PHOTO-IDENTIFICATION OF THE KOREA-OKHOTSK GRAY WHALE (*ESCHRICHTIUS ROBUSTUS*) POPULATION IN 2002

Interim Report

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INTRODUCTION

There are currently two gray whale (*Eschrichtius robustus*) populations: the eastern (California-Chukotsk) and western (Korea-Okhotsk). Very recently these populations were on the verge of disappearing and were classified as endangered species. However, the eastern population recovered and in November 1991 the U.S. National Oceanic and Atmospheric Administration removed this population from the endangered species list, which they had been on since 1967. The population size of eastern gray whales (26,000 specimens) is now greater than it was before their intensive depopulation (Rugh et al. 1999).

The existence of the western gray whale population is currently causing great concern. The Red Book of the Russian Federation has listed the western gray whale as an endangered (Category I) species (Perlov et al. 1996, Red Book of the Russian Federation 2001) and they are also considered endangered by the United States government (USFWS 1997). Presently, western gray whales are considered by the International Union for the Conservation of Nature (IUCN) to be critically endangered (Hilton-Taylor 2000, Weller & Brownell 2000). The IUCN Red List criteria used to support this reclassification were as follows: (1) the population is geographically and genetically distinct (LeDuc et al. 2002); and (2) the population plausibly contains less than 50 reproductive individuals (Hilton-Taylor 2000, Weller & Brownell 2000).

Much of the gray whale life cycle takes place in the coastal zones of densely populated countries with intensive fishing and shipping. Western gray whales are vulnerable to hazards at all three life stages: (1) during whale reproduction in the southern part of their range, the location of which is presently unknown; (2) during prolonged northerly-southerly migrations; and (3) in their known feeding areas off the northeast coast of Sakhalin Island, Russia. The long-held belief that their wintering grounds were along the south coast of the Korean Peninsula has not been recently substantiated (Rice 1998). Wintering grounds are now believed to be located in the South China Sea, possibly along the coast of Guangdong province and/or around Hainan Island (Rice 1998). However, specific calving sites have never been observed. Two feeding areas have been identified off Sakhalin Island: (1) a shallow (generally <20 m deep) feeding site along the coast of Piltun Bay; and (2) a deeper feeding site ~30-40km offshore of Chayvo Bay in waters 35-45m deep (Maminov & Yakovlev 2002, Weller et al. 2002a) (Figure 1). Oil and gas development in proximity to western gray whale feeding areas along the northeast coast of Sakhalin Island, especially during the summer migration period, could negatively impact western gray whales.

According to shore-based observations and vessel-based photo-identification studies conducted in the Piltun feeding site since 1994, a total of 106 individual whales have been identified as of late 2001 (Weller et al. 2002b). Monitoring of the number of individuals in this population, identifying migration routes and periods, identifying females with calves, indirectly determining the physiological condition of the specimens, and the seasonal and daily whale movements cannot be precisely determined without using photo-identification methods (Bradford et al. 2002, Weller et al. 2002a,b). This method has been successfully used when studying various aspects of eastern gray whale biology off the west coast of North America (Darling 1984, Calambokidis et al. 2002). The discovery in 2001 of a significant whale feeding area offshore of Chayvo Bay, in addition to the previously documented coastal Piltun feeding area gave researchers the task of studying the movements of the whales between these two areas. The creation of an

annually updated catalog of the gray whales of north-eastern Sakhalin is extremely necessary both for studying various aspects of gray whale biology and for monitoring the size and status of the population.

METHODS

From 5 September to 13 October 2002, photo-identification work was performed from zodiacs launched from the team's base ship, the *Nevelskoy* tugboat (425 t displacement) owned by the EPRON company (home port of Vladivostok) (Figure 2). The *Nevelskoy's* fuel self-sufficiency provides 25 days of continuous operation (additional fuel tanks are installed for 11-day fuel supply) and a crew of 17. The vessel-based western gray whale monitoring program included photo-identification, prey sampling, vessel surveys, and acoustic monitoring.

The photo-ID team adopted the following provisions almost immediately in the course of their operations:

a) During poor conditions for photographing whales (fog, torrential rain, high seas, and poor light). Photo-ID operations on the zodiacs were ceased and, weather permitting, benthos sampling operations from the *Nevelskoy* were intensified.

b) When benthos sampling operations were conducted in the monitored areas or in places where whales at that given moment were not observed in the vicinity of the ship, Zodiac-based whale searches were not conducted even in good weather. In order to ensure navigational and operational safety on small vessels, the Zodiac did not travel great distances from the base ship. A second emergency Zodiac had to be no more than 10 minutes away. If the whale search was difficult and did not produce sufficient results and the trips to the areas with recently observed whales would have taken a long time, the priorities in this case were to complete other ship-based research tasks (acoustics, prey sampling, vessel surveys) and to travel during the night.

c) Photo and video imagery data were not taken of whales located far from the vessel if the ship was at anchor during benthos-related or other operations and could not accompany the Zodiac in accordance with the marine safety requirements.

d) Observations of the sea surface to detect whales were made daily after the vessel had left Vladivostok, and they were continuous in all types of weather. When operations were planned for days with good working conditions, this made it possible for the photo-identification group to economize the time during transits to potential whale photography sites and to more effectively search for subsequent groups. This was particularly true for the Offshore feeding area where the distances between groups or individual whales were greater than in the Piltun feeding area, while the limited data on whale distribution on the Offshore area were obtained only for a short period in 2001 (Maminov & Yakovlev 2002).

