Fisheries Research 205 (2018) 149–157

Contents lists available at ScienceDirect

Fisheries Research

journal homepage: www.elsevier.com/locate/fishres

Capture efficiency of a fine mesh seine in a large river: Implications for abundance, richness, and diversity analyses

Derek P. Crane[a,*,1], Kevin L. Kapuscinski[b,1]

[a] Department of Biology, Coastal Carolina University, 107 Chanticleer Drive East, Conway, SC 29526, USA
[b] School of Biological Sciences, Lake Superior State University, 650 West Easterday Avenue, Sault Ste. Marie, MI 49783, USA

ARTICLE INFO

Handled by Bent Herrmann

Keywords:
Capture efficiency
Seine
False negative error
Richness
Diversity

ABSTRACT

Seining is a commonly used method for sampling fishes in shallow water, but studies that rely on data collected by seining rarely include corrections based on varied capture efficiencies for species or size classes, or account for false negative errors of detection. We sampled fishes in shallow, nearshore areas of a large river using a fine-mesh seine within a blocknet to estimate capture efficiencies for age-0 and yearling-and-older (YAO) fishes, make comparisons among species (within age groups), and determine if capture efficiencies were affected by water depth and aquatic vegetation cover. We also estimated the proportions of sites that individuals were present but not detected for each species, compared estimated taxa richness and Shannon diversity index values to true values, and determined if richness estimates were affected by water depth and aquatic vegetation cover. We found that capture efficiencies of age-0 fishes were not affected by depth, but did differ among four levels of vegetation cover and these relationships differed among species. Capture efficiencies differed among YAO species (range of species-specific means = 0.17–0.93), but were not affected by vegetation cover or depth. Total abundance of age-0 and YAO fishes (summed across species) captured during the first seine haul were highly correlated with true abundance (age-0 $r = 0.96$; YAO $r = 0.95$) but underestimated. Species and age-specific captures from the first seine haul were also highly correlated with true abundance. Finally, proportions of false negative errors of detection were typically higher for YAO than age-0 fishes, and estimated taxa richness and Shannon diversity were correlated with true values, but generally underestimated. Numerous biotic and abiotic factors appear to drive wide variations in capture efficiencies and false negative errors of detection among species, so results from any one study are likely only applicable to particular species. However, seining is an adequate method for investigating within species or total relative abundance (summed across species) trends. Further, seining-based abundance estimates are likely adequate for identifying habitat features associated with relatively high and low catches for a given species. Therefore, seining may be an effective method for comparing these values across sites to gain insights about what types of habitat or locations are most productive for nearshore fishes.

1. Introduction

Catches in fishing gears may be biased for species composition, size of fishes, and abundance due to gear avoidance and selectivity, which pose a significant issue for fisheries scientists interested in obtaining representative samples of wild populations. Capture efficiency can be affected by fish size, life stage, behavior, body morphology, and environmental factors (Hayes et al., 2012). Quantifying capture efficiency and selectivity of a particular gear is important for making scientifically sound management decisions because uncorrected biases or catch rates may lead to erroneous study conclusions. For example, Rudstam et al. (1984) observed substantial differences between corrected and uncorrected gill net estimates of age structure for cisco (*Coregonus artedi*). Quantifying efficiency and selectivity of gear can improve accuracy of population estimates and correct bias of population indices (Henderson and Wong, 1991); however, this is only true if selectivity and bias are constant. Nonconstant selectivity and bias are more problematic than constant bias or selectivity because they can lead to increased uncertainty in population estimates or indices, and likely arise from factors that are in addition to or interacting with issues related to gear selectivity such as water temperature, light intensity (i.e., daylight vs. night sampling), and habitat sampled (see Hayes et al., 2012; Hubert

* Corresponding author.
E-mail addresses: dcrane@coastal.edu (D.P. Crane), kkapuscinski@lssu.edu (K.L. Kapuscinski).
[1] Crane and Kapuscinski contributed equally to this work.

https://doi.org/10.1016/j.fishres.2018.04.018
Received 13 September 2017; Received in revised form 23 April 2018; Accepted 24 April 2018
0165-7836/

Fig. 1. Example of block net design for estimating capture efficiencies of nearshore fishes in the upper Niagara River. Seining was conducted through the middle of the blocked area and the blocked area was larger than the seined area to allow for escapement of fishes around the ends of the seine.

et al., 2012 for thorough discussions on factors affecting capture efficiency of active and passive gears). Correcting capture efficiency can be challenging if there is nonconstant selectivity and bias because factors affecting capture efficiency may interact and it may require substantial effort and controlled experiments to estimate the effects of those factors.

