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Viewpoint

Out of sight but not out of mind: Harmful effects of derelict traps in selected U.S. coastal waters

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ABSTRACT

There is a paucity of data in the published literature on the ecological and economic impacts of derelict fishing traps (DFTs) in coastal ecosystems. We synthesized results from seven NOAA-funded trap fisheries studies around the United States and determined that DFT-caused losses to habitat and harvestable annual catch are pervasive, persistent, and largely preventable. Based on this synthesis, we identified key gaps to fill in order to better manage and prevent DFTs. We conclude with suggestions for developing a U.S. DFT management strategy including: (1) targeting studies to estimate mortality of fishery stocks, (2) assessing the economic impacts of DFTs on fisheries, (3) collaborating with the fishing industry to develop solutions to ghost fishing, and (4) examining the regional context and challenges resulting in DFTs to find effective policy solutions to manage, reduce, and prevent gear loss.

1. Introduction

Marine debris is a pervasive and growing international problem. Patches of plastic debris in the middle of the Pacific and Atlantic Oceans (Barnes et al., 2009; Goldstein et al., 2012; Gregory, 2009; Howell et al., 2012; Law et al., 2010; Moore et al., 2001), and larger debris such as the Japanese dock that washed up on the Oregon coast after the tsunami in 2011, are notable worldwide (NOAA Marine Debris Program, 2013). While marine debris includes these highly visible objects, it also includes other types of solid pollution such as abandoned vessels, trash, anthropogenic particles like microplastics that may not be visible to the naked eye, and derelict fishing gear including lost and discarded nets and traps (United States Congress, 2006). Derelict fishing gear is a type of debris that, while less obvious than floating pollutants, may have broader and potentially more harmful implications. This gear, whether accidentally lost or intentionally discarded, has a tendency to continue to fish for variable amounts of time; this phenomenon is known as ghost fishing (Brown and Macfadyen, 2007). Ghost fishing results in the loss of both targeted commercial species as well as non-target species and can damage seafloor habitats. Its impacts tend to be "out of sight" and are chronic stressors in many fisheries (Matsuoka et al., 2005). Yet, despite the important and negative impacts ghost fishing by derelict fishing traps (DFTs) can have on recreational and commercial fish stocks, there is a surprising lack of published data examining the extent of the problem, including both the ecological and economic impacts to fisheries and habitats. In addition, there have been few attempts to synthesize the available data to develop a broad understanding of the scope of the problem (Macfadyen et al., 2009).

This review and synthesis is a first step in gaining a specific understanding of the issue of DFTs in U.S. coastal waters, comparing several trap fisheries from around the U.S. for regional similarities and differences in the severity of the problem and the challenges faced in managing DFTs. We focus on derelict fishing traps, defined as traps that are abandoned, lost, and some percent of which are still ghost fishing. Previous studies have investigated the degree of trap loss, or the number of derelict traps, and/or the amount of ghost fishing in selected regions of some commercial fisheries (Antonelis et al., 2011; Breen, 1987; Bullimore et al., 2001; Chiappone et al., 2004; Guillory, 1993; Stevens et al.,

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2000). However, there is a significant need to advance the state of the science on DFTs as a national problem, and on regional, species-specific ecological and economic impacts. This synthesis provides an overview of the DFT problem by integrating work funded by the NOAA Marine Debris Program from seven key fisheries representing a majority of gear types and trap fisheries in the United States (Fig. 1), along with other published literature, to gain a better understanding of DFTs in U.S. waters. Fisheries include the Dungeness crab (*Cancer magister*) fisheries in Alaska and Puget Sound, the blue crab (*Callinectes sapidus*) fishery in Maryland, Virginia, and North Carolina, the spiny lobster (*Panulirus argus*) fishery in Florida, and the coral reef fish fishery in the U.S. Virgin Islands. The data in this paper were previously reported to the NOAA Marine Debris Program at the end of grants, but many of these findings are not available within the peer-reviewed literature. Thus, this synthesis brings all the data together to gain a broader understanding of the scope of the DFT problem and ensures these data are available in the peer-reviewed literature. The main questions we address are: (1) How many DFTs exist in each fishery and what is their spatial distribution? and (2) What are DFT impacts to fishermen, target and non-target organisms, and habitat? Based on the synthesis of all seven studies, we determined that there is a need to develop a DFT management strategy. We propose an initial strategy that will help inform the science, policy, and management of DFTs at the local, state, and federal level. Our strategy includes (1) targeting studies to estimate mortality of fishery stocks, (2) integrating social science research with targeted ecological research, (3) involving the fishing industry in collaborative projects to develop solutions to ghost fishing, and (4) examining the regional context and challenges resulting in DFTs to find effective policy solutions.

