Title: The rise of climate-induced Federal Fishery Disasters in the United States

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**Abstract:** For over three decades, the United States federal government has provided assistance to commercial, recreational, and indigenous fishing communities following the disastrous consequences of mismanagement or extreme environmental events. While these Federal Fisheries Disasters have resulted in billions of US dollars of Congressional allocations and revenue loss, the declaration process is largely ad hoc, and lacks the detail sufficient to properly assess allocation fairness and benefit. Nonetheless, the frequency of fishery disaster declarations has increased over time, and disaster causes have shifted from anthropogenic (e.g. mis-management) to extreme environmental events (e.g. marine heatwaves). As climate change drives higher rates of such extreme events, the federal system for fisheries disaster declaration and mitigation must evolve in order to effectively protect fishing communities and their societal benefit.

**Short Title:** Fishery disasters in the United States

**One Sentence Summary:** Extreme environmental events fuel growth in a poorly documented, multi-billion dollar fishery disaster assistance program.

**Main Text:**

***Federally Declared Fishery Disasters***

Marine fisheries in the United States (U.S.) generate $212B in annual revenue, and provide 1.7M part- and full-time jobs (*1*). At times, however, fisheries management failures and extreme environmental events have had disastrous consequences for fishing communities. When U.S. fisheries are impacted beyond federally designated economic thresholds, the U.S. Secretary of Commerce can declare a Federal Fishery Disaster (*2*) that results in financial compensation for impacted fishing communities (Fig. 1). We demonstrate that the frequency of declared Federal Fishery Disasters has increased markedly over the last 30 years, and that environmental events (e.g. marine heatwaves, hurricanes) have become the dominant cause of such disasters over time. As disaster rates climb, driven by extreme climate-related events, proactive rather than reactive mitigation strategies are needed to ensure the security of fishing communities and seafood supplies.

To illustrate the scale and trends of disasters and their associated economic impacts, we developed a national database of all Federal Fishery Disaster requests and declarations in the U.S., and synthesized the associated spatial and temporal data reported in U.S. federal disaster records. From 1989-2020, the federal government approved 71 Federal Fishery Disasters (with an additional 7 pending) spanning every federal fisheries management region and coastal state/territory in the country.

Fishery disaster review and assistance implementation timelines follow a six-step process, and requests are typically filed by either the state governor or elected or duly appointed representatives of affected indigenous fishing communities (Fig. 1). For a request to be approved, three criteria must be met: (1) there must be an identified state, federal, or Native American fishery resource disaster associated with either species population decline or loss of fishing infrastructure, (2) there must be a specified cause (e.g., natural, anthropogenic, or undetermined), and (3) there must be economic impact resulting from the disaster. For a Federal Fishery Disaster to be declared, federal policy requires commercial fisheries revenue losses of more than 80% relative to the mean annual revenue over the most recent five-year period (*2*). Revenue losses between 35-80% receive further evaluation, and losses less than 35% are generally not eligible for assistance. In total, 4 separate sections of two different federal acts (Magnuson-Stevens Fishery Conservation and Management Act, Interjurisdictional Fisheries Act) define Federal Fishery Disaster causes, types of assistance, and use of funds, with only partial agreement between them (*2*).

Disaster assistance can be structured in numerous ways, although always with fishing communities as the primary intended beneficiaries. Assistance can be appropriated by U.S. Congress and routed through Interstate Fishery Commissions (e.g., Pacific States Marine Fisheries Commission) or individual states, and then allocated directly to fishers and fishing communities through grants, job training, cooperative agreements, contracts, or low-interest loans (*2*). Assistance can also be administered to fisheries science or management programs, including data collection, compensated reduction in capacity, or resource restoration projects. While compensation of fishing communities is the goal of disaster assistance, we found that approximately 40% of federal determinations failed to identify the specific fishery(ies) impacted by the disaster, making any future efforts to accountability in assistance allocation difficult, if not impossible.

