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# Fishery Interaction and Availability of Atka Mackerel Prey for Steller Sea Lions: Results from a Local Abundance and Movement Study of Atka Mackerel

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**A**tka mackerel (*Pleurogrammus monopterygius*) are the most abundant commercially exploited groundfish in the Aleutian Islands, Alaska. They display a highly aggregated patchy distribution, centered around island passes and areas of high currents. Atka mackerel are demersal batch spawners with males guarding nests for up to six months of the year. Females aggregate in large schools near the spawning grounds, presumably to feed. Atka mackerel is the predominant prey of the endangered Steller sea lion in the Aleutian Islands. Trawl exclusion zones of 10 to 20 nm have been established around rookeries to protect Steller sea lion prey abundance. This study estimated the movement and local abundance of Atka mackerel with a mark recapture experiment using an integrated tagging model. Atka mackerel were tagged, released, and recovered from 2000 – 2006 in four local areas inside and outside of trawl exclusion zones in the Aleutian Islands. Population abundance was examined with respect to Steller sea lion prey energetic requirements within the trawl exclusion zones. Atka mackerel local movement patterns across these harvest boundaries was related to local fishing patterns and the interaction between fishery and prey abundance was examined.

Keywords: Mark recapture, integrated tagging model, fish abundance, fish movement, fishery interactions, Atka mackerel, Aleutian Islands, Steller sea lion, predator-prey interaction.

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*Introduction:*
Atka mackerel (*Pleurogrammus monopterygius*) are a member of the greenling species and occur in Alaska from the Aleutian archipelago in the west to the Shumagin Islands in the Gulf of Alaska. **A**tka mackerel is the most abundant commercially exploited groundfish in the Aleutian Islands, Alaska. They display a highly aggregated patchy distribution, centered around island passes and areas of high currents. Atka mackerel are demersal batch spawners with males guarding nests for up to six months of the year. Females aggregate in large schools near the spawning grounds, presumably to feed. Atka mackerel is the predominant prey of the endangered Steller sea lion in the Aleutian Islands. Trawl exclusion zones (TEZs) of 10 to 20 nm have been established around rookeries to protect Steller sea lion prey abundance.

The objective of this project was to evaluate the efficacy of trawl exclusion zones at maintaining sufficient quantities of Atka mackerel prey for Steller sea lions (SSL) in the Aleutian Islands. Tag release-recovery methods were used to estimate local abundance and movement rates inside and outside TEZs at several sites in the Aleutian Islands. Movement rates are of interest because fish moving from inside to outside TEZs are vulnerable to commercial fishing.

*Methods:*
From 2000-2006 58,654 Atka mackerel have been tagged and released at Seguam Pass, Tanaga Pass, Amchitka Island and Kiska Island (Table 1, Figs. 1 and 2) by the National Marine Fisheries Service. The platforms used were the chartered commercial shoreside trawler FV *Pacific Explorer* and the chartered commercial factory trawler *Seafisher*. Fish were captured for tagging with heavy duty bottom trawls at low quantities (less than 2 metric tons) and immediately transferred to live tanks aboard the vessel. Tags used were Floyd T-bar tags individually numbered that were inserted into the dorsal musculature of the fish. Recovery sampling was conducted aboard a chartered commercial factory trawler. Numbers of fish caught were estimated by subsampling every haul for species composition, similar to groundfish observer sampling aboard commercial fishing vessels. Tagging procedures and recovery sampling are described in detail in McDermott et al., 2005. Biomass and movement rates were estimated with an integrated model that uses maximum likelihood to estimate all parameters simultaneously (McDermott et al., 2005).

<u>Recruitment factor</u>
For the analysis of the data from 2002 through 2003, the model was adjusted to take recruitment into account. Atka mackerel experienced a higher than average recruitment event of 3 year old fish in 2002 and 2003 at all three study sites. This was most likely due to higher than average year classes during 1998 and 1999 (Lowe et al., 2005). When length frequency distributions were compared between the tag release events in July and the tag recovery events in September and October, it became apparent that a large influx of young untagged fish had diluted the population in all of the study areas. In order to account for this recruitment event, a recruitment factor was calculated by which the population had increased as a whole The number of fish examined for tags was then adjusted by the recruitment factor to represent the fish present at time of tag release before the recruitment event took place. Therefore the model results from 2002 and 2003 represent population sizes at time of tagging before the recruitment event took place and are conservative.

