Observations of Larval Development of Clear Lake Hitch, *Lavinia exilicauda chi*, with Regard to Differences in Temperature in Their Environment

An Individual Study, Spring 2012
Sunny Franson

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Unless otherwise noted, images by S. Franson

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Abstract

The purpose of the study was to further observe the effect of temperature on development of eggs and larvae of Clear Lake hitch, *Lavinia exilicauda chi*. Successful egg incubation and development of larval hitch might require specific environmental parameters (ref. pgs. 17-18 Final Report, 2011). A simple study was performed to gather information about the effect of temperature on larvae. It was an endeavor to learn more about this stage of the life cycle of Clear Lake hitch, being mindful that temperatures in the Clear Lake basin can and often do fluctuate substantially from early spring to early summer.

Background

Assemblage of field work and data for a final report for a US Fish and Wildlife Grant, 2008-2011, at Robinson Rancheria Environmental Center, highlighted differences in successful and unsuccessful rearing and development of larval stages of Clear Lake hitch. Monitoring during trials in spring, 2011 showed differences between a group of three basins in a hatchery setting, and in a small tank. These were in levels of dissolved oxygen (ref. pg.12, Supp. 4, Final Report, 2011), phosphate levels (ref. pg.9, Supp. 4, Final Report, 2011), and temperature readings (ref. pg.12, Supp. 4, Final Report, 2011).

In this study levels of dissolved oxygen and trace phosphate were not addressed, for two reasons. The first was that noting temperatures was amenable for an independent study in a home environment. The second was that in spring 2011, larvae unexpectedly thrived and grew in a small tank with markedly lower levels of dissolved oxygen*, and higher levels of trace phosphate, than were measured in the 3-basin environment where they didn't develop past perhaps 24 to 48 hours after collection and where they eventually perished (ref. Supp. 4, and pgs.9, 12 and 13, Supp. 4, Final Report).

*A note in the graph (Final Report, Supp.4, pg.12) for dissolved oxygen noted meter malfunction; consistent measurements were nevertheless noted (pers.obs).

Field Procedures

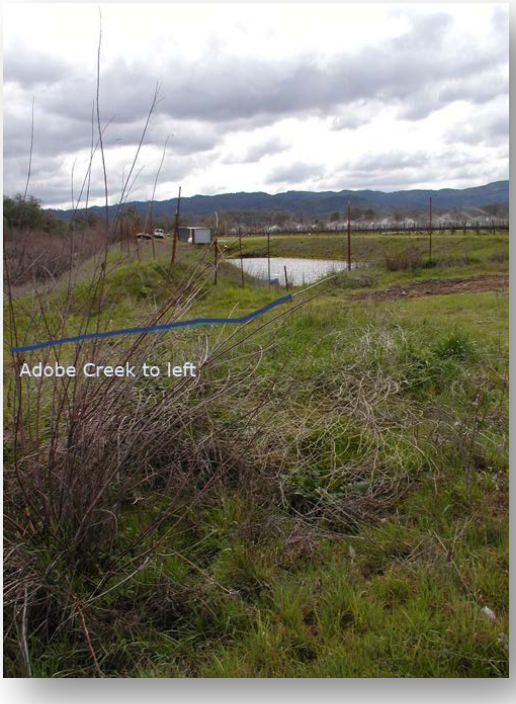
Field surveys occurred from 15.February.2012 to 29.April.2012. Three deceased gravid females were found, and reports of volunteers from the Chi Council for the Clear Lake Hitch and from local tribal members indicated that migration was underway mostly in creeks to the west of Clear Lake. In the northshore area a school was sighted at Hwy. 20 at Middle Creek Bridge (see counts for 2012 at the Chi Council's website, http://lakelive.info/chicouncil/2012results.htm). Unfortunately through personal field work no migrating hitch in the northshore and Scotts Creek areas were observed and no eggs were found, in northshore tributaries or elsewhere. On 29.April 6 mm. larvae were discovered and collected from the field, by gently scooping a few at a time into a small plastic container, gathering about 40 individuals in all.

They were found in a small inlet leading to Adobe Creek above Bell Hill Road (ref. map and CNNDB data sheet), at 38°57'25.88"N, 122° 53'28.30"W (DeLorme coordinates, refined with Google Earth). This inlet appears to be an overflow from a reservoir alongside Adobe Creek. Fish in various stages of growth were in this small channel. Larger fish were in a minimal current mid-channel, gradations of smaller fish were closer to the channel's banks, and the smallest were in the flooded grassy areas beside it.

Identification was based on several factors. Two of three deceased gravid female hitch found near the collection site were close to this area, and a stranded, wounded gravid female was found a few feet away. Two individual larvae were later examined and found to have characteristics and pigmentation that were observed in Spring 2011 (ref. pgs.3-9, Supp.4, Final Report, 2011). Larvae exhibited behavior that appeared to be pronounced and consistent during field work with hitch larvae in 2011: larvae of several species headed back into containers when water was poured out to reduce water levels. However larval hitch banded together and darted for the container's edge. They also hovered at the downstream edges of pooled areas in fields (ref. pg.5, Supp. 1, Final Report, 2011).

This hitch was found stranded in a small pool and had suffered a severe wound directly beneath her mouth.
Image courtesy of S.Franson, taken during field work with Big Valley Environmental Department, 4.4.2012.