We used the frequency of Federal Fishery Disasters, and data associated with each disaster approval (fishery, year, state, ex-vessel revenue, and Congressional appropriations) to create standardized economic metrics and analyze temporal trends in disaster determinations. In so doing, we open a discussion regarding more proactive solutions for managing fishery disasters. This is especially critical in a time when the number of federal assistance requests [i.e., Federal Emergency Management Agency (FEMA) natural disasters] has reached an all-time high this year (since 1953) due to the COVID-19 pandemic (*3*), and while climate change impacts pose a growing threat to coastal fisheries, communities, economies, and ecosystems.

***Impacts of Fishery Disasters***

Federal Fishery Disasters have generated large, yet highly variable revenue impacts throughout the U.S. during the last three decades, and the frequency of disasters is increasing over time (Fig. 2). We estimate fishery disasters have resulted in $2B (2019 USD) in Congressional allocations to date, and an additional, conservative estimate of $3.2B (2019 USD) in direct revenue loss. These values are undoubtedly underestimates given that seven assistance requests are pending, and five approved allocation amounts were unreported in the determination documents (and thus unaccounted for). In addition, revenue contributions from recreational fisheries, that generate $68B in annual economic impact nationwide (*4*), were not included our impact estimates. Finally, these values only account for losses to direct commercial revenue, while indirect economic losses across the supply chain are undoubtedly larger (*5, 6*).

The median revenue loss across all approved Federal Fishery Disasters (38.3% loss) was notably less than the 80% threshold that triggers federal determination of a commercial fishery failure, and is just above the 35% threshold that allows further federal review of disaster assistance requests. We also identified 12 cases of federal disaster approvals in which fishery-specific revenue actually increased during the approved disaster year (we omitted these cases from our impact estimates under the rationale that gains in one fishery do not erase losses sustained in another). It is important to note that we strictly followed Federal Fishery Disaster determination guidelines for economic impact estimation; that is, the mis-matches between federally declared thresholds and actual economic impacts associated with affected fisheries are not due to our inability to accurately calculate the economic impact of disasters. Rather, they reflect real discrepancies between threshold rules and declaration decisions. Because Federal Fishery Disaster determination documents lack justification for such discrepancies, approved exceptions to thresholds appear to be ad hoc in nature.

While not currently captured in Federal Fishery Disaster determinations, the non-economic impacts of fishery disasters and closures can be large (*7*). For example, 29 of 71 approved Federal Fishery Disasters (and four pending) came from Native American communities with intimate connections to salmon populations that span millennia. However, limited syntheses of disaster impacts to indigenous communities exist (*7*). Native American fisheries represent a far more extensive history of coastal harvest and culture than commercial or recreational fisheries. Knowledge of the disruptions in such cultural relationships is a necessary part of efforts to mitigate the totality of fishery disaster impacts, yet such considerations are not currently part of the Federal Fishery Disaster determination process.

***Rates and Drivers of Fishery Disasters***

The frequency of Federal Fishery Disasters has increased over time (Fig. 2), with a highly variable assistance request response time (time from disaster occurrence to disbursement, ranging from 0-4 years; Fig. 1). The causes of disasters included a broad range of anthropogenic factors and extreme environmental events. In the early days of Federal Fishery Disaster determinations, disasters were largely caused by poor fisheries management. Fortunately, disasters driven by mismanagement are on the wane as fisheries management improves (*1*). On the other hand, impacts of climate change on marine ecosystems and fisheries are evident (8), as environmentally-driven disasters are on the rise (Fig. 2), fueled by extreme environmental events that are symptomatic of a changing climate (*9*). For example, the west coast marine heat wave produced a broad range of coastwide impacts (*10*), including several approved Federal Fishery Disasters (e.g., *6*). While disaster causes varied through time, the top three extreme environmental events (marine heatwaves, hurricanes, and HABs) dominated the most recent five years of the 30-year time series (Fig. 2, inset panel).

Across all Federal Fishery Disaster declarations, assistance payouts were often executed over two years after the disaster event. Such delayed response times are likely due both to the complex determination and allocation process, and the burden of increasing disaster assistance request rates. The administrative process can be contentious because federal assistance timelines can significantly lag impact events, federal decision-making is often unclear (or undocumented), impacted individuals or entities may be difficult to identify, and the degree of economic impacts may be difficult to quantify (*2*).

