JOURNAL OF
ECOLOGY AND ENVIRONMENT
http://www.jecoenv.org

Note

J. Ecol. Environ. 38(3): 383-388, 2015

Use of the cast net for monitoring fish status in reservoirs distributed in the Korean peninsula

Ju-Duk Yoon[1], Jeong-Hui Kim[2], Hae-Jin Lee[3] and Min-Ho Jang[2,*]

[1]Biological Resource Center, Kongju National University, Gongju 314-701, South Korea
[2]Department of Biology Education, Kongju National University, Gongju 314-701, South Korea
[3]Nakdong River Environmental Research Center, National Institute of Environmental Research, Goryeong 717-873, South Korea

Abstract

Reservoirs consist of two different environments, the littoral and the pelagic zone, and different fishing gear is commonly used in each zone—gill nets in the pelagic zone and electrofishing in the littoral zone. However, an active fishing gear, the cast net, is normally used instead of electrofishing for scientific studies in South Korea. In order to estimate cast net effectiveness for determining fish status in reservoirs, the study was conducted at 15 reservoirs with two different fishing gears: a cast net in the littoral zone and gill nets in the pelagic zone. When combining catches of both gears, species richness increased substantially compared to using one gear only. There was a size difference in fish caught by each net, and small fish were predominantly caught with the cast net due to its small mesh size (7 mm). The combined length of six species, used for length-weight relationship analysis, collected with the cast net was smaller than that collected with gill nets (independent *t*-test, $P < 0.05$). In this study, cast net sampling provided sufficient data for the littoral zone, but not enough to identify the overall fish assemblage in studied reservoirs. Utilization of only one gear can therefore lead to substantial underestimation of fish status, and a combination of both gears is recommended for determining more reliable estimates of fish status in reservoirs.

Key words: cast net, freshwater fish, gill net, littoral zone, reservoir

INTRODUCTION

Determination of fish assemblages in certain regions is fundamental and important work in fish ecology. For appropriate estimation of fish fauna, selection of fishing gear is important and directly influences species diversity and yield of the catch. Selection of inappropriate fishing gear introduces problems like under- or over-estimation of species diversity, and results do not reflect the real status (Rotherham et al. 2007, 2011).

Reservoirs typically consist of two different environments—the littoral and the pelagic zones—with different physical and chemical characteristics. Because these characteristics can affect the composition of the fish assemblage (Matthews 1998), sampling of both zones with appropriate fishing gear is important. The gill net and electrofishing are generally used for fish sampling in reservoirs. Although gill nets have various mesh sizes, corresponding to size and body type of different fish, they are insufficient for catching small fish.

Therefore, other fishing gear is required, such as electrofishing or the cast net. However, electrofishing is pro-

http://dx.doi.org/10.5141/ecoenv.2015.040

Received 13 January 2015, **Accepted** 28 April 2015

***Corresponding Author**
E-mail: jangmino@kongju.ac.kr
Tel: +82-41-850-8285

pISSN: 2287-8327 eISSN: 2288-1220

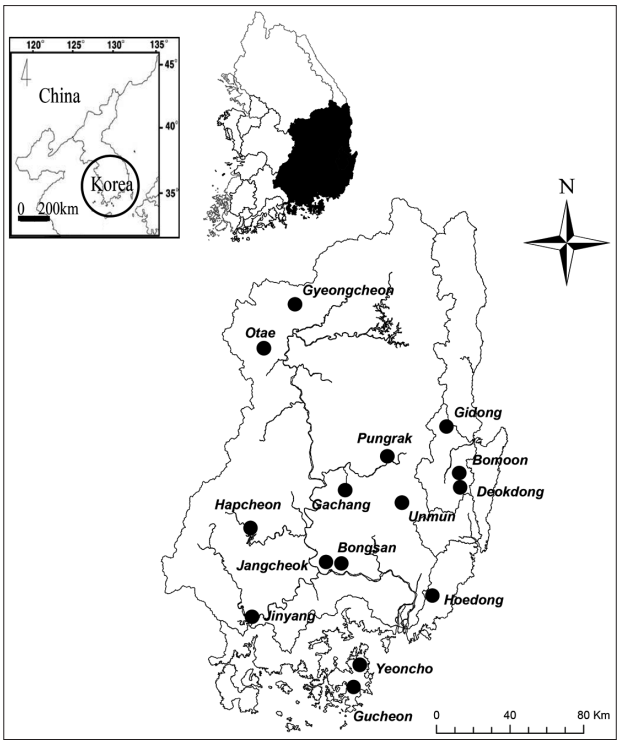

Fig. 1. Location of fifteen manmade reservoirs. All of reservoirs were distributed in the south-eastern part of the Korean peninsula.

