20130814_Taiwan Review - Balancing on the Brink

ノートブック: 0108_press reports
作成日: 2013/08/14 9:36
URL: http://taiwanreview.nat.gov.tw/ct.asp?ctNode=1446&xItem=207223&mp=1

Current Issue

Balancing on the Brink

Byline: STEVEN CROOK Publication Date: 08/01/2013

The Formosan landlocked salmon is found only in Taiwan. (Photo Courtesy of Wen Guo-chang, Shei-Pa National Park)

The Formosan landlocked salmon is an ancient symbol of Taiwan and an important bellwether for climate change.

It is a normal weekday at Wuling Recreation Area, which is under the jurisdiction of Shei-Pa National Park and lies deep in a mountainous part of central Taiwan's Taichung City. Tourists are trickling through the park's Taiwan Salmon Eco Center, a building named for and housing a small number of Formosan landlocked salmon, members of an endangered fish species found nowhere else on Earth. "I didn't know it was the fish on the money," says one visitor, pointing to the image of two salmon on a replica of Taiwan's NT$2,000 (US$67) banknote. Other sightseers comment on the salmon's diet (mostly aquatic insects), or how healthy the fish look.

For most people, the center is the only place where they can get near enough to a school of Formosan landlocked salmon to see the spots that mottle the top and lower parts of each fish's body. To protect the salmon, tourists are not allowed close to Qijiawan Creek, the nearby waterway that is the species' main habitat. The creek, which is 15.3 kilometers long and 7 to 12 meters wide, drains an area of 76 square kilometers.

"The center provides a chance for the public to see these beautiful fish up close. When they can see the salmon, they'll appreciate and recognize the need to protect them. Then, they'll give their support to conservation measures," says Lin Hsing-juh (林幸助), a professor in the Department of Life Sciences at National Chung Hsing University in Taichung and leader of the Wuling Long-Term Ecological Research (WLTER) team. He explains that the salmon displayed in the center were not taken from Qijiawan Creek, but rather bred in captivity.

Official efforts to bolster the Formosan landlocked salmon population date from the 1980s, when the species was listed first as a valuable natural asset under the Cultural Heritage Preservation Act, then as a protected species under the Wildlife Conservation Act. Scientists, however, have been taking an interest in the fish for almost a century.

Taiwan was a Japanese colony from 1895 to 1945. In 1917, while visiting a police station in what is now Yilan County's Datong Township, an assistant to Japanese scientist Masamitsu Oshima (1884–1965) was told that fish similar to Japanese trout existed in high-altitude streams in Taiwan's northeast. With the help of Atayal aborigines in the Yilan area—who called the species *bunban* or *kulubang*—the assistant obtained a salted tail of one fish.

When Oshima returned to Taiwan from Stanford University in the United States early the following year, he was intrigued. He gathered additional specimens and set to work describing the fish's characteristics in words and diagrams. In a June 1919 Japanese-language article in an agricultural bulletin, Oshima alerted the world to the existence of what is today commonly called the Formosan landlocked salmon.

Suitable Label

In his initial report that year, Oshima dubbed the species Salmo saramao, Saramao being the name of an Atayal community near today's Lishan Village in Taichung City's Heping District from which a specimen was taken. But when David S. Jordan, a former Stanford president who served as Oshima's research instructor, wrote the first English-language report about the discovery, he decided Oncorhynchus masou formosanus was a more suitable label, reasoning that Formosa (as Westerners then called Taiwan) was known to the outside world, whereas Saramao was not.

The salmon's eggs do not hatch in water warmer than 12 degrees Celsius, making the fish vulnerable to global warming. (Photo Courtesy of Yu Jen-hao, Shei-Pa National Park)

Originally regarded as a subspecies of the cherry salmon (aka masu salmon, Oncorhynchus masou) found in Japan, the Korean Peninsula and Russia's Far East, the Formosan landlocked salmon is now regarded by most researchers as a species in its own right. Accordingly, its scientific name has been amended to Oncorhynchus formosanus, under which the species is listed in the Fish Database of Taiwan maintained by Academia Sinica, Taiwan's foremost research institution, as well as in the International Union for Conservation of Nature Red List of Threatened Species.

