The Incidence of Killer Whale Tooth Rakes on Western Gray Whales off Sakhalin Island, Russia

DAVID W. WELLER [1], AMANDA L. BRADFORD [2], ALEXANDER M. BURDIN [3, 4] AND ROBERT L. BROWNELL, JR. [1]

[1] NOAA Fisheries, Southwest Fisheries Science Center, La Jolla, California, USA

[2] School of Aquatic and Fishery Sciences, University of Washington, Seattle, Washington, USA

[3] Kamchatka Branch of Pacific Institute of Geography, Far East Branch - Russian Academy of Sciences, Petropavlovsk, Kamchatka, RUSSIA

[4] Alaska Sealife Center, Seward, Alaska, USA

Contact e-mail: dave.weller@noaa.gov

INTRODUCTION

Killer whales (*Orcinus orca*) are known to attack nearly all species of baleen whales but observations of attacks are not common. Gray whales (*Eschrichtius robustus*) are the species most frequently observed to be attacked by killer whales. Although observations of killer whale attacks on large whales are relatively few, the presence of killer whale tooth rakes on the bodies, flippers, and flukes of most species of baleen whales demonstrate that non-lethal attacks occur. This paper provides a preliminary analysis of the incidence of killer whale tooth rakes on western gray whales photo-identified off Sakhalin Island, Russia.

METHODS

From 1997 to 2007, following an opportunistic effort in 1994 and a pilot study in 1995, western gray whale photo-identification surveys were carried out annually during summer months off the northeastern coast of Sakhalin Island, Russia, in the nearshore waters proximate to Piltun Lagoon. Further information about the study area and a detailed description of the photo-identification data collection and analysis protocols can be found in Weller *et al*. (1999). From 1994 to 2007, 337 photo-identification surveys were conducted, resulting in 5,167 sightings of 169 individual whales. A sighting consisted of at least one high quality photo-identification image, although usually multiple images were collected. Additionally, 14 sightings of 11 of these individuals were obtained in 2002 during a survey of an ephemeral feeding area approximately 60 km southeast of Piltun Lagoon (Burdin *et al*., 2002). Overall, 34,030 film and digital images from 5,181 sightings of 169 photo-identified western gray whales were examined in the present scarring analysis. The sex of 142 of these individuals is known from genetic analyses of biopsy samples collected in coordination with photo-identification efforts (Weller *et al*., 2008).

A protocol employed to quantify anthropogenic scarring of western gray whales (Bradford *et al*., 2009) was extended to assess killer whale tooth rakes on these whales. As the aim of the scar quantification approach was to provide a minimum estimate of killer whale interactions, the entire photo-identification dataset was utilized, even though: 1) photographic coverage is unequal across body regions within and between individuals, and 2) the target body region for photo-identification may not be particularly vulnerable to scarring. Therefore, all available images of an individual whale were examined for the presence of killer whale rake marks in 21 defined regions spanning the entire body (Fig. 1). Specifically, for each survey sighting of a whale, one or more of the designated codes (Table 1) were assigned to all body regions of that individual. Thus, a line of recorded data consisted of 21 cells, each comprised of one or more codes indicating if the body region of that whale during that sighting was either: (1) without killer whale scarring; (2) with killer whale scarring; (3) partially visible with or without killer whale scarring; or 4) not visible. These data for each survey sighting were then collapsed in order to produce an annual killer whale scar composite of each whale for use in subsequent summaries and analyses. An annual killer whale scar composite was thus one line of data containing all information (i.e., presence of killer whale scarring and degree of visibility) gleaned about each body region of a whale during a given year. Note that while the described protocol systematically quantified the presence of killer whale scarring, it could not enumerate scarring events. All coding was conducted by one analyst (ALB), as recommend for consistency in scarring analyses (Neilson, 2006). However, it was previously demonstrated that this protocol could be used by more than one researcher to achieve similar results (Bradford *et al*., 2009). Killer whale rake mark determinations in the present analysis were based on images and descriptions from other baleen whale studies (e.g., George *et al*., 1994; Naessig and Lanyon, 2004; Mehta *et al*., 2007; Steiger *et al*., 2008).