Movement rate

To reasonably bound the movement rates, an uninformative prior on movement rates was specified such that if tag-recapture data were absent or uninformative, the expected movement rate between areas would be equivalent to random diffusion.

Exploitation rate

Seasonal exploitation rates for each area were calculated by dividing total tons caught by the fishery during August through October by the local biomass estimated with tagging data for the respective year of the study. The data for the catch statistics were derived from the NORPAC observer database.

*Results and discussion*

Population sizes and biomass were highest at Seguam Pass and lowest at the south end of Amchitka Island and are summarized in Table 2 for biomass and Fig. 3 for abundance. In all areas, biomass inside the TEZs was similar to or greater than biomass outside the TEZs (Table 2). In all areas, movement rates from inside to outside were similar to or less than movement rates from outside to inside, with the exception of Amchitka Island where movement rates were estimated to be greater from inside to outside. In addition, movement rates were greater overall at Amchitka Island than at any of the other study areas (Fig. 4).

The results suggest that TEZs in Seguam, Tanaga Passes, and Kiska, where Atka mackerel biomass is relatively high and movement is relatively low, may be effective at preserving local foraging areas for Steller sea lions. In contrast, the TEZ at the south end of Amchitka, where biomass is low compared to other areas and movement is high, may be less effective. These differences in movement relative to TEZs may be due to differences in the distribution of Atka mackerel habitat. For example, the boundaries of the TEZs at Seguam and Tanaga passes appear to coincide with natural Atka mackerel habitat boundaries (by chance). In contrast, the TEZs at Amchitka Island, and Kiska Island appear to bisect Atka mackerel habitat. This may be why movement rates relative to TEZ boundaries at Amchitka and Kiska were higher than at Seguam and Tanaga passes.

The local exploitation rates estimated in this analysis were low for Seguam and Tanaga Pass (1% and 3%, respectively) and no danger of localized depletion of prey is expected. However, lower biomass and higher exploitation rates at Amchitka (50%) make this area susceptible to localized depletion during the time of the fishery in the area outside the trawl exclusion zone (Fig. 5). Because the fish at Amchitka seemed to move freely between inside and outside the TEZ, fish might be vulnerable to the fishery in both areas, inside and outside the TEZ. The exploitation rate of the combined population of Amchitka south both inside and outside the TEZ was estimated at 29%. This could affect Steller sea lion foraging success if the fish inside the trawl exclusion zone are also affected by this high exploitation rate. Movement at Amchitka in between both areas has been described as high, indicating that the south end of Amchitka Island has a greater potential for a small scale fishing effect on the foraging success of Steller sea lions. It is therefore important to understand fishery dynamics at a local scale to assess the variable effect of fishing small scale affects of the fishery.

In general, these results indicate that Atka mackerel fishing patterns are variable throughout the Aleutian Islands and exploitation rates can be high in local areas.

*References*

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McDermott, S. F., Fritz, L.W. and Haist, V. 2005. Estimating movement and abundance of Atka mackerel (*Pleurogrammus monopterygius*) with tag-release-recapture data. Fisheries Oceanography 14 (Suppl. 1): 113-130.

