Assessment of the Conservation Status and Needs of Taylor' Salamander
Final Report

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Project Rationale

Taylor's Salamander is a critically endangered amphibian species with a very small distribution, restricted to Laguna Alchichica, a unique crater lake in central Mexico. This lake has very special characteristics such as a high salinity and alkaline pH. The real population size of the salamander is unknown, as well as its biology, behaviour and the threats that it is facing.

On the other hand, the lake is located right next to a highway and there are people living inside the crater and selling food and beverages to tourists. During the Holy Week, the lake hosts thousands of visitors who come swimming and they usually leave tons of trash after their visit. Also local people use to harvest the endemic fish *Poblana alchichica* from May to October, sometimes catching salamanders accidentally.

The uniqueness of the lake and the salamander, the lack of knowledge about the species and the absence of concrete conservation actions oriented to protect the lake and its species, make them very vulnerable. This is the reason why it is very important to improve the knowledge about the salamander and the threats it is facing, in order to apply the right actions for its conservation.

Location

The project took place at Lake Alchichica, located in the border between the States of Puebla and Veracruz in Mexico (19° 25′ N, 97° 24′ W), with an altitude of 2,290 m.a.s.l.

Summary

We have already done 10 trips to Alchichica. After standardizing our methods (trapping time, type of traps and floating devices) we have been following the same methods since last December. We have solved all the problems regarding traps and the weather and we have already started taking gill samples from salamanders for the ecotoxicology tests. The first lot of samples was taken last august and sent to the University of Campeche where it will be processed.

To date, we have caught 211 salamanders, from which 82.5% (174) have been caught in the traps; the rest were found by spotlighting at night. The information this has given us on the distribution of the salamander in the lake was until now unknown. About 38% of the salamanders have been found between 20 and 30 meters deep, 33% have been found between 11 and 20 meters, and 29% have been found below 10 meters deep – the majority of these were found at night by spotlighting. This suggests that they seem to prefer deep areas of the lake and come to the shallow areas at night. Salamanders' vertical distribution varies across the year. During the warm months, most of them do not go below 20 meters while during the cold months most salamanders go below that depth; this may be driven by cyclical hypoxia in the lake or by temperature changes (or both). To date, the sex ratio of the population is 48% males, 27% females and 25% unsexed juveniles. We already have a distribution map from salamanders in the lake, having identified areas where they are significantly abundant. We now know that they don't use their lungs significantly to breathe; they don't suffer decompression sickness as we have thought before starting the project and they have very reduced lungs indeed. We have identified gastrointestinal parasites, the nematode *Hedruris siredonis*, with the help from experts in the subject we have found salamanders with high burdens associated with morbidity and mortality. We published a paper on this using data from the project (Michaels et al., 2016). We have subsequently collected and processed 41 faecal samples from salamanders in order to measure parasite load and try to correlate it with body condition. Our results show that those 41 salamanders have two parasites (*Hedruris siredonis* and *Eimeria sp.*) present in very variable loads, however none of those individuals

showed signs of disease which means that the range of parasite load values we have found could be considered as the normal range within the population.

In order to address the social aspect of conserving *A. taylori*, we have performed a total of 750 surveys directed to schoolchildren, teachers and general population. Only 10.6% of the population knows about the salamander, however schoolchildren seem not to know the species. Most people use the lake for recreation, however the good news is that motor boats are not commonly used, they prefer swimming or eating and playing around the lake. Only 10% of the surveyed people said that they use salamanders as a resource; however salamanders used for human consumption come from other lakes, not from Alchichica, and are therefore a different species (*A.* cf. *velasci*). We have also organised three rubbish clearance events in the lake during this period. We were also present during Holy Saturday in the lake when about 3000 people visited Alchichica as a traditional celebration. I had been told by local authorities that visitors leave very high amounts of rubbish during the celebration, so we were speaking to people, giving plastic bags and asking them to keep their rubbish there so it could be picked by the authorities at the end of the day. We also gave each person a postcard with information about the lake and the salamander and explained them the importance of their conservation. Sadly, the results were not what I expected but at least a few people decided to cooperate.

We are also in discussion with local and regional authorities about the possibility of affording legal protection to Alchichica.

Reference:

Michaels, C.J., Díaz, J.A.H., Muciño, M.D.C.C., Muñoz-García, C., Osorio-Sarabia, D., Acebes, L., Couchman, O., Owen, N. and Waterman, C., 2016. Fatal parasitosis caused by Hedruris siredonis (Nematoda) Baird, 1858 in the Alchichica salamander *Ambystoma taylori* Brandon, Maruska and Rumph 1982. Herpetology Notes, 9, pp.43-46.