38°57'25.88"N, 122° 53'28.30"W
Image courtesy of Google Earth

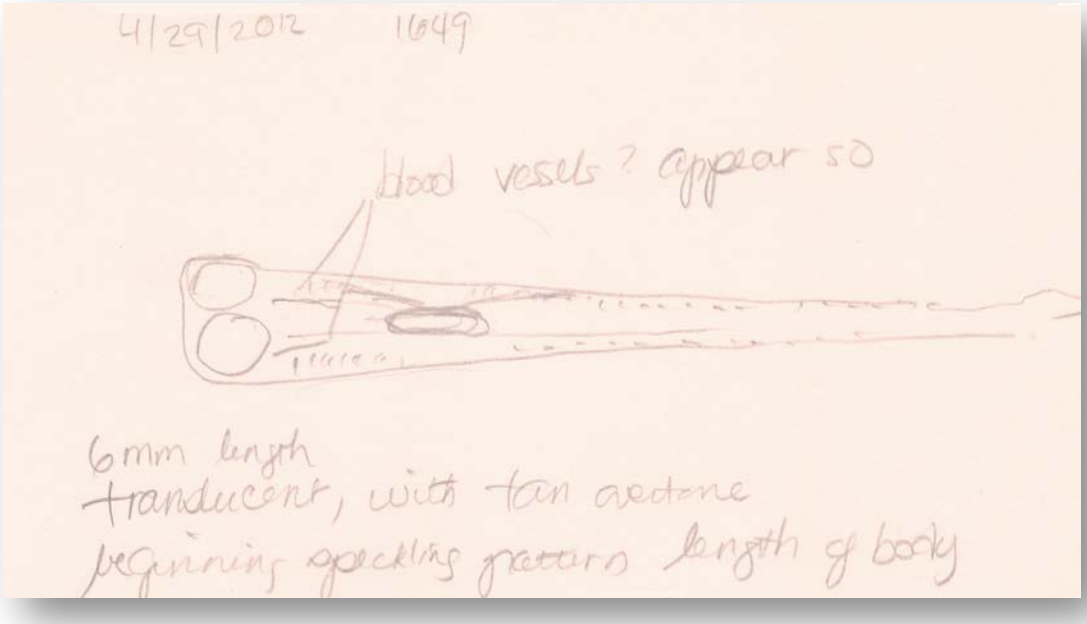


Reservoir and small stream channel. Image courtesy of S.Franson while in field with personnel from Big Valley Environmental Center, 3.23.2012

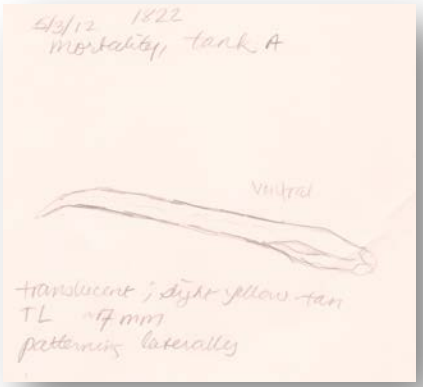
Water was not being pumped from the reservoir on 4.29.2012, date of collection, and the rock dam boosted water levels. The small channel entered Adobe Creek, below. Image, 4.29.2012

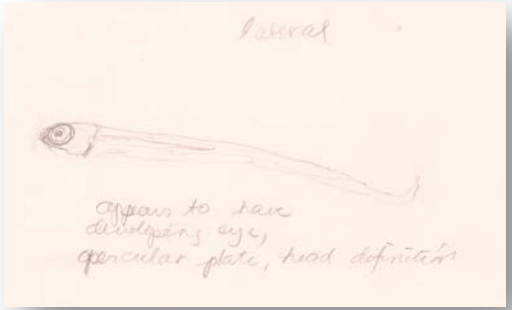
Larger fish were managing a mild current in the channel. Smaller fish and larvae drifted toward the sides; the smaller they were, the further from the current.
Images, 4.29.2012

Larvae were estimated to have hatched probably 2.5 to 3.5 weeks previously. The beginnings of an undeveloped opercular plate and definition for a head were observed under a 10x field scope. Eyes were black, very large and were the primary anterior feature. Patterning was observed along body length as noted in 2011 (ref. pg.7, Supp.4, Final Report) and reviewed in Swift (ref. pgs. 77-79, Swift, 1965).



Sketch, 4.29.2012





Sketches, mortalities from Tank A, 5.2.2012

Materials and Method

Equipment consisted of a DeLorme Earthmate PN-60 GPS unit, two new and unopened 5 gallon glass aquaria, a DeltaTrak digital thermometer (-40°C to 155°C), a small hand net used to remove extensive surface algae and overabundance of aquatic insects competing for microscopic prey, two small plastic containers used to scoop larvae when gathering them and to scoop water from Rodman Slough when replenishing microorganisms, a small bucket, and a digital camera.

The intent was to compare developing eggs and/or larvae in two aquaria that were arranged to be as identical to each other as possible, apart from a difference of from 3 to 5°C in water temperature, and allowing for the natural fluctuations of daytime and nighttime temperatures of ambient air.

Two 5-gallon glass aquaria were placed side by side in a small shop area. Tank A was left unheated. A small, 10 W heater was attached to the wall of the second tank, Tank B. Both tanks had covers with lights that were kept on in daytime and turned off at night, and both had open areas for aerators that were not installed. Every effort was made to maintain the same aquatic environment within the two tanks, and water and plants were collected only from streams and a slough in which hitch are known to have been sighted in the past.

On 4.29.12, about twenty larvae were placed in each tank, fitness and activity were noted with each temperature check, and development was monitored. A small number of sacrifices were examined under 10x power.

Monitoring occurred AM and PM for temperatures of water in tanks and for ambient air, for observations about numbers, appearance, activity, and behavior of fish, including any notes of interest such as addition of water from Rodman Slough. Weekly or bi-weekly as required, both tanks were replenished with small amounts of water infused with algae and accompanying infusoria as a food source.

