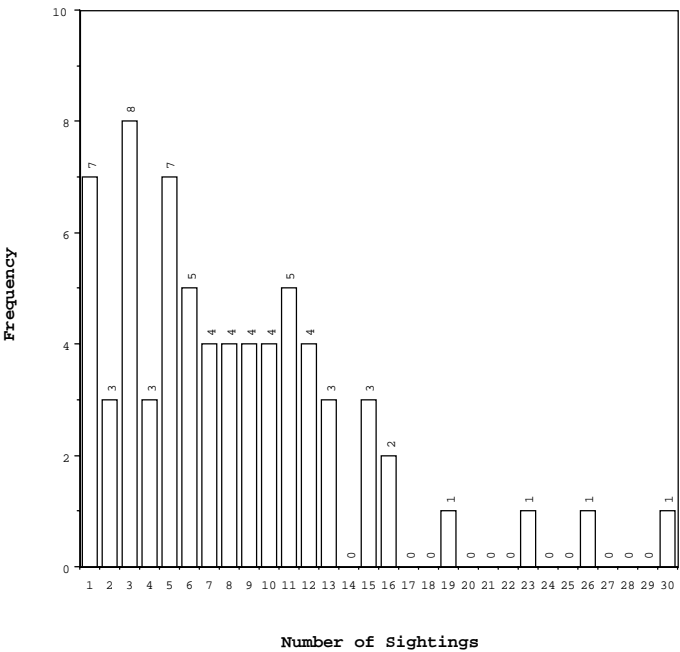


Figure 12. Sighting frequencies for whales identified in 1999.

### ***Mother-Calf Pairs***

Two mother-calf pairs (040/077 and 038/071) were identified during the study, and ranked among some of the most-frequently sighted whales. Occurrence patterns for these mother-calf pairs are detailed in Fig. 9. Of the two mothers identified in 1999, one was seen in three previous years and first identified in 1995 while the other was observed in two previous years and first identified in 1997. While neither of these two whales had been previously identified as mothers, both were sighted in 1998 when they were pregnant. These findings emphasize the multiple year return to this region by reproductive females, a trend also evident in the 1997-1998 datasets. The observed crude birth rate for 1999, as calculated by dividing the number of calves observed by the total number of all whales identified (including calves) in a given year (see Clapham and Mayo 1990), was 2.9%. The crude birth rate in 1999 was considerably lower than the 4.3% and 13.2% reported for 1997 and 1998, respectively. Of the 11 calves identified between 1995-1998, five (45.5%) were sighted in at least two years. Of these five calves, four were born and first sighted in 1998 and resighted in 1999. While it is presently undetermined if calf return rates correspond with calf survivorship, these findings suggest that calf mortality within the first year may be relatively high.

Mothers and calves were closely bonded at the onset of the 1999 sampling period. However, our observation records documented disaffiliation between these pairs between 16-24 July for animals 040/077 and between 9-20 August for 038/071. These dates represent one day after the last sighting of the mother/calf pair together and the next subsequent sighting of either the mother or calf independent from one another. Once these pairs disaffiliated, the newly independent calves were occasionally sighted together, but never again seen in the company of their mothers despite continued occurrence of both mothers in the study area.

### ***Physical Condition and Health Status***

During the 1999 field season, our team regularly observed and documented at least 10 whales that appeared to be unusually thin. The evident thinness of these animals could be noticed, in most cases, within several minutes of approaching individuals by small boat for photo-identification purposes. Similar observations were not documented during previous studies off Piltun in 1997 and 1998. Laboratory analysis of 1999 photographs and video revealed several morphological attributes correlated with a particular individual being described as thin. Diagnostic features varied between individuals, but consisted of at least one of the following: 1) an obvious subdermal protrusion of the scapula (shoulder blade) from the body with an associated thoracic



depression surrounding the insertion of the flipper; 2) the presence of a post-cranial depression; and 3) a pronounced ridge along the dorsal aspect of the lumbar and caudal vertebrae resulting in the appearance of a “bulge” along the lateral flank. For whales deemed to be thin in 1999, we examined photographs of them taken in 1997-1998. While not yet complete, this preliminary inter-annual comparison revealed that thin whales in 1999 were not obviously thin in previous years.

## DISCUSSION

Findings presented here provide new information regarding western gray whales on their summer feeding grounds in the Okhotsk Sea. During the study, most whales demonstrated high levels of seasonal site fidelity and annual return to an area off the northeastern coast of Sakhalin Island, Russia. These inter- and intra-annual resighting patterns, combined with the continuous occurrence of feeding behavior, suggest that this coastal habitat plays an important role in the feeding ecology of this remnant population.

Pod sizes observed during 1999 were primarily small, with most groups composed of four or fewer whales. These observed pod sizes closely correspond with those reported for eastern gray whales feeding in the Bering and Chukchi Seas (Zimushko and Ivashin 1980, Votrogov and Bogoslovskaya 1980, Bogoslovskaya *et al.* 1981, Würsig *et al.* 1986), and are similar to the mean group sizes of 1.8 in 1997 and 2.0 in 1998 observed during previous field studies off Piltun (Weller *et al.* 1999, Würsig *et al.* 1999, Würsig *et al.* 2000). Variables thought to influence group size characteristics include social factors, predation pressure, and prey availability (Krebs and Davies 1993). As social factors related to breeding are presumably relaxed on the feeding grounds (Würsig *et al.* 1986), and predation pressure does not appear to be excessive (as indicated by the low number of killer whale sightings during the study), the major determinant of group size during summer feeding is probably related to foraging efficiency.

Gray whales in other parts of the North Pacific are suspected to sometimes segregate by age while on their feeding grounds (Zenkovich 1937, Votrogov and Bogoslovskaya 1980, Bogoslovskaya *et al.* 1981, Darling 1984, Darling *et al.* 1998). One possible explanation for the limited number of individuals identified between 1994-1999 ( $n = 88$ ) could be that only a portion of the population, stratified by age, uses the northeastern Sakhalin coast. Age-class segregation was not, however, apparent in our observations. During the course of study, we regularly documented

the presence of adult reproductive females, their young of the year calves, numerous whales of apparent adult body size, and at least five known two-year-old individuals.

An additional alternative explanation for the limited number of whales identified during the study is that only a small portion of a larger population migrates to the northeastern Sakhalin Island coast. Small numbers of eastern gray whales have been reported to summer along the North American coast from Alaska to California, never fully migrating to more northern feeding areas (Rice and Wolman 1971). While a similar pattern may occur for the western gray whale population, aerial and ship-based surveys in the northern Okhotsk Sea reported finding concentrations of whales only in a relatively small area off Piltun Lagoon, but one that may exceed the boundary typically covered by our research vessel during this study (Blokhin *et al.* 1985; Berzin *et al.* 1988, 1990, 1991; Blokhin 1996; Berzin in press, Weller *et al.* in review). Our lack of photographic effort in other regions along the Sakhalin Island coast, and the virtual absence of data from this population's southern range off China, Korea, and Japan, prohibits further speculation regarding potential subpopulation structuring.

A majority of the whales identified between 1994-1999 displayed high rates of annual return to the study area. The annual return of whales to this region is similar to that reported for eastern gray whales off Vancouver Island (Darling 1984), and may be suggestive of foraging area philopatry as has been hypothesized for humpback whales (*Megaptera novaeangliae*) in the southern Gulf of Maine (Clapham *et al.* 1993). Annual return to the same geographic feeding area has been observed for a variety of other baleen whales (Agler *et al.* 1990, Dorsey *et al.* 1990, Sears *et al.* 1990, Clapham *et al.* 1993), and in the present case emphasizes the significance of the Piltun region as an important feeding ground for western gray whales.

Occurrence patterns of the whales identified between 1994-1999 suggest a reasonably strong intra-seasonal fidelity to the area. The mean period between first and last sighting of whales in the Piltun region was 57.2 days, and over one-half of the whales identified on a yearly basis were sighted in either two or three months. However, even whales demonstrating seemingly strong site fidelity were on occasion apparently absent from the region. It is difficult to determine if breaks in individual resighting patterns represent occasions when whales were in the study area but were missed photographically, or if these breaks were indicative of movements to other regions between sightings. Our findings suggest that whales take short excursions away from the study site,

presumably related to foraging, but eventually return. Support for this idea comes from survey days on which we sampled 50 km north, 25 km south, and up to 10 km offshore of our typical search area. In each case, whales found at the periphery of the study site were feeding, and all identified individuals had previous and subsequent sightings within the more typical survey area near the lagoon entrance. In many cases, whales identified 50 km north of the lagoon entrance on one day, would be photographed the following day immediately off or to the south of the lagoon mouth. These ranging patterns suggested that whales were regularly moving up and down a limited portion of northeastern Sakhalin Island coastline. While data collected in 1997-1998 also indicated that whales were immigrating to and emigrating from the study area, the present findings suggest that these forays may have been more frequent in 1999.

Darling *et al.* (1998) characterized gray whales off Vancouver Island as having “foraging ranges” that in some cases extend over hundreds of kilometers. While existing data are insufficient to allow us to reliably assess movement patterns outside the current study area, we suggest that the unique habitat structure and infaunal prey ecology characteristic of our study site favors seasonal site fidelity as opposed to the coastal ranging behavior described by Darling *et al.* (1998). Our photographic resighting data showing seasonal and annual fidelity appear to support this hypothesis, as do findings from over 200 shore-based whale counts conducted between 1997-1998 from the lighthouse near the mouth of Piltun Lagoon (Ivashchenko 1999, Würsig *et al.* 1999, Würsig *et al.* 2000). Theodolite-determined pod locations during these counts indicated that the highest concentrations of feeding gray whales were usually within 10 km of the lagoon mouth, and less than 5 km offshore (Würsig *et al.* 1999, Würsig *et al.* 2000). Similarly, aerial and ship-based surveys of the Okhotsk Sea found only limited numbers of gray whales away from the northeastern Sakhalin Island coast (Blokhin *et al.* 1985; Berzin *et al.* 1988, 1990, 1991; Blokhin 1996; Berzin in press, Weller *et al.* in review). This apparent distributional fidelity to the coastal waters near the channel opening of Piltun Lagoon may reflect a particular biological richness of the region, perhaps related to enrichment of near-shore marine waters by nutrient-laden tidal effluent from the lagoon. While further information regarding the benthic ecology of the region is needed, this explanation may at least partially account for the high annual return and intra-seasonal site fidelity of many individuals observed.

Eleven mothers and thirteen calves were identified between 1994-1999. Calves separated from their mothers between July and mid-September. Using a mean birth date of 10 January as calculated for eastern gray whales (Rice and Wolman 1971), it appears that calves off Sakhalin Island separate from their mothers when 6-8 months old. This age at separation closely corresponds with the 7-month lactation period estimated for the species (Rice and Wolman 1971). Thus, if August is used to estimate the typical period of separation for western gray whale mother-calf pairs, January may represent the peak calving period, as is true for the eastern population (Rice and Wolman 1971).

Of the two mothers identified in 1999, both were sighted in 1998 when they were pregnant. Both lactating and pregnant females are under especially high energetic demands (Rice and Wolman 1971, Lockyer 1984). Therefore, it is imperative that they feed in regions capable of meeting their elevated energetic requirements. The seasonal site fidelity and annual return of reproductive females reported here, combined with their need for high-quality habitat, suggest that the northeastern Sakhalin Island coast is of particular biological importance to this endangered whale population.

The observations of what appeared to be unusually skinny whales during the 1999 field season are of concern. In light of the potential importance of these observations, a group of 10 experts on large whales (not affiliated with our project), including biologists, toxicologists, physiologists, and veterinarians assembled on 2 December 1999 at the 13th Biennial Conference on the Biology of Marine Mammals in Hawaii, to evaluate our photographs of 10 whales (including one 1999 mother and calf) of particular concern, and express their collective opinions. All participants stated that these whales appeared to be abnormally thin and that the overall muscle mass of the whales appeared to be diminished. After much discussion, it was agreed by consensus that these whales appeared to be in generally “poor” physical condition.

A leading authority on eastern North Pacific gray whales (J. Calambokidis) stated that the condition of whales photographed off Piltun looked similar to several whales he observed in poor health and displaying abnormal behavior in past years off the southern part of Puget Sound, Washington. We have now compared skinny whale photographs from Puget Sound to those from Piltun, and many of the diagnostic features we used to define a whale as being thin, were also apparent in the Washington images. While the causal mechanism(s) for the observed deterioration of physical condition in some whales off Piltun in 1999 is unknown, the meeting participants

suggested that any of the following alone or in combination may be contributing: 1) disease; 2) stress induced metabolic shifts; 3) natural or human produced changes in prey availability.

The presence of unusually thin whales in the region is a point of concern, and needs further follow-up evaluation using a suite of techniques including benthic assessments of prey density, and physiological and toxicological evaluations of blubber, skin, and fecal samples to assess the potential contribution of disease and stress. While benthic information can only be obtained by systematic sampling of nearshore waters in future years, we are currently working in collaboration with researchers at the National Marine Fisheries Service, Southwest Fisheries Science Center, to investigate molecular-level stress indicators in relation to the health of gray whales off Piltun (Southern and Dizon 1999). In order to further monitor the survivorship, annual return, and health-related status of individual whales off Piltun (especially those deemed to be in poor physical condition during 1999), we strongly recommend that the current photo-recognition research be continued in 2000 and combined with benthic and physiological studies.

## CONCLUSIONS AND RECOMMENDATIONS

Industrial activities on the continental shelf off eastern Sakhalin Island have steadily increased in the past several years, and are scheduled to continue. The nearly constant drilling and production activities during ice-free periods, in addition to the associated increase in aircraft and shipping traffic now occurring off Piltun Lagoon, have introduced new and presently under-studied sources of potential disturbance to western gray whales on their feeding grounds. Planned industrial development in other regions off eastern Sakhalin Island will also introduce potential sources of disturbance to gray whales as they migrate to and from their southern breeding grounds.

While data collected in 1997 and 1998 revealed subtle behavior shifts possibly related to industrial activity (Würsig *et al.* 1999, Würsig *et al.* 2000), the high level of annual return and seasonal site fidelity to the Piltun region suggest that whales have not been displaced from their summer feeding grounds by an increased anthropogenic presence. However, the noted northern distribution shift for many pods during 1999, in combination with the reported poor physical condition of some whales, are clearly points of potential concern.

Although it is presently impossible to determine the causal mechanisms responsible for the reported changes in distribution and physical condition, industrial influence cannot be ruled out. For example, the apparent northern shift in whale distribution may simply reflect naturally occurring fluctuations in gray whale prey distribution and abundance. Alternatively, this shift may

be related to presently undetected industry-related effects on the benthic biomass of the general area. Therefore, we recommend that benthic studies designed to obtain a baseline understanding of gray whale prey distribution and availability be implemented. Without proper baseline data regarding this topic, it would be difficult to determine the ecological impacts on the nearshore benthic community caused by a catastrophic industrial accident (e.g. oil spill). Similarly, the poor physical condition noted for several whales during 1999 may represent a natural phenomenon within the population; however, it is also possible that the deterioration in body condition is related to cumulative physiological stress correlated with long-term exposure to industrial variables such as underwater noise (Richardson *et al.* 1995). Therefore, we recommend that shore-based behavioral studies incorporating theodolite and focal observation techniques following those developed by Würsig *et al.* (1999, 2000) be conducted concurrent to continuous acoustic monitoring in order to evaluate the relationship between industrial activity and whale behavior.

Given the endangered status of the western gray whale population, we strongly recommend that the current research effort be continued to further monitor the health status, annual return, calf and adult survivorship, and crude birth rates, while at the same time expanding to incorporate studies on: behavioral reactions of whales to industrial noise including aircraft and vessel traffic; nearshore benthic habitat and prey communities; distribution and occurrence patterns of whales at broader spatial scales along the eastern Sakhalin coast; and local movement patterns and migratory routes to and from the Piltun area *via* radio and satellite telemetry.

## **ACKNOWLEDGEMENTS**

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## **APPENDIX 1**

Summary of major findings, mitigation strategies, and future research recommendations from studies conducted in 1997 and 1998 by Texas A&M University and Kamchatka Institute of Ecology and Nature Management.

