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Carmel River Reroute and Dam Removal Fish Passage Assessment (Spring 2020)

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Executive Summary

San Clemente Dam was removed in 2015 to improve opportunities for *Oncorhynchus mykiss* spawning in the Carmel River. A new river channel was constructed to bypass the dam site in 2015. Large boulders used to create step pool sequences were transported into more stable positions during high flows of winter 2017. The post-2017 boulder geometry, and shallow riffles may pose barriers to fish migration at certain flows. This report is the third year of a five-year project to assess potential physical barriers to *O. mykiss* passage.

The occurrence of either of the following conditions (based on draft monitoring approach developed by NMFS and CDFW in March of 2017) was considered a potential barrier.

1) At a given channel cross section, the dimensions of the single passage corridor—or passage corridor that is most conducive to passage where multiple corridors exist—indicate that the maximum flow depth is less than 1 foot.
2) Where a hydraulic drop spans the wetted channel width, and jump behavior is required to pass the feature due to absence of an identifiable subsurface corridor, the required jump height is greater than 1 foot, the downstream jump takeoff pool depth is less than 2 feet, or such jumps occur in a sequence of four or more.

The third year of monitoring occurred on May 9 and May 11, 2020 in approximately 60 cfs flow. We described 5 sites of concern where the depth along the most conducive corridor approached the 1-foot minimum depth. Each site description includes the location and geometry of the potential barrier, including photographs, and total station surveys. Given that none of the 5 impediments extended farther than a few feet, we believe a healthy adult steelhead would be able to transit the entire site at 60 cfs.

The site is naturally evolving; fish passage conditions are changing in response to cobble and boulder transport during winter flows.

Acknowledgements

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1 Introduction

San Clemente Dam was removed from the Carmel River in 2015 (Fig. 1) to improve conditions for all life stages of both resident (rainbow trout) and anadromous (steelhead) forms of *Oncorhynchus mykiss* (NMFS 2013; Boughton et al. 2016). The project was called “Carmel River Reroute and Dam Removal.”

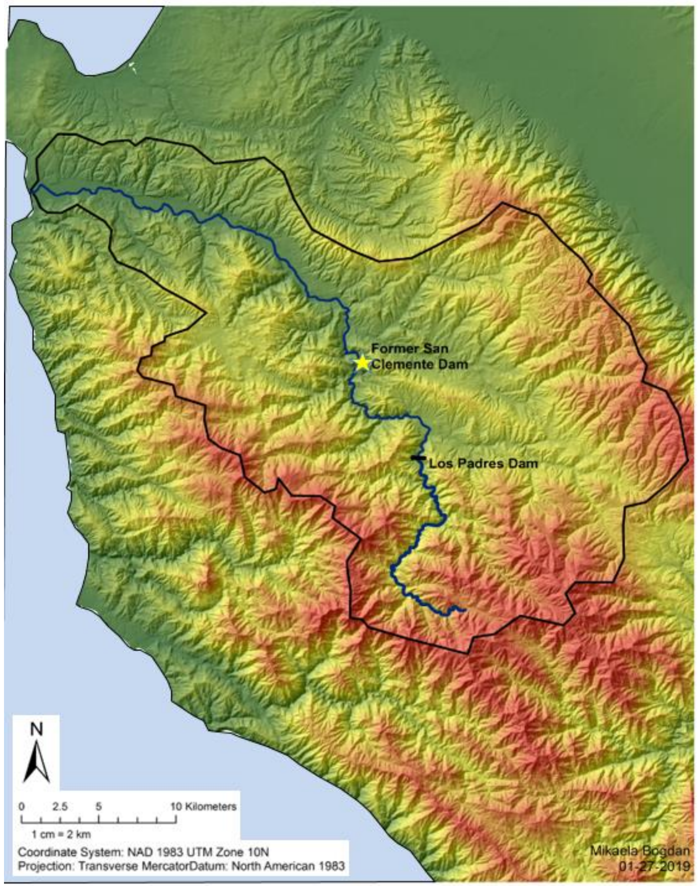

Figure 1. Location of the Carmel River Dam Removal and Reroute Project.

A new channel was constructed to foster migration past the former dam site, including a reach cut through bedrock to circumvent sediment sequestered in the old reservoir. The channel was designed to accommodate adult steelhead passage in flows as low as 15 cfs. A relatively steep reach of the new channel spanning from San Clemente Creek to the dam site was impacted by rare high-magnitude events in 2017 (Fig. 2). Fish barriers and channel stability are continuing concerns given the stochastic boulder arrangement in the reorganized channel bed. The large boulders are still mobile in flows as low as 6000 cfs, leading to uncertainty in future channel configurations and barriers (Smith et al. 2020). Geomorphic surveys have been conducted annually to assess fish passage at the site.

