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Behind the Humpback Whale Watching

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Abstract

Humpback whales (Megaptera novaeangliae) have become the hotspot of human boat tourism in recent decades. As a species that spends a huge amount of time near coasts for migrating, breeding, and reproducing, humpback whales are very accessible for the whale watching industry and can be potentially affected by it. A few well-studied whale-watching potential impacts on their daily behaviors, reproduction and breeding, or migration are analyzed in this paper. It is suggested that boat tourism may have either direct or indirect impacts on humpback whales' daily habits, migration, reproduction, or breeding. This paper can be used as a reference to analyze impacts of whale watching on other whale species and make the whale-watching industry more sustainable.

Keywords

Whale Watching; Humpback Whale; Reproduction; Behavior; Migration; Impacts.

1. Introduction

Whales are an indispensable component of the global ecosystem as they are ecologically significant and human related. They act as consumers of fishes and invertebrates, as prey to other high trophic level predators, as reservoirs for nutrients, and as energy sources and habitats in the deep-sea ecosystem (Roman et al., 2014). The change of whales' population may alter the structure and function of the marine ecosystem. Human activities, especially whale watching, the activity of observing cetaceans including whales and dolphins in their natural habitat, increased drastically in recent years. In 2008, 13 million people participated in whale watching in 119 countries, generating total expenditure of $2.1 billion (O!Connor et al., 2009). The method for the public to watch whales for touristic reasons is mainly by boat tour and the target is mostly humpback whales. Humpback whales (*Megaptera novaeangliae*) spend a huge amount of time near coasts for both reproduction and migration, and most of their breeding grounds are nearshore in Fig 1.

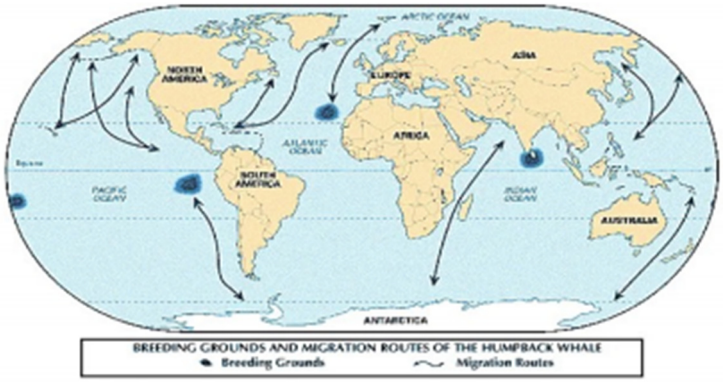

Fig 1. The breeding grounds and migration routes of the humpback whale

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The lines with arrows represent the migration routes of humpback whales in the global view; the dark blue patches are their breeding ground for reproduction. A majority of humpback whales' activities happen around coastal areas, meaning that they are easily influenced by human activities. (*Image: Encyclopædia Britannica, Inc)* Both adult humpback whales and calves move between coastal and offshore during the breeding season (Derville et al., 2018), indicating that they easily contact humans and may be influenced by boat tourism.

Most of the previous research investigated the impacts of boat tourism on the daily behaviors, migrations, or breeding separately. Therefore, collecting, combining, and analyzing those influences will assist scientists better understand how humans should protect humpback whales scientifically and manage the whale-watching industry' environmental sustainability. This paper will analyze a few well-studied impacts caused by whale watching on humpback whales. The research question about how humpback whales are disturbed by the presence of whale watching activities will also be answered. The hypothesis is that daily behaviors, migration, reproduction, and breeding of humpback whales can be affected by boat tourism. This paper allows future researchers to gain a comprehensive and up-to-date understanding of the influences of boat tourism on humpback whale and use a similar research method to investigate effects of human activities on other marine mammals.

2. Discussion

2.1. Behavior

Boat tourism has some short-term impacts on daily behaviors of humpback whales, including changes in path predictability (directness and deviation index), swim speed, diving time, etc. In a study in the south coast ofNew South Wales (NSW), Australia, researchers discovered that when the commercial whale-watching vessels are present, the mean dive times and the overall percentage of time humpback whales spent submerged were significantly higher. Specific parameters can be found in Table 1.