Determining levels of activity was by nature subjective but was organized by using the water column, numbers of fish seen and therefore survivors, and their movement. The water column was divided into 3 areas, top, mid, and bottom. Numbers assigned were from 5, or most active, to 1, or least active. 5 was assigned when all or nearly all the fish were observed moving easily in the top, mid, and bottom levels of the tanks, or throughout the water column. 4 was assigned when fewer fish were noted, or all fish were at 2 of 3 levels in the water column. 3 was assigned when not all fish were seen and were at 2 of 3 areas in the water column. 2 was assigned when most fish were seen but were sluggish, or few fish were seen at 2 levels in the water column. 1 was assigned when few fish were seen, those were sluggish and they were in 1 level of the water column. The goal was consistency so a sense of fitness and comfort could be estimated. Tank lights were turned on for a short time before fish were observed for their movement, since hitch feed diurnally (Geary and Moyle, 1985). Immediately after water including prey items were added to the tanks, fish were given time before notes were taken, since they tended to prey on items that were near the surface and light or near plants and substrate.

Tank environments were followed for presence and movement of snails, aquatic insects and appearance of aquatic plants.

Results

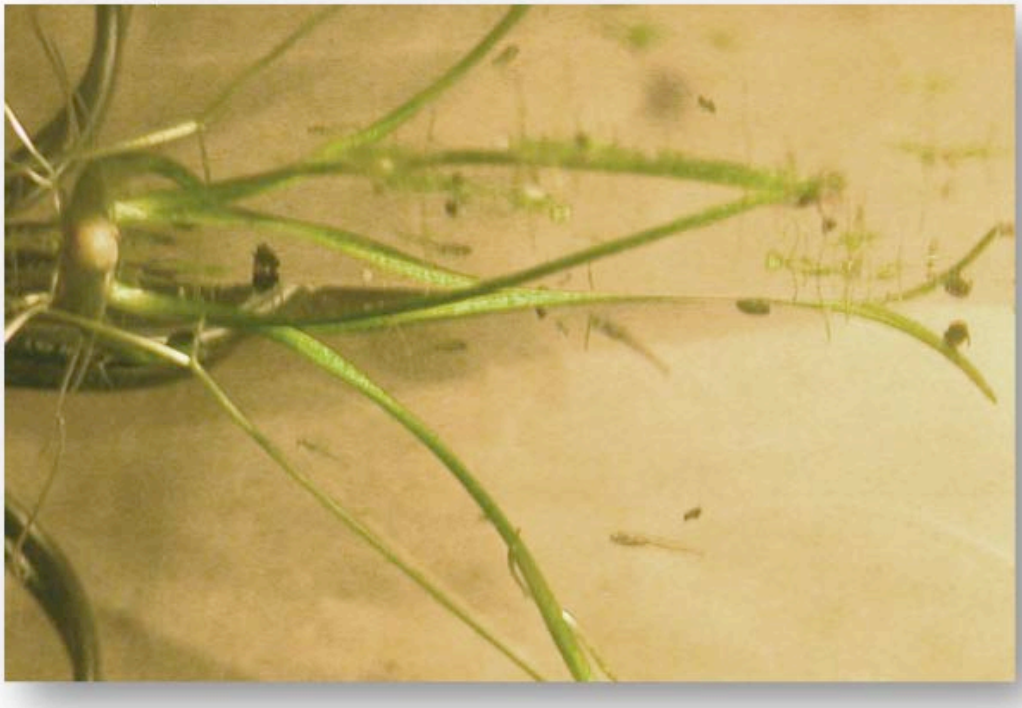
Tank A (cooler): Initially, approximately 20 larvae appeared to be moving easily but were not active and were observed hovering either at the top of the water column or near the bottom. About half of the larvae perished over several days. By 5.4.12, 10 to 12 individuals were observed, often near the water's surface. As days lengthened and warmed,

their activity levels increased, heads and fin structures developed, and patterning faded into silver and tan coloring with a dark spot at the base of the caudal fin.

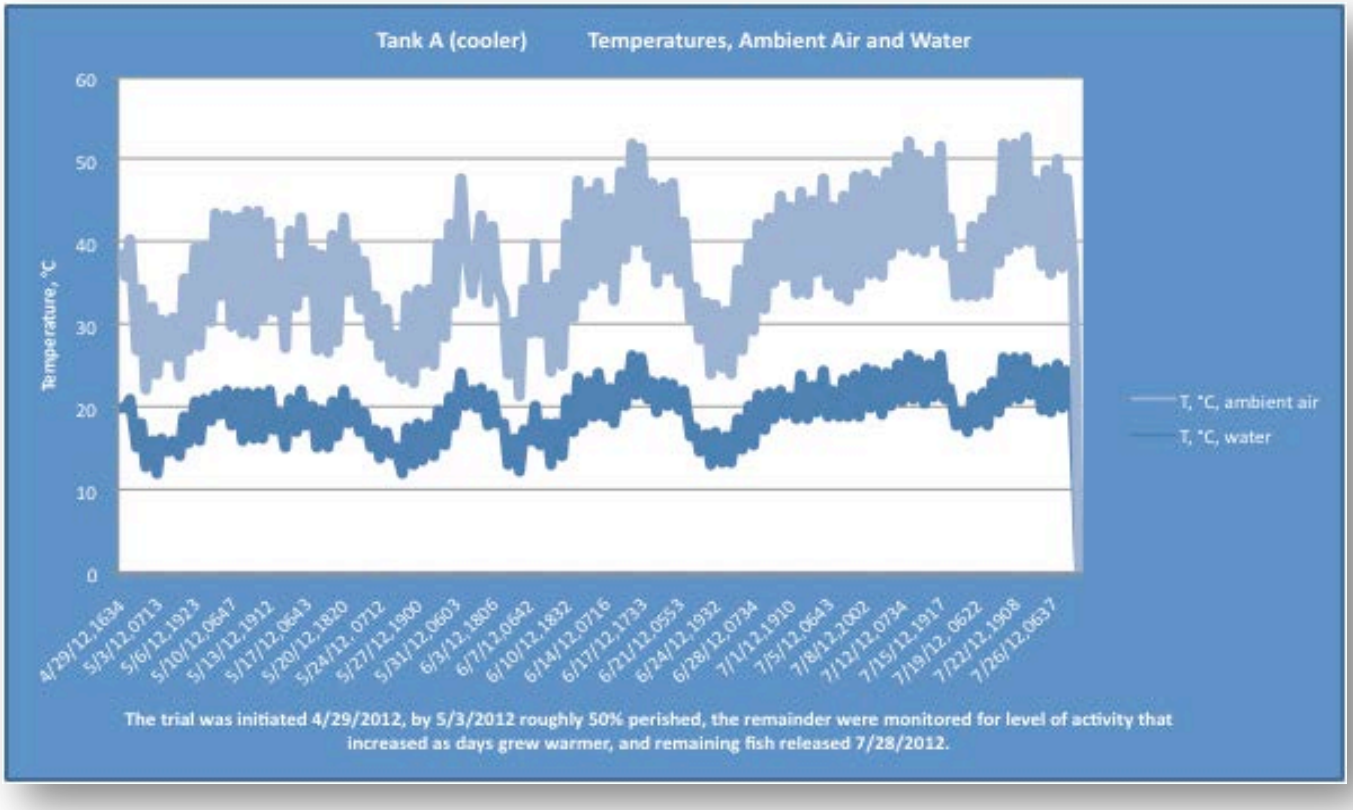
Note: On 6.22.12 at 0617, 4 fish were seen, rather quiet and at the bottom level. This behavior had been observed in Tank B on 5.11.12, when its tank environment appeared to have approached an inhospitable environment, and all larvae perished. Therefore at 1819, aquatic insects and surface algae were removed from Tank A and fresh water was introduced. In the following days the tank environment appeared to stabilize.

