Humpback Whale Entanglement in Fishing Gear in Northern Southeastern Alaska

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Abstract

The prevalence of non-lethal entanglements of humpback whales in fishing gear in northern southeastern Alaska (SEAK) was quantified using a scar-based method. The percentage of whales assessed to have been entangled ranged from 52 percent (minimal estimate) to 71percent (conditional estimate) to 78 percent (maximal estimate). The conditional estimate is recommended because it is based solely on whales with unambiguous scars. Eight percent of the whales in Glacier Bay/Icy Strait acquired new entanglement scars between years, although the sample size was small. Calves were less likely to have entanglement scars than older whales and males may be at higher risk than females. The percentage of whales with entanglement scarring is comparable to the Gulf of Maine where entanglement is a substantial management concern. Consequently, SEAK humpback whale-fisheries interactions may warrant a similar level of scrutiny.

Introduction

From 1997 through 2004, 52 humpback whales (*Megaptera novaeangliae*) were reported entangled in fishing nets and/or lines in Alaska (or were reported elsewhere and were confirmed to be entangled in Alaskan fishing gear.) Seventy-seven percent of the reports involved SEAK humpback whales (unpublished data, National Marine Fisheries Service (NMFS) Alaska Regional Office). Wounds resulting from entanglements can often be seen on the posterior caudal peduncle (the narrowing of the body at the insertion point of the flukes). These wounds can remain visible as unique scarring patterns years after the entanglement incident.

Robbins and Mattila (2001) examined whales' caudal peduncles for entanglement-related scarring and concluded that 48–65 percent of the humpback whales photographed annually between 1997 and 2002 in the Gulf of Maine had been entangled. Until now there have been no systematic efforts to quantify the prevalence of humpback whale entanglement in Alaska. Managers in southeastern Alaska have had to rely on eyewitness reports as the only estimate of the magnitude of the problem, but not all entangled whales are found or reported. In 2001, NMFS acknowledged the pressing need for a detailed assessment of humpback whale entanglement in Alaska.

The objectives of this study were to (1) estimate the percentage of humpback whales in northern SEAK that have been non-lethally entangled based on caudal peduncle scars, (2) analyze the entanglement scar data in conjunction with existing long-term humpback whale demographic data to identify any particularly vulnerable segments of the humpback whale population and (3) describe the distribution of scarred humpback whales in relation to the distribution and amount of commercial fishing in the study area. This paper focuses on objectives 1 and 2 only.

Methods

We conducted 1,139 hours of vessel-based surveys for humpback whales in northern SEAK between May 2003 and November 2004. We approached the whales in outboard-driven motorboats 4–6.5 m in length and took high resolution photographs of each whale's caudal peduncle by operating the boat parallel and slightly forward of each whale as it dove. In order to reduce observer bias towards scarred whales, we collected caudal peduncle photographs from all suitably positioned whales. Whales were identified based on the pigmentation and morphology of the ventral surface of their tail flukes and dorsal fin.

We used a photographic coding technique developed and ground-truthed in the Gulf of Maine by Robbins and Mattila (2001) to assess the likelihood that a whale had been entangled in the past. We divided each whale's caudal peduncle into six areas, coded these areas for signs of entanglement-related scarring (table 1) and assigned an overall entanglement status code (table 2) to whales with adequate photographic coverage.

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Table 1. Summary of scar code descriptions (after Robbins and Mattila, 2001).

Code	Scar Code Description
S0	No visible marks
S1	Non-linear marks or apparently randomly oriented linear marks
S2	Linear marks or wide areas lacking pigmentation, which did not appear to wrap around the feature
S3	Linear or wide scars which appeared to wrap around the feature
S4	At least one visible linear notch or indentation (generally on the dorsal or ventral peduncle)
S5	Extensive tissue damage and deformation of the feature
SX	Feature could not be coded due to lack of photographic coverage or inadequate photo quality

Three methods were used to estimate the percentage of whales that had been non-lethally entangled:

$$\text{Minimal Entanglement Scarring Percentage} = \frac{\sum E3 + \sum E4}{\sum E0 + \sum E1 + \sum E2 + \sum E3 + \sum E4}$$

$$\text{Conditional Entanglement Scarring Percentage} = \frac{\sum E3 + \sum E4}{\sum E0 + \sum E1 + \sum E3 + \sum E4}$$

$$\text{Maximal Entanglement Scarring Percentage} = \frac{\sum E2 + \sum E3 - \sum E4}{\sum E0 + \sum E1 + \sum E2 + \sum E3 + \sum E4}$$

where:

E0, E1, E2, E3 and E4=the number of whales assigned entanglement status codes E0, E1, E2, E3 and E4, respectively.

Two-tailed Fisher's exact tests of independence (Zar, 1999) were used to test for significant differences between percentages.

Individual whales with adequate photographs in both years were used to estimate the annual rate of entanglement scar acquisition between 2003 and 2004. The whale's caudal peduncle photographs from both years were compared and assessed to estimate the amount of new entanglement-related scarring occurring between 2003 and 2004. This rate was calculated by dividing the number of whales in 2004 with an increase in entanglement scarring by the total number of individuals with adequate photographic coverage in both years.

Table 2. Summary of entanglement status codes (after Robbins and Mattila, 2001).