Field Photo-identification Methods

A 4.8 m Zodiac with a 45 HP outboard motor was used in the whale photography operations. The operator controlled the boat using a rudder, which made it possible to have an excellent field of view. The group members wore survival suits and were

equipped with sunglasses. In addition to the rescue aids, the boat contained the following equipment and instruments:

- Mariner's compass
- Magellan 320 GPS
- Marine radio Icom IC-M3A with spare batteries
- Motorola radio station
- Speedtech digital depth-finder
- Wind speedometer
- Waterproof adhesives, bags, towels, 2 Pelican waterproof cases with a silica gel packet (1 kg).
- A set of special all-weather paper for recording data, watch
- Sony DCR TR V 730 NTSC digital video camera with a 4.1 – 73.8 zoom lens and an aperture of 1:1.8
- Nikon D1X digital camera
- 35 mm Nikon F100 film camera
- Spare power units for the photo and video cameras
- Nikkor 300 mm lens with an aperture of 1:4.0 and a protective UW/1x Rodenstock E77 filter
- Nikkor 80-200 mm lens with an aperture of 1:2.8
- Stock for photography
- Two sets of CompactFlash memory cards with a 128 and 192 MB capacity, made by Lexar
- 6 sets of Fuji "Velvia 100F" slide film
- Two Maxell XP-metal Digital 8 tapes for the video camera – 60 minutes each

When possible, the photography method was standardized and only occasionally varied based on the weather or certain features of the whales' behavior. When Zodiacs could be safely launched into the water, the whales were initially observed from the bridge of the *Nevelskoy*. After the photo-ID team was summoned, each member's readiness was checked and they were given safety instructions. The radios were checked and the charge of the batteries was verified. The timers on the photo, video, and other equipment were checked. The assignments were given to the team member responsible for communications with the Zodiac, the marine mammal observer, the operator of the auxiliary Zodiac, the navigator, the boatswain, and the winchman.

After the Zodiac was launched into the water, the operator entered the boat first and started the motor, and then another group member entered the boat to receive the equipment. After all of the equipment had been loaded and positioned, the remaining group members entered the boat. After checking the motor and establishing communications with the bridge radios and with the responsible person on duty, the Zodiac left the ship in the direction of the whale sighting.

When approaching whales, the Zodiac's speed was reduced and, at a minimum distance of 100 m, the group determined the depth, coordinates, weather conditions, the number and location of the whales, their behavior, the direction of their movement, the presence of food spots from whales on the sea surface, the presence of orcas, sharks (or other animals) and passing ships. When the recorder was entering all of this data on waterproof paper, the video operator removed the camera from its waterproof cases and prepared it to be used with the stock and with soft towels to protect it from sea spray.

Depending on the light conditions and the estimated photo distance, the 300 mm lens was usually installed on Nikon D1X in advance. Since the light-receiving matrix of this camera is almost half the size of the frame for 35 mm film cameras, the actual focal length of the lens for this digital camera corresponds to the use of a 450 mm lens for a film camera.

Using a tripod; and a lens with such a long focal length when photographing a moving object on land required a shutter speed of at least 1/500. The same kind of shot from a moving or rocking boat requires a shutter speed of at least 1/1000 or 1/2000. The "exposure priority" of 1/1000 was set in advance on the film and digital cameras (for sunny, cloudless weather they were set to 1/2000 and 400 ISO film was used). In overcast weather or at dusk, the sensitivity was increased to 800 ISO for the Nikon D1X.

The use of highly sensitive equipment made it possible to use F-stop settings of 5.6, 8, and even 11 during short exposures, which increased the depth of field of the image. The shots were recorded as JPEGs using the color selection Adobe RGB and a high resolution.

The F100 film camera was also set with an "exposure priority" of 1/1000. The film sensitivity was set at 400 ISO, but Velvia film with a sensitivity of 100 ISO was used. A special method called the "push process" made it possible to obtain properly exposed shots. Along with slide film, the group used regular Fuji 400 ISO film in order to check the quality of the whale photography using regular photographic materials.

A large aperture (1:2.8) Nikkor 80-200 mm zoom lens was used less often, and it was always set to 200 mm and was usually used during poor light conditions, especially on gray autumnal days, in bad shooting conditions (high seas), or when there was not enough time or it would have been hazardous (spray, drizzle) to change the film or the Compact Flash memory card. Using this lens expedited and improved focusing, but when the whales did not come close to the Zodiac or when they were moving away, the whale images were too small due to the short focal length. A teleconverter (x1.4), which increases the focal length of the lens, was used only in rare cases on calm seas, since the stress on the bayonet (type of lens mount) sharply increases during jolts on the Zodiac in high seas and the contacts could be broken or there could be other mechanical damage to the camera or the lens.

The whales were usually photographed using auto-focusing and serial (frame-by-frame) photography, although it should be noted that the auto-focus for the 300 mm lens is quite slow and worked uncertainly, especially when whales surfaced. The spout and spray made it impossible to have clear focus on the animal's body surface. Manual focus was used only when the place and time of the whale's surfacing could be predicted with a certain amount of accuracy.

A combination of lens (permanent and attachable) had to be used. Besides eliminating glare, especially from the water surface, they provided a certain amount of protection from minute particles of spray.

The video camera recorded various types of whale behavior and "accompanied" and backed up the photography. When the whales were sufficiently close (50-200 m), during continuous shooting, priority was given to videotaping whales swimming together and to females with calves, rather than to individual whales swimming alone.

The video operator preset the minimum focus for zooming, which made it possible to focus more quickly on the object and then only later to gradually increase the focal length, "nearing" the object as much as possible. The video footage has still not been processed for photo-identification purposes, nor has the slide film from the Nikon F100 camera, as training and subsequent photo matching is still in progress.

The actual whale photographing process was conducted based on the weather (waves and swells), the position of the sun, the whales' behavior -- feeding or "traveling", individual or in a group, a pair, or a mother with a calf.

The group tried to film the side of the whale (first from the right and then from the left) in the dorsal area near the weakly expressed hump (the coloring and the arrangement of the spots in this location are the most important, relatively permanent identification feature).

