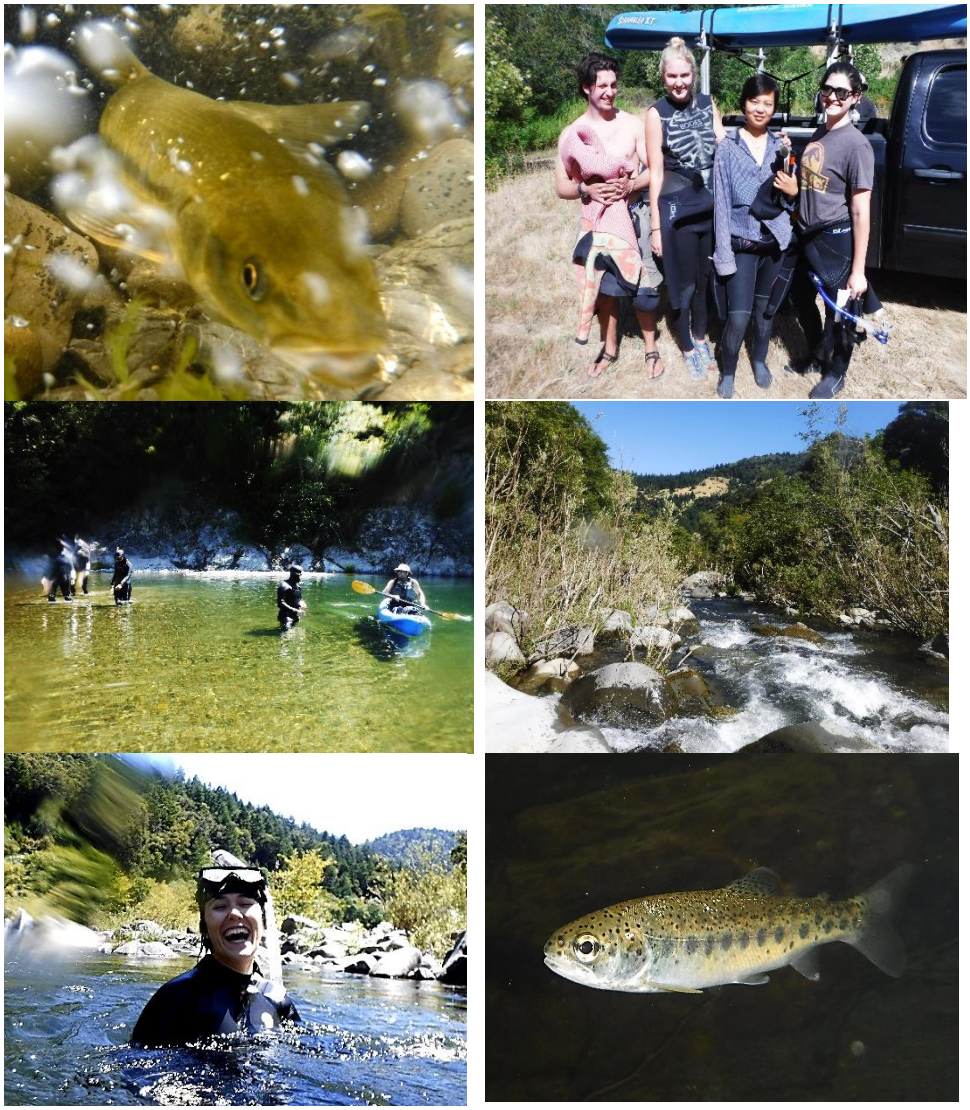
Sacramento Pikeminnow in the South Fork Eel River: Trend Monitoring Summer 2017



By: **Patrick Higgins, ERRP Managing Director**

July 21, 2017

Acknowledgements

ERRP wishes to thank Jeff Hedin and the Standish Hickey State Park Interpretive Association for providing a