Scientists agree that Taiwan's salmon shares ancestry with its Japanese counterpart, and that DNA comparisons suggest the two species split around 800,000 years ago. In a paper published by the *Journal of the National Taiwan Museum* in 2010, Shieh Ying-tzung (謝英宗), a member of the museum's Department of Research, theorizes that "the most likely timing of ... salmon straying and moving onto Taiwan is 0.78 million years ago after a meteorite strike." The impact, he says, not only led to significant global cooling but also caused magnetic north and south to switch places. "This combination of cooler sea temperatures and the salmon's potentially confused magnetic tracking sensitivity would have allowed northern cherry salmon populations to stray southward as far as Taiwan," he says.

According to the Council of Agriculture, the island does not lack for endemic fish species, as around 30 of Taiwan's more than 150 freshwater species are found nowhere else. In terms of size, lifespan and breeding habits, the Formosan landlocked salmon is unexceptional. Few individuals grow to more than 40 centimeters in length. They reach sexual maturity in their second year and usually breed in November; few live more than four years. Most salmon species are anadromous—meaning they are born in rivers, migrate to the ocean, then return to freshwater to reproduce—yet landlocked salmon populations exist in North America and Russia. What makes Oncorhynchus formosanus truly special is the species' location and scarcity.

The basin the species inhabits lies at around 24 degrees 21 minutes north latitude and no part dips below 1,740 meters above sea level. The Formosan landlocked salmon is thus both the southernmost salmon species in the world and the one at the highest altitude.

The local salmon species is landlocked not because there is no route to the ocean, but because it has no tolerance for warm temperatures. Oncorhynchus formosanus eggs do not hatch in water warmer than 12 degrees Celsius and the fish struggle to survive if the water temperature exceeds 17 degrees Celsius because fungi and bacteria attack their tissues.

The Taiwan Salmon Eco Center gives visitors an opportunity to see the Formosan landlocked salmon up close. (Photo Courtesy of Yu Jen-hao, Shei-Pa National Park)

Formosan landlocked salmon used to be abundant in six tributaries of the upper Dajia River around Wuling. By the mid-1980s, however, there were fewer than 300 in the wild, and the species had disappeared altogether from some waterways. Scientists attribute at least part of the salmon's decline to agricultural development in the Wuling area after 1963. Not only did pesticides and fertilizers begin polluting the water around that time, but the clearing of forest tracts to grow crops also began to make peak flows more extreme, with the result that salmon were more likely to get washed downstream during typhoons.

Meanwhile, the construction of several small dams across the streams the species inhabits have made the waterways slower, shallower and thus warmer. The sediment they hold back blocks the flow of water that delivers oxygen to salmon eggs, so fewer hatch. Such dams are impassable, meaning fish forced downstream are unable to return to cooler waters where they are more likely to survive. And by dividing the salmon population into isolated groups, the barriers increase the risk of inbreeding.

The population of Formosan landlocked salmon has fluctuated in recent years, but a count earlier this year recorded 5,400 individuals—the most since the WLTER project was launched in 2004. Nevertheless, the fish is still one of the rarest salmon in the world.

Little wonder, then, that researchers in Taiwan and abroad regard the species as extraordinarily precious. "This most unusual fish is quite possibly the most endangered and threatened salmon in the world," says Peter S. Rand, a senior conservation

biologist at the Wild Salmon Center, a US-based nonprofit organization that aims to research and protect salmon ecosystems around the Pacific Rim.

"I think the Formosan landlocked salmon is a very valuable species," says Yuya Makiguchi, a research assistant in the College of Bioresource Sciences at Nihon University in Japan's Kanagawa Prefecture. "As well as being an ancient symbol of Taiwan, the Formosan landlocked salmon is a key that'll help us understand the evolutionary biology of cherry salmon since the last glacial age," he adds.

Liao Lin-yan (廖林彥), chief of Wuling Station at Shei-Pa, says the Formosan landlocked salmon deserves protection because of what can be learned from it about climate change. "It's a very important environmental-indicator species and thus must be closely monitored," he says.

