



Chronic social disruption following a systemic fishery failure

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In the United States, the iconic groundfish fishery for Gulf of Maine cod has endured several dramatic reductions in annual catch limits and been federally declared an economic disaster. Using a repeated cross-sectional survey of fishing captains to assess potential social impacts of the fishery failure, we found that psychological distress and social disruption were pervasive throughout New England fishing communities. For instance, our results indicate that 62% of captains self-reported severe or moderate psychological distress 1 y after the crisis began, and these patterns have persisted for 5 y. Using classification tree analyses, we found that low levels of trust in fisheries management was the most powerful predictor of both initial and chronic psychological distress. Distress was most severe among individuals without income diversity and those with dependents in the household. Compared to other aspects of fisheries, measuring and managing for noneconomic social outcomes and human well-being has lagged behind, even though it is a necessary component of mitigating the adverse impacts of fisheries disruptions.

disasters | social impact assessment | well-being | fisheries | social-ecological systems

Although fishery declines are often used to portray the harmful ecological consequences of overexploitation and ineffective management, they also result in disrupted livelihoods and social systems (1–3). Moreover, while the ecological and economic dimensions of fisheries collapses have garnered substantial concern across scientific, public, and political realms, quantitatively measuring and managing for the well-being of resource users and communities has received less investment (4, 5). Here, we describe a longitudinal social impact study documenting widespread and chronic psychological distress and social disruption in New England fishing communities following the failure of the iconic groundfish fishery for Atlantic Cod (*Gadus morhua*).

The fishery for Atlantic Cod in the Northeast United States dates back to the 16th century; however, recent assessments estimate that cod abundances in the Gulf of Maine (GOM) have reached record lows (6). In December of 2011, National Oceanic and Atmospheric Administration (NOAA) Fisheries announced that an assessment of GOM cod determined that overfishing was occurring on an overfished stock and that fishing pressure should be reduced by upwards of 90% to assure recovery. Notably, the overfishing scenario largely resulted from uncertainties in previous stock assessments and not exceeded catch limits. While continuing to evaluate the fishery status and consider potential socioeconomic impacts, NOAA implemented interim reductions of 22% in 2012 and publicly forecasted the inevitability of further cuts. Subsequently, on 13 September 2012, the US Secretary of Commerce declared the Northeast groundfish fishery an economic disaster, and, soon after, NOAA announced that catch limits for 2013 would be reduced by more than 75%. Annual catch limits remained near historical lows in following years.

Following the disaster declaration, we conducted repeated cross-sectional telephone surveys of groundfish permit holders 3 times over 6 y and measured psychological distress using Horowitz's Impact of Event Scale (IES), social disruption in family and community relationships, and social capital as indicated by

trust in key actors and institutions (7). The IES scale comprises 15 Likert-type questions measuring the prevalence of intrusive thoughts and avoidance behaviors scored from 0 to 5 as Not at all = 0, Rarely = 1, Sometimes = 3, and Often = 5. The resulting 75-point scale has been interpreted using ordinal categories as representing a proxy for posttraumatic stress disorder as Sub-clinical = 0 to 8, Mild = 9 to 25, Moderate = 26 to 43, and Severe = 44+ and widely applied in studies of event-related disruption (8, 9). To quantify broader perceptions of social disruption, we measured perceived changes in work, community, future plans, family, and family future plans over the previous year. Trust was measured using a 5-point Likert-type scale where 1 represented “No Trust” and 5 represented “Complete Trust” for specifically named entities, which were then aggregated into key groups (e.g., Fisheries Management). The resulting final sample sizes and response rates were 158 and 32% for 2013, 116 and 32% for 2015, and 133 and 43% for 2018. Our study was approved by Northeastern University's Institutional Review Board (Protocol 12-07-25), and informed consent was obtained from all participants. All survey instruments, protocols, and metadata are publicly available at Northeastern University's Digital Repository Service (<http://hdl.handle.net/2047/D20323569>).