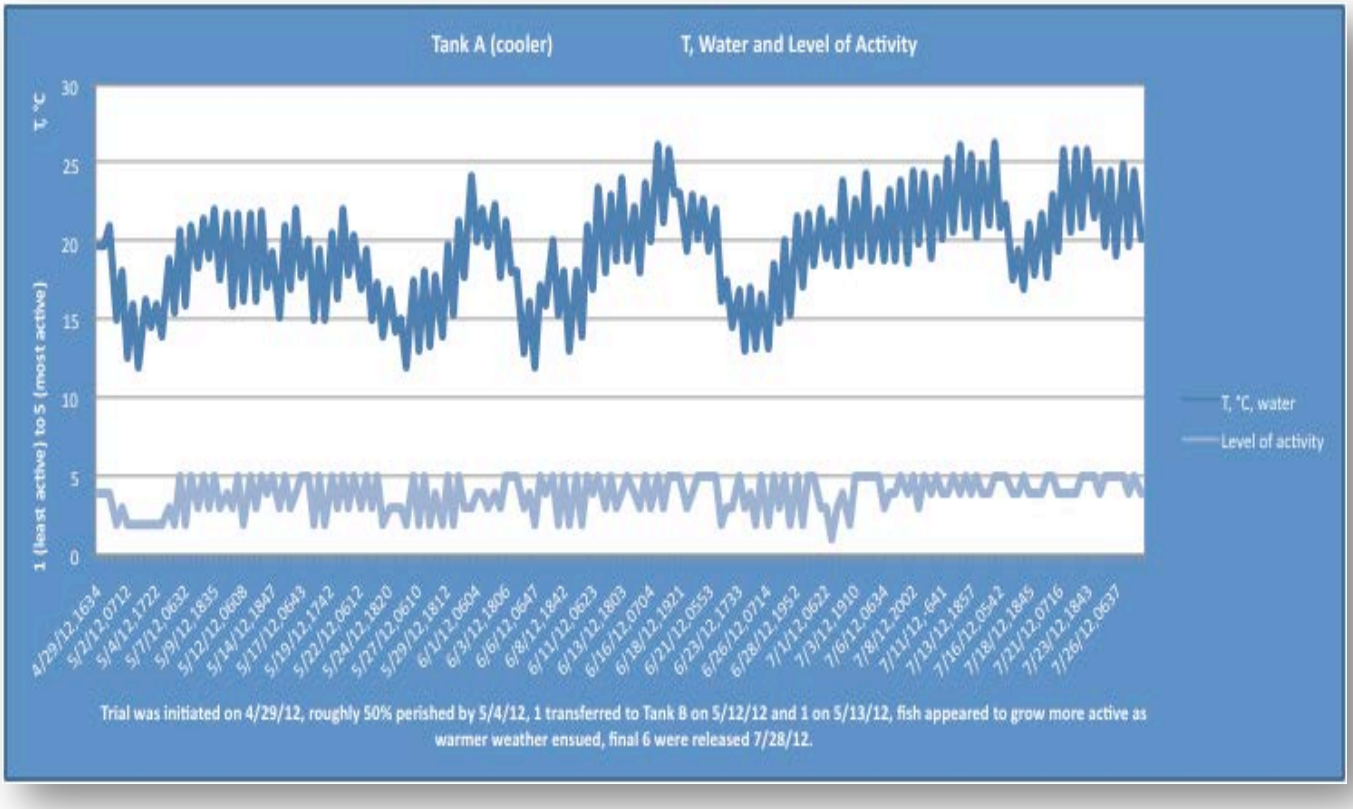
By 7.4.12, 6 fish continued to grow and appeared increasingly less affected by variations in temperature. Those 6 were released on 7.28.12.

During the study, hitch larvae were easily visible in tank A, where there were aquatic plants primarily from a shoreline of Rodman Slough, snails, various algae, copepods, small crustaceans, various aquatic insects, various nematodes, snails and a tadpole.



