

Redwood National Park Annual Report 2018



Response of headwater amphibians to logging impacts and assessing potential for restoration in Redwood National and State Parks

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OBJECTIVES

The objectives of this study are to 1) assess how past logging practices have altered headwater amphibian populations and their habitat in a highly sensitive redwood watershed and, 2) determine if there are remnant source populations of amphibians and stream characteristics that can be prioritized for future restoration efforts.

STUDY SITE

This control-treatment study was conducted in the Redwood National and State Parks (RNSP) in Humboldt County, Northern California (Figure 1). The treatment, Streelow Creek watershed, is a tributary of Prairie Creek and lies within the boundaries of Redwood National Park. Streelow Creek was heavily logged and roaded during the mid- 1940s to early 1960s and remains in a highly degraded state. For this study we chose to specifically survey the North Fork of Streelow Creek because we believed it to be most comparable with the control. However, we will refer to North Fork Streelow Creek as just Streelow Creek throughout the rest of the document for simplicity. The control, Godwood Creek Watershed, lies immediately adjacent to Streelow Creek watershed in Redwood State Park. Godwood Creek is a pristine watershed that is extremely similar to Streelow Creek, aside from logging history, including orientation, stream gradients and channel form, topography, geology and forest species composition.

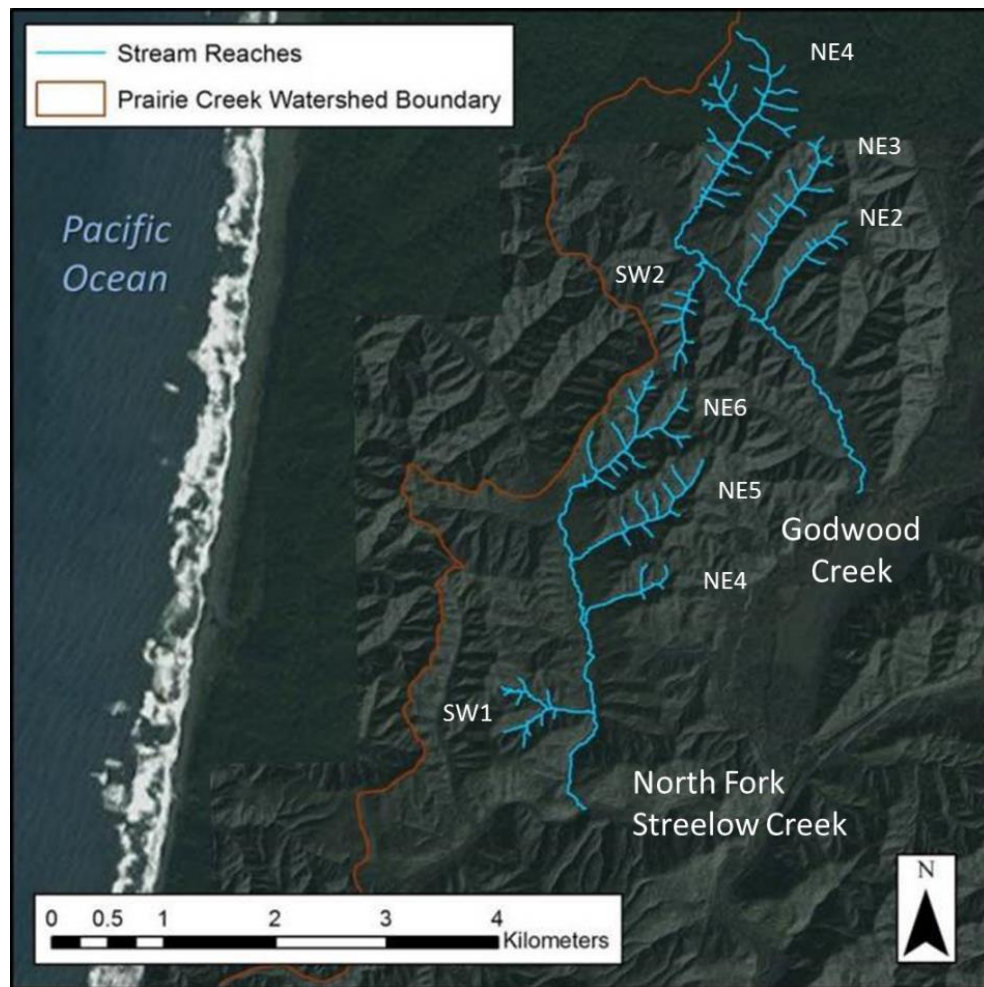


Figure 1. A map of Streeflow Creek (Redwood National Park) and Godwood Creek (Redwood State Park). The four tributaries that were surveyed in each watershed is labeled. The paired tributaries are as follows: NE6-NE4 ; NE5-NE3 ; NE4-NE2 ; SW1-SW2; Streeflow and Godwood tributaries, respectively.

METHODS

2016 Field Season

We chose 4 tributaries in each watershed to survey by pairing tributaries that were similar in drainage size and orientation (Figure 1). The 2 mainstems were delineated into 4 200-meter survey reaches and placed with a stratified-random method. Surveys throughout the tributary and mainstem reaches consisted of 1) mapping, 2) habitat surveys, 3) amphibian surveys, 4) systematic stream samples (SSS), and 5) flow. Survey protocols varied slightly between tributaries and mainstem reaches due to differences in fluvial morphology that resulted in ambiguous pool-riffle sequences.

Mapping

We continuously documented the locations for all mapping variables, recorded as the distance (meters) from the beginning of the reach, throughout the entirety of each mainstem and tributary reach. The mapping variables included 1) proportion of slow-water (SW) and fast-water (FW), 2) proportion of open, buried and subsurface channel, 3) amount and type of large woody debris (LWD) and spanners (SPAN), and 4) the occurrence of LWD jams. The proportion of SW and FW was only documented in mainstem reaches due to the ambiguous pool-riffle delineation in tributary reaches.