When the digital camera with the capability of producing multiple serial shots was used without consuming expensive slide film, we tried to shoot a series from the head to the tail. They were re-photographed as a guarantee. In a number of cases, primarily with "traveling" whales, the group was only able to shoot a single, lighted side of the whale. Shots of parts of the body that were in the shadow when there was strong side lighting were often not informative (even after computer processing) and after inspection were not used in the interests of time.

When feeding whales were photographed, it was easier to shoot two sides due to the random changes of direction in the series of dives relative to the direction of the sun's rays.

In shallow areas, the group focused mainly on photographing right and left sides of the whale and then moved on to photograph other whales. Waiting for a partial appearance of the flukes could have taken a long time to obtain. The flukes appeared relatively often in the new offshore area during dives of feeding whales to depths of 30-45 m.

A different shooting tactic was often used in the deeper Offshore area than in the shallow Piltun area. When a spout appeared, the group traveled fairly quickly (depending on the seas) in the direction of the whale and were able (not always) to shoot the side at a distance of 100-200 m, making a parallel course during the second, third, or fourth inhalation by the whale. Then the dorsal area was photographed from a stopped Zodiac, from behind the whale when it was diving, and then ventral side of the fluke was shot. When slowly approaching a whale diving in one place and emerging far away in a different, unpredictable location, the Zodiac was unable to approach to an acceptable distance for photographing.

High seas greatly interfere with detecting whales and their spouts. A large wave quickly obscures the whale from the field of view. In these cases, the shots were made in a very short series "on the fly", often when the Zodiac was slowly cresting a wave.

After the photography work was finished, the Zodiac returned to the ship. The film was put into a refrigerator. All images from the memory cards of the Compact Flash digital camera were downloaded to a Toshiba laptop using a SanDisk ImageMate card reader. The quality of the images was analyzed based on the photography settings and the weather features in order to subsequently adjust them. Two CD copies were made on the computer. After verifying that the CD was recorded, the data was erased from all of the memory cards for subsequent missions, even if they had a lot of available memory. The

cameras and lenses were cleaned immediately after returning to the ship, using a special liquid and cloth. Possible errors in the camera settings were checked, and the equipment was put in sealed cases containing freshly desiccated silica gel. The battery units were put into the charger no matter how much they were used. The handwritten survey and whales data was recorded on waterproof paper during the mission and was entered into the computer on the day of the mission. After verifying that the computer entries were identical to the handwritten ones, two CD copies were made.

Photo-identification Processing

According to the gray whale identification methods developed (Darling 1984, Calambokidis et al.1994, C. Tombach, LGL Limited, pers. comm.), the features of the patterns on the skin, injuries, signs of previously attached animals, scars received from diving near the ocean floor or from the teeth of predators, as well as shark and orca bites, barnacle spots, and communities of marine lice act as good markers of individual variability. Together, they provide reliable identification signs, with various degrees of hierarchy and preservation over time. Variations in fluke shape, which are used more often to identify sperm whales (Whitehead 1990), are seldom applicable to gray whales, with the exception of damage from propellers and from the teeth of predators (Figures 3c,d).

The digital images of whales for subsequent creation of a gray whale database and catalog (digital and hard-copy) were processed in a laboratory in accordance with the procedure suggested by C. Tombach (LGL Limited). The best images were selected from the shots taken. Copies of them were processed using Adobe Photoshop and Adobe Illustrator and they were printed on an Epson Photo Stylus 960 color printer. Backup copies were made daily.

The following whale areas (views) were selected to create the database (in order of priority): right side, left side, dorsal fluke and ventral fluke (Figure 3). After the photos were grouped together by view (when available) for a given whale (which is assigned an ID number), they were compared with all available images on the computer to establish the frequency of encounters with the same whale on subsequent days.

In addition, shots were selected that portray jumping (breach), show the head, demonstrate uncommon behavior, show marked coloring (Figure 4), very large pigmentation or other spots, etc., that could serve as good differentiation markers in field observations. Special attention was paid to identifying whales with various differentiations from the “physiological norm” – so-called emaciated or “skinny” whales. We did not recognize emaciated whales in the field during the 2002 mission, however they may have been present and further post-season training and analysis will identify abnormal physiological condition of whales. During post-season analysis to date, we identified two photographs of whales that appeared physically abnormal in the offshore area in October (Figure 5).

This report does not cover procedural issues associated with video processing, as training in this area is still in progress.

RESULTS

Collecting data to create the gray whale catalog is a time consuming process. The objective of the photo-identification group is closely tied to the other objectives of the vessel-based monitoring program (prey sampling, vessel surveys, acoustics). Without studying whale distribution in 2002 and their seasonal movements, the search for photo targets, especially in the recently discovered offshore area, would have taken a lot of time. Identifying and outlining areas with a high benthic invertebrate biomass content, as well as determining poor quality areas with low benthic biomass, made it possible to successfully search for new locations of whale concentrations. The distribution of the mission's time on the *Nevelskoy*, based on the weather conditions in the operations area in 2002, is presented in Table 1.

Field operations related to photo-identification constituted 22.8% of the total vessel-based program mission time. The team's late start (5 September 2002) reduced the number of Zodiac launches in October due to the prolonged storms common to northeast Sakhalin during this time (Table 1). It should be noted that intensive photo-identification operations in this region starting in October were not very effective, although the data from photographs that indirectly demonstrate the physiological condition of the whales before their southerly migration is valuable for studying the biology of the species.

Photo and video imagery data of the whales were taken over the course of 13 days. A total of 93 whale sightings were recorded during this time (taking into account repeat encounters) (Figure 6). The average number of whales encountered on a photo day was 7.15. The temporal and quantitative characteristics of the "net time" or average duration of the missions, as well as the number of frames shot, are presented in Table 2. Without counting the time spent searching for whales from the ship and the time elapsed from the moment the Zodiac left the ship until the actual start of photography, i.e., the time from preparing the cameras for operation when approaching a whale until completion of photography (packing the cameras in the waterproof boxes), the so-called "net time", was 44 hours and 14 minutes.

