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A Survey to Examine the Effects of the Chinese Mitten Crab on Commercial Fisheries in Northern California

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Introduction

The recent arrival of the Chinese mitten crab (*Eriocheir sinensis*) to the San Francisco Estuary has caused widespread concern about the potential ecological and economic effects of this species in its new environment. First discovered in 1992 by a shrimp trawler in South San Francisco Bay, the mitten crab population has quickly expanded to thousands of square kilometers of the estuary and its tributaries.

The abundance, widespread distribution, and potential negative effects of this crab have particularly caused concern among members of the estuary's fishing community. The mitten crab is catadromous; it begins its life in the saline waters of the bay and migrates up into fresh waters to mature. After one to five years in these waters, it returns in the fall to the open waters of the bay to reproduce. The mitten crab is an excellent migrator, and may cover hundreds of kilometers of a river during its lifetime. The crab is omnivorous, but may shift to a more carnivorous diet as it ages (Tan 1984). The likelihood that the crab is able to capture free-swimming fish is low—we and other researchers have kept these crabs and fish in containment together and observed little interaction between them (Panning 1939; D. Rudnick, personal observation, see "Notes"). However, mitten crabs have extremely sharp carapaces and claws and, when captured in fishing gear with the intended catch, they have been reported to cause damage to catch (Panning 1939). At periods of high abundance in the estuary, mitten crabs have become a serious nuisance by stealing bait from recreational anglers (K. Hieb, personal communication, see "Notes"). They can also be a hindrance by fouling fishing lines and gear.

Little research has been conducted in this system or in other parts of the world where the crab has been introduced to identify and quantify the crabs' effects on commercial fishing efforts. Because commercial fishers are continuously working in the bay, they could provide a wealth of knowledge about the distribution, abundance, and behavior of the crab. Our objectives were therefore twofold: (1) to identify and quantify the negative effects of the Chinese mitten crab on commercial harvest of San Francisco Bay seafood; and (2) to establish the potential for data collection by commercial fishermen to increase our understanding of the ecology of this species.

Methods

We applied and received permission to obtain contact information for commercial fishing licensees in California from the Department of Fish and Game. Licensees were not identified in the database by the area in which they fish or by their target species, so we narrowed the list to those with contact information in the San Francisco Bay area. We then randomly chose 30 contacts to receive the survey.

Our survey was mailed with a cover letter explaining the purpose of our study and confirming that responses would be used anonymously and collectively, unless the recipient agreed otherwise. This survey was developed with the assistance of the UC Berkeley Survey Research Center. Survey questions confirmed: the type of fishery the recipient was engaged in; the equipment used; the area in which they fished; whether, when, and how often mitten crabs were collected; and if damage to the harvest was observed in the presence of the crabs. Recipients were invited to provide further contact information and indicate if they would be willing to participate in further research.

The survey was mailed in September of 2000. If, after 30 days, no response was received, we followed up with a phone call to the recipient to ensure that the survey was received, that it was pertinent to them (that is, that they fished in the San Francisco Estuary), and to ask if they had further questions. Respondents who were willing to continue to participate were sent data collection sheets to more closely and continuously track mitten crab collections.

Results

Nine completed surveys were returned by mail—a one-third response rate. Two surveys were returned in the mail indicating incorrect addresses and telephone numbers also were incorrect. Following up by telephone, four additional recipients indicated that they did not fish in or near San Francisco Bay, had never seen a mitten crab, and therefore, did not return the survey. Of respondents who returned surveys, two fished outside the bay and had never collected mitten crabs.

All respondents who were actively fishing in the bay or Delta reported capturing mitten crabs either as bycatch or on the outside of their fishing equipment. Respondents fished for a variety of seafood (shrimp, gobies, sculpin, crayfish, and herring) using a variety of gear types (trawl nets, gill nets, hook and line, and traps). All respondents reported their first capture of mitten crabs in 1995 or 1996.

Mitten crabs were reported year-round during fishing efforts, but the highest numbers of crabs were reported during winter months (November-February) (Figure 1).

