Preservation of Reservoir by both Drainage and Removal of Exotic Species

OKAMURA Yutaka

In Japan, reservoirs were built from the 8th century to the first half of the 20th century to cater to the demand from the spread of rice cultivation. The responsibility of maintaining these reservoirs rests with the farmers living in the zones where the reservoirs are located. The role and spread of these reservoirs has changed remarkably in recent times owing to the decline in agriculture and increasing urbanization. The Conference for the Preservation of Reservoir Biodiversity in Nagoya, which was established by the city office and several civic organizations, with support from the Japanese Ministry of Environment, studied the biodiversity of these reservoirs and discussed the removal of exotic species from nine ponds in the city.

Key words: biodiversity, drainage, exotic species, reservoir

1. Introduction

There are many freshwater species inhabiting ponds compared to other water areas such as rivers and lakes. One characteristic of ponds is that many rare and endangered species inhabit the area (Williams et al., 1999). Biological invasion is a major threat to farm pond biodiversity. Although it is generally believed that pond draining is effective in eradicating alien fish, according to Nishikawa et al., (2009), pond draining showed no effect on the presence or absence of the Bluegill (*Lepomis macrochirus*). Rather, pond draining stimulated the multiplication of the Red swamp crayfish (*Procambarus clarkii*). Periodic drainage of reservoirs aerates the water and effectively controls anaerobic sediment to allow increase of the habitat of fishes that prey on large-sized plankton, such as the water flea. The quality of pond environments can be kept excellent if drained every three to four years (Hayashi et al., 1995). There are three positive effects of "sediment desiccation," a process that includes phosphorus and nitrogen dynamics: (1) approximately 3% of organic matter in the sediment are decomposed, (2) release of phosphorus into refilled irrigation water decreases by approximately 33%, and (3) release of nitrogen increases by approximately 250% (Hiramatsu & Suzuki, 2007).

Regarding the restoration of birds by draining reservoirs, Yoshitsuru et al. (2008) reported that the Little Grebe bird (*Tachybaptus ruficollis*) has declined markedly in marshes and ponds in Japan. The Largemouth bass (*Micropterus salmoides*) is partly responsible for this decline because they prey on Little Grebe chicks. Little Grebes have not bred since 1990 at the Uwaike Pond in Aichi. A year after the drainage of

the pond and the extermination of introduced fish species in 2006, Little Grebes bred successfully three times and produced 10 chicks in 2007. If the Largemouth bass and the Bluegill are too large, the prickles on their dorsal fins become dangerous and the Little Grebe cannot eat them. Furthermore, when a Largemouth bass eats native small fishes, such as the Stone moroko (*Pseudorasbora parva*), and the numbers decrease, there is a tendency for birds with a short beak to also decrease in number.

In this report, the preservation activities in the Ama-ike reservoir of Moriyama ward, Nagoya, Japan are discussed. The preservation activities are as follows: 1. Capture all living things in the reservoir, wash the reservoir, and sort the captured species; 2. Collect data on all species, remove the exotic species, and provide temporary protection to the native species; 3. Organize an exhibition of the captured species wherein their characteristics are explained; 4. Implement historically known civic measures that will help improve the biodiversity of the Ama-ike reservoir and its outlying areas; 5. Construct an island to protect waterfowls from the animals that use dredged earth and sand.

Perhaps the breeding of native species can be promoted by removing exotic fauna. This report discusses the preservation activities in the Ama-ike reservoir of Moriyama ward, Nagoya, Japan.

2. Purpose of traditional reservoir drainage in Nagoya

Nagoya had 360 reservoirs in 1965, most of which were built for the purpose of supplying water for agricultural use, and they were unevenly distributed on the hills of the eastern part where supply of water from a river is difficult. With rapid economic growth and the resultant large-scale housing and land development, farmland disappeared and the number of reservoirs decreased to 117 in 1999. Moreover, during this time, reservoirs were designed to regulate floods, as seen in many examples, but this change lacked consideration of the natural environment (Wakayama, 2004). In ponds that were supplied with only rain and spring water, the water quality, which was muddy with fine silt, was excellent until the second half of the 1970s. However, the silt decreased sharply beginning in the second half of the 1980s, until transparency became high. The change in the water quality is related to the luxuriant growth of submerged plants and a remarkable reduction of the suspended substances as well as a reduction of total nitrogen and the amount of chlorophyll (Tsuchiyama, 2004).

