Crater Lake National Park

Science and Learning Center Student Fellowship 2015

Tyler Dearman

Survey of Adult Long-Toed Salamanders (*Ambystoma macrodactylum*) Inside the Crater Lake Caldera

Introduction

Observations about the geology, flora, and fauna of the Crater Lake area have been occurring since long before the formation of the National Park in 1902. Human interaction in this area has been traced as far back as the eruption of Mt. Mazama. With the arrival of white settlers to the area in the 1800s, the park presented an early opportunity for these people to conduct research in this unique environment. This careful examination of the area continues to this date, continuously presenting researchers with new opportunities to learn about the interactions taking place in the natural environment inside the park.

Today some of the interactions observed within the park are a direct result of anthropogenic modification of the ecosystem. One particularly interesting modification has been the introduction of fish species into Crater Lake itself. Documented as first occurring in 1888, the practice of stocking fish in the lake occurred until 1941 (Girdner, 2002). During this period, nearly 2 million fish comprising five species were introduced to Crater Lake; though today only two species persist, rainbow trout (*Oncorhynchus mykiss*) and kokanee salmon (*Oncorhynchus nerka*) (Girdner, 2002). The subsequent introduction of the signal crayfish (*Pacifastacus leniusculus klamathensis*) in 1941 has also been an ecological modification of interest in the park.

Within Crater Lake there are two native salamander species, which coexist within the caldera. These are the Mazama newt (*Taricha granulosa mazamae*), and the Long-toed salamander (*Ambystoma macrodactylum*). Both species have documented observations dating back to the late 19th century. Abundance was first described by B.W. Evermann in 1896, and study of both species has been ongoing. Much of the research, however, has been focused on the Mazama newt, and there had been no recent systematic survey of the long-toed salamander within the Crater Lake caldera since the mid-20th century.

This project was implemented to fill the information gap, and systematically survey Long-toed salamanders within the Crater Lake Caldera. Particularly of interest was a historical comparison of abundance, as park naturalists had described a wealth of observed specimens in the early 20th century. (Farner and Keezer, 1953). With the introduction of potential prey species as mentioned above, and the current research being conducted regarding the relationship between these species and the Mazama newt, this project helped examine the poorly understood

relationship between these species and the long-toed salamander. Particularly this study examined the impact of crayfish on the long-toed salamander distribution and compared present distribution to historical observations from early 20th century naturalists such as Farner and Keezer, 1953; Campbell, 1929; Evermann, 1896; Farner; 1946, Funkhouser, 1949; Heath, 1938; Slevin, 1928; and Vincent, 1947.

Methods

Site Selection

Sites were selected for two main criteria: historical observations and known crayfish prevalence. Long-toed salamanders were described historically to persist at Red Cloud Cliff (Cloudcap Bay), Eagle Cove, and Wizard Island (Evermann, 1896). Therefore, these sites were reexamined during this survey. Additional sites were selected to determine the edges of Long-toed salamander distribution, and in areas of known crayfish habitation. A list of all survey locations is included in the Appendix (A-1).

Survey Methodology

Surveys were timed in order to create a rate of capture (number of individuals found/time). Based on information obtained from Farner & Keezer (1953), our surveys focused on the area between one and two meters from the water's edge. In these areas rocks were overturned, with particular attention being given to areas where moisture was found under rocks. Long-toed salamanders found were then collected and placed in a bucket with water. Once the timed survey was complete these specimens were examined. Individuals were weighed and measured (snout-vent, snout-tail). Additionally, a DNA sample was taken to augment concurring research being done on the species to determine genetic variation between caldera collected samples and those found elsewhere in the park. This sample was obtained by taking a small tissue sample from the tail. Once sampling was complete specimens were released back into the survey area.

Results

Data regarding seasonal crayfish surveys was provided by Crater Lake National Park researchers Scott Girdner, Mark Buktenica, and David Hering. This data was used to compare Long-toed salamander habitat to the known distribution of crayfish within the Crater Lake caldera. We found that in known crayfish sites Long-toed salamanders were not observed, and vice-versa (Figure 1).