## 1997 SUMMARY

- Aerial and vessel surveys suggested that while gray whales were detected to the north and south of Piltun Lagoon, the only major concentrations observed were located near the study site. These findings are in support of previous TINRO aerial and ship-based survey results which also reported that major concentrations of gray whales in the coastal waters of Sakhalin were observed predominately near Piltun Lagoon.
- Acoustic monitoring of geophysical survey activity revealed received sound levels from seismic pulses of approximately 153 dB re 1  $\mu$ Pa, zero-to-peak; 159 dB re 1  $\mu$ Pa, peak-to-peak; and 139 dB re 1  $\mu$ Pa, averaged over one second while the seismic survey vessel was 30-35 km from shore. These findings indicated that even at relatively large distances, seismic noise was detectable within the nearshore area that gray whales were typically located.
- Theodolite tracking determined that most pods were sighted within 6 km of shore. Intra-seasonal changes in pod distribution indicated that whales moved into deeper water as the summer season progressed. This distributional change suggested that pods may have remained closer to shore during seismic periods (July to mid-August) and shifted to more offshore waters (late-August to early-September) once seismic surveying was terminated.
- Shore-based scans counted 397 pods, with an average of 4.8 pods and 8.4 whales per scan. Scans collected during non-seismic, seismic, and post-seismic periods showed a trend of fewer pods being detected immediately after seismic periods than during non-seismic periods. This pattern suggested that pods began to shift their distribution out of the study site during periods of seismic noise, resulting in the lower whale numbers counted during the subsequent post-seismic condition.
- Photo-identification surveys identified 46 whales, and revealed high levels of seasonal site fidelity, and annual return of previously identified individuals. These occurrence patterns, in combination with the regular observation of several mother-calf pairs, emphasizes the importance of the Piltun area as a major feeding ground for at least part of the population.
- Theodolite tracks during focal observations detected changes in whale swim speeds and orientations relative to seismic sound. Alterations in leg speed, leg delta, and linearity indicated a trend of faster and straighter swimming over larger areas during seismic periods. We hypothesize that these behavioral changes may be indicative of disturbance to feeding behavior which is generally characterized by limited linear movement and a high degree of angular change between surfacings.
- Focal pod observations revealed that whales had the longest intervals between exhalations during non-seismic periods. The more rapid breathing rate detected during seismic and post-seismic periods is difficult to interpret but clearly indicates a fundamental physiological change which may or may not prove deleterious to individual whales.

## 1998 SUMMARY

- Aerial surveys suggested that gray whales generally remained within 5 km of shore, and were distributed mostly off the mouth of Piltun Lagoon, or to the north. These results support our shore-based observations during 1997 and 1998, and closely resemble earlier TINRO aerial and ship-based survey results that found large aggregations of gray whales predominantly near Piltun Lagoon. Further, the lack of sightings in waters surrounding the Sakhalinskaya and Molikpaq suggest that more offshore waters are probably not typical gray whale habitat. Based on these findings, and in order to minimize any potential disturbance impacts, we recommend that industry-related vessel and aircraft traffic remain outside the area of high whale numbers (see Fig. 14) between June and November (when whales are actively feeding) and maintain a minimum distance from shore of 8-10 km.
- Comparisons of benthic organisms collected near the Molikpaq, and prey items identified from gray whale feces showed nearly no overlap. This apparent discrepancy in species composition may explain the strong nearshore affinity of whales off Piltun. Thus, findings from benthic studies near the Molikpaq do not appear directly comparable to more nearshore regions, and therefore may not adequately characterize gray whale feeding habitat. The ecology of the nearshore benthic community off Piltun is poorly known. In order to assess changes in gray whale prey density and availability related to potential industrial impacts (e.g. oil spills), in addition to understanding naturally occurring seasonal and annual fluctuations, we recommend that detailed benthic studies be conducted in regions where gray whales are known to feed.
- Whales were present throughout the research period, but were especially low in numbers between 31 August and 5 September. This period of particularly low abundance overlapped precisely with the arrival of the Molikpaq and the associated 10-15 support vessels. While speculative, the noticeable but temporary decline in the number of whales in the study area at that time may have represented a short-term shift in distribution, resulting from unusually high industrial activity. The cumulative effects of such short-term responses over extended periods of time (e.g. year after year) are presently unresolved, and can only be assessed by additional long-term study. Therefore, we recommend that shore-based behavioral studies incorporating theodolite and focal observation techniques be conducted concurrent to continuous acoustic monitoring in order to evaluate the relationship between industrial activity and whale behavior.
- The mean numbers of pods and whales detected per scan were lower overall than those reported by our research team in 1997. Without further data, it is impossible to determine if this pattern represents a gradual decline in the number of whales returning to the area, perhaps as a result of increased industrial activity, or merely represents a natural annual fluctuation in abundance. These findings represent a point of potential concern, and we recommend that detailed shore-based studies of the kind described in this report be continued for at least several additional years to monitor this situation.
- Similar to the results obtained by the 1998 aerial surveys, theodolite-tracking determined that a majority of pods were sighted within 5 km of shore. Intra-seasonal changes in pod distribution indicated that whales moved into deeper water as the summer season progressed. This pattern was also documented in 1997, and may reflect a seasonal change in prey abundance and

availability. As stated above, in order to minimize any potential disturbance impacts from industry-related activities, we recommend that vessel and aircraft traffic remain outside the area of high whale numbers (see Fig. 14) between June and November (when whales are actively feeding) and maintain a minimum distance from shore of 8-10 km.

- Photo-identification surveys in 1998 identified 53 whales, with only six previously unidentified non-calves sighted. The asymptote in the rate at which new individuals were discovered, combined with high inter-annual resighting rates, suggest that the western population of gray whales may be smaller than previously estimated. The continued photographic monitoring of this population is an essential step in assessing the true population level, and is necessary for proper development of conservation policies. We recommend that this research program be continued, and closely coordinated with genetic studies to determine population identity and individual relationships. In addition, it would be of significant value to conduct photo-identification surveys along the entire eastern Sakhalin Island coast to determine if other gray whale feeding areas exist, and if gray whales identified off Piltun utilize such areas.
- Seven mother-calf pairs were identified during the 1998 field season, and the estimated crude birth rate for 1998 was approximately twice as high as that reported for 1997. Of the seven mothers identified in 1998, six were sighted in 1997 when they were newly-pregnant. Both lactating and pregnant females are under especially high energetic demands, probably making it imperative that they feed in regions capable of meeting their elevated metabolic requirements. The seasonal site fidelity and annual return of reproductive females reported here, combined with their need for high-quality habitat, suggest that the northeastern Sakhalin Island coast is of particular biological importance to this whale population. Therefore, we recommend that benthic studies designed to obtain a baseline understanding of gray whale prey distribution and availability be implemented. Without proper baseline data regarding this topic, it would be difficult to determine the ecological impacts, or lack thereof, on the nearshore benthic community caused by a catastrophic industrial accident (e.g. oil spill).

## **APPENDIX 2**

Sakhalin Energy Investment Company 1999 Scope of Work.



## **WORK ORDER NO. 01**

**This Work Order references Service Contract Number HAAEV, which provides for the issuance of Work Orders by Company, and is to be performed under the terms and conditions of said Contract and those contained herein.**

Work Order N0. 01, entered into by and between Sakhalin Energy Investment Company Ltd. and Texas A&M International Research Foundation, LLC (“Contractor”) is effective from the 1st day of May, 1999 and shall terminate on the 30th day of May, 2000.

### **Scope of Work to be Performed:**

1999 Marine Mammal Photo Identification.

Photographic studies of whales, particularly gray whales (*Eschrichtius robustus*) (a species of special concern in the area), are designed to provide information on the size of the local population (number of unique individuals using a local area) that may be present in some parts of the study area. This site-specific information will help in the interpretation of distribution and abundance information collected during the extensive and intensive aerial surveys.

Photo-identification surveys are best conducted from a boat on suitable days when weather and visibility are appropriate. Methods should ensure that whales are not disturbed (e.g., slow cautious approach) and procedures should be standardized from one session to the next to ensure optimum comparability of images. Methods should include the use of both 35-mm cameras using both color and high resolution black and white film, and the use of a high quality (preferably digital) video camera

### **Appendix 3**

Sighting records for whales photographically identified in 1999.

| Whale ID number | Aspect | Date    | Group number | Initial sighting location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface temperature |
|-----------------|--------|---------|--------------|----------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|-------------------------|
| 001             | R,L    | 6/29/99 | 3            | 52                                           | 52.529                                       | 143                                         | 21.229                                      |                   |                         |
| 001             | R,L,F  | 6/29/99 | 4            | 52                                           | 52.635                                       | 143                                         | 21.318                                      | 16.0              | 1.8 °C                  |
| 001             | R,L,F  | 8/9/99  | 9            | 52                                           | 56.627                                       | 143                                         | 20.863                                      | 15.0              | 15.1 °C                 |
| 002             | R,L    | 7/3/99  | 1            | 52                                           | 53.732                                       | 143                                         | 22.086                                      | 22.0              |                         |
| 002             | R,L    | 7/18/99 | 4            | 52                                           | 54.847                                       | 143                                         | 20.633                                      | 13.0              | 14.7 °C                 |
| 002             | R,L    | 7/29/99 | 6            | 52                                           | 54.924                                       | 143                                         | 21.051                                      | 17.5              |                         |
| 002             | L      | 7/29/99 | 12           | 52                                           | 54.916                                       | 143                                         | 20.436                                      | 16.5              |                         |
| 002             | R,L,F  | 8/3/99  | 3            | 52                                           | 48.339                                       | 143                                         | 22.316                                      | 14.5              | 10.3 °C                 |
| 002             | R      | 8/3/99  | 4            | 52                                           | 50.760                                       | 143                                         | 20.707                                      | 7.0               |                         |
| 002             | R      | 8/20/99 | 1            | 52                                           | 51.198                                       | 143                                         | 20.062                                      |                   |                         |
| 002             | R,L,F  | 8/22/99 | 9            | 52                                           | 55.914                                       | 143                                         | 20.843                                      | 14.5              |                         |
| 002             | R,L    | 8/22/99 | 12           | 52                                           | 57.697                                       | 143                                         | 22.413                                      | 23.0              |                         |
| 002             | R,L    | 8/22/99 | 14           | 52                                           | 58.186                                       | 143                                         | 21.396                                      | 20.0              |                         |
| 003             | R      | 6/29/99 | 2            | 52                                           | 53.287                                       | 143                                         | 21.293                                      | 16.0              |                         |
| 003             | R      | 7/3/99  | 1            | 52                                           | 53.732                                       | 143                                         | 22.086                                      | 22.0              |                         |
| 003             | R,L    | 7/6/99  | 1            | 52                                           | 50.854                                       | 143                                         | 21.315                                      | 12.5              |                         |
| 003             | R,L    | 7/9/99  | 1            | 52                                           | 49.784                                       | 143                                         | 21.956                                      | 16.5              |                         |
| 003             | R,L    | 7/9/99  | 3            | 52                                           | 51.363                                       | 143                                         | 22.081                                      | 18.5              |                         |
| 003             | R,L    | 7/11/99 | 1            | 52                                           | 50.620                                       | 143                                         | 21.018                                      | 9.0               | 7.8 °C                  |
| 003             | R,F    | 7/11/99 | 5            | 52                                           | 52.147                                       | 143                                         | 21.922                                      | 17.5              |                         |
| 003             | L      | 7/11/99 | 6            | 52                                           | 51.789                                       | 143                                         | 21.723                                      | 15.5              | 7.1 °C                  |
| 003             | R,F    | 7/13/99 | 2            | 52                                           | 52.410                                       | 143                                         | 21.739                                      | 16.5              |                         |
| 003             | R      | 7/13/99 | 3            | 52                                           | 53.839                                       | 143                                         | 23.391                                      | 19.0              | 10.9 °C                 |
| 003             | R,L    | 7/20/99 | 6            | 52                                           | 53.380                                       | 143                                         | 20.730                                      | 13.0              | 7.5 °C                  |
| 003             | R      | 7/24/99 | 2            | 52                                           | 53.317                                       | 143                                         | 20.956                                      | 13.0              |                         |
| 003             | L      | 7/25/99 | 2            | 52                                           | 51.685                                       | 143                                         | 21.751                                      | 16.0              |                         |
| 003             | L,F    | 7/28/99 | 3            | 52                                           | 55.208                                       | 143                                         | 21.017                                      | 15.5              |                         |
| 003             | R,L,F  | 7/28/99 | 4            | 52                                           | 55.647                                       | 143                                         | 21.104                                      | 16.5              | 4.2 °C                  |
| 003             | R,L,F  | 7/29/99 | 2            | 52                                           | 53.454                                       | 143                                         | 21.304                                      | 15.0              |                         |
| 003             | L,F    | 7/29/99 | 5            | 52                                           | 54.631                                       | 143                                         | 21.068                                      | 14.5              |                         |
| 003             | L      | 7/29/99 | 12           | 52                                           | 54.916                                       | 143                                         | 20.436                                      | 16.5              |                         |
| 003             | R,L,F  | 8/3/99  | 3            | 52                                           | 48.339                                       | 143                                         | 22.316                                      | 14.5              | 10.3 °C                 |
| 003             | R      | 8/9/99  | 3            | 52                                           | 51.987                                       | 143                                         | 22.260                                      | 16.0              |                         |
| 003             | R,L    | 8/9/99  | 4            | 52                                           | 53.239                                       | 143                                         | 21.341                                      | 14.0              |                         |
| 003             | R      | 8/9/99  | 9            | 52                                           | 56.627                                       | 143                                         | 20.863                                      | 15.0              | 15.1 °C                 |
| 003             | R,L    | 8/10/99 | 1            | 52                                           | 50.488                                       | 143                                         | 20.954                                      | 7.1               |                         |
| 003             | R,L    | 8/22/99 | 9            | 52                                           | 55.914                                       | 143                                         | 20.843                                      | 14.5              |                         |
| 004             | R,L    | 7/3/99  | 6            | 52                                           | 52.271                                       | 143                                         | 20.922                                      | 11.0              |                         |
| 004             | L      | 7/6/99  | 1            | 52                                           | 50.854                                       | 143                                         | 21.315                                      | 12.5              |                         |

| Whale ID number | Aspect | Date    | Group number | Initial sighting location (degrees north) | Initial sighting location (minutes north) | Initial sighting location (degrees east) | Initial sighting location (minutes east) | Initial Depth (m) | Sea surface temperature |
|-----------------|--------|---------|--------------|-------------------------------------------|-------------------------------------------|------------------------------------------|------------------------------------------|-------------------|-------------------------|
| 004             | R,L,F  | 7/8/99  | 3            | 52                                        | 51.114                                    | 143                                      | 21.424                                   | 13.0              | 4.3 °C                  |
| 004             | L      | 7/9/99  | 1            | 52                                        | 49.784                                    | 143                                      | 21.956                                   | 16.5              |                         |
| 004             | R      | 7/13/99 | 2            | 52                                        | 52.410                                    | 143                                      | 21.739                                   | 16.5              |                         |
| 004             | R,L    | 7/13/99 | 3            | 52                                        | 53.839                                    | 143                                      | 23.391                                   | 19.0              | 10.9 °C                 |
| 004             | R,L,F  | 7/14/99 | 2            | 52                                        | 50.729                                    | 143                                      | 21.602                                   | 16.5              | 9.2 °C                  |
| 004             | R,L    | 7/15/99 | 3            | 52                                        | 51.884                                    | 143                                      | 20.884                                   | 7.5               | 7.8 °C                  |
| 004             | R,L    | 7/16/99 | 3            | 52                                        | 52.692                                    | 143                                      | 20.641                                   | 11.5              | 4.9 °C                  |
| 004             | R,L    | 7/18/99 | 4            | 52                                        | 54.847                                    | 143                                      | 20.633                                   | 13.0              | 14.7 °C                 |
| 004             | R,L    | 7/20/99 | 4            | 52                                        | 53.137                                    | 143                                      | 20.654                                   | 12.0              |                         |
| 004             | L      | 7/29/99 | 12           | 52                                        | 54.916                                    | 143                                      | 20.436                                   | 16.5              |                         |
| 004             | R,L    | 8/4/99  | 1            | 52                                        | 51.169                                    | 143                                      | 21.068                                   |                   |                         |
| 004             | R,F    | 8/22/99 | 17           | 53                                        | 01.803                                    | 143                                      | 19.115                                   | 14.0              |                         |
| 004             | R,L    | 9/4/99  | 3            | 52                                        | 47.487                                    | 143                                      | 23.449                                   | 18.0              | 9.2 °C                  |
| 004             | R,L    | 9/4/99  | 5            | 52                                        | 52.893                                    | 143                                      | 22.179                                   | 15.5              |                         |
| 004             | R      | 9/5/99  | 2            | 52                                        | 50.730                                    | 143                                      | 21.683                                   | 15.5              |                         |
| 004             | R      | 9/6/99  | 2            | 52                                        | 57.806                                    | 143                                      | 20.135                                   | 13.0              | 9.6 °C                  |
| 004             | L,F    | 9/6/99  | 3            | 52                                        | 59.579                                    | 143                                      | 19.695                                   | 14.5              |                         |
| 004             | L      | 9/13/99 | 6            | 52                                        | 52.952                                    | 143                                      | 21.469                                   | 16.0              |                         |
| 004             | R      | 9/13/99 | 8            | 52                                        | 52.697                                    | 143                                      | 21.447                                   |                   |                         |
| 004             | L      | 9/17/99 | 3            | 52                                        | 51.431                                    | 143                                      | 23.093                                   | 20.0              |                         |
| 004             | R,L    | 9/17/99 | 8            | 52                                        | 48.652                                    | 143                                      | 21.561                                   | 9.7               |                         |
| 004             | R      | 10/4/99 | 1            | 52                                        | 55.294                                    | 143                                      | 20.618                                   | 12.5              | 8.4 °C                  |
| 004             | R      | 10/5/99 | 1            | 52                                        | 49.025                                    | 143                                      | 21.191                                   | 11.5              |                         |
| 004             | L      | 10/6/99 | 5            | 53                                        | 10.416                                    | 143                                      | 18.023                                   | 16.0              |                         |
| 004             | R      | 10/6/99 | 10           | 53                                        | 07.305                                    | 143                                      | 16.772                                   | 6.0               |                         |
| 004             | L      | 10/7/99 | 1            | 52                                        | 49.976                                    | 143                                      | 21.648                                   | 16.0              |                         |
| 004             | R      | 10/8/99 | 3            | 52                                        | 48.659                                    | 143                                      | 21.484                                   | 9.0               |                         |
| 005             | R,F    | 7/28/99 | 1            | 52                                        | 50.288                                    | 143                                      | 21.629                                   | 15.5              |                         |
| 005             | R,L    | 7/29/99 | 7            | 52                                        | 54.982                                    | 143                                      | 20.651                                   | 13.5              |                         |
| 005             | L,F    | 7/29/99 | 12           | 52                                        | 54.916                                    | 143                                      | 20.436                                   | 16.5              |                         |
| 005             | L,F    | 8/7/99  | 2            | 52                                        | 51.151                                    | 143                                      | 21.870                                   | 17.0              | 7.6 °C                  |
| 005             | R,F    | 8/7/99  | 3            | 52                                        | 52.707                                    | 143                                      | 21.002                                   | 12.5              |                         |
| 005             | R,F    | 8/7/99  | 5            | 52                                        | 55.711                                    | 143                                      | 20.797                                   | 14.0              |                         |
| 006             | R,L    | 7/8/99  | 2            | 52                                        | 54.292                                    | 143                                      | 19.771                                   | 6.1               | 1.6 °C                  |
| 006             | R      | 7/20/99 | 7            | 52                                        | 54.651                                    | 143                                      | 20.707                                   | 13.5              |                         |
| 006             | L      | 7/23/99 | 3            | 52                                        | 50.208                                    | 143                                      | 21.636                                   | 17.0              |                         |
| 006             | R,L    | 7/23/99 | 5            | 52                                        | 50.892                                    | 143                                      | 21.455                                   | 14.0              | 15.8 °C                 |
| 006             | R,L    | 7/29/99 | 10           | 53                                        | 00.732                                    | 143                                      | 19.679                                   | 15.5              |                         |

