Newell Creek Limit of Anadromy

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Summary

This report reviews and synthesizes the available information concerning the limit of anadromy and habitat quality for anadromous salmonids in Newell Creek. A bedrock chute downstream of Newell Creek Dam is judged to be a complete barrier to coho salmon (*Oncorhynchus kisutch*) and a temporal barrier and practical limit of anadromy for steelhead (*Oncorhynchus mykiss*). Additional barriers to steelhead migration upstream of Newell Creek Dam, not previously identified, are also documented.

Newell Creek Anadromous Reach Limit

There is a bedrock chute in Newell Creek approximately 1 mile upstream from the confluence of Newell Creek with the San Lorenzo River and approximately 0.7 miles downstream from Newell Creek Dam (Figures 1-3). The chute has long been considered a migration obstacle to migrating salmonids. Don Alley estimated that the falls is passable at flows in the range of 200 to 300 cfs (Alley, et al. 2004). The bedrock chute occurs in a longer section beginning about 0.85 miles upstream of the San Lorenzo River confluence that is dominated by bedrock substrate that occurs in frequent shelves or steps of a few inches to a few feet in height. These bedrock shelves also limit the ability of steelhead or coho salmon to migrate upstream and may make upstream areas inaccessible at certain flow levels. During reconnaissance surveys in May 2006 at a flow of about 5 cfs, minimum thalweg depth on many of these shelves was only 0.1 to 0.2 feet (Hagar, personal observation).

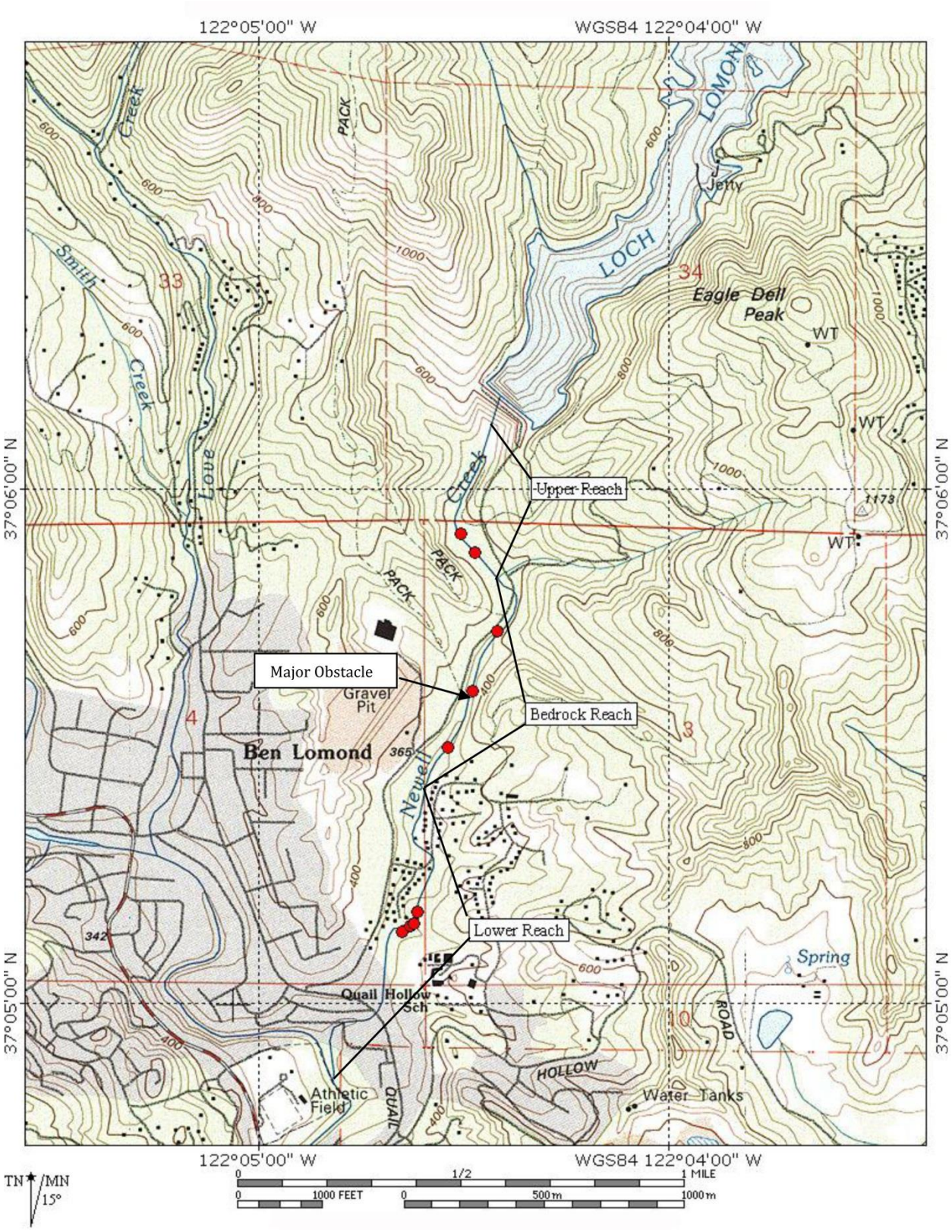


Figure 1. Lower Newell Creek (red dots are electrofishing sites).