Habitat Surveys

In the mainstem reaches, habitat surveys occurred in 3-5 meter (5 m was desired) units that were placed with a stratified random method within SW and FW sections. We defined SW sections as pools, runs, or slack water and FW sections as riffles, cascades or any area where there was noticeable surface disturbance. In the tributaries, survey units were 2-3 meters (3 m was desired) and were placed every 50 meters (regardless of SW or FW). At each habitat sampling unit, which is also the location of the amphibian surveys, we measured the length of the unit and placed start and end flags marked with the distance from the start of the reach. This allowed us to return to the exact location to conduct resurveys and to provide a visual unit-boundary for the surveyor. We took habitat measurements at 3 interval cross-sections placed at $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ along the unit. At each cross-section we measured the wetted width (the representative width of the wetted stream at a specific location), depth, substrate type, and overhanging cover. These measurements were pooled and averaged across cross-sections for analysis. We also recorded the stream gradient within each unit to reflect the site-specific gradient.

Amphibian Surveys

We conducted amphibian surveys in the same units as the habitat surveys. We surveyed for the larval form of the three obligate headwater amphibians that occur in forested watersheds in northern California: the coastal giant salamander (*Dicamptodon tenebrosus*), the coastal tailed frog (*Ascaphus truei*) and the southern torrent salamander (*Rhyacotriton variegatus*). The adult forms of all three species were also encountered and recorded. Surveys for torrent salamanders were specifically conducted in any side seep or spring that was found. We conducted all surveys moving from downstream to upstream to reduce the likelihood of sediment disruption reducing visibility.

We used a light-touch amphibian survey method to reduce the amount of disturbance to the amphibians and their habitat. We recorded the start and end of each survey and the time to detection of each individual caught to the nearest second. We used viewing buckets and aquarium nets to capture the amphibians. We identified all amphibians caught to species, measured their snout-vent length (salamanders) or total length (frogs), and recorded the sex when possible. Animals that were caught were held in a Ziploc bag filled with stream water for the duration of the survey (up to 50 min) to ensure they were not double counted. They were immediately released back into the stream where they were found. We randomly resurveyed 1/3 of the units in each reach in order to account for detection probabilities.