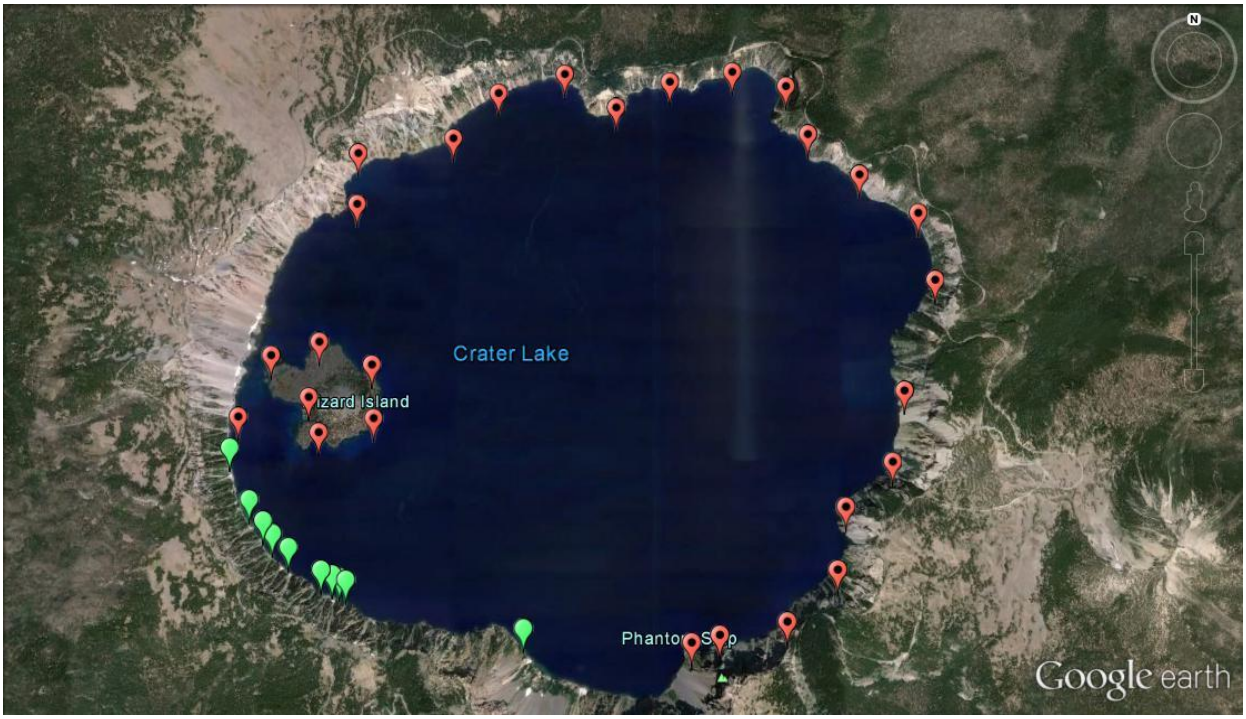

Figure 1 - Red Markers represent crayfish observed in 2015, Green Markers represent Long-Toed Salamanders found in 2015

It was also observed that capture rate of crayfish declined in areas near the edges of salamander observations.