| Whale ID number | Aspect | Date    | Group number | Initial sighting location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface temperature |
|-----------------|--------|---------|--------------|----------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|-------------------------|
| 006             | R,L,F  | 8/3/99  | 1            | 52                                           | 47.758                                       | 143                                         | 21.475                                      | 10.5              |                         |
| 006             | R      | 8/3/99  | 2            | 52                                           | 47.281                                       | 143                                         | 21.862                                      | 13.5              |                         |
| 006             | R      | 8/20/99 | 16           | 52                                           | 57.509                                       | 143                                         | 19.547                                      | 10.5              |                         |
| 006             | R,L    | 8/20/99 | 17           | 52                                           | 58.076                                       | 143                                         | 19.507                                      | 11.5              |                         |
| 006             | R,F    | 8/20/99 | 18           | 52                                           | 58.643                                       | 143                                         | 19.615                                      | 13.5              |                         |
| 006             | R,L    | 8/22/99 | 22           |                                              |                                              |                                             |                                             | 10.5              |                         |
| 006             | L      | 8/26/99 | 3            | 52                                           | 49.556                                       | 143                                         | 21.527                                      | 12.0              |                         |
| 006             | R,L    | 8/26/99 | 8            | 52                                           | 50.385                                       | 143                                         | 21.772                                      | 15.5              |                         |
| 006             | R,L    | 8/30/99 | 2            | 52                                           | 48.409                                       | 143                                         | 21.081                                      | 7.5               |                         |
| 006             | R,L    | 9/19/99 | 2            | 52                                           | 53.017                                       | 143                                         | 21.295                                      | 14.5              |                         |
| 006             | R,L    | 9/25/99 | 12           | 53                                           | 13.127                                       | 143                                         | 16.337                                      | 12.0              |                         |
| 006             | R,L    | 9/25/99 | 16           | 53                                           | 12.143                                       | 143                                         | 16.028                                      | 7.5               |                         |
| 007             | R,L,F  | 8/7/99  | 1            | 52                                           | 50.357                                       | 143                                         | 21.576                                      | 16.5              | 7.6 °C                  |
| 007             | R,L,F  | 8/7/99  | 2            | 52                                           | 51.151                                       | 143                                         | 21.870                                      | 17.0              |                         |
| 007             | R,L    | 8/8/99  | 2            | 52                                           | 49.411                                       | 143                                         | 21.249                                      | 14.5              |                         |
| 007             | R,L,F  | 8/9/99  | 6            | 52                                           | 54.308                                       | 143                                         | 20.498                                      | 11.5              |                         |
| 007             | R,L,F  | 8/9/99  | 8            |                                              |                                              |                                             |                                             | 11.0              |                         |
| 007             | R,L,F  | 8/22/99 | 9            | 52                                           | 55.914                                       | 143                                         | 20.843                                      | 14.5              |                         |
| 007             | R,L    | 8/22/99 | 12           | 52                                           | 57.697                                       | 143                                         | 22.413                                      | 23.0              |                         |
| 007             | L,F    | 8/22/99 | 19           | 52                                           | 57.028                                       | 143                                         | 19.537                                      | 10.5              |                         |
| 007             | R      | 8/26/99 | 6            | 52                                           | 50.461                                       | 143                                         | 21.468                                      | 14.5              | 12.0 °C                 |
| 007             | R,L    | 9/17/99 | 8            | 52                                           | 48.652                                       | 143                                         | 21.561                                      | 9.7               |                         |
| 007             | L      | 9/22/99 | 7            | 52                                           | 58.381                                       | 143                                         | 20.243                                      | 14.0              |                         |
| 007             | L      | 9/25/99 | 12           | 53                                           | 13.127                                       | 143                                         | 16.337                                      | 12.0              |                         |
| 007             | L      | 9/25/99 | 16           | 53                                           | 12.143                                       | 143                                         | 16.028                                      | 7.5               |                         |
| 007             | R,F    | 10/6/99 | 3            | 53                                           | 08.470                                       | 143                                         | 17.379                                      | 11.0              |                         |
| 007             | R,F    | 10/7/99 | 5            | 52                                           | 57.235                                       | 143                                         | 20.005                                      | 12.5              |                         |
| 007             | R,L,F  | 10/8/99 | 4            | 52                                           | 48.633                                       | 143                                         | 21.325                                      | 8.2               |                         |
| 009             | R,F    | 7/14/99 | 3            | 52                                           | 53.048                                       | 143                                         | 21.191                                      | 14.5              |                         |
| 009             | F      | 7/14/99 | 4            | 52                                           | 52.851                                       | 143                                         | 21.552                                      | 16.0              | 8.9 °C                  |
| 009             | R,L    | 7/15/99 | 2            | 52                                           | 51.917                                       | 143                                         | 20.743                                      | 12.0              |                         |
| 009             | R,L    | 7/16/99 | 3            | 52                                           | 52.692                                       | 143                                         | 20.641                                      | 11.5              | 4.9 °C                  |
| 009             | R,L    | 7/20/99 | 3            | 52                                           | 53.011                                       | 143                                         | 20.691                                      | 12.0              |                         |
| 009             | R      | 7/24/99 | 6            | 52                                           | 58.218                                       | 143                                         | 19.588                                      | 12.0              | 16.1 °C                 |
| 009             | L      | 7/25/99 | 3            | 52                                           | 51.718                                       | 143                                         | 21.418                                      | 13.5              |                         |
| 009             | R,L    | 7/25/99 | 4            | 52                                           | 51.574                                       | 143                                         | 21.239                                      | 13.0              |                         |
| 009             | R,L,F  | 8/7/99  | 3            | 52                                           | 52.707                                       | 143                                         | 21.002                                      | 12.5              |                         |
| 009             | L      | 8/7/99  |              |                                              |                                              |                                             |                                             |                   |                         |
| 009             | R,L    | 8/16/99 | 7            | 52                                           | 53.455                                       | 143                                         | 20.375                                      |                   |                         |

| Whale ID<br>number | Aspect | Date     | Group<br>number | Initial sighting<br>location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface<br>temperature |
|--------------------|--------|----------|-----------------|-------------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|----------------------------|
| 009                | R,L    | 8/25/99  | 4               | 52                                              | 53.949                                       | 143                                         | 20.637                                      | 11.5              |                            |
| 009                | L      | 8/26/99  | 9               | 52                                              | 50.939                                       | 143                                         | 21.380                                      | 12.5              |                            |
| 009                | R      | 9/4/99   | 2               | 52                                              | 49.683                                       | 143                                         | 22.154                                      | 11.0              |                            |
| 009                | L      | 9/4/99   | 10              | 52                                              | 52.743                                       | 143                                         | 20.946                                      | 12.0              |                            |
| 009                | R      | 9/13/99  | 4               | 52                                              | 52.832                                       | 143                                         | 20.945                                      | 13.5              |                            |
| 009                | L,F    | 9/25/99  | 7               | 52                                              | 59.307                                       | 143                                         | 19.820                                      | 13.0              |                            |
| 009                | R      | 9/29/99  | 3               | 52                                              | 52.061                                       | 143                                         | 20.908                                      | 12.0              |                            |
| 009                | L      | 10/11/99 | 6               | 52                                              | 59.202                                       | 143                                         | 19.552                                      | 14.0              | 6.6 °C                     |
| 010                | R,L    | 7/11/99  | 6               | 52                                              | 51.789                                       | 143                                         | 21.723                                      | 15.5              | 7.1 °C                     |
| 010                | R,L    | 7/23/99  | 6               | 52                                              | 51.053                                       | 143                                         | 21.673                                      | 16.0              |                            |
| 010                | L      | 8/20/99  | 2               | 52                                              | 51.171                                       | 143                                         | 21.845                                      | 16.5              |                            |
| 010                | R,L    | 8/20/99  | 3               | 52                                              | 50.886                                       | 143                                         | 21.709                                      | 15.5              | 12.9 °C                    |
| 010                | R,L,F  | 8/20/99  | 5               | 52                                              | 51.179                                       | 143                                         | 21.970                                      | 17.5              |                            |
| 010                | R,L    | 8/22/99  | 8               | 52                                              | 55.944                                       | 143                                         | 20.629                                      | 13.5              |                            |
| 010                | R,L    | 8/24/99  | 5               | 52                                              | 54.360                                       | 143                                         | 20.488                                      | 11.5              |                            |
| 010                | R,L,F  | 8/25/99  | 6               | 52                                              | 53.374                                       | 143                                         | 19.898                                      | 9.5               |                            |
| 010                | R,L    | 8/26/99  | 9               | 52                                              | 50.939                                       | 143                                         | 21.380                                      | 12.5              |                            |
| 010                | R,F    | 8/30/99  | 4               | 52                                              | 53.159                                       | 143                                         | 20.942                                      | 13.0              | 12.8 °C                    |
| 010                | R,L    | 9/2/99   | 3               | 52                                              | 53.825                                       | 143                                         | 20.267                                      | 11.0              |                            |
| 010                | L      | 9/13/99  | 1               | 52                                              | 50.299                                       | 143                                         | 21.787                                      | 17.5              |                            |
| 010                | R,L    | 9/13/99  | 3               | 52                                              | 52.537                                       | 143                                         | 21.049                                      | 13.0              |                            |
| 010                | L      | 9/13/99  | 5               | 52                                              | 52.877                                       | 143                                         | 20.863                                      | 13.0              |                            |
| 010                | R      | 9/13/99  | 6               | 52                                              | 52.952                                       | 143                                         | 21.469                                      | 16.0              |                            |
| 010                | R      | 9/17/99  | 9               | 52                                              | 48.749                                       | 143                                         | 21.521                                      |                   |                            |
| 010                | L,F    | 9/22/99  | 1               | 52                                              | 50.312                                       | 143                                         | 22.307                                      |                   |                            |
| 010                | R,L    | 10/6/99  | 7               | 53                                              | 13.003                                       | 143                                         | 16.340                                      | 11.0              | 7.4 °C                     |
| 010                | R,L    | 10/7/99  | 6               | 53                                              | 12.900                                       | 143                                         | 16.219                                      | 11.5              |                            |
| 010                | L      | 10/11/99 | 7               | 53                                              | 13.448                                       | 143                                         | 16.501                                      | 14.0              |                            |
| 010                | R,L    | 10/11/99 | 8               | 53                                              | 13.466                                       | 143                                         | 16.325                                      | 14.0              |                            |
| 011                | R,L    | 7/9/99   | 4               | 52                                              | 55.080                                       | 143                                         | 21.203                                      | 16.0              | 4.0 °C                     |
| 011                | R,L,F  | 7/9/99   | 5               | 52                                              | 53.415                                       | 143                                         | 21.556                                      | 15.5              | 5.6 °C                     |
| 011                | R,L    | 7/11/99  | 8               | 52                                              | 52.992                                       | 143                                         | 21.044                                      | 12.5              | 7.4 °C                     |
| 011                | R      | 7/11/99  | 10              | 52                                              | 52.409                                       | 143                                         | 21.112                                      | 12.0              |                            |
| 011                | R      | 7/14/99  | 3               | 52                                              | 53.048                                       | 143                                         | 21.191                                      | 14.5              |                            |
| 011                | R,L,F  | 7/14/99  | 4               | 52                                              | 52.851                                       | 143                                         | 21.552                                      | 16.0              | 8.9 °C                     |
| 011                | R,L    | 7/15/99  | 2               | 52                                              | 51.917                                       | 143                                         | 20.743                                      | 12.0              |                            |
| 011                | R,L    | 7/16/99  | 2               | 52                                              | 51.512                                       | 143                                         | 21.510                                      | 14.5              | 5.1 °C                     |
| 011                | R,L    | 7/18/99  | 4               | 52                                              | 54.847                                       | 143                                         | 20.633                                      | 13.0              | 14.7 °C                    |
| 011                | R,L    | 7/23/99  | 5               | 52                                              | 50.892                                       | 143                                         | 21.455                                      | 14.0              | 15.8 °C                    |

| Whale ID<br>number | Aspect | Date    | Group<br>number | Initial sighting<br>location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface<br>temperature |
|--------------------|--------|---------|-----------------|-------------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|----------------------------|
| 011                | L      | 7/23/99 | 6               | 52                                              | 51.053                                       | 143                                         | 21.673                                      | 16.0              |                            |
| 011                | R,L    | 8/8/99  | 1               | 52                                              | 49.746                                       | 143                                         | 21.405                                      | 15.5              |                            |
| 011                | R,L    | 8/8/99  | 6               | 52                                              | 50.673                                       | 143                                         | 21.286                                      | 12.0              |                            |
| 011                | L      | 8/8/99  | 7               | 52                                              | 50.367                                       | 143                                         | 21.799                                      | 16.0              |                            |
| 011                | R      | 8/9/99  | 5               | 52                                              | 53.108                                       | 143                                         | 20.850                                      | 12.0              |                            |
| 011                | R,L    | 8/10/99 | 3               | 52                                              | 50.983                                       | 143                                         | 21.075                                      | 10.0              |                            |
| 011                | R,L    | 8/10/99 | 4               | 52                                              | 51.688                                       | 143                                         | 20.681                                      | 9.0               |                            |
| 011                | R,L    | 8/20/99 | 4               | 52                                              | 50.960                                       | 143                                         | 21.072                                      | 10.5              |                            |
| 011                | R      | 8/23/99 | 6               | 52                                              | 52.920                                       | 143                                         | 20.880                                      | 11.5              |                            |
| 011                | R,L    | 8/24/99 | 10              | 52                                              | 56.197                                       | 143                                         | 20.184                                      | 11.5              |                            |
| 011                | R,L    | 8/25/99 | 6               | 52                                              | 53.374                                       | 143                                         | 19.898                                      | 9.5               |                            |
| 011                | R,L    | 9/4/99  | 3               | 52                                              | 47.487                                       | 143                                         | 23.449                                      | 18.0              | 9.2 °C                     |
| 011                | R      | 9/4/99  | 7               |                                                 |                                              |                                             |                                             | 6.7               |                            |
| 011                | R      | 9/4/99  | 9               | 52                                              | 49.994                                       | 143                                         | 21.493                                      | 16.5              |                            |
| 011                | R      | 9/19/99 | 4               | 52                                              | 53.096                                       | 143                                         | 20.734                                      | 12.0              |                            |
| 011                | L      | 9/19/99 | 8               | 52                                              | 53.334                                       | 143                                         | 20.591                                      | 11.5              |                            |
| 011                | R,L    | 9/21/99 | 3               | 52                                              | 51.770                                       | 143                                         | 21.068                                      | 12.0              |                            |
| 011                | R      | 9/22/99 | 2               | 52                                              | 52.101                                       | 143                                         | 21.185                                      | 12.0              |                            |
| 011                | L      | 9/22/99 |                 |                                                 |                                              |                                             |                                             |                   |                            |
| 011                | R      | 9/25/99 | 4               | 52                                              | 53.435                                       | 143                                         | 20.678                                      | 12.0              |                            |
| 012                | R,L,F  | 7/14/99 | 1               | 52                                              | 49.661                                       | 143                                         | 21.642                                      | 14.0              |                            |
| 012                | R,L    | 7/14/99 | 2               | 52                                              | 50.729                                       | 143                                         | 21.602                                      | 16.5              | 9.2 °C                     |
| 012                | R,L,F  | 7/14/99 | 4               | 52                                              | 52.851                                       | 143                                         | 21.552                                      | 16.0              | 8.9 °C                     |
| 012                | R,L,F  | 7/24/99 | 6               | 52                                              | 58.218                                       | 143                                         | 19.588                                      | 12.0              | 16.1 °C                    |
| 012                | R      | 7/27/99 | 7               | 52                                              | 55.844                                       | 143                                         | 19.921                                      | 10.5              | 3.6 °C                     |
| 012                | R,L,F  | 7/28/99 | 2               | 52                                              | 51.138                                       | 143                                         | 21.762                                      | 15.5              |                            |
| 012                | R,F    | 8/3/99  | 3               | 52                                              | 48.339                                       | 143                                         | 22.316                                      | 14.5              | 10.3 °C                    |
| 012                | R,L,F  | 8/7/99  | 5               | 52                                              | 55.711                                       | 143                                         | 20.797                                      | 14.0              |                            |
| 012                | L      | 8/7/99  | 6               | 52                                              | 57.290                                       | 143                                         | 20.698                                      | 15.5              | 9.6 °C                     |
| 012                | R,L    | 8/9/99  | 8               |                                                 |                                              |                                             |                                             | 11.0              |                            |
| 012                | R,F    | 8/10/99 | 8               | 52                                              | 53.198                                       | 143                                         | 20.731                                      | 12.0              |                            |
| 012                | R,L,F  | 8/16/99 | 6               | 52                                              | 52.911                                       | 143                                         | 20.404                                      | 10.0              |                            |
| 012                | R,L,F  | 8/20/99 | 13              | 52                                              | 55.480                                       | 143                                         | 19.996                                      | 10.5              |                            |
| 012                | R,F    | 8/20/99 | 14              | 52                                              | 56.381                                       | 143                                         | 19.443                                      |                   | 11.9 °C                    |
| 012                | L,F    | 8/22/99 | 4               | 52                                              | 54.444                                       | 143                                         | 21.159                                      | 14.5              |                            |
| 012                | L,F    | 8/24/99 | 13              | 52                                              | 56.214                                       | 143                                         | 20.572                                      | 12.0              | 11.9 °C                    |
| 013                | R,L    | 7/18/99 | 2               | 52                                              | 49.887                                       | 143                                         | 21.842                                      | 14.5              | 14.4 °C                    |
| 013                | R,L    | 7/18/99 | 3               | 52                                              | 52.024                                       | 143                                         | 23.143                                      | 20.0              |                            |
| 013                | R,L    | 7/29/99 | 10              | 53                                              | 00.732                                       | 143                                         | 19.679                                      | 15.5              |                            |