Table 1. Tag release and recovery number for Atka mackerel

| Year | Area | Tags Released | Tag recovered |
|---|---|---|---|
| 2002 | Seguam | 24,999 | 58 |
| 2002 | Tanaga | 11,207 | 46 |
| 2003 | Amchitka | 14,530 | 769 |
| 2006 | Kiska | 7,918 | 129 |
| Total | | 58,654 | 1,002 |

Table 2. Biomass estimates (thousands of metric tons) for Atka mackerel inside and outside trawl exclusion zones (TEZ) in the four different study areas.

| | | Inside TEZ | | | Outside TEZ | | | Total |
|---|---|---|---|---|---|---|---|---|
| Year | Area | *Biomass* | *Lower 95 C. I.* | *Upper 95 C.I.* | *Biomass* | *Lower 95 C. I.* | *Upper 95 C.I.* | *Biomass* |
| 2002 | Seguam | 273.45 | 150.77 | 468.98 | 61.47 | 26.51 | 125.70 | 334.92 |
| 2002 | Tanaga E | 56.23 | 11.85 | 180.54 | 26.91 | 14.63 | 49.34 | 83.13 |
| 2002 | Tanaga W | 17.48 | 1.76 | 46.81 | 17.86 | 1.80 | 46.73 | 35.33 |
| 2003 | Amchitka S | 10.10 | 1.38 | 22.02 | 7.89 | 0.98 | 20.95 | 17.99 |
| 2003 | Amchitka N | 14.69 | 1.62 | 32.56 | 14.14 | 1.47 | 31.96 | 28.83 |
| 2006 | Kiska | 59.66 | 7.33 | 157.71 | 57.92 | 18.96 | 105.86 | 117.58 |