Figure 2. Major migration obstacle 0.7 miles downstream of Newell Creek Dam, April 11, 2017, preliminary flow estimate about 18cfs (City of Santa Cruz preliminary gage data).

Figure 3. Major migration obstacle 0.7 miles downstream of Newell Creek Dam, April 11, 2017

Figure 4. Major migration obstacle 0.7 miles downstream of Newell Creek Dam, April 11, 2017.

Hydraulic Characteristics

The chute that is 0.7 miles downstream of Newell Creek Dam consists of a sloped bedrock ledge that rises a total of about 4.9 feet over a distance of about 27 feet. Even if a steelhead could leap from the relatively shallow pool at the base of the ledge, data presented in Powers and Orsborn (1985) indicates that the horizontal distance (27 feet) is too great for even a steelhead in prime condition (condition coefficient of 100%).

HES conducted more detailed measurements at the bedrock chute and a bedrock shelf (N P-3) about 0.8 miles downstream of the dam (HES 2014). HES noted the presence of potential passage routes on both banks (HES 2014), as follows:

"This obstacle is more complex than N P-3 with 3 distinct potential migration pathways. The center of the bedrock ledge is a relatively uniform chute with relatively constant slope and some portions approaching laminar flow. On the right side there is an overflow channel with two drops of 1.5 to 2 feet and shallow flow over relatively steep bedrock in the lower part. On February 25, 2008 at a flow of approximately 43 to 49 cfs, this channel was too shallow and had insufficient depth in the plunge pools to be passable. At higher flows this side may be passable. On the left side, the bedrock is more stepped forming a turbulent cascade with two small, shallow plunge pools. Although the plunge pools are quite small (about 2-3 feet in diameter) and have depths of only 1 to 1.5 feet, they may offer enough velocity reduction to allow fish to ascend this side of the ledge. On February 25, 2008 at a flow of 46 cfs the depth of flow along this pathway was too shallow in places to meet passage criteria. In addition, there was significant air entrainment in the highly turbulent flow along this pathway, reducing the fluid density and the propulsive force of a fishes swimming movements."

The central chute was analyzed in more detail. For short chutes velocity may be determined by the equation:

$$V_{SC} = (2gH)^{0.5} \qquad 1)$$

where V_{SC} is the velocity down a short chute, g is the acceleration due to gravity (32.2 fps^2), and H is the total vertical drop between two pools (Powers and Orsborn 1985). Using this equation, velocity in the steepest part of the cascade would be approximately 11 fps. While this is within the burst speed range for both steelhead and coho salmon, the turbulence in this cascade

presents difficulty by deflecting the fish from its course and causing excessive expenditure of energy to resist upwellings, eddies, entrained air, and vortices. Most of the fish's energy is utilized simply to maintain position and direction (Powers and Orsborn 1985).

The central chute in this obstacle is comparable to N P-3 but has a slightly steeper slope (17% compared to 12% at N P-3). The uneven face of this ledge is more difficult to survey for cross-sectional area, wetted perimeter, or mean depth. Due to the steeper slope, it is likely that higher levels of flow are required to meet a 0.6 foot depth criteria than the estimated 230 cfs required at N P-3. Assuming other channel variables are similar to N P-3 the increased slope at N P-4 alone would result in suitable passage depth (0.6 feet) at a flow of 204 to 327 cfs. This flow range would correspond to mean velocity estimates of 10 to 16 fps. Only a steelhead in top condition would be capable of ascending at the upper end of the velocity range. A coho salmon would likely be incapable of passing this obstacle, even at the lower velocity estimate.

In summary, HES concluded that an adult steelhead would not be able to leap the upper barrier and that its ability to swim over it (past the bedrock chute) would be limited by shallow depth of flow and high velocity, but may be possible for a fish in peak condition at a flow in the range of about 200 to 325 cfs. It is unlikely that adult coho salmon would be able to pass this obstacle at any flow (HES 2014). This is consistent with the previous assessment by Don Alley (Alley et al. 2004).

On April 11, 2017, a team of biologists representing NOAA Fisheries, CDFW, and the City of Santa Cruz conducted a site visit at the bedrock chute. The team confirmed the HES assessment although there were different opinions about the level of flow that might be needed for passage.