| Whale ID number | Aspect | Date    | Group number | Initial sighting location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface temperature |
|-----------------|--------|---------|--------------|----------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|-------------------------|
| 013             | R,L,F  | 8/16/99 | 7            | 52                                           | 53.455                                       | 143                                         | 20.375                                      |                   |                         |
| 013             | R,L,F  | 8/25/99 | 5            | 52                                           | 54.622                                       | 143                                         | 20.670                                      | 12.5              |                         |
| 013             | R,L    | 8/26/99 | 5            | 52                                           | 50.757                                       | 143                                         | 22.027                                      | 15.0              |                         |
| 013             | R,L    | 8/26/99 | 10           | 52                                           | 52.354                                       | 143                                         | 21.430                                      | 13.0              |                         |
| 013             | L      | 8/30/99 | 6            | 52                                           | 56.362                                       | 143                                         | 20.077                                      | 11.5              |                         |
| 013             | R,L    | 9/4/99  | 16           | 53                                           | 04.881                                       | 143                                         | 18.265                                      | 13.0              | 5.4 °C                  |
| 013             | R      | 9/22/99 | 8            | 53                                           | 04.137                                       | 143                                         | 19.208                                      | 15.0              |                         |
| 013             | R,L    | 9/25/99 | 11           | 53                                           | 12.258                                       | 143                                         | 17.769                                      | 19.5              |                         |
| 014             | R,F    | 7/28/99 | 1            | 52                                           | 50.288                                       | 143                                         | 21.629                                      | 15.5              |                         |
| 015             | R,L    | 6/29/99 | 1            | 52                                           | 53.720                                       | 143                                         | 20.677                                      | 12.0              | 2.0 °C                  |
| 015             | R      | 6/29/99 | 3            | 52                                           | 52.529                                       | 143                                         | 21.229                                      |                   |                         |
| 015             | R,L    | 7/3/99  | 5            | 52                                           | 51.247                                       | 143                                         | 21.531                                      | 12.5              |                         |
| 015             | R,L    | 7/8/99  | 1            | 52                                           | 52.097                                       | 143                                         | 19.813                                      | 5.6               |                         |
| 015             | R      | 7/23/99 | 4            | 52                                           | 49.943                                       | 143                                         | 22.053                                      | 13.0              |                         |
| 015             | R,L    | 7/24/99 | 1            | 52                                           | 51.587                                       | 143                                         | 21.400                                      | 13.0              | 15.0 °C                 |
| 015             | L      | 7/24/99 | 10           | 52                                           | 50.005                                       | 143                                         | 21.672                                      | 16.5              |                         |
| 015             | L      | 7/25/99 | 1            | 52                                           | 50.139                                       | 143                                         | 21.774                                      | 16.5              |                         |
| 015             | R      | 7/27/99 | 1            | 52                                           | 49.859                                       | 143                                         | 22.107                                      | 12.5              |                         |
| 015             | R      | 7/28/99 | 1            | 52                                           | 50.288                                       | 143                                         | 21.629                                      | 15.5              |                         |
| 015             | L      | 8/8/99  | 1            | 52                                           | 49.746                                       | 143                                         | 21.405                                      | 15.5              |                         |
| 015             | L      | 8/9/99  | 1            | 52                                           | 50.258                                       | 143                                         | 21.554                                      | 16.5              |                         |
| 015             | R,L    | 8/22/99 | 3            | 52                                           | 53.058                                       | 143                                         | 20.933                                      | 12.5              | 11.0 °C                 |
| 015             | R      | 8/22/99 | 24           | 52                                           | 50.377                                       | 143                                         | 21.801                                      | 17.0              |                         |
| 015             | R,L    | 8/23/99 | 3            | 52                                           | 50.031                                       | 143                                         | 21.857                                      | 14.5              |                         |
| 015             | R,L    | 8/25/99 | 1            | 52                                           | 51.173                                       | 143                                         | 21.357                                      | 12.0              |                         |
| 015             | L      | 8/26/99 | 1            | 52                                           | 50.397                                       | 143                                         | 21.899                                      | 16.0              |                         |
| 015             | R      | 8/26/99 | 4            | 52                                           | 50.537                                       | 143                                         | 21.792                                      | 15.5              |                         |
| 015             | L      | 8/26/99 | 8            | 52                                           | 50.385                                       | 143                                         | 21.772                                      | 15.5              |                         |
| 015             | R      | 9/4/99  | 1            | 52                                           | 49.308                                       | 143                                         | 22.551                                      | 14.5              |                         |
| 015             | R      | 9/4/99  | 13           | 53                                           | 00.188                                       | 143                                         | 19.871                                      | 18.0              |                         |
| 015             | R      | 9/15/99 | 5            | 52                                           | 49.382                                       | 143                                         | 21.353                                      | 15.0              | 12.2 °C                 |
| 015             | R      | 9/17/99 | 2            |                                              |                                              |                                             |                                             |                   | 11.7 °C                 |
| 015             | R      | 9/17/99 | 7            | 52                                           | 50.161                                       | 143                                         | 21.790                                      | 16.5              |                         |
| 015             | R,L    | 9/22/99 | 4            | 52                                           | 52.630                                       | 143                                         | 22.344                                      | 18.0              |                         |
| 015             | R,L    | 9/25/99 | 1            | 52                                           | 51.466                                       | 143                                         | 21.664                                      | 15.5              | 9.9 °C                  |
| 015             | R,L    | 10/5/99 | 3            | 52                                           | 51.360                                       | 143                                         | 20.940                                      | 10.5              |                         |
| 015             | L      | 10/6/99 | 1            | 52                                           | 50.668                                       | 143                                         | 21.933                                      | 16.5              |                         |
| 015             | R,L    | 10/7/99 | 1            | 52                                           | 49.976                                       | 143                                         | 21.648                                      | 16.0              |                         |
| 015             | R      | 10/8/99 | 1            | 52                                           | 50.148                                       | 143                                         | 22.041                                      | 14.5              |                         |



| Whale ID number | Aspect | Date     | Group number | Initial sighting location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface temperature |
|-----------------|--------|----------|--------------|----------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|-------------------------|
| 015             | L      | 10/9/99  | 2            | 52                                           | 49.856                                       | 143                                         | 21.509                                      | 16.5              | 6.9 °C                  |
| 015             | R      | 10/11/99 | 1            | 52                                           | 49.773                                       | 143                                         | 21.431                                      | 16.0              |                         |
| 015             | R      | 10/13/99 | 2            | 52                                           | 49.792                                       | 143                                         | 21.396                                      | 16.5              |                         |
| 016             | R,L    | 7/3/99   | 2            | 52                                           | 53.158                                       | 143                                         | 21.447                                      | 16.5              |                         |
| 016             | R      | 7/3/99   | 8            | 52                                           | 52.735                                       | 143                                         | 23.067                                      | 15.5              | 4.3 °C                  |
| 016             | R      | 7/6/99   | 1            | 52                                           | 50.854                                       | 143                                         | 21.315                                      | 12.5              |                         |
| 016             | L      | 7/8/99   | 3            | 52                                           | 51.114                                       | 143                                         | 21.424                                      | 13.0              |                         |
| 016             | R,L    | 7/9/99   | 4            | 52                                           | 55.080                                       | 143                                         | 21.203                                      | 16.0              |                         |
| 016             | R,L    | 7/16/99  | 1            | 52                                           | 51.405                                       | 143                                         | 21.803                                      | 17.0              | 4.0 °C                  |
| 016             | L      | 7/20/99  | 10           | 52                                           | 57.955                                       | 143                                         | 20.258                                      | 15.0              |                         |
| 016             | R,L    | 8/24/99  | 2            | 52                                           | 51.023                                       | 143                                         | 23.270                                      | 21.0              |                         |
| 016             | R,L    | 8/26/99  | 5            | 52                                           | 50.757                                       | 143                                         | 22.027                                      | 15.0              |                         |
| 016             | L      | 9/15/99  | 2            |                                              |                                              |                                             |                                             |                   |                         |
| 016             | R      | 9/19/99  | 8            | 52                                           | 53.334                                       | 143                                         | 20.591                                      | 11.5              |                         |
| 016             | R,L    | 10/6/99  | 2            | 53                                           | 06.668                                       | 143                                         | 18.261                                      | 13.0              |                         |
| 016             | L      | 10/11/99 | 5            | 52                                           | 59.511                                       | 143                                         | 18.735                                      | 9.5               |                         |
| 017             | R,L    | 7/8/99   | 2            | 52                                           | 54.292                                       | 143                                         | 19.771                                      | 6.1               | 1.6 °C                  |
| 017             | R      | 7/20/99  | 7            | 52                                           | 54.651                                       | 143                                         | 20.707                                      | 13.5              |                         |
| 017             | R,L    | 7/24/99  | 8            | 52                                           | 59.982                                       | 143                                         | 21.156                                      | 21.0              |                         |
| 017             | R,L    | 7/27/99  | 4            | 52                                           | 54.602                                       | 143                                         | 22.455                                      | 22.0              |                         |
| 017             | R,L    | 7/27/99  | 8            | 52                                           | 57.436                                       | 143                                         | 20.371                                      | 14.0              |                         |
| 017             | L      | 8/3/99   | 1            | 52                                           | 47.758                                       | 143                                         | 21.475                                      | 10.5              |                         |
| 017             | R,L    | 8/3/99   | 3            | 52                                           | 48.339                                       | 143                                         | 22.316                                      | 14.5              |                         |
| 017             | R,L    | 8/22/99  | 11           | 52                                           | 56.745                                       | 143                                         | 23.048                                      | 21.0              |                         |
| 017             | R,L    | 8/22/99  | 13           | 52                                           | 57.721                                       | 143                                         | 22.554                                      | 24.0              | 11.0 °C                 |
| 017             | R,L    | 8/23/99  | 1            | 52                                           | 50.707                                       | 143                                         | 21.740                                      | 16.5              |                         |
| 017             | R,L    | 8/23/99  | 3            | 52                                           | 50.031                                       | 143                                         | 21.857                                      | 14.5              |                         |
| 017             | R,L    | 8/24/99  | 3            | 52                                           | 52.728                                       | 143                                         | 20.847                                      | 11.5              |                         |
| 017             | R,L    | 9/25/99  | 9            | 53                                           | 08.079                                       | 143                                         | 16.841                                      | 7.7               | 9.5 °C                  |
| 017             | R,L    | 9/29/99  | 8            | 52                                           | 53.124                                       | 143                                         | 20.448                                      | 11.5              |                         |
| 018             | R,L    | 7/8/99   | 2            | 52                                           | 54.292                                       | 143                                         | 19.771                                      | 6.1               |                         |
| 018             | R,L    | 7/14/99  | 8            | 53                                           | 03.094                                       | 143                                         | 19.168                                      | 14.0              |                         |
| 018             | R      | 7/18/99  | 4            | 52                                           | 54.847                                       | 143                                         | 20.633                                      | 13.0              | 14.7 °C                 |
| 018             | R,L    | 7/29/99  | 3            | 52                                           | 52.585                                       | 143                                         | 20.978                                      | 13.0              |                         |
| 018             | R,L,F  | 8/22/99  | 16           | 53                                           | 01.124                                       | 143                                         | 19.428                                      | 13.5              |                         |
| 018             | R      | 8/24/99  | 14           | 52                                           | 58.201                                       | 143                                         | 19.389                                      | 11.0              |                         |
| 018             | R      | 9/2/99   | 8            | 53                                           | 01.999                                       | 143                                         | 18.945                                      | 13.0              | 11.6 °C                 |
| 018             | L      | 9/25/99  | 12           | 53                                           | 13.127                                       | 143                                         | 16.337                                      | 12.0              |                         |
| 018             | R      | 9/25/99  | 13           | 53                                           | 13.378                                       | 143                                         | 16.347                                      | 12.5              |                         |