One to three Zodiac launches (missions) a day were completed when conditions were good. There were a total of 24 Zodiac missions. The average number of missions per photo day was 1.8. The net time of a mission was 110.6 minutes, during which an average of 98 shots were taken, (only the data for the Nikon D1X digital camera were processed) or 181 shot per photo day (0.89 shots per minute).

The time from when the Zodiac left the ship to the start of photography was strongly dependent on certain circumstances: the ship's anchorage, the weather during the photography, the number of whales, and their behavior. On successful days this time amounted to 4-10 minutes, 10-20 minutes on less successful days, and 20-95 minutes on unsuccessful days (Table 3).

Quantitative data of efforts when photographing gray whales in the conditions of northeast Sakhalin are of interest due to the existence of two feeding areas.

A total of nine days, consisting of 17 missions (with an average number of 2.0 missions per photo day), were spent in the Offshore area to photograph whales. A total of 72 encounters with gray whales (with repeat encounters) were recorded during this time. The average number of whales encountered per photo day in this area was 8.0. The total

amount of net time spent (not counting the time from Zodiac launch to actual photography, or from the end of photography to the return to the ship) was 32 hours and 59 minutes. The net time of a mission in the Offshore area was 116.4 minutes. Averaged data on the operation of the Nikon D1X digital camera was 204 frames per photo day (or 104 frames per mission) or 0.89 frames per minute of photography time (Table 4).

A total of 4 days were spent photographing whales in the Piltun area. This was caused, on the one hand, by the greater interest in the new Offshore area, which had to be studied in more or less normal weather conditions. On the other hand, the autumnal bout of storms made it impossible to perform photo-identification operations in the Piltun area due to the need to finish the benthic sampling stations grid. Operations in the Piltun area consisted of 8 missions with an average number of 2.0 missions per photo day. A total of 21 encounters with whales were recorded, including repeat encounters of individual whales. The average number of whales encountered per photo day in this area was 5.25. The total amount of net time spent in the Piltun area, not including the time from Zodiac launch to actual photography, or from the end of photography to the return to the ship, was 12 hours and 14 minutes. The net time of a mission in the Piltun area *[sic]* was 96.6 minutes. Averaged data on the operation of the Nikon D1X digital camera was 185 frames per photo day for this area (or 92 frames per mission) or 0.96 frames per minute of photography time (Table 5).

During the photography missions there was no apparent behavioral response by whales to the photography process.

No obvious behavioral differences were observed in the "whale-Zodiac" situation between the two feeding areas, with the exception of those related to the great depth and the absence of the shore. Predictability (when assessing movements) in whale behavior in the Piltun area was somewhat higher than in the Offshore area. Photo effectiveness when converted to unit of time, mission, or day was higher in the Offshore are due to the poor weather conditions during October.

In regard to the data processing to create the catalog, only the data obtained with the digital camera were processed at the time of this interim report. Forty-six sequential numbers were assigned to the specimens based on an analysis of the photographs (Table 6).

Not all whales have all four photographic views (1) right and (2) left side, dorsal (3), and ventral (4) side of the fluke. Data from the film camera is required, along with additional information from processing the video imagery. This data will be incorporated into the continuing analyses.

All four views were obtained for 17 individuals, three views for 3, two views for 9, and one view for 17 whales. There was an average of 2.4 views per whale.

An analysis of just the digital images for 13 days of photo-identification revealed repeat encounters with individual whales. For example, over the 13-day period, three individuals were encountered three times, 14 were encountered two times, and 27 were encountered only once (an average of a 1.4 occurrence frequency per whale) (Table 6).

Interesting results are expected from comparing the whales recorded by us in 2002 with catalogs from previous years. For example, in D. Weller's database for 1997 the first individual that was photographed in 1997 in the coastal Piltun area near Piltun Bay was

the same whale that we encountered in the Offshore area on 14 September 2002 at the location of 52.25582°N, 143.71108°E and then re-encountered 10 days later on 24 September 2002 at 52.21776°N, 143.63221°E. After the data processing and comparative analysis, it was given the number RGW003. All identification areas of the body (the 4 views) were photographed on this whale. This comparison of two databases at the very beginning of the analysis has immediately produced an important result – the whales move from one feeding field to another, and the two areas – the coastal and the offshore – are merely different "feeding sites" for this population. After the catalog is created and a serious analysis is conducted, the dynamics of the movements between the feeding areas will be clearer.

More refined quantitative data can be obtained only after the first phase of catalog creation is completed. Further training will occur in 2003 to complete the 2002 catalog and conduct further analyses.

LITERATURE CITED

Bradford, A.L., A.M. Burdin, P.R. Wade, Y.V. Ivashchenko, G.A. Tsidulko, G.R. VanBlaricom and D.W. Weller. 2002. Survival estimates of western gray whales (*Eschrichtius robustus*). Report to the International Whaling Commission (SC/54/BRG9). 19p.

Calambokidis J., J.R. Everson, G.H. Steiger, and S.J. Jeffries. 1994. Gray whales of Washington State: natural history and photographic catalog. Cascadia Research Collective, Olympia, Washington. 28p.

Calambokidis J., J.D. Darling, V. Deecke, P. Gearin, M. Gosho, W. Megill, C.M. Tombach, D. Goley, C. Toropova and B. Gisborne. 2002. Abundance, range and movements of a feeding aggregation of gray whales (*Eschrichtius robustus*) from California to southeastern Alaska in 1998. Journal of Cetacean Research and Management 4(3), P. 267- 276.

Darling, J.D. 1984. Gray whales off Vancouver Island, British Columbia. Pp. 267-87. *In*: M.L. Jones, S.L. Swartz and S. Leatherwood (eds.) The Gray Whale, *Eschrichtius robustus*. Academic Press, Orlando, Flordia. Xxiv+600pp.

Hilton-Taylor, C. 2000. 2000. IUCN Red List of Threatened Species. IUCN/SSC, Gland, Switzerland and Cambridge, UK.