hibited by law in Korea, although this method is particularly applicable for sampling the littoral zone (Brosse et al. 2007, Miranda and Boxrucker 2009, Menezes et al. 2013, Říha et al. 2015). The cast net is commonly used in Korea instead of electrofishing. It has been used to catch fish staying at or inhabiting shallow areas, such as wetland and the littoral zone, and to supplement impoundment collections (Meador and Kelso 1990, Stevens 2006, Stevens et al. 2006, Sheaves and Johnston 2008). It can cover a large area per deployment, compared with a throw trap, and is efficient where the gill net and the seine net are ineffective to use (Stein III et al. 2014).

The objective of this study was to estimate cast net effectiveness for sampling reservoirs distributed over the south-eastern part of the Korean peninsula. Fish assemblages and diversity indices were mainly used for estimation. Based on these results, we discuss the utilization of the cast net for monitoring the littoral zone of reservoirs.

MATERIALS AND METHODS

The study was conducted at 15 reservoirs, distributed in the south-eastern part of the Korean peninsula, used for diverse purposes such as agriculture, electricity, and drinking water (Fig. 1). Two different fishing gears were used: a cast net (mesh size = 7 mm, net area = 16.6 m^2) for the littoral zone and two types of gill net (mesh size = 30 mm and 70 mm, length = 50 m) for the pelagic zone. These types of gill nets are commonly used for scientific purposes in Korea. The fish were caught in June and October from 2010 to 2012. To avoid rainfall impact, we selected sampling periods before and after the monsoon season. Two reservoirs were investigated in 2010, five in 2011, and eight in 2012. Ten cast net samplings were conducted in the littoral zone, following the shoreline, and gill nets were set up overnight for about 12 hours, including two twilight periods.

The Shannon diversity index (Pielou 1975) was calculated to compare catches with two different fishing gears, following the equation $H = -\Sigma P_i \times \ln P_i$, where $P_i = n_i/N$, n_i is the number of individuals of a particular species and N is the total number of individuals in the samples.

Total length (TL, cm) and body weight (BW, g) were measured to analyze potential differences in the length-weight relationship (LWR) of six species between fishing gears. Occurrence and the possibility for statistical comparison of fishing gears were considered for species selection in this analysis. If one species was caught predominantly with the gill nets and rarely with the cast net, that species was excluded. Thus, the six species were *Carassius auratus, Pseudorasbora parva, Hemibarbus labeo, Zacco platypus, Hemiculter eigenmanni*, and *Lepomis macrochirus*. Every measurement was processed immediately at the study sites. The collected fish were moved to an aerated tank (100 × 100 × 80 cm) and subsequently anesthetized using 0.1 g/L ethyl 3-aminobenzoate methanesulfonate salt (Sigma-Aldrich, Munich, Germany). TL and BW were measured with a digital caliper and a digital balance to the nearest 0.1 cm and the 0.1 g, respectively. After measurement, fish were moved to a recovery tank and released, at the site where they had been caught, after complete recovery. LWR was estimated following the equation $W = aL^b$, where W = BW, L = TL, and a and b are parameters of regression (Ricker 1973, Jobling 2008). Logarithmic transformation was applied to the regression, thus the equation was transformed to $\log(W) = \log(a) + b \log(L)$. The 95% confidence limits for a and b were calculated to confirm the distance between b and an isometric value of 3 (Froese 2006).

Differences in catch composition between fishing gears were analyzed using nonmetric multidimensional scaling (NMDS) and analysis of similarities (ANOSIM), performed with the software primer 6 (Primer-E Ltd.,

Plymouth, UK). NMDS constructs two-dimensional ordination in a manner that best represents relationships among samples in a similarity matrix (Field et al. 1982). Similarity matrices were generated for catch compositions by square-root-transforming the raw abundance data and calculating the Bray–Curtis similarity index for each pairwise comparison.