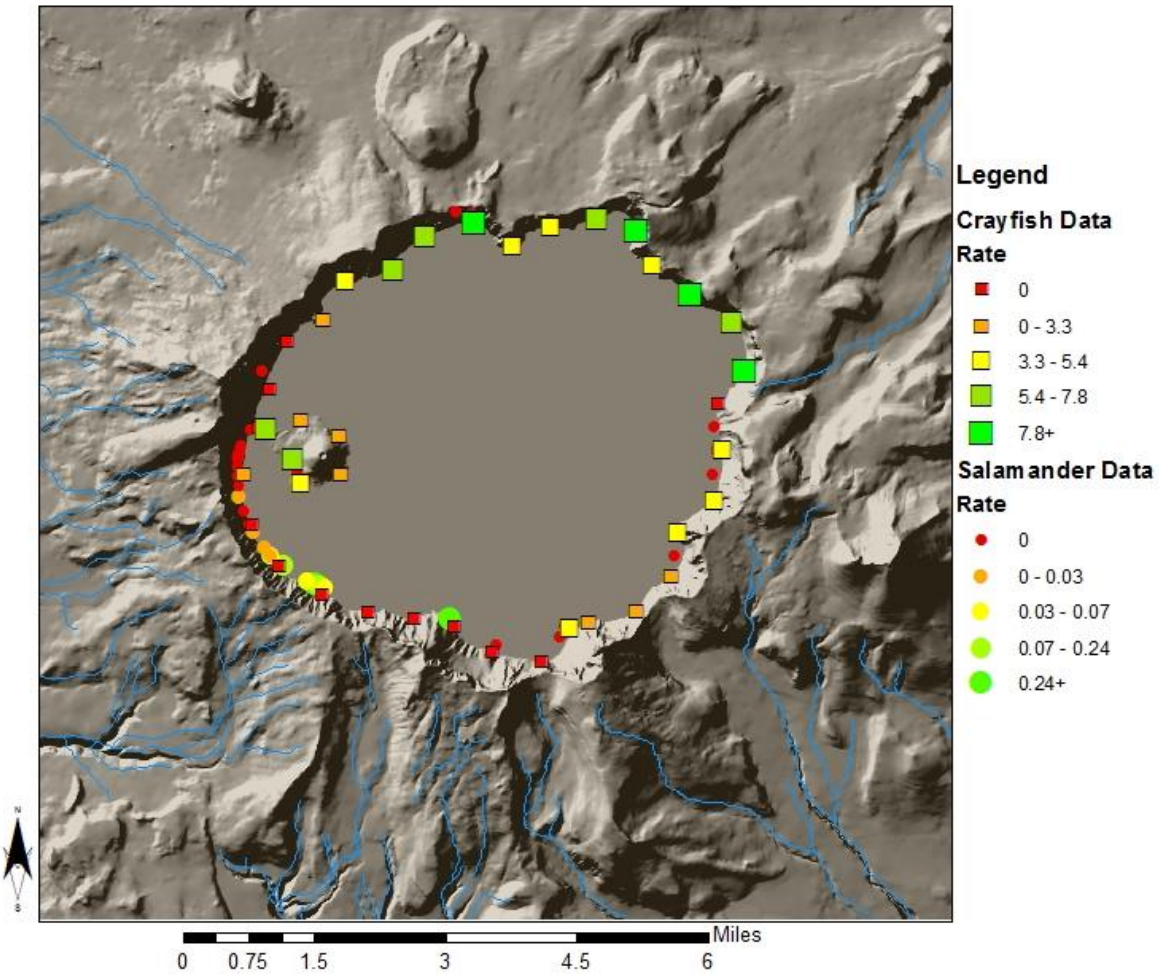

Figure 2 - Capture Rate (Individuals/Time in minutes) of both Salamanders and Crayfish

Comparing the results from this study to historical documents, Long-toed salamanders may have decreased in range. Traditionally found at Red Cloud Cliff (Cloudcap Bay), Eagle Cove, and Wizard Island, individuals were only observed in the areas surrounding Eagle Cove during this survey; Wizard Island and Cloudcap Bay are now known habitat for crayfish. Based on our observations, Long-toed salamanders were constrained to the Southwest corner of the caldera. Despite a small range, density was quite high, with a capture rate as high as 0.6 (25 specimens found in 14 minutes). In many of these high density areas, many more specimens could have been collected had the time at the site been extended.

Size and weight measurements are included in the Appendix (A-2), and are summarized in Figure 3 below.

	Snout-Vent Length (mm)	Snout-Tail Length (mm)	Weight (g)
Samples Measured	46	46	46
Mean	51.73913043	98.5	3.297826087
Standard Deviation	4.814029417	11.08903362	0.845770952

Figure 3 - Summary Measurements of Collected Specimens

Size and weight data did not show variation between sites, and appeared to show a healthy distribution of different sizes and weights of the individuals captured.

Discussion

Based on the observational data obtained during this survey it appears that the Long-toed salamander may exhibit risk factors brought on by encroachment of invasive species. Comparing past and present survey notes, it appears that the species' range is in decline within the Crater Lake caldera. With the lack of salamanders found on Wizard Island and at Cloudcap Bay (though historically found at these sites), and the abundance of crayfish found in these locales, it can be suggested that these are correlating factors. A view of the distribution data of both species seems to show that the two species do not cohabitate within the caldera. Further studies empirically documenting a predator/prey relationship could provide causation to this phenomenon. Paired with more robust abundance data built from mark-recapture studies of both species, a Lotke-Volterra model could be built to predict the impact of this relationship moving forward.

It may also be safe to assume that within this range, abundance may have also decreased over the past one hundred and twenty years since first catalogued by Evermann (1896). During his surveys he described the Long-toed salamander to be "exceedingly abundant," and that "[m]ore than a hundred specimens were collected and many more could have been obtained . . . Sometimes as many as a dozen or fifteen were found under a single flat stone" (Evermann, 1896). The recent survey in the summer of 2015 seemed to lack this level of abundance. A high density of individuals found under a single large flat rock was four or five individuals and perhaps one or two Mazama Newts (*Taricha granulosa mazamae*).

Though not empirical, this data is highly suggestive, and offers the opportunity for further research and tracking of the habitat of the species. By conducting annual or biennial studies using this survey as a template, researchers could observe trends in changing habitats of the Long-toed salamander. By creating a more robust data set, evidence could be obtained to help decision-makers manage invasive species within the caldera and, if deemed necessary, develop and implement protective measures for the Long-toed salamander.

