Bycatch Mitigation Strategies in the Gulf of Alaska

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Executive Summary: Commercial fishing is a crucial industry in Alaska's economy, but unsustainable fishing practices, especially bottom trawling, lead to excessive bycatch and economic discards. This poses a major threat to marine ecosystems and their biodiversity, which puts the resources within Alaska's fisheries at risk of diminishing to a point where they cannot meet human demand. Through extensive research and evaluation of this issue and existing legislation that governs Alaska's fisheries, we recommend the full implementation of two specific measures across all of Alaska's fisheries. One is electronic monitoring on all vessels in the form of deep learning cameras, and the other is a "freeze the footprint" approach on bottom trawling, which protects key seafloor habitats within the existing area that has been damaged by previous trawling activity. These efficient methods are a safer alternative to on-site observation, and they will lead to a healthier seafloor ecosystem, which is essential for marine life. Alaskan communities rely on their fisheries, and maintaining healthy marine ecosystems is critical to economic stability.

I. Introduction

Commercial fisheries are a valuable economic enterprise for Alaska. In 2019 alone, Alaska's commercial fisheries employed over 31,000 fishermen that harvested 5.7 billion pounds of seafood valued at $2.0 billion (McKinley Research Group 2022). The economic benefit of the Alaskan commercial fishing industry does not come without major conservation and resource management concerns (Davies *et al.* 2009, 661–72).

The commercial fishing practice known as bottom trawling threatens Alaska's marine ecosystems (Simeon, Kampnich, and Songstad 2022). Bottom trawling collects organisms along the ocean floor via towing a net behind a boat (NOAA, n.d.). Bottom trawling allows for many fish to be caught at once which results in high profits. Despite its economic benefits, bottom trawling destroys coral and essential marine life habitats (Simeon, Kampnich, and Songstad 2022) and results in bycatch, "fish that are harvested in a fishery, but that are not sold or kept for personal use" (50 CFA §600.350 National Standard 9). Bycatch cannot be sold or kept for personal use and is therefore often returned to the ocean dead or dying (Davies *et al.* 2009, 661–72). Common species caught as bycatch off the coast of Alaska include Chinook and chum salmon, red king crab, Tanner crab, snow crab, and halibut. Negative impacts of bycatch are summarized in Table 1.

Without proper measures to address and manage bycatch, commercial fishing can damage ocean ecosystems, impact biodiversity, and harm or kill protected species (Benaka, Cimo, and Jenkins 2012).

Implication	Description
Overfishing	Bycatch contributes to overfishing and therefore the depletion of fish stocks (NOAA 2023).
Economic loss	Bycatch has the potential to reduce fishery profits by generating costs while accruing no additional revenue, or to force the fishery to close early (Hall, Alverson, and Metuzals 2000, 204–19).
Harm to protected species	Bycatch can negatively affect species such as dolphins, sea turtles, protected fish, and whales by harming animals, contributing to population declines, and impeding population recovery (NOAA, n.d.).
Diminishing future yields	Overfishing has impacts on future yields of small-boat or Native fishermen that depend on these species for food and their livelihoods (Simeon, Kampnich, and Songstad 2022).
Trophic cascade	Bycatch has negative impacts on biodiversity by altering the availability of prey and removing top predators, which then alters species composition and the food chain (Hall, Alverson, and Metuzals 2000, 204–19).

Table 1: The negative implications of bycatch.

Alaska's commercial fisheries are managed under the Magnuson-Stevens Act (MSA), the primary federal law that governs marine fisheries management within United States waters. The North Pacific Management Council, established by the MSA, rules Alaska's fisheries. National Standard 9 states that conservation and management measures set by councils, including the North Pacific Management Council "shall, to the extent practicable: (1) minimize bycatch; and (2) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch" (50 CFA §600.350 National Standard 9). Councils must also consider the bycatch effects of existing and planned conservation and management measures (Witherell et al. 2000). Bycatch can impede efforts to protect marine ecosystems and disrupt efforts to achieve sustainable fisheries. It also increases uncertainty concerning total fishing-related mortality, which makes it more difficult to assess the status of stocks, set appropriate fishing allowances and define overfishing levels, and to ensure that allowances are attained, and overfishing levels are not exceeded (Ibid.). Regulations under The Magnuson-Stevens Act and coastal mitigation strategies help reduce bycatch and increase the sustainability of Alaskan fisheries. Despite these regulations, bycatch remains a major issue. Additional solutions could be implemented to reduce commercial fishery bycatch in Alaska.

