

## **Killer whale (*Orcinus orca*) depredation on longline catches of bottom fish in Alaskan waters**

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Depredation by killer whales on longline catches of bottomfish has been documented in the Bering Sea and Aleutian Islands since the mid 1960's. Fish targeted include sablefish (*Anoplopoma fimbria*), greenland turbot (*Reinhardtius hippoglossoides*), Pacific halibut (*Hippoglossus stenolepis*), searcher (*Bathymaster signatus*), and arrowtooth flounder (*Atheresthes stomias*). Predation rates vary considerable by season with an average of 20% to 25% of the sets documenting the presence of killer whales during fishing operations. Fish are either damaged or completely stripped from the longline resulting in 70-80% of the longline caught fish consumed. Although interactions with killer whales and Alaskan longline operations have been documented now for nearly 40 years, it is not possible to determine if an increasing trend in killer whale depredation is occurring since reporting within the commercial fleet has been inconsistent. Available information (to include both photographic and genetic data) suggests that several, resident pods of killer whales are involved in these interactions.

Various methods have been tried to reduce or eliminate whale depredation on commercially valuable fish. Limited success has been achieved by 1) the use of dummy buoys, 2) long-distance movements greater than 60 nautical miles, 3) temporary cessation of fishing activities, 4) changing target species to Pacific cod, and 5) the use of pot gear. Most fishermen stated that shooting, seal bombs, and other techniques were ineffective means of driving the whales away. A summary of the methods employed to help reduce or eliminate these interactions is provided in Table 1. Possible other methods to help reduce or eliminate killer whale depredation on longline caught blackcod are given in Table 2. Three important factors must be properly evaluated when considering methods to reduce or eliminate marine mammal/fishery interactions: 1) the adverse effect on the mammals, 2) the adverse effect to the fishery, and 3) the feasibility of the method being used in the fishery (gear, costs, etc). In the case of killer whales, their depredation behavior is constantly being positively reinforced by food. Food represents the strongest reward known for shaping animal behavior. To alleviate fishery interactions involving marine mammals requires a high level of effort or harassment and a long-term commitment to properly reshape, if possible, the depredation behavior. If animals are killed during the fishery interactions (i.e., no learning can take place), this would also limit the possible solutions to an even greater extent.

Table 1. Summary of methods employed to discourage whale depredation on longline catches.

METHOD	RESULT	COMMENT
Seal Bombs	Not effective	Occasionally a startled response but whales did not leave area.
Decoy Boats	Not effective	Did not confuse whales.
Blank Sets	Not effective	Whales immediately returned to vessel with live, blackcod on lines.
Dummy Buoys	Some effect	Whales occasionally lost interest and left the area.
Combined Hauling	Not effective	Whales would move between vessels.
Stop Operations	Some effect	Occasionally helped.
Night Fishing	Not effective	No apparent difference in behavior.
Short Movements	Not effective	Movements < 60 nmiles
Long Movements	Some effect	Movements > 60 nmiles; vessels would out run whales.
Change of Target Species	Very effective	Switch to Pacific cod.
Shooting	Not effective	Whales still in area.
Explosives	Unknown	Not adequately tested.
Electrical Current	Not effective	No other information.
Trap Gear	Very effective	Depredation did not occur.
Tangle Imitators	Not effective	Did not confuse whales.
Acoustic Harassment	Unknown	Not adequately tested.
Bang Pipe	Not effective	No apparent difference in behavior.

Table 2. Possible methods to help reduce or eliminate killer whale depredation on longline caught blackcod.

METHOD	COMMENT
Sparker Devices	Attached to gangion; emits flash of light and transient sound to startle whales.
Rubber Bullets	Irritant to whales.
Electrical Current	Electrical shock to whales.
Masking of Sounds	Interference of acoustical stimulus responsible for attracting whales to vessel.
Playback Sessions	Recorded sounds from longline operations reproduced back into the water. No food reward associated with attraction to vessel.
Bubble Screen	Interference with active/passive acoustical sense or vision of whales.
Accessory Skiffs	Deployed from main vessel into vicinity of whales causing possible visual and acoustical harassment.
Sonic Devices	Acoustic harassment in frequency range that would be sensitive to whales' hearing.
Lithium Chloride/ether	Strong emetic producing vomiting reaction.
Operant Conditioning	Behavioral modification of whales. Weak signal precedes strong, aversive signal.
Management Solutions	a) Gear modifications, b) pot gear, c) seasonal restrictions (fishing in an area when killer whale density may be low), d) actual fishery closure in areas with high levels of depredation.
Multiple/Cumulate Approaches	Various combinations of above.