*Frequency of flows in the potential passage rang*e

If we assume that steelhead could indeed pass the bedrock chute at flow in the range of 200 to 325 cfs, it is possible to estimate how often flows at this level would occur. Simulated data (provided by Gary Fiske and Associates) for daily average flows below Loch Lomond (based on daily average inflow to Loch Lomond), were evaluated to determine frequency of flows in a suitable range that would exist in the absence of Loch Lomond. The natural flow in Newell Creek only rarely reaches levels suitable for passage of adult steelhead at this site. Daily average flow during the steelhead migration season (Dec through April) would be in the hypothetically suitable range 0.9% of the time of the time during the 1936 to 2014 hydrologic study period. In 41 of the 79 study years (52%), there would be no occurrence of flows in the suitable range. In 9 more years (an additional 11%), flow would be in the hypothetically suitable range for only one day. The greatest amount of time with hypothetically suitable flow

in any year was nine days and these were not consecutive but had a few brief events with any migration period lasting no more than two days.

Habitat conditions and Steelhead populations upstream of the barrier

Habitat conditions between the bedrock chute and the dam are not that good for steelhead. During habitat surveys conducted in 2007, it was found that the bedrock dominated reach (where the chute is located) and the upstream reach below Newell Creek Dam had markedly less instream cover and less potential spawning area than did the lower reach (Table 1). The uppermost reach had the least suitable habitat for *O. mykiss* including less extensive and shallower pools, less instream cover, and less potential spawning area. Abundance of O. mykiss in both visual surveys during the habitat assessment and in electrofishing surveys dropped off markedly in the upper half of the bedrock reach (beginning upstream of the bedrock chute) and in the uppermost reach (HES 2007).

Table 1. Population and Key Habitat Characteristics for Newell Creek Downstream of Loch Lomond (*Source*: HES 2007).

Reach	Habitat Unit	*O. mykiss* density (# per 100 ft.)	Reach Average *O. mykiss* density	% of Pools with max. depth >= 2 ft.	% of pools with >= 20% of unit with cover	Spawning area per 100 ft.
Lower	25	21	21	71	81	24
	26	85				
	26b	NA				
	29	21				
Bedrock[1]	55	29	15	100	29	13
	69	14				
	80	0				
Upper	105	5	2	38	13	10
	110	0				

[1] Double line indicates location of major migration obstacle.

The San Lorenzo River Salmonid Enhancement Plan (Alley et al. 2004) also evaluated the quality of habitat above the reservoir. The Plan considered the potential for restoring steelhead to the Newell Creek watershed upstream of Loch Lomond, specifically the possibility of transporting steelhead past Loch Lomond Reservoir to habitat in upper Newell Creek. Their conclusion was as follows:

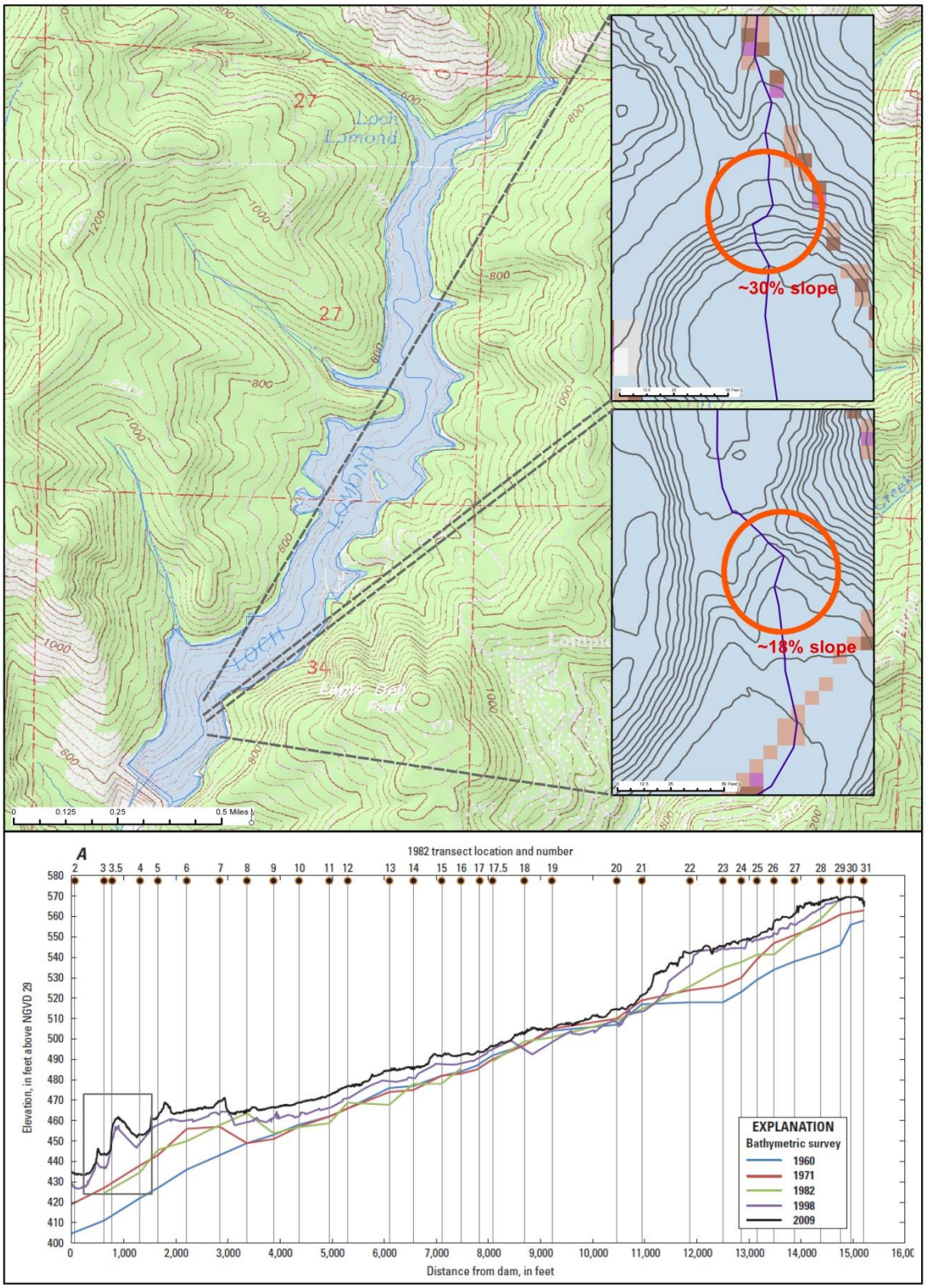
"Although the dam on Newell Creek is a complete barrier to steelhead migration, there would be little benefit in transporting adults above and providing smolt passage down past the dam. There is less than 2 miles of stream habitat for salmonids, which is of low quality due to relatively shallow pools, low baseflow and limited escape cover (Alley unpublished). Juvenile growth may be expected to be slow." (Alley et al. 2004 p.51).