Systematic Stream Sample (SSS)

We also obtained habitat data from the Systematic Stream Samples (SSS) which we utilized to quantify similarities in stream/basin morphology between the logged and unlogged watershed. If the basins proved to be similar, then we could assume any differences in amphibian populations or stream habitat characteristics were not due to differences in the underlying stream/basin morphology. To thoroughly document the stream/basin morphologies we conducted an SSS every 50 meters along mainstem and tributary reaches regardless if the channel was exposed or buried. At each SSS we recorded several measurements including: stream gradient, canopy cover, valley width and slope, and conducted an additional habitat survey. If an SSS survey randomly occurred at a buried section, we would not conduct a habitat survey or record the stream gradient.

Flow

We documented flow at least twice annually within both mainstems and all tributary reaches. We took flow measurements at locations where the channel was the most amenable to accurate recordings. We utilized a float method where we recorded the time it took an object (usually an oxalis leaf) to travel 1-2 meters and repeated this at least three times to obtain an average speed. We also recorded the average depth and wetted width at the same location to enable calculation of flow.

2017 Field Season

To document annual variation in amphibian populations or their associated habitat characteristics we conducted a second field season in 2017. During the months of July to August, we went back to the same study area and randomly surveyed 1/3 of the units surveyed in the 2016 field season. We conducted surveys as reported above in the summer of 2016, but we did not conduct additional SSS. We assumed that variables such as canopy cover, valley width and slope would not change within a year. We also conducted an additional survey, watershed temperature profiling (see next section). To account for detection probability we resurveyed all units in the mainstem reaches.

Watershed Temperature Profiling

We measured stream temperature to nearest 0.1° C during the 2017 field season with iButton temperature loggers. We deployed 24 iButtons throughout the Streelaw Creek and Godwood Creek watersheds to determine if there are still impacts from logging that are affecting the water temperature profiles by comparing the differences in several temperature criteria (e.g., 7-day mean maximum and minimum temperatures, 7-day moving average maximum and minimum temperatures) between watersheds. We left the iButtons in the watersheds for just over a month between 23-July – 2-September. The iButtons are made to be submerged in water, so to waterproof the iButtons we covered all iButtons with 3-layers of Plasti-Dip and placed them in 50-ml Conical Centrifuge Tubes.

RESULTS

During the 2016 field season (May 22 – August 31) we surveyed for headwater amphibians in a total of 236 units with 138 of the units in the tributary reaches (Godwood = 93 units; Streelow = 45 units) and 98 of the units in the mainstem reaches (Godwood = 55; Streelow = 43). To account for detection probability, we conducted resurveys at 39 of the mainstem units. We did not conduct resurveys in the tributary reaches due to the time and effort it would take to return to the units. During the 2017 field season (July 7 – August 9) we surveyed a total of 54 units in the tributary reaches (Godwood = 30 and Streelow = 24) and 32 units in the mainstem reaches (Godwood = 16; Streelow = 16). We resurveyed all 32 units in the mainstem reaches.

We conducted preliminary exploration of amphibian distribution and occupancy using ArcGIS to create distribution maps of the 3 headwater species. From a simple visual assessment there appears to be a difference in amphibian occupancy and distribution between the two watersheds with the most obvious difference seen in the tailed frogs. In Streelow Creek tailed frogs were only found to be present in two survey units within the mainstem (Figure 2) and were not found in any of the four surveyed tributaries.