To compare statistical differences in abundance data, such as number of species or number of individuals, and calculated values, such as the Shannon diversity index or parameters *a* and *b* from LWR, the Wilcoxon signed rank test was used. The independent t-test was used to analyse length differences of fish collected by the two fishing gears. These comparisons were performed using SPSS ver. 18.0 (SPSS Inc., Chicago, IL, USA).

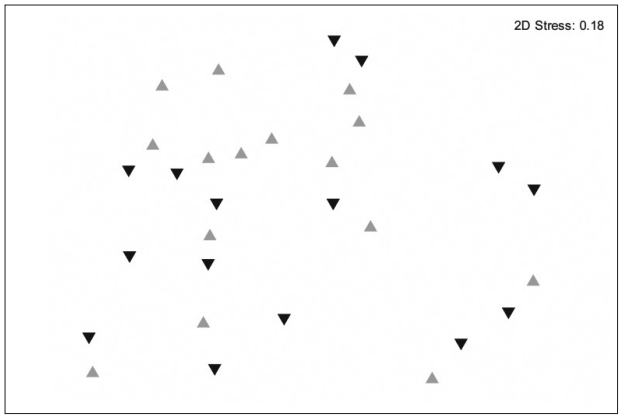

Fig. 2. Non-metric multidimensional scaling of samples based on the Bray-Curtis similarities calculated from square-root transformed abundances of fish species at each study sites. This plot showing a clear distinction between sites that fish collected by the cast net (black triangle) and gill nets (grey triangle).

RESULTS

The number of species and individuals, and Shannon diversity indexes are presented in Table 1. Although means for gill nets were always higher than for the cast net, there were no statistical differences (Wilcoxon signed rank test, $P > 0.05$). However, in four reservoirs the number of species collected with the cast net was higher than that caught with gill nets. The mean number of species collected with both gears was 3.1 ± 1.1. When combining catches, the number of species substantially increased. The mean number of individuals collected with gill nets was higher than that caught with the cast net. The Shannon diversity index increased in most cases when combining catches, but at six reservoirs, the index decreased. Species of families Cobitidae and Gobiidae, which have an

Table 1. Number of fish species and individuals, and Shannon diversity index of two different fishing gears

Reservoir name	Study year	Number of species				Number of individuals			Shannon's H		
		GN	CN	GN & CN	Both	GN	CN	Both	GN	CN	Both
Gachang*	2010	6	7	2	11	32	75	106	1.37	1.45	1.87
Hoedong*	2010	8	10	4	14	114	29	143	1.41	1.77	1.82
Gyeongcheon	2011	5	3	2	6	42	24	66	0.83	0.34	0.73
Jangcheok	2011	4	4	3	5	62	8	70	0.72	1.21	0.90
Jinyang	2011	11	5	4	14	139	121	260	1.69	1.09	1.52
Otae	2011	10	8	4	14	60	60	120	1.81	1.42	1.88
Unmoon*	2011	5	9	3	11	23	29	52	1.41	1.64	1.81
Bomoon	2012	10	5	2	13	46	25	71	2.00	1.09	2.17
Bongsan	2012	11	8	2	12	34	91	125	2.13	1.11	1.54
Deokdong	2012	6	4	2	8	61	22	83	1.31	1.05	1.58
Gidong*	2012	5	6	3	8	146	79	225	1.13	1.15	1.22
Gucheon	2012	10	7	5	12	31	21	52	2.12	1.32	2.14
Hapcheon	2012	12	9	5	16	101	100	201	1.81	1.27	1.79
Pungrak	2012	4	3	2	5	45	26	71	0.95	0.82	1.11
Yeoncho	2012	5	5	3	7	82	28	110	0.53	1.05	0.97
Mean		7.5	6.2	3.1	10.4	67.9	49.2	117	1.4	1.2	1.5
SD		2.9	2.3	1.1	3.6	39.8	35.3	64.8	0.5	0.3	0.4

GN, gill nets; CN, cast net; GN & CN, collected both gears; SD, standard deviation.
*more species were collected by the cast net than gill nets.