If the bedrock chute is passable at certain flows, and if there is a sufficient amount of time when flows are in a passable range, the reach of Newell Creek above the site of Newell Creek Dam may have supported an anadromous run of steelhead. Construction of the dam may have resulted in loss of anadromous habitat above the dam. Bathymetry surveys of the reservoir were examined to determine whether any other obstacles to migration may have existed prior to construction of the Dam. The survey, completed in 2008 with a 2 foot contour interval, shows two steep sections of 18% and 30% gradient located 1700 feet and 2000 feet upstream of the fish release (the point where flow is released to Newell Creek from Loch Lomond). These locations seem to present even more severe obstructions than the bedrock chute 0.7 miles downstream of the dam. The lower feature has a 6 foot elevation gain over a 32 foot distance; the upper has an 8 foot elevation gain over a 26 foot distance. Separately or in combination, these features would have severely limited and likely precluded passage of steelhead and coho salmon to upstream habitat. The quality of habitat upstream of these obstacles, in the present inundation zone of Loch Lomond, is unknown. Habitat characterization downstream of the Dam and D.W. Alley habitat surveys in Newell Creek upstream of the reservoir, indicate relatively low quality habitat for salmonids. It would be reasonable to assume, in the absence of other information, that habitat in the inundation zone was of similar quality.

Conclusion

The bedrock chute 0.7 miles downstream of Newell Creek Dam precludes migration of steelhead the majority of the time and is judged a complete barrier to coho salmon. Although steelhead may be able to pass the chute during some isolated conditions (estimates are a window of flow from 200 to 325 cfs), the frequency of potential migration conditions is too low to support a consistent anadromous run. Therefore, the bedrock chute is considered the limit of anadromy for both coho salmon and steelhead. This is supported by observations of very few *O. mykiss* upstream of the chute compared to downstream reaches. Bathymetric surveys

indicate the presence of two additional steep gradient sections located between 1700 and 2000 feet upstream of the lower base of Newell Creek Dam that likely formed complete barriers to steelhead migration before construction of the Dam. Habitat quality between the chute and Newell Creek Dam is judged to be relatively poor for production of steelhead.



Top: Newell Creek Reservoir (USGS topographic map, 40' contours) showing historic path of Newell Creek, including pre-dam barriers (2' contours derived from 2008 bathemetric surveys; Sea Engineering Inc., 2009).
Bottom: Comparison of thalweg altitude for five bathymetric surveys (1960, 1971, 1982, 1998, and 2009), as compared with distance from the dam along the thalweg, Loch Lomond Reservoir, Santa Cruz County, California. Source: USGS Scientific Investigations Report 2011–5141.

Documents Cited

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