Acknowledgements

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Appendix

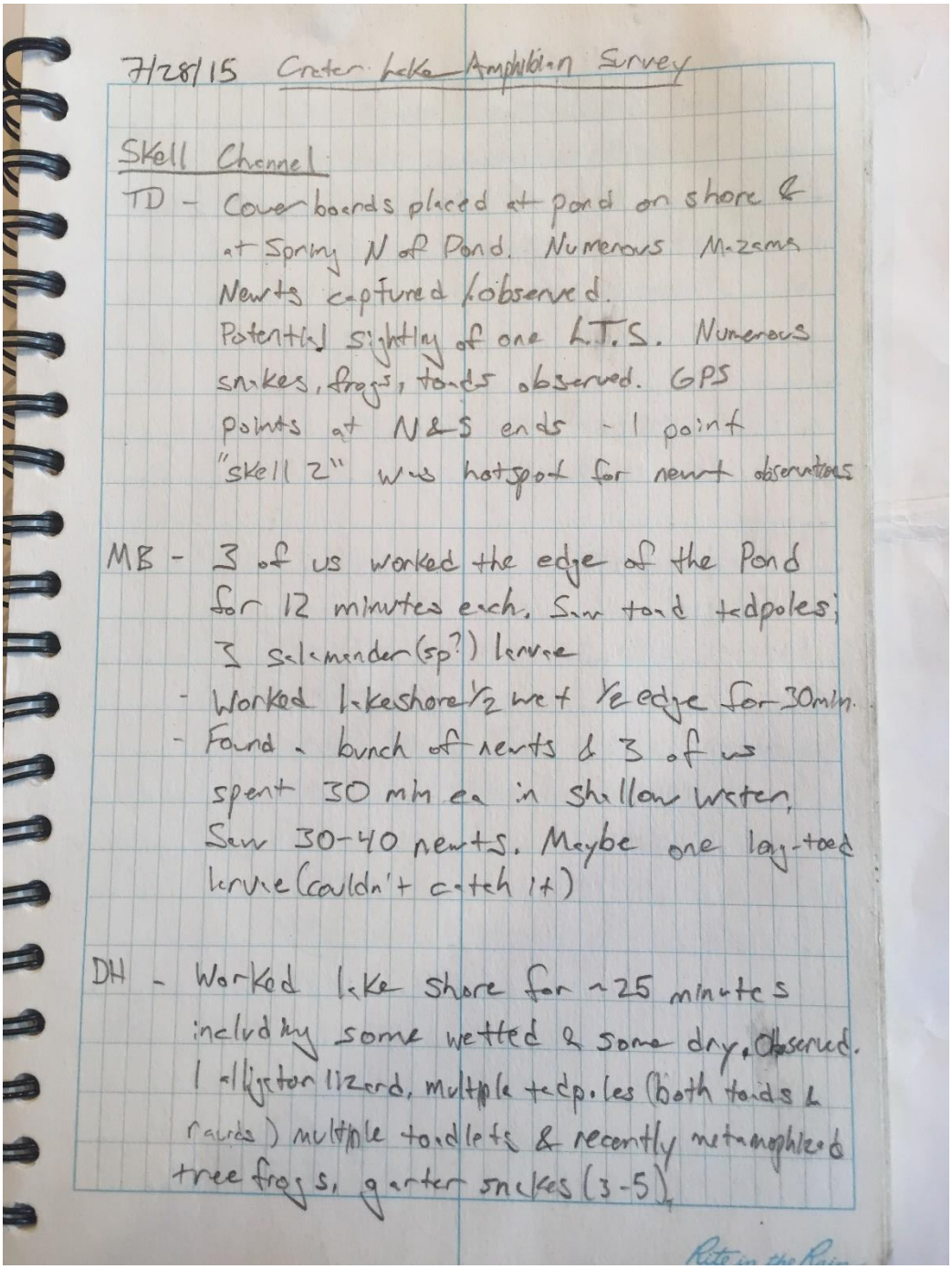
A-1 (Site Locations and Rate of Capture)

Site Name - Abbreviated	Number LTS Found	Time Searched	Number of Surveyors	Rate	UTM ZN 10T	
					LOC X	LOC Y
Chaski 1	17	8	4	0.53125	572122	4751175
Cloudcp-1	0	10	3	0	576982	4754721
Cloudcp-2	0	20	3	0	577021	4754333
Coudcp-3	0	20	3	0	577026	4754248
Cloudcp-4	0	10	3	0	576952	4753859
Eagle 1	22	30	3	0.244444444	569714	4751804
Eagle Re	25	14	3	0.595238095	569619	4751836
Eagle 3	7	25	4	0.07	569797	4751771
EPHNTM 1	0	10	3	0	576243	4752354
NEDGE	0	12	3	0	568387	4752954
PHTM-1	0	10	1	0	574225	4751069
PHTM-2	0	10	1	0	574122	4750874
S Skell Pd	1	15	2	0.033333333	568227	4753454
SK SP-1	0	30	2	0	568190	4754004
SK SP-2	0	30	2	0	568199	4754188
SK SP-3	0	30	2	0	568229	4754245
SK SP-4	0	30	2	0	568252	4754390
SKELL 1	0	12	3	0	568196	4753833
SKELL 2	0	25	3	0	568214	4753649
SKELL SP48	0	10	2	0	568194	4754136
SK SP-5	0	25	2	0	568425	4754669
SK SP-6	0	15	2	0	568633	4755752
Snowcave	0	10	3	0	572978	4750711
Steel E	0	15	3	0	572506	4758649
Steel W	0	15	3	0	572215	4758666
Wizard Is	0	8	3	0	569298	4753896
Eagle 4	5	23	3	0.072463768	568816	4752352
Eagle 5	0	30	2	0	568304	4753176
Eagle 6	2	10	4	0.05	569469	4751894
Eagle 7	14	15	4	0.233333333	569033	4752178
Eagle 8	2	23	4	0.02173913	568816	4752352
Eagle 9	1	13	4	0.019230769	568685	4752515
Eagle 10	1	17	4	0.014705882	568493	4752785
Eagle 11	0	20	2	0	568304	4753176

