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Joint Use of Side-scan Sonar and ROV to Census Burbot

We used side-scan sonar and a remotely operated vehicle (ROV) to census adult burbot (*Lota lota*) on a 156-ha portion of Julian's Reef in southwestern Lake Michigan. Our efforts provided a detailed map of the lake bed and its surficial substrates and videotapes for accurately mapping burbot distribution and developing reliable estimates of burbot density.

Burbot Are Difficult to Census With Conventional Techniques

Burbot are abundant in suitable habitat in lakes and streams in continental Eurasia and North America, south to about 40°N latitude, but are often difficult to capture with conventional gear and techniques. Consequently, there are few published censuses and estimates of burbot density.

Burbot are important because they are abundant in some habitats, support popular recreational fisheries in some areas, and may compete with or prey on other desirable fish. Thus, reliable information about burbot distributions and abundance would facilitate management and assessment of the species' interactions with the fish community.

The survey methods and the side-scan sonar equipment that we used to map the lake bed were described in recent publications. The ROV, which carried a low-light video camera and was deployed on a tether, was used during the day (1018–1651 h) to videotape the lake bed along 17 transects that included representation of all of the substrate types in the study area (Table). The camera output was displayed on a video monitor aboard the survey vessel. Water depth where the ROV was operating was continuously displayed on the monitor and recorded on videotape.

Daylight Survey Catches Burbot Napping

Burbot are nocturnal and were easily videotaped during daylight. All were within 1 m of the bottom. A few were swimming slowly, but most were lying motionless on the lake bed as if sleeping. The burbot exhibited no reaction to the ROV until it was less than 1 m from them. Burbot abundance on each transect was determined by dividing the number of burbot counted on the transect by the size of the area of lake bed that was viewed while counting. The ROV was operated so that the strip of lake bed displayed within a counting frame on the monitor screen was about 1 m wide. The count area in hectares was calculated as the length of transect in meters multiplied by 10^{-4}.

Burbot Densities On Julian's Reef Are the Highest Recorded

Ninety-six burbot were recorded on videotapes covering 6,900 m^2 of lake bed at depths of 23–41 m in the study

area (Table). Burbot density averaged 139 (range, 0–571)/ha—substantially higher than the highest density reported in the literature (59–95/ha). Direct comparison of estimates for Julian's Reef with other published estimates may be inappropriate. The Julian's Reef estimates are actual counts of undisturbed, free-living fish made on measured areas of lake bed, whereas the other estimates are based on catch–effort and tag-and-release data, which are more difficult to translate into reliable estimates of density.

POSSIBLE BIASES OF THE ROV CENSUS METHOD ARE INCOMPLETELY KNOWN

The biases associated with burbot density estimates made from ROV observations are incompletely known. The method seems to be conservative and would probably underestimate the true density, especially if cover was present that would allow burbot to burrow and escape detection. There was insufficient cover to conceal adult burbot on the reef. However, no juvenile burbot were seen; they might have been hiding in the loose rubble, as has been reported for small burbot in other areas. Burbot might also escape detection by avoiding the ROV before they appeared in the viewing field of the video camera. Observations of burbot made with the ROV in the present study and with the ROV and from a manned submarine in other studies, however, suggest strongly that burbot do not attempt to avoid the ROV, except at close range, when they are well within view and can be counted. These observations, which were made under a wide range of conditions (including bright natural illumination, artificial light in the absence of natural light, water depths to more than 300 m, and videocamera viewing distances of as great as 3–4 m), also indicated that burbot were not attracted to the ROV.

RELIABLE CENSUSES MUST STRATIFY COUNT DATA

Burbot were not distributed evenly across the study area. They were present on the lake bed at 23–36 m, but were most abundant on bedrock and rubble substrates near the crest of the reef at 23–28 m, where the water temperature was 8–13°C—their preferred summer temperature range. This suggests that the best estimates of density will be obtained when counts are made during daylight and when count data can be stratified with reference to water temperature and to a side-scan sonar map showing substrate and bathymetry. Reliable censuses will allow fishery managers to better understand the role of burbot in the fish community and better manage their fishery resources.

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Table. Number and density of burbot (*Lota lota*) along 17 transects on Julian's Reef in southwestern Lake Michigan.

Transect number	Transect length (m)[a]	Number of burbot	Density (no./ha)[b]
1	141	0	0.0
2	90	0	0.0
3	926	18	194.4
4	352	11	312.5
5	425	1	23.5
6	611	2	32.7
7	239	0	0.0
8	377	6	159.2
9	412	3	72.8
10	350	20	571.4
11	349	16	458.5
12	364	3	82.4
13	458	4	87.3
14	462	6	129.9
15	442	5	113.1
16	446	1	22.4
17	469	0	0.0
Total	6,913	96	–
Mean	–	–	138.9

[a] The width of the strip of lake bed recorded on videotape along each transect the strip width) is 1 m. The transect length (m) × the strip width (m) equals the area (m^2) of lake bed viewed along the transect.

[b] Burbot density (number/ha) = [(number of burbot recorded on videotape along the transect) ÷ (number of m of lake bed viewed along the transect)] × 10^4.