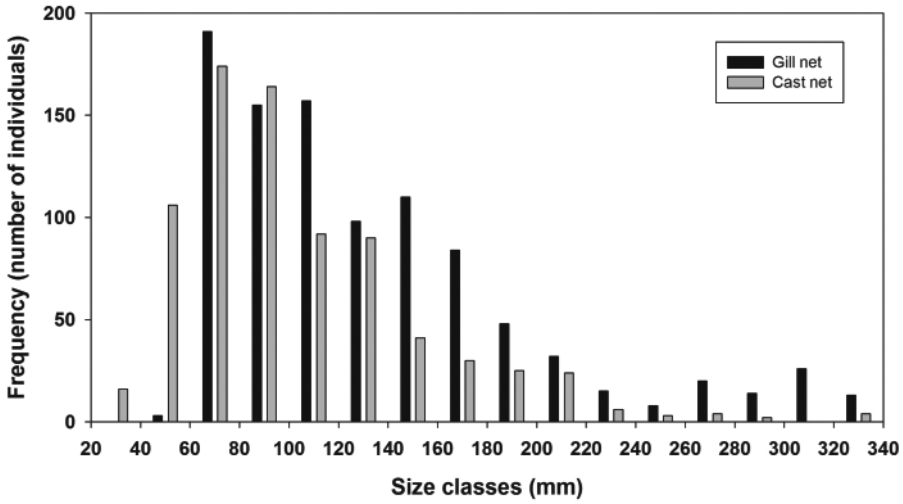

Fig. 3. Length distribution of collected fishes from fifteen reservoirs using two different fishing gears. TLs of all collected fishes were used. Frequency means summation of number of individuals which are included in certain size classes. Size classes were grouped by 20 mm from 20 mm to longer than 320 mm total length.

elongated body shape or a small-sized body, were mainly collected with the cast net. Although the mean number of species collected with gill nets was higher than with the cast net, ANOSIM did not detect significant differences in catch composition between fishing gears (Global R = 0.027, $P > 0.05$). Samples from the fishing gears cannot be grouped according to gear in the NMDS ordination plot (Fig. 2).

Length distribution patterns of fish collected with each gear were similar (Fig. 3). Fish of the size class 6–12 cm dominated catch with all sampling gear, and importance of other size classes gradually decreased with size increment. In case of gill nets, the number of collected individuals increased once more in the size class > 26 cm. These fish were collected with a gill net with a mesh size of 7 cm. Conversely, very few fish were collected of length less than 6 cm. Most small fish were caught with the cast net, owing to its small mesh size (7 mm).

LWRs are shown in Table 2. Parameter *b* ranged from 2.605 for *C. auratus* to 3.263 for *L. macrochirus* in gill nets samples and from 2.829 for *H. labeo* to 3.237 for *Z. platypus* in cast net samples. Although the value was different between fishing gears, no statistical difference was found (Wilcoxon signed rank test, $P > 0.05$). TLs of the six species selected for LWR analysis were significantly smaller in the catch with the cast net than in the catch with gill nets (independent t-test, $P < 0.05$; Table 2)

DISCUSSION

The littoral zone is important for many fish species (Pierce et al. 2001). Many small and juvenile fish use the littoral zone of reservoirs as feeding ground and to avoid predators (Lewin et al. 2004). In this study, the cast net was used for investigating fish status in the littoral zone of reservoirs instead of electrofishing. This increased the number of species identified in each reservoir, and in some cases, more species were caught with the cast net than with gill nets (Table 1). This means that the cast net improved fish data in the littoral zone of studied reservoirs. However, cast net sampling could not represent fish assemblages in entire reservoirs. Therefore, combining catches with both gears is strongly recommended to determine fish assemblage in reservoirs.

If only one gear is used for sampling, there is a possibility of substantial underestimation of fish status. In case of the Jinyang reservoir, only 5 species were collected with the cast net, a huge difference compared to the number of species collected with both gears. The same was found in other reservoirs as well. Big fish were predominantly caught in the pelagic zone with gill nets. Many small fish species and juveniles live in the littoral zone (Brosse et al. 2007), so that cast net sampling could be important and effective for collecting fishes.