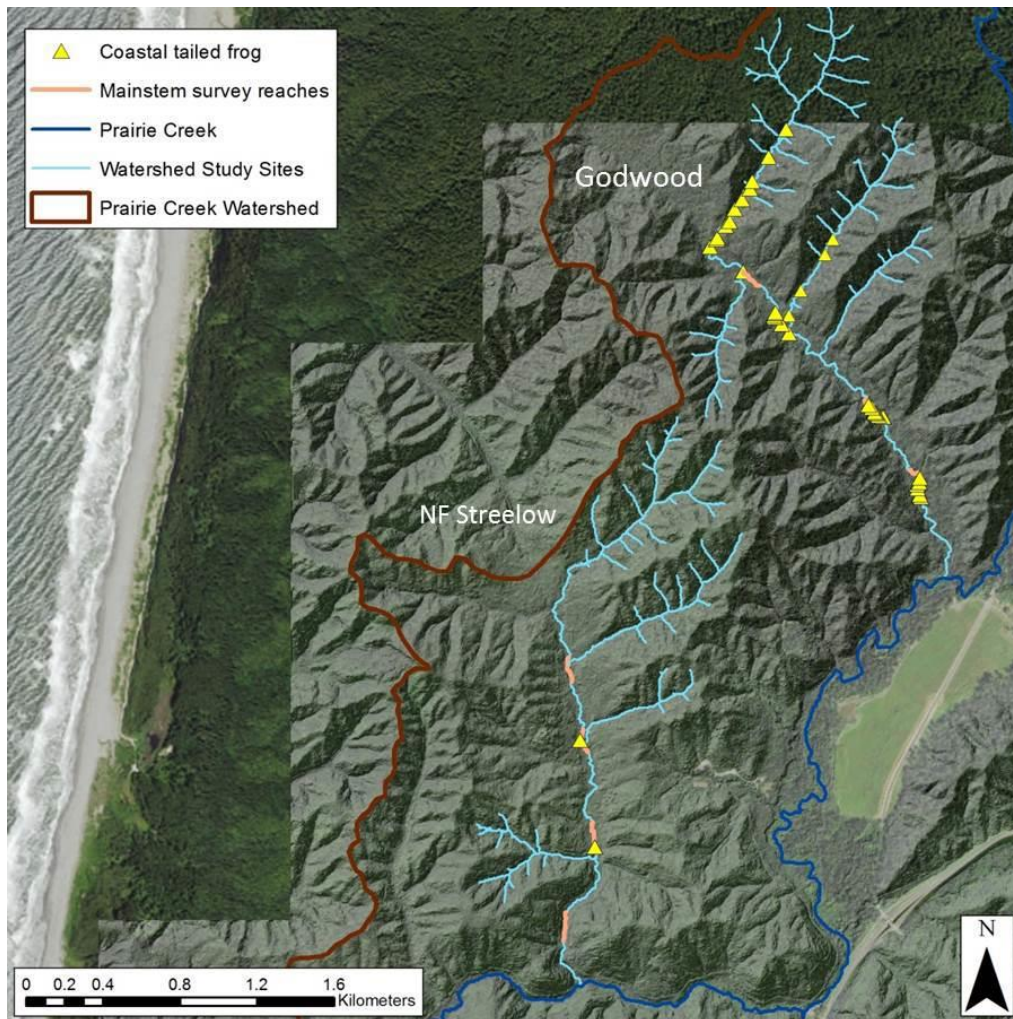


Figure 2. Distribution of coastal tailed frogs in Streeflow Creek and Godwood Creek (only 2016 field season data). Tailed frogs were widely distributed throughout Godwood Creek, however they were only found to be present in two survey units within the mainstem of Streeflow Creek. Tailed frogs were not found in any of the four surveyed tributaries of Streeflow Creek.

Southern torrent salamanders were found patchily distributed throughout the mainstem and tributaries of Godwood Creek, with many being concentrated in the higher headwater reaches (Figure 3). Of the 28 seeps surveyed in Godwood Creek, 19 of them were occupied by torrents (naive occupancy estimate = 67.86%).

