Unarmored Threespine Stickleback

Shay Creek Population

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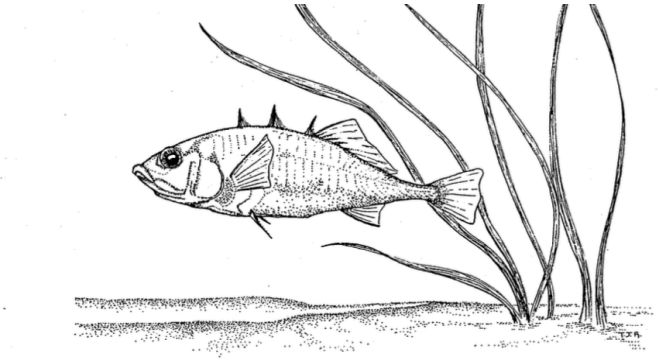
Abstract:

The Unarmored Threespine Stickleback (*Gasterosteus aculeatus williamsoni*) also known as the Shay Creek Stickleback is found in the Big Bear area of California. It has been listed as federally endangered since 1970 and protected by the State of California since 1971. While it has been successfully transplanted to ponds in the area, the last vestige of its natural habitat is found in a small pool called Shay Pond (after which the fish is named). Shay Creek at one time connected Baldwin Lake to Shay Pond however both the creek and the lake are now dry leaving only a deep pool that is fed by groundwater where the stickleback was able to survive. Due to extraction of water from an upstream creek and decreased rainfall, the pond has come close to drying up completely. It is now maintained by the Big Bear Community Services District, which was placed responsible for maintaining water in the pond by bringing in supplemental water through pipelines. The loss of habitat that the Unarmored Threespine Stickleback have undergone has been drastic however introducing the species to different ponds in the area will potentially be a way to reduce the threat to the species. Security of this species in the short-term is dependent on expanding its range to different ponds or lakes in the region that could host the Unarmored Threespine Stickleback in a secure habitat. This paper identifies Bluff Lake as a potential site for transplantation of the Unarmored Threespine Stickleback, taking into consideration some key water quality indicators and essential habitat needs.



Source: Fish Species of Special Concern in California

Unarmored Threespine Stickleback Background:

The Unarmored Threespine Stickleback, now referred to as UTS for the rest of the paper, is a freshwater fish that is scale-less and will typically grow in length up to five centimeters and lacks lateral plates. They differ from sticklebacks of other sub-species by having short dorsal and pelvic spines, rounded pectoral and caudal fins, reduced denticulation of the spine, and a less streamlined body (U.S. Fish and Wildlife Service). They have three sharp dorsal spines anterior to the dorsal fin that offer some protection from predators. Adult coloration is typically an olive to dark green on the sides and back with a white to golden color along its abdomen. Reproductive males take on a shiny black coloration on its sides and back along with iridescent blue eyes and a bright red color on the throat and anterior ventral area. The Shay Creek Stickleback in particular shows a greater extent of red coloration than other populations in nuptial males than other population in the subspecies. The UTS form loose schools except during the breeding season. During the breeding season, males set up nests out of strands of algae and pieces of aquatic plants that are sealed with kidney secretions. The female UTS lays her eggs in the nest made by the male, leaving the male to guard the eggs until they hatch. After the eggs hatch the male will stay with the young for some time. UTS typically live for up to a year, some have been known to live longer (Malcolm, 1995).

The UTS typically is found in slow or standing water with an abundance of both submerged and emerged aquatic vegetation. In addition, there must be algae and loose sediment available for nest building. The UTS feed on benthic insects, small crustaceans, and snails. Shaded areas with no predatory fish and algal mats are ideal for the UTS and can all be found in Shay Pond. While Baldwin Lake was becoming dry, the UTS were able to withstand high salinities and pH as the lake evaporated. Essentially, UTS need water depth sufficient enough to

prevent becoming anoxic in the summer and freeze all the way through during the winter, aquatic vegetation for both nest building and to provide cover, and small invertebrates as a food source (Malcolm, 1995).

