



Mitigating Seafood Waste Through a Bycatch Donation Program

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Discarding of prohibited, under-sized, or non-target finfish is a major problem globally. Many such unwanted or banned catches do not survive long enough to be released alive, creating complex ecological and policy issues for the fishing industry. In U.S. Federal waters, regulation requires bycatch to be avoided as practicable and bycatch of some finfish species is designated as prohibited species catch (PSC). By regulation, PSC cannot be retained or sold and it must be returned to the sea (dead or alive). Some PSC species have strict limits to further incentivize their avoidance and limit bycatch mortality and these limits can lead to fishery closures. Despite extensive efforts to avoid bycatch in the U.S. and elsewhere, unwanted catches still occur, creating the potential for substantial food waste. We present one rarely discussed approach to maximize the value of dead, unwanted or prohibited finfish catches. The Prohibited Species Donation (PSD) program utilizes trawl fishery PSC that would otherwise be discarded by instead donating it to hunger relief organizations. This program simultaneously provides food and reduces waste while avoiding inadvertent incentives for catching prohibited species. For 26 years, the non-profit organization, SeaShare, has worked with the Alaska seafood industry to distribute 2,660 t (~23.5 million servings) of prohibited species donations (salmon and halibut), high quality seafood that would have otherwise been discarded due to prohibition on retention. The PSD program provides an example that addresses food security and social value, an under-represented perspective in the global dialogue on unwanted catches.

Keywords: prohibited species, seafood waste, fisheries management, seafood industry, fishery discards

INTRODUCTION

Discards account for nearly 10% of global fishery catches annually (Zeller et al., 2017), and this wasteful practice has been an increasing focus of management, research, and public concern. Finfish may be discarded for many reasons (e.g., regulations prohibit retention, fish are undersized, lack of market demand or value, quota overage). Some countries (e.g., Norway, Chile, Iceland), and

more recently, the European Union have banned discarding (Karp et al., 2019). One goal of such bans is to incentivize more selective fishing, encouraging fishermen to fill their holds with valuable target species instead of unwanted (prohibited, under-sized, or non-target) catches that often get wasted (Borges et al., 2016). Despite such efforts to minimize discards, bycatch cannot be completely eliminated in most fisheries. From the food security perspective, better utilizing the spectrum of edible fish catches and thus, minimizing waste should be a priority (Borges et al., 2016; Van Putten et al., 2019).

Historically, the focus on waste reduction in fisheries has been on the supply-side of the issue, largely centered around efforts to avoid unwanted catches altogether. However, Van Putten et al. (2019) focused on complementary, demand-side mechanisms, exploring ways that small or non-target species might still add value. While their analysis strictly focused on economic value, we illustrate an additional demand-side mechanism that addresses food security concerns by taking a social value perspective. We describe one of the longest running bycatch donation programs of its kind in North America that might serve as a model, in particular for Europe, as it addresses the challenge of discarding finfish at sea via implementation of its new discard ban.

In federal waters off Alaska, Pacific halibut and salmon are occasionally caught incidentally using trawl gear, the only way to profitably target some groundfish species. Halibut and salmon are designated as prohibited species catches (PSC). These PSC are the targets of other fisheries and must be avoided while fishing for groundfish; groundfish fisheries are not allowed to retain or sell them and all PSC must be discarded and returned to the sea whether dead or alive (with minimum harm if alive), except when retention is required or authorized by other applicable law (North Pacific Fishery Management Council (NPFMC), 2019). Trawl catcher vessels targeting groundfish do not have the ability to sort their catches until the catches are offloaded at shoreside processing plants so there is little chance of PSC surviving long enough to be released alive from shoreside operations. Additionally, many of the PSC that are caught by catcher-processors or delivered to floating processors at sea do not survive (many halibut are released alive on bottom trawl catcher processors). Extensive observer coverage reduces the likelihood of unmonitored discarding and all PSC are counted by observers, with systematic sampling programs for biological data.