Tank A
Image from 5.2.2012

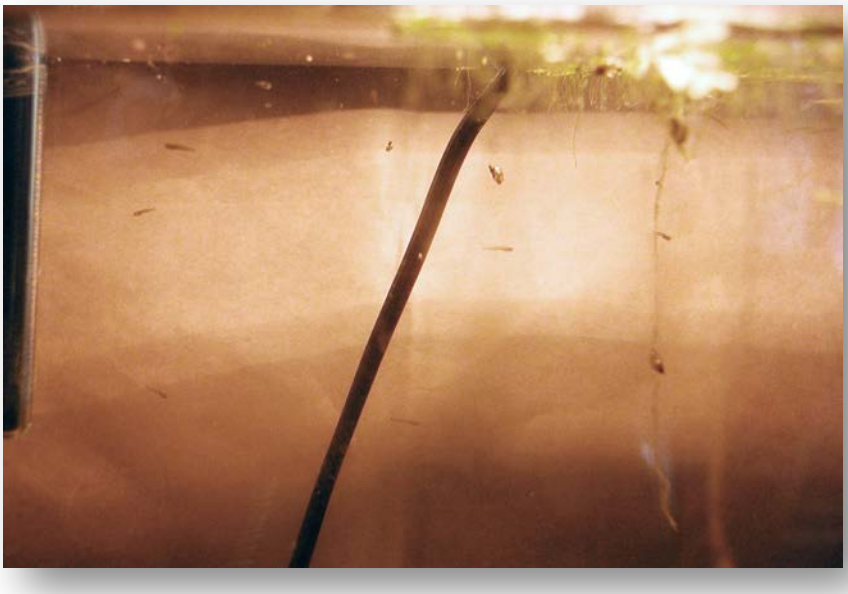

Tank A (cooler) Temperatures, Ambient Air and Water
Temperature, °C
60
50
40
30
20
10
0
4/29/12,1634
5/3/12,0713
5/6/12,1923
5/10/12,0647
5/13/12,1912
5/17/12,0643
5/20/12,1820
5/24/12, 0712
5/27/12,1900
5/31/12,0603
6/3/12,1806
6/7/12,0642
6/10/12,1832
6/14/12,0716
6/17/12,1733
6/21/12,0553
6/24/12,1932
6/28/12,0734
7/1/12,1910
7/5/12,0643
7/8/12,2002
7/12/12,0734
7/15/12,1917
7/19/12, 0622
7/22/12,1908
7/26/12,0637
T, °C, ambient air
T, °C, water
The trial was initiated 4/29/2012, by 5/3/2012 roughly 50% perished, the remainder were monitored for level of activity that increased as days grew warmer, and remaining fish released 7/28/2012.


Tank A (cooler) T, Water and Level of Activity
T, °C
1 (least active) to 5 (most active)
30
25
20
15
10
5
0
4/29/12,1634
5/2/12,0712
5/4/12,1722
5/7/12,0632
5/9/12,1835
5/12/12,0608
5/14/12,1847
5/17/12,0643
5/19/12,1742
5/22/12,0612
5/24/12,1820
5/27/12,0610
5/29/12,1812
6/1/12,0604
6/3/12,1806
6/6/12,0647
6/8/12,1842
6/11/12,0623
6/13/12,1803
6/16/12,0704
6/18/12,1921
6/21/12,0553
6/23/12,1733
6/26/12,0714
6/28/12,1932
7/1/12,0622
7/3/12,1910
7/6/12,0634
7/8/12,2002
7/11/12, 641
7/13/12,1857
7/16/12,0542
7/18/12,1845
7/21/12,0716
7/23/12,1843
7/26/12,0637
T, °C, water
Level of activity
Trial was initiated on 4/29/12, roughly 50% perished by 5/4/12, 1 transferred to Tank B on 5/12/12 and 1 on 5/13/12, fish appeared to grow more active as warmer weather ensued, final 6 were released 7/28/12.

Tank B (warmer): Approximately 20 individuals appeared to be immediately active and moving easily at all levels of the water column during daytime, and near the water's surface in early morning.

As in Tank A, Tank B contained hitch larvae, aquatic plants of the same mix and quantity as Tank A, various algae, copepods, small crustaceans, various aquatic insects, various nematodes, snails and introduced tadpoles (see below).

- On 5.10.12 at 1815, 14 were observed swimming actively, mostly in the top level of the water column.
- On 5.11.12 at 1844, 3 were observed at the bottom level. Carcasses were not seen.
- On 5.12.12 at 1747, no fish were observed. 1 individual from Tank A (cooler) was introduced.
- On 5.13.12 at 0712, no fish were observed although daphnia were seen. At 1912 1 individual from Tank A was introduced. In case the process of what was failing in Tank A could be stopped or reversed, the heating unit was unplugged.
- On 5.14.12 at 1847, 1 tadpole that had been healthy and growing in Tank A was introduced.
- On 5.15.12 at 0612, neither fish nor tadpole could be found and no carcasses were seen. At 1454 about 10 tadpoles, 1-1.5 cm., from Middle Creek were introduced. Some stayed at the top level of the water column, and some swam freely. At 1713, they were near the surface, some were still, but others were swimming.
- On 5.16.12 at 0612, all tadpoles had perished, and 4 carcasses were seen. At 1844, there were no fish and no tadpoles, only immature daphnia, snails, and decaying vegetation.
- From 5.17.12 on, snails and aquatic plants were monitored. Daphnia were not found. Water was fairly clear, similar to Tank A.
- On 5.29.12 at 0608, there were no snails, increased detritus, and decaying plants, although surface algae appeared healthy. Tank B was emptied at 1615.



