Global Reintroduction Perspectives: 2018

Case studies from around the globe

Edited by Pritpal S. Soorae

IUCN/SSC Reintroduction Specialist Group (RSG)

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Lessons learned from the reintroduction of the Chinese giant salamander

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Introduction

The Chinese giant salamander (*Andrias davidianus*) is the world's largest amphibian and is endemic to China. The species was once widely distributed in all three major river systems in central and southern China and has been found in various water bodies including streams, rivers, and underground waterways in karst caves (Wang *et al.*, 2004). Due to habitat destruction, water pollution and over-exploitation for its flesh, the species has suffered an 80% population decline since the 1950s (Liang *et al.*, 2004). In 2004, it was listed as Critically Endangered by the IUCN Red List, making it one of the most threatened amphibians in the world. In China, it was listed as a Class II Protected Species in 1989, which prohibits by law the collection of wild salamanders. However, wild populations do not appear to be rebounding due to continued threats and without restocking efforts the recovery of salamander populations might be slow, given their rarity and long generation intervals (sexual maturity occurs at 6 - 8 years or longer). Thus, captive-breeding and reintroduction are possible conservation strategies for restoration and recovery of wild populations and down-listing from its current threat level. To test this theory, our team released 31 salamanders into two head-water streams in Shaanxi Province in central China and monitored their survival and movement for one year using radio-

Chinese giant salamander

telemetry and passive integrated transponder (PIT) tags. The goals of this project are listed below.

Goals

- Goal 1: Evaluate survivorship and compare morphometric variables of post-release animals, following capture-recapture, to wild-caught conspecifics.
- Goal 2: Identify environmental variables and habitats that are selected by released giant salamanders.
- Goal 3: Assess post-release migration distances, linear home range sizes, activity, and compare seasonal movement patterns.
- Goal 4: Raise local awareness of giant salamander conservation through releasing ceremonies and local field assistant training.

Success indicators

- Indicator 1: Radio transmitters would work normally for at least one year, enabling data collection on the salamander's reintroduction.
- Indicator 2: More than 50% of released individuals survived the first year and experienced growth similar to conspecifics.
- Indicator 3: Animals that survived had a period of settlement and chose habitat similar to wild animals.
- Indicator 4: Salamanders established territory and followed seasonal movement patterns similar to wild animals.
- Indicator 5: Increased local awareness of giant salamander conservation, such that no poaching happened during the reintroduction study.

Project summary

Feasibility: Over the past 20 years, the high market price of giant salamander meat has invoked a rapid development of a salamander farming industry. Approved by provincial fisheries bureau, these farms are expected to help generate income for rural families and support local villages. Some farms have gained sufficient experience rearing these salamanders that reproduction has become very successful in recent years (Cunningham *et al.*, 2016). Thus, salamander farms could provide a large and stable source population for reintroduction programs throughout the country if managed correctly.

In 2009, a partnership was established between Shaanxi Institute of Zoology, Memphis Zoo and Mississippi State University to conduct a reintroduction project of captive-reared Chinese giant salamanders into the wild in Shaanxi Province. This project represents a positive model for the conservation of China's aquatic ecosystems that works with local industry, which is perhaps the only hope for biodiversity in many cases. We are hopeful that this project will serve as a positive example to inspire other conservation initiatives across China, especially those dealing with threatened aquatic species.

Implementation: The two head-water rivers selected for reintroduction were the Heihe and the Donghe rivers in the Qinling Mountains. The Heihe River, on the north slope of the mountains, belongs to the Weihe River watershed, which is the largest branch of the Yellow River. The Donghe River, on the south slope of the Mountains, belongs to the Hanjiang River watershed, which is the largest branch of the Yangtze River. Wild Chinese giant salamanders were abundant in these

Recapturing giant salamanders

two rivers in the past according to local villagers; however, they have rarely been observed in recent years.

Thirty-two juvenile giant salamanders were purchased from two farms within the Qinling Mountains for this reintroduction study. Half the animals were collected as larvae from the wild and head-started in captivity; whereas, the other half were born in captivity from stock that was collected from our release site. The Heihe group of released salamanders were about three years old with body mass that ranged from 0.36 - 1.14 kg; whereas, the Donghe group of salamanders were about five years old at release with body mass ranging from 1.10 - 2.34 kg. In March 2013, all salamanders were surgically implanted with VHF radio transmitters and PIT tags for identification and tracking (Marcec *et al.*, 2016). Half the salamanders were released six weeks post-surgery into the Heihe River, while the Donghe River group were release 16 weeks post-surgery. One salamander from the Heihe group died before release because of dehiscence of suture and several more cases were observed afterwards in the river, prompting the later release of animals into the Donghe River so they could fully recover.

Post-release monitoring: Two field assistants from local communities were trained to monitor the reintroduced salamanders at both sites. Animals were located every day through radio telemetry and presence/absence checked using an under-water inspection camera occasionally. Monitoring continued until the battery life of transmitters died (the last radio signal was collected in September 2014). Near the end of the study, recapture of all living individuals was attempted before the radio signals disappeared. We recorded body mass, snout-vent length, total body length, any abnormalities and external parasites for all recaptured salamanders to compare to their pre-release morphometric data, and compared to wild caught conspecifics. Once all measurements were completed, salamanders were released at the same location where they were caught.