A-2 (Length and Weight Measurements)

Sample Number	Snout-Vent Length (mm)	Snout-Tail Length (mm)	Weight (g)
150728-1	56	105	3.4
150728-2	51	120	4.1
150728-3	51	105	3.2
150728-4	55	110	4.2
150728-5	56	107	4.4
150728-6	50	103	3.5
150728-7	58	111	4.7
150728-8	53	102	4.2
150728-9	60	121	5
150728-10	56	112	4.7
150728-11	49	102	3.7
150728-12	51	102	3.5
150728-13	59	111	4
150728-14	47	81	2.4
150728-15	46	92	3
150728-16	55	105	4
150728-17	51	105	3.7
150728-18	54	101	3.6
150728-19	61	116	4.9
150728-20	57	106	4.2
150728-21	55	115	3.5
150728-22	43	85	2.4
150729-1	47	88	2.6
150729-2	53	96	3
150729-3	46	86	3
150729-4	44	78	1.9
150729-5	57	98	3.9
150729-6	48	87	2.4
150729-7	43	88	2.2
150729-8	47	86	2.5
150729-9	54	99	2.7
150729-10	58	113	4.6
150729-11	50	93	3.3
150729-12	47	88	2.7
150729-13	52	93	3.2
150729-14	51	92	2.3
150729-15	52	95	3
150729-16	54	96	2.9
150729-17	45	86	1.6
150729-18	59	104	3.6
150729-19	53	95	2.9
150729-20	46	84	2.1
150729-21	52	96	2.5
150729-22	55	101	2.7
150729-23	46	96	3.1
150729-24	47	76	2.7
Mean	51.73913043	98.5	3.2978261
Standard Deviation	4.814029417	11.08903362	0.845771

A-3 (Written Notes)



7/28/15 Crater Lake Amphibian Survey

Skell Channel

TD - Coverboards placed at pond on shore & at Spring N of Pond. Numerous Mazama Newts captured/observed. Potential sighting of one L.T.S. Numerous snakes, frogs, toads observed. GPS points at N & S ends - 1 point "Skell 2" was hotspot for newt observations

MB - 3 of us worked the edge of the Pond for 12 minutes each. Saw toad tadpoles; 3 salamander (sp?) larvae
- Worked lakeshore ½ wet ½ edge for 30min.
- Found a bunch of newts & 3 of us spent 30 min ea in shallow water. Saw 30-40 newts. Maybe one lay-toed larvae (couldn't catch it)

DH - Worked lake shore for ~25 minutes including some wetted & some dry. Observed. 1 alligator lizard, multiple tadpoles (both toads & ranids) multiple toadlets & recently metamorphized tree frogs, garter snakes (3-5).

Rite in the Rain

GPS
S Skell Pd

S. of Skell Channel

Pond - cover was much less
Algae was prominent
- lots of tonds/frogs & tadpoles
- 1 minnow near

Steel Bay

TD · Notes: Observed dead/alive cryfish
Lizards (3)
Started gravel center of steel bay beach, worked east & west (GPS marked edges) ~30 min.
· No cover board deployed
· Dry no pools out of water
· overturned rocks - driftwood.

