

Countermeasures against Alien Fishes (Largemouth Bass and Bluegill) in Lake Biwa

Atsuhiko IDE* and Shinsuke SEKI*

Abstract Lake Biwa is one of the world's most ancient lakes, with an origin going back four million years. Many aquatic organisms, including more than 30 endemic species or subspecies of fish and molluscs inhabit the lake, and various kinds of fisheries have targeted those animals for centuries. Bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*) were first found in Lake Biwa in 1965 and 1974. While bluegill spread gradually through the shallow water zones and into small lagoons surrounding the lake, largemouth bass increased explosively in the 1980s. Simultaneously, native fishes such as crucian carp and bitterlings disappeared from the coastal shallows. After that, the population of bluegill began to increase.

In recent years, bluegill has comprised over 90% of the fish fauna in Lake Biwa's south basin. Since 1985, fishermen have been trying continuously to reduce these alien species by several means. Fishing gear such as Eri (a set-net), gill nets, and pulling nets have been used. Recently, over 400 metric tons per year of these alien fishes have been eliminated. At the same time, the Shiga Prefectural Fisheries Experimental Station has tried to develop more effective gear to catch them. We have devised a pot trap, with its top covered by a sheet to provide shade, for efficient capture of the alien fishes, and a small beam trawl for use in beds of submerged aquatic vegetation. Other methods for the eradication of the alien fishes are currently under study.

Key words: Lake Biwa, Alien fish, Largemouth bass, Bluegill

Introduction

Lake Biwa, located on the main island of Honshu, is the largest lake in Japan. It is 63.5 km long and has a maximum width is 22.8 km. Its maximum depth is 104 m. The lake has a north basin and a south basin, with mean depths of 43 m and 4 m (Figure 1).

Lake Biwa is one of the world's most ancient lakes with an origin going back four million years. Many aquatic organisms, including more than 30 endemic species or subspecies of fish and molluscs, inhabit the lake. About 50 fish species or subspecies are distributed in the lake, and more than 10 of them are endemic. The richness of the fauna in the lake may be related to the variety of habitats, including littoral areas with emergent

plants, littoral gravelly areas, littoral rocky areas, offshore shallow and offshore deep water.

Various kinds of fisheries have existed over the hundreds of years the lake has been fished. A gill net fishery, Okisukuiami (a scoop net in offshore) fishery, Chubikiami (a pulling net) fishery, a shell dredge net fishery, and Eri (a labyrinth-like set-net) fishery are included among them. The total annual commercial catch of fish and crustaceans was about 4,000 metric tons during the 1970s and 1980s.

The populations of most native littoral fish species, including nigorobuna (*Carassius carassius grandoculis*) and honmoroko (*Gnathopogon caeruleus*), which are the most important commercial fishes in the lake, have decreased greatly in the past twenty years. The decrease was probably caused by increases in the populations

of the alien fishes largemouth bass (*Micropterus salmoides*) and bluegill (*Lepomis macrochirus*, Figure 2). This report describes countermeasures against alien fishes in Lake Biwa.

Invasion of Alien Fishes

In Lake Biwa, largemouth bass were first found in the north basin in 1974. Their distribution spread throughout the littoral areas by 1980, and the population increased explosively in the 1980s. Bluegill were found in Nishinoko, one of lagoons surrounding Lake Biwa, in about 1965, and the fish spread gradually through the shallow water zones in the 1970s (Terashima 1977). The population began to increase in about 1990, and increased explosively in about 1993.

Stomach contents of the alien fishes in Lake Biwa are shown in Figure 3. Bluegill feed on aquatic plants, zooplankton and insects, in addition to fish eggs and shrimp, while largemouth bass prey mainly on fish and shrimp. The results indicate that bluegill influences other littoral fish species by the competing for food and consuming fish eggs, and largemouth bass affect fish and shrimp through predation.

