

## **An Experiment of Simulated Predation: Can River Otters Become Food Limited in a Marine System?**

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## **Introduction**

River otters (*Lontra canadensis*) inhabiting marine environments feed primarily on intertidal and demersal fishes in the nearshore system (Larsen 1984, Bowyer et al. 1994). Investigations were conducted from 1995 to 1998 in Prince William Sound, Alaska, to determine whether river otters and three other top predators inhabiting the nearshore environment continued to be negatively influenced by chronic effects from the 1989 *Exxon Valdez* oil spill. That ecosystem study (Nearshore Vertebrate Predator [NVP] project) addressed the questions: Have these species recovered? If not, is it oil, or is it food? (Holland-Bartels 1999). In that study, densities of intertidal and demersal fishes that are commonly consumed by river otters were compared between oiled and nonoiled sites and between random sites and latrines used by river otters (Holland-Bartels 1999).

In this companion study, a manipulative experiment was conducted to ask the question: Can river otters affect their prey base (i.e., can river otters become food limited in a marine system)? Previous studies investigating predator-prey interactions of Eurasian otters (*Lutra lutra*) and fishes (Koop and Gibson 1991; Kruuk et al. 1988) conducted experiments removing fishes (*Pholis gunnellus*, *Zoarces viviparus*, and *Ciliata mustela*) from study plots by collecting fishes from under rocks and vegetation at low tide, when only a few centimeters of water remained. Both studies noted that removed fishes were replaced within two tidal cycles by new fishes, concluding that predators likely could not deplete an area of those species of fishes. Those studies were limited to assessing only fishes that seek refuge under rocks and vegetation as the tide recedes and therefore did not evaluate potential effects of predation on all types of fishes consumed by otters.

## Methods

We used scuba equipment to conduct a fish removal experiment in Herring Bay (oiled site) from late July to mid-August 1997, to test the hypothesis that otter predation influences local abundance of fishes. Three removal and three control sites with similar aspects and intertidal substrate characteristics were selected for the experiment. Prior to removal experiments, demersal fishes were counted at each site along two transects separated by 20 m, running perpendicular to shore. Transects extended a distance of 30 m or to a depth of 15 m, whichever occurred first. Each site was permanently marked with 6 mm nylon rope delineating the centrally located 30 m transects (i.e., a 20 m wide by 30 m long area) and a buffer zone on either side of the transects (15 m wide by 30 m long).

At each transect, fish in the water column were counted over a 2 m wide swath along the bottom and a second diver moved aside vegetation and counted benthic fishes in a 1 m wide swath. All fishes were identified to family and classified into three size categories (<8 cm, 8-15 cm, >15 cm). Following preremoval assessment of fish abundance at all sites, intense localized predation was simulated at removal sites by divers attempting to spear and remove all fishes. Four divers conducted fish removals at each removal site on three consecutive days. Two divers were assigned to the central 30 by 20 m area and a single diver to each of the outer areas. Each diver conducted a systematic search of the area attempting to spear any fish >8 cm in length that was encountered. Spearing episodes lasted 25-68 minutes. Immediately upon surfacing, divers recorded the number of fish seen but not successfully speared (i.e. number of fish missed) by fish family and size category (8-15 cm and >15 cm). Fish speared during the removal experiments were preserved in 10% buffered formalin for P4501A1 analysis.

Censuses of central areas were conducted to assess post-removal influences of simulated predation because the number of fishes encoun-

tered on preremoval transects was few compared with the number of fishes removed. Two days after the fish removals were completed, a census was done on the central 30 by 20 m area of each removal and control site, counting all demersal and pelagic fishes encountered. Censuses were repeated at each site two weeks later. Census dives involved a systematic search of the entire area and required 53-82 minutes to complete, depending on the amount of vegetation.

Fish removal data were analyzed using paired sample *t*-tests and GLM repeated measures analyses employing SAS software. Models were based on type (removal or control) because there were insufficient degrees of freedom to run models by site. Paired *t*-tests conducted on preremoval transects detected no difference between control and removal sites in fish abundance ( $F = 16.69$ ,  $P = 0.07$ ) thus sites were appropriate for comparison of post-removal abundance of fishes. Significantly more fishes (>8 cm) were missed than were removed ( $F = 7.18$ ,  $P = 0.04$ ), with greater numbers of fishes missed and removed on each subsequent day of the experiment (Figure 1). Divers likely acquired a better search image for fishes as the experiment progressed, and fishes likely became more cautious when divers were present as a result of previous experience.

A GLM repeated-measures analysis of post-removal censuses detected no difference between removal and control sites in number of fishes >8 cm present at each census ( $F = 0.06$ ,  $P = 0.824$ ). There was, however, a difference in fish abundance between sampling events ( $F = 248.44$ ,  $P = 0.04$ ), with a greater number of fishes present in the first post-removal census compared with the second census (Figure 2). By fish family (>8 cm), only sculpin differed significantly between removal and control sites (greater at control sites;  $F = 289.0$ ,  $P = 0.037$ ), whereas cod (greater in rep #1;  $F = 497.03$ ,  $P = 0.028$ ) and Pricklebacks (*Stichaeidae*) (greater in rep #2;  $F = 99999.9$ ,  $P < 0.001$ ) differed significantly between census repetitions (Figure 2).

