

## Movements of western gray whales from the Okhotsk Sea to the eastern North Pacific

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### ABSTRACT

The western North Pacific (WNP) population of gray whales (*Eschrichtius robustus*) is listed as critically endangered by the IUCN and its continued ability to survive is of concern. As part of a long-term study on WNP whales off Sakhalin Island, Russia, a photo-catalog comparison to eastern North Pacific (ENP) gray whales was undertaken to detect possible population mixing. The WNP/ENP catalog comparison involved 181 and 1,200 individuals, respectively, and resulted in six matches (three males, two females, and one whale of unknown sex). Three of the six whales were first identified as calves (with their mothers) off Sakhalin. All ENP sightings of Sakhalin whales occurred off southern Vancouver Island, BC, and were collected during only two days of effort. Three whales were identified on 02 May 2004 and 25 April 2008, respectively. The three whales in 2004 were together in a single group, while the three whales in 2008 were in two groups in close proximity. All six whales were sighted off Sakhalin prior to their ENP sightings and five were observed off Sakhalin subsequent to being sighted in the ENP. Four whales were sighted in both the ENP and WNP in the same year, three in 2004 and one in 2008. As the ENP catalog represents only a fraction of the total number of individuals in the ENP population (~19,000), it is likely that more WNP/ENP exchange has occurred than was detected during this comparison. Although these matches provide new records of WNP to ENP movements, winter/spring observations of gray whales off Japan, including a 2006/2007 photo-match from Honshu to Sakhalin, indicate that not all gray whales identified off Sakhalin share a common wintering ground. Thus, it is possible that the number of whales in the WNP population is smaller than previously estimated and therefore of increased conservation concern.

KEYWORDS: GRAY WHALE; PACIFIC OCEAN; MOVEMENT PATTERNS; CONSERVATION

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### INTRODUCTION

The western gray whale (*Eschrichtius robustus*) population is listed as critically endangered by the IUCN and its continued ability to survive is of concern. The most recent population assessment by Cooke *et al.* (2008), using a Bayesian individually-based stage structured model, reported a median 1+ (non-calf) estimate of 130 individuals (90% Bayesian CI = 120-142). Research on this population has been ongoing since 1995, primarily on the feeding ground off northeastern Sakhalin Island, Russia (Weller *et al.*, 1999; Bradford *et al.*, 2008; Lang *et al.*, 2010) but also, recently, off southeastern Kamchatka (Vertyanin *et al.*, 2004; Tyurneva *et al.*, 2010; Burdin *et al.*, 2011).

Our photo-identification studies on the Sakhalin feeding ground have documented (1) pronounced seasonal site fidelity and annual return of known individuals, (2) utilization of the area by reproductive females when pregnant, resting and accompanying their calves and (3) return to the area by many individuals first identified as calves (Weller *et al.*, 1999, 2002; Bradford *et al.*, 2008). Genetic studies utilizing both mitochondrial and nuclear markers have observed significant levels of differentiation between western North Pacific (WNP) and eastern North Pacific (ENP) gray whales, indicating that some degree of reproductive isolation occurs (Lang, 2010; Lang *et al.*, 2011).

Some of the whales identified feeding in the coastal waters off Sakhalin, including reproductive females and calves, have also been documented off the southern and eastern coast of Kamchatka (Tyurneva *et al.*, 2010; Burdin *et al.*, 2011). Further, sightings of whales observed off Sakhalin have been recorded off the northern Kuril Islands in the eastern Okhotsk Sea and Bering Island in the western Bering Sea (Weller *et al.*, 2003).

While information regarding the summer feeding areas of gray whales in the WNP has become increasingly available in the past decade, little is known about the current migratory routes and wintering areas of these animals. Historic evidence suggests that the coastal waters of eastern Russia, the Korean Peninsula and Japan were part of the migratory route at one point in time and that areas in the South China Sea may have been used as wintering grounds (see review in Weller *et al.*, 2002). Observations of gray whales off Japan have been made for hundreds of years (Omura, 1984), including 13 records since 1990 (Kato *et al.* 2010). Between 2005 and 2007, four female gray whales were fatally entrapped in set nets while migrating along the Pacific coast of Honshu. One of these females, entrapped in January 2007, was matched to an earlier photograph of it as a calf (with its mother) while on the Sakhalin feeding ground in 2006 (Weller *et al.*, 2008). This match provided the most contemporary link between the Sakhalin feeding ground and a winter migratory route in WNP.