After the population of largemouth bass increased explosively, the catch of crucian carp decreased rapidly (Figure 4). At the same time, most bitterling species (small native cyprinid fishes) disappeared from the littoral areas of the lake. In addition, the population of bluegill increased explosively after the catch of crucian

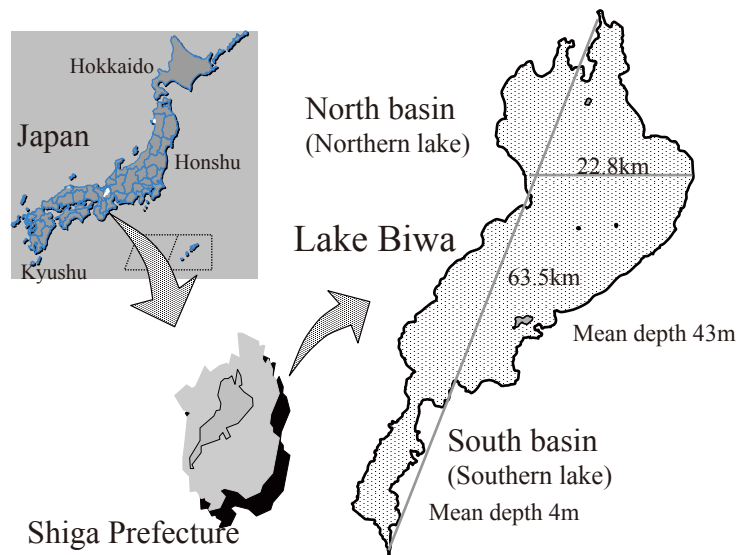


Fig. 1. The outline of Lake Biwa.



Largemouth bass

Micropterus salmoides

Bluegill

Lepomis macrochirus

Fig. 2. Alien fishes affecting native fish fauna in Lake Biwa.

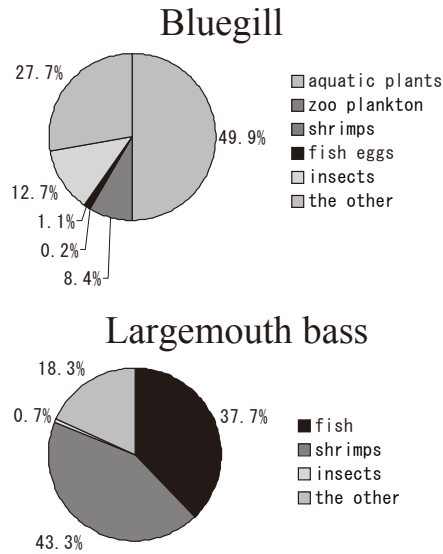


Fig. 3. Weight frequencies of stomach contents of the alien fishes inhabiting Lake Biwa studied in 2003.

carp became stable a reduced level. After that, the annual catch of honmoroko began to decrease as well. The annual catch of littoral commercial species in the lake has decreased to half of that recorded in the 1970s and 1980s.

Fish Fauna in the Littoral Zones of Lake Biwa

The percentages of largemouth bass, bluegill and other species captured by small set-nets at four littoral sites in Lake Biwa in 2002 or 2003 are shown in Figure 5. The percentages of largemouth bass were greatest at the two sites in the northern part of the lake, while the of bluegill portion of the catches exceeded 90% at the two southern

sites. At present, the alien fishes are the dominant species in the littoral zones of the lake.

Elimination of Alien Fishes

The project to eliminate the alien fishes from Lake Biwa was initiated by fishermen who have received administrative financial support since 1985. The project was developed in order to protect the native fishes. Usual fishing gear such as Eri, gill nets, and Chubikiami are being used for the project. Eri has a structure that guides fish into the main nets. Gill nets are used to capture the alien fishes mainly in the south basin of Lake Biwa, and most of the fish species captured are bluegill. Many alien fishes can be captured by Chubikiami in water 10 m deep in the north basin of Lake Biwa.

The administrative support for the project was increased beginning in 2002. As the result, the amount of alien fishes captured, which was less than 300 metric tons annually before 2001, increased to more than 400 metric tons annually year since 2002 (Figure 6).

The alien fishes captured by fishermen are transferred in carts to a factory where they are processed into fish powder, which is used as an ingredient for animal feed.

The usual fishing gear types used for capturing alien fishes have some problems. Those gears