RESULTS

The 5,181 survey sightings were collapsed into 844 annual scar composites representing 169 photo-identified western gray whales, with a median of four composites per whale (range = 1-11). Of the 169 photo-identified individuals, 74 whales (43.8%; 39 males, 26 females, nine of unknown sex) were found to have evidence of at least one killer whale encounter based on the presence of visible scarring (Fig. 2). At least 22 of these whales (29.7%; 14, 6, 2) were determined to have been attacked during the course of the study based on observing a formerly unscarred fully visible body region later acquire killer whale rake marks. These male and female whales include both calves and non-calves, although relatively few attacks on calves were identified (Fig. 3). In eight of these cases, the annual timing of the interaction was apparent (i.e., when a body region was coded as fully visible without the scar in the year preceding a new killer whale scar designation). Of these occurrences, the presumed killer whale interactions occurred in the months prior to the 1999 (one calf of unknown sex), 2000 (one male non-calf), 2001 (one male non-calf and one female calf), 2002 (one male calf), 2003 (two male non-calves) and 2007 (one male calf) field seasons. Most of the killer whale rake marks were found on the left and right tips and trailing edges of the flukes (BR12, BR14, BR17, and BR18), followed by the left and right back and dorsal ridge (BR5, BR6, BR7L, and BR7R) (Fig. 4).

DISCUSSION

The relatively high incidence of killer whale tooth scarring on some regional populations of baleen whales suggests that predatory attempts are probably more regular than indicated by field observations alone, and many attacks are unsuccessful. Tooth rakes may not be truly indicative of predation attempts by killer whales however, but may instead represent capture practice or instruction of predatory techniques for younger members of the group. Rake marks may also result from killer whales testing baleen whales to assess the presence of particularly vulnerable individuals (i.e., calves) that may be easily separated from a group and killed.

The incidence of killer whale tooth scars on western gray whales is markedly high when compared to similar estimates made for other baleen whale populations. Mehta *et al*. (2007) used photographic and sighting data from long-term studies of baleen whales in 24 regions worldwide to determine the proportion of whales with killer whale tooth rakes. The results of this study showed that there is considerable geographic variation in the proportion of whales with rake marks, ranging from 0% to 40% in different regions. Steiger *et al*. (2008) reported that 15% of the photographs collected from humpback whales (*Megaptera novaeangliae*) throughout the North Pacific contained killer whale tooth rakes. The overall average for humpback wintering areas and feeding areas were 18% (range = 6-31%) and 9% (range = 5-20%), respectively.

The western gray whale population is critically endangered and at such low numbers that even low levels of mortality related to killer whale attacks could hinder its recovery. Thus, the high incidence of killer whale scars documented in the current study may represent a previously underestimated threat to the population.

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Table 1

Scar codes assigned to western gray whale body regions during image analysis, as adapted from Hamilton et al. (1998) in Bradford et al. (2009)

Code	Definition	Description
N	No Scar	No killer whale scars visible
*	New Scar	Used in combination with the killer whale scar code to indicate the first sighting of a scar
O	Killer whale rake marks	Highly structured scars in the form of thin, white parallel lines
P	Partially Visible	Used in combination with the killer whale scar code to denote that the body region is only partially photographed or is too dark, out of focus, or distant in the image to completely assess scarring[a]
X	Not Visible	Body region was not photographed at all or is too dark, out of focus, or distant in the image to assess scarring

[a] The ventral portions of the following body regions (BR) were assumed never to be visible: BR5, BR6, BR8, and BR9. Thus, a ‘P’ was not assigned in these regions unless parts of the dorsal surface were obscured or not photographed.