We examine the issue of PSC in the North Pacific in the context of the mitigation hierarchy, which seeks to minimize and offset the impacts from human activities (Arlidge et al., 2018). The North Pacific Fishery Management Council (NPFMC) and the Alaska seafood industry have a long history of cooperative efforts to reduce bycatch and to mitigate potentially deleterious effects on both ecosystems and other fisheries, while still meeting harvest goals. Such mitigation efforts apply operational modifications to fishing (e.g., bycatch limits, gear modifications, time-area closures) but after bycatch has been eliminated to the extent practicable, some PSC will inevitably remain. Historically, all PSC in Alaska was discarded at sea to avoid any incentive for trawlers to encounter such species. However,

U.S. decision-makers agreed that some of these prohibited finfish need not be banned from human consumption altogether. In Alaska, trawl-caught salmon and halibut can contribute to the nation's food security by way of the Prohibited Species Donation (PSD) program, which allows for the donation of PSC through food banks. This donation of PSC provides a type of offsetting for the impacts of bycatch by minimizing the waste of the fish whose bycatch was unavoidable. We first describe the problem of salmon and halibut PSC and the efforts to avoid and minimize them. We then describe the PSD program as the last in a series of efforts to avoid the waste of seafood resources.

Salmon Prohibited Species Catch

Salmon play a vital economic, cultural, and dietary role for Alaska communities and concerns over salmon bycatch (e.g., Ianelli and Stram, 2015; Murphy et al., 2016) and declines of some salmon populations (e.g., Murphy et al., 2013; Schindler et al., 2013) have been pervasive for decades. Most salmon PSC is incidentally caught by fleets targeting walleye pollock using mid-water trawls. While PSC numbers are what count against bycatch limits, the ratio of bycatch to target catch in this fishery is quite low. In the past few decades, salmon PSC in Alaska has averaged about 200,000 fish annually from an average pollock catch of more than 1.3 million metric tons (on average, 0.15 and 0.18 salmon t^{-1} pollock for the Bering Sea and Gulf of Alaska, respectively, from 1991 to 2019). In the Bering Sea, Chinook (*Oncorhynchus tshawytscha*) and chum salmon (*O. keta*) accounted for approximately 10 and 90% of the salmon PSC, respectively from 2011 to 2019 (National Marine Fisheries Service (NMFS), 2020a,b). Recently in the Bering Sea, about one-quarter to one-half of Chinook salmon PSC has consisted of fish that originated from Bering Sea rivers (e.g., Guthrie et al., 2019b), while the majority of chum salmon PSC originated from Asian rivers or hatcheries (e.g., Whittle et al., 2018). In the Gulf of Alaska, fewer salmon are bycaught due to substantially smaller scale trawl fisheries; such catches are predominantly Chinook salmon originating from rivers and hatcheries in British Columbia and the U.S. West Coast (Guthrie et al., 2019a).

Salmon PSC has declined substantially in recent years, likely due to mitigation efforts and regulations that further limit bycatch. Efforts to mitigate salmon bycatch in the Bering Sea and Gulf of Alaska (Gisclair, 2009; Stram and Ianelli, 2015) have relied on cooperation and collaboration among agencies, the seafood industry, and Alaskan communities. These efforts include, but are not limited to gear modifications (e.g., salmon excluder devices, e.g., Gauvin et al., 2013), fixed time/area and rolling hotspot closures (Haflinger and Gruver, 2009; Little et al., 2014), and an extensive regulatory overhaul (National Marine Fisheries Service (NMFS), 2010; Stram and Ianelli, 2015). Particularly notable in the regulatory overhaul is a series of incentive plans that involve performance-based, tradable limits for salmon PSC with multi-year mechanisms to encourage long-term bycatch avoidance behavior (Sugihara et al., 2018) and a lower bycatch limit when western Alaska Chinook salmon returns are low. Thus, while salmon PSC still occurs in pollock trawl fisheries,

the level of discards is likely much less than without extensive mitigation efforts.