Tank B
Image from 5.2.2012

Tank A,
5.15.2012

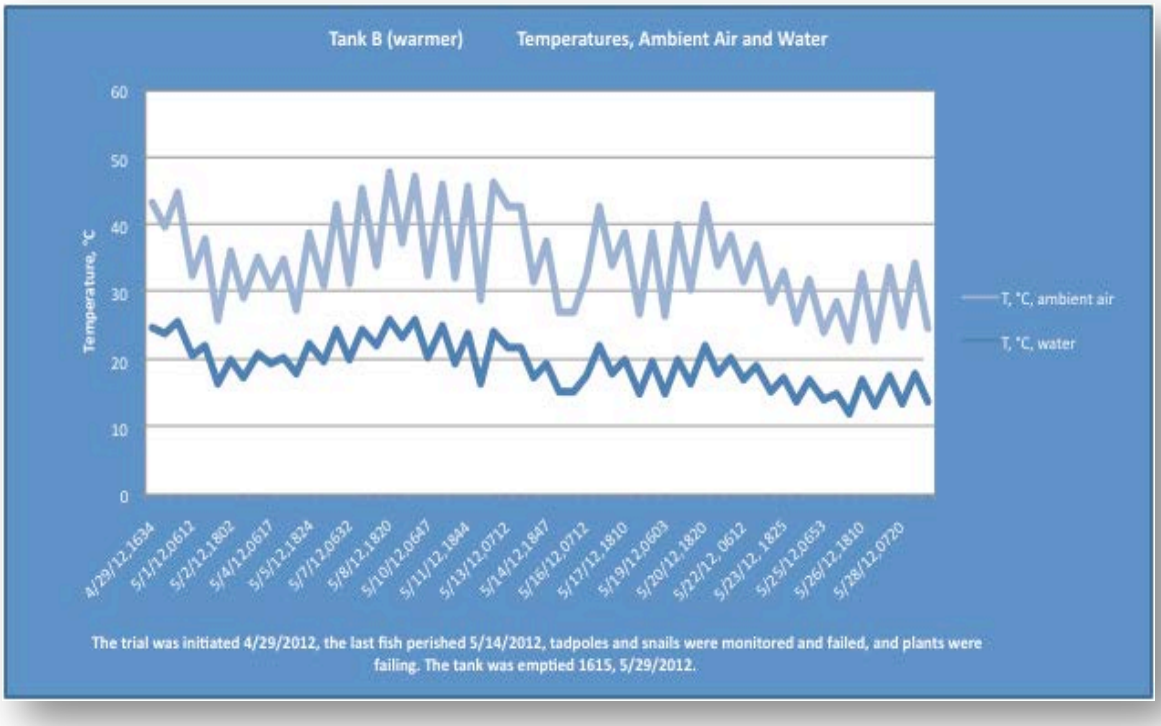
1 juvenile hitch
Free floating algae
(Fam. Azollaceae)

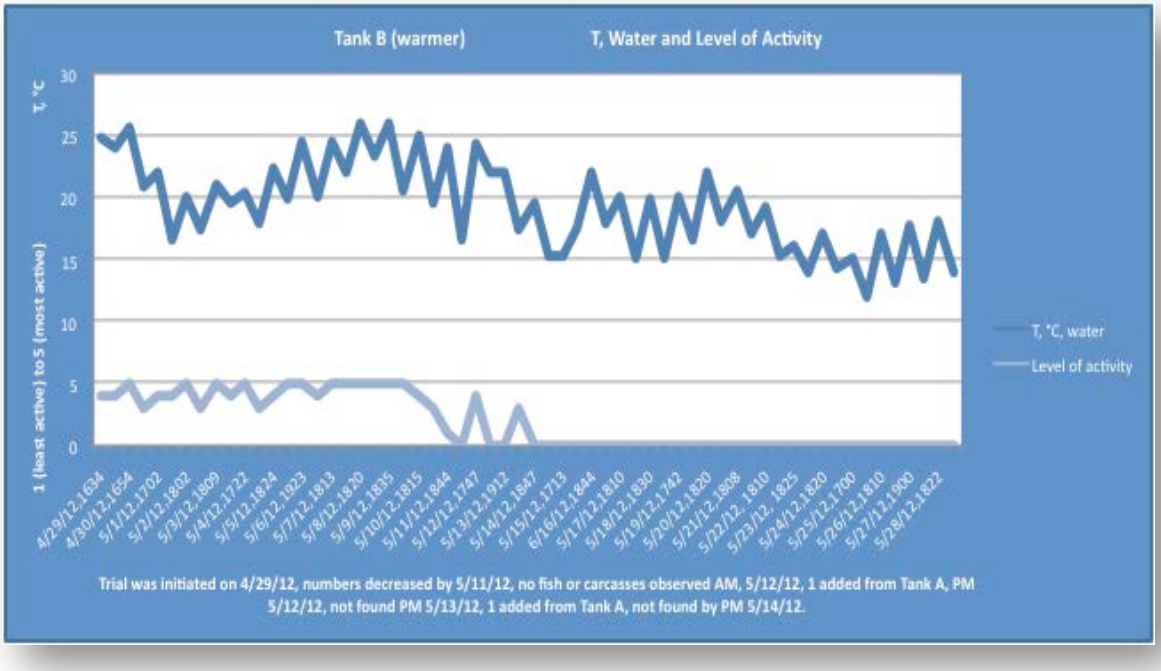
Tank B,
5.11.2012

1 hitch seen;
Deteriorating plant
matter

Tank B,
5.15.2012

Introduced tadpoles
near or at surface


Tank B (warmer)
Temperatures, Ambient Air and Water
Temperature, °C
60
50
40
30
20
10
0
4/29/12,1634
5/1/12,0612
5/2/12,1802
5/4/12,0617
5/5/12,1824
5/7/12,0632
5/8/12,1820
5/10/12,0647
5/11/12,1844
5/13/12,0712
5/14/12,1847
5/16/12,0712
5/17/12,1810
5/19/12,0603
5/20/12,1820
5/22/12, 0612
5/23/12, 1825
5/25/12,0653
5/26/12,1810
5/28/12,0720
T, °C, ambient air
T, °C, water
The trial was initiated 4/29/2012, the last fish perished 5/14/2012, tadpoles and snails were monitored and failed, and plants were failing. The tank was emptied 1615, 5/29/2012.