2. Study descriptions

In this paper, we compare the methods and results of seven studies (Fig. 1) focused on derelict trap debris resulting from both commercial and recreational fishing. This field of research is developing, and data collection using common metrics proved difficult. The studies reported here are some of the first in the United States to take a systematic approach to understand the extent of the derelict fishing trap issue. Estimating mortality caused by derelict gear remains challenging and thus economic impact is even more difficult to reliably estimate. For each study, the amount of DFTs present in the fishery was assessed. The studies used multiple techniques to determine the quantity of trap debris, which are fully described in Table 1. Generally, researchers found that visible detection by cameras or divers worked well in high visibility conditions (shallow and clear water), while sonar was most adaptable to wide ranges of depth and visibility conditions outside of reef or highly variable substrate types. Most studies chose to stratify the study area by the level of commercial fishing effort, and included this variable in subsequent analysis. Ghost fishing and habitat impact assessments were conducted based on study objectives. A mixture of in-situ assessment methods were used by various investigators; for example, divers assessed catch contained in ghost pots (Maselko et al., 2013) and researchers used field experiments to simulate and evaluate the effects of derelict fishing traps on target species and habitat (Clark et al., 2012; Havens et al., 2008). Because each study was designed to address specific regional challenges associated with DFTs, the focus of each study varied. For example, the North Carolina study focused on the impact of DFTs on the diamondback terrapin (*Malaclemys terrapin*), while the USVI study focused on better understanding the fishing community. Meta-analysis was challenging given differences among study design and scope. Statistical analysis on common metrics (e.g., number of DFTs) was not possible given the different methods of data collection. Therefore, our analysis is mainly qualitative and highlights the need for standard reporting metrics to facilitate comparisons. We provide some economic implications for the estimated impacts of DFTs, highlighting a case study comparing the ghost fishing capture rate to the entire fishery, and utilizing additional published literature to expand outside the seven studies reported here.

3. Results and discussion

3.1. The scope of the DFT problem: Number, distribution, persistence

The average number of DFT km^{-2} varied in each region and ranged from 5 to 47 DFT km^{-2} with the highest density in the Maryland portion of the Chesapeake Bay study (Table 2). These averages do not always show the variability by habitat type or fishing intensity that was sometimes found in the field. In Florida, for example, different habitat types were surveyed and macroalgae had the lowest density of trap debris; conversely, coral reef habitats had the highest density despite fishermen's efforts to avoid coral reefs when fishing (Uhrin et al., 2014). In the Maryland main stem of the Chesapeake Bay, variability ranged from 28 to 75 DFT

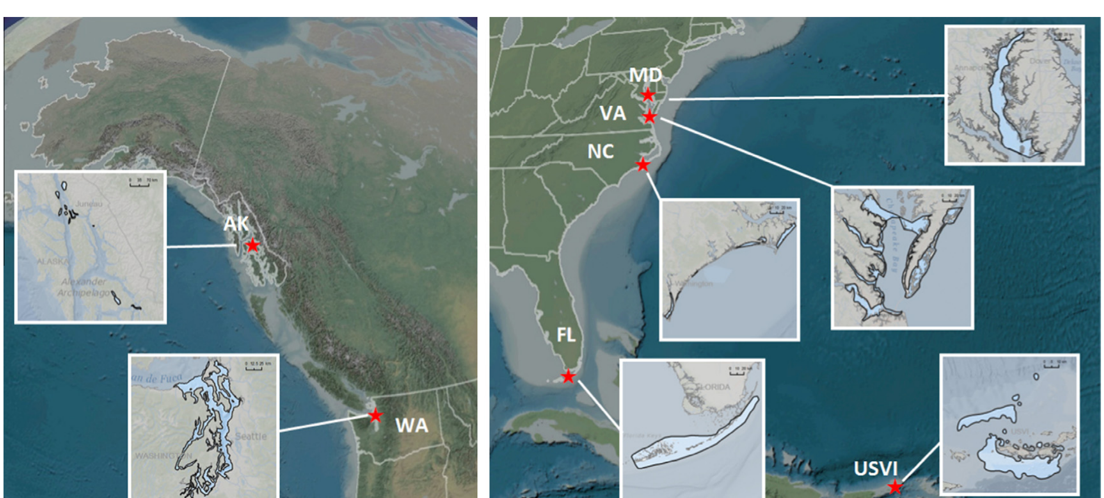

Fig. 1. Map of the study locations in the USA (credit: Robb Wright, NOAA).