A guide teaches tourists about the effort to save Taiwan's endangered salmon at Shei-Pa National Park. (Photo Courtesy of Chang Yan-ling, Shei-Pa National Park)

According to Liao, the park has embarked upon a three-stage conservation program and has thus far completed the first phase: restoring the health of the current habitat of the salmon to the point where the fish and other native species can consistently reproduce. Other fish species sharing Qijiawan Creek include the Taiwan shoveljaw carp or Onychostoma barbatulum, and Beaufortia kweichowensis, often called the Chinese hillstream loach. In Liao's opinion, one of the area's most alluring inhabitants is the tawny fish owl. "It's Taiwan's largest owl, but there are very few of them," he explains. "There have been instances of them eating Formosan landlocked salmon." The salmon remains the main focus of the conservation program, however. "Because of funding and manpower constraints, it's impossible to set too many conservation goals," Liao says. "But from the point of view of biodiversity, each species plays an irreplaceable role in the ecosystem."

The second phase of the conservation program, which is aimed at improving conditions in creeks near the Qijiawan, is now underway. The third-phase, ultimate goal is to make every stretch of the upper Dajia River where the Formosan landlocked salmon once thrived fit for the fish once again.

"The overall success of the program will be judged by salmon numbers and geographical distribution, and whether the fish can reproduce sufficiently in the wake of floods or other circumstances," Liao says. "In 2009 and 2010, we released about 500 salmon into Luoyewei Creek. There has been reproduction and the population has grown steadily. In 2012, researchers found 1,200 salmon, so the creek has reached its carrying capacity. We'll continuously monitor the population, but in the short term there won't be any additional releases."

Up to 120,000 people visit the Taiwan Salmon Eco Center each year, and Liao thinks that by helping the public understand the government's conservation policy, the center bolsters efforts to save the salmon. The influx of visitors is monitored, however, and all sewage in Wuling Recreation Area is treated before being discharged, so that tourists do not cause water pollution problems, he says.

Farming has also been scaled back in the Wuling area, but according to National Chung Hsing University's Lin, more can be done to ameliorate agriculture's impact on the salmon's habitat. "The first priority for the government should be to protect the habitat from human disturbance, and there's still some pollution from effluents with high-nutrient concentrations. These should be collected and treated," he says. "Also, the riparian zone should be restored by adding vegetation. This would filter effluents entering the stream and decrease the water temperature by 2 or 3 degrees Celsius, mitigating the expected increase in temperature due to global warming."

The national park began addressing human disturbance on a larger scale by partially removing four dams on Gaoshan Creek—a three-kilometer-long waterway with a small Oncorhynchus formosanus population—from 1999 and 2001. After investigating the results, Lin says he is convinced that ridding the salmon's habitat of all such dams would boost the species' survival prospects, adding that the fish's population has surged in Qijiawan Creek since the May 2011 demolition of one particular barrier in that stream.

"I do support removing all river dams in the salmon area," Lin says. "Our previous studies have shown there are many benefits for the species." When dams are demolished, "the resulting ecological corridors can help gene exchange among different subpopulations of the salmon," he says. "Individual salmon washed down the river during typhoon floods can return upstream, and the proportion of boulders in the river increases." During floods, he explains, salmon can shelter in the lee of boulders and so avoid being swept downriver.

Shei-Pa's clear, beautiful and remote Qijiawan Creek provides the salmon's main habitat. (Photo Courtesy of Shei-Pa National Park)

The importance of boulders was also noticed by Nihon University's Makiguchi, who together with five Japanese and three Taiwanese researchers spent August 2007 tracking the movements of landlocked salmon in Qijiawan Creek. Their findings appeared in a 2009 issue of Academia Sinica's *Zoological Studies*. To gain a better understanding of the species' seasonal movement patterns, the team tagged 10 salmon with miniature radio transmitters weighing just 1.1 grams. When recording the location of the tagged fish, the researchers also tried to ascertain "habitat characteristics such as whether or not there were boulders, deep pools, or large woody debris," their report says. They concluded that "boulders ... are an essential habitat component for Formosan landlocked salmon."

That discovery surprised Makiguchi. "Boulders are possibly one of the habitats for salmon in streams in Japan, but it seems boulders in Qijiawan Creek are an 'essential' habitat for Formosan landlocked salmon," he says. "One of the characteristics of the creek is that it lacks fallen trees or plants. Therefore, I speculate that the Formosan landlocked salmon has to use boulders as escape as well as holding sites."