Tank B (warmer)
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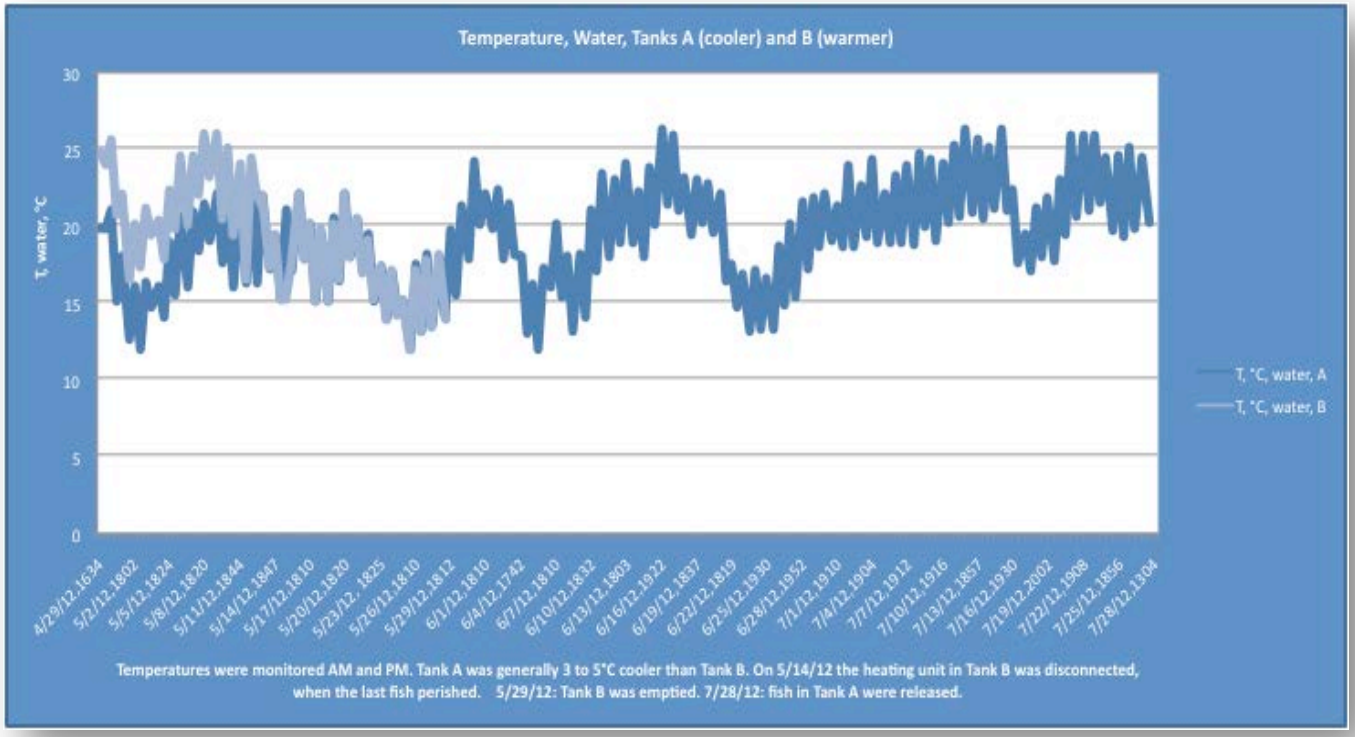
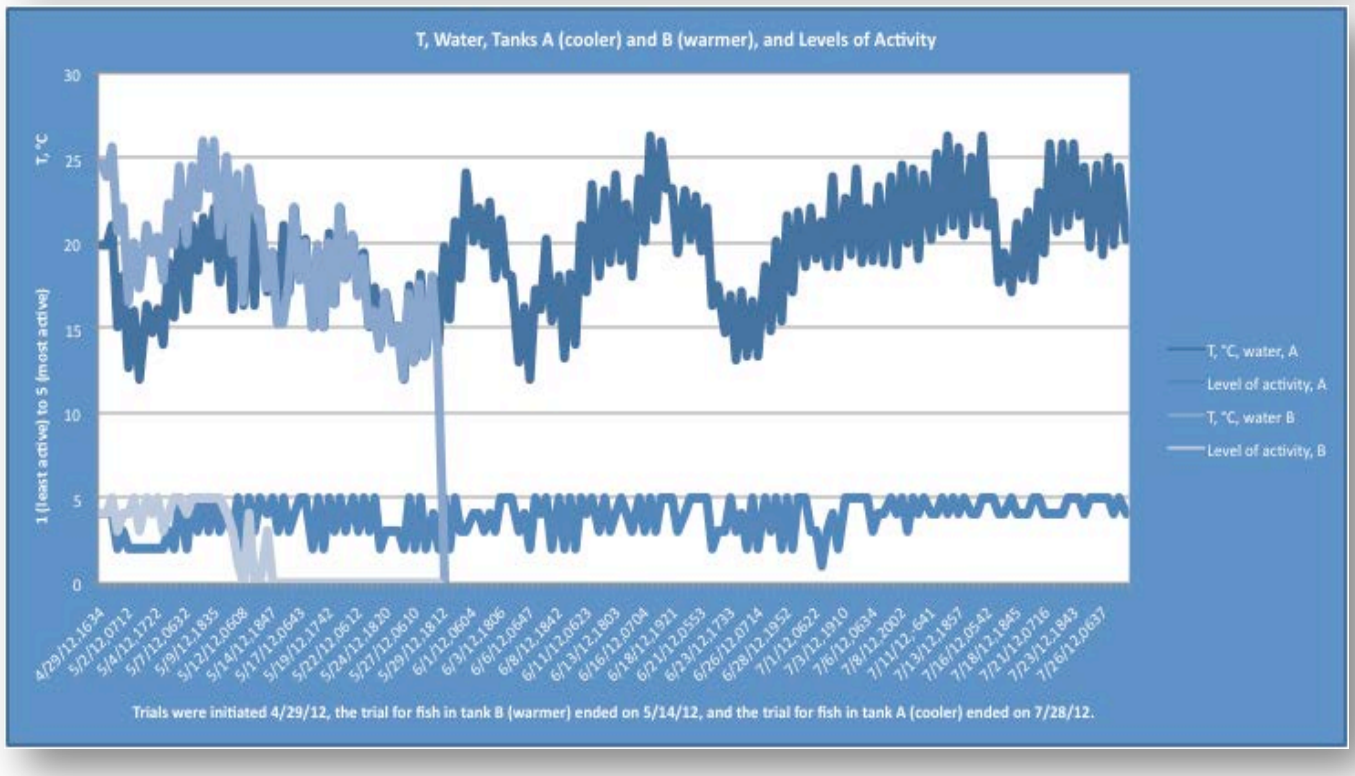
4/29/12,1634
4/30/12,1654
5/1/12,1702
5/2/12,1802
5/3/12,1809
5/4/12,1722
5/5/12,1824
5/6/12,1923
5/7/12,1813
5/8/12,1820
5/9/12,1835
5/10/12,1815
5/11/12,1844
5/12/12,1747
5/13/12,1912
5/14/12,1847
5/15/12,1713
6/16/12,1844
5/17/12,1810
5/18/12,1830
5/19/12,1742
5/20/12,1820
5/21/12,1808
5/22/12, 1810
5/23/12, 1825
5/24/12,1820
5/25/12,1700
5/26/12,1810
5/27/12,1900
5/28/12,1822
T, °C, water
Level of activity
Trial was initiated on 4/29/12, numbers decreased by 5/11/12, no fish or carcasses observed AM, 5/12/12, 1 added from Tank A, PM 5/12/12, not found PM 5/13/12, 1 added from Tank A, not found by PM 5/14/12.