Unarmored Threespine Stickleback Source: Morgan Ball

Location/Distribution:

The Big Bear area that is home to the UTS is an area of high endemism and hosts a large array of biodiversity including a variety of rare, threatened, and endangered species. This can potentially be explained by a period of glaciation, which brought species from lower elevations up to higher elevations that then remained, when the glaciers retreated; the sticklebacks may have been among these species. A unique feature of the UTS is its wide array of diversity within the subspecies based on their location causing some to suggest that the Shay Creek Stickleback should be considered its own distinct population segment based on its genetic variance from the lower altitude UTS; however, this is still up for debate and requires further studies to be done (U.S. Fish and Wildlife Service). The Shay Creek Stickleback therefore has some differences genetically and in its behavior from other UTS probably because of its evolution within an

isolated basin. The native stickleback population at Shay Pond is the remnant of the once flowing Shay Creek. The pond is provided supplemental water by the Big Bear Community Service District as mitigation for drawing water from a stream in the area that would impact that availability of water in Shay Pond, which, when left on its own is maintained by available groundwater. The CSD is required to pump water into the pond to prevent drying up from over-pumping of ground water however the CSD does not have the authority to maintain the habitat (Portie, 2006). Shay Creek when flowing, once served as a tributary to Baldwin Lake, carrying UTS along the way. One thing that sets this particular population of sticklebacks apart from others is this location. Typically found below 3,000 feet above sea level, this population is able to survive at around 6,700 feet (California Department of Fish and Wildlife).

A fence surrounds Shay Pond in order to keep people and animals away from the area and to protect the UTS. However, the area surrounding the pond is residential and open . Both of these activities are sources of potential harm to the UTS particularly for nitrogen runoff into the pond, which puts the pond at risk for eutrophication. Shay Pond is also in close proximity to an unpaved road that can also be a source of pollution. One of the most concerning aspects of this habitat is the encroachment of wetland vegetation to the open water, which drastically reduces that amount of open water habitat available for the UTS. The overgrowth of the vegetation as well as sediment has been cleaned out on multiple occasions however there is no management plan or scheduled cleanup to maintain the vegetation around the pond. The area around Shay Pond known as Shay Meadow as well as the land underlying the pond have been in conservation status, however there is little maintenance and the proximity to potential sources of pollution is a substantial source of concern for the safety and integrity of the conservation lands (California Department of Fish and Wildlife). Restoration of the meadow and parts of the creek flow would

be beneficial to the UTS, as they would have a wider range of habitat and be able to move freely from one pond to another.

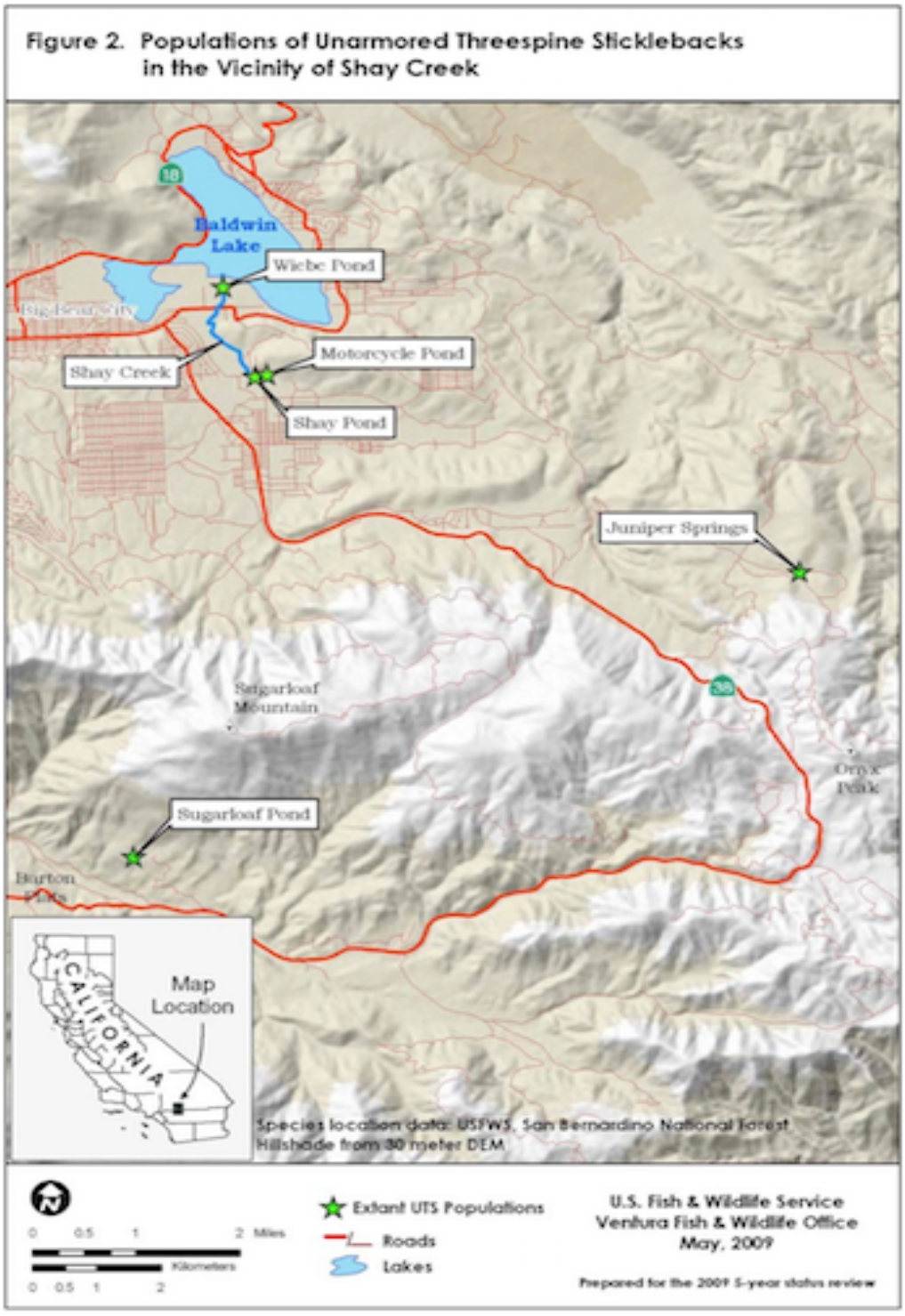
The UTS has been found in Shay Creek, Shay Pond, Sugarloaf Pond, Juniper Springs, Motorcycle Pond, Wiebe Pond, and Baldwin Lake however is currently only found at Shay Pond, Sugarloaf Pond, and Juniper Springs (US Fish and Wildlife Service). Both Sugarloaf Pond and Juniper Springs are transplanted populations that were introduced in order to maintain the population of the UT. The latter three of the listed habitats are no longer able to support the UTS. Shay Pond was able to persist through the drying up of the creek because it was a deep pool within the creek that maintained a population once the creek itself ran dry and is sustained through the supplemental water supplied by the CSD however the other habitats were not so lucky and most have dried up since. The drying of its natural habitat is among the largest of threats to the UTS population in the area. Shay Pond does freeze over during the winter, however this has not affected the ability for the population that resides within the pond to survive.