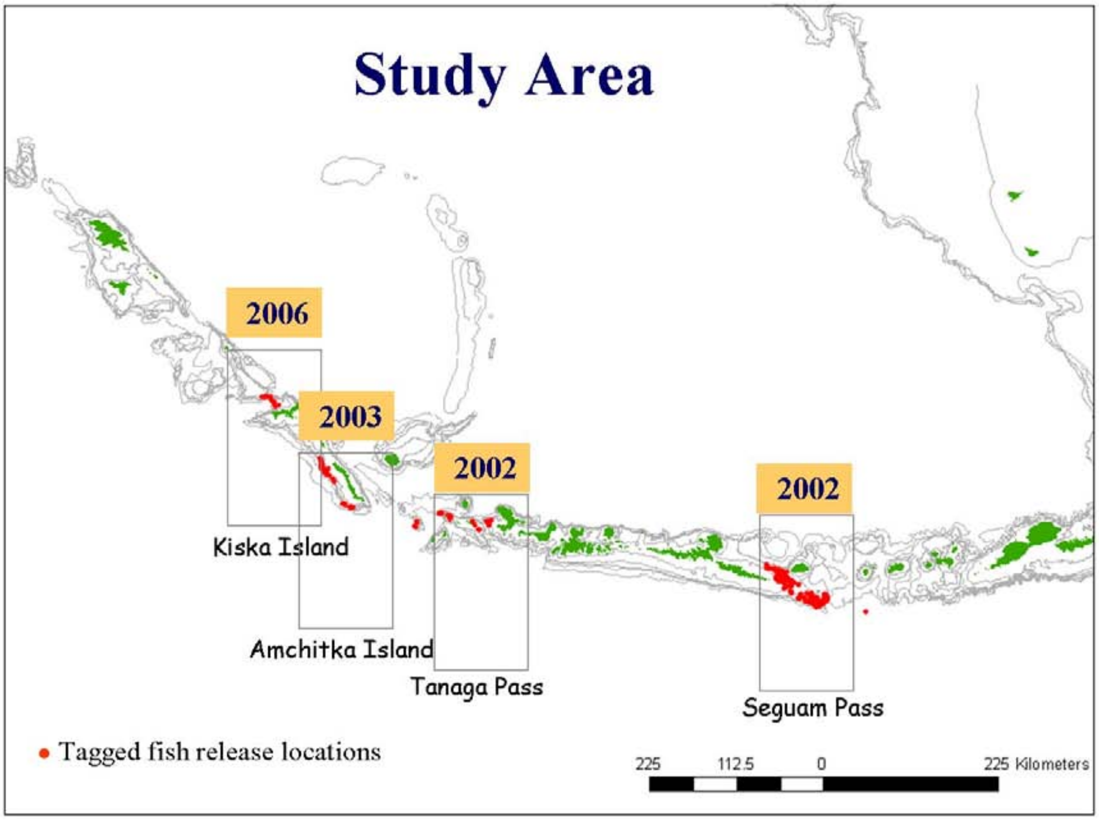


Figure 1. Study areas and tag release and recovery locations

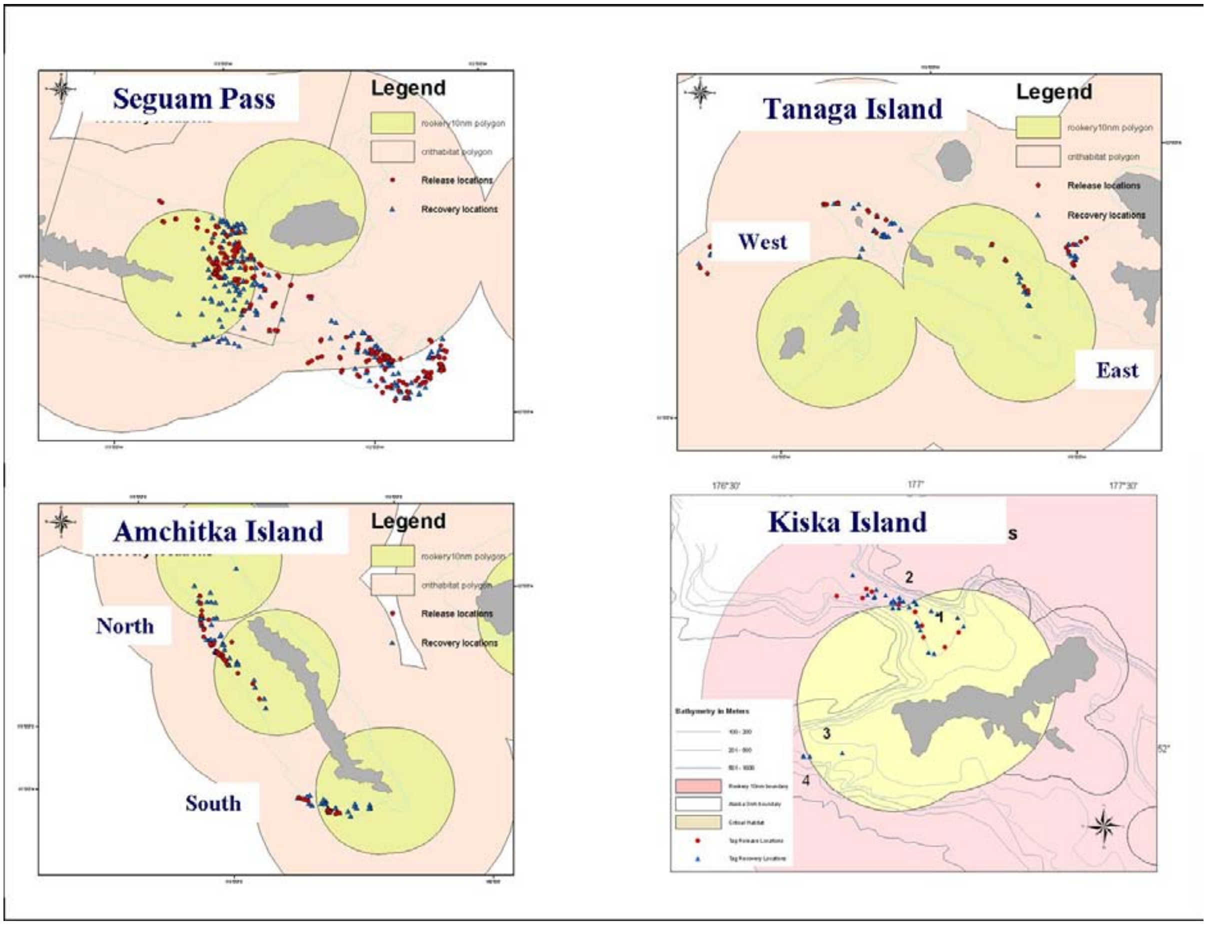


Figure 2. Atka mackerel release and recovery locations for the respective study areas in the Aleutian Islands.

