ANNUAL REPORT FY13
Habitat Assessment Funded Research

Project Title: Identifying habitat use by male and female red king crabs during mating season.

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Goals:

Red king crabs (*Paralithodes camtschaticus*) are a valuable resource in Bristol Bay, Alaska that is jointly managed by NMFS and the Alaska Department of Fish and Game; however, little is known about their habitat requirements (NPFMC, 2011a). Ovigerous female red king crabs aggregate in shallow waters to release their larvae in the late spring or early summer (Armstrong et al., 1993; Loher and Armstrong, 2005). Immediately after larval release, they molt, mate, and extrude a new batch of eggs. The larvae remain in the plankton for several months, and then settle onto benthic habitat and molt to the first crab stage. Complex habitat, either biogenic or non-biogenic (Sundberg and Clausen, 1977; McMurray et al., 1984; Loher and Armstrong, 2000), is critical for newly settled juveniles as it represents a predation refuge for them (Stoner, 2009; Pirtle and Stoner, 2010; Stoner et al., 2010; Long et al., 2012). These habitats are typically found in near-shore shallow areas; in Bristol Bay, the best habitat is probably along the edge of the Alaska Peninsula (McMurray et al., 1984).

Several issues involving habitat use by reproductively mature red king crab are of interest to managers. First, temperature may be very important in determining the distribution of mature females. Laboratory experiments show that the optimal temperature range for red king crab embryo development is 3-8ºC (Nakanishi, 1987), and this may lead females to avoid waters <2ºC (Loher and Armstrong, 2005). In cold years, this avoidance may push females into shallow water that is not sampled during the Eastern Bering Sea Trawl Survey, the NMFS survey used to assess the stock, reducing their catchability and leading to uncertainty in the survey abundance of mature females and the male/female sex ratio (Dew, 2008; Chilton et al., 2010). A second issue deals with male movement and overlap with females during the mating season (Dew, 2008). Currently, the spawning stock, which is used to define the stock-recruit curve for the assessment model which sets the total allowable catch, is defined as the lesser of either male reproductive potential or female spawning abundance (Zheng et al., 1995). However, this assumes that all mature males mate every year, but if incomplete overlap in habitat use by male and female red king crab occurs during the mating season, this assumption would lead to an overestimate of the spawning stock. This may be compounded in cold years because it is not known whether male crabs avoid cold water habitats, as do female crabs (Chilton et al., 2010). If they do not, then the overlap in habitat use by male and female crabs could vary among years. Additionally, the overfishing level for red king crab is set using only the estimate of mature male biomass as the spawning stock estimate because of uncertainty in the overlap in habitat use between males and females (NPFMC, 2011b); better defining this overlap will enable the use of an egg-production

model, which will provide a more accurate measure of the stock reproductive potential. In 2012 we were funded through a Stock and Habitat Assessment Improvement Plan proposal to use pop-up tags to identify the female spawning habitat which is critical for the protection of that habitat from trawling (Evans et al., 2012). While the current grant focuses on the issues of female catchability during the trawl survey and overlap in the male/female habitat use, the results will complement our previous funded project by providing a second estimate of crab spawning habitat and allow us to quantify interannual variation and thus better define this critical habitat.

This work will provide direct evidence for the hypothesis that the distribution of brooding female red king crabs is controlled by their thermal habitat requirements (Loher and Armstrong, 2005). Further, it will improve our catchability estimates by providing an estimate of the proportion of mature female crabs in the Bristol Bay stock that move outside the survey area to molt and mate, which has important implications for the assessment of red king crab (Dew, 2008; Chilton et al., 2010). It will also examine whether males have a similar thermal habitat requirement and give an estimate of habitat-use overlap between male and female red king crabs during mating. This will help to determine if current assumptions used when defining the red king crab spawning stock are realistic. Finally, this project estimates the red king crab spawning habitat which has implications for trawl closures to protect red king crab spawning habitat (Evans et al., 2012). A second year's worth of data will allow us to examine any interannual differences in the spawning habitat and will allow managers to incorporate any variance into the design of trawl closure areas.

Approach:

We propose to track mature male and female red king crabs to examine how their habitat requirements change with temperature and to identify overlap in their habitat use during the mating season using pop-up tags. Mature crabs captured during the 2015 Eastern Bering Sea Trawl Survey, will have a pop-up tag affixed to their carapaces using marine-grade epoxy, and be released back into the wild. Half of the 80 tags will be affixed to males and half to females. Only healthy, active, new-shell crabs without any injuries will be used, and females will have to have newly extruded eggs. The tagged crabs will be released randomly throughout their distribution in Bristol Bay to ensure that the tagged crabs are representative of the population. Sensors on the tags will record light levels, 3-axis magnetic field strength, and temperature. The light levels (Seitz et al., 2011) and magnetic field measurements will be used to calculate daily positions, and a running average will be applied to improve the precision. This, combined with temperature readings from the tags, bottom temperatures acquired during the bottom trawl survey and from NOAA's KC-2 mooring in Bristol Bay (Chilton et al., 2010), will allow us to define the thermal habitat requirements for both sexes and relate crab movement to changes in water temperature.

The tags affixed to male crabs will be programed to pop up in June during the mating season, while those affixed to female crab will be programed to pop up in July after the mating season. Because female crabs molt shortly after releasing larvae and prior to mating, the tags will remain affixed to the exuvia in the exact location of spawning, which is why they will be programed for release later than those of the males. After the tags pop up, they will transmit the

data accumulated over the deployment period as well as their exact location to the ARGOS satellites. This will give the precise locations of both sexes during the mating period.

Tags will be purchased in the 4th quarter of 2013, deployed during the trawl survey in 2015, and will transmit their data back during the early summer of 2016.

Work Completed:

The project is currently on schedule. The purchase order for the pop-up tags was awarded on June 12, and all other purchases were completed by the end of the fiscal year. The real tags will be delivered in the spring of 2014. The tags will be deployed one year later than originally anticipated. This is the second grant funded to use pop-up tags to examine habitat use by red king crab in Bristol Bay. The first grant, "Locating essential spawning grounds for red king crab", was funded in 2012 and the tags were scheduled to be deployed on the 2013 survey. However, the company that is providing our tags failed to deliver the tags in time for the survey this year and we had to put off deployment until next year. Because of that, we have to conduct that project during the 2014 survey which will force us to put off this project till the 2015 survey as we will be unable to conduct both projects in the same year.

Applications:

Results and applications are not available yet.

Publications/Presentations/Webpages:

- N/A

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