Activities performed according to the Project plan

The table below describes the activities performed according to the project plan proposed at the beginning.

Vision: Long term conservation of Lake Alchichica and its biodiversity, especially Taylor's salamander.			
Project Purpose: Improving the knowledge about status and threats for Taylor's salamander and engaging community in conservation actions to save the species from extinction.			
	Indicators	**Progress and Achievements**	**Actions still required/planned**
Output 1: To improve the knowledge about Taylor's salamander biology and its habitat.			
Activity 1.1: Estimating salamander population size and structure in Alchichica.	Results of population size and structure.	We have caught a total of 211 salamanders, from which 174 have been caught in the traps while 47 were found during night surveys. To date, the sex ratio from the population is 48% males, 27% females and 25% unsexed juveniles. We have not found any marked salamander (i.e. no confirmed recaptures), but we still have photos as a backup method for identifying recaptures. Therefore we do not have a population estimate yet.	We still need to go through the photos taken from November to March in order to test if we find any recapture with this method. Also, because we had a problem of stolen traps last year, we still need to complete one more field survey to finish the population study.
Activity 1.2: Gathering data on microhabitat use, period of activity and distribution within the lake.	Information about salamander's biology.	We knew from the first six months of work that salamanders were active at night on the edges of the lake. After analysing data collected from the traps, we know that 38% of the caught salamanders have been found between 20 and 30 meters deep and 71% have been found below 11 meters deep, which means that they seem to prefer deep areas from the lake and come to the shallow areas only at night. We already have a distribution map from salamanders in the lake, having identified areas where they are significantly abundant. We now know that they don't use their lungs to breathe, they don't suffer decompression sickness as we have thought before starting the project and they have very reduced lungs indeed. Some days we remained on the edge of the lake waiting for the light to go away and we saw some salamanders coming from the deep but some others coming out from the stromatolites on the edge,	

		mainly young animals. We also have data on how salamander distribution changes in different seasons along the year, but we don't know if this movement is due to temperature or oxygen concentrations.	
Activity 1.3: Getting data on environmental variables water temperature and salinity along the day on different seasons during the year.	Data about the daily and monthly variation of water temperature and salinity.	We have temperature measurements across 15 months. The lowest surface temperature registered in the water was 15 degrees C while the highest was 22 degrees C. From May to September, the temperature has been very stable, 19 degrees at night and 22 degrees during the day. While in December and February the temperature is 15 degrees at night and 17 during the day, but in cool days it remains at 15 degrees all day long. Salinity persisted during the whole year.	
Output 2: To quantify the impact of human activities such as: agriculture, harvesting, tourism and domestic wastes over salamander's habitat.			
Activity 2.1: Water quality analysis.	Results of water quality analysis.	We continued taking water samples tor water quality tests, we got some samples from 12 and 15 meters deep but all of them keep giving the same results: ammonia, nitrites, nitrates and phosphate are 0ppm.	Some water samples were sent to a specialized lab for a more accurate analysis and to test the presence of heavy metals, however the results will be ready next month.
Activity 2.2: Identification of products used in agriculture: fertilizers, pesticides by surveys in local community and farmers around the lake.	Information about the fertilizers and pesticides used in agriculture.	I have gathered some information on possible sources of pollution around the lake, I found the following: Fertilizers (urea, ammonium sulfate, and a product called triple 16 with nitrogen, phosphorus and potassium), weed killers (atrazine, glyphosate and imazethapyr). Some of these products could affect salamanders development and sex determination which could be a potential threat for the population.	Some water samples were sent to a specialized lab for a more accurate analysis and to test the presence of heavy metals, however the results will be ready next month.
Activity 2.3: Identification of salamander uses by local people by surveys in local community.	Information about how local people use salamanders: food, traditional medicine.	Most local people haven't even seen the salamanders. They are very difficult to find and catch, so people don't use them as they do with other species from the lakes nearby.	There is not a plan in the immediate future. However as part of another project, I am planning to work with the Ambystomatid salamanders from the other crater lakes.