Krasnaya Kniga Rossiyskoy Federatsii. Zhivotnye [Red Book of the Russian Federation. Animals]. 2001. Ast and Astrel - Balashikha, Aginskoe - 862 p. (in Russian).

LeDuc, R.G., D.W. Weller, J. Hyde, A.M. Burdin, P.E. Rosel, R.L. Brownell, Jr., B. Würsig, and A.E. Dizon. 2002. Genetic differences between western and eastern North Pacific gray whales (*Eschrichtius robustus*). Journal of Cetacean Management 4:1-6.

Maminov M.K. and Y.M.Yakovlev. 2002. New data on the abundance and distribution of the gray whale on the northeastern Sakhalin shelf. Conference "Marine Mammals of Holarctic" Baikal 11-13 September 2002. P.170-171.

Perlov, A.S., V. Vladimirov, Z.V. Reviankina, J. Ismail-Zade, S. Yazvenko, and S.R. Johnson. 1996. Review of literature/information regarding marine mammals in the vicinity of Sakhalin Island, Okhotsk Sea, Russia. Final Report from Pacific Research Institute of Fisheries and Oceanography (TINRO), State Committee for Fisheries and Oceanography, Vladivostok, Russia, and LGL Limited, environmental research associates, Sidney BC., Canada, for Marathon Oil Company, Littleton, CO. 32 p.

Rice, D.W. 1998. Marine mammals of the world: Systematics and distribution. Society for Marine Mammalogy Special. Publication 4. 231 p.

Rugh, D.J., M.M. Muto, S.E. Moore, and D.P. DeMaster. 1999. Status review of the eastern North Pacific stock of gray whales. U.S. Department of Commerce. NOAA Tech. Memo. NMFS-AFC-103. 96 p.

USFWS (U.S. Fish and Wildlife Service). 1997. Endangered and threatened wildlife and plants. U.S. Dep. of Interior, U.S. Government Printing Office, Washington, DC. 52 p.

Weller, D.W. and R.L. Brownell, Jr. 2000. *Eschrichtius robustus* (Asian or Northwest Pacific Stock). In: C. Hilton-Taylor (comp.) 2000 IUCN Red List of Threatened Species. IUCN/SSC, Gland, Switzerland and Cambridge, UK.

Weller, D.W., A.L. Bradford, A.M. Burdin, T. Miyashita, T. Kariya, A.M. Trukhin, S.A. MacLean, V.A. Vladimirov and N.V. Doroshenko. 2002a. Photographic recaptures of western gray whales in the Okhotsk Sea. Report to the International Whaling Commission (SC/54/BRG13). 8p.

Weller D.W., A.M. Burdin., A.L. Bradford, G.A. Tsidulko, Y.V. Ivashchenko and R. L. Brownell Jr. 2002b. Gray whales off Sakhalin Island, Russia: June-September 2001. A joint U.S.-Russian scientific investigation. Draft final Report by Texas A&M University, College Station, TX, and Kamchatka Institute of Ecology and Nature Management, RAS, Petropavlovsk-Kamchatskii, Russia, for SEIK, Yuzhno-Sakhalinsk, Russia. 75 p.

Whitehead H. 1990. Computer assisted individual identification of sperm whale flukes. Report of the International Whaling Commission (Special issue), 12 P.71-77.