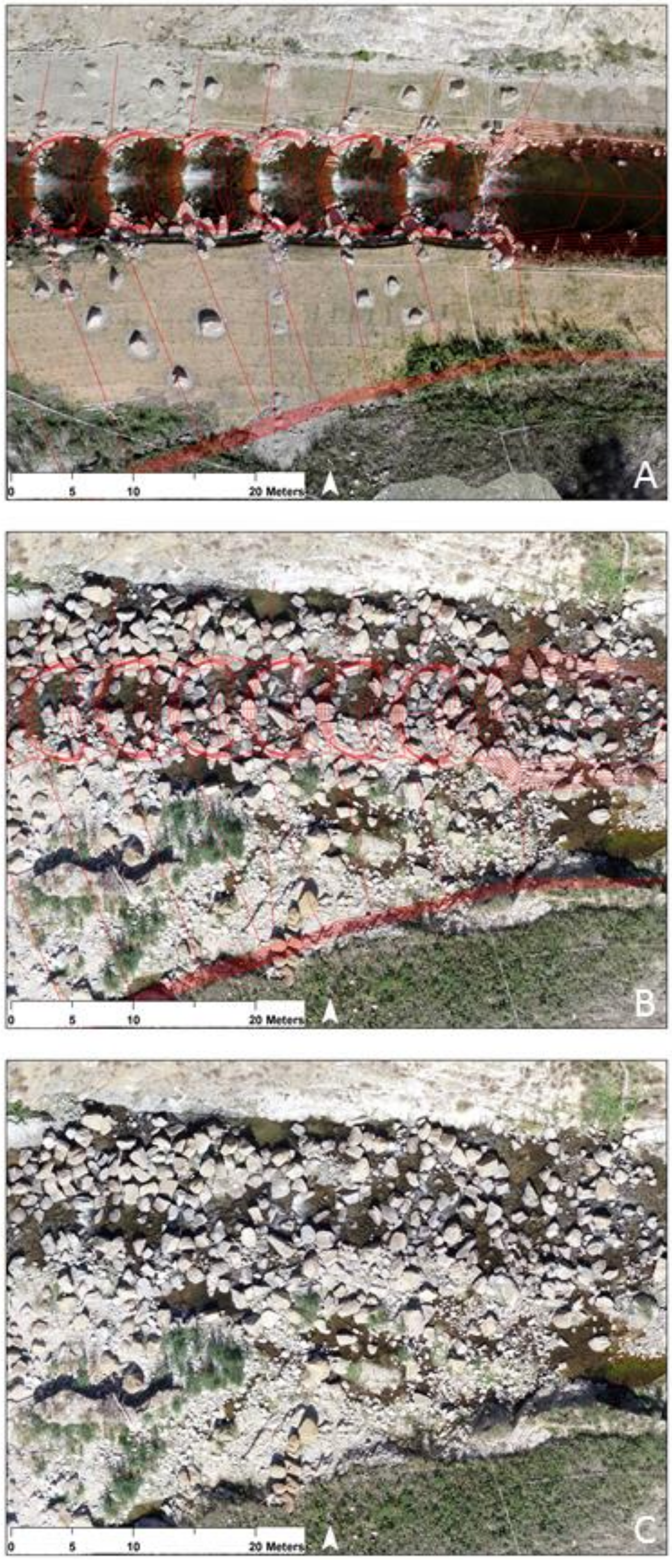

Figure 2. Example of step-pool sequences “auto-naturalized” by high flows of 2017. A) Design blueprint on step pool sequence in 2016. B) Same view as A in 2017. C) Same image as B with design removed.

The initial geomorphic fish-passage survey along the constructed channel occurred in summer 2018 (17 cfs). The assessment documented problematic fish passage conditions at summer base flow conditions (Smith et al. 2018). The next annual survey was completed in 2019 at 60 cfs, which is more typical of winter base flow conditions. That survey found no significant barriers, but eight sites were described or surveyed in detail because they were close to the 1-foot minimum depth condition (Smith et al 2019). The current report presents the third annual geomorphic fish-passage survey, conducted on May 9 and May 11 at a flow of approximately 60 cfs.

2 Methods

2.1 River Discharge During Assessment

The spring 2019 survey included a visual inventory of potential barriers on May 9, 2020. More detailed surveys of specific sites spanned both May 9 and May 11, 2020. The flow was approximately 60 cfs during those days as indicated by the Sleepy Hollow gage, located one mile downstream of the site.

2.2 Visual Assessment

Potential barriers to fish passage (impediments) were identified along the 4100 ft length of the project site. A leveling rod was used to measure minimum water depths and maximum jump heights along the most conductive corridor in the river (Fig. 3). We based our assessment on criteria presented in the CRRDR post-construction monitoring plan (AECOM, 2018). As was done in 2019, we did not consider narrow "width" to indicate a potential barrier, and we used the maximum depth (instead of average depth) when assessing the one-foot minimum depth value (Pers. Comm. Steven McNeely, AECOM). The two criteria for identifying impediments are:

- **At a given channel cross section, the dimensions of the single passage corridor—or passage corridor that is most conducive to passage where multiple corridors exist—indicate that the maximum flow depth is less than 1 foot.**

- **Where a hydraulic drop spans the wetted channel width and jump behavior is required to pass the feature due to absence of an identifiable subsurface corridor, the required jump height is greater than 1 foot, the downstream jump takeoff pool depth is less than 2 feet, or such jumps occur in a sequence of four or more.**

The impediment sites were sequentially numbered from downstream to upstream. The UTM (NAD 83) coordinates for each site were recorded (Appendix A) and plotted on an orthophoto base map. Site photographs were taken to document the problem areas.


Figure 3. Estimating jump heights and water depths at 60 cfs (May 9, 2020).

2.3 Total Station Surveys

Each site identified as a potential impediment was surveyed with Nikon 5" total station. We surveyed the thalweg longitudinal profile and a critical cross section where the depth problem was present. The cross section transect was not necessarily perpendicular to the banks. Instead, it followed the critical riffle crest geometry. Total station shot elevations were used to determine channel bottom elevations, while co-located depths were read from a leveling rod. Each survey closed with < 0.01 m error. All cross sections were plotted as a downstream view.

3 Results

Five potential impediments were identified for detailed total station surveys during the visual inventory (Fig. 4). All five sites were selected for shallow conditions, near or slightly below 1 foot of depth. Hydraulic drops greater than 1 foot were present, but each was navigable without jump behavior.