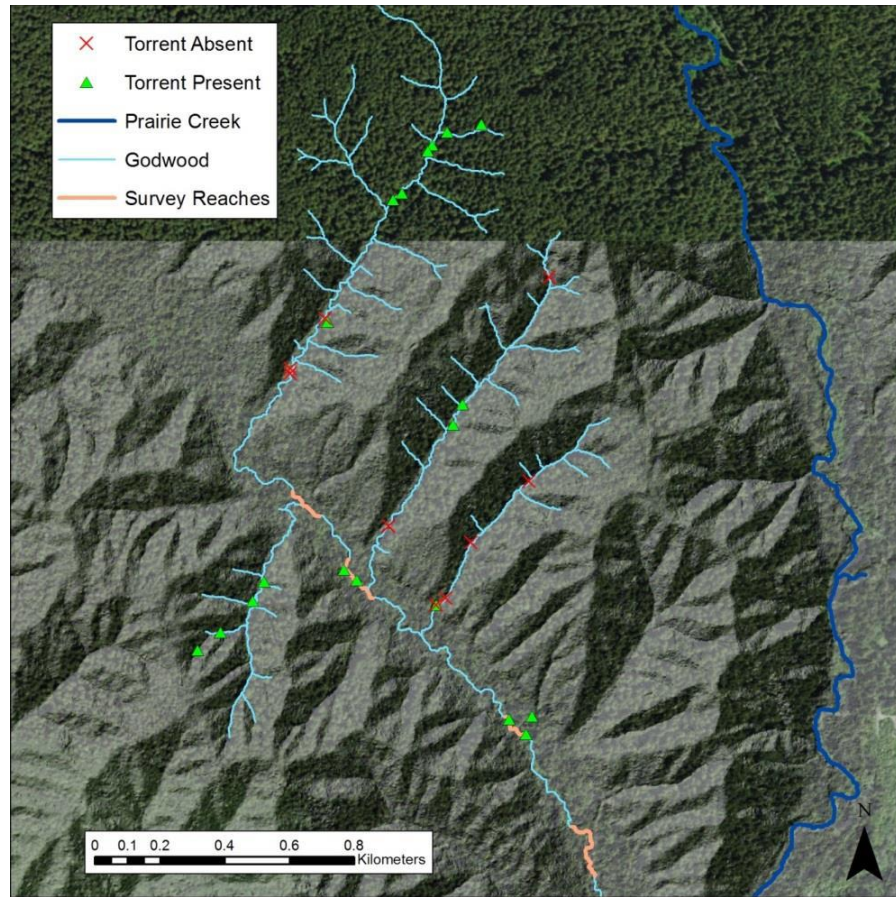


Figure 3. Distribution of southern torrent salamanders in Godwood Creek (only 2016 field season data). Green triangles indicate where torrents were found to occupy a seep. Red 'Xs' indicate where seeps were found to have no torrents.

In Streelow Creek, torrent salamanders were also patchily distributed however none were found along the main channel (Figure 4). Of the 23 seeps surveyed in Streelow Creek, 14 were occupied by torrents (naïve occupancy estimate = 60.87%).