Photo.1. Drainage of Hira-ike pond which is near Ama-ike pond in 1935. Fishes were caught with landing nets. There is little mud of bottom as annual event.

The Ama-ike pond, previously located on the east-northeast end of Nagoya, began to experience land adjustment in 1966 with 130 houses and now exceeds 2000 houses. The agriculture committee was responsible for the reservoir drainage for 47 years until

1963 (Photo. 1). The primary purposes of the drainage of reservoirs at that time were the following: (1) the precipitating mud was removed, which provided both good water quality and sufficient water for agriculture; (2) the mud in which the nutrients accumulated was dried and made into manure; (3) by drying the mud in winter, both the water quality and the putrefaction of sediments were improved; (4) The bank was repaired; and (5) Large fish were made into a source of protein in winter.

3. The 1997 drainage plan of the Ama-ike pond that failed

Since the Ama-ike pond was used only as a fishing pond of what reclamation escaped, the water quality deteriorated and the stinks were released in the summer. Because of this, in 1997 there was talk of reviving the "drainage of the pond," which was an annual event before the 1960s. The region from the eastern Owari hill to the Chita peninsula in the Aichi prefecture was one of the greatest reservoir zones in Japan, placed on a par with the Setouchi district of western Japan. Many people yearn for memories of getting muddy and catching fish with their hands from the "drainage of the pond." The school district council chairman, the principal of the elementary school, and the parent-teacher association (PTA) chairman began discussing and negotiating with the parks and ponds engineering office. The reply from the division was as follows: (1) From the rebuilt stage to the flood basin, the bottom of the pond was made into a plane from the shape of an earthenware mortar. (2) Processing of accumulated slime is difficult. (3) The fishhook etc. has fallen and there is a problem in safety. (4) Once the pond is drained, water will not collect until it rains. (5) Aren't the collected fish thrown away after all? After extensive discussions, a drainage plan was changed and the community settled to ride on canoes and to be familiar with the reservoir (Okamura & Satoh, 1998).

These are the statements from officials of the region regarding how the environment affects various people. The Ama-ike pond was an important pond that sends water to rice fields. People were able to swim there and there were also many fireflies. With the repair work, the pond would become a flat ground and water would not flow. In the traditional method of pond drainage, many fish collected and children and adults would become ecstatic. Finally, they would ride on 10 canoes especially prepared for the event and about 60 people would enjoy the activity (Okamura & Satoh, 1998). (Photo. 2)

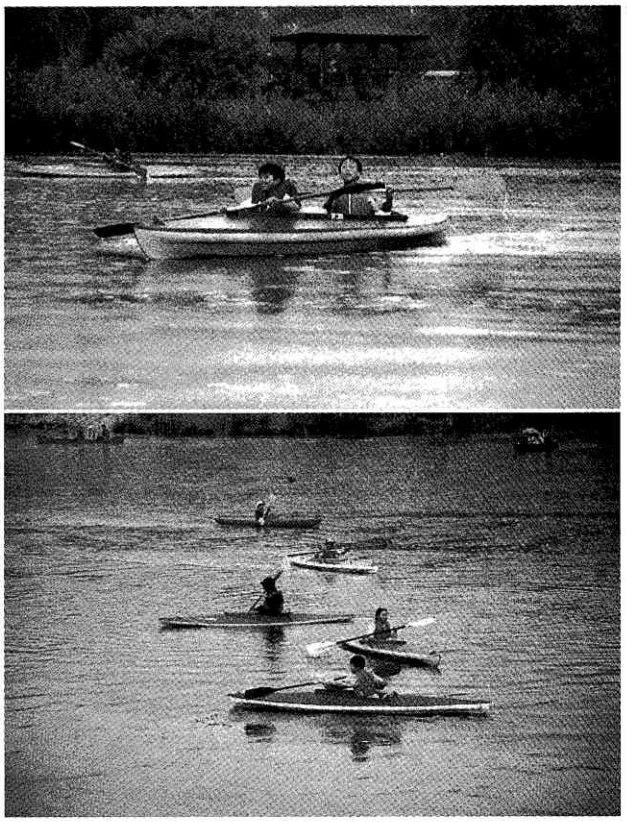

Photo. 2. We played with the canoe without carrying out drainage of the Ama-ike pond in 1997.