Photo by: Anju Aldis

Overgrown vegetation encroaching on open water space at Shay Pond

Photo by: Anju Aldis

Vegetation covering spout that provides water to the pond



Source: UTS 5-Year Review, USFWS

U.S. Fish and Wildlife Service map showing populations of UTS. Current populations occur at Shay Pond, Sugarloaf Pond, and Juniper Springs

Bluff Lake:

Bluff lake is currently owned and managed by The Wildlands Conservancy and is part of the Bluff Lake Reserve, which includes not only the lake but also the surrounding meadow. Located at 7,600 feet it is a 20-acre lake that at one time hosted a population of non-native catfish however, has since been cleared out and restored ecologically (The Wildlands Conservancy). Currently there are no fish living in the lake. The surrounding meadow is home to several federally endangered plant species including the Bird-Footed Checkerbloom, which is endemic to the Big Bear Area. The lake itself does have a healthy amount of aquatic plant life as well as vegetation around the shores that can provide some protection for the UTS. The lake will freeze over in the winter, however not all the way through. Additionally the area is protected from human activity allowing restricted, passive use of the space and requests its visitors to leave no trace with their activities. Because this is a privately owned ecological reserve, Bluff Lake offers a safe environment for the UTS if they were to be transplanted as well as plenty of space for population growth. In lieu of Shay Creek flowing, Bluff Lake is a possible transplant site where the UTS population will have a place to expand past the confines of a poorly managed pond and have protection from pollutants and potential harm from human activities because of its level of protection. The lake does have a children's camp in close proximity, however they camp is well educated on the endangered species' associated with the meadow and have restricted access and use of the land and lake.

Photo by: Taku Shiozaki

Bluff Lake

Water Quality:

Using a water probe on loan from the Chemistry Department at the University of Redlands as well as nitrogen and phosphorous test strips, indicators of water quality were taken at both Bluff Lake and Shay Pond. These included pH, dissolved oxygen, conductivity, temperature, nitrate levels, and phosphate levels. Samples were taken over two days and four different locations in Shay Pond, the results were averaged out and are shown in the table below. Due to weather restrictions, only one sample was obtained at Bluff Lake, with the results also shown in the table below.