Most differences in fish abundance occurred between sampling events rather than between control and removal sites, indicating a seasonal fluctuation in fish abundance that likely was not related to the removal experiment. The change in abundance for all fishes >8 cm between post-removal sampling periods (Figure 2) was driven primarily by cod, which were not targeted for removal. Preliminary food habit data obtained in 1996 from 25 samples of otter feces collected from latrine sites in Jackpot and Herring bays indicated that cod were not an important prey item for river otters at those sites (Holland-Bartels 1997). Pricklebacks also varied in abundance between post-removal censuses (Figure 2) and were present in greater numbers at removal sites compared to control sites.

Only sculpin occurred in lower numbers at removal sites compared with control sites during post-removal sampling, indicating that these relatively sedate fishes, which are commonly consumed by river otters (Larsen 1984, Holland-Bartels 1997), may be affected by predation. Nonetheless, when abundance of all fishes was considered, there was no difference

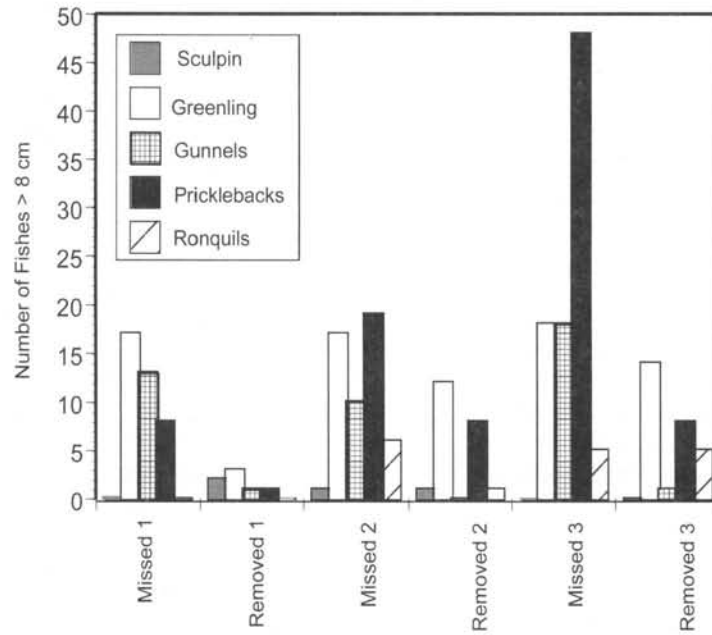


Figure 1. Total number of fishes > 8 cm missed and removed at fish removal sites ( $n = 3$ ) on three successive days of spearing by divers.

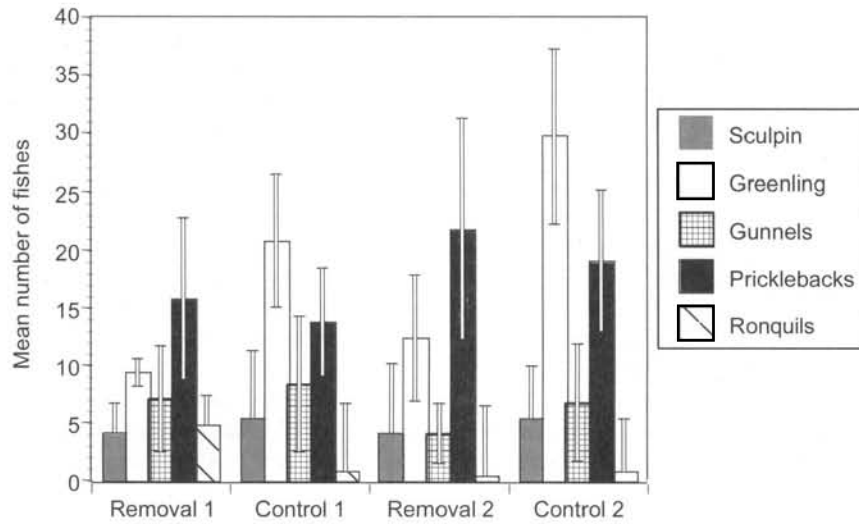


Figure 2. Mean number of fishes occurring at removal and control sites two days (removal and control 1) and two weeks (removal and control 2) after removal of fishes was conducted.

between removal and control sites in post-removal abundance of fishes >8 cm, indicating that the removal of fishes at those sites did not affect the subsequent number of most fish species that were present. Our conclusions agree with those of previous otter-fish studies (Koop and Gibson 1991; Kruuk et al. 1988). Because of the mobility of most demersal fishes, prey removed by predators are quickly replaced and depletion of a site is unlikely when fishes occur at densities similar to those noted during this study.

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