FIGURES

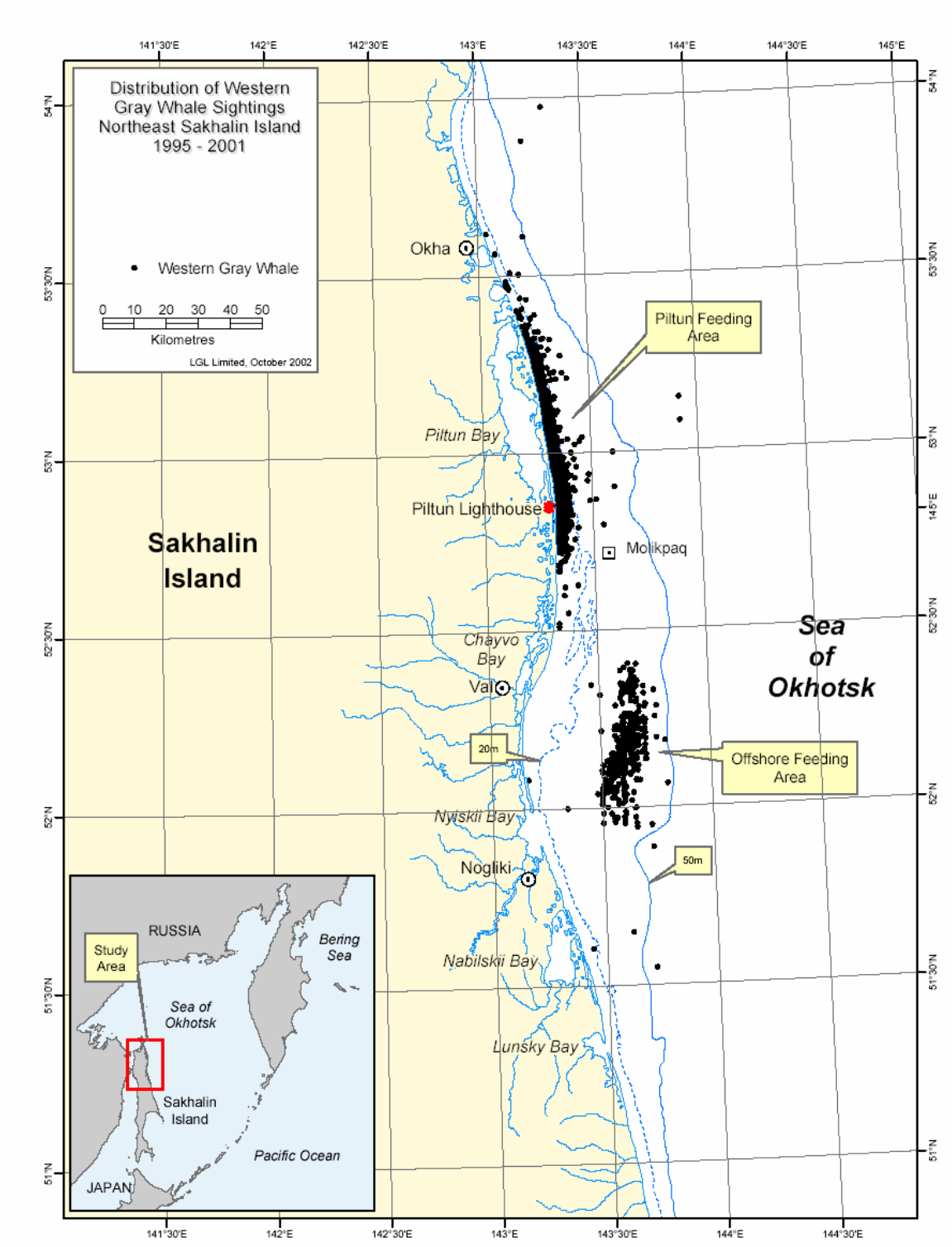

Figure 1. Western gray whale feeding areas off the northeast coast of Sakhalin Island, Russia.

Figure 2. Research ship *Nevelskoy*.

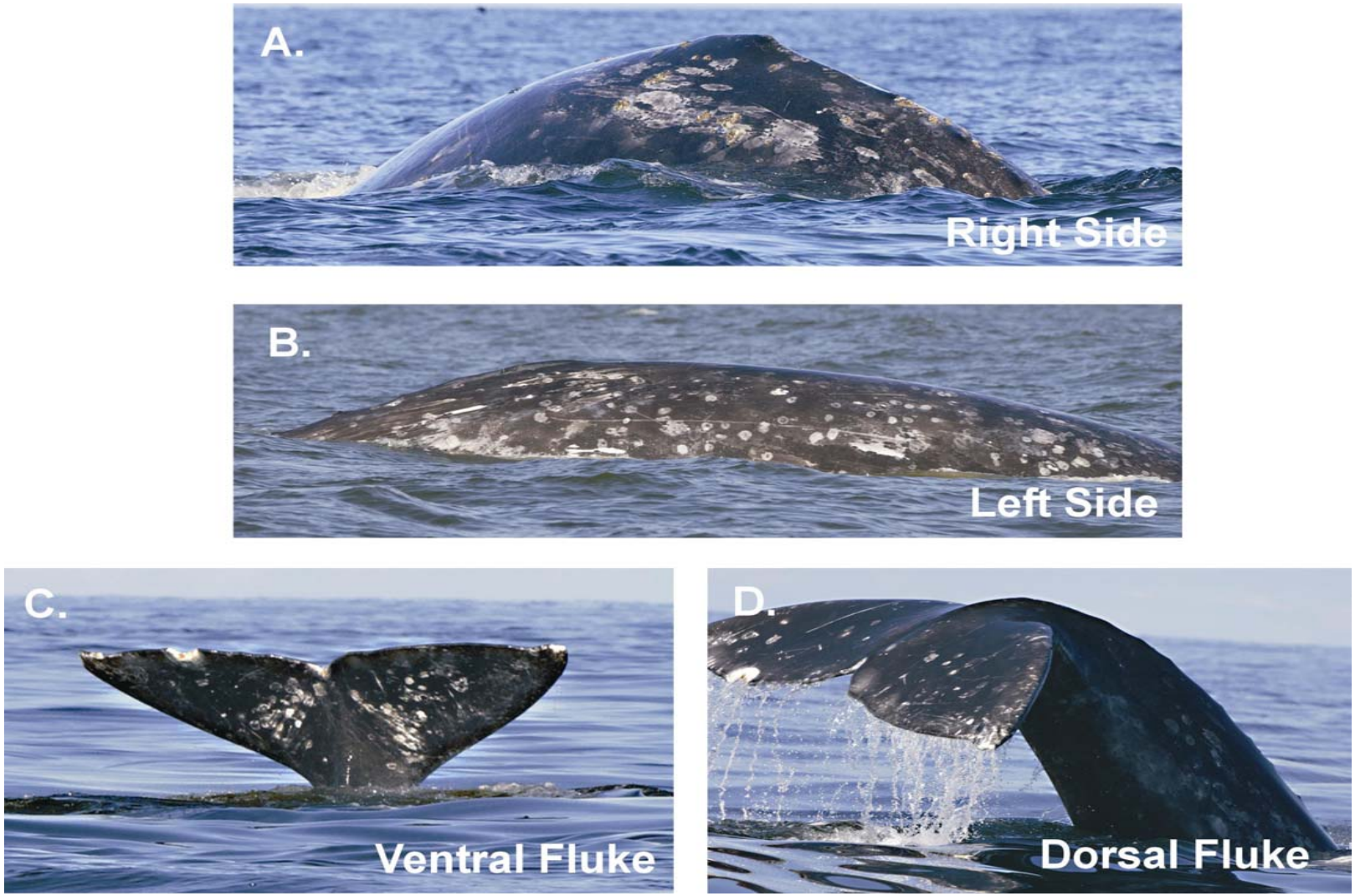

Figure 3. Views photographed and used for matching and identification of individual western gray whales.

Figure 4. Distinctive markings or “callosities” on the head of a western gray whale, photographed off the northeast coast of Sakhalin Island, Russia.

Figure 5. Right side of abnormally thin western gray whale photographed in the Offshore feeding area off the northeast coast of Sakhalin Island, 12 October 2002.