Halibut Prohibited Species Catch

Pacific halibut (*Hippoglossus stenolepis*) in Alaska support a highly valuable multi-sector industry consisting of targeted commercial and recreational fisheries, charter fishing, and subsistence. The NMFS, NPFMC, and Pacific Fishery Management Council work with the International Pacific Halibut Commission (IPHC) to sustainably manage shared halibut stocks across west coast waters of the U.S. and Canada. The IPHC sets annual directed fishery catch limits while the NPFMC and other agencies (Fisheries and Oceans Canada, Pacific Fishery Management Council) set their own regional bycatch limits in fisheries targeting non-halibut species. Over the last few decades, concerns have focused on declining coast-wide halibut biomass (Stewart and Hicks, 2019) and the impacts of both discards in the target halibut fishery (e.g., under-size halibut) and bycatch from non-halibut fisheries (Martell et al., 2015). From 1992 to 2018, halibut bycatch across all IPHC management areas steadily declined from a high of 9,203 t to a low of 2,748 t. The estimated impacts of bycatch on the yield of targeted halibut catches have varied (Stewart et al., 2020) and simulations suggest substantial economic impacts to the halibut industry, though the actual value depends on fish prices and assumptions about fish movement (Martell et al., 2015).

The NPFMC and commercial fisheries industry have explored numerous mechanisms to mitigate halibut PSC. In 1999, bottom trawling was prohibited for targeted pollock fishing in the Bering Sea to mitigate halibut encounters (65 FR 31105). In 2011, Amendment 80 to the Bering Sea-Aleutian Islands groundfish management plan restructured and rationalized the mixed-species bottom trawl fishery, which primarily targets rock and yellowfin sole. In combination with the restructuring of target species quotas, the formation of cooperatives (which pre-dated Amendment 80), gear modifications, deck sorting (release of live fish which are deducted from bycatch tallies), intra-cooperative penalty structures, avoidance of night sets, and fixed and rolling hotspot closures, halibut PSC has remained below limits (See Abbott et al., 2015 and Holland, 2018 for broader discussions). In 2016, halibut PSC limits were reduced by as much as 25% for some fishery sectors (trawl and hook-and-line) in Alaska, bringing total PSC limits to 3,515 t in the Bering Sea and 1,972 t in the Gulf of Alaska (Amendment 111; 81 FR 24714). Meanwhile, the NPFMC and the NMFS are developing dynamic PSC limits that are based on halibut abundance to further mitigate impacts to stocks.

Prohibited Species Donation Program

The PSD program was developed by NMFS and the NPFMC to minimize the waste of valuable fish protein associated with bycatch by creating a regulatory framework through which unavoidable PSC can be donated to hunger relief organizations.

The PSD program authorized donations of salmon PSC in 1993, first as a pilot program, and in 1996 through Amendments 26 and 29 to the Fishery Management Plans for Groundfish in the North Pacific (61 FR 38358). In 1998, a pilot program included

Pacific halibut donations and in 2000, the halibut program was reauthorized (Amendment 50; 63 FR 32144). Participation in the PSD program is voluntary and fishermen and seafood processors can enroll or leave the program at will. The industry must remove the head and guts from any donated fish (which are not tax-deductible) and store the fish in a manner that is fit for human consumption. Industry participants are allowed to process the head and guts for fish meal and oil, which can be subsequently sold (69 FR 52609), though such earnings are negligible. Any costs incurred by industry participants in handling the fish are born solely by them and are not reimbursed. Annual participation from the seafood industry varies slightly; in 2018, participants included 136 catcher boats, 11 shoreside processors, 38 at-sea processors, and two re-processors in Washington State (to inspect, trim, steak, and re-pack).

The PSD program provided the regulation to allow PSC donations to food banks, but it did not establish the mechanism (financial or logistical) for distribution. The program allows NMFS to authorize a distributor of PSC donations. Distributors must apply to NMFS and meet criteria for recordkeeping, reporting, food standards, storage, and distribution. Since inception of the PSD program, SeaShare has been the only applicant, and thus, the only authorized distributor of PSC.

SeaShare

SeaShare is a non-profit, donation-funded organization whose mission is to distribute valuable seafood protein to economically disadvantaged individuals across Alaska and the United States. During its 26 years, SeaShare has grown in scope and impact, and it distributes both PSC and target species (e.g., groundfish) seafood donations through Feeding America's (feedingamerica.org) national network of food banks. The logistical and financial burden of processing, transporting, certifying, and distributing seafood donations falls on SeaShare, which in turn relies on voluntary partnerships and financial support from fishermen and seafood processors who want to improve nutrition in Alaska and reduce waste. With the help of these partners, SeaShare has installed freezers in remote Alaska communities, enrolled freight donors, and qualified additional food banks to receive donated fish. Since 2004, SeaShare has distributed more than 2,386 finished metric tons of salmon and 276 finished metric tons of halibut (Figure 1). In total, these donations exceed 2,662 t of seafood, nearly 23.5 million servings (1.82 servings kg⁻¹).