4. Structure of the Ama-ike pond

The Ama-ike pond was prepared as a flood basin as part of the elementary school establishment and park preparation in 1985. The following four considerations were carried out on the occasion of the repair. (1) In order to maintain the function of the previous fishing place, the fish nursery block was prepared and the fishing place was made into the shape of stairs. (2) The high-water channel, which is not soaked in water, was prepared for a flood below the 5-year probability. (3) Both the natural stone pitching on the bank and the grass pitching on the dug portions were stretched on the surface of the slope of the shore protection. (4) The growth place of the reed was prepared for nature conservation, such as wild birds, and the nourishment of animals and plants was accomplished by gently sloping the soil surface by 1/10. (5) In order to attempt continuity with the circumference, a passage, a small stage, and stairs were prepared. Two steps of drain holes were designed so that the water depth became 60cm after removing the plug of the upper hole and all water might drain out when removing the plug of the lower hole. (Fig. 1)

5. The drainage of the Ama-ike pond in 2010

In relation to the 10th Convention of the Biological Diversity Conference Parties (COP10), held in October, 2010, the Conference for the Preservation of Reservoir Biodiversity in Nagoya, which was established by the city office and several civic organizations with support from the Japanese Ministry of Environment, studied the biodiversity of these reservoirs and discussed the removal of exotic species from nine ponds in the city. As a local execution unit, the executive committee of the drainage of Ama-ike pond was formed in order to discuss plans of action. The executive committee consisted of two local school district liaison councils, four volunteer organizations, one elementary school, three organizations relevant to the ward office, and three organizations relevant to the city office, with 27 representatives who participated in 3 prior investigative commissions.

In the present Ama-ike pond, since the agricultural function of the reservoir was lost, the following four objectives were presented. (1) Promote breeding of the native species ensures the biodiversity of the region with removal of exotic fauna. (2) Promote the environmental preservation of the region and brew responsibility for children to maintain the native environment in the future. (3) Use for preservation and

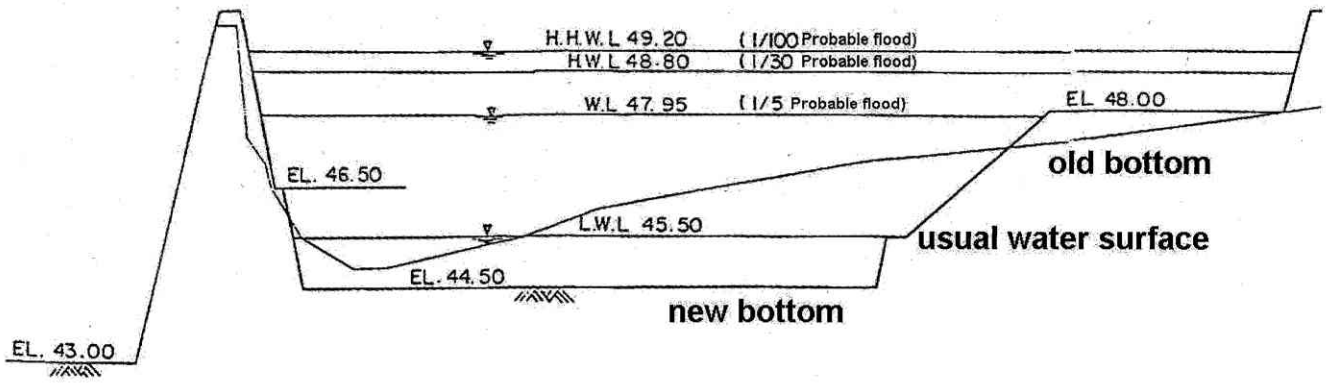

Fig. 1. The section of the Ama-ike pond of repair before and after.

reproduction of native species of the region by investigating the inhabiting species in detail. (4) Improve the water quality of ponds by drying the bottom mud for a long time.

The working sequence of the drainage of reservoirs is as follows. (1) Draining: Although the plug was removed and drainage began three weeks before the event, since the draining speed was 1cm every hour and draining the entire pond would take four days, or 100 hours, the displacement was adjusted and they prepared for the event date. There were few illegal disposal items on the pond bottom. (2) Washing and Sorting: The living entities scooped up by the dragnet and the landing net were washed in cold water and were sorted according to exotic fauna species and native species. (3) Measurement of the number and size for every species: After weighing each fish and giving a number for every species, we discussed the restrictive measures of the dominant species and the promotion measures of biodiversity. (4) Exhibition of the gathered living entities: Attendants exhibited the living creatures that were extracted from the pond in a tank and explained the mode of life and the ecology of the pond to the public. (5) Protection of the native species:

Photo. 3 The drainage of the Ama-ike pond in October, 2010. Top left and right: People who caught fishes by the dragnet and the landing nets. Bottom left: Washing and sorting activities. Bottom right: Display of the caught fishes etc..