| Whale ID number | Aspect | Date     | Group number | Initial sighting location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface temperature |
|-----------------|--------|----------|--------------|----------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|-------------------------|
| 018             | R      | 10/5/99  | 1            | 52                                           | 49.025                                       | 143                                         | 21.191                                      | 11.5              |                         |
| 018             | R,L    | 10/7/99  | 2            | 52                                           | 49.622                                       | 143                                         | 21.970                                      | 10.5              |                         |
| 018             | R,L    | 10/8/99  | 4            | 52                                           | 48.633                                       | 143                                         | 21.325                                      | 8.2               |                         |
| 018             | R      | 10/9/99  | 3            | 52                                           | 49.109                                       | 143                                         | 21.579                                      | 9.5               |                         |
| 018             | R      | 10/13/99 | 1            | 52                                           | 49.863                                       | 143                                         | 22.047                                      | 13.0              |                         |
| 019             | R,L    | 7/14/99  | 5            | 52                                           | 53.600                                       | 143                                         | 21.459                                      | 16.5              |                         |
| 019             | R,F    | 7/18/99  | 4            | 52                                           | 54.847                                       | 143                                         | 20.633                                      | 13.0              | 14.7 °C                 |
| 019             | R,L,F  | 7/20/99  | 7            | 52                                           | 54.651                                       | 143                                         | 20.707                                      | 13.5              |                         |
| 019             | R,L,F  | 8/22/99  | 9            | 52                                           | 55.914                                       | 143                                         | 20.843                                      | 14.5              |                         |
| 019             | R,L,F  | 8/24/99  | 6            | 52                                           | 55.441                                       | 143                                         | 21.021                                      | 15.5              |                         |
| 019             | R      | 8/25/99  | 2            | 52                                           | 52.999                                       | 143                                         | 21.421                                      | 15.0              |                         |
| 019             | R      | 9/4/99   | 11           | 52                                           | 55.566                                       | 143                                         | 21.141                                      | 18.0              |                         |
| 019             | R,L    | 9/6/99   | 4            | 53                                           | 02.156                                       | 143                                         | 20.671                                      | 19.5              |                         |
| 019             | R,L    | 9/17/99  | 4            | 52                                           | 51.334                                       | 143                                         | 23.370                                      | 22.0              |                         |
| 019             | R,L    | 9/19/99  | 2            | 52                                           | 53.017                                       | 143                                         | 21.295                                      | 14.5              |                         |
| 019             | R,L,F  | 9/19/99  | 7            | 52                                           | 54.933                                       | 143                                         | 20.955                                      | 15.5              |                         |
| 019             | L      | 9/22/99  | 5            | 52                                           | 53.325                                       | 143                                         | 21.352                                      | 14.5              |                         |
| 019             | L      | 9/25/99  | 2            | 52                                           | 53.062                                       | 143                                         | 21.007                                      | 13.5              |                         |
| 021             | R,F    | 7/27/99  | 4            | 52                                           | 54.602                                       | 143                                         | 22.455                                      | 22.0              |                         |
| 021             | R,L,F  | 7/27/99  | 5            | 52                                           | 55.132                                       | 143                                         | 20.759                                      | 13.5              |                         |
| 021             | R,L    | 8/7/99   | 6            | 52                                           | 57.290                                       | 143                                         | 20.698                                      | 15.5              | 9.6 °C                  |
| 021             | R,L,F  | 8/23/99  | 8            | 52                                           | 53.967                                       | 143                                         | 21.528                                      | 16.0              | 11.5 °C                 |
| 023             | R,L,F  | 7/24/99  | 9            | 53                                           | 02.655                                       | 143                                         | 19.523                                      | 16.5              |                         |
| 023             | R,L    | 8/9/99   | 15           | 53                                           | 01.217                                       | 143                                         | 18.537                                      | 9.5               |                         |
| 023             | R,L    | 8/10/99  | 7            | 52                                           | 53.478                                       | 143                                         | 20.765                                      | 12.0              |                         |
| 023             | L      | 8/23/99  | 5            | 52                                           | 52.241                                       | 143                                         | 21.554                                      | 14.0              |                         |
| 023             | R,L,F  | 9/2/99   | 5            | 52                                           | 56.281                                       | 143                                         | 21.288                                      | 18.5              |                         |
| 023             | R      | 9/2/99   | 7            | 52                                           | 58.063                                       | 143                                         | 19.793                                      | 13.0              |                         |
| 023             | R,L    | 9/22/99  | 9            | 53                                           | 04.139                                       | 143                                         | 18.646                                      | 12.5              |                         |
| 023             | R,L,F  | 10/6/99  | 4            | 53                                           | 10.057                                       | 143                                         | 17.978                                      | 15.0              |                         |
| 023             | L      | 10/11/99 | 7            | 53                                           | 13.448                                       | 143                                         | 16.501                                      | 14.0              |                         |
| 024             | R,L    | 7/18/99  | 2            | 52                                           | 49.887                                       | 143                                         | 21.842                                      | 14.5              | 14.4 °C                 |
| 024             | R,L,F  | 8/9/99   | 2            | 52                                           | 50.650                                       | 143                                         | 21.583                                      | 15.0              | 12.4 °C                 |
| 024             | R,L    | 8/10/99  | 2            | 52                                           | 50.309                                       | 143                                         | 21.118                                      | 7.6               |                         |
| 024             | R,L,F  | 8/23/99  | 7            | 52                                           | 53.677                                       | 143                                         | 20.716                                      | 12.0              |                         |
| 024             | R,L,F  | 8/24/99  | 8            | 52                                           | 55.533                                       | 143                                         | 20.347                                      | 11.5              |                         |
| 024             | L      | 8/24/99  | 12           | 52                                           | 56.355                                       | 143                                         | 20.191                                      | 12.0              |                         |
| 024             | R,L,F  | 9/2/99   | 6            | 52                                           | 57.716                                       | 143                                         | 20.409                                      | 15.0              |                         |
| 024             | R,L    | 9/25/99  | 16           | 53                                           | 12.143                                       | 143                                         | 16.028                                      | 7.5               |                         |

| Whale ID<br>number | Aspect | Date     | Group<br>number | Initial sighting<br>location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface<br>temperature |
|--------------------|--------|----------|-----------------|-------------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|----------------------------|
| 024                | L      | 10/4/99  | 2               | 52                                              | 54.609                                       | 143                                         | 20.713                                      | 13.0              |                            |
| 024                | R,L    | 10/6/99  | 9               | 53                                              | 16.351                                       | 143                                         | 14.458                                      | 9.2               |                            |
| 024                | R      | 10/11/99 | 9               | 53                                              | 13.950                                       | 143                                         | 14.975                                      | 7.2               |                            |
| 027                | R,L,F  | 7/23/99  | 5               | 52                                              | 50.892                                       | 143                                         | 21.455                                      | 14.0              | 15.8 °C                    |
| 027                | R,F    | 7/27/99  | 7               | 52                                              | 55.844                                       | 143                                         | 19.921                                      | 10.5              | 3.6 °C                     |
| 027                | R,L,F  | 8/9/99   | 1               | 52                                              | 50.258                                       | 143                                         | 21.554                                      | 16.5              |                            |
| 028                | R,F    | 8/7/99   | 7               | 52                                              | 54.550                                       | 143                                         | 20.810                                      |                   |                            |
| 028                | R      | 8/9/99   | 5               | 52                                              | 53.108                                       | 143                                         | 20.850                                      | 12.0              |                            |
| 028                | R      | 8/16/99  | 1               | 52                                              | 51.413                                       | 143                                         | 21.712                                      | 15.5              |                            |
| 028                | R      | 8/16/99  | 5               | 52                                              | 52.828                                       | 143                                         | 20.248                                      | 9.5               |                            |
| 028                | R,F    | 8/16/99  | 6               | 52                                              | 52.911                                       | 143                                         | 20.404                                      | 10.0              |                            |
| 028                | R,L    | 8/22/99  | 15              | 52                                              | 59.957                                       | 143                                         | 19.710                                      | 15.5              |                            |
| 028                | R      | 8/24/99  | 4               | 52                                              | 53.155                                       | 143                                         | 20.328                                      | 9.5               | 11.7 °C                    |
| 028                | R,F    | 9/4/99   | 8               | 52                                              | 47.379                                       | 143                                         | 21.964                                      | 13.0              |                            |
| 030                | R,L    | 7/8/99   | 2               | 52                                              | 54.292                                       | 143                                         | 19.771                                      | 6.1               | 1.6 °C                     |
| 030                | R,L,F  | 7/9/99   | 4               | 52                                              | 55.080                                       | 143                                         | 21.203                                      | 16.0              | 4.0 °C                     |
| 030                | R,L,F  | 7/13/99  | 2               | 52                                              | 52.410                                       | 143                                         | 21.739                                      | 16.5              |                            |
| 030                | R,L,F  | 7/14/99  | 6               | 52                                              | 55.476                                       | 143                                         | 21.039                                      | 16.5              | 8.4 °C                     |
| 030                | R,L,F  | 7/16/99  | 1               | 52                                              | 51.405                                       | 143                                         | 21.803                                      | 17.0              |                            |
| 030                | L      | 7/18/99  | 4               | 52                                              | 54.847                                       | 143                                         | 20.633                                      | 13.0              | 14.7 °C                    |
| 030                | R,L,F  | 7/20/99  | 8               | 52                                              | 56.679                                       | 143                                         | 20.637                                      | 15.5              | 9.0 °C                     |
| 030                | R,L,F  | 7/28/99  | 3               | 52                                              | 55.208                                       | 143                                         | 21.017                                      | 15.5              |                            |
| 030                | R,L,F  | 8/16/99  | 8               | 52                                              | 53.833                                       | 143                                         | 21.190                                      |                   |                            |
| 030                | R,L,F  | 8/22/99  | 16              | 53                                              | 01.124                                       | 143                                         | 19.428                                      | 13.5              |                            |
| 030                | R      | 8/24/99  | 14              | 52                                              | 58.201                                       | 143                                         | 19.389                                      | 11.0              |                            |
| 030                | R,L,F  | 8/30/99  | 5               | 52                                              | 55.438                                       | 143                                         | 21.044                                      | 16.0              |                            |
| 033                | R,L    | 8/7/99   | 2               | 52                                              | 51.151                                       | 143                                         | 21.870                                      | 17.0              | 7.6 °C                     |
| 033                | R,L    | 8/16/99  | 6               | 52                                              | 52.911                                       | 143                                         | 20.404                                      | 10.0              |                            |
| 033                | L      | 8/16/99  | 7               | 52                                              | 53.455                                       | 143                                         | 20.375                                      |                   |                            |
| 033                | R      | 8/20/99  | 16              | 52                                              | 57.509                                       | 143                                         | 19.547                                      | 10.5              |                            |
| 033                | L      | 9/2/99   | 6               | 52                                              | 57.716                                       | 143                                         | 20.409                                      | 15.0              |                            |
| 033                | R,L    | 9/4/99   | 14              | 53                                              | 01.455                                       | 143                                         | 19.111                                      | 13.5              |                            |
| 033                | R,L    | 9/25/99  | 14              | 53                                              | 13.541                                       | 143                                         | 16.322                                      | 13.5              |                            |
| 033                | R,L    | 10/11/99 | 2               | 52                                              | 49.372                                       | 143                                         | 21.995                                      | 12.0              |                            |
| 033                | L      | 10/13/99 | 1               | 52                                              | 49.863                                       | 143                                         | 22.047                                      | 13.0              |                            |
| 034                | R,L    | 7/20/99  | 2               | 52                                              | 51.163                                       | 143                                         | 21.717                                      | 16.5              |                            |
| 034                | R,L    | 7/24/99  | 2               | 52                                              | 53.317                                       | 143                                         | 20.956                                      | 13.0              |                            |
| 034                | R,L    | 7/29/99  | 1               | 52                                              | 53.519                                       | 143                                         | 21.129                                      | 15.0              |                            |
| 034                | R      | 7/29/99  | 7               | 52                                              | 54.982                                       | 143                                         | 20.651                                      | 13.5              |                            |

| Whale ID number | Aspect | Date     | Group number | Initial sighting location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface temperature |
|-----------------|--------|----------|--------------|----------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|-------------------------|
| 034             | L      | 7/29/99  | 12           | 52                                           | 54.916                                       | 143                                         | 20.436                                      | 16.5              |                         |
| 034             | R      | 8/3/99   | 2            | 52                                           | 47.281                                       | 143                                         | 21.862                                      | 13.5              |                         |
| 034             | R,L    | 8/16/99  | 2            | 52                                           | 52.522                                       | 143                                         | 20.550                                      | 10.5              |                         |
| 034             | R      | 8/16/99  | 4            | 52                                           | 52.812                                       | 143                                         | 20.334                                      | 10.0              |                         |
| 034             | R,L    | 8/16/99  | 5            | 52                                           | 52.828                                       | 143                                         | 20.248                                      | 9.5               |                         |
| 034             | L      | 8/16/99  | 6            | 52                                           | 52.911                                       | 143                                         | 20.404                                      | 10.0              |                         |
| 034             | R,L    | 8/25/99  | 6            | 52                                           | 53.374                                       | 143                                         | 19.898                                      | 9.5               |                         |
| 034             | R      | 8/26/99  | 6            | 52                                           | 50.461                                       | 143                                         | 21.468                                      | 14.5              | 12.0 °C                 |
| 034             | R      | 9/6/99   | 4            | 53                                           | 02.156                                       | 143                                         | 20.671                                      | 19.5              |                         |
| 034             | R,L    | 9/13/99  | 3            | 52                                           | 52.537                                       | 143                                         | 21.049                                      | 13.0              |                         |
| 034             | L      | 9/13/99  | 8            | 52                                           | 52.697                                       | 143                                         | 21.447                                      |                   |                         |
| 035             | R,L,F  | 7/20/99  | 9            | 52                                           | 57.308                                       | 143                                         | 19.746                                      | 12.0              |                         |
| 035             | R,L    | 8/9/99   | 8            |                                              |                                              |                                             |                                             | 11.0              |                         |
| 035             | R,L    | 9/25/99  | 15           | 53                                           | 12.382                                       | 143                                         | 16.058                                      | 9.5               |                         |
| 036             | R,L    | 7/11/99  | 8            | 52                                           | 52.992                                       | 143                                         | 21.044                                      | 12.5              | 7.4 °C                  |
| 036             | R,L    | 8/20/99  | 13           | 52                                           | 55.480                                       | 143                                         | 19.996                                      | 10.5              |                         |
| 036             | R,L,F  | 8/20/99  | 14           | 52                                           | 56.381                                       | 143                                         | 19.443                                      |                   | 11.9 °C                 |
| 036             | L,F    | 8/22/99  | 7            | 52                                           | 55.804                                       | 143                                         | 20.201                                      | 11.5              |                         |
| 036             | R,L,F  | 8/22/99  | 22           |                                              |                                              |                                             |                                             | 10.5              |                         |
| 036             | R,L    | 8/24/99  | 15           | 52                                           | 59.311                                       | 143                                         | 19.675                                      | 13.5              |                         |
| 036             | R,L    | 8/25/99  | 3            | 52                                           | 53.105                                       | 143                                         | 20.443                                      | 10.0              |                         |
| 036             | R,L    | 9/17/99  | 8            | 52                                           | 48.652                                       | 143                                         | 21.561                                      | 9.7               |                         |
| 036             | R,F    | 9/19/99  | 3            | 52                                           | 53.125                                       | 143                                         | 21.325                                      | 14.5              |                         |
| 036             | R,F    | 9/21/99  | 1            | 52                                           | 49.735                                       | 143                                         | 21.802                                      | 11.5              |                         |
| 036             | L,F    | 9/22/99  | 6            | 52                                           | 56.847                                       | 143                                         | 20.431                                      | 13.5              |                         |
| 036             | R,L,F  | 9/25/99  | 8            | 53                                           | 07.022                                       | 143                                         | 17.746                                      | 11.5              | 9.8 °C                  |
| 036             | R,F    | 10/6/99  | 8            | 53                                           | 16.133                                       | 143                                         | 15.187                                      | 12.5              |                         |
| 036             | R,L,F  | 10/7/99  | 7            | 53                                           | 16.616                                       | 143                                         | 14.917                                      | 11.5              |                         |
| 036             | R      | 10/11/99 | 5            | 52                                           | 59.511                                       | 143                                         | 18.735                                      | 9.5               |                         |
| 036             | L      | 10/11/99 | 6            | 52                                           | 59.202                                       | 143                                         | 19.552                                      | 14.0              | 6.6 °C                  |
| 037             | R      | 7/20/99  | 7            | 52                                           | 54.651                                       | 143                                         | 20.707                                      | 13.5              |                         |
| 037             | R,L    | 8/10/99  | 6            | 52                                           | 53.596                                       | 143                                         | 19.953                                      | 8.5               |                         |
| 037             | R,L    | 8/16/99  | 2            | 52                                           | 52.522                                       | 143                                         | 20.550                                      | 10.5              |                         |
| 037             | R      | 8/20/99  | 16           | 52                                           | 57.509                                       | 143                                         | 19.547                                      | 10.5              |                         |
| 037             | R,L    | 8/22/99  | 2            | 52                                           | 51.748                                       | 143                                         | 21.352                                      | 13.0              |                         |
| 037             | R      | 8/22/99  | 6            | 52                                           | 55.523                                       | 143                                         | 19.755                                      | 9.0               |                         |
| 037             | R,L    | 8/22/99  | 19           | 52                                           | 57.028                                       | 143                                         | 19.537                                      | 10.5              |                         |
| 037             | R      | 9/6/99   | 6            | 53                                           | 04.274                                       | 143                                         | 18.457                                      |                   |                         |
| 037             | R,L    | 9/13/99  | 3            | 52                                           | 52.537                                       | 143                                         | 21.049                                      | 13.0              |                         |