Activity 2.4: Identifying if there is any drainage going directly to the lake.	Localization of drainage pipes around the lake.	No drainage pipes have been found around the lake. However, as stated six months ago, pollution by trash is still the main problem in the lake.	
Output 3: To evaluate the health status of Taylor's salamander population.			
Activity 3.1: Estimating the prevalence of infectious diseases in the population: chytridiomycosis and pathogenic bacteria.	Number of individuals infected with chytrid fungus.	All salamanders have been swabbed for chytrid, but the samples have not been processed yet. We have also collected 41 faecal samples from salamanders in order to measure parasite load and try to correlate it with individual's body condition. Our results show that those 41 salamanders have two parasites (*Hedruris siredonis* and *Eimeria sp.*) present in very variable loads, however none of those individuals showed signs of disease which means that the range of parasite load values we have found could be considered as the normal range within the population.	We just finished taken Bd swabs, they still need to be processed.
Activity 3.2: Estimating prevalence of deformities in the population.	Number of individuals presenting deformities.	We have not found many deformities in the population. The most common we have seen is reduced gills associated with poor body condition in 7 individuals.	We will continue gathering data on this during the last survey.
Activity 3.3: Assessing the effect of pollutants over salamanders (ecotoxicology).	Results of ecotoxicology analysis.	We have taken 45 gill samples for the ecotoxicology tests. The first 18 samples were already processed finding one individual with signs of severe intoxication, and five with signs of moderate intoxication.	The rest of the tissue samples still need to be processed and we will take a last set of samples in May.
Output 4: To create awareness among local community about the importance of the lake and its biodiversity in order to mitigate the threats over the salamander.			
Activity 4.1: Creating a regulation of activities on the lake Alchichica together with local government.	Number of meetings with local government.	We are working with the Tourism Director from Tepeyahualco in order to solve this. She is very willing to help and we have also identified the need of installing trash containers around the lake. Two containers were already installed in the lake. We organised an event during Holy Saturday, installing a module with salamanders in	We will install at least one more container next to the lake, and we still need to design and make the signage. We will visit the lake during the Holy Saturday and make a campaign against littering by stopping cars when coming down to the lake to talk to people and give them plastic bags to keep their trash.
Activity 4.2: Designing and advertisement for tourists with information about the lake and its species. This will also include a list of rules that should be followed on the lake. Installing it on the border of the lake.	Installation of the advertisement.		

		an aquarium in order to show them to people, explain them the importance of the species and the lake and give plastic bags so they can collect at least their own trash and bring it back to us.	
Activity 4.3: Creating awareness among farmers in order to reduce the use of fertilizers and pesticides / finding strategies to improve their agricultural techniques to cultivate organic products.	Change in the amount of fertilizers and pesticides used by farmers.	I already have information regarding the products that could be a potential threat for the salamanders.	