Survival rates of the two groups of salamanders were calculated and we also identified the most influential factors on their survival. The Donghe group had an annual survival rate of 0.7 in their first year in the wild, which was comparable to wild and reintroduced hellbenders (Bodinof *et al.*, 2012). However, the younger group of animals at Heihe River had a much lower survival rate of 0.4, largely because of the dehiscence of suture sites following release and several large floods that washed the animals downstream beyond detection. Salamanders would have had a higher survival rate if they had a longer recovery time from surgery. For those salamanders that survived and were recaptured, they all

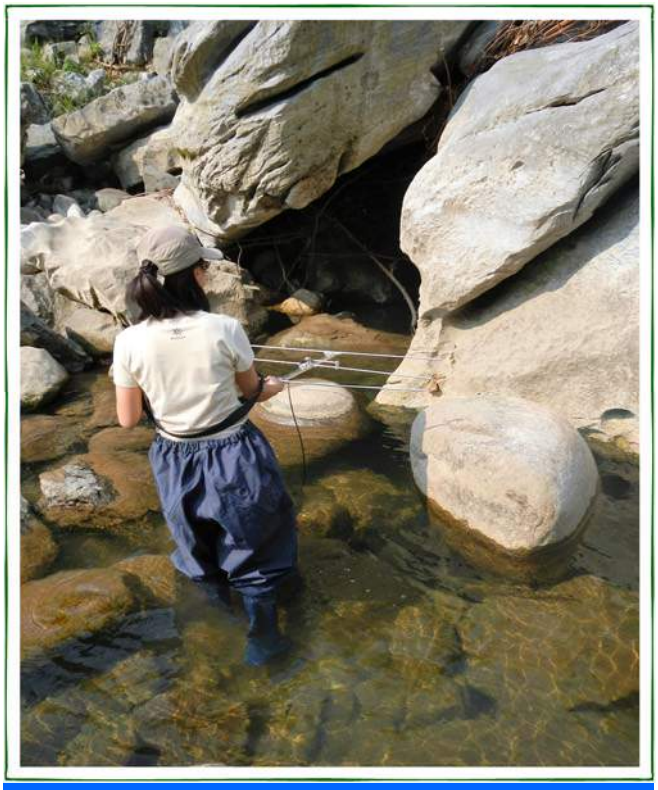
increased in body mass and total length after a year in the wild and they were only 7% lighter than wild animals of the same length (Zhang *et al.*, 2016). Habitat selection analyses confirmed that large boulders were the most important environmental variable to post-release settlement for reintroduced salamanders (Zhang *et al.*, 2017). Salamanders were able to move long distances, up to 880 m/in a single day; however, they usually made short-distance movements of ~10 m/day. They moved more frequently than hellbenders, with an overall sedentariness smaller than 0.3. The annual linear home range of these salamanders were about 300 m. Salamanders showed different movement patterns across seasons, such that they had a higher sedentariness, shorter daily movement, and smaller linear home range in winter than in summer (Zhang *et al.*, in prep).

Major difficulties faced

- The surgically implanted radio transmitters worked well on giant salamanders; however, it took too much time for salamanders to recover from surgery (need almost four months to fully recover). If not given enough time to recover, salamanders may experience dehiscence of suture sites after release and die soon thereafter. Furthermore, internal transmitters only last for about one year and it is difficult to replace expired transmitters with new units, thus longer monitoring plans could not be applied.
- Flooding shortly after the first release negatively impacted our smaller animals such that many of them were injured or moved beyond our ability to locate them.
- The two rivers chosen as release sites by the Provincial Fisheries Bureau were outside of any protected areas such that poaching could be a threat to our released animals now that the study has concluded.

Major lessons learned

- Captive-reared Chinese giant salamanders, even though they were raised for commercial use, could survive over a year following release with an annual



Radio-tracking giant salamanders

survival rate comparable to wild or captive-reared hellbenders reintroduced to the wild.

- For juvenile giant salamanders, older individuals may survive better than younger animals, considering their better recovery from surgery and higher resistance to floods.
- Newly released salamanders are susceptible to floods, especially younger individuals. Floods may cause injuries or long-distance movements downstream away from suitable release sites; thus, reducing salamander survivorship. It is better to release salamanders in autumn, when the rainy season is over.
- Large boulders are the most important variable selected by salamanders for settlement; thus, habitat structure providing appropriate cover should be carefully considered when selecting release sties.
- Captive-reared juvenile giant salamanders have a relatively high fidelity to release sites and are tolerant of conspecifics, which may contribute to the re-establishment of a population in the wild.
- Release sites outside of protected areas can support reintroduced giant salamander populations for short time periods; however, they remain at a high risk of poaching. It will be difficult and impractical to apply longer conservation plans outside of protected areas, considering logistics, manpower, funds, and poaching pressure. Soliciting permission to release salamanders in protected areas should be a future goal of the reintroduction program.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reason(s) for success/failure:

- Chinese giant salamanders are long-lived amphibians and mature at 6 - 8 years old. To establish a self-sustaining wild population this needs to be a long -term project with continued reintroductions, monitoring, funding and support from both government and the private farming industry. Our project was the first step to show that captive-reared giant salamanders are suitable for reintroduction, but we are still far from claiming that this reintroduction was successful as viewed through the lens of a self-sustaining and reproducing wild population. We do not have any data to support this with the limited number of animals released and limited monitoring period.
- The two rivers selected as release sites had good water quality, abundant fish and invertebrates for salamanders to prey on, and plenty of large boulders for them to hide beneath. In addition, natural predators were probably extirpated from our two sites, such that there was very little threat to them outside of poaching. Hence, quality of the habitat helped with the success of the project.
- The two field assistants trained to monitor salamanders were leaders of the local communities. Villages near our release sites were fully aware that we released salamanders into the rivers and that they were being monitored by community leaders; thus, poaching was minimized during this project. Hence, community buy-in to the project helped with the success of the project.

- The final fate of released salamanders could not be determined because funding was limited to continue monitoring work past a year once the radio signal failed. Regular funding, e.g. support from related governmental agencies (Federal, Provincial and County), should be acquired for when new reintroduction projects are planned, such that more animals can be released and long-term action plans toward monitoring can be established.

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