

Burbot Consumption and Relative Abundance in the Apostle Islands Region of Lake Superior

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ABSTRACT. Burbot (*Lota lota*), are native Lake Superior piscivores that share similar habitat and food resources with other predators including lean and siscowet lake trout (*Salvelinus namaycush*). To better understand their ecological role in the fish community, we combined fisheries assessment information from 1970 to 2002 with a bioenergetics model to estimate their predatory impact in the Apostle Islands region of Lake Superior. Relative abundance declined in the Apostle Islands region from 3.41 fish/1,000 m in 1978 to 0.27 fish/1,000 m in 1998. Fishing mortality was minimal based on creel estimates and observed bycatch in the commercial fishery. Burbot < 400 mm consumed a higher fraction of small prey items such as *Mysis relicta*, fish eggs and sculpins (*Cottidae*) while larger burbot were almost exclusively piscivorous. Overall diet composition (by mass) was represented primarily by *Coregonus* spp. (64%) and rainbow smelt (*Osmerus mordax*) (17%). We estimated the burbot population size in the Apostle Islands between 1970 and 2000 at 56,541 to 1,585,035 age 1+ fish. This population consumed between 56 and 1,584 metric tonnes (0.13 to 3.54 kg/ha) of prey. Increases in both lean and siscowet lake trout abundance have likely contributed to the decline in burbot abundance through predation and/or competition for food resources. Given the current burbot population in the Apostle Islands, this species is unlikely to control production of prey fish or invertebrate taxa.

INDEX WORDS: Burbot, Apostle Islands, Lake Superior, diet, abundance, bioenergetics, fish community.

INTRODUCTION

Burbot (*Lota lota*) are freshwater cod that have a circumpolar distribution from Eurasia to North America, southward to about 40°N (Scott and Crossman 1973). In Lake Superior, burbot are native piscivores that share similar habitat and food resources with other predators, including the lean and siscowet forms of lake trout (*Salvelinus namaycush*). Like the lake trout, burbot abundance declined due to sea lamprey (*Petromyzon marinus*) predation (Smith 1968, Lawrie and Rahrer 1973, Smith and Tibbles 1980), and has subsequently increased following sea lamprey control. Burbot inhabit all waters of Lake Superior, from tributaries

during spawning (Schram 2000) to depths of at least 366 m (Boyer *et al.* 1989). Although found throughout Lake Superior, burbot are not economically important to the fishery. Burbot are incidentally caught by commercial fishers targeting lean lake trout and lake whitefish (*Coregonus clupeaformis*), and recreational anglers targeting mainly lean lake trout and Pacific salmon.

Fisheries management agencies around Lake Superior are committed to maintaining genetically diverse self-sustaining populations of lean lake trout (Horns *et al.* 2003). However, recent bioenergetics analyses have noted a predator-prey imbalance in the fish community of western Lake Superior (Negus 1995, Ebener 1995). These studies, focused only on predatory salmonines, raised concerns

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about the impact of current predator stocking programs on lean lake trout rehabilitation and increased predation/competition by expanding siscowet populations. Burbot and lean lake trout are the top predators in the nearshore community while siscowet lake trout are top predators in the deepwater community (Harvey and Kitchell 2000). Stable isotope analyses suggest siscowet have little dietary overlap with lean lake trout but suggest they prey frequently on burbot (Harvey *et al.* 2003). Further, food web modeling suggests lean lake trout would benefit from the removal of burbot (Kitchell *et al.* 2000). Collectively, these observations confirm the need to better describe the ecological role of burbot in Lake Superior. Attempts to balance predator demand with prey supply will only be successful when all major predators, not just salmonids, are considered.

Our objective was to improve our understanding of the ecological role of burbot in the Apostle Islands region of Lake Superior. We combined assessment information collected during routine Wisconsin Department of Natural Resources (WDNR) surveys with a bioenergetics model for burbot (Rudstam *et al.* 1995) to estimate the predatory impact of burbot on the fish community in the Apostle Islands region. Through an improved understanding of burbot ecology and a more complete description of predator-prey relationships in the Apostle Islands, we hope to identify the role of this predator in the food web.

STUDY AREA

Burbot were collected in the Apostle Islands region of Lake Superior (Fig. 1). The region (447,337 ha) is characterized by 22 islands and the adjacent mainland, with a shoreline of red clay, sand, sandstone, and boulders (Nuhfer and Dalles 1987). Water depths rarely exceed 65 m, with the exception of a trench near the eastern edge of the islands where the bottom depth reaches 140 m.

METHODS

A total of 1,194 burbot was sampled by the WDNR at 11 locations in the Apostle Islands every year during July and August from 1970–1979, and every even numbered year from 1980 to 2002, except 1996. Nylon nets were used from 1970 through 1990, and monofilament nets were used from 1991 through 2002. Monofilament nets may have higher catchability than nylon nets although no attempt

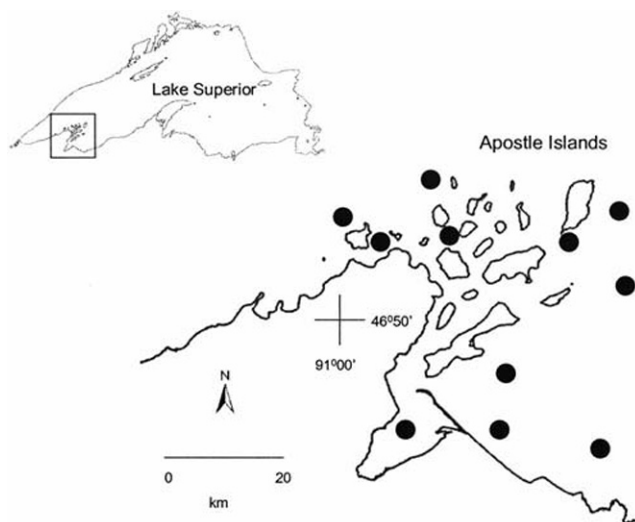


FIG. 1. Apostle Islands region, Lake Superior, showing gill net sampling locations, 1970–2002. Solid circle = net location.

was made to compare gears. All nets contained twelve 91 m panels of different stretch meshes from 38 to 178 mm in 12.7 mm increments (total length 1,092 m). Nets were set for 24 hours at depths from 4 to 115 m. From 1996 through 2001, 319 additional burbot were collected for subsequent determination of length, weight, age, and diet. Ages were determined by examining whole otoliths under a binocular microscope (Bailey 1972, Muth and Smith 1974). Stomach contents were identified to species, where possible, and enumerated and weighed to determine percent occurrence and percent by weight for each item.

Catch per unit effort (CPUE) of burbot was used to describe annual abundance. Geometric mean CPUE was calculated by averaging, across lifts, the $\log_e(x+1)$ number of burbot caught per 1,000 m and then backtransformed.

While we could not directly estimate the fishing mortality rate, we used the observed by-catch from the commercial fishery, and reported creel from the recreational fishery to estimate the relative contribution of fishing mortality to total mortality.

To better understand the ecological role of burbot, we combined the bioenergetics parameter set developed for burbot (Rudstam *et al.* 1995) with the computer software developed by Hanson *et al.* (1997) to explore patterns of consumption by burbot. Required information for the bioenergetics modeling included annual estimates of stock size, age structure, mortality, and weight at age for the

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