Our survey research revealed that the failure of the GOM cod fishery resulted in severe psychological distress for fishing captains and social disruption in fishing communities. Using questions from the Horowitz IES and anchored to the federal “fishery failure” declaration, categories of moderate or severe psychological distress represented 53 to 62% of captains across all years (Fig. 1A). When compared to 2013, the proportion of respondents in subclinical and mild categories increased over time, but the prevalence of severe effects remained at 28 to 35%. Perceptions of social disruption were typically greater than 50% across years and categories, while most severe for work, community, and future plans (Fig. 1B). Social capital in the fishing industry, measured as trust in other fishers and fishing business partners, was moderately high across years (Fig. 1C). However, trust in government, fisheries management, and environmental nongovernmental organizations was generally low.

To evaluate which factors were most predictive of psychological distress in the first (2013) and last (2018) years in the time series, we used tree-based classification models using the Chi-squared Automatic Interaction Detection Method (CHAID) and the following predictor variables: trust (in each of the 5 groups from Fig. 1C), occupational diversity, whether they employ family members, number of employees, dependent in household, household income, gender, year born, and marital status. We found that a low level of trust in fisheries management was the most

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The authors declare no competing interest.

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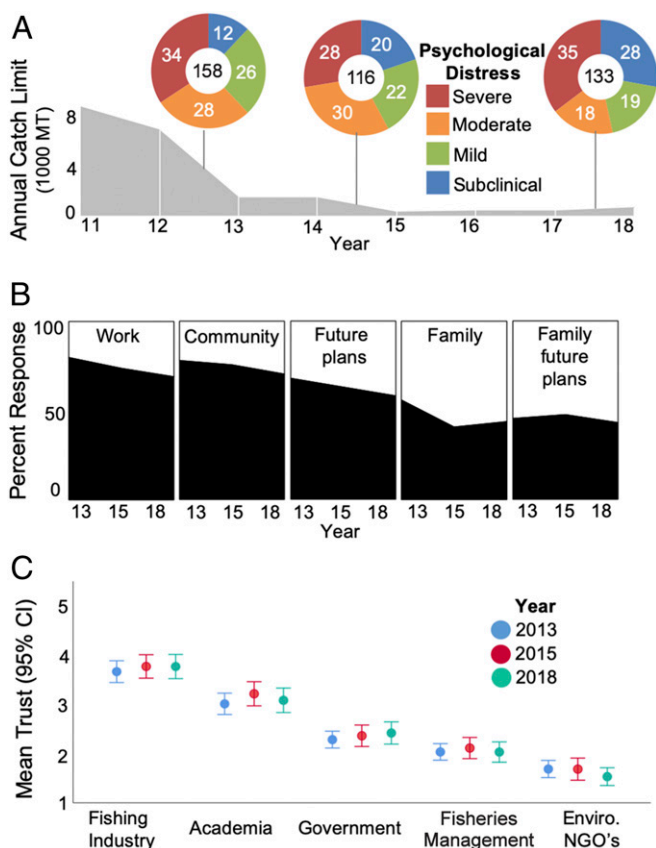


Fig. 1. Results of a repeated cross-sectional survey of fishing captains showing temporal patterns of (A) psychological distress, (B) perceptions of social disruption (area shown in black), and (C) trust in key groups involved in fisheries management. For A, value in the center of each circle reflects sample size.

powerful predictor of both initial and chronic psychological distress (Fig. 2). Among these most severely distressed groups, impacts were most severe among individuals without income from another occupation in the past 5 y and those with dependents in the household. While our analyses indicate that income diversity may buffer the social impacts of a fisheries collapse, we also found that income diversity declined from 31% in 2013 to 22% in 2018.

The fishery failure and ensuing social disruption resembles more well studied natural and technological disasters (10, 11),

which may offer valuable lessons for understanding and reducing social impacts (9, 12). For instance, communities struck by natural hazards typically rebound faster because high social cohesion and a supportive community response promote recovery. Conversely, communities impacted by human-caused disasters typically exhibit longer-term trauma and sociological problems as various parties dispute the characterization, causes, and effects of the disruption. While fisheries declines can be clearly driven by both natural and human processes, the groundfish failure shares many traits with human-caused or contested disasters. For instance, long-term studies of Cordova, AK, a fishing community devastated by the 1989 *Exxon Valdez* oil spill, revealed that social disruption, trauma, and loss of trust in institutions (i.e., recreancy) continued for decades among residents embroiled in litigation and stakeholder disputes (13).