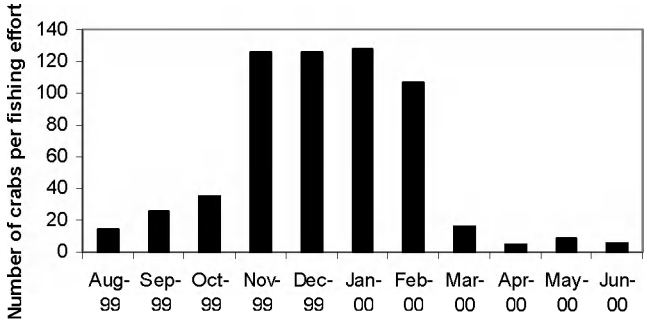

Figure 2 Average number of crabs per fishing effort, 1999–2000

All five respondents that were engaged in shrimping using trawl nets reported damage to their catch. Effects included damage to and death of catch as a result of being pressed against the spiny carapace of the crabs, and increased time for cleaning of equipment because of crabs being tangled in nets and lines. Estimates of direct damage to shrimp from the crabs ranged from 5% to 40% of catch during periods of high mitten crab abundance. One respondent indicated that mitten crabs were actively eating shrimp in the net; others remarked that most damage occurred from the spiny carapace and legs of the crabs puncturing the shrimp.

Two respondents, one fishing for crayfish using traps and one fishing for herring using gill-nets, reported no discernible damage to catch by mitten crabs.

Discussion

The results of this survey align closely with what is known about the life history of the Chinese mitten crab. Mitten crabs are present year-round in the brackish portions of tributaries, but reach their highest densities in their breeding grounds in winter months, also the time when respondents reported the highest numbers of crabs. Damage to and interference with commercial harvests is therefore concentrated in this season.

Juvenile and adult mitten crabs are benthic animals, grazing on detritus and other food sources at the bottom of the water column; therefore, the highest rates of capture should occur when using methods that collect animals from the bottom of the estuary, such as trawling. Benthic stationary traps, as are used in the crayfish industry, often do not attract crabs, as was observed in this survey and others and research that we have conducted (Rudnick and others 2000). The shrimp industry, which uses low-speed trawls to harvest shrimp, is the industry that reported the highest level of damage in this survey, and should be targeted for further research and identification of the Chinese mitten crab's effects on commercial fishing.

We received many individual comments and suggestions from respondents that, while not quantifiable, provide valuable information and directions for further inquiry. Observations included noticing an inverse relationship between the speed of the trawl and the number of mitten crabs collected; remarking on high abundance of mitten crabs and higher levels of salinity and/or depth; and wondering about possible connections between the increase in mitten crabs and decline of other species such as Dungeness crab. One respondent also emphasized the link between commercial and recreational fisheries affected by the mitten crab, stating that recreational fishermen who buy his products for bait have become so frustrated by losing bait to these crabs that they have stopped buying his products, causing his sales to decline.

Our survey was limited by several factors, including no prior information of where survey recipients fished and what seafood was harvested. Prior knowledge of this information would have ensured that recipients were appropriate for the survey and ensured coverage of the range of industries operating in the estuary. In addition,

follow-up efforts to ensure surveys were complete were often difficult, because industry members are extremely busy and hard to contact.

We believe that the quantity and quality of data received provided useful information about mitten crab effects to these industries. Four respondents have agreed to collect long-term data on mitten crabs captured during their fishing efforts, and this year we have begun coordinating reporting and analysis of these data. These new data should enable us to better understand relationships among gear type, gear use, and crab collection rates, as well as provide more specific information about location of collections and relation to physical, chemical, and temporal parameters.

Conclusions

Potential negative effects of invasive species are often cited as the basis for developing policies for management and control of these species, but we often do not have the information needed to quantify these effects. We have identified effects to fishing industries by the Chinese mitten crab, including damage to and preying on catch, reduction in sales of bait fish, and increased time spent separating crabs from catch. In our survey, effects were concentrated in the shrimping industry, and this industry should be a target for further research and management considerations.

The Chinese mitten crab's historical invasions of the waterways of several European countries suggests its population abundance oscillates, and several years of low abundance may be followed by a population explosion. There is still much that needs to be understood about the population dynamics and life history of this species. Commercial and recreational fishermen can be valuable allies in tracking this population, increasing our knowledge about its life history, and helping us understand the extent of its effects in the San Francisco Estuary.

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