LWR is used for comparing weight to length of fish (Froese 2006). It is useful for fisheries management (Crec'hriou et al. 2012), and can provide information on the population status of a species in a habitat (Petrakis

Table 2. Descriptive estimation of length-weight relationship parameters for six dominant species collected by two different fishing gears in reservoirs (the value of correlation coefficient for all species were exceeded 0.975)

Species	TL (cm)						LWR parameters and statistics					
	GN			CN			GN			CN		
	Mean	Min	Max	Mean	Min	Max	*a*	95% CL of *a*	*b*	95% CL of *b*	*b*	95% CL of *b*
*Zacco platypus***	11.6	7.9	16.3	8	6.4	11.9	0.0030	0.0020 - 0.0048	3.477	3.2968 - 3.6566	3.237	3.0228 - 3.4517
*Hemiculter eigenmanni***	16	11.7	23.1	11	5.5	21.0	0.0067	0.0049 - 0.0097	3.027	2.9028 - 3.1503	3.104	3.0084 - 3.1993
*Pseudorasbora parva***	9.2	6.8	11.4	7.1	4.1	9.2	0.0130	0.0076 - 0.0268	2.831	2.5450 - 3.1171	3.206	3.0639 - 3.3477
*Lepomis macrochirus***	11.7	5.6	22.5	10.3	4.7	23.1	0.0094	0.0083 - 0.0106	3.263	3.2107 - 3.3155	3.101	3.0351 - 3.1676
*Carassius auratus***	14.5	7	29.7	8.6	3.8	22.0	0.0511	0.0427 - 0.0612	2.605	2.5365 - 2.6736	2.831	2.7008 - 2.9605
*Hemibarbus labeo**	19.4	10.4	33.7	14.6	11.2	26.0	0.0047	0.0031 - 0.0071	3.140	3.0020 - 3.2780	2.829	2.6889 - 2.9683

GN, gill net; CN, cast net; Min, minimum; Max, maximum; *a*, intercept; *b*, slope; 95% CL of *a* and *b*, confidence limits (95%) range of *a* and *b*; $^{*}P < 0.05$, $^{**}P < 0.001$.

and Stergiou 1995), environmental condition, and food availability. The values for parameter *b* were within the expected range (2.5–3.5), following Froese (2006). It was different depending on fishing gear, but these differences were not significant. They were probably generated by characteristics of fishing gears so that small fish were caught predominantly with the cast net and bigger fish predominantly with gill nets. When we calculated LWRs of similar TL sections only which were duplicated both gears, the parameter *b* showed similar values. Thus, *b* could be changed according to characteristics of fishing gear. Therefore, using the same fishing gear is suggested for comparison of LWRs in different locations. The value of parameter *a*, which can be used as an indicator of the body shape of the fish (Froese 2006), is also influenced by the type of gear.

Gill nets are passive fishing gear and a well-known fishing gear for reservoirs. The cast net is an active fishing gear, enabling sampling of littoral zones similar to electrofishing. There are some problems and limitations when using the cast net in the littoral zone of reservoirs. First, aquatic plants such as free-floating and floating leaves are abundant during high temperature periods (Oke 1987, Woodward 1987, Riis et al. 2012), and cast net sampling could be affected. However, Stein III et al. (2014) insisted that a cast net is useful in the submersed aquatic vegetated area. Second, if the depth of the littoral zone is more than 2 m, the descent of a cast net to the bottom takes a relatively long time, thus many fish could escape from it. Finally, catch rate is highly affected by the investigator's skill. However, these problems are easily addressed. In this study, the cast net was appropriate for collecting fish in the littoral zone. Thus, the cast net could replace electrofishing for sampling the littoral zone of reservoirs. Additionally, a combination of the cast net and gill nets is recommended for more reliable fish status estimates in reservoirs.

ACKNOWLEDGEMENTS

This research was supported by the Nakdong River Watershed Management Fund relating to Fundamental Investigations of the Environment of the Nakdong River.