II. Laws governing fishery conservation and management.

i. The Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Act (MSA) was passed by Congress in 1976 by the National Oceanic and Atmospheric Association (NOAA) with the main objective of fostering long-term sustainability for marine ecosystems and the economic state of commercial marine fisheries. The MSA governs marine fisheries management in waters belonging to the United States. The MSA has several main objectives, which include preventing overfishing, rebuilding overfished stocks, increasing overall fishery sustainability, and protecting essential fish habitat (NOAA, n.d.). A declared purpose is "to promote the protection of essential fish habitat… under Federal permits, licenses, or other authorities that affect…such habitat," (MSA § 2, 104-297) and the law stands "to foster and maintain the diversity of fisheries in the United States" (MSA § 2, 101-627). Congress defines the term *bycatch* as "fish which are harvested in a fishery, but which are not sold or kept for personal use, and includes economic discards and regulatory discards," (MSA § 3, 104-297) and defines *economic discards* as "fish which are the target of a fishery, but which are not retained because they are of an undesirable size, sex, or quality, or for other economic reasons" (MSA § 3, 104-297).

The MSA details measures to regulate bycatch in fisheries under the jurisdiction of the North Pacific Council in section 313. Under subsection 104-297 (f), it establishes that the North Pacific Council is to implement conservation and management measures to lower the total amount of economic discards occurring in the fisheries of its jurisdiction to reduce overall bycatch throughout a certain period of time. Also, in subsection 104-297 (g,) it states that the North Pacific Council can implement a system of fines in a fishery to provide incentives to reduce bycatch rates. The fines collected through this incentive system are to be deposited into the Council's Observer Fund to be available to help offset costs related to the reduction of bycatch. Since the initial enactment of the MSA in 1976, there have been two prominent additional amendments and additions. One amendment came in 1996 with the Sustainable Fisheries Act, and the other in 2007 with the MSA Reauthorization Act. The Sustainable Fisheries Act introduced several updated science, management, and conservation mandates for U.S. fisheries. This revision acknowledged the utmost importance of sustaining a healthy marine habitat for the ecosystems that lay beneath the surface of fisheries. It strengthened the requirements of fisheries to better uphold the two main purposes of the MSA, preventing overfishing and rebuilding overfished stocks. The MSA Reauthorization Act of 2007 further revised and built upon the MSA with updated science and management practices. One standout from this revision is that it enhanced international cooperation by addressing illegal, unregulated, and unreported fishing and the issue of bycatch (NOAA 2023). Revisions of the MSA have paved the way for additional regulation and closer monitoring and tighter enforcement of bycatch regulations, the formation of the Alaskan Bycatch Review Taskforce as an example; however, this issue has persisted through the past few decades to the present day. These revisions provide a foundation for solving the issue of bycatch, but further action is needed to mitigate the current state of this issue.

ii. Alaska Bycatch Review Task Force

The Alaskan government responded to the issue of bycatch through the creation of the Alaska Bycatch Review Task Force (ABRTF Administrative Order No. 326). The ABRTF focused on four main topics: bycatch's impact on fisheries, policy recommendations for fishery resources in Alaska, assuring state agencies are using funds to better understand bycatch, and highlighting scientific data for policymakers and the public (Hughes 2022).

The ABRTF's final report gave thorough recommendations for how the state of Alaska should continue mitigation. The report was organized by research recommendations, state engagement recommendations, and management/task force recommendations. Many of these suggestions centered around the need for more research on why certain species are so often a product of bycatch. Examples of their recommendations for the species include improved information on migration paths through tagging, research on the impact of fishing gear on the species' habitats, and increased studying of the impact of repeated capture and release (Ibid.)

State engagement recommendations suggest that current methods of communication by the state about bycatch need to be improved. The need for state engagement came from public demand for more information regarding bycatch. The ABRTF stated in its final report that if there was a broader understanding of bycatch, more people would be willing to participate in its mitigation. Advocating and securing research funds for bycatch was identified by the ABRTF as another point of improvement. The ABRTF suggested that these research funds go towards modification of gear technology to reduce bycatch. The ABRTF also recommended creating a State of Alaska Bycatch Policy, which would guide the Alaska Board of Fisheries when addressing bycatch issues (Ibid.). Management recommendations centered around species caps, open and closed areas, rationalization, and observers/electronic monitoring. Recommendations for Gulf of Alaska Fixed Gear, Gulf of Alaska Trawl Gear, Bering Sea Fixed Gear, and Bering Sea Trawl Gear were proposed to mitigate bycatch (Ibid.). There were also management recommendations in the final report that would increase utilization of bycatch, rather than simply discarding it.