Additional evidence of the achievements

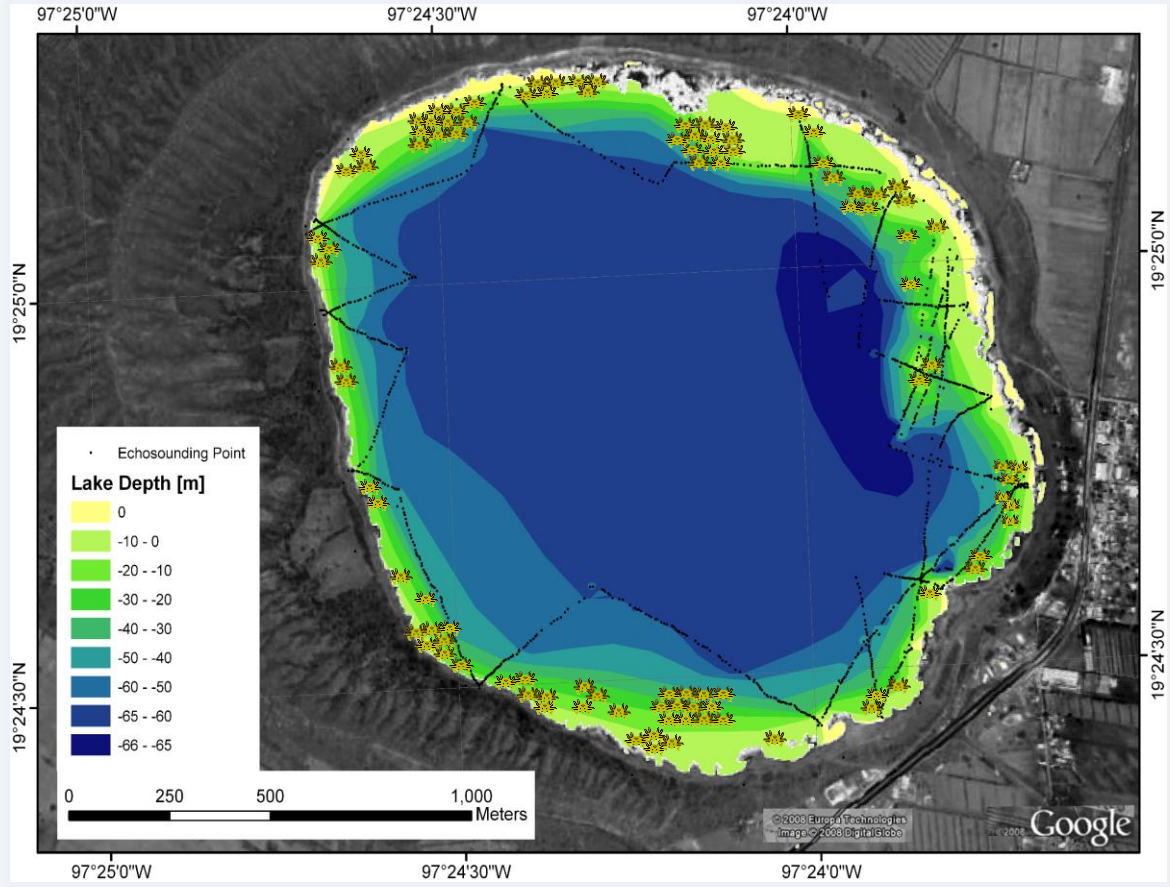

Fig. 1. The map shows salamanders abundance in different areas of the lake. Individuals are represented by little axolotl faces, and colours represent the different layers of depth in from lake.

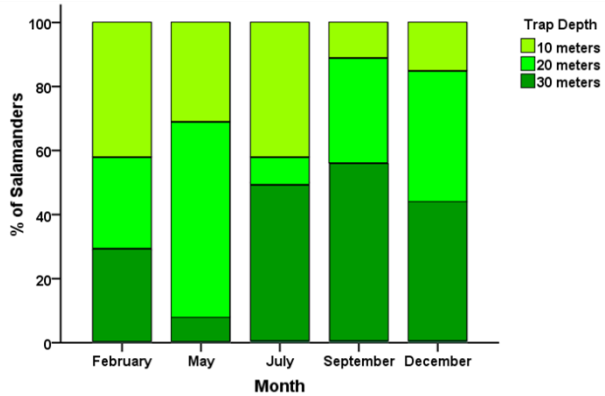

Fig. 2 (Left). Vertical distribution of salamanders during different months. During May, the warmest month, salamanders move to shallower areas while during Autumn and Winter they move to deeper areas. We suspect this is due to the changes in oxygen concentration but we have not been able to prove that assumption.

Fig. 3 (Left). Comparison of lung size between *Ambystoma lermaense* (left) and *Ambystoma taylori* (right). Both photos were taken at the same scale to show the difference in lung size between species.

Fig. 4. Panoramic view of Alchichica in 1940 (above) and 2016 (below). The photo below clearly shows the decrease of the level of the lake where it is possible to see stromatolites that used to be covered by water. The water used to cover the road that it is possible to see in the photo below. We have recorded a decrease of 36cm during two years.

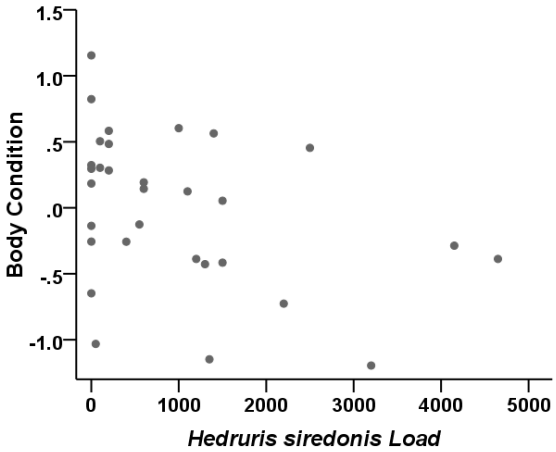

Fig. 5 (Left). Effect of parasite load of *H. siredonis* over salamanders' body condition. No significant effect was found, so we can consider this as the normal range of parasite load in the population.

Changes to work plan and schedule

The project is a bit delayed with some activities which are not complete yet: population study, processing *Bd* samples, ecotoxicology tests, installing signage around the lake. We have some problems during this time including traps being stolen, difficulties with the lab we were planning to work with and they have cause the delay. However we have solved all the problems and I think all the activities will be finished during the next

four months. Also I have to say that I have spent the last month in a publicity campaign for the project because we are participating on a contest from Volkswagen for funding to continue with the project and this has been a cause of the delay too. As soon as I complete all the activities planned, I will send you an update.