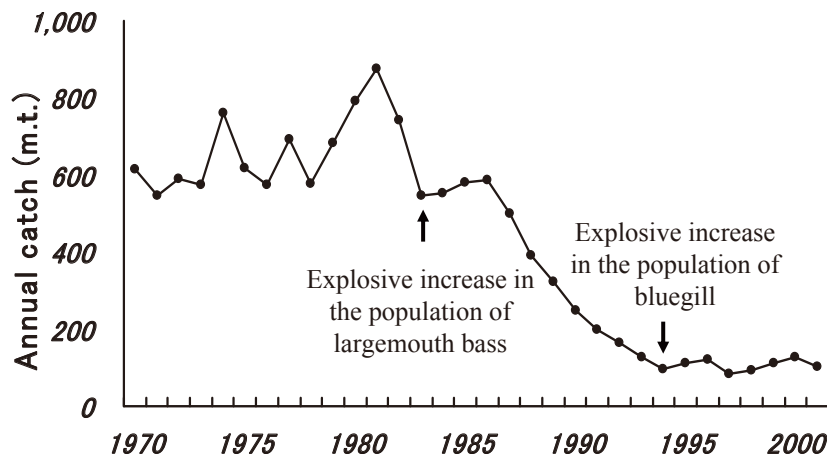


Fig. 4. Change of the annual catch of crucian carp in Lake Biwa, and relationships between the change and the increase in alien fishes.

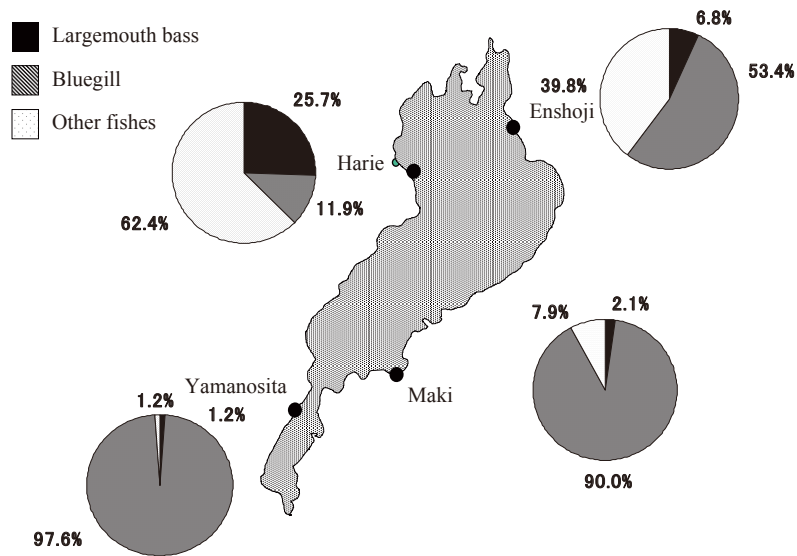


Fig. 5.

Fig 5. Percentages of largemouth bass, bluegill and other fishes captured by small set-nets at four littoral sites in Lake Biwa in 2002 or 2003.

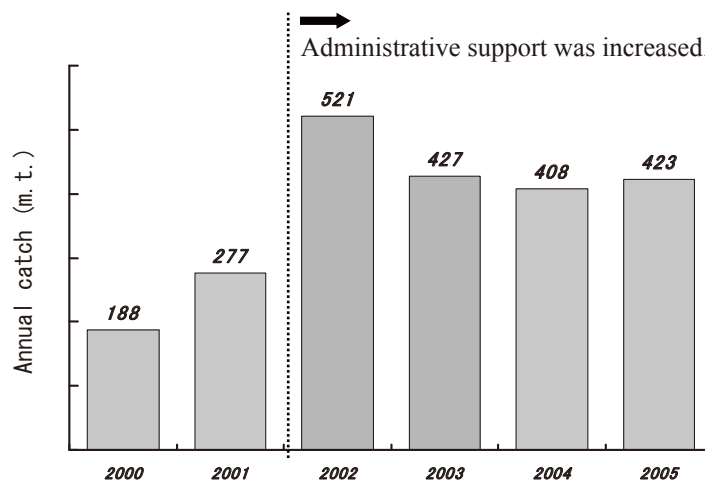


Fig. 6. Annual catches of the alien fishes in Lake Biwa.

cannot be used in the shallow water zones that many alien fishes inhabit because they are too big to set up in those zones. The gears are also not easily used in areas where aquatic plants grow thickly because the plants obstruct setting of the gears. Small (young) alien fishes are not efficiently captured by the traditional gear types, in particular, gill nets. The solution of these problems is necessary to eliminate the alien fishes efficiently.

In order to solve the problems, we devised two new types of fishing gear. Test results showed that a covering sheet put on the top of a pot trap increased its effectiveness in capturing the alien fishes when they gather in shaded areas.

The new gear devised for use in shallow water zones is shown in Figure 7. We call this trap "Shading" Type Pot Trap. In the studies, we could capture the alien fishes, in particular bluegill, more efficiently with the gear during its spawning season. The maximum number of the alien fishes captured with one shading type pot trap set for 24 hours in shallow water zones of Lake Biwa or in the lagoons surrounding the lake was 65.