| Whale ID number | Aspect | Date    | Group number | Initial sighting location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface temperature |
|-----------------|--------|---------|--------------|----------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|-------------------------|
| 037             |        | 9/13/99 |              |                                              |                                              |                                             |                                             |                   |                         |
| 037             | R      | 9/25/99 | 8            | 53                                           | 07.022                                       | 143                                         | 17.746                                      | 11.5              | 9.8 °C                  |
| 037             | R,L    | 9/29/99 | 1            | 52                                           | 52.227                                       | 143                                         | 21.265                                      | 14.0              |                         |
| 037             | L      | 9/29/99 | 9            | 52                                           | 53.718                                       | 143                                         | 19.968                                      | 9.2               |                         |
| 037             | R      | 9/29/99 | 10           | 52                                           | 53.551                                       | 143                                         | 19.984                                      | 9.0               |                         |
| 037             | R      | 10/3/99 | 1            | 52                                           | 58.669                                       | 143                                         | 19.776                                      | 13.0              |                         |
| 037             | R      | 10/6/99 | 4            | 53                                           | 10.057                                       | 143                                         | 17.978                                      | 15.0              |                         |
| 038             | R,L    | 6/29/99 | 5            | 52                                           | 50.318                                       | 143                                         | 20.822                                      | 7.0               | 6.5 °C                  |
| 038             | R      | 7/3/99  | 9            | 52                                           | 50.971                                       | 143                                         | 20.444                                      | 6.1               |                         |
| 038             | R      | 7/6/99  | 2            | 52                                           | 50.534                                       | 143                                         | 20.513                                      | 4.0               | 6.1 °C                  |
| 038             | L      | 7/8/99  | 4            | 52                                           | 50.235                                       | 143                                         | 21.018                                      | 6.0               |                         |
| 038             | R,L    | 7/8/99  | 5            | 52                                           | 50.729                                       | 143                                         | 20.561                                      | 5.0               |                         |
| 038             | R      | 7/9/99  | 2            | 52                                           | 49.981                                       | 143                                         | 21.084                                      | 5.2               | 3.7 °C                  |
| 038             | R,L    | 7/11/99 | 2            | 52                                           | 49.350                                       | 143                                         | 20.074                                      | 3.8               | 7.0 °C                  |
| 038             | R,L    | 7/13/99 | 1            | 52                                           | 50.901                                       | 143                                         | 20.526                                      | 6.5               | 10.1 °C                 |
| 038             | R,L    | 7/18/99 | 1            | 52                                           | 50.063                                       | 143                                         | 20.984                                      | 7.6               |                         |
| 038             | R      | 7/20/99 | 1            | 52                                           | 51.003                                       | 143                                         | 20.127                                      | 4.0               |                         |
| 038             | L      | 7/21/99 | 1            | 52                                           | 50.901                                       | 143                                         | 20.398                                      | 5.5               |                         |
| 038             | L      | 7/21/99 | 2            | 52                                           | 50.400                                       | 143                                         | 20.870                                      | 3.5               |                         |
| 038             | R,L    | 7/24/99 | 14           | 52                                           | 48.261                                       | 143                                         | 19.809                                      | 5.0               |                         |
| 038             | R      | 8/3/99  | 4            | 52                                           | 50.760                                       | 143                                         | 20.707                                      | 7.0               |                         |
| 038             | R,L    | 8/7/99  | 9            | 52                                           | 50.536                                       | 143                                         | 20.923                                      |                   |                         |
| 038             | R,L    | 8/8/99  | 4            | 52                                           | 48.425                                       | 143                                         | 19.956                                      | 6.0               |                         |
| 038             | R,L    | 8/20/99 | 9            | 52                                           | 53.839                                       | 143                                         | 21.592                                      | 17.0              |                         |
| 038             | L,F    | 8/20/99 | 12           | 52                                           | 54.649                                       | 143                                         | 20.346                                      | 11.0              |                         |
| 038             | R,L    | 8/25/99 | 6            | 52                                           | 53.374                                       | 143                                         | 19.898                                      | 9.5               |                         |
| 039             | R,L,F  | 7/14/99 | 1            | 52                                           | 49.661                                       | 143                                         | 21.642                                      | 14.0              |                         |
| 039             | L      | 7/14/99 | 2            | 52                                           | 50.729                                       | 143                                         | 21.602                                      | 16.5              | 9.2 °C                  |
| 039             | R,L,F  | 7/20/99 | 2            | 52                                           | 51.163                                       | 143                                         | 21.717                                      | 16.5              |                         |
| 039             | R      | 7/20/99 | 5            | 52                                           | 53.102                                       | 143                                         | 21.073                                      | 14.0              |                         |
| 039             | R,L    | 7/28/99 | 3            | 52                                           | 55.208                                       | 143                                         | 21.017                                      | 15.5              |                         |
| 039             | R,L,F  | 7/29/99 | 9            | 53                                           | 02.043                                       | 143                                         | 18.898                                      | 13.0              | 3.0 °C                  |
| 040             | R,L    | 7/15/99 | 1            | 52                                           | 50.399                                       | 143                                         | 20.670                                      | 2.9               | 6.7 °C                  |
| 040             | L      | 7/15/99 | 4            | 52                                           | 51.572                                       | 143                                         | 20.203                                      | 8.1               |                         |
| 040             | R      | 7/24/99 | 3            | 52                                           | 53.528                                       | 143                                         | 21.326                                      | 14.0              |                         |
| 040             | R,L    | 7/28/99 | 4            | 52                                           | 55.647                                       | 143                                         | 21.104                                      | 16.5              | 4.2 °C                  |
| 040             | R,L    | 7/29/99 | 4            | 52                                           | 52.565                                       | 143                                         | 21.089                                      | 13.5              | 2.4 °C                  |
| 040             | L      | 7/29/99 | 7            | 52                                           | 54.982                                       | 143                                         | 20.651                                      | 13.5              |                         |
| 040             | R,L    | 7/29/99 | 11           | 52                                           | 59.454                                       | 143                                         | 19.603                                      | 13.0              |                         |

| Whale ID<br>number | Aspect | Date     | Group<br>number | Initial sighting<br>location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface<br>temperature |
|--------------------|--------|----------|-----------------|-------------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|----------------------------|
| 040                | R,L    | 8/7/99   | 3               | 52                                              | 52.707                                       | 143                                         | 21.002                                      | 12.5              | 9.6 °C                     |
| 040                | R,L,F  | 8/7/99   | 4               | 52                                              | 54.279                                       | 143                                         | 20.598                                      | 12.0              |                            |
| 040                | R,L    | 8/7/99   | 6               | 52                                              | 57.290                                       | 143                                         | 20.698                                      | 15.5              |                            |
| 040                | L      | 8/9/99   | 10              | 52                                              | 58.456                                       | 143                                         | 20.067                                      | 13.5              |                            |
| 040                | R,L    | 8/16/99  | 2               | 52                                              | 52.522                                       | 143                                         | 20.550                                      | 10.5              |                            |
| 040                | L      | 8/20/99  | 6               | 52                                              | 51.585                                       | 143                                         | 21.596                                      | 14.0              | 12.0 °C                    |
| 040                | R,L    | 8/22/99  | 2               | 52                                              | 51.748                                       | 143                                         | 21.352                                      | 13.0              |                            |
| 040                | R      | 8/22/99  | 6               | 52                                              | 55.523                                       | 143                                         | 19.755                                      | 9.0               |                            |
| 040                | R      | 8/26/99  | 6               | 52                                              | 50.461                                       | 143                                         | 21.468                                      | 14.5              |                            |
| 040                | R      | 8/26/99  | 7               | 52                                              | 50.155                                       | 143                                         | 21.994                                      | 13.0              |                            |
| 040                | L      | 9/4/99   | 5               | 52                                              | 52.893                                       | 143                                         | 22.179                                      | 15.5              | 14.4 °C                    |
| 041                | R      | 7/18/99  | 2               | 52                                              | 49.887                                       | 143                                         | 21.842                                      | 14.5              |                            |
| 041                | R,L    | 7/18/99  | 3               | 52                                              | 52.024                                       | 143                                         | 23.143                                      | 20.0              |                            |
| 041                | R,L    | 7/18/99  | 4               | 52                                              | 54.847                                       | 143                                         | 20.633                                      | 13.0              |                            |
| 041                | R,L    | 7/24/99  | 5               | 52                                              | 56.160                                       | 143                                         | 21.421                                      | 19.0              |                            |
| 041                | R,L    | 7/25/99  | 6               | 52                                              | 54.062                                       | 143                                         | 21.084                                      | 14.0              | 15.7 °C                    |
| 041                | R,L    | 7/27/99  | 7               | 52                                              | 55.844                                       | 143                                         | 19.921                                      | 10.5              |                            |
| 041                | R      | 8/20/99  | 11              | 52                                              | 54.304                                       | 143                                         | 20.397                                      | 11.5              |                            |
| 041                | R,L    | 8/22/99  | 11              | 52                                              | 56.745                                       | 143                                         | 23.048                                      | 21.0              |                            |
| 041                | R,L    | 8/22/99  | 13              | 52                                              | 57.721                                       | 143                                         | 22.554                                      | 24.0              |                            |
| 041                | R      | 8/22/99  | 21              |                                                 |                                              |                                             |                                             | 5.6               | 3.6 °C                     |
| 041                | R,L,F  | 8/23/99  | 8               | 52                                              | 53.967                                       | 143                                         | 21.528                                      | 16.0              |                            |
| 041                | R      | 9/6/99   | 5               | 53                                              | 03.685                                       | 143                                         | 19.301                                      | 15.0              |                            |
| 042                | R      | 7/24/99  | 4               | 52                                              | 54.561                                       | 143                                         | 21.927                                      | 17.0              |                            |
| 042                | R,L,F  | 7/24/99  | 11              | 52                                              | 49.309                                       | 143                                         | 22.089                                      | 12.0              |                            |
| 042                | R,L    | 8/9/99   | 3               | 52                                              | 51.987                                       | 143                                         | 22.260                                      | 16.0              | 11.0 °C                    |
| 042                | R,L,F  | 8/22/99  | 9               | 52                                              | 55.914                                       | 143                                         | 20.843                                      | 14.5              |                            |
| 042                | L      | 8/22/99  | 11              | 52                                              | 56.745                                       | 143                                         | 23.048                                      | 21.0              |                            |
| 042                | L      | 8/22/99  | 16              | 53                                              | 01.124                                       | 143                                         | 19.428                                      | 13.5              |                            |
| 042                | L      | 8/22/99  | 17              | 53                                              | 01.803                                       | 143                                         | 19.115                                      | 14.0              |                            |
| 042                | R,L    | 8/26/99  | 2               | 52                                              | 51.362                                       | 143                                         | 22.030                                      | 17.5              | 11.5 °C                    |
| 042                | R,L,F  | 9/25/99  | 10              | 53                                              | 10.493                                       | 143                                         | 17.994                                      | 16.0              |                            |
| 042                | R      | 10/6/99  | 4               | 53                                              | 10.057                                       | 143                                         | 17.978                                      | 15.0              |                            |
| 042                | R,L    | 10/7/99  | 7               | 53                                              | 16.616                                       | 143                                         | 14.917                                      | 11.5              |                            |
| 042                | L      | 10/11/99 | 10              | 53                                              | 17.200                                       | 143                                         | 14.713                                      | 12.5              |                            |
| 043                | R,L,F  | 7/27/99  | 4               | 52                                              | 54.602                                       | 143                                         | 22.455                                      | 22.0              | 11.0 °C                    |
| 043                | R,L,F  | 8/9/99   | 3               | 52                                              | 51.987                                       | 143                                         | 22.260                                      | 16.0              |                            |
| 043                | R,L    | 8/10/99  | 7               | 52                                              | 53.478                                       | 143                                         | 20.765                                      | 12.0              |                            |
| 043                | R,L    | 9/25/99  | 9               | 53                                              | 08.079                                       | 143                                         | 16.841                                      | 7.7               |                            |

| Whale ID number | Aspect | Date    | Group number | Initial sighting location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface temperature |
|-----------------|--------|---------|--------------|----------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|-------------------------|
| 043             | R,L    | 9/29/99 | 8            | 52                                           | 53.124                                       | 143                                         | 20.448                                      | 11.5              | 9.5 °C                  |
| 044             | R,L    | 7/23/99 | 2            | 52                                           | 49.791                                       | 143                                         | 20.804                                      | 5.5               | 15.6 °C                 |
| 044             | R,L,F  | 7/24/99 | 13           | 52                                           | 45.532                                       | 143                                         | 20.457                                      | 9.5               |                         |
| 044             | R,L    | 8/9/99  | 15           | 53                                           | 01.217                                       | 143                                         | 18.537                                      | 9.5               |                         |
| 044             | R      | 8/20/99 | 1            | 52                                           | 51.198                                       | 143                                         | 20.062                                      |                   |                         |
| 044             | R      | 8/20/99 | 13           | 52                                           | 55.480                                       | 143                                         | 19.996                                      | 10.5              |                         |
| 044             | R      | 8/20/99 | 14           | 52                                           | 56.381                                       | 143                                         | 19.443                                      |                   | 11.9 °C                 |
| 047             | L      | 7/3/99  | 2            | 52                                           | 53.158                                       | 143                                         | 21.447                                      | 16.5              |                         |
| 047             | R,L    | 7/3/99  | 4            | 52                                           | 53.880                                       | 143                                         | 21.080                                      | 14.5              |                         |
| 047             | R,L    | 7/3/99  | 7            | 52                                           | 52.752                                       | 143                                         | 21.721                                      | 16.0              |                         |
| 047             | R,L    | 7/13/99 | 3            | 52                                           | 53.839                                       | 143                                         | 23.391                                      | 19.0              | 10.9 °C                 |
| 047             | R,L,F  | 7/14/99 | 7            | 53                                           | 00.479                                       | 143                                         | 19.585                                      | 14.0              | 9.8 °C                  |
| 047             | R,L,F  | 7/16/99 | 3            | 52                                           | 52.692                                       | 143                                         | 20.641                                      | 11.5              | 4.9 °C                  |
| 047             | R,F    | 7/24/99 | 12           | 52                                           | 46.886                                       | 143                                         | 22.201                                      | 15.5              |                         |
| 047             | R,L    | 7/25/99 | 3            | 52                                           | 51.718                                       | 143                                         | 21.418                                      | 13.5              |                         |
| 047             | R,L,F  | 8/7/99  | 6            | 52                                           | 57.290                                       | 143                                         | 20.698                                      | 15.5              | 9.6 °C                  |
| 047             | R      | 8/20/99 | 6            | 52                                           | 51.585                                       | 143                                         | 21.596                                      | 14.0              |                         |
| 047             | R,L    | 8/22/99 | 16           | 53                                           | 01.124                                       | 143                                         | 19.428                                      | 13.5              |                         |
| 047             | R,L    | 8/22/99 | 17           | 53                                           | 01.803                                       | 143                                         | 19.115                                      | 14.0              |                         |
| 047             | R,L    | 8/24/99 | 7            | 52                                           | 55.776                                       | 143                                         | 20.324                                      | 11.5              |                         |
| 047             | R,F    | 8/26/99 | 6            | 52                                           | 50.461                                       | 143                                         | 21.468                                      | 14.5              | 12.0 °C                 |
| 047             | R,L    | 9/2/99  | 1            | 52                                           | 53.476                                       | 143                                         | 20.013                                      | 8.7               |                         |
| 047             | L      | 9/2/99  | 2            | 52                                           | 53.339                                       | 143                                         | 20.317                                      | 10.0              |                         |
| 047             | R,L    | 9/4/99  | 4            | 52                                           | 47.182                                       | 143                                         | 22.668                                      | 14.5              |                         |
| 047             | L      | 9/4/99  | 5            | 52                                           | 52.893                                       | 143                                         | 22.179                                      | 15.5              |                         |
| 048             | R      | 7/25/99 | 7            | 52                                           | 55.199                                       | 143                                         | 20.707                                      | 13.0              |                         |
| 048             | R,L    | 7/27/99 | 5            | 52                                           | 55.132                                       | 143                                         | 20.759                                      | 13.5              |                         |
| 049             | R,L,F  | 7/27/99 | 2            | 52                                           | 52.986                                       | 143                                         | 21.546                                      | 17.0              | 5.1 °C                  |
| 049             | R      | 7/27/99 | 5            | 52                                           | 55.132                                       | 143                                         | 20.759                                      | 13.5              |                         |
| 049             | R,L    | 7/27/99 | 6            | 52                                           | 55.455                                       | 143                                         | 20.463                                      | 13.0              |                         |
| 049             | R,L,F  | 7/29/99 | 1            | 52                                           | 53.519                                       | 143                                         | 21.129                                      | 15.0              |                         |
| 049             | R      | 7/29/99 | 5            | 52                                           | 54.631                                       | 143                                         | 21.068                                      | 14.5              |                         |
| 049             | R      | 7/29/99 | 7            | 52                                           | 54.982                                       | 143                                         | 20.651                                      | 13.5              |                         |
| 049             | R,L,F  | 7/29/99 | 12           | 52                                           | 54.916                                       | 143                                         | 20.436                                      | 16.5              |                         |
| 049             | R,L    | 8/10/99 | 3            | 52                                           | 50.983                                       | 143                                         | 21.075                                      | 10.0              |                         |
| 049             | R,F    | 8/20/99 | 2            | 52                                           | 51.171                                       | 143                                         | 21.845                                      | 16.5              |                         |
| 049             | R,L    | 8/20/99 | 17           | 52                                           | 58.076                                       | 143                                         | 19.507                                      | 11.5              |                         |
| 049             | R,L    | 8/20/99 | 18           | 52                                           | 58.643                                       | 143                                         | 19.615                                      | 13.5              |                         |
| 049             | L      | 9/2/99  | 4            | 52                                           | 54.640                                       | 143                                         | 20.289                                      | 10.5              |                         |