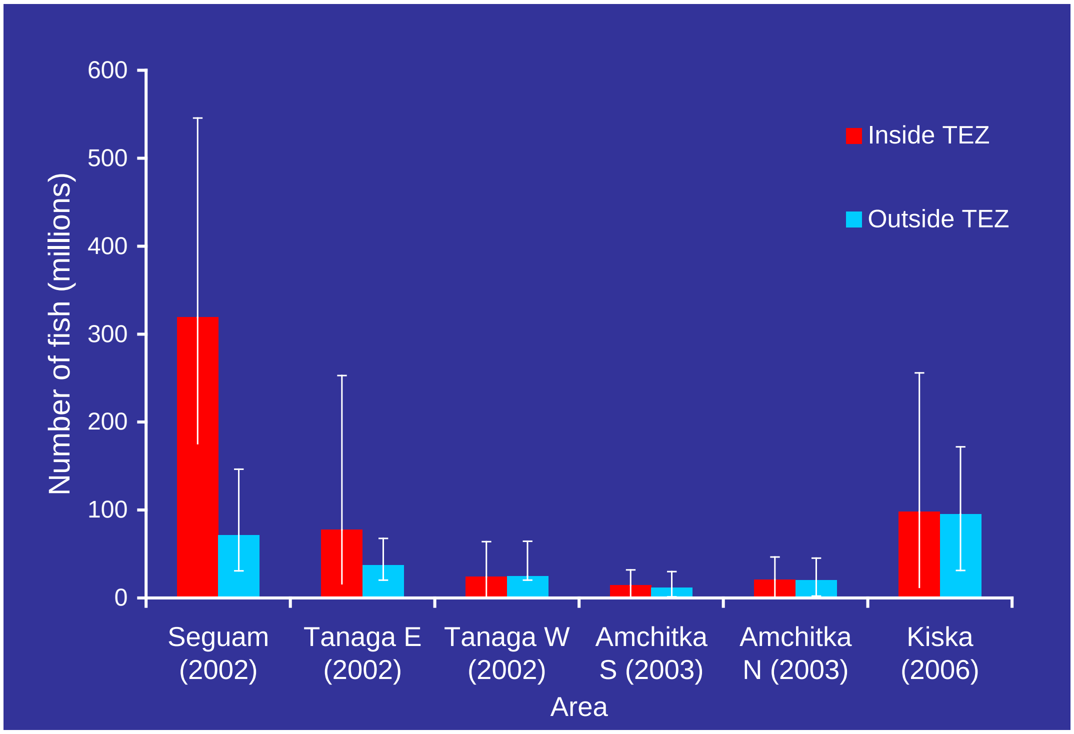


Figure 3. Model estimates of Atka mackerel abundance (millions) inside and outside the trawl exclusion zones (TEZs) in each study area.