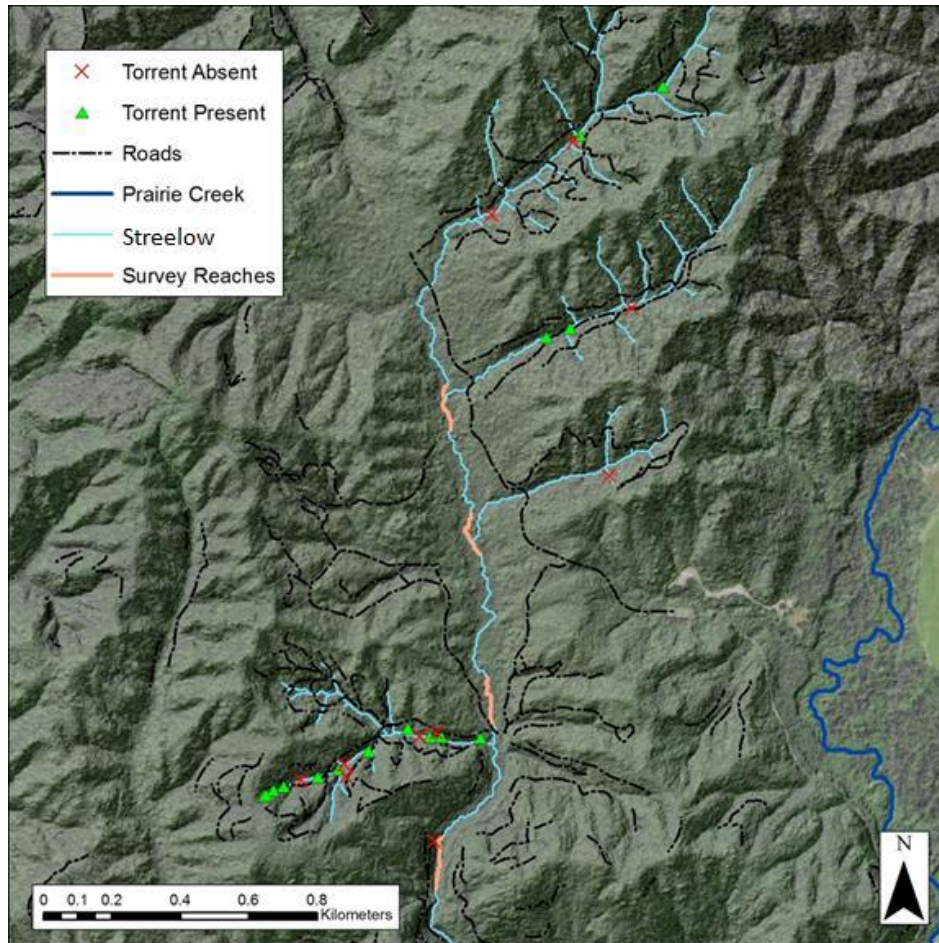


Figure 4. Distribution of southern torrent salamanders in North Fork Streelow Creek (only 2016 field season data). Green triangles indicate where torrents were found to occupy a seep. Red 'Xs' indicate where seeps were found to have no torrents.

Coastal Giant salamanders were widely distributed throughout both watersheds, but there appears to be a higher occupancy in Godwood Creek (Figure 5). Unlike in Godwood Creek, giant salamander distribution in Streelow Creek does not reach into the upper-most headwater reaches.