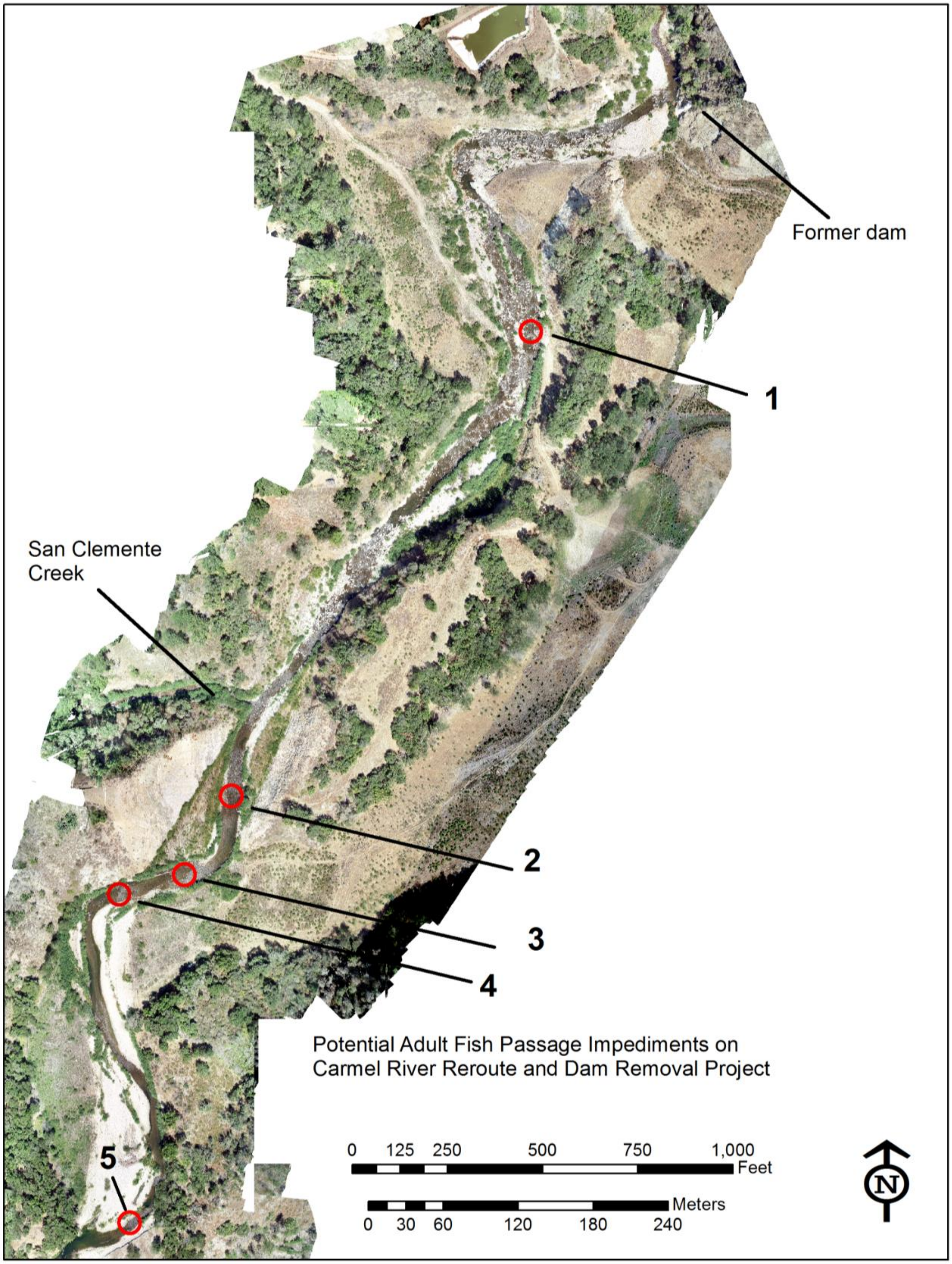

Figure 4. Five sites identified as potential impediments to fish passage. Orthophoto obtained on 8/31/19.

Site 1 (black bar in Fig. 5) is most favorable passage up a short step that had a maximum depth of approximately 0.9 ft (Figs. 6, 7, 8). The site is located approximately 10 ft upstream of an impediment (black arrow) surveyed as site 23 in summer 2018 and site 2 in 2019.

Figure 5. Site 1 showing locations of longitudinal profile (red) and cross section (black). Black bar indicates the cross section where shallow water is the most conducive path. Flow is to the north. Red dots are total station shots. Black arrow shows impediment surveyed in both 2018 and 2019 (Smith et al. 2018; 2019). Background image is blended orthophoto and hillshade obtained 5/2/2019 at a flow of 85 cfs.

Figure 6. Site 1 field photo. Shallow conditions existed in the gap between boulders.

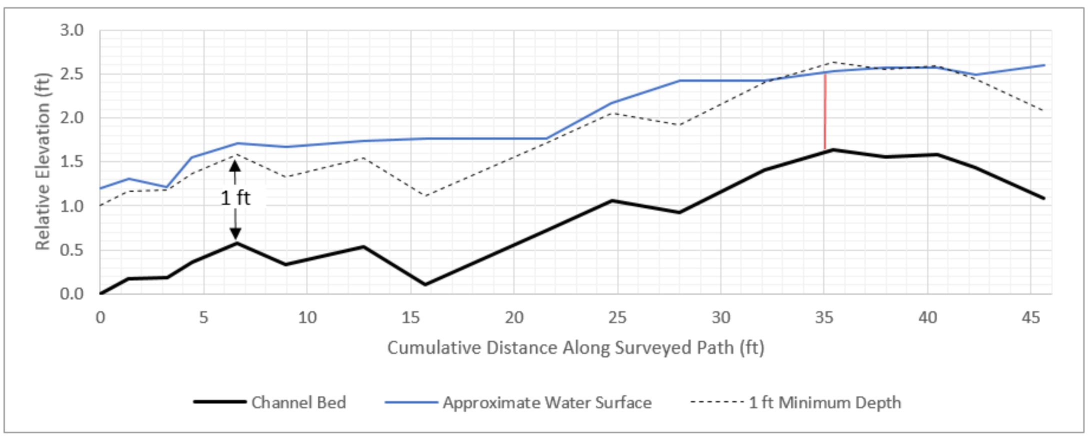

Figure 7. Site one longitudinal profile. Dashed black line shows 1-foot minimum required depth. Red line shows location of cross section (Fig. 8).

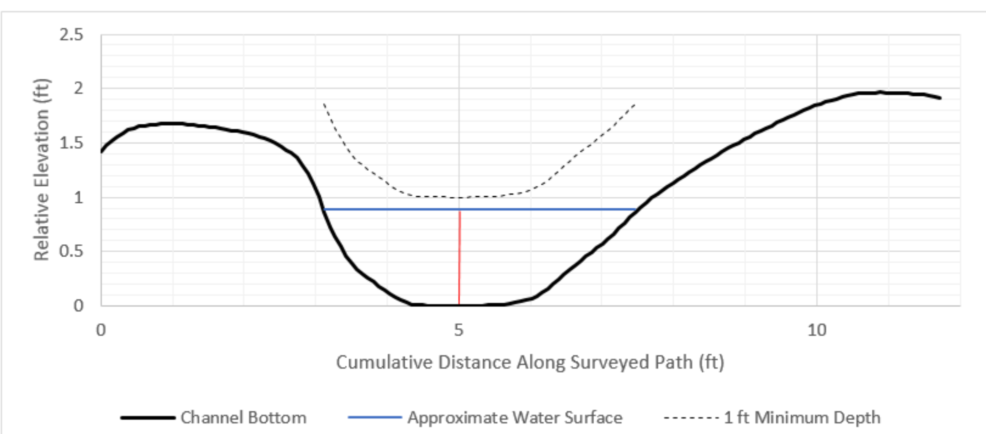

Figure 8. Site 1 cross section. Red line shows intersection with longitudinal profile. Topographic data extracted from digital surface model obtained in May 2, 2019.