Processing, shipping, storing, and distributing donations to Alaska's coastal and interior villages is complex, expensive, and requires extensive partnerships. SeaShare receives frozen donations primarily from fishermen and processors in Dutch Harbor, Akutan, and Kodiak, Alaska (Figure 2). The processors that donate salmon and halibut do not necessarily have the capacity to process these fish. Instead, much of the frozen donations are transported to Washington State, where they are processed (inspected, trimmed, steaked) for final distribution back to Alaska or in the contiguous United States. SeaShare facilitates this processing at a cost of approximately \$0.18–0.22 kg⁻¹ using funds raised through grants and donations. Some of the seafood donations on Kodiak Island are processed and

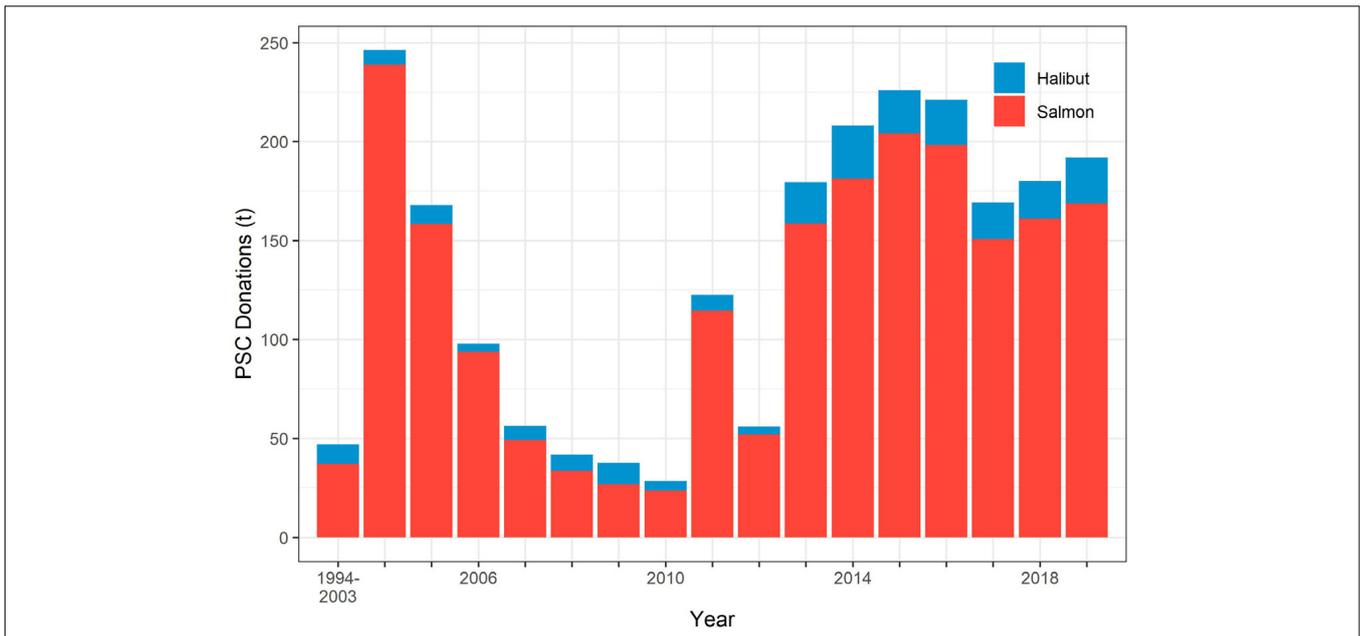


FIGURE 1 | Weights of annual salmon and halibut donations through the Prohibited Species Donation program. The 1994–2003 data are only available in aggregate form so these data are presented instead as an approximate annual average over this period (for halibut, from 1998 to 2003).