Comparisons of Tanks A and B show distinct, consistent differences in temperature, in survival and in related levels of activity, remembering that on 5.13.12 the heating unit was disconnected in Tank B when fish perished, after which tadpoles, then snails, and then plants were monitored to help evaluate that environment.





Discussion

Roughly ½ of larval hitch introduced into Tank A (cooler) perished within a few days of temperatures that hovered around 15°C and lower, after which temperatures were generally greater than 15°C, and the remaining population appeared to stabilize. As the survivors in Tank A grew and developed, they appeared better able to tolerate instances of both cold and heat. Their level of activity reflected some stability even with elevations and dips in temperature. Fish developed distinct heads, refined eyes, opercular plates, distinct fins, and more easily seen decurved lateral lines. They eventually lost, or mostly lost, patterning that faded to a silver-tan with a dark spot at the base of the caudal fin.

Larval hitch introduced into Tank B (warmer) were active and appeared healthy for about 12 days, when they became sluggish and disappeared literally overnight. Any balanced environment that would encourage growth and development of larval hitch apparently failed. Subsequent introductions of 2 fish, one at a time, of 1 tadpole, then of about 10 tadpoles, indicated that the aquatic environment was unable to sustain them, because each individual and each group perished within the first 24 hours. The heating unit had been disconnected after the introduction of the second hitch in case a cooler temperature would help, but apparently that did not stop whatever process was occurring. Only a few larger tadpole carcasses were ever found. Eventually snails in Tank B failed as well. A month after the trial began, plant life that had not already decayed was in a state of decay.

Causes other than sustained warmer temperatures were not identified. Extensive sampling and microscopy might have helped to identify specific reasons other than general deterioration of habitat, but fish and other life perished. An ecological equilibrium in Tank B might have been more fragile than anticipated and a threshold of some kind reached, leaving Tank B unable to support aquatic animals and plants. But that is conjecture, and only implications can be suggested.

Both tanks had water from the same places, and any water added was added to each in equal amounts, from the same source.

In summary, Tank A appeared to maintain an equilibrium with a variety of plant and animal life that supported developing larval hitch as they grew, after spring temperatures edged into warmer temperatures of late spring and summer. Because it had a small heating unit, Tank B was warmer during spring days and initially accommodated plant and animal life. At first fish were more active there, but water became less clear, plants began to deteriorate, and both snails and fish began to congregate near the water's surface. Tank B developed a environment that was hostile to the larval fish and that was unable to stabilize or to support even snails and plant life. Each tank supported microbial life, small crustaceans, nematodes, snails, plants, occasional small aquatic insects, and more that were not visible to the naked eye, although tiny fish were observed feeding on what couldn't be seen. Those lived on in Tank A, but what had been seen, perished in Tank B.

Implications for hitch in a natural environment are that they survive as developing larvae in temperatures that are generally greater than 15°C. As they grow, they appear better able to tolerate cooler and warmer temperatures over temporary intervals of time. If larvae are confined to a single, small area with temperatures that can exceed 25°C on occasion and are consistently ± 20°C, they appear active, but an equilibrium of some kind within their aquatic environment might fail in a relatively short time, as happened in 11 to 12 days in Tank B. A similar environment in the natural world would probably not support their survival.

Results of this project imply that as larvae and very young developing fish, Clear Lake hitch are sensitive to temperatures that remain at 15°C or lower. Also, changes in their immediate environment, possibly resulting from extended warmer temperatures, might

result in their inability to survive when confined to a small space such as pooling in streams. This is in addition to the obvious: when streams pool, there is neither stream habitat for larvae to develop and grow, nor fish passage for larvae or young juveniles to return to slough and lakeshore environments. Further implications are hitch appear to develop and grow in fairly defined niches created and controlled by climate and rainfall in the Clear Lake basin and by anthropogenic influences.

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- Supplement 1: Summary of Tasks and Findings, 2009 and 2010
- Supplement 3: Trials 1 and 2, Egg Incubation, Spring 2011
- Supplement 4: Trial 3, Review of Larval and Juvenile Growth, Spring 2011
- Supplement 5: Observations 2011 and Counts 2006--2011

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