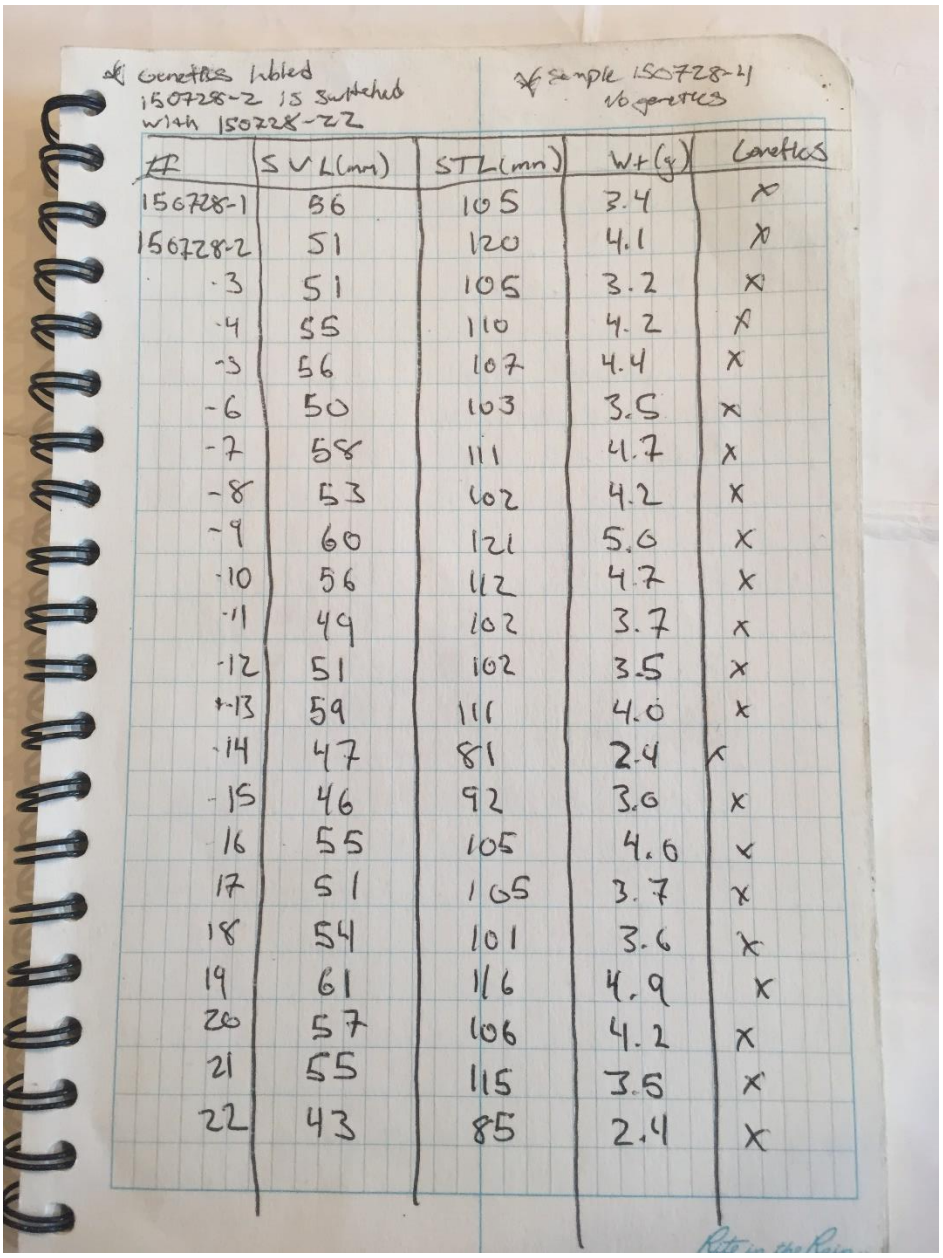
DH - Notes: Walked west along shore, turning over first cobble then larger boulders & flat rocks, also searched driftwood accumulations in gravel beach. Then explored cottonwood stand up ~15m from shore. Most debris was dry, also turned some submerged rocks along shore. Almost every rock had a cryfish. Observed cryfish, lizards (5)

MB Notes - worked upper edge of beach for 20 min along terrestrial edge. Rooted through rotten logs & under rocks.
No Salamanders, 1 unidentified lizard

Eagle Cove.

· Base of dog-leg avalanch chute just W of SPR 42

Notes - Walked along waters edge, overturned rocks out of water but still wet underrock.
30 m/n search time x 3 people ~100' of shoreline.



Genetics labled 150728-2 is switched with 150228-22

Sample 150728-4 no genetics

#	SVL(mm)	STL(mm)	Wt(g)	Genetics
150728-1	56	105	3.4	x
150728-2	51	120	4.1	x
-3	51	105	3.2	x
-4	55	110	4.2	x
-5	56	107	4.4	x
-6	50	103	3.5	x
-7	58	111	4.7	x
-8	53	102	4.2	x
-9	60	121	5.0	x
-10	56	112	4.7	x
-11	49	102	3.7	x
-12	51	102	3.5	x
-13	59	111	4.0	x
-14	47	81	2.4	x
-15	46	92	3.0	x
16	55	105	4.0	x
17	51	105	3.7	x
18	54	101	3.6	x
19	61	116	4.9	x
20	57	106	4.2	x
21	55	115	3.5	x
22	43	85	2.4	x

7/29/15 Temp 16°C

Talus W. of Spring 42

S. Eagle Cove - GPS Eagle Cove 3

- 3 Nests
7 LTS

4 of us sampled 25m/y primarily overturning shore Rocks.

	STL	SVL	Weight	Genetics
150729-1	88	47	2.6	X
150729-2	96	53	3.0	X
" -3	86	46	3.0	X
" -4	78	44	1.9	X
" -5	98	57	3.9	X
" -6	87	48	2.4	X
" -7	88	43	2.2	

Eagle | Cover boards placed at GPS loc Eagle 2

7/29

Chuski GPS Chuski 1.