Site 2 (Fig. 9) is the head of a low-gradient riffle located 200 ft upstream of San Clemente Creek, within the reroute bedrock cut. The riffle was deeper than one foot except near the riffle crest (Fig. 10), which had a maximum depth of approximately 0.9 feet along the most favorable pathway (Figs. 10, 11, 12). This site was reported as site 43 in summer 2018 and site 4 in 2019.

Figure 9. Site 2 with approximate locations of longitudinal profile (red) and cross section (black). Flow is toward the north. Background image is blended orthophoto and hillshade obtained 5/2/2019 at a flow of 85 cfs.

Figure 10. Site 2 field photo. Shallow conditions observed at riffle crest.

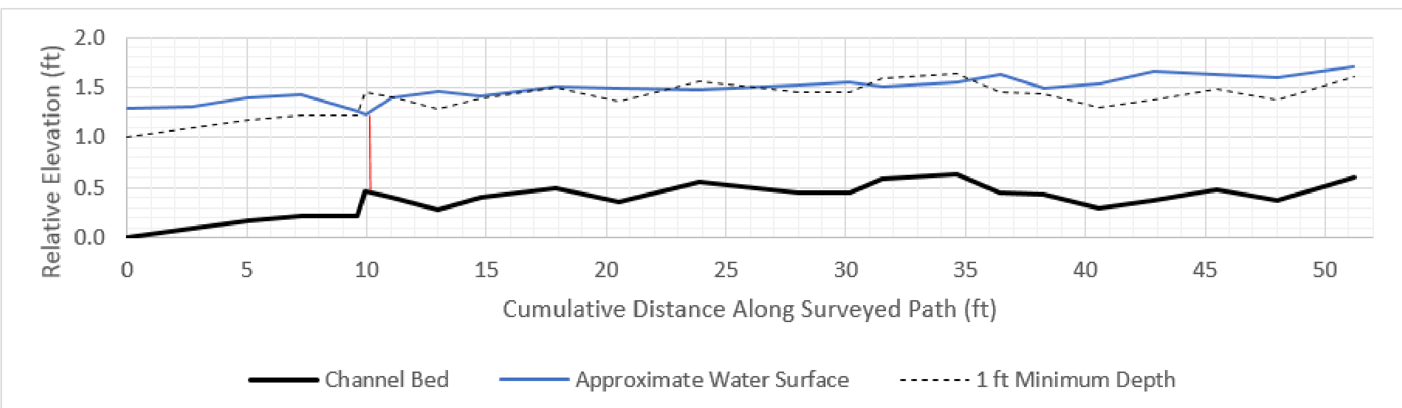

Figure 11. Site 2 longitudinal profile. Red line shows the intersection with cross section.

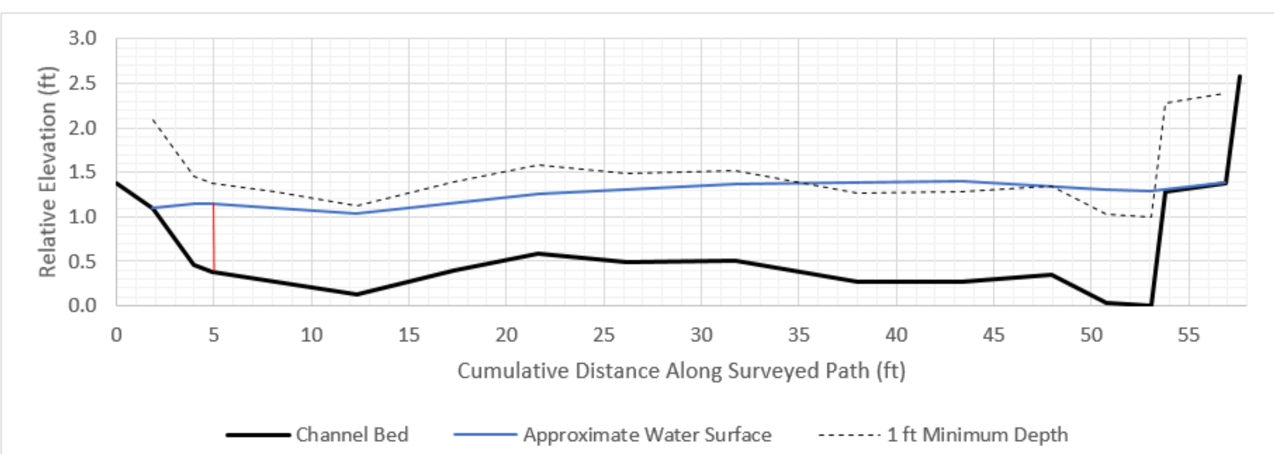

Figure 12. Site 2 cross section survey. Red line shows the intersection with cross section.

Site 3 is the head of a low-gradient riffle within the reroute reach (Fig. 13). It has a complex crest that crossed the channel at a low angle to the banks. The riffle was deeper than one foot except near the riffle crest where the maximum depth of the most conductive passage was approximately 0.9 feet (Figs. 14, 15, 16). This location is site 45 surveyed in summer 2018 and site 5 surveyed in 2019.

Figure 13: Site 3 with approximate locations of longitudinal profile (red) and cross section (black). Flow is toward the northwest. Background image is orthophoto obtained 8/31/2019 at a flow of 17 cfs.

Figure 14. Site 3 field photo. Shallow conditions at riffle crest.