While the task force created was originally only a year-long project that was disbanded in November of 2022, there have been discussions of creating a permanent task force to combat the ongoing problem of bycatch in Alaska. The ABRTF suggested that the state of Alaska should create a permanent

advisory to facilitate communication about bycatch and inform bycatch policy. The task force's work was an extremely important first step for determining how (ABRTF 2022) and why bycatch occurs. However, for the issue to be solved, the recommendations of the task force need to be enacted and a more permanent team needs to be implemented to promote long-term bycatch mitigation.

iii. Coastal mitigation strategies

Fishing regulations in Alaska can be statewide or specifically pertain to the Gulf of Alaska. In both cases, bycatch and bottom trawling are addressed and regulated. Specifically in the Gulf of Alaska, the North Pacific Fisheries Management Council prohibits bottom trawling for all groundfish species in designated areas along the Gulf's continental shelf. This is important in protecting and mitigating high-relief coral communities, which populate the Gulf and are at high risk of damage by bottom trawling (NOAA 2020).

Further, shortly after the establishment of The Alaska Department of Fish and Game, the department began publishing a yearly statewide commercial groundfish fishing regulations booklet shortly after the establishment of the department. This booklet outlines general provisions and statutes based on different areas of Alaska's coast and inlets regarding commercial groundfish fishing. It also encompasses many different aspects of commercial fishing, including species regulations, regulations surrounding fishing tools, and the presence of bycatch on board a Commercial Fisheries Entry Commission (CFEC) permit holder's vessel. In the case of bycatch presence on board a CFEC vessel, Section 5 AAC 28.070 outlines that, unless otherwise specified, in both a groundfish fishery and a halibut fishery, the vessel may not have *any* bycatch on board (The Alaska Department of Fish and Game 2023). The commissioner may deem it necessary to allow a CFEC permit holder to have bycatch of a different groundfish or halibut species on board by a weight of up to 20 percent of the species on board. The commissioner may utilize this ability to conserve resources, avoid waste, prevent overharvest, or facilitate consistency of state and federal regulations of a bycatch species (Ibid.)

Along with general fishing guidelines, NOAA Fisheries released a final draft of the "National Bycatch Reduction Strategy'' in December of 2016. This draft outlined a five-year implementation plan to reduce bycatch from 2020 to 2024. The beginning steps include evaluating and reviewing bycatch data to determine the stock of species as well as risk level and estimated damage to coral reefs (NOAA, n.d.). The strategy also includes the implementation of Standardized Bycatch Reporting Methodology (SBRM) requirements. This implementation strategy is fairly extensive and involves many different aspects of fishing regulations that are valuable in bycatch mitigation (NOAA, n.d.).

III. Recommended courses of action

i. Monitor catches using cameras and machine learning software

Machine learning is a form of artificial intelligence that can improve the management of fisheries by allowing the automated monitoring of catches for both target and non-target species (Mannocci *et al*. 2021). Machine learning collects, manages, and analyzes data from onboard cameras and gives insight into catch totals and species composition (Bradley *et al.* 2019, 564–83). Compared to current bycatch monitoring methods, deep learning cameras are more efficient, can be used on a widespread scale, and reduce human error (Ovalle, Vilas, and Antelo 2022). These cameras can provide more accurate information about fishing activity and better evidence for future decision-making. They will also improve the professional reputation of the fishing industry. Camera use will reduce the need for fishery observers to be present on fishing vessels. Fishery observers are scientists who identify, count, and monitor what fishing vessels catch. Being a fishery observer can be a very dangerous job as observers face intimidation, are sometimes harmed by assault, and may even go missing for identifying vessels lying about their catches (Ewell *et al.* 2020). Cameras are a safer alternative to on-site observers in monitoring fishing activity and mitigating bycatch. Heavy fines can be administered to vessel operators if a camera is damaged to disrupt footage evidence. A concern that arises when considering the use of machine learning and cameras on fishing vessels is cost. Fish processors and registered buyers are currently required by NOAA to pay an ex-vessel value-based fee to NMFS to support the funding and

deployment of observers on vessels (NOAA, n.d.). These required fees could in turn be used to fund the operation of cameras and machine learning software on vessels, thus reducing the overall cost.

New Zealand is at the forefront of machine learning technology and policy implementations for strengthening fisheries management and mitigating bycatch (Parker 2022). Their government has established the Oceans and Fisheries portfolio to help manage our oceans. The vision for the portfolio is to "ensure the long-term health and resilience of ocean and coastal ecosystems, including the role of fisheries" (Parker 2022). To do this, New Zealand has enacted The Fisheries Amendment Act (2022) which is encouraging better fishing practices through "the provision, installation, and maintenance of electronic and other equipment on fishing vessels to observe fishing and related activities". The act will further the use of on-board cameras. It follows the 2019 rollout of cameras in core Maui dolphin habitats (New Zealand Fisheries Amendment Act 2022). In New Zealand, 300 inshore fishing vessels will get cameras by the end of 2024. The software uses machine learning to recognize relevant activity for recording (Parker 2022). When the software detects activities, such as setting a net or hauling, the cameras move into high-definition capture, and the relevant footage is stored and marked for upload (Parker 2022). Some Regional Fisheries Management Organizations (RFMO) have also been pushing for electronic monitoring (EM) as opposed to human observation for a few years. One example is the purse seine tropical tuna fishery in the Indian and Atlantic oceans, which started a voluntary EM program in 2017 (Lekunberri *et al.* 2022). New Zealand is not the first to use electronic monitoring on boats, but they are leading with the successful implementation of new machine learning technology.