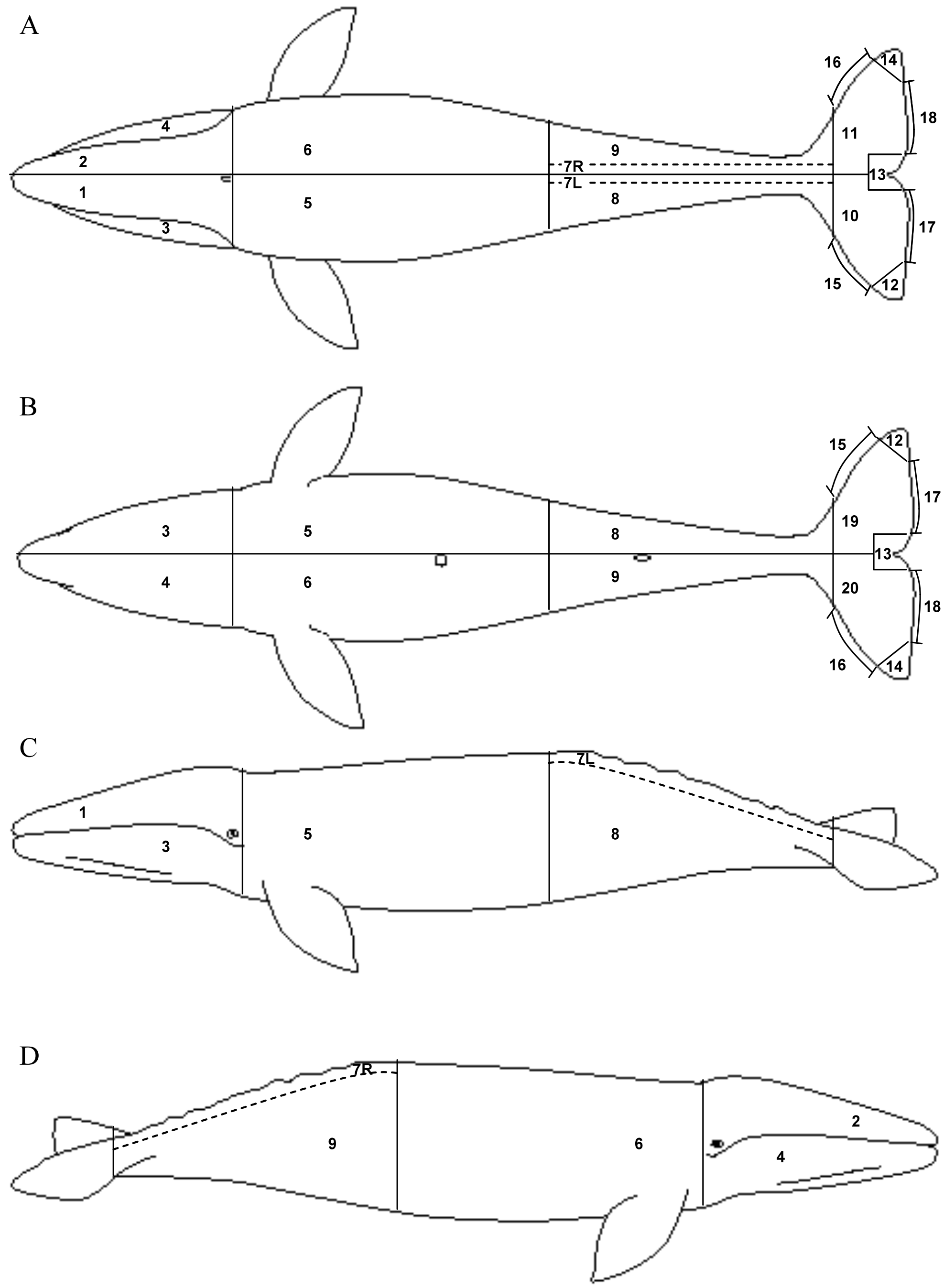

Fig. 1. Dorsal (A), ventral (B), left side (C), and right side (D) views of western gray whale body regions (n = 21) examined for killer whale scarring. Note that while body regions are numbered 1 through 20, number 7 is divided into separate right (R) and left (L) regions. Gray whale outlines courtesy of J. L. Sumich.

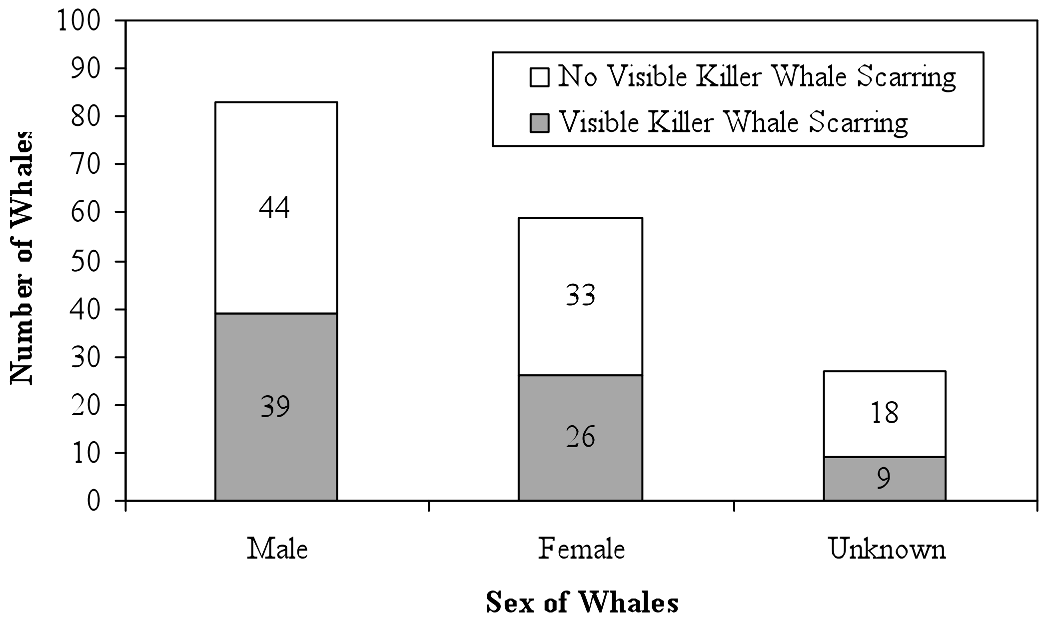

Fig. 2. Number of western gray whales (n = 169) with and without visible killer whale rake marks according to sex class.