The issues of stakeholder trust, conflict, and litigation are particularly salient for the Northeast US groundfish fishery. A pair of federal lawsuits highlights this contention in recent history. The first, filed by Massachusetts Attorney General Martha Coakley in May 2013, asserted that recent management actions represented “callous disregard for the well-being of New England fishermen.” In contrast, similarly timed litigation filed by 3 environmental groups accused NOAA Fisheries of violating the Magnuson–Stevens Fishery Conservation and Management Act (MSFCMA) and specifically opposed management measures allowing carry-over of uncaught groundfish to the following year. The Massachusetts lawsuit on behalf of the fishing industry was dismissed, whereas the environmental groups’ lawsuit was successful in arguing that the management measures intended to provide socioeconomic reprieve would instead worsen risks and consequences of overfishing.

While the cornerstone fisheries management legislation in the United States mandates the consideration of social impacts in scientific and regulatory actions, effective implementation faces numerous obstacles (5). For instance, a paucity of quantitative social data and lack of management targets for individual and community well-being often constrain social considerations in management. Traditionally, a perceived impediment to the effective inclusion of individual-level social data has been the costs and logistical challenges associated with surveys and interviews. However, longitudinal studies to measure individual and community well-being would cost far less than what is required for biological monitoring of fish stocks. Moreover, multiple survey- and interview-based programs already exist for the purposes of monitoring fishing effort and catch, which could potentially be leveraged or expanded to incorporate key social metrics. Not only are these data necessary to provide the best available science for regulatory decisions, as is mandated by

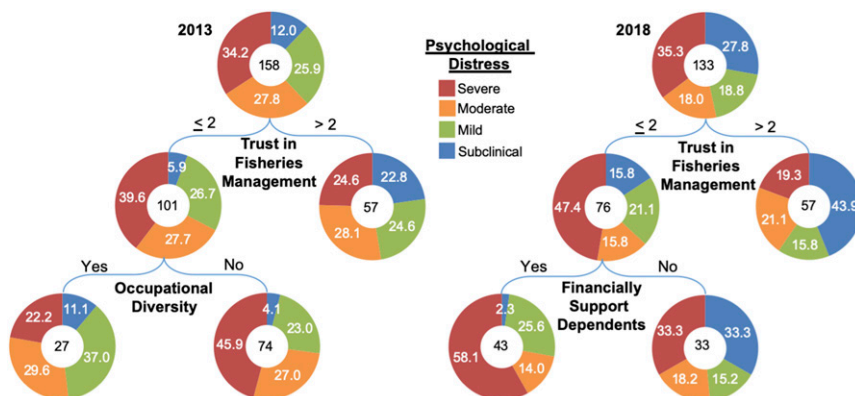


Fig. 2. Results of classification tree analysis to identify the most powerful explanatory variables of IES category in the initial 2013 and final 2018 surveys. Separate branches indicate statistical differences at $P \leq 0.05$. Value in the center of each circle reflects number of individuals.

MSFCMA, but placing a higher priority on social outcomes could also bolster trust, enable more effective fisheries management, and promote environmental justice.

The Northeast groundfish fishery provides a cautionary tale of how a fishery failure can severely harm well-being in fishing communities. Since 2010, there have been 33 disaster declarations approved and another 8 pending for US fisheries impacted by a wide range of stressors. Notably, these declarations do not generally include instances where established catch limits were exceeded. Commercial fishing involves numerous risks, notably health and financial, but previous studies have argued that these risks may contribute to happiness and job satisfaction (14). However, the broader social and cultural fabric of fishing communities has been deteriorating from a multitude of stressors, including declining fish populations, less

regulatory flexibility, and social change. Like many other places impacted by changing environments, the social and psychological dimensions are often unrecognized or unmeasured (15). Current fisheries management processes are well structured to assess the biological status of fish stocks, acceptable catch levels, and, when necessary, rebuilding targets. Measuring social impacts and managing to promote the well-being of human communities should be equally important for fisheries scientists and managers.

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