Disadvantages of using cameras and machine learning to monitor catches

There are potential challenges to implementing camera use and machine learning software on trawlers. Biological samples cannot be captured without an in-person observer on board (Khokher *et al.* 2021, 257-66). These cameras capture enormous amounts of data, but only a small percentage of it is analyzed. In some cases, this percentage is as low as 10% due to high attendance costs (Ibid). When it comes to machine learning, factors like weather conditions, frame rate, and resolution can affect how efficient this solution is. The constantly moving environment of fishing vessels may also affect the accuracy of the machine learning's object detection function, and therefore cause miscalculations. However, there is developing technology that would be able to prevent these miscalculations (Ibid).

ii. Consider a "freeze the footprint" approach to bottom trawling

"Freeze the footprint" is a mitigation strategy that limits the impacts of trawling by confining activities to previously trawled areas (McConnaughey *et al.* 2019, 319-37). This mitigation strategy also uses maps to protect key seafloor habitats within the existing footprint. Conservation areas can be identified, and priority habitat features' location and extent are visualized (Warrenchuck *et al.* 2022). If priority or essential habitats are within the trawling footprint, these areas will also become off-limits to bottom trawling to protect these important areas. It is important that freezing the footprint is coupled with regulations and/or quota controls to ensure that sustainable fishing practices remain in these areas (Ibid.). Regulations and quota controls will result in a further reduction of bycatch. The living sea floor is necessary for feeding, breeding, and refuge for fish and marine mammals. Trawling damages those habitats. Therefore, as trawling expands to newer areas, the numbers of vital undisturbed areas dwindle. "Freezing the footprint" could be discussed and considered at upcoming North Pacific Fishery Management Council (NPFMC) meetings as they have done in the Bering Sea.

Limited trawling is consistent with NOAA's Deep-sea Coral and Sponge Strategic Plan. NOAA has used this mitigation strategy along many areas of the U.S. West Coast, British Columbia, the Bering Sea, and the Arctic. The Gulf of Alaska is the last place on the U.S. West Coast where industrial bottom trawling is still allowed in areas that are vital habitats for fish and other animals like coral (Warrenchuck *et al.* 2022). This method could be especially beneficial to the Gulf of Alaska because it supports many coastal communities that need a healthy ocean for food security. "In addition to harming seafloor habitat, bottom trawlers in Alaska catch and often waste non-targeted salmon, halibut, crab and other species central to the lives of Alaskans." (Ibid.). By tackling

bottom trawling through the "freeze the footprint" method, bycatch numbers will decrease, and food security could be restored. Limiting trawling to previously trawled areas can reduce the area in the Gulf of Alaska where fisheries are able to trawl, therefore reducing ecosystem damage and bycatch in the process (Witherell et al. 2000).

Disadvantages of taking a "freeze the footprint" approach to limit trawling impact

Mitigation via the "freezing the footprint" approach requires the accurate identification of seafloor areas previously damaged by bottom trawling activity. However, assessments of trawling damage are surprisingly rare, so these areas are not always identified (Williams *et al.* 2020). Most of what is known about which areas have been trawled and which haven't come from fishing vessel logbook data, but we cannot be sure of how damaged, if at all, these areas are as trawling has differing impacts dependent on the seafloor depth (Ibid.). If the "freeze the footprint" method was to be adopted in the Gulf of Alaska, it would require the assessment of previously trawled areas to ensure the method is effective. This would require the use of monitoring vessels and cameras which would have an economic impact. Another potential disadvantage to the "freeze the footprint" method is its unknown impact on other fisheries or other regulatory regions of the sea. The current commercial fishing fleets will be displaced, and it is unclear what impact this will have on displaced fleets or other fisheries.

IV. Conclusion

Commercial fishing as an industry has thrived in the Gulf of Alaska for decades, but its use of bottom trawling has led to excessive amounts of bycatch and environmental damage. Bycatch threatens the health and biodiversity of the marine ecosystems within the Gulf of Alaska, and therefore affects the livelihoods of Alaskans that depend on the gulf. Implementing electronic monitoring and a "freeze the footprint" approach will not only prevent bycatch, but also protect fragile marine ecosystems within the gulf.

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