| Whale ID number | Aspect | Date     | Group number | Initial sighting location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface temperature |
|-----------------|--------|----------|--------------|----------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|-------------------------|
| 051             | R,L    | 7/28/99  | 3            | 52                                           | 55.208                                       | 143                                         | 21.017                                      | 15.5              |                         |
| 051             | R,L    | 8/9/99   | 12           | 53                                           | 00.609                                       | 143                                         | 20.011                                      | 18.0              |                         |
| 051             | R      | 8/20/99  | 12           | 52                                           | 54.649                                       | 143                                         | 20.346                                      | 11.0              |                         |
| 051             | R      | 9/6/99   | 6            | 53                                           | 04.274                                       | 143                                         | 18.457                                      |                   |                         |
| 052             | R,L    | 7/11/99  | 9            | 52                                           | 52.873                                       | 143                                         | 20.926                                      | 12.0              |                         |
| 052             | R,L    | 7/14/99  | 9            | 53                                           | 02.942                                       | 143                                         | 18.928                                      | 13.0              | 9.2 °C                  |
| 052             | R,L    | 7/24/99  | 1            | 52                                           | 51.587                                       | 143                                         | 21.400                                      | 13.0              | 15.0 °C                 |
| 052             | R,L,F  | 7/27/99  | 3            | 52                                           | 53.619                                       | 143                                         | 21.996                                      | 17.5              |                         |
| 052             | R,L    | 8/20/99  | 7            | 52                                           | 52.495                                       | 143                                         | 21.530                                      | 14.5              |                         |
| 052             | R,L    | 9/4/99   | 6            | 52                                           | 47.082                                       | 143                                         | 21.791                                      | 12.0              |                         |
| 052             | L      | 9/4/99   | 9            | 52                                           | 49.994                                       | 143                                         | 21.493                                      | 16.5              |                         |
| 052             | R,L    | 9/29/99  | 10           | 52                                           | 53.551                                       | 143                                         | 19.984                                      | 9.0               |                         |
| 053             | R,L,F  | 7/8/99   | 1            | 52                                           | 52.097                                       | 143                                         | 19.813                                      | 5.6               |                         |
| 053             | R,L    | 7/24/99  | 7            | 52                                           | 59.554                                       | 143                                         | 20.248                                      | 15.5              |                         |
| 053             | F      | 7/25/99  | 3            | 52                                           | 51.718                                       | 143                                         | 21.418                                      | 13.5              |                         |
| 053             | R,L,F  | 7/25/99  | 5            | 52                                           | 51.421                                       | 143                                         | 21.786                                      | 16.0              | 15.8 °C                 |
| 053             | R,F    | 8/16/99  | 4            | 52                                           | 52.812                                       | 143                                         | 20.334                                      | 10.0              |                         |
| 053             | R,L,F  | 8/20/99  | 12           | 52                                           | 54.649                                       | 143                                         | 20.346                                      | 11.0              |                         |
| 053             | R,F    | 8/20/99  | 13           | 52                                           | 55.480                                       | 143                                         | 19.996                                      | 10.5              |                         |
| 053             | R,F    | 8/20/99  | 16           | 52                                           | 57.509                                       | 143                                         | 19.547                                      | 10.5              |                         |
| 053             | L      | 8/20/99  | 17           | 52                                           | 58.076                                       | 143                                         | 19.507                                      | 11.5              |                         |
| 053             | R,L,F  | 9/2/99   | 4            | 52                                           | 54.640                                       | 143                                         | 20.289                                      | 10.5              |                         |
| 053             | R      | 9/29/99  | 9            | 52                                           | 53.718                                       | 143                                         | 19.968                                      | 9.2               |                         |
| 053             | L,F    | 9/29/99  | 11           |                                              |                                              |                                             |                                             | 10.5              |                         |
| 053             | R,F    | 10/6/99  | 6            | 53                                           | 12.628                                       | 143                                         | 16.620                                      | 10.0              |                         |
| 053             | R,F    | 10/7/99  | 6            | 53                                           | 12.900                                       | 143                                         | 16.219                                      | 11.5              |                         |
| 053             | R      | 10/11/99 | 8            | 53                                           | 13.466                                       | 143                                         | 16.325                                      | 14.0              |                         |
| 054             | R      | 8/26/99  | 6            | 52                                           | 50.461                                       | 143                                         | 21.468                                      | 14.5              | 12.0 °C                 |
| 054             | L      | 9/29/99  | 2            | 52                                           | 52.187                                       | 143                                         | 20.954                                      |                   |                         |
| 054             | R,L    | 9/29/99  | 5            | 52                                           | 52.671                                       | 143                                         | 20.710                                      | 12.0              |                         |
| 054             | R      | 9/29/99  | 10           | 52                                           | 53.551                                       | 143                                         | 19.984                                      | 9.0               |                         |
| 055             | R,L,F  | 7/29/99  | 3            | 52                                           | 52.585                                       | 143                                         | 20.978                                      | 13.0              |                         |
| 055             | R,L,F  | 8/7/99   | 3            | 52                                           | 52.707                                       | 143                                         | 21.002                                      | 12.5              |                         |
| 055             | R,L,F  | 8/23/99  | 6            | 52                                           | 52.920                                       | 143                                         | 20.880                                      | 11.5              |                         |
| 055             | R,L,F  | 8/25/99  | 3            | 52                                           | 53.105                                       | 143                                         | 20.443                                      | 10.0              |                         |
| 055             | R,F    | 8/26/99  | 5            | 52                                           | 50.757                                       | 143                                         | 22.027                                      | 15.0              |                         |
| 055             | R      | 8/26/99  | 7            | 52                                           | 50.155                                       | 143                                         | 21.994                                      | 13.0              |                         |
| 055             | R,F    | 9/4/99   | 12           | 52                                           | 58.613                                       | 143                                         | 18.962                                      |                   |                         |
| 055             | R,L,F  | 9/19/99  | 6            | 52                                           | 54.376                                       | 143                                         | 21.842                                      | 18.0              |                         |



| Whale ID number | Aspect | Date     | Group number | Initial sighting location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface temperature |
|-----------------|--------|----------|--------------|----------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|-------------------------|
| 055             | R,F    | 9/25/99  | 8            | 53                                           | 07.022                                       | 143                                         | 17.746                                      | 11.5              | 9.8 °C                  |
| 055             | R      | 10/6/99  | 8            | 53                                           | 16.133                                       | 143                                         | 15.187                                      | 12.5              |                         |
| 055             | R,L,F  | 10/7/99  | 7            | 53                                           | 16.616                                       | 143                                         | 14.917                                      | 11.5              |                         |
| 055             | R,L    | 10/11/99 | 5            | 52                                           | 59.511                                       | 143                                         | 18.735                                      | 9.5               |                         |
| 056             | R,L    | 7/11/99  | 11           | 52                                           | 52.968                                       | 143                                         | 19.763                                      | 6.0               |                         |
| 056             | R,L    | 7/28/99  | 5            | 52                                           | 51.254                                       | 143                                         | 20.705                                      | 9.0               | 7.6 °C                  |
| 056             | R,L    | 7/29/99  | 8            | 52                                           | 57.600                                       | 143                                         | 19.298                                      | 9.5               |                         |
| 056             | R,L    | 8/10/99  | 4            | 52                                           | 51.688                                       | 143                                         | 20.681                                      | 9.0               |                         |
| 056             | R,L    | 9/13/99  | 2            | 52                                           | 51.019                                       | 143                                         | 21.426                                      | 13.5              |                         |
| 056             | R,L    | 9/19/99  | 5            | 52                                           | 53.351                                       | 143                                         | 20.506                                      | 11.0              |                         |
| 056             | R      | 9/25/99  | 16           | 53                                           | 12.143                                       | 143                                         | 16.028                                      | 7.5               |                         |
| 056             | R,L    | 9/29/99  | 4            | 52                                           | 52.372                                       | 143                                         | 21.269                                      |                   |                         |
| 056             | R      | 10/6/99  | 10           | 53                                           | 07.305                                       | 143                                         | 16.772                                      | 6.0               |                         |
| 057             | R,L    | 8/8/99   | 6            | 52                                           | 50.673                                       | 143                                         | 21.286                                      | 12.0              |                         |
| 057             | R      | 8/8/99   | 7            | 52                                           | 50.367                                       | 143                                         | 21.799                                      | 16.0              |                         |
| 057             | R,L    | 8/25/99  | 6            | 52                                           | 53.374                                       | 143                                         | 19.898                                      | 9.5               |                         |
| 057             | R,L    | 10/6/99  | 11           | 53                                           | 01.783                                       | 143                                         | 17.966                                      | 7.2               |                         |
| 057             | R,L    | 10/7/99  | 1            | 52                                           | 49.976                                       | 143                                         | 21.648                                      | 16.0              |                         |
| 057             | R      | 10/8/99  | 2            | 52                                           | 50.034                                       | 143                                         | 21.818                                      | 16.5              |                         |
| 057             | R,L    | 10/9/99  | 4            | 52                                           | 49.062                                       | 143                                         | 21.064                                      | 13.0              |                         |
| 057             | R,L    | 10/11/99 | 3            | 52                                           | 49.304                                       | 143                                         | 21.236                                      | 15.0              |                         |
| 058             | R,L,F  | 8/8/99   | 8            | 52                                           | 50.193                                       | 143                                         | 21.026                                      | 4.3               |                         |
| 058             | R,L    | 8/10/99  | 4            | 52                                           | 51.688                                       | 143                                         | 20.681                                      | 9.0               |                         |
| 058             | R,L    | 8/16/99  | 3            | 52                                           | 53.888                                       | 143                                         | 19.987                                      | 9.2               |                         |
| 058             | R      | 8/24/99  | 11           | 52                                           | 56.301                                       | 143                                         | 20.210                                      |                   |                         |
| 058             | L      | 9/15/99  | 4            | 52                                           | 49.252                                       | 143                                         | 21.228                                      | 14.0              |                         |
| 058             | R      | 9/25/99  | 16           | 53                                           | 12.143                                       | 143                                         | 16.028                                      | 7.5               |                         |
| 059             | R,L,F  | 7/3/99   | 2            | 52                                           | 53.158                                       | 143                                         | 21.447                                      | 16.5              |                         |
| 059             | R,L    | 7/3/99   | 6            | 52                                           | 52.271                                       | 143                                         | 20.922                                      | 11.0              |                         |
| 059             | R      | 7/3/99   | 8            | 52                                           | 52.735                                       | 143                                         | 23.067                                      | 15.5              |                         |
| 059             | R,L,F  | 7/14/99  | 6            | 52                                           | 55.476                                       | 143                                         | 21.039                                      | 16.5              | 8.4 °C                  |
| 059             | R,L    | 7/23/99  | 7            | 52                                           | 52.789                                       | 143                                         | 21.161                                      | 14.0              |                         |
| 059             | R,L,F  | 7/24/99  | 5            | 52                                           | 56.160                                       | 143                                         | 21.421                                      | 19.0              |                         |
| 059             | R,L    | 8/23/99  | 4            | 52                                           | 50.684                                       | 143                                         | 21.652                                      | 15.5              |                         |
| 059             | R,L    | 8/23/99  | 5            | 52                                           | 52.241                                       | 143                                         | 21.554                                      | 14.0              |                         |
| 059             | R,F    | 9/25/99  | 13           | 53                                           | 13.378                                       | 143                                         | 16.347                                      | 12.5              | 15.7 °C                 |
| 062             | R,L    | 10/5/99  | 2            | 52                                           | 51.237                                       | 143                                         | 21.064                                      | 11.0              |                         |
| 062             | R      | 10/6/99  | 9            | 53                                           | 16.351                                       | 143                                         | 14.458                                      | 9.2               |                         |

| Whale ID<br>number | Aspect | Date    | Group<br>number | Initial sighting<br>location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface<br>temperature |
|--------------------|--------|---------|-----------------|-------------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|----------------------------|
| 062                | R      | 10/8/99 | 1               | 52                                              | 50.148                                       | 143                                         | 22.041                                      | 14.5              |                            |
| 067                | R,L    | 7/8/99  | 2               | 52                                              | 54.292                                       | 143                                         | 19.771                                      | 6.1               | 1.6 °C                     |
| 067                | R,L    | 7/24/99 | 5               | 52                                              | 56.160                                       | 143                                         | 21.421                                      | 19.0              | 15.7 °C                    |
| 067                | R,L,F  | 7/28/99 | 3               | 52                                              | 55.208                                       | 143                                         | 21.017                                      | 15.5              |                            |
| 067                | R,L,F  | 8/8/99  | 5               | 52                                              | 50.594                                       | 143                                         | 21.800                                      | 17.0              |                            |
| 067                | R,L,F  | 8/22/99 | 5               | 52                                              | 55.293                                       | 143                                         | 20.817                                      | 14.0              |                            |
| 067                | R,L    | 8/22/99 | 19              | 52                                              | 57.028                                       | 143                                         | 19.537                                      | 10.5              |                            |
| 067                | L      | 8/23/99 | 2               | 52                                              | 50.308                                       | 143                                         | 21.740                                      | 15.5              |                            |
| 068                | R,L    | 9/15/99 | 1               | 52                                              | 50.004                                       | 143                                         | 21.944                                      | 13.5              |                            |
| 070                | R,F    | 7/25/99 | 5               | 52                                              | 51.421                                       | 143                                         | 21.786                                      | 16.0              | 15.8 °C                    |
| 070                | R,F    | 8/3/99  | 3               | 52                                              | 48.339                                       | 143                                         | 22.316                                      | 14.5              | 10.3 °C                    |
| 070                | R,L,F  | 8/8/99  | 3               | 52                                              | 48.361                                       | 143                                         | 21.418                                      | 9.0               |                            |
| 070                | R,L,F  | 9/6/99  | 3               | 52                                              | 59.579                                       | 143                                         | 19.695                                      | 14.5              |                            |
| 070                | R,L,F  | 9/13/99 | 8               | 52                                              | 52.697                                       | 143                                         | 21.447                                      |                   |                            |
| 071                | R,L    | 6/29/99 | 5               | 52                                              | 50.318                                       | 143                                         | 20.822                                      | 7.0               | 6.5 °C                     |
| 071                | R,L    | 7/3/99  | 9               | 52                                              | 50.971                                       | 143                                         | 20.444                                      | 6.1               |                            |
| 071                | R      | 7/6/99  | 2               | 52                                              | 50.534                                       | 143                                         | 20.513                                      | 4.0               | 6.1 °C                     |
| 071                | L      | 7/8/99  | 4               | 52                                              | 50.235                                       | 143                                         | 21.018                                      | 6.0               |                            |
| 071                | L      | 7/8/99  | 5               | 52                                              | 50.729                                       | 143                                         | 20.561                                      | 5.0               |                            |
| 071                | R,L    | 7/9/99  | 2               | 52                                              | 49.981                                       | 143                                         | 21.084                                      | 5.2               | 3.7 °C                     |
| 071                | R,L    | 7/11/99 | 2               | 52                                              | 49.350                                       | 143                                         | 20.074                                      | 3.8               | 7.0 °C                     |
| 071                | R,L    | 7/13/99 | 1               | 52                                              | 50.901                                       | 143                                         | 20.526                                      | 6.5               | 10.1 °C                    |
| 071                | R,L    | 7/18/99 | 1               | 52                                              | 50.063                                       | 143                                         | 20.984                                      | 7.6               |                            |
| 071                | R      | 7/20/99 | 1               | 52                                              | 51.003                                       | 143                                         | 20.127                                      | 4.0               |                            |
| 071                | L,F    | 7/21/99 | 1               | 52                                              | 50.901                                       | 143                                         | 20.398                                      | 5.5               |                            |
| 071                | L      | 7/21/99 | 2               | 52                                              | 50.400                                       | 143                                         | 20.870                                      | 3.5               |                            |
| 071                | R,L    | 7/24/99 | 14              | 52                                              | 48.261                                       | 143                                         | 19.809                                      | 5.0               |                            |
| 071                | R,L    | 8/3/99  | 4               | 52                                              | 50.760                                       | 143                                         | 20.707                                      | 7.0               |                            |
| 071                | R,L    | 8/7/99  | 9               | 52                                              | 50.536                                       | 143                                         | 20.923                                      |                   |                            |
| 071                | R,L    | 8/8/99  | 4               | 52                                              | 48.425                                       | 143                                         | 19.956                                      | 6.0               |                            |
| 071                | R,L    | 8/22/99 | 23              | 52                                              | 51.372                                       | 143                                         | 20.299                                      | 7.6               |                            |
| 071                | R      | 8/24/99 | 9               | 52                                              | 56.056                                       | 143                                         | 19.819                                      | 9.5               |                            |
| 071                | R,L    | 8/30/99 | 1               | 52                                              | 49.269                                       | 143                                         | 20.793                                      | 10.0              |                            |
| 071                | R,L    | 9/4/99  | 7               |                                                 |                                              |                                             |                                             | 6.7               |                            |
| 071                | R,L    | 9/5/99  | 3               | 52                                              | 50.171                                       | 143                                         | 21.300                                      | 13.5              |                            |
| 071                | L      | 9/7/99  | 1               | 52                                              | 49.016                                       | 143                                         | 20.882                                      | 12.0              |                            |
| 071                | R,L,F  | 9/17/99 | 1               | 52                                              | 50.096                                       | 143                                         | 21.586                                      | 16.0              |                            |
| 071                | R,F    | 9/19/99 | 4               | 52                                              | 53.096                                       | 143                                         | 20.734                                      | 12.0              |                            |
| 071                | R      | 9/19/99 | 9               | 52                                              | 51.062                                       | 143                                         | 21.003                                      | 10.5              |                            |