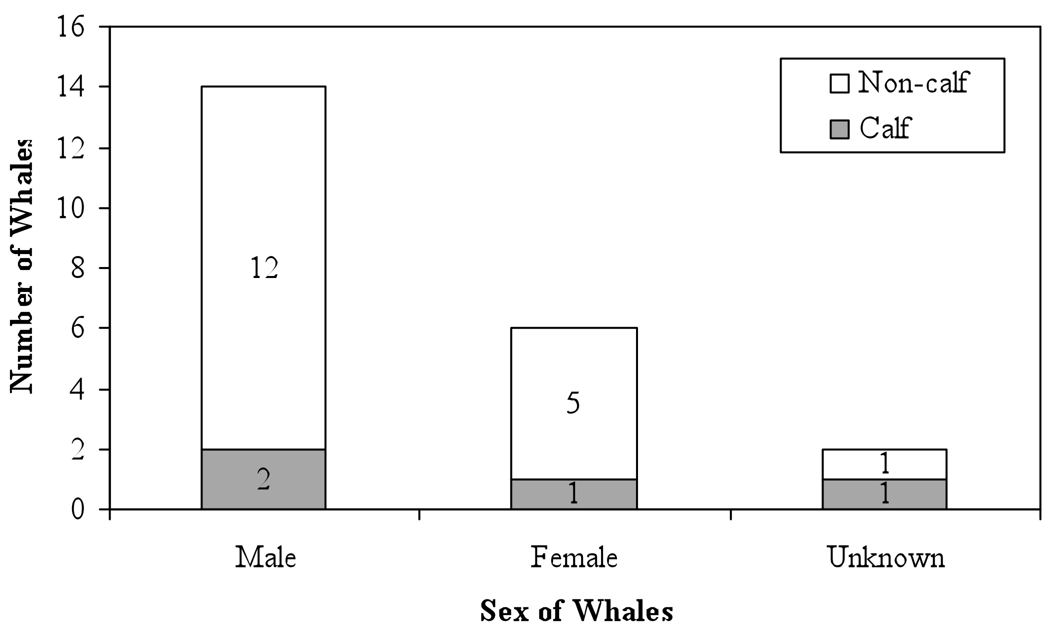

Fig. 3. Number of western gray whales (n = 22) determined to have acquired killer whale rake marks during the course of the study according to sex class.

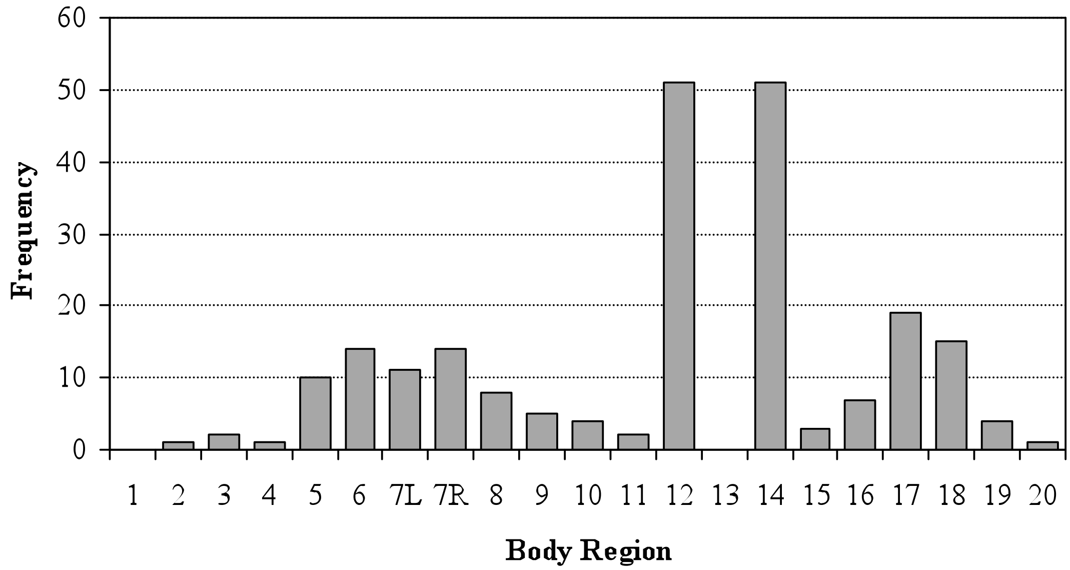

Fig. 4. Frequency of killer whale rake mark sets (n = 222) by body region for 169 photo-identified western gray whales. Note that while repeated observations of the same rake marks within a body region are represented only once per individual, individual whales can have rake marks across multiple body regions.