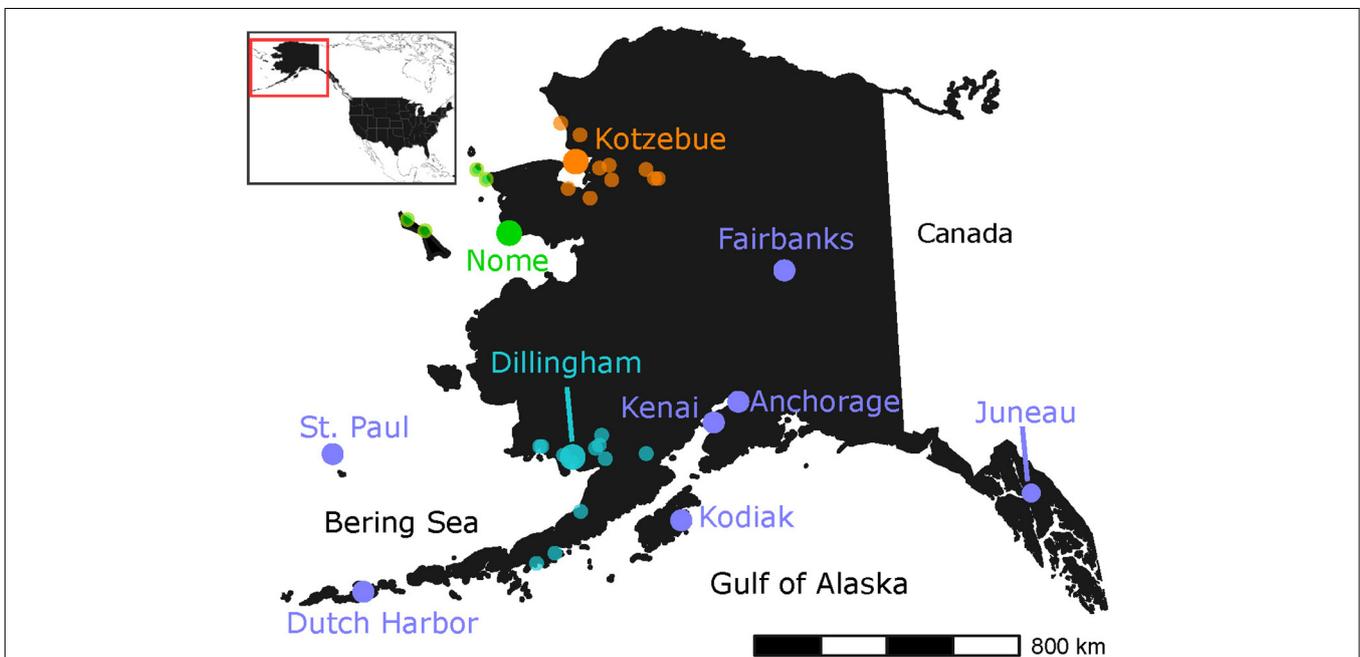


FIGURE 2 | Alaska food banks and food distribution center locations. Large purple circles are locations of food banks that receive donations directly from SeaShare. Smaller colored circles are food banks or communities that receive donations from the distribution locations denoted by the larger circles of the same color.

distributed locally without the extra step of transportation to the lower 48. In Alaska, there are several larger towns with food banks and/or the requisite infrastructure that receive donations directly from SeaShare or through SeaShare’s partners (Figure 2). Meanwhile, other locations act as regional distribution hubs (e.g., Kotzebue, Nome, Dillingham) and SeaShare has invested

in additional infrastructure (e.g., frozen storage) in several such locations. Leveraging a partnership with the United States Coast Guard, nearly 54.4 t of halibut have been flown to Kotzebue and Nome, two hub communities, since 2013. Much of this food is subsequently distributed to smaller towns and villages. This complex supply chain includes nearly 40 communities across

Alaska that receive seafood at no cost to them, in addition to some non-Alaska U.S. communities.

DISCUSSION

In Alaska, salmon and halibut have strict bycatch limits that can lead to fishery closures if exceeded. As the targets of other fisheries, any market-based distribution of these catches could create conflict with their respective target fisheries. However, because salmon and halibut are relatively expensive seafood, donation to food banks provides them to people who could not otherwise afford them. This avoids competition for the consumer market of these products, minimizes waste, and serves a population in need. This donation model may not work in every circumstance. For example, in the Pacific whiting fishery off the U.S. west coast, regulation allows donation of some salmon bycatch but logistics have prevented SeaShare from making donation programs cost-effective. However, regulation supports future creative efforts should the situation change.