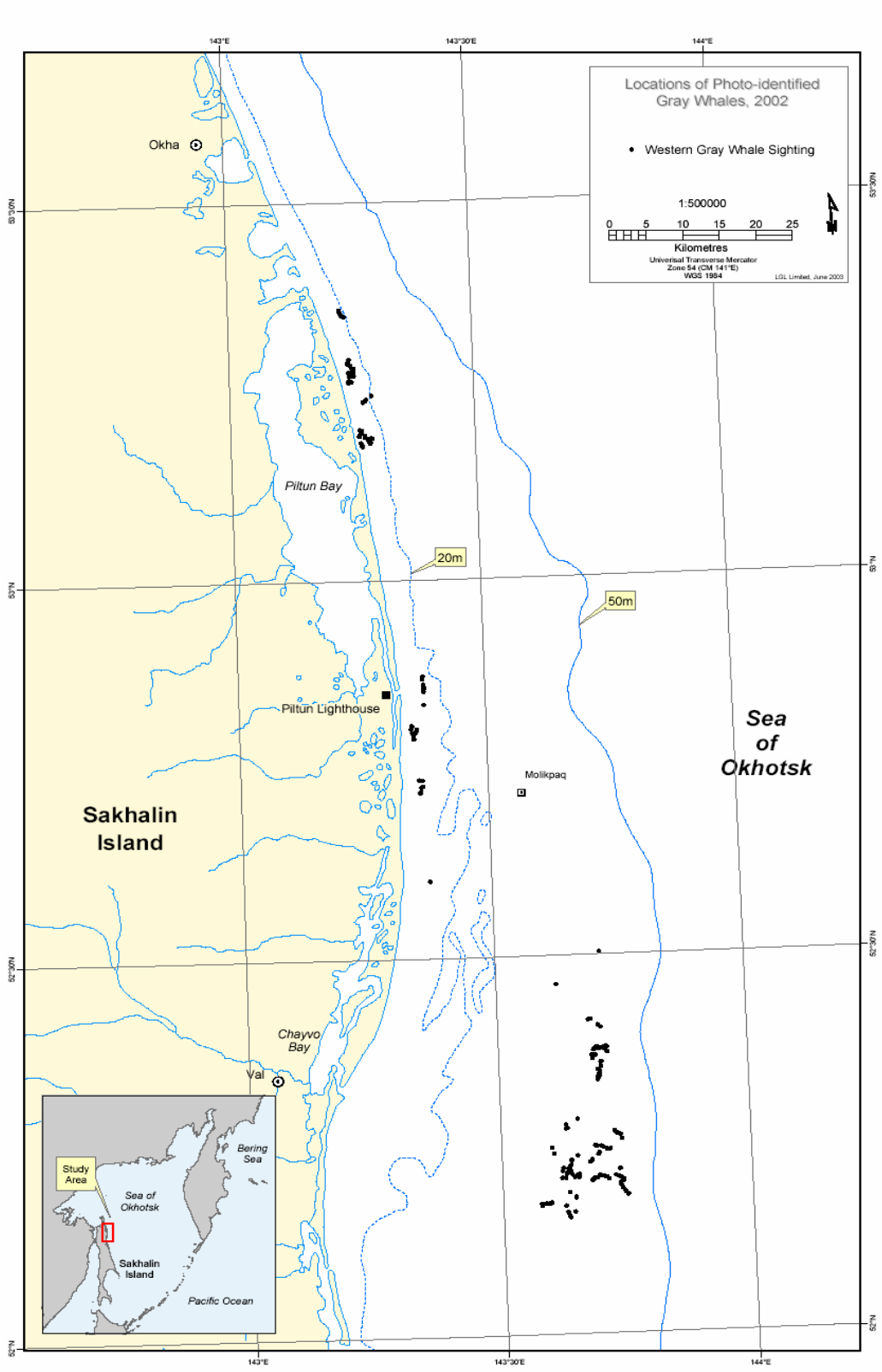

Figure 6. Locations of photo-identified western gray whales off the northeast coast of Sakhalin Island, Russia, 2002.

TABLES

Table 1. Distribution of time spent on the *Nevelskoy*, 2002.

Date	Type of activity	Number of days
August 30 - September 4	sailing from Vladivostok	6
September 5 - 10	actual operations	6
September 11 - 12	storm conditions	2
September 13 - 20	actual operations	8
September 21	storm conditions	1
September 22 - 30	actual operations	9
October 1 - 5	storm conditions	5
October 6 - 7	relocation, shelter from storm	2
October 8 - 9	storm conditions	2
October 10 - 13	actual operations	4
October 14	storm conditions	1
October 16 - 17	transferring equipment	2
October 17 - 25	sailing to Vladivostok, storms	9
	Total	**57**
	actual operations	27 days
	of the research personnel	or 47.4%

Table 2. Overall data on mission duration and photographing frequency for the Nikon D1X digital camera during whale photo-identification off the northeast coast of Sakhalin Island, Russia, 2002.

Date	Mission No.	Duration in minutes	No. of NikonD1X frames	No. of whales encountered
2002-09-14	1	160	104	7
	2	89	77	
2002-09-15	1	50	3	2
2002-09-16	1	97	28	8
	2	62	16	
	3	94	57	
2002-09-17	1	96	0	4
	2	77	9	
2002-09-23	1	165	239	12
	2	128	94	
2002-09-24	1	178	118	16
	2	128	116	
2002-09-27	1	82	51	2
	2	7	5	
2002-09-28	1	107	80	7
	2	156	105	
2002-10-07	1	180	203	10
2002-10-10	1	107	86	6
	2	101	147	
2002-10-11	1	213	402	5
2002-10-12	1	136	120	12
	2	98	153	
2002-10-15	1	57	71	2
	2	86	71	
Total		2654	2355	93
13 days	24 missions	44 hours14 min.		

Total time spent photographing whales
(not counting the time from Zodiac launch to actual photography,
from the end of photography to the return to the ship):

2654 min. (44hr.14min.)
24 missions
Avg. number of missions per photo day - 1.8
Avg. duration of the "net time" of a mission -110.6 min.