***Fishery Disaster Policy Reform***

The Federal response to the growing impacts of fishery disasters clearly needs reform, but the lack of standardized reporting in Federal Fishery Disaster requests and determinations makes identifying solutions difficult. The finding that many of the published determinations failed to list the specific commercial fisheries used to make the determination is problematic. While disasters ranged in scale from individual rivers and fisheries to multiple states and fishing communities, the details provided in determination documents do not reflect the complexity of disaster impacts. Detailed, mechanistic descriptions of economic impact determinations will afford transparency when the Secretary of Commerce determines there are special circumstances that may justify using a lower threshold of percent revenue loss in Federal Fishery Disaster determinations, and a more streamlined and fair process for allocating assistance. A detailed accounting of determinations might also reveal aspects of the determination process that are leading to such highly variable response times.

As currently structured, the legal framework for declaring Federal Fishery Disasters focuses exclusively on the economic impact of direct loss of revenue from commercial fisheries. However, there is no question that the broader market and non-market value of fisheries losses grossly outweigh the direct revenue loss (*5*). These additional impacts encapsulate fisheries supply chains, cultural values, and non-commercial impacts. The fact that the existing legal mechanisms for fishery disaster assistance hinge only on commercial revenue loss may explain why many declared Federal Fishery Disasters fail to meet the defined economic loss thresholds (e.g. in some disasters, revenue actually increases); it is likely lawmakers are making a good-faith effort to account for the true breadth of economic and societal loss stemming from disaster. However, the lack of a codified mechanism for doing so contributes to inaccurate accounting of financial assistance.

As disaster impacts to fishing communities worsen via increased disaster frequencies, federal response times to mitigate these impacts continue to lag by years in most cases (*2*). Developing proactive, rather than reactive, mitigation strategies may partially address this problem. Recent shifts in the causes of fishery disasters toward extreme environmental events suggest a need to explore incentive structures for linking disaster assistance with proactive climate-ready fisheries management (*11*). Regional fishery disaster vulnerability assessments (*12*) and ecosystem-based fishery management approaches (*13*) may be useful in guiding science and management efforts toward this end. Industry insurance mechanisms, such as those trialed in west coast salmon fisheries, might also mitigate future extreme event scenarios by providing timely assistance to those in greatest need, as well as incentivized support for climate-ready fisheries management goals (*14*).

There has never been a better time to identify and implement efficiencies in government responses to disasters. The COVID-19 pandemic has added a new layer of impacts across virtually every sector of the global economy, including fisheries (*15*). By Sept. 2020, the U.S. had already reached a record annual number of FEMA natural disasters declared (56% of which are linked to COVID-19 to date) in the history of U.S. natural disaster declarations (1953-2020). In the fisheries sector, the seafood industry landscape has been severely impacted, with entire fleets tied to the docks, and fisheries market closures occurring around the world (*15*). The pandemic has led to an unprecedented need for federal assistance across a significant portion of the U.S. economy, including $300M approved for fishery disasters in 2020 as part of the Coronavirus Aid, Relief, and Economic Security Act (CARES Act). The scale of need for federal assistance this year (e.g., fishery disasters, COVID-19, record west coast wildfire impacts, etc.) highlights the critical importance of maximizing efficiency in the federal assistance process, and the impact of every federal dollar spent during these extreme and uncertain circumstances.

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Timeline

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**Fig. 1.** Federal fishery disaster request, determination, and administration process. Agency seals represent institutional involvement during each step of the disaster assistance process. Time periods in parentheses represent the mean (±SD) duration required for each step to occur. While the total implementation time is known (shown after step 6), some individual time steps do not have associated duration information.

Chart, scatter chart

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**Fig. 2.** Model estimated change in the number of Federal Fishery Disasters by impact year. The dark blue line represents the maximum likelihood fit (fixed effect of year), while the light blue shaded regions represent the 95% confidence intervals. The inset box shows the estimated change in the probability of causal drivers to these disasters (environmental, anthropogenic, or both) based on ordinal logistic regression (see supplemental materials). The rug plot (tick marks, jittered around each year) at the bottom of the inset panel represents the number of declared disasters (of any cause) per year.