The second new type of gear we developed is a small beam trawl which is effective in beds of submerged aquatic vegetation (Figure 8). The gear was designed after gear used in the Japanese coastal seas to capture shrimp (Tsudani 1978).

The trawl net has two beams. The length of the first beam is 3 m and that of the second beam is 2 m. These two beams stabilize the net for towing in beds of submerged aquatic plants. This net is towed with mowing down the aquatic plants. The maximum catch of alien fishes in test tows of three minutes duration in Lake Biwa's south basin was 1.7kg.

Figure 9 shows the length frequency distributions of bluegill and largemouth bass captured by the small beam trawl in the south basin in 2003. As shown in the graphs, the small beam trawl could capture young alien fishes of less than 60 mm standard length, which are hard to capture with other types of fishing gear.

The new fishing gears have been introduced for the project to eliminate the alien fishes in 2005. The removal of those fishes from Lake Biwa will probably proceed more efficiently by using the older and the new fishing gears in parallel. Verification of the effect of the new gears to the project will be reported on in the future.

The Shiga Prefecture Government established a new local ordinance "Biwa-ko Jorei" in 2003. This ordinance asks recreational fishermen not to release the alien fishes captured in Lake Biwa, in order to get their collaboration in helping to eliminate the alien fishes.

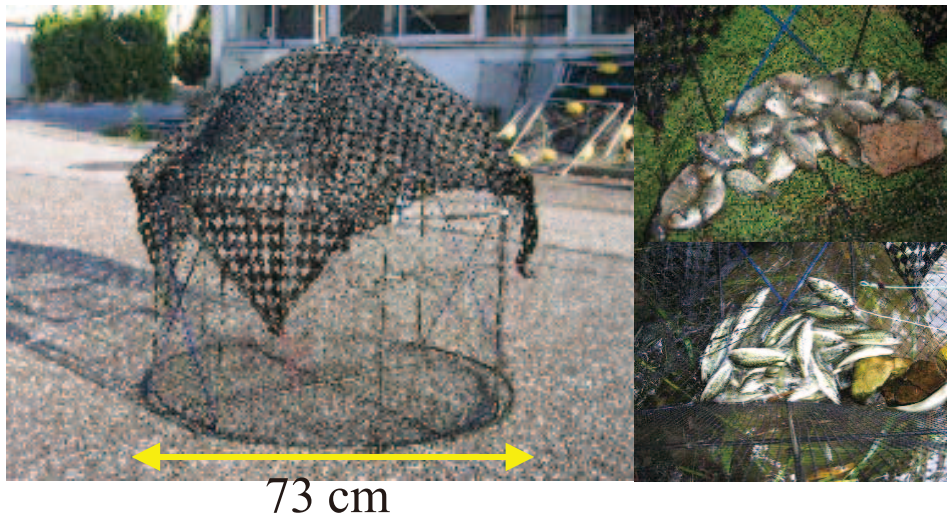


Fig. 7. "Shading" Type Pot Trap for the alien fishes.

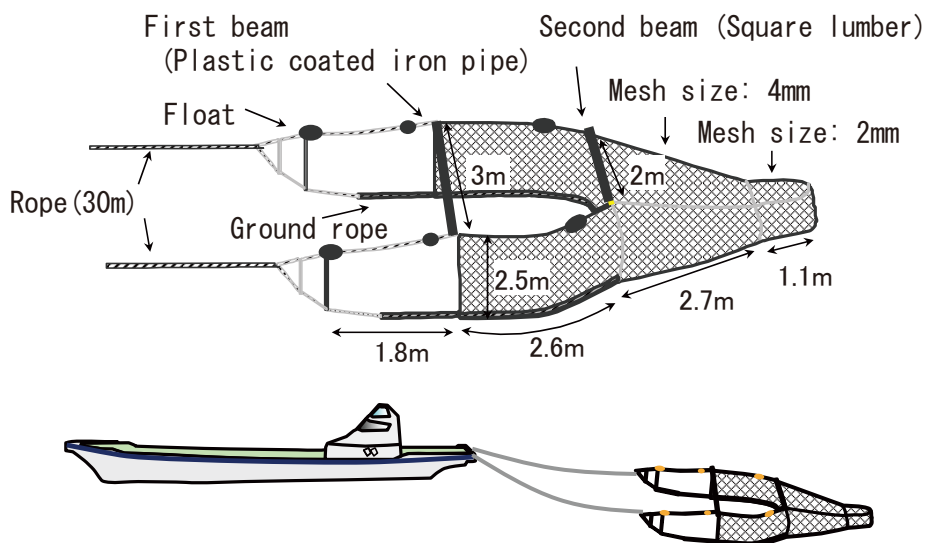


Fig. 8. Appearance of a small beam trawl.