LITERATURE CITED

Brosse S, Grossman GD, Lek S. 2007. Fish assemblage patterns in the littoral zone of a European reservoir. Freshw

Biol 52: 448-458.
Crec'hriou R, Neveu R, Lenfant P. 2012. Length–weight relationship of main commercial fishes from the French Catalan coast. J Appl Ichthyol 28: 861-862.
Field JG, Clarke KR, Warwick M. 1982. A practical strategy for analyzing multi-species distribution patterns. Mar Ecol Prog Ser 8: 37–53.
Froese R. 2006. Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. J Appl Ichthyol 22: 241-253.
Jobling M. 2008. Environmental factors and rates of development and growth. In: Handbook of Fish Biology and Fisheries, Vol. 1: Fish Biology (Hart PJ, Reynolds JD, Eds). Blackwell Publishing Ltd, Oxford, pp 97-122.
Lewin WC, Okun N, Mehner T. 2004. Determinants of the distribution of juvenile fish in the littoral area of a shallow lake. Freshw Biol 49: 410-424.
Matthews WJ. 1998. Patterns in Freshwater Fish Ecology. Chapman and Hall, New York, NY.
Meador MR, Kelso WE. 1990. Growth of largemouth bass in low salinity environments. T Am Fish Soc 119: 545–552.
Menezes RF, Borchsenius F, Svenning JC, Søndergaard M, Lauridsen TL, Landkildehus F, Jeppesen E. 2013. Variation in fish community structure, richness, and diversity in 56 Danish lakes with contrasting depth, size, and trophic state: does the method matter? Hydrobiologia 710: 47-59.
Miranda LE, Boxrucker J. 2009. Warmwater fish in large standing waters. In: Standard Methods for Sampling North American Freshwater Fishes (Bonar SA, Huber WA, Willis DW. Eds). American Fisheries Society, Bethesda, pp 29-42.
Oke TR. 1987. Boundary Layer Climates, 2nd ed. Routledge, London.
Petrakis G, Stergiou KI. 1995. Weight-length relationships for 33 fish species in Greek waters. Fish Res 21: 465-469.
Pielou EC. 1975. Ecological Diversity. Wiley, New York.
Pierce CL, Sexton MD, Pelham ME, Liao H, Larscheid JG. 2001. Dynamics of the Littoral Fish Assemblage in Spirit Lake, Iowa, and Implications for Prey Availability for Piscivores. N Am J Fish Manag 21:884-896.
Ricker WE. 1973. Linear regressions in fisheries research. J Fish Res Board Can 30: 409-434.
Říha M, Ricard D, Vašek M, Prchalová M, Mrkvička T, Jůza T, Čech M, Draštík V, Muška M, Kratochvíl M, Peterka J, Tušer M, Seďa J, Blabolil P, Bláha M, Wanzenböck J, Kubečka J. 2015. Patterns in diel habitat use of fish covering the littoral and pelagic zones in a reservoir. Hydrobiologia 747: 111-131.
Riis T, Olesen B, Clayton JS, Lambertini C, Brix H, Sorrell BK. 2012. Growth and morphology in relation to temperature and light availability during the establishment of three invasive aquatic plant species. Aquat Bot 102: 56-64.
Rotherham D, Underwood AJ, Chapman MG, Gray CA. 2007. A strategy for developing scientific sampling tools for fishery-independent surveys of estuarine fish in New South Wales, Australia. ICES J Mar Sci 64: 1512-1516.
Rotherham D, Macbeth WG, Kennelly SJ, Gray CA. 2011. Reducing uncertainty in the assessment and management of fish resources following an environmental impact. ICES J Mar Sci 68: 1726-1733.
Sheaves M, Johnston R. 2008. Influence of marine and freshwater connectivity on the dynamics of subtropical estuarine wetland fish metapopulations. Mar Ecol Prog Ser 357: 225-243.
Stein III W, Smith PW, Smith G. 2014. The cast net: an overlooked sampling gear. Mar Coast Fish 6: 12-19.
Stevens PW. 2006. Sampling fish communities in saltmarsh impoundments in the northern Indian River Lagoon, Florida: cast net and culvert trap gear testing. Fla Scientist 69: 135-147.
Stevens PW, Montague CL, Sulak KJ. 2006. Patterns of fish use and piscivore abundance within a reconnected saltmarsh impoundment in the northern Indian River Lagoon, Florida. Wetl Ecol Manag 14: 147-166.
Woodward FI. 1987. Climate and Plant Distribution. Cambridge University Press, Cambridge.