Photographs (and video) were taken over 13 days, together with benthos operations.

Averaged photography (data only for the D1X digital camera) :

181 frames per photo day
98 frames per "net time" of one mission
0.89 frames per minute
1 frame per 1.13 minutes

A total of 93 whale encounters were recorded during this time (including repeat encounters and the number of whales that have been identified at this time from less than all four views)

Avg. number of whales encountered per photo day - 7.15

Table 3. Zodiac time on water when traveling from Nevelskoy to gray whale groups before starting photo-identification.

Date	Mission No.	Zodiac operating time launch	arrival	Time from launch to photography
2002-09-14	1	14:04	16:49	12
	2	17:28	19:20	8
2002-09-15	1	17:54	19:04	13
2002-09-16	1	10:30	12:32	18
	2	13:38	15:16	16
	3	15:43	18:07	19
2002-09-17	1	10:00	11:51	8
	2	13:19	15:32	7
2002-09-23	1	12:05	15:13	18
	2	15:48	18:11	7
2002-09-24	1	12:37	15:25	4
	2	15:55	18:17	6
2002-09-27	1	11:10	12:39	4
	2	13:48	16:14	95
2002-09-28	1	9:51	11:51	6
	2	12:52	15:55	20
2002-10-07	1	10:35	13:45	5
2002-10-10	1	10:13	12:18	8
	2	15:59	18:04	10
2002-10-11	1	12:56	16:46	9
2002-10-12	1	12:56	15:47	28
	2	16:17	18:21	8
2002-10-15	1	9:53	11:23	8
	2	14:20	16:03	4

Table 4. Summary data on photo-identification of gray whales in the Offshore area, northeast Sakhalin Island, Russia, 2002.

Date	Mission No.	Duration of mission "net time"	No. of D1X frames	Number of whales
2002-09-14	1	160	104	7
	2	89	77	
2002-09-15	1	50	3	2
2002-09-16	1	97	28	8
	2	62	16	
	3	94	57	
2002-09-17	1	96	0	4
	2	77	9	
2002-09-23	1	165	239	12
	2	128	94	
2002-09-24	1	178	118	16
	2	128	116	
2002-10-10	1	107	86	6
	2	101	147	
2002-10-11	1	213	402	5
2002-10-12	1	136	120	12
	2	98	153	
9 days	17 missions	1979 min. 32 hr.59min.	1769	72

Total time spent photographing whales in the offshore area
(not counting the time from Zodiac launch to actual photography,
from the end of photography to the return to the ship):

1979 min. (32hr.59min.)
17 missions
Avg. number of missions per photo day - 1.9
Avg. duration of the "net time" of a mission -116.4 min.

Photographs (and video) were taken over 9 days, together with benthos operations.

Averaged photography (data only for the D1X digital camera) :

204 frames per photo day
104 frames per "net time" of one mission
0.89 frames per minute
1 frame per 1.12 minutes

A total of 72 whale encounters were recorded over 9 days (including repeat encounters and the number of whales that have been identified at this time from less than all four views)

Avg. number of whales encountered per photo day - 8.0

Table 5. Summary data on photo-identification of gray whales in the Piltun area, northeast Sakhalin Island, Russia, 2002.

Date	Mission No.	Duration of mission "net time"	No. of D1X frames	Number of whales
2002-09-27	1	82	51	2
	2	7	5	
2002-09-28	1	107	80	7
	2	156	105	
2002-10-07	1	180	203	10
	2	98	153	
2002-10-15	1	57	71	2
	2	86	71	
		773 min.	739	21
4 days	8 Missions	12hr.53min		

Total time spent photographing whales:
(not counting the time from Zodiac launch to actual photography,
or from the end of photography to the return to the ship):

773 min. (12hr.14min)
8 missions
Avg. number of missions per photo day - 2.0
Avg. duration of "net time" of a mission - 96.6 min.

Photographs (and video) were taken over 4 days, together with benthos operations.

Averaged photography (data only for the D1X digital camera) :

185 frames per photo day
92 frames per "net time" of one mission
0.96 frames per minute
1 frame per 0.96 minutes

A total of 21 whale encounters were recorded over 4 days (including repeat encounters and the number of whales that have been identified at this time from less than all four views)

Avg. number of whales encountered per photo day - 5.25

Table 6. Number of identification views and occurrence frequency.
of gray whales off northeast Sakhalin Island, 2002

Whale No.	Number of views for photo-ID	Number of encounter days
RGW001	4	1
RGW002	4	3
RGW003	4	2
RGW004	2	1
RGW005	2	2
RGW006	4	2
RGW007	4	1
RGW008	4	1
RGW009	3	1
RGW010	2	2
RGW011	1	1
RGW012	4	2
RGW013	1	1
RGW014	1	1
RGW015	3	1
RGW016	4	3
RGW017	1	1
RGW018	4	3
RGW019	4	1
RGW020	4	1
RGW021	1	2
RGW022	2	1
RGW023	1	1
RGW024	4	2
RGW025	4	1
RGW026	2	2
RGW027	1	1
RGW028	4	2
RGW029	2	2
RGW030	3	2
RGW031	2	1
RGW032	2	2
RGW033	1	1
RGW034	2	1
RGW035	1	1
RGW036	1	1
RGW037	1	1
RGW038	1	1
RGW039	1	1
RGW040	1	1
RGW041	1	2
RGW042	4	2
RGW043	1	1
RGW044	1	1
RGW045	4	1
RGW046	4	1
	2.4 views per whale	1.4 occurrence frequency

per whale

In total:
4 views were obtained for 17 whales
3 views were obtained for 3 whales
2 views were obtained for 9 whales
1 view was obtained for 17 whales

Whale occurrence frequency for the entire photo period (13 days):
3 whales were encountered 3 times
14 whales were encountered 2 times
27 whales were encountered once