Table 1. The mean dive time of humpback whales under different condition

	Median	IQR	Mean rank	Test statistics
Mean dive time (MDT) (min)				
Vessel present	2.8	2.35	188.08	$U = 12{,}241, Z = -2.79^a$
Vessel absent	2.1	2.60	157.51	
Percentage time submerged (%TS)				
Vessel present	53	47.44	192.18	$U = 11{,}395, Z = -3.70^a$
Vessel absent	33	52.86	151.64	
Mean blow interval (MBI) (min)				
Vessel present	0.9	0.65	171.64	$U = 14{,}036, Z = -0.64$
Vessel absent	0.9	0.85	178.65	

$^aP < 0.05$.

Using Mann– Whitney *U* analysis, the mean dive time, percentage of time submerge and mean blow interval for humpback whale pods when vessels were present (n = 206) and when no vessels were present (n = 144) are calculated (Stamation et al., 2009) The frequency of peduncle slaps and side flukes were higher without vessels, but the behaviors related to respiration and diving, such as rise, slip under, and fluke down, were substantially more common when boats approached (Stamation et al., 2009). Humpback whales in Godthaabsfjord, West Greenland show a similar pattern. Whale swimming speed increases while time of long

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dives and the ratio between surfacings and long dives diminish after the presentation ofWhale watch vessels (Boye et al., 2010). The apparent median surface speed of the whales increased from 5.4 km/h " 4.5 (no boat present) to 6.1 km/h "4.3 (boats present) and the long dives of whales shorten 117 seconds on average after whale watching boats present (from 271 sec "195 to 388 sec + 222) (Boye et al., 2010). The humpback whales only perform 4.3 surfacings when boats are present but perform 9.3 surfacings when left undisturbed (Boye et al., 2010).

Further research in New Caledonia indicates that the approach of vessels to humpback whales can also affect their daily behaviors by affecting their path predictability. A majority of humpback whales (80%) modified their behavior after encountering boats mainly by changing their path predictability (directness and deviation index) (Schaffar et al., 2013) and showing an cost-effective and efficient avoidance strategy in Table 2.

Table 2. Changes of humpback whales' behaviors

Response variables	Groups showing significant change (%)	% of change (SE) and direction Significant groups	Non-significant groups
Swim speed (knots)	44	133 (229) ↑	5 (28) ↑
Dive time (min)	20	56 (16) ↑	–3 (23) ↓
Directness index	60	–9 (16) ↓	1 (7) ↑
Deviation index (degree min^{-1})	64	11 (37) ↑	1 (9) ↑

The tourists boats are within 1000 m of humpback whale groups (n = 25) for each of the response variables. The directness index is the path predictability of the whales over the length of the tracking session and the deviation index is the change in the whale!s course (angle between observations) over 1 minute. Arrows represent a decrease or increase of the response variable (Schaffar et al., 2013).Humpback whales increase the sinuosity of their path as boats get closer, and when the distance between boats and whales is smaller than 100m, they possibly increase the sinuosity by over 100% (Schaffar et al., 2013).

2.2. Reproduction, Breeding, and Migration

Whale watching has more significant disturbances on humpback whale pods with calves during the migration to the breeding areas. Any abnormal behavior can become extra energetically costs for humpback whales. Stamation et al. (2009) discovered that calf pods were more sensitive to the presence of vessels than non-calf pods. With the presence of a whale-watching vessel, blow frequency, percentage of time spent submerged and mean dive time of pods with calves change significantly (Stamation et al., 2009). Breach and roll frequencies are lower in the presence of vessels for calf pods (Stamation et al., 2009).

Female humpback whales with a calf also show a considerable deterioration in body condition during the breeding season as a result of boat tourism, and extra energy expended in response to disturbance may have an impact on their reproductive or breeding ability. Due to the fact that humpback whales do not feed in breeding grounds, female whales depend on energy reserves for breeding their calves, and thus behaviors that consume extra energy of female whales can also affect the growth of offspring. In the breeding ground of northern Peru, presence of tourist boats can cause the swim speed of humpback whales increase, and mass-specific cost of transport (COT) decreased as the number of boats increased (Villagra et al., 2021), which may further affect the nutrients availability of calves. Although researchers

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discovered that the change of whales' breath frequencies and swimming speeds is more significant in groups without calves (Villagra et al., 2021), the impacts of those minor changes in breath frequencies on mother whales and their calves is still unknown.