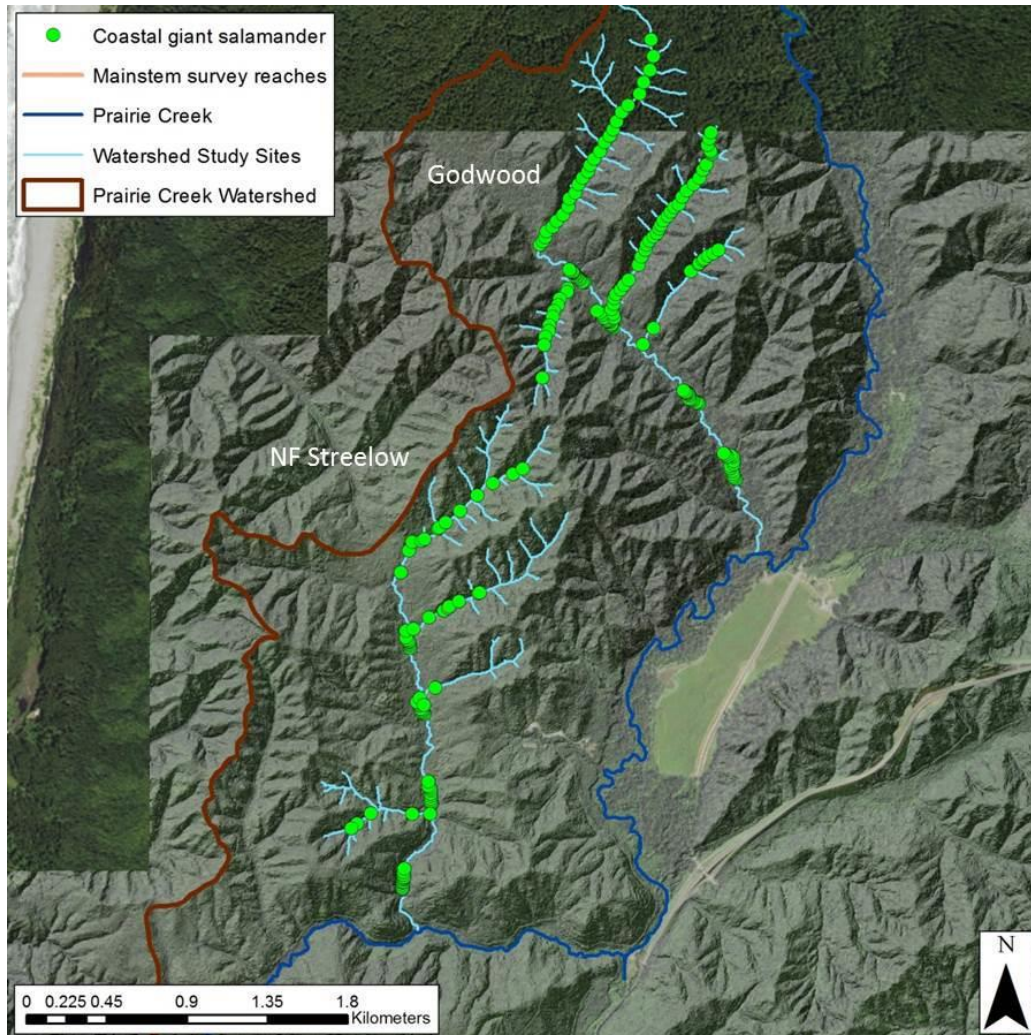


Figure 5. Coastal giant salamanders were widely distributed throughout both watersheds, however there was a higher abundance within Godwood Creek (only 2016 field season data).

A comparison of watershed morphologies and stream characteristics showed that Streelow Creek and Godwood Creek are very similar with the largest difference in the valley widths and slope.

Table1. Watershed morphology and stream characteristic comparison shows strong similarities between the watersheds.

	Streelow Creek	Godwood Creek	Difference
Wetted Width	124 cm	142 cm	8 cm
Canopy Cover	94%	87%	7%
Stream Temp	12.48°C	12.05°C	0.43°C
Valley Width	124 m	143 m	19 m
Valley Slopes	21°	25°	4°
Stream Gradient	1°	2°	1°
Depth	9.6 cm	10.9 cm	1.3 cm

When comparing between paired reaches, there were consistently higher portions of subsurface or buried channel in Streeflow Creek (Figure 6). In the Streeflow Creek and Godwood Creek tributaries, the average contiguous subsurface length was 19.6 m and 17 m with the longest contiguous subsurface section spanning 175 m and 110 m, respectively.