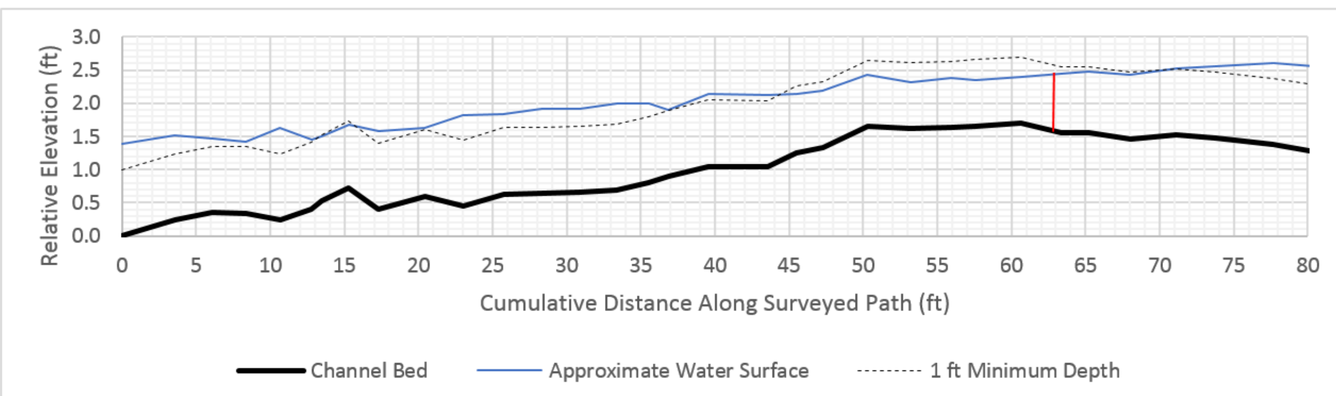

Figure 15. Site 3 longitudinal profile. Red line shows the intersection with cross section.

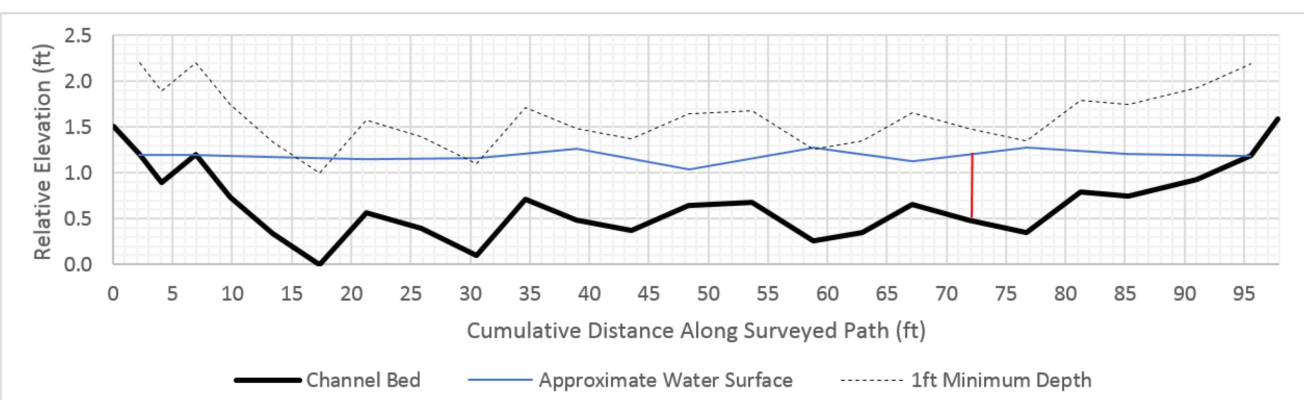

Figure 16. Site 3 cross section survey. Red line shows the intersection with cross section.

Site 4 is a low-gradient riffle located 180 ft (55 m) upstream of site 3 (Fig. 17). It is the first riffle upstream of the reroute reach bedrock cut. The riffle was deeper than one foot, including the riffle crest (Figs. 18, 19, 20). This site was surveyed as site 48 in summer 2018 and site 6 in 2019.