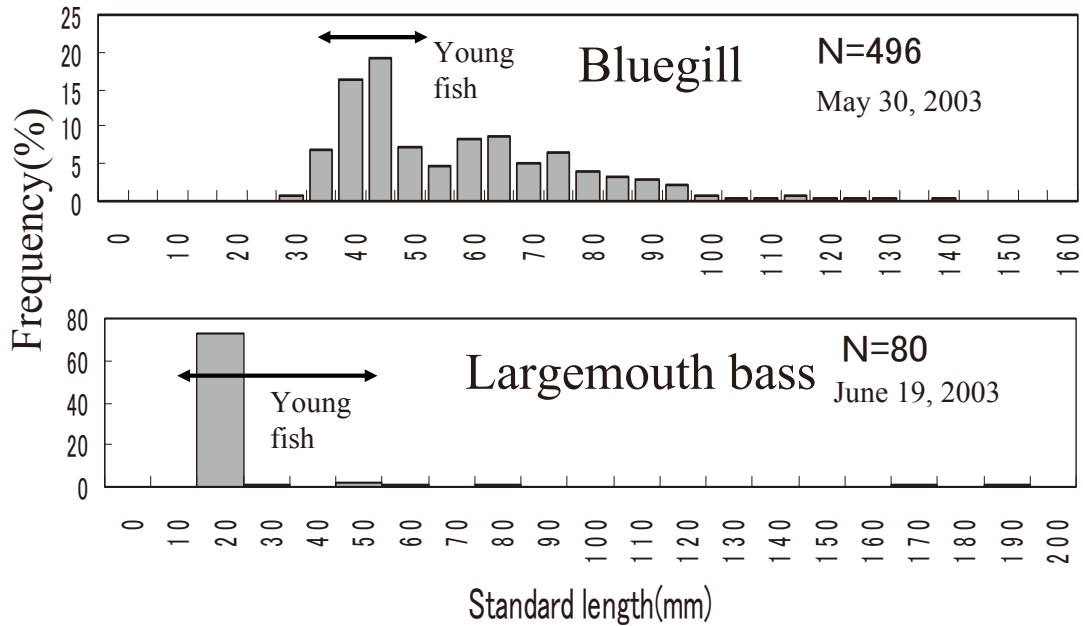


Fig. 9. Length frequency distributions of the alien fishes captured by the small beam trawl net in Lake Biwa's south basin.

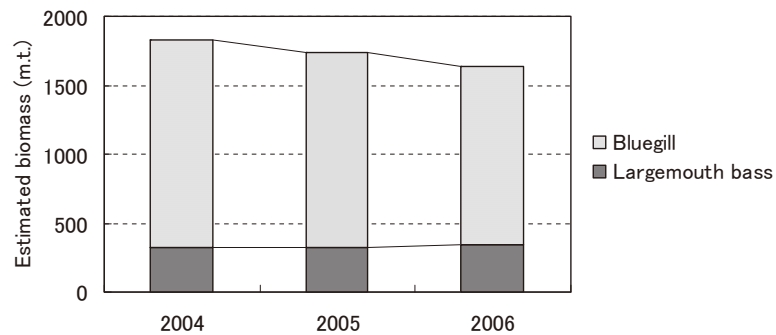


Fig. 10. Biomass of the alien fishes estimated from the data on the fishes captured by the project to eliminate.

Future Plans

As the result of the project to eliminate the alien fishes, the estimated biomass of bluegill in Lake Biwa, tended to decrease recently, but that of largemouth bass continues to be stable (Figure 10). It is, therefore, necessary to increase the countermeasures against largemouth bass. As the next step, we will study methods that might be used to prevent breeding by largemouth bass. The ultimate goal is to restore the Lake Biwa ecosystem to one that has a fauna comprised only of native fishes.

sinnyugyo. Tansuigyo (Fewshwater Fish), 3:38-43.

Tsudani, T. 1978. Coastal small beam trawlers (Kogi Ami). Illustrations of fishing boats, Tokyo. pp. 59-63.

References

Terashima, A. 1977. Biwako ni seisokusuru