Increasing in swimming speed, which can be caused by boat tourism, also affects the development and survival of calves. An increment in migration velocity leads to calf growth rates decreasing in Fig 2.

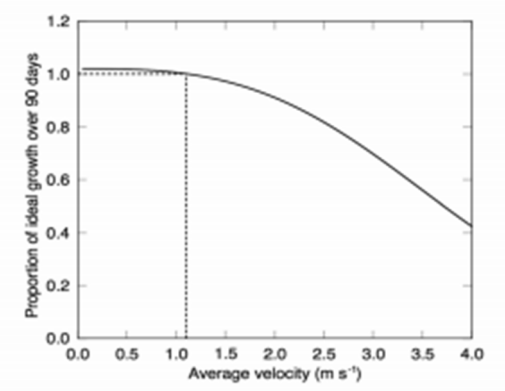

Fig 2. Changes in the growth of calves with average velocity

The ideal growth rate is defined as 28 kg day^{-1}. With increasing in average migration travel velocity, the growth of calves decreases over a 90 day migration (Braithwaite et al., 2015).

Calf growth is reduced by 85 percent when average speed is increased from 1.1 m/s (the ideal speed at the ideal growth rate) to 2.2 m/s. An extra migration distance can also result in a drop in calf growth, with whales arriving a certain time behind schedule at the foraging grounds (Braithwaite et al., 2015).

Additionally, boat tourism may bring physical damages to lactating female humpback whales. During the stationary migration process, lactating females mainly rest at shallow depths which can be reached by the hull of commercial ships, and thus the potential for ship strike collisions increases (Bejder et al., 2019). A majority of vessel strikes to whales (59%) that happened in Australian waters (15% of the world cases) are related to humpback whales (Peel et al., 2018).

Whale watching may also hinder the communication between humpback whales and further affect their reproduction and breeding. One of the most indispensable communicating methods between adult female and male humpback whales is applying acoustics (songs) to attract potential mates (Herman, 2016). Similarly, acoustic contact is important between mother whales and calves, which is crucial for the survival of the calf (Bejder et al., 2019). In Exmouth Gulf, the ambient noise produced by few vessels overlap with humpback whale sounds, and researchers indicated that moderate increases of noise from vessels can decrease the communication ranges of humpback whales considerably (Bejder et al., 2019).

However, Weinrich and Corbelli hold an opposite perspective by illustrating that whale watching exposure does not link with calving rate (amount of calves/number ofyears sighted) or calf production and survival of individual females. No correlation can be found between a female humpback whale's mean calving rate and either the cumulative number of boat interactions or the cumulative time of whale watching exposure (Spearman-rank correlation, $r = 0.008$, $p = 0.89$) (Weinrich & Corbelli, 2009). Whales with higher exposure were shown to be much more likely to have offspring and have those calves survive in several studies (Weinrich & Corbelli, 2009).

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3. Conclusion

Whale watching has been shown to potentially affect the daily behaviors, migration, breeding, and reproduction of humpback whales either directly or indirectly, and thus the hypothesis that humpback whales could be affected by the boat tourism is correct. For daily behaviors, such as swim speed, respiration rate, path predictability (directness and deviation index), diving time and percentage of time humpback whales spent submerged, can be affected after vessels approach. As for reproduction and breeding, scientists have divergences regarding the influence of commercial vessels on reproduction rate of calves and development and survivorship for both mother humpback whales and calves. According to current research, it is necessary to make policies to manage the boat tourism industry scientifically including regulating the amount and type of tourist boats, the distance to keep between boats and whales, the time and areas should be avoided during whale watching, etc.

However, more research should be done to further understand the long-term effects of boost tourism on humpback whales' population. Influences of whale watching on their migration such as migration routes, energy use along the migration routes, food availability, communication within species, and development and survivorship of adult whales and their calves can be investigated to better understand the impacts of boat tourism on humpback whale's population in a long term.

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