In an effort to obtain more information about the southern migration route(s) and wintering area(s) of WNP gray whales, a collaborative satellite telemetry project was undertaken in 2010 by a team of Russian and American scientists<sup>1</sup>. A 13-year old male gray whale named “Flex” was tagged on the Sakhalin feeding ground in October 2010 and tracked to the ENP off the west coast of the U.S.<sup>2,3</sup> While the objective of this tagging study was to document gray whale movements in the WNP, the tracking of “Flex” to the ENP provided the impetus for the WNP/ENP photo-identification catalog comparison described herein.

## METHODS

Photo-identification images of 181 individual western gray whales (called the WNP catalog herein<sup>4</sup>) collected off Sakhalin between 1994-2009 by a Russia-U.S. joint research program were compared to a catalog of nearly 1200 eastern gray whales (called the ENP catalog) identified by Cascadia Research Collective and its collaborators working in U.S. and Canadian waters from California to Alaska (Calambokidis *et al.*, 2002; 2010). The ENP catalog focuses on several hundred gray whales called the Pacific Coast Feeding Group (PCFG) that feed during summer and fall in coastal waters between northern California and the Gulf of Alaska but also includes a small number ( $n=247$ ) of migrating gray whales identified in the spring (March to May) during their northward passage to the Bering, Beaufort and Chukchi Seas.

## RESULTS

The WNP/ENP catalog comparison resulted in a total of six confirmed matches, including three males, two females, and one whale of unknown sex (Table 1). None of these six whales are known PCFG animals and, to date, have only ever been sighted a single time during either May or April.

Table 1  
Sighting summary information for six whales matched between the WNP and ENP.

Whale ID	Sex	Years Sighted WNP	Date Sighted ENP	ENP Sighting Coordinates
RUS-U.S. 002 / CRC 0817	M	94-95, 97, 99-01, 04-09	02 May 2004	48°41.41'N 124°58.06'W
RUS-U.S. 032 / CRC 1045 <sup>1</sup>	M	97-98, 01-05, 07-10	25 April 2008	48°53.81'N 125°24.54'W
RUS-U.S. 035 / CRC 0809 <sup>2</sup>	M	95, 97, 98-07, 09-10	02 May 2004	48°41.41'N 124°58.06'W
RUS-U.S. 078 / CRC 0825	U	97, 99, 02-04, 06-10	02 May 2004	48°41.41'N 124°58.06'W
RUS-U.S. 119 / CRC 1040 <sup>3</sup>	F	03, 10	25 April 2008	48°44.01'N 125°07.70'W
RUS-U.S. 135 / CRC 1042 <sup>4</sup>	F	04	25 April 2008	48°44.01'N 125°07.70'W

<sup>1</sup> RUS-U.S. 032 / CRC 1045 – “Flex”. First identified off Sakhalin as a calf in 1997.

<sup>2</sup> RUS-U.S. 035 / CRC 0809 – Putative father of 2 (strict criterion) or 4 (relaxed criterion) Sakhalin calves (for definitions see Lang, 2010). Years that these calves were first identified are: 1998, 2001, 2002 and 2003.

<sup>3</sup> RUS-U.S. 119 / CRC 1040 – First identified off Sakhalin in 2003 as a calf.

<sup>4</sup> RUS-U.S. 135 / CRC 1042 – First identified off Sakhalin in 2004 as a calf.

<sup>1</sup> <http://www.iucn.org/wgwap/?6614/International-scientists-track-endangered-whale-to-discover-breeding-grounds>

<sup>2</sup> <http://mmi.oregonstate.edu/Sakhalin2010>

<sup>3</sup> [http://www.sevin.ru/menues1/index\\_rus.html?../ExpeditionsRAS/Gray\\_whale/Gray\\_whale.html](http://www.sevin.ru/menues1/index_rus.html?../ExpeditionsRAS/Gray_whale/Gray_whale.html)

<sup>4</sup> The number of whales in this catalog ( $n=181$ ) does not correspond to the estimated size of the population.

Remarkably, all six of the matches were from only two days of effort in the ENP, with three whales identified on 02 May 2004 and three on 25 April 2008. The three whales identified on 02 May 2004 were together in a single group while the three whales recorded on 25 April 2008 were in two separate groups but in close proximity. All of the sightings of WNP gray whales in the ENP occurred off the west coast of southern Vancouver Island, BC (near Barkley Sound).