Until the water of the pond was recovered, the fish were preserved in a nearby pond in order to protect them until the beginning of March so that they can return before the breeding season. (6) Discharge of the native species: Return the native species gathered and all sorted species in the beginning of March in 2011 to the Ama-ike pond.

The number of participants was about 1000, quenching and sorting, and about 500 visitors. The exterminated fishes of foreign descent were about 420kg in total, and the details are as follows: a large number of Largemouth bass (26kg), the Bluegill (15kg), many Topminnows (*Gambusia affinis*), four American Bullfrogs (*Rana catesbeiana*), two Grass carps (*Ctenopharyngodon idellus*) (28kg), many Common carps (*Cyprinus carpio*) (357kg), and three Red swamp crawfishe (*Procambarus clarkii*). The details of the protected native species are as follows: about 700 discharged Japanese crucian carps (*Carassius cuvieri*) and many stone morokos, the common freshwater goby (*Rhinogobius sp.*) and the Lake prawn (*Palaemon paucidens*) etc. As for exotic species, there were a few Largemouth bass and Bluegill, a lot of Common carps and Topminnows were confirmed, and two large-sized Grass carps, which exceeded 1m, were captured for the first time in the reservoirs in Nagoya. Although 700 large and medium-sized Japanese crucian carps were captured, it was recognized that there were few small young fish and the reproduction was spoiled by predation of the large-sized fishes such as carp. Twenty dead bodies of the Chinese pond musse (*Sinanodonta woodiana*), a near threatened species that is eating the common freshwater goby etc. in the sands, were found. It was also found that the deposition of slime has spoiled the native habitat (BPRNEA, 2010). (Photo. 3)

Although the fields of the Reed grass (*Phragmites communis*) were the spawning places and as important as the hiding places, marks of the vermin damage by the Common carps etc. were found in them. There were very few kinds of water plants. One Japanese mitten crab (*Eriocheir japonica*), which migrates around rivers and ponds from the sea, was found, thus showing that the Ama-ike pond is not isolated from surrounding environments (BPRNEA, 2010).

As a result of draining all water from the reservoir and allowing the bottom mud to dry the following spring, both the transparency of the water and the total nitrogen content of the bottom mud increased. The drying up the reservoir helped to restore its water quality (Yoshida & Hotta, 1990). Allowing the pond to dry for three days was found to be insufficient to eradicate the Japanese rose bitterling (*Rhodeus ocelllatus kurumeus*). The dredging was fairly effective in purification of the pond. However, unless any other measures are taken after dredging, the sediment might soon accumulate again and thereby diminish the effectiveness of dredging (Okamoto & Kobayashi, 1997). In order to prevent the foreign rose bitterling, we have to completely dry the sludge by performing the drainage of the reservoir for a long period. The mud cannot be dried during spring. It is best to dry the mud throughout the winter beginning from autumn (Shirai et al., 2009).

6. Conclusions

In order to make the biota of the Ama-ike pond rich, the following three proposals are given based on the above results. (1) Sometimes, thin out the large-sized

crucian carps. (2) Preserve the Reed grass fields that bring up laying eggs and the fries. (3) It is necessary to perform reservoir drainage periodically for protection of the native species. (4) It is necessary to restrict an angler's ground bait for both the control of slimes and the improvement of water quality. (5) Since the sediment was disturbed by the drainage of the reservoir, as for the water plant, which becomes the spawning grounds and the hiding places of fries, the dormancy seeds may bud (BPRNEA, 2010).

When the reservoir was utilized as a source of water for agricultural use, the basin had few pollution sources, and the drainage of the reservoir was carried out every several years. During the drainage process, the sediment of the pond was dried and dredged, thus preventing declining water quality. Since the depth of the water of a reservoir is also shallow, it is easy to be polluted, and if the amount of inflow of contamination increases by development of a nearby basin, contamination will progress rapidly. It is recognized in Nagoya that diversion (interception of sewage inflow), flashing (increase in the amount of streams), the dredge of a sediment, etc. are effective for purification of the water quality of reservoirs. It is also recognized that newly collected rainwater, after draining the reservoir and drying the sediment, raises water quality temporarily. Although a level of environmental achievement can be attained by the above methods, at the present, when the needs for civic environment are developing, it is required (Wakayama, 2004).

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