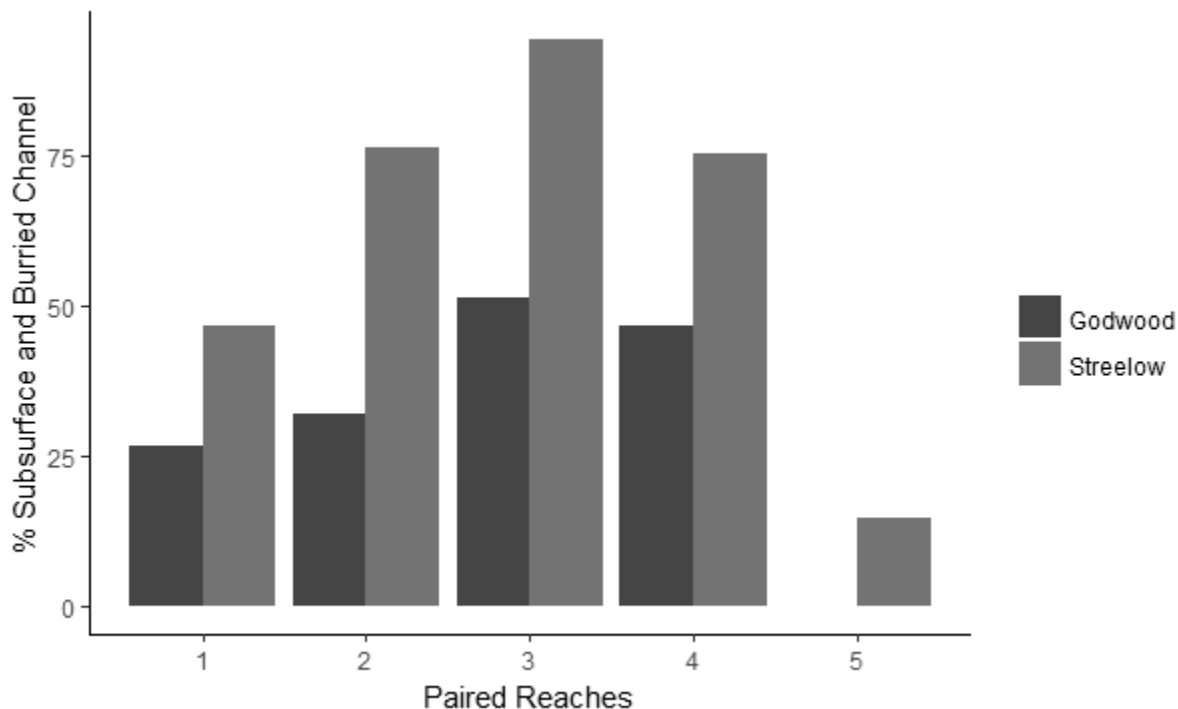


Figure 6. Stream reaches in Streeflow Creek had consistently higher proportion of buried and subsurface channel. Paired reaches 1-4 are the tributary reaches and paired reach 5 are the mainstem reaches pooled within watershed.

The average proportion of sediments (fines and sand) in sample units in Streeflow Creek was 32.32%, compared to an average of 10.63% in Godwood Creek. The average proportion of coarse substrate (cobbles and pebbles) in sample units in Streeflow Creek was 20.22%, compared to an average of 57.60% in Godwood Creek. We observed that the reaches in Streeflow also tended to have a higher amount of LWD per unit than Godwood Creek, however the LWD that was in Godwood Creek tended to be much bigger (> 50 cm). Both watersheds have very low stream gradients, with gradients >5° only in the uppermost headwater reaches. Temperatures between the watersheds did not significantly differ, with average daily temperatures between 11- 12°C.

We are currently running single-species, single-season occupancy models separately for each of the species to estimate their probability of occupancy and to determine what site or observation covariates may affect the probability of occupancy. We will also be running single-species, multi-season (dynamic) occupancy models to determine how changes in occupancy are driven by colonization and local extinction. **All results will be submitted in a final draft once we have submitted a completed thesis and it is accepted by Humboldt State University.**

CONCLUSION

The similarities between Streelow Creek and Godwood Creek allows for accurate assessment of the impacts of logging on headwater amphibian populations and their habitat characteristics. Although analyses are still in progress, the obvious difference in amphibian populations between the watersheds demonstrated in amphibian distribution maps suggest that there are still lasting effects from logging even 60 years post logging. The drastic difference in the distribution of tailed frogs is likely a result of high levels of sediment deposited from historical logging practices and through erosion. The sediment accumulation in Streelow Creek has completely covered the majority of coarse substrate, essentially eliminating the majority of suitable habitat for all life stages of the tailed frog. The giant salamanders are widely distributed throughout the study sites suggesting they can tolerate the higher levels of sediment better than the tailed frog and torrent salamander. The increased amount of sediment from historical logging practices combined with a low gradient channel, highly erodible geology, and large amounts of woody debris creating sediment dams leaves Streelow Creek almost incapable of naturally ridding itself of the excess sediment.

Despite these seemingly unfavorable attributes, successful restoration of Streelow Creek (determined through further amphibian population and habitat characteristic surveys post restoration) seems attainable. The presence of all three headwater amphibians (albiet lower occupancy and distribution) demonstrates that the Streelow Creek has naturally recovered enough to support these sensitive species. Even in a low gradient stream like Streelow Creek, heavy rainfall during winter months should have the ability to move sediment down through the watershed. If key sediment plugs can be identified in the upper headwater reaches and are slowly removed prior to large rain events, Streelow Creek could potentially resume natural recovery.