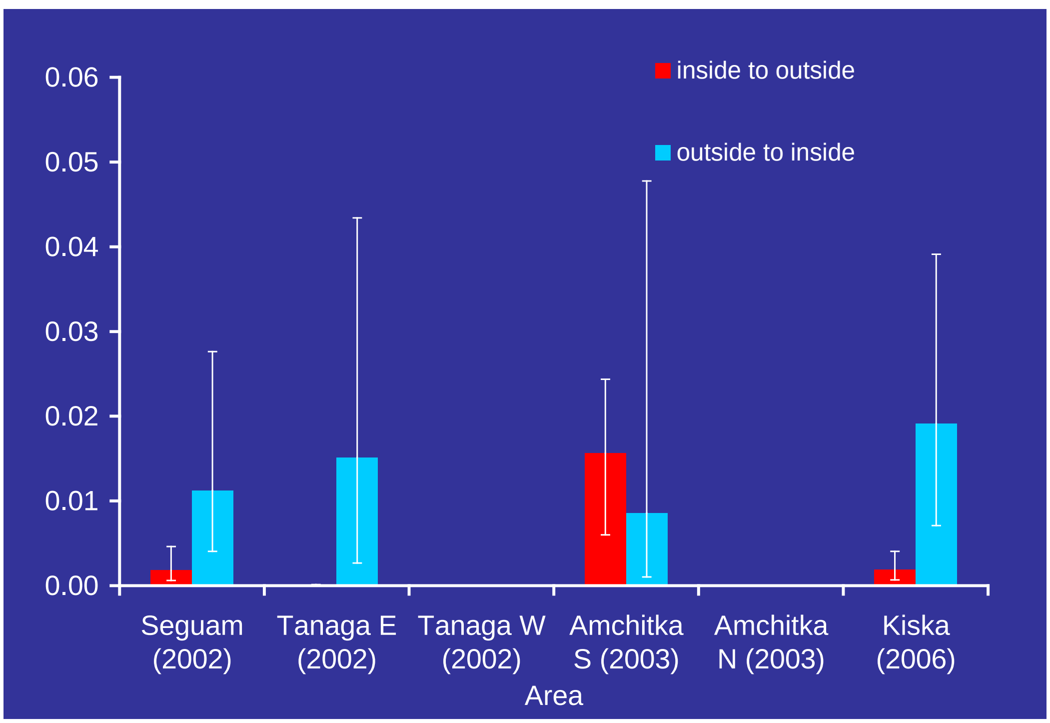


Figure 4. Probability of movement from inside to the outside of the trawl exclusion zone (TEZ) and outside to inside the TEZ for each study area.

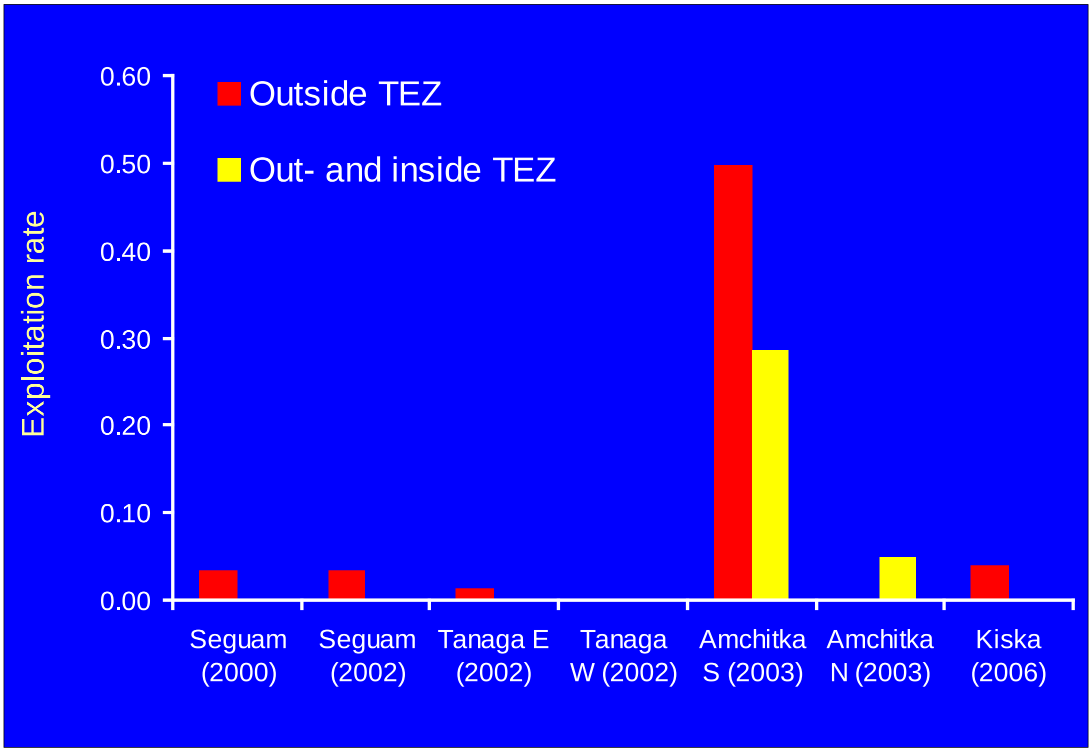


Figure 5. Local exploitation rates for each of the study areas relative to trawl exclusion zones (TEZ).