| Whale ID number | Aspect | Date     | Group number | Initial sighting location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface temperature |
|-----------------|--------|----------|--------------|----------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|-------------------------|
| 071             | R      | 9/22/99  | 3            | 52                                           | 52.114                                       | 143                                         | 20.767                                      | 11.0              |                         |
| 071             | R      | 9/25/99  | 6            | 52                                           | 53.761                                       | 143                                         | 20.126                                      | 10.0              |                         |
| 071             | R      | 9/25/99  | 17           | 52                                           | 50.411                                       | 143                                         | 21.140                                      | 9.0               |                         |
| 071             | R,L,F  | 9/29/99  | 7            | 52                                           | 53.387                                       | 143                                         | 20.147                                      | 9.5               |                         |
| 071             | R,L    | 10/5/99  | 4            | 52                                           | 51.255                                       | 143                                         | 20.888                                      | 10.0              | 7.6 °C                  |
| 071             | L      | 10/6/99  | 13           | 52                                           | 46.656                                       | 143                                         | 21.270                                      | 15.5              |                         |
| 071             | L      | 10/7/99  | 3            | 52                                           | 50.097                                       | 143                                         | 21.515                                      | 17.0              | 7.8 °C                  |
| 071             | R      | 10/11/99 | 4            | 52                                           | 48.970                                       | 143                                         | 20.877                                      | 13.0              |                         |
| 071             | R      | 10/13/99 | 4            | 52                                           | 51.773                                       | 143                                         | 19.993                                      | 6.5               |                         |
| 072             | L,F    | 7/3/99   | 2            | 52                                           | 53.158                                       | 143                                         | 21.447                                      | 16.5              |                         |
| 072             | R,L,F  | 7/3/99   | 3            | 52                                           | 52.901                                       | 143                                         | 21.491                                      | 16.0              |                         |
| 072             | R,L,F  | 7/3/99   | 7            | 52                                           | 52.752                                       | 143                                         | 21.721                                      | 16.0              |                         |
| 072             | R      | 7/3/99   | 8            | 52                                           | 52.735                                       | 143                                         | 23.067                                      | 15.5              |                         |
| 072             | R,L    | 8/9/99   | 8            |                                              |                                              |                                             |                                             | 11.0              |                         |
| 072             | R,L    | 8/16/99  | 5            | 52                                           | 52.828                                       | 143                                         | 20.248                                      | 9.5               |                         |
| 072             | R      | 8/16/99  | 6            | 52                                           | 52.911                                       | 143                                         | 20.404                                      | 10.0              |                         |
| 072             | R      | 8/20/99  | 13           | 52                                           | 55.480                                       | 143                                         | 19.996                                      | 10.5              |                         |
| 072             | R      | 8/20/99  | 14           | 52                                           | 56.381                                       | 143                                         | 19.443                                      |                   | 11.9 °C                 |
| 072             | R      | 8/24/99  | 10           | 52                                           | 56.197                                       | 143                                         | 20.184                                      | 11.5              |                         |
| 072             | L      | 8/24/99  | 13           | 52                                           | 56.214                                       | 143                                         | 20.572                                      | 12.0              | 11.9 °C                 |
| 072             | R,L    | 9/2/99   | 1            | 52                                           | 53.476                                       | 143                                         | 20.013                                      | 8.7               |                         |
| 072             | R      | 9/4/99   | 15           | 53                                           | 01.344                                       | 143                                         | 19.431                                      | 14.5              |                         |
| 073             | R,L,F  | 7/3/99   | 1            | 52                                           | 53.732                                       | 143                                         | 22.086                                      | 22.0              |                         |
| 074             | R,L    | 7/11/99  | 3            | 52                                           | 48.793                                       | 143                                         | 21.614                                      | 10.0              |                         |
| 074             | R,L,F  | 7/11/99  | 4            | 52                                           | 50.732                                       | 143                                         | 21.652                                      | 16.5              | 7.0 °C                  |
| 074             | L      | 7/11/99  | 7            | 52                                           | 52.013                                       | 143                                         | 21.123                                      | 12.0              |                         |
| 074             | R,L,F  | 7/13/99  | 3            | 52                                           | 53.839                                       | 143                                         | 23.391                                      | 19.0              | 10.9 °C                 |
| 074             | R,L,F  | 7/13/99  | 4            | 52                                           | 54.299                                       | 143                                         | 23.135                                      | 21.0              | 10.6 °C                 |
| 074             | R,L    | 8/10/99  | 5            | 52                                           | 52.655                                       | 143                                         | 19.661                                      | 5.6               |                         |
| 074             | R,L,F  | 8/20/99  | 12           | 52                                           | 54.649                                       | 143                                         | 20.346                                      | 11.0              |                         |
| 074             | R,L    | 8/30/99  | 1            | 52                                           | 49.269                                       | 143                                         | 20.793                                      | 10.0              |                         |
| 074             | R      | 8/30/99  | 3            | 52                                           | 50.954                                       | 143                                         | 21.072                                      | 11.0              |                         |
| 074             | R,L    | 9/2/99   | 1            | 52                                           | 53.476                                       | 143                                         | 20.013                                      | 8.7               |                         |
| 074             | L      | 9/2/99   | 2            | 52                                           | 53.339                                       | 143                                         | 20.317                                      | 10.0              |                         |
| 074             | R,F    | 9/4/99   | 11           | 52                                           | 55.566                                       | 143                                         | 21.141                                      | 18.0              |                         |
| 075             | R,L,F  | 7/13/99  | 2            | 52                                           | 52.410                                       | 143                                         | 21.739                                      | 16.5              |                         |
| 075             | R,F    | 8/4/99   | 2            | 52                                           | 51.520                                       | 143                                         | 20.954                                      | 10.5              |                         |
| 075             | R,L,F  | 8/26/99  | 3            | 52                                           | 49.556                                       | 143                                         | 21.527                                      | 12.0              |                         |
| 075             | R      | 8/26/99  | 4            | 52                                           | 50.537                                       | 143                                         | 21.792                                      | 15.5              |                         |

| Whale ID number | Aspect | Date     | Group number | Initial sighting location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface temperature |
|-----------------|--------|----------|--------------|----------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|-------------------------|
| 075             | R,L    | 9/2/99   | 6            | 52                                           | 57.716                                       | 143                                         | 20.409                                      | 15.0              |                         |
| 075             | R,L,F  | 9/4/99   | 5            | 52                                           | 52.893                                       | 143                                         | 22.179                                      | 15.5              |                         |
| 076             | R,L    | 7/14/99  | 2            | 52                                           | 50.729                                       | 143                                         | 21.602                                      | 16.5              | 9.2 °C                  |
| 076             | R,L    | 7/14/99  | 4            | 52                                           | 52.851                                       | 143                                         | 21.552                                      | 16.0              | 8.9 °C                  |
| 076             | L      | 7/18/99  | 4            | 52                                           | 54.847                                       | 143                                         | 20.633                                      | 13.0              | 14.7 °C                 |
| 076             | R,L    | 7/23/99  | 7            | 52                                           | 52.789                                       | 143                                         | 21.161                                      | 14.0              |                         |
| 076             | R,L    | 7/24/99  | 2            | 52                                           | 53.317                                       | 143                                         | 20.956                                      | 13.0              |                         |
| 076             | R,L    | 7/25/99  | 5            | 52                                           | 51.421                                       | 143                                         | 21.786                                      | 16.0              | 15.8 °C                 |
| 077             | R      | 7/8/99   | 6            | 52                                           | 50.299                                       | 143                                         | 20.171                                      | 4.1               | 13.5 °C                 |
| 077             | R,L    | 7/15/99  | 1            | 52                                           | 50.399                                       | 143                                         | 20.670                                      | 2.9               | 6.7 °C                  |
| 077             | L      | 7/15/99  | 4            | 52                                           | 51.572                                       | 143                                         | 20.203                                      | 8.1               |                         |
| 077             | L      | 8/22/99  | 18           | 53                                           | 58.445                                       | 143                                         | 18.864                                      |                   |                         |
| 077             | R,L    | 8/30/99  | 1            | 52                                           | 49.269                                       | 143                                         | 20.793                                      | 10.0              |                         |
| 077             | R,L    | 9/5/99   | 1            | 52                                           | 51.412                                       | 143                                         | 21.325                                      | 12.5              |                         |
| 077             | R      | 9/5/99   | 4            | 52                                           | 53.135                                       | 143                                         | 20.119                                      | 8.7               |                         |
| 077             | L      | 9/6/99   | 1            | 52                                           | 53.961                                       | 143                                         | 20.544                                      | 11.5              | 11.5 °C                 |
| 077             | R      | 9/7/99   | 1            | 52                                           | 49.016                                       | 143                                         | 20.882                                      | 12.0              |                         |
| 077             | L      | 9/15/99  | 5            | 52                                           | 49.382                                       | 143                                         | 21.353                                      | 15.0              | 12.2 °C                 |
| 077             | L      | 9/17/99  | 5            | 52                                           | 50.074                                       | 143                                         | 21.620                                      | 16.0              |                         |
| 077             | R      | 9/17/99  |              |                                              |                                              |                                             |                                             |                   |                         |
| 077             | R      | 9/19/99  | 1            | 52                                           | 52.039                                       | 143                                         | 20.747                                      | 10.5              |                         |
| 077             | R      | 9/25/99  | 3            | 52                                           | 53.232                                       | 143                                         | 20.719                                      | 12.5              |                         |
| 077             | L      | 9/25/99  |              |                                              |                                              |                                             |                                             |                   |                         |
| 077             | L,F    | 10/5/99  | 3            | 52                                           | 51.360                                       | 143                                         | 20.940                                      | 10.5              |                         |
| 077             | L      | 10/6/99  | 12           | 52                                           | 51.606                                       | 143                                         | 20.529                                      | 9.5               |                         |
| 077             | L      | 10/7/99  | 3            | 52                                           | 50.097                                       | 143                                         | 21.515                                      | 17.0              | 7.8 °C                  |
| 077             | R,L    | 10/11/99 | 4            | 52                                           | 48.970                                       | 143                                         | 20.877                                      | 13.0              |                         |
| 078             | R,L,F  | 7/20/99  | 10           | 52                                           | 57.955                                       | 143                                         | 20.258                                      | 15.0              |                         |
| 078             | F      | 7/28/99  | 3            | 52                                           | 55.208                                       | 143                                         | 21.017                                      | 15.5              |                         |
| 078             | L,F    | 8/16/99  | 7            | 52                                           | 53.455                                       | 143                                         | 20.375                                      |                   |                         |
| 078             | R,L,F  | 8/20/99  | 14           | 52                                           | 56.381                                       | 143                                         | 19.443                                      |                   | 11.9 °C                 |
| 078             | R,L,F  | 8/30/99  | 5            | 52                                           | 55.438                                       | 143                                         | 21.044                                      | 16.0              |                         |
| 079             | R,L,F  | 7/24/99  | 9            | 53                                           | 02.655                                       | 143                                         | 19.523                                      | 16.5              |                         |
| 079             | R,L    | 7/25/99  | 6            | 52                                           | 54.062                                       | 143                                         | 21.084                                      | 14.0              |                         |
| 079             | R,L,F  | 8/9/99   | 7            | 52                                           | 54.928                                       | 143                                         | 21.320                                      | 17.0              |                         |
| 079             | L      | 8/9/99   | 11           | 52                                           | 59.174                                       | 143                                         | 19.587                                      | 13.0              |                         |
| 079             | L      | 8/9/99   | 14           | 53                                           | 00.486                                       | 143                                         | 19.506                                      | 13.5              |                         |
| 080             | R,F    | 7/28/99  | 1            | 52                                           | 50.288                                       | 143                                         | 21.629                                      | 15.5              |                         |
| 081             | R,L,F  | 8/7/99   | 8            | 52                                           | 51.160                                       | 143                                         | 21.477                                      |                   |                         |

| Whale ID number | Aspect | Date     | Group number | Initial sighting location<br>(degrees north) | Initial sighting location<br>(minutes north) | Initial sighting location<br>(degrees east) | Initial sighting location<br>(minutes east) | Initial Depth (m) | Sea surface temperature |
|-----------------|--------|----------|--------------|----------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------|-------------------------|
| 081             | R,L,F  | 8/9/99   | 8            |                                              |                                              |                                             |                                             | 11.0              |                         |
| 081             | R,L,F  | 8/20/99  | 4            | 52                                           | 50.960                                       | 143                                         | 21.072                                      | 10.5              |                         |
| 081             | R,F    | 8/20/99  | 6            | 52                                           | 51.585                                       | 143                                         | 21.596                                      | 14.0              |                         |
| 081             | R,F    | 8/20/99  | 8            | 52                                           | 52.873                                       | 143                                         | 21.383                                      | 15.0              |                         |
| 081             | R,F    | 8/20/99  | 15           | 52                                           | 57.058                                       | 143                                         | 19.891                                      | 11.5              |                         |
| 081             | R,L    | 8/22/99  | 19           | 52                                           | 57.028                                       | 143                                         | 19.537                                      | 10.5              |                         |
| 081             | F      | 9/2/99   | 8            | 53                                           | 01.999                                       | 143                                         | 18.945                                      | 13.0              | 11.6 °C                 |
| 081             | R,L,F  | 9/21/99  | 1            | 52                                           | 49.735                                       | 143                                         | 21.802                                      | 11.5              |                         |
| 081             | R,F    | 9/22/99  | 8            | 53                                           | 04.137                                       | 143                                         | 19.208                                      | 15.0              |                         |
| 081             | R,L    | 9/25/99  | 15           | 53                                           | 12.382                                       | 143                                         | 16.058                                      | 9.5               |                         |
| 081             | L,F    | 10/11/99 | 7            | 53                                           | 13.448                                       | 143                                         | 16.501                                      | 14.0              |                         |
| 082             | R,L,F  | 8/9/99   | 13           | 53                                           | 01.110                                       | 143                                         | 18.893                                      |                   |                         |
| 083             | R,L    | 8/9/99   | 15           | 53                                           | 01.217                                       | 143                                         | 18.537                                      | 9.5               |                         |
| 083             | R      | 8/23/99  | 8            | 52                                           | 53.967                                       | 143                                         | 21.528                                      | 16.0              | 11.5 °C                 |
| 083             | R      | 9/25/99  | 15           | 53                                           | 12.382                                       | 143                                         | 16.058                                      | 9.5               |                         |
| 084             | R      | 8/22/99  | 20           |                                              |                                              |                                             |                                             | 9.0               |                         |
| 084             | R,L    | 8/24/99  | 8            | 52                                           | 55.533                                       | 143                                         | 20.347                                      | 11.5              |                         |
| 084             | R      | 8/24/99  | 16           | 52                                           | 57.386                                       | 143                                         | 18.899                                      | 5.6               |                         |
| 084             | R      | 10/11/99 | 9            | 53                                           | 13.950                                       | 143                                         | 14.975                                      | 7.2               |                         |
| 085             | R,L,F  | 8/20/99  | 2            | 52                                           | 51.171                                       | 143                                         | 21.845                                      | 16.5              |                         |
| 085             | R,L    | 8/20/99  | 10           | 52                                           | 54.122                                       | 143                                         | 20.367                                      | 11.0              |                         |
| 085             | L      | 8/22/99  | 1            | 52                                           | 51.129                                       | 143                                         | 21.385                                      | 13.0              |                         |
| 085             | R,L    | 8/24/99  | 1            | 52                                           | 50.426                                       | 143                                         | 21.660                                      | 16.5              |                         |
| 085             | R      | 8/26/99  | 3            | 52                                           | 49.556                                       | 143                                         | 21.527                                      | 12.0              |                         |
| 085             | R,L    | 9/4/99   | 14           | 53                                           | 01.455                                       | 143                                         | 19.111                                      | 13.5              |                         |
| 086             | L      | 8/30/99  | 1            | 52                                           | 49.269                                       | 143                                         | 20.793                                      | 10.0              |                         |
| 086             | R      | 9/5/99   | 3            | 52                                           | 50.171                                       | 143                                         | 21.300                                      | 13.5              |                         |
| 086             | R      | 9/13/99  | 2            | 52                                           | 51.019                                       | 143                                         | 21.426                                      | 13.5              |                         |
| 086             | L      | 9/17/99  | 5            | 52                                           | 50.074                                       | 143                                         | 21.620                                      | 16.0              |                         |
| 086             | R,L    | 9/19/99  | 4            | 52                                           | 53.096                                       | 143                                         | 20.734                                      | 12.0              |                         |
| 086             | R      | 9/25/99  | 5            | 52                                           | 53.736                                       | 143                                         | 19.972                                      | 9.5               |                         |
| 086             | L      | 10/5/99  | 3            | 52                                           | 51.360                                       | 143                                         | 20.940                                      | 10.5              |                         |
| 086             | R      | 10/6/99  | 13           | 52                                           | 46.656                                       | 143                                         | 21.270                                      | 15.5              |                         |
| 086             | L      | 10/9/99  | 1            | 52                                           | 50.034                                       | 143                                         | 21.251                                      | 13.5              |                         |
| 086             | R      | 10/9/99  | 5            | 52                                           | 50.011                                       | 143                                         | 21.362                                      | 16.0              |                         |
| 086             | L      | 10/13/99 | 3            | 52                                           | 51.132                                       | 143                                         | 20.192                                      | 5.0               |                         |
| 087             | R,L    | 9/25/99  | 12           | 53                                           | 13.127                                       | 143                                         | 16.337                                      | 12.0              |                         |
| 087             | R,L    | 9/25/99  | 16           | 53                                           | 12.143                                       | 143                                         | 16.028                                      | 7.5               |                         |