Three of the six whales were first identified as calves (with their mothers) on the Sakhalin feeding ground during 1997 (no. 032/1045), 2003 (no. 119/1040) and 2004 (no. 135/1042), respectively. All six whales had sightings off Sakhalin prior to their respective sightings in the ENP and five (83%) had sightings off Sakhalin subsequent to their ENP sightings. Four whales were sighted in the ENP and WNP in the same year, three in 2004 and one in 2008. Of the three whales identified off Vancouver Island on 02 May 2004, two were sighted off Sakhalin on 31 July 2004 while the third was first sighted on 6 August 2004. "Flex" (no. 032/1045) was sighted off Sakhalin in 2007 during July (29<sup>th</sup>), August (4,18,25<sup>th</sup>) and September (7,8,9<sup>th</sup>), off southern Vancouver Island on 25 April 2008 and then back off Sakhalin on 19 July 2008. The movements of "Flex" detailed here were all prior to the telemetry derived track showing him moving from the WNP off Sakhalin in October 2010 to the ENP off the U.S. west coast in February 2011<sup>1</sup>. Thus, "Flex" has made the trip from the WNP to the ENP more than once.

## DISCUSSION

The six photographic matches reported here provide new information that is of broad significance to understanding the population structure and mixing of gray whales in the Pacific (see Lang *et al.*, 2011). Particularly intriguing is the high number of matches made given that the ENP catalog used for comparison focuses on PCFG whales and has only a small number ( $n=247$ ) of the approximately 19,000 gray whales (Laake *et al.*, 2009) that pass the Pacific Northwest during the spring migration (March to May). Even smaller numbers of whales in the ENP catalog have been identified during the spring off the coast of Vancouver Island where the six whales matched were observed ( $n=26$  for southern Vancouver Island;  $n=48$  for all of western Vancouver Island). Given that the ENP catalog contains only a small fraction (1,200) of the total number of individuals (~19,000) in the ENP population, it is likely that more WNP/ENP exchange has occurred than was detected during this comparison.

The high match rate observed in this study suggests there is a spatio-temporal behavioral factor that makes WNP whales more likely to have been identified in the small ENP spring sample. That all the matches came from sightings on only two days, mostly in the same groups and in localized areas, indicates that whales from the Sakhalin feeding ground remain associated, at least to some degree, even when in the ENP. These six whales were sighted in an area where some whales tend to linger and feed during the northbound migration. Feeding whales are often found in more nearshore waters and over extended periods of time, potentially making them more likely to be photographed than animals rapidly migrating pass the area. The long distance and potential open water crossing required for transit from the ENP to the WNP may make it advantageous for whales to spend time feeding in the Pacific Northwest (e.g. Vancouver Island) prior to undertaking a westerly passage to Sakhalin.

Although the high number of matches reported here was somewhat surprising, WNP to ENP movements were not completely unexpected. Lang (2010) reported that two adult individuals from the WNP, sampled off Sakhalin in 1998 and 2004, matched the microsatellite genotypes, mtDNA haplotypes, and sexes (one male, one female) of two whales sampled off central California on 20 and 23 March 1995. When these two genetic matches are combined with the six photographic matches reported herein, a total of eight adult WNP gray whales have been matched to the ENP. These eight matches include four males and three females, providing evidence that both sexes, in approximately equal numbers, move between the WNP and the ENP. Interestingly, one of the males (no. 035/0809) matched in this study was determined to be the father of two and possibly four calves identified off Sakhalin (Lang, 2010). Despite this level of mixing, significant mtDNA and nuclear genetic differences between whales utilizing the Sakhalin feeding ground and those summering in the ENP support the continued recognition of Sakhalin animals as a distinct unit (Lang *et al.*, 2011).

Adding to the complexity of mixing between the WNP and ENP are contemporary records of gray whales off Japan. There have been 13 reports of gray whales in Japanese waters since 1990 (Kato *et al.*, 2010). One of these reports includes a whale first identified as a calf accompanied by her mother off Sakhalin Island in 2006 that was later fatally entrapped in a set net off the Pacific coast of Honshu in January 2007

Weller *et al.*, 2008). While observations of gray whales in Japan have been made between November and August, a majority of these records are concentrated between March and May. This March to May period coincides with when the six matched whales described here were sighted in the ENP. These findings indicate that not all gray whales identified off Sakhalin share a common wintering ground and suggest that the number of whales estimated to be in the WNP population may possibly be lower than previously thought.

The use of photo-identification methods, in combination with genetic and telemetry techniques, are essential to furthering our understanding of gray whale population structure. It is recommended that other existing photo collections and tissue samples of WNP and ENP gray whales (e.g. those from Sakhalin, Kamchatka, Chukotka, Mexico and Japan) be used to further examine gray whale movement patterns and population structure within the Pacific. Ideally, a collaborative Pacific wide study should be undertaken, similar in scope to what has been done for humpback whales in the Atlantic and Pacific.

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