A lot of research has been done on Formosan landlocked salmon, yet Lin thinks some topics deserve further attention: "For example, what microhabitats do they require for their life cycle? Water depth? Temperature? Sediment grain size? Water chemistry? Habitat type? Also, how high can the salmon jump?" he asks. "If we can find answers to these questions, Qijiawan Creek could be managed better, and streams where the salmon once lived could be restored accordingly."

The park does not say how much it budgets each year to support the work being done by outside researchers like Lin, but according to Liao such assistance often includes funding, the issuing of permits, arranging accommodation and providing salmon specimens.

Opinions differ as to what the future holds for Formosan landlocked salmon. "The salmon are stronger than we think, and for sure they'll be thriving for more than 100 years because they already know how to resist typhoon floods in the field," Lin says. "They are an umbrella species, meaning that if their habitat can be properly protected, the whole ecosystem can also be protected."

Park staff and volunteers release captive-bred salmon fingerlings at Shei-Pa National Park. (Photo Courtesy of Chang Ru-lin, Shei-Pa National Park)

Gwo Jin-chywan (郭金泉), a professor in the Aquaculture Department at National Taiwan Ocean University in Keelung, northern Taiwan, says the survival of the Formosan landlocked salmon is, "very, very important," but he is not as optimistic as Lin about the species' future. "I don't think the fish will be thriving in 100 years' time, because the fish won't have much luck throughout the next 100 years," says Gwo, whose research interests include aquaculture, cryobiology and conservation. "A major forest fire, a big earthquake or disease may wipe out the population. Forest fires have happened before in the salmon's habitat," he says.

Gwo cites the impact of a relatively recent weather event as an example. "Typhoon Ariel in 2004 was indeed a disaster for the species," he says, referring to the storm that breached a hatchery and led to more than 3,200 artificially propagated salmon escaping into Qijiawan Creek. The hatchery-cultivated fish were the descendants of just five pairs of wild salmon, and research suggests that they have homogenized the gene pool of the species.

This is a serious concern, because the greater the genetic variation within a species, the easier it is for that species to adapt to changing conditions. According to Gwo, studies of the river's salmon population between 2004 and 2008 found "striking genetic homogeneity, most likely the result of improper hatchery practices and the massive escape of hatchery-reared salmon."

Gwo provided input on the establishment of the Taiwan Salmon Eco Center, and believes the facility goes some way to introducing the species and the problems it faces to non-scientists. He believes, however, that the center's teaching should extend further, saying it does not educate the public about the importance of genetic diversity, for example. "One objective of the center is preserving the long-term genetic diversity of salmon by cryopreserving the semen of valuable males and crossing them with females with different genetic backgrounds, in order to maintain as much genetic diversity for as long as we can," he says. "Geneticists hope to create 5,000 genetically different salmon, not 5,000 homogeneous salmon."

Scientists have suggested ways in which the species' genetic base could be broadened. Following the International Formosan Landlocked Salmon and Masu Salmon Symposium—held in Taipei in October 2009 and co-organized by Gwo—John R. Gold, Regents Professor in the Department of Wildlife and Fisheries Sciences at Texas A&M University, suggested that new genes be introduced into the Taiwanese species from its closest relatives in Japan. Crossbred fish would not be released into the wild, he emphasized, but studied and held in reserve in case they were needed to save the species. Gold expressed doubt that Oncorhynchus formosanus would survive long enough as a species for normal genetic mutation to give it the ability to adapt to changing conditions, stating that "global warming may push the salmon to the brink in a decade or so." Gwo backs Gold's proposal, and mentions surrogate broodstock—the transplanting of immature germ, or reproductive, cells from one salmonoid species into another—as among "new techniques that could save the endangered salmon."

The state of the Formosan landlocked salmon population in the wild is far less precarious than it was a quarter of a century ago. What the next few decades bring in terms of climate change, natural disasters and conservation efforts will determine whether the species becomes even more secure, or again teeters on the brink.

Steven Crook is the author of Taiwan: The Bradt Travel Guide.