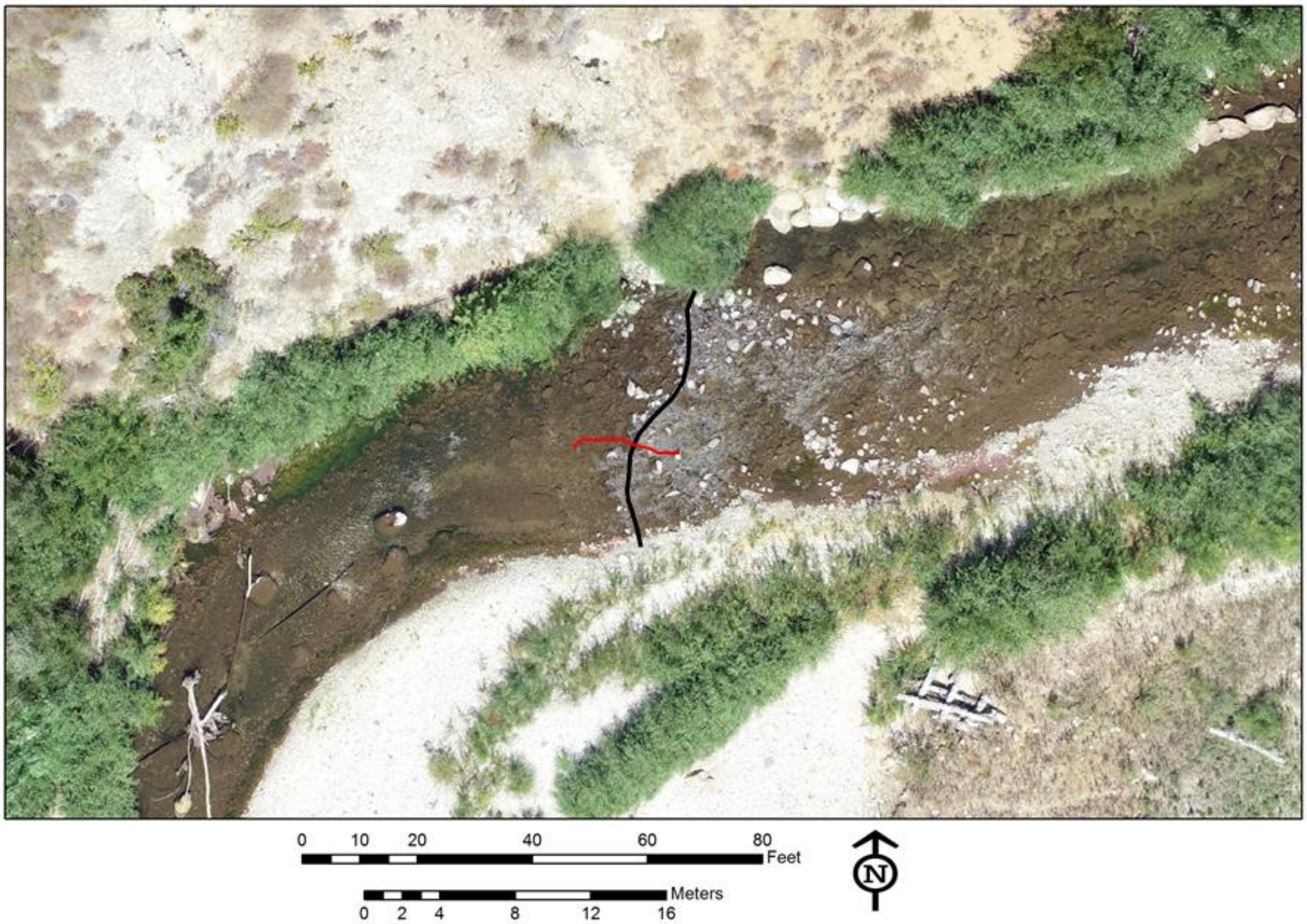

Figure 17. Site 4 with approximate locations of longitudinal profile (red) and cross section (black). Flow is toward the northwest. Background image is orthophoto obtained 8/31/2019 at a flow of 17 cfs.

Figure 18. Site 4 field photo.   Shallow conditions at riffle crest.

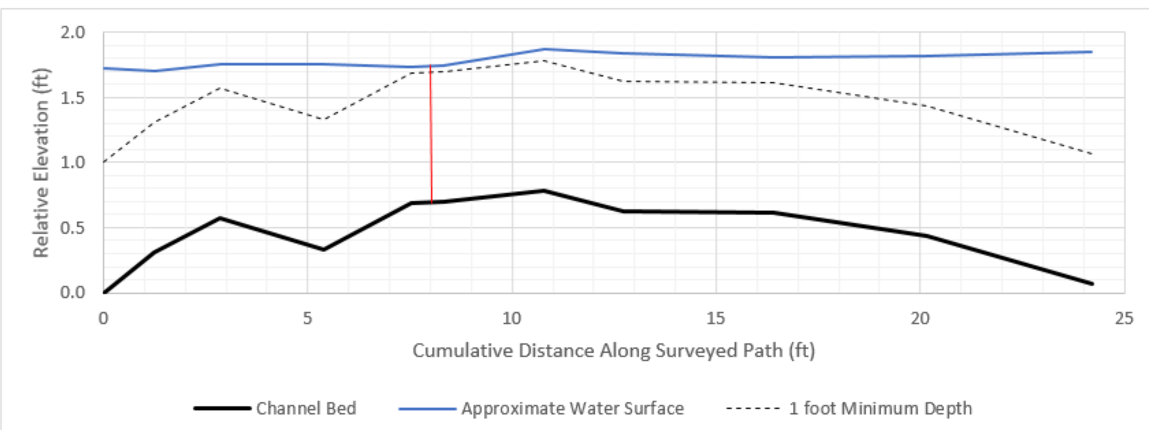

Figure 19. Site 4 longitudinal profile. Red line shows the intersection with cross section.

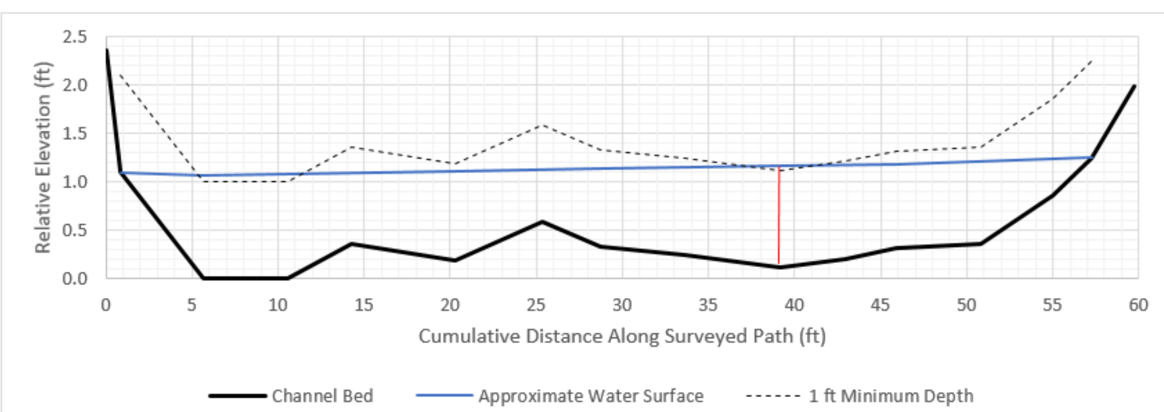

Figure 20. Site 4 cross section survey. Red line shows the intersection with cross section.

Site 5 is a low-gradient riffle located within the reservoir reach 150 ft (65 m) downstream from the upstream limit of the CRRDR (Fig. 21). The riffle was deeper than one foot except for a five-foot long reach that was at, or slightly below, the 1-foot minimum depth along the most favorable pathway (Figs. 22, 23, 24). This site was reported as impediment 51 in summer 2018 and impediment 8 in 2019.