E of Spring 24

Sample	STL	SVL	Mass	Gonetics
150729-8	86	47	2.5	X
" 9	99	54	2.7	X
10	113	58	4.6	X
11	93	50	3.3	X
12	88	47	2.7	X
13	93	52	3.2	X
14	92	51	2.3	X
15	95	52	3.0	X
16	96	54	2.9	X
17	86	45	1.6	X
18	104	59	3.6	X
19	95	53	2.9	X
20	84	46	2.1	X
21	96	52	2.5	X
22	101	55	2.7	X
23	96	46	3.1	X
24	76	47	2.7	

part of tail previously missing

3 newts observed 17 LT 5

4 of us for 8 minutes

found ~~[illegible]~~ above shoreline. Near Spring

cardboard placed

I found in dry spring channel

No survey in water

Rite in the Rain

Skell N. of Spring 48 Skell SP 98

- Started GPS SKSP-1
  2 of us walked to SKSP-2 30 min
  observed lots of toads / frogs
  tadpoles observed in pond.
  Surveyed lake shore - spring - pond
  No newts / LTS / crayfish.
- Started GPS SKSP-3 → SKSP-4
  Observed swarm of toads in all life stages in pond right off shore
  No LTS / possible Newt larvae
  30 min.
- Crayfish observed SKSP-5
- Toads observed in abundance along heavy rockfall area.
- No LTS observed
- surveyed to GPS SKSP-6

7/30/15

Wizard Island - old Gait boat house

Literature noted - pond behind former boat house. Area that appears to have been pond. holds no water

- cryfish observed
  3 of us searched 10mins

CloudCap Bay

- GPS Cloudcp-1
  - Very large rocks from slide. (1) Garter snake found. No LTS 10min/person
  - Dead Cryfish
- GPS Cloudcp-2 → Cloudcp-3
  Better habitat area than cloudcp-1
  (more gravel under rocks)
  No LTS
  ~ 20-25 cryfish found.
  3 people 20 min.
- GPS Cloudcp-4 (Near spring)
  - Quality habitat (similar to Eagle cove/Chuska)
  - Lots of cryfish (dead & alive)
  - No LTS.

Rite in the Rain

East of Phantom ship GPS EPHNTMSP-1

Good habitat
Cryfish observed
No LTS / Newts

S of Phantom ship GPS PHTM-1 → PHTM-2

Cryfish
Not great habitat — large rocks
~~Several~~ Juvenile fish
2 snakes. NO LTS/Newts

GPS SNOWCAVE

Snow Cave or Snow shoot E of Chuski

No Cryfish
Tadpoles in pool
1 Frog. No LTS/NEWTS

8/27/15

Eagle Cove - Dogleg cut back shoot
- RESURVEY - GPS EAGLE 1, 2, 3

NO LTS under 2 coverboards

Tyler - 21 LTS 4 NEWTS
MARK - 4 LTS 2 NEWTS, 2-3 Terrestrial
KRISTEN - 0 LTS 0 NEWTS