Code	Likelihood of Past Entanglement	Entanglement Status Code
E0	NONE	No evidence of entanglement (no marks present)
E1	LOW	Marks were observed, but did not suggest a previous entanglement. Scar codes did not generally exceed S2 in any documented region
E2	AMBIGUOUS	Entanglement-like elements were present, but there was no consistent pattern. At least one region was generally assigned a scar code of S3 or higher
E3	HIGH	Marks appeared to be entanglement-related and minor tissue damage was evident. At least two regions were generally assigned scar codes of S3 or higher
E4	HIGH	Marks appeared to be entanglement-related and major tissue damage was evident. At least two regions were assigned scar codes of S3 or higher. At least one region was coded as S5

Results

We photographed the caudal peduncle of 303 humpback whales and assigned entanglement status codes to 180 unique individuals. The photographic coverage and/or quality of 123 whales was insufficient to assign codes (*i.e.,* photographs were too distant, blurry and/or were taken at a poor angle).

The percentage of whales assessed to have been entangled ranged from 52 percent (95 percent CI: 45 percent, 60 percent) (minimal estimate) to 71 percent (95 percent CI: 62 percent, 78 percent) (conditional estimate) to 78 percent (95 percent CI: 72 percent, 84 percent) (maximal estimate). The conditional estimate is recommended because it is based solely on unambiguous scars. Eight percent (95 percent CI: 1 percent, 25 percent) of the whales in Glacier Bay/Icy Strait acquired new entanglement scars between 2003 and 2004.

The whales with adequate quality photographs consisted of 62 females, 33 males and 85 whales of unknown sex. The minimal scarring percentage of males (82 percent) was higher than that of females (55 percent) and the difference was significant (P=0.013). However, males and females did not have significantly different conditional scarring percentages (males 87 percent, females 72 percent) (P=0.165) or maximal scarring percentages (males 88 percent, females 79 percent) (P=0.402).

The whales with adequate quality photographs consisted of 12 calves (*i.e.,* whales less than one year old) and 168 older whales. The minimal scarring percentage of calves (17 percent) was lower than that of older whales (55 percent) and the difference was significant (P=0.015). In addition, the conditional scarring percentage of calves (29 percent) was lower than that of older whales (73 percent) and the difference was significant (P=0.023). However, calves and older whales did not have significantly different maximal scarring percentages (calves 58 percent, older whales 80 percent) (P=0.137).

Discussion and Conclusions

The minimal, conditional and maximal entanglement scarring percentages indicate that the majority (52–78 percent) of the humpback whales in northern SEAK have been entangled at some point in their lives. Most apparently shed the gear on their own, unless whales are being disentangled by humans much more often than is reported. The conditional estimate (71 percent) is recommended because it is based solely on whales with unambiguous scars. The estimate of the annual rate of entanglement scar acquisition (8 percent) is highly uncertain due to the small sample size of whales with adequate photographs in both years. Similar rates of annual entanglement scar acquisition were found in the Gulf of Maine from 1997 through 2002 (8–25 percent) (Robbins and Mattila 2004).

These results indicate that entanglements are much more common in northern SEAK than previously thought based on reports of entangled whales. Nevertheless, a scar-based approach is expected to underestimate the true frequency of entanglement because it cannot account for (1) whales that died before they could be detected, (2) entanglements that did not involve the caudal peduncle and (3) entanglement injuries that were so old or faint that they had healed beyond recognition. In addition, whales that were entangled once were coded the same as whales that were entangled multiple times.

The minimal estimates indicate that male humpback whales may be more likely to become non-lethally entangled than female humpback whales. It is unknown why males would have a higher minimal entanglement percentage than females. The fact that males' and females' maximal and conditional scarring percentages were not significantly different indicates that the difference in minimal scarring percentages is attributable to differences in the number of whales of each sex with an ambiguous entanglement history.

The minimal and conditional estimates suggest that calves are less likely to become non-lethally entangled than older whales. A lower incidence of scarring in calves is expected because calves had less time to accumulate entanglement scarring than adults. However, the minimal scarring percentage of calves in northern SEAK (17 precent) was higher than in the Gulf of Maine, where only 9 percent of calves were assessed to have been entangled (Robbins and Mattila, 2001), but this is not a significant difference. Continued sampling of calves in SEAK would elucidate if the scarring percentages found during this study are typical.

Management Implications

From a management perspective, data on the rate of serious injury and mortality due to entanglements would be most useful but are difficult, if not impossible, to obtain. Scarring data cannot be used to estimate the lethal entanglement rate. Managers also need to know the effects of non-lethal entanglements on humpback whale fitness. For instance, female humpback whales in the Gulf of Maine that survived being entangled were less likely to be lactating than females that had not been entangled, suggesting that non-lethal entanglements may have an impact on reproductive success (Robbins and Mattila, 2001).

While the specific circumstances that led to most past entanglements will never be known, a description of the current distribution of commercial, subsistence and sport fishing gear in SEAK which overlaps with areas of high whale numbers seasonally would increase managers' understanding of sources of current potential threats to this population on a regional scale and could help inform management actions aimed at preventing entanglements. This approach would entail identifying areas where humpback whales regularly concentrate in SEAK and examining how these areas overlap with fishing "hotspots" to identify areas that may warrant monitoring and/or special protection. Prevention is the key and may mean that some gear modifications are needed. Disentangling whales from fishing gear is a last resort that requires proper training and NMFS authorization.

Humpback whale-fisheries interactions in northern SEAK may warrant a similar level of management scrutiny as the Gulf of Maine where entanglement has been identified as a substantial management concern, based on similarities in the amount of non-lethal entanglement scarring between the two populations.

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