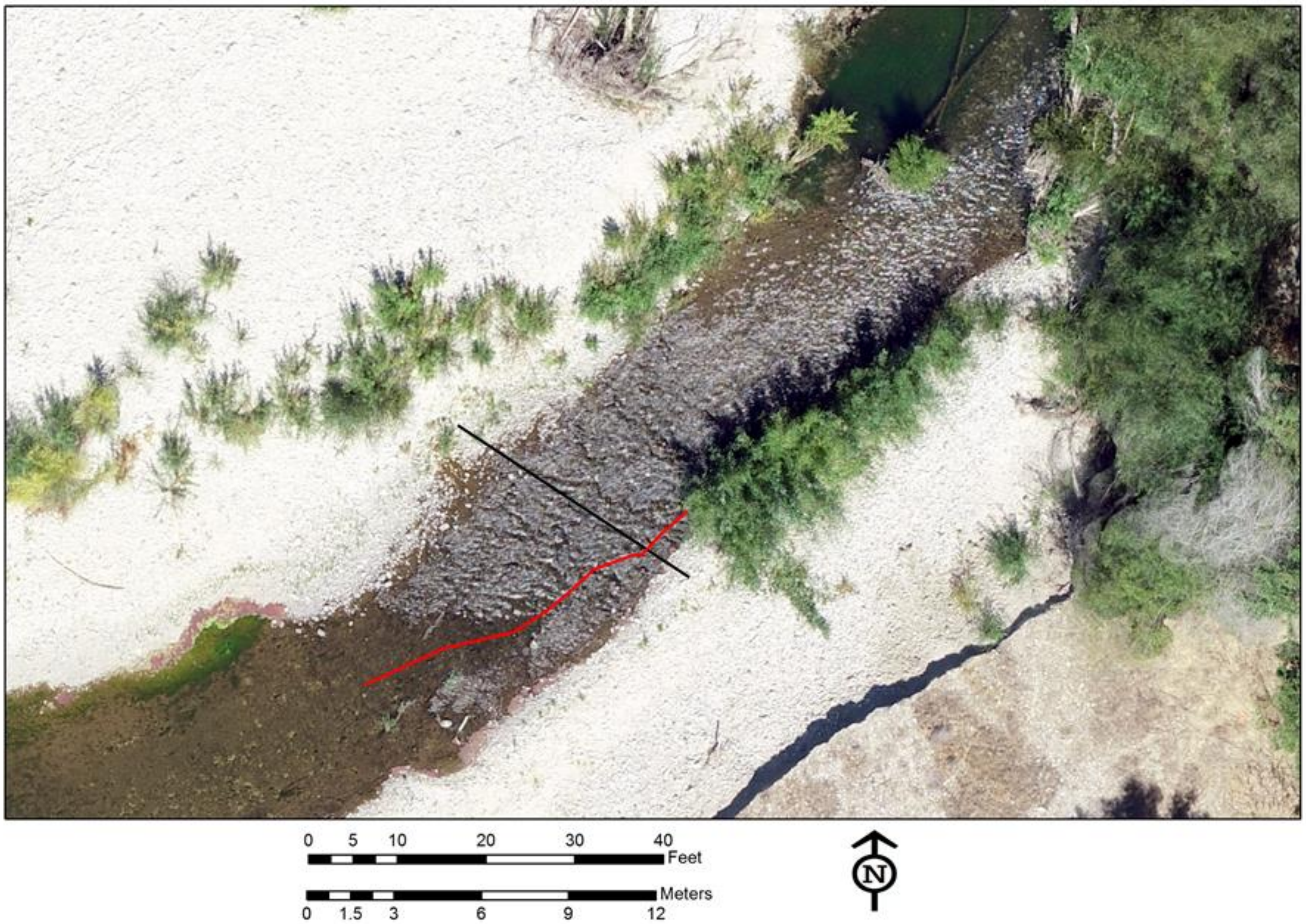

Figure 21. Site 5 with approximate locations of longitudinal profile (red) and cross section (black). Flow is toward the northwest. Background image is orthophoto obtained 8/31/2019 at a flow of 17 cfs.

Figure 22. Site 5 field photo.   Shallow conditions within riffle.

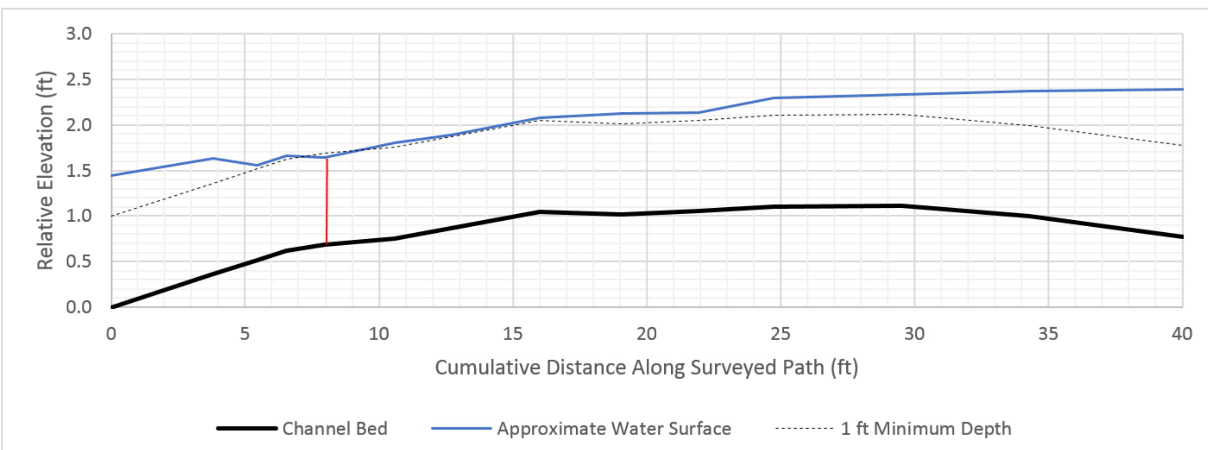

Figure 23. Site 5 longitudinal profile. Red line shows the intersection with cross section.

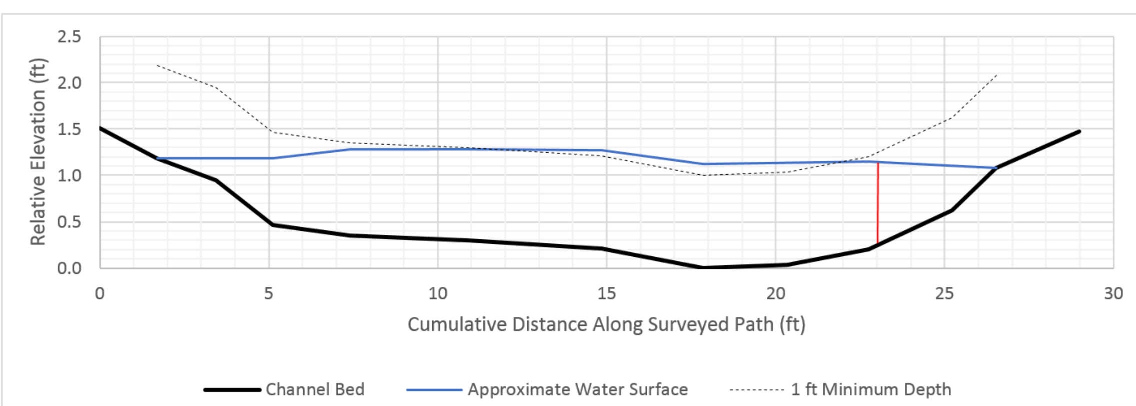

Figure 24. Site 5 cross section survey. Red line shows the intersection with cross section.