NORTH → BETWEEN COVER BOARDS
SEARCHED 14 MINS - LOWER SLOPE
MORE GRAVEL/cobble

MIDDLE → SEARCHED 14 MINS

SOUTH → NORTH → SOUTH
- GOT STEEPER / BIGGER BOULDERS

Rite in the Rain

NORTH OF POINT

SITE 568816, 4752352

TYLER 10 MIN - 4 LTS
MARK 6 MIN - 1 LTS
KRISTEN 7 MIN - 0 LTS - 1 TREEFROG

LOTS OF TOADLETS

SITE 568304 4753176
TYLER 15 MIN - 0 LTS
MARK 15 MIN - 0 LTS

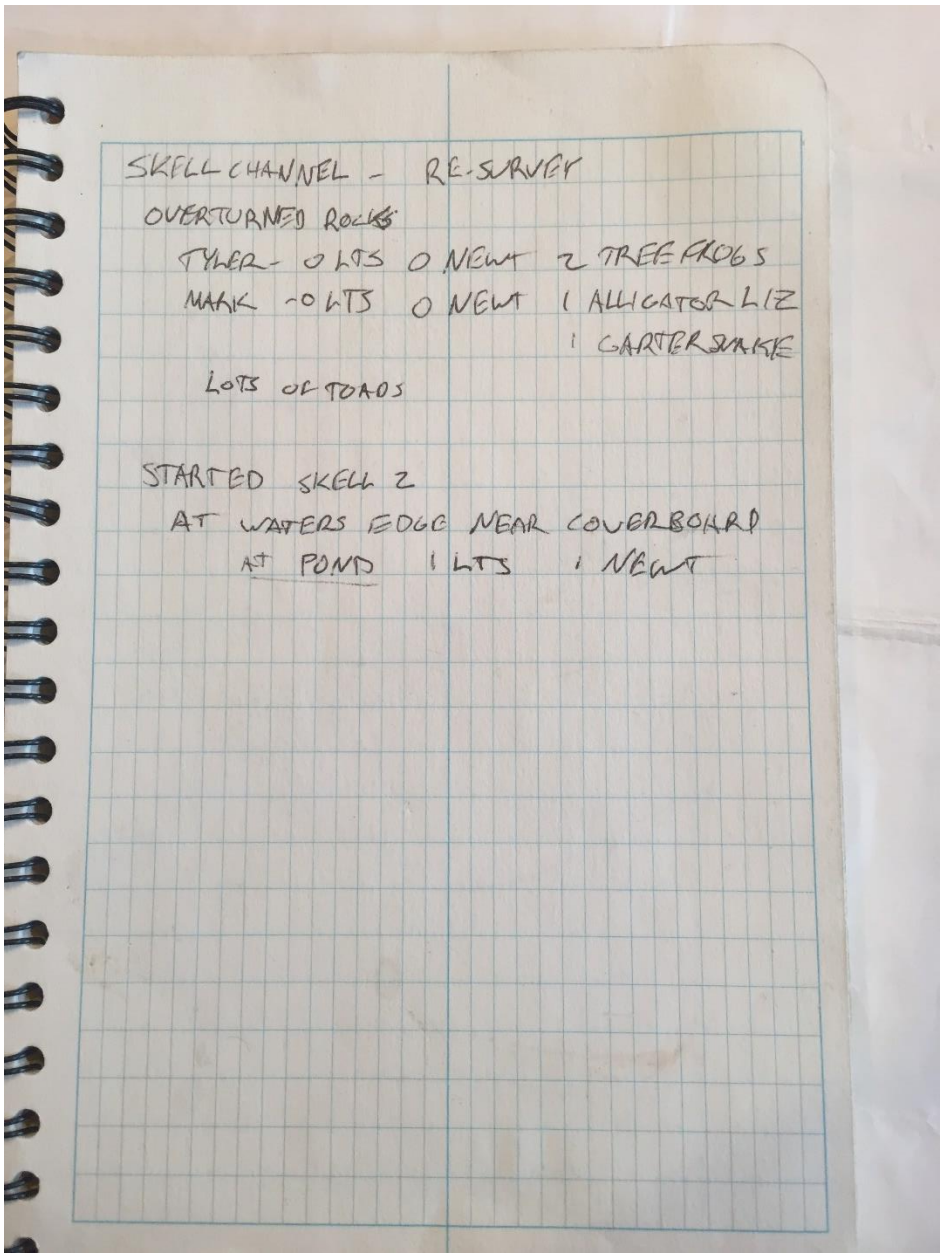
HABITAT LOOKS GOOD - GRAVEL/DAMP UNDER ROCKS

THOUSANDS OF WESTERN TOADS
2 ALLIGATOR LIZARDS
1 TREE FROG

4 GARTER SNAKES

NEDGE SITE
WALKED FROM SITE ↑ TO
568387, 4752954

MARK SAMPLED 6 MIN — 1000+ TOADLETS
GRAVEL SUBSTRATE — 1 ALLIGATOR LIZ
· POSSIBLE BARRIER — 1 TREEFROG
N. OF SITE - LESS GRAVEL - LARGE FLAT ROCKS



SKELL CHANNEL - RE-SURVEY

OVERTURNED ROCKS

TYLER - 0 LTS 0 NEWT 2 TREE FROGS

MARK - 0 LTS 0 NEWT 1 ALLIGATOR LIZ

1 GARTER SNAKE

LOTS OF TOADS

STARTED SKELL 2

AT WATERS EDGE NEAR COVERBOARD

AT POND 1 LTS 1 NEWT

Terrestrial long-toed search 8-5-15

Personnel = Newt-crayfish workshop

2 groups of 4 people each

Site ~~2~~ 569469, 4751894 4 people

- 4 people, 10 mins. : 2 longtoed, 2 toadlets.
- 569033, 4752178 4 people
  longtoed = 14, 15 minutes
  1 larval newt, 1 subadult newt
  more than 20 toadlets
- (260) 568816, 4752352 22 minutes 4 people
  2 longtoed
  3 newts
  2 treefrogs
  1000+ toadlets.
  1 [illegible]
- 566685, 4752515 13 minutes. (four people?)
  0 longtoed
  3 newts (in the water)
  30+ toadlets

(cont.) Terrestrial long-toed search 6-5-15

- 566493, 4752785 4 people 17 min
  - 1 longtoed
  - 0 newts
  - 100+ toedlets

- 566304 4753176. 2 people 20 min
  - 0 longtoed
  - 0 newts
  - 100+ toedlets

(Springfed pond w nothing)

A-4 (Additional Pictures)


Scout Pro
400g
0.0 g
PRINT
Unit
ON/ZERO
Off
OHAUS


PHENIX
RESEARCH PRODUCTS
800.767.0665
PhenixResearch.com
SCS-000R
Red Screw Caps with O-Rings, 500/Bag
WHSE: 001 BIN: G-5-1


WARNING
AVISO
AVERTISSEMENT
ON/ZERO
Off
Scout Pro