Water Quality Indicator	Shay Pond	Bluff Lake
pH	7.6	8.3
Conductivity	388 µS/cm	100 µS/cm
Dissolved Oxygen	7.9 mg/L	9.4 mg/L
Temperature	11.94 C	6.6 C

pH:

pH is a measure of the hydrogen ions in the water ranges from a scale of 0-14, with 7 being neutral and numbers below being acidic and above being basic. pH affects the solubility of organic compounds, metals, and salts and can affect the species that will be found in certain bodies of water. The range of livable pH varies for species, although typically prefer a range of about 6.5-9. UTS are resilient fish that can survive in higher pH as was exhibited during periods of evaporation at Baldwin Lake when the UTS continued to live as salinity and pH rose. While the pH of Bluff Lake is higher than that of Shay Pond, it is still within the suitable range for life.

Conductivity:

Conductivity is a measurement of the ability of a liquid to carry an electrical current and is used to determine the total dissolved solids that are present. Conductivity in freshwater is affected by the surrounding geology because it measures the concentration of ions in the water, which would come from the surrounding soils. More ions create higher conductivity and fewer ions produce lower conductivity. Total dissolved solids can be an indicator of pollution. The presence of dissolved solids is also important for animals to keep their cells from swelling. Freshwater fish, like the UTS are able to thrive in a wide range of conductivity, ideally from

100-2,000 μs/cm (microsiemens per centimeter). Both Shay Pond and Bluff Lake are within this parameter.

Dissolved Oxygen:

Dissolved oxygen refers to the amount of free oxygen molecules present in water. It is essential to maintaining life in water as it is used for respiration. Dissolved oxygen in freshwater will vary with season, location, and depth. Necessary dissolved oxygen levels depend on largely on the species. Because the level of dissolved oxygen at Bluff Lake is higher than that of Shay Pond the results suggest that it would be suitable for sustaining life.

Temperature:

Temperature can affect both the dissolved oxygen content and conductivity of water. Lower temperatures have the ability to hold more dissolved oxygen, which would help to explain the higher levels of dissolved oxygen in Bluff Lake. Temperature also affects the conductivity. If temperature goes up then the conductivity will do the same because ions are able to move faster in warmer temperatures. Additionally, warmer temperatures will yield higher concentrations of ions because solids will dissolve more easily in warmer water. Shay Pond had a higher temperature than Bluff Lake, likely due to its lower elevation and consequently higher conductivity and lower dissolved oxygen.

Nitrogen/Phosphates:

Nitrogen and phosphates are both nutrients that act as fertilizers for aquatic plants. If nutrient loading occurs lakes and ponds can be at risk for eutrophication—a process by which excessive plant growth cause large amounts of dead organic matter and the microorganisms that break down the plant matter use up all of the available oxygen leaving the water unable to sustain life. Nitrogen can come from animal waste or runoff from fertilizers among other

sources. This is concerning especially for Shay Pond as it is in an area where it can easily be contaminated. When tested for nitrates using test strips results ranged from 10 to 0.5 ppm (parts per million). Freshwater usually will range from 0.1 to 4 ppm however the levels exhibited at Shay Pond are not unusual as they are very close to potential sources of nitrogen runoff. Phosphates are typically associated with detergents as well as fertilizers and were found to range from 15 to 30 ppm. Bluff Lake showed lower levels of both nitrates with a result of 0.5 ppm however, had the same level of phosphates at 30 ppm.

Overall, the results of the water tests did not reveal any major discrepancies that would cause alarm or show that Bluff Lake should be found unsuitable for the UTS. However, further water analysis should be done throughout seasons and comparisons with other ponds where transplantation has been successful, such as Sugarloaf Pond to gauge whether there are a range of conditions the UTS could survive in.

Conclusion:

Shay Pond is a vulnerable habitat for the Stickleback. It is in a populated area that suffers from increased human activities and development. Because of this, in order to secure this unique population, transplantation to a new lake in the area could be beneficial to ensure that the population is not at risk for extinction. While it would be ideal to maintain Shay Meadow and Creek to its former glory, the undertaking is a big one and requires collaboration between private landowners and government agencies. Restoration of the meadow and proper maintenance of the pond would be beneficial to plant and animal species that previously inhabited the area. Due to the successful transplantation in ponds and lakes in the area however, transplantation is an immediate solution to the vulnerability of the species. Bluff Lake would serve as a potential site

due to its proximity to Shay Pond as well as the level of protection offered in the area. Bluff Lake is isolated from high traffic areas that reduce the risk for pollution and interference by people or animals such as horses. Based on the limited water data collected, it is difficult to make a definitive conclusion whether the lake would be suitable, however it is a promising location that would be less vulnerable to the effects of drought or development than Shay Pond. This particular population of UTS found in Shay Pond is a important to protect because of the unique attributes that set it apart from UTS found elsewhere. The species contributes to the high level of endemism that occurs in the Big Bear area and its biodiversity. Additionally it is a vestige of glaciation that shows the resilience of the species to survive and adapt in the higher elevations.

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