4 Discussion

The spring 2018 fish passage survey inventoried approximately 51 impediments to adult fish passage at a flow of 17 cfs (Smith et al. 2018). All but seven of those shallow-water impediments were drowned out by deeper water present during the 60 cfs flow in summer 2019 (Smith et al. 2019). The seven sites identified in 2019 fell short of the minimum prescribed design criteria for fish passage by only 0.1 ft, and for only short distances, leading to the conclusion that there were no significant barriers for healthy adult *O. mykiss*.

We draw the same conclusion for the site at 60 cfs in the spring 2020 fish passage survey. Of the 5 sites surveyed, all were very close to the 1-foot minimum depth, and fish would have to navigate through areas < 1 ft for relatively short distances. The sites were widely spaced so no additional stress was present from clustered impediments. Given the site conditions and behavioral traits of steelhead (Powers and Orsborn 1984; Grantham 2013), we believe that healthy adult steelhead and rainbow trout would be able to navigate the entire site at 60 cfs. We observed Pacific lamprey nest-building activity during the survey, demonstrating that other anadromous species have successfully navigated through the site.

Smith et al. (2019) noted that bed mobility could lead to changes in the fish passage characteristics at the site. Three points of evidence indicate that the bed geometry is evolving.

1) Two sites surveyed in 2019 were passable in 2020, although the flow rates were very similar.
2) While five surveyed sites were at the same location as sites surveyed the previous year, the specific location in the bed where critically shallow water occurred had shifted in some instances (e.g., Fig. 5).
3) Smith et al. (2020) found that 17% of 218 large boulders they studied moved at least 10 cm in the 6000 cfs peak flows of 2019.

These observations underscore the point that fish passage characteristics at the study area are naturally evolving as both the cobbles in the riffle crests and boulders in the steeper reaches continue to move.

5 References

AECOM. 2018. Carmel River Reroute and San Clemente Dam Removal Post-Construction Activity Plan, Habitat Monitoring & Reporting Plan. 66p.

Boughton DA, East A, Hampston L, Kiernan J, Leiker, S, Mantua N, Nicol C, Smith D, Urquhart K, Williams T, Harrison L. 2016. Removing a dam and re-routing a river: Will expected benefits for Steelhead materalize in Carmel River, California? NOAA Technical Memorandum, NOAA-TM-NMFS-SWFSC-553. US Department of Commerce. Southwest Fisheries Science Center, Santa Cruz, CA. 89 pp.

[CSUMB] Marson L, Besson J, Biordi C, Conlen A, DeWolf K, Gravelle M, Hubbard H, MacSween L, Santos R, Sosa M, Thompson K, Trejo-Arce J, Smith D. 2016. First Year Assessment of the Carmel River Reroute and Dam Removal Project. Division of Science and Environmental Policy. Senior Thesis Report, 101 pp. http://ccows.csumb.edu/pubs/reports/CCoWS_GEOL460_CarmelRiverRestorationYearOneAssess_160528.pdf

East AE, Pess GR, Bountry JA, Magirl CS, Ritchie AC, Logan JB, Randle TJ, Mastin MC, Minear JT, Duda JJ., Liermann MC., McHenry ML., Beechie TJ., Shafroth PB. 2015. Large-scale dam removal on the Elwha River, Washington, USA: River channel and floodplain geomorphic change. Geomorphology 246: 687-708.

Grantham. 2013. Use of hydraulic modelling to assess passage flow connectivity for salmon in streams. River Research and Applications 29(2): 250-267. https://onlinelibrary.wiley.com/doi/10.1002/rra.1591

Harrison, L.R., East, A.E., Smith, D.P., Logan, J.B., Bond, R., Nicol, C., Williams, T.H., Boughton, D.A., Chow, K. and Luna, L. 2018. River response to large-dam removal in a Mediterranean hydroclimatic setting: Carmel River, California, USA. Earth Surface Processes and Landforms, DOI: 10.1002/esp.4464. https://doi.org/10.1002/esp.4464..

[NMFS] National Marine Fisheries Service. 2013. Biological Opinion, The Carmel River Reroute and San Clemente Dam Removal Project at the San Clemente Dam on the Carmel River. National Marine Fisheries Service Southwest Region. North Central Coast Office, Tracking Number 2013/9633.

Powers, P. and Orsborn, J. 1984. "New Concepts in Fish Ladder Design: Analysis of Barriers to Upstream Fish Migration, Volume IV of IV; Investigation of the Physical and Biological Conditions Affecting Fish Passage Success at Culverts and Waterfalls", 1982-1984 Final Report, Project No. 198201400, 134 electronic pages, (BPA Report DOE/BP-36523-1)

Smith D., Bogdan, M., Klein J., and Terzoli, A. 2018. Carmel River Reroute and Dam Removal Fish Passage Assessment (Summer 2018). Watershed Institute, California State University Monterey Bay, Publication No. WI-2018-07, 43 pp.

Smith D., Bogdan, M., Nava, D. 2019. Carmel River Reroute and Dam Removal Fish Passage Assessment (Summer 2019). Watershed Institute, California State University Monterey Bay, Publication No. WI-2019-07, 29 pp.

Smith. D. Kortman S. Wandke J. Kwan-Davis R. Caudillo A. Klein J. Gennaro M. Bogdan M. and Vennerus P. 2020. Controls on large boulder mobility in an "auto-naturalized" constructed step-pool river: San Clemente Dam removal and reroute project, Carmel River, California, USA. Earth Surf. Process. Landforms. https://doi.org/10.1002/esp.4860

6 Appendix A: Site Locations

site	E	N
1	615651	4032928
2	615417	4032524
3	615379	4032454
4	615324	4032447
5	615336	4032176

UTM NAD83 (10) meters