Seining is a common method for sampling fishes in shallow water, and has been shown to capture a greater number of species than other gears in these habitats and greater abundance given an equal amount of effort (in the form of hours worked; Dewey et al., 1989; Lapointe et al., 2006). Seining surveys also have the benefits of low sampling mortality (Dauble and Gray, 1980) and less survey time lost following schedule disruptions (e.g., from severe weather events) than passive gears that require soak times (Lapointe et al., 2006). Studies using seines, however, rarely include corrections based on varied capture efficiencies or false negative errors of detection for species or size classes. Using uncorrected seine catches can misinform biologists about the presence/absence of species or rank order of abundance among species if the species present have different vulnerabilities to capture (Lyons, 1986; Connolly, 1994).

Previous studies quantifying capture efficiency of seines have used circular seining methods or seined towards shore (Lyons, 1986; Pierce et al., 1990; Bayley and Herendeen, 2000; Lapointe et al., 2006), and studies of capture efficiency in large rivers are rare (but see Holland-Bartels and Dewey, 1997). Circular seining methods may be effective when using boats or in lentic waters with little current, but conducting a circular seine haul in lotic environments may be difficult due to water currents. Seining towards shore can be effective for documenting species diversity or abundance regardless of habitat, but may not be adequate for studies making comparisons among habitats because habitat types may be associated with particular depths (i.e., seining in a transect towards shore may cross multiple habitat types). For example, nearshore areas in lakes and large rivers often contain a zone absent of vegetation directly adjacent to shore due to wind and ice scour, but may transition to a densely vegetated zone with increasing depth and distance from shore. Seining parallel to shore allows for individual seine hauls to sample a single habitat type and therefore allows for comparison of catches among habitats. Seining onto shore is also impractical in areas with dense terrestrial vegetation, sheet pile, rip-rap, or emergent vegetation near the water's edge. Holland-Bartels and Dewey (1997) seined parallel to shore when investigating capture efficiency in the Mississippi River, but they seined with the bridles of the seine as close as possible to a blocknet. Because seining for purposes other than investigating capture efficiency frequently do not use blocknets, blocknets that are not sufficiently larger than the area swept by the seine may not allow for escape of fishes around the ends of the seine. Therefore, capture efficiencies estimated using a blocknet that is the same dimensions as the area swept by the seine may be inflated compared to standard methods that do not include a blocknet.

To investigate the capture efficiency of a fine mesh seine in shallow, lotic habitats, we used a parallel-to-shore seining technique at 21 randomly selected sites within the upper Niagara River. Our objectives were to (1) estimate capture efficiency for age-0 and yearling-and-older (YAO) fishes and make comparisons among species (within age groups), (2) determine if capture efficiencies were affected by water depth and aquatic vegetation cover, (3) estimate the proportions of sites that individuals were present but not detected for each species (Type II error), and (4) compare estimates of taxa richness and Shannon diversity index values from a single seine haul with true values.

2. Methods

2.1. Seining

Seining was conducted at 21 sites in New York waters of the upper Niagara River. Sampling occurred 13 July 2015 through 24 July 2015 during daylight hours (generally 9–5; high light period of the day). Sites were randomly selected using the random point generator in ArcGIS (ArcGIS 10.1, Esri, Redlands, California), and all sampling occurred in waters < 1.3 m deep because our ability to effectively seine in deeper waters was poor. At each site, we first deployed a 60.96 m bag seine made of 1.59 mm delta nylon mesh to construct an 18.29 m long × 12.19 m wide blocknet. The corners of the net were held in place with rebar, and small anchors were clipped along the sides and upstream end of the blocknet. The blocknet's bottom line was made of 54.5 kg/182.9 m leadcore rope to prevent escape underneath the nets. Due to water current, the actual dimensions of the blocked area varied from site to site (mean = 209 m^2, SE = 2.0 m^2) and were measured to