No matter how creative fishermen become, some unwanted catches, and thus, some waste, will still exist (e.g., prohibited species are still discarded under the Landing Obligation). However, by allowing flexibility for bottom-up approaches, new opportunities to minimize waste may arise. The PSD program did not create a top-down bycatch distribution or donation strategy; rather, it removed a regulatory barrier that allowed creative solutions to improve social value and minimize waste. This idea of facilitating flexibility and creative solutions also lies at the foundation of the European Landing Obligation, in which a ban on discards is expected to drive fishers toward creative ways to make fishing more selective (Borges et al., 2016). Rochet et al. (2014) framed the policy as “an obligation for people to find solutions to reduce discards.”

In the case of market discards, one driver of seafood waste is a lack of market demand or value (Van Putten et al., 2019). Thus, Iñarra et al. (2019) presented ways to add value to unwanted catches, framed around a conceptual model from the EU Directive on Waste (European Parliament Council, 2008). Iñarra et al. (2019) describe a hierarchy of potential fates for unwanted catches, ordered by decreasing economic value, with human consumption at the top followed by bio-products, animal feed, industrial uses, energy production, agronomy (compost), and finally, disposal. Their proposed decision tree for prioritizing potential fates of catches considers the environmental impacts (CO₂ emissions and water usage) associated with downstream production. Environmental impacts certainly have economic costs, but the framing of such considerations seems as much about social value as it does the economic value. In this context, the valorization of unwanted catches could more explicitly include social value. For example, what are the trade-offs between the economic value of catches that become compost relative to the social value of feeding people.

In 2015, the United Nations adopted a set of Sustainable Development Goals, including improvement of global food security and nutrition. Even in developed nations, an estimated 60 million people annually rely on food banks (Gentilini, 2013),

making a strong case for programs that could simultaneously address food insecurity while also reducing amounts of food that are wasted because of regulatory or market barriers. SeaShare fills a critical nutritional need for protein, especially in Alaska, where more than 14% of the population and nearly 20% of children are food insecure, or lacking consistent access to safe, sufficient, and nutritious food (Feeding America, 2014). Most healthy adults require at least 50–70 g of protein per day (Institute of Medicine, 2005) and in a 2014 survey of food donation recipients, 54% of respondents listed protein (meat or seafood) among their most desired donated food items. Additionally, 81% said that a strategy for coping with food insecurity was to purchase less expensive and less healthy foods instead of healthier, yet more expensive protein (Feeding America, 2014). Thus, seafood donations meet a nutritional need that may be otherwise cost prohibitive for recipients.

In comparing global discard approaches, Karp et al. (2019) made a distinction between developed countries with generally low levels of catch utilization (high potential for waste) vs. developing countries with generally fewer discards and greater catch utilization (less waste). While higher levels of utilization may not necessarily yield direct conservation benefits for captured fish, the idea can still be framed around the mitigation hierarchy (Arlidge et al., 2018). The first three steps of the hierarchy seek to *avoid, minimize, and restore* human impacts at the location of potentially harmful activities, as do many of the bycatch and discard efforts described here (e.g., time-area closures, gear modifications, bycatch limits). Meanwhile, the fourth step of *offsetting* impacts typically occurs offsite and does not necessarily benefit bycaught stocks directly. Distribution of would-be discards has a direct benefit on human health while also offsetting the demand for protein (or less healthy alternatives) that might require additional production. Thus, donation of seafood discards creates a type of social offsetting by enabling food banks and the seafood industry to provide more healthy seafood protein with a greater environmental and cost efficiency.

DATA AVAILABILITY STATEMENT

Publicly available datasets were analyzed in this study. These data can be found here: https://github.com/jordanwatson/Prohibited_Species_Donation_Program.

AUTHOR CONTRIBUTIONS

JW designed study. All authors contributed to writing of the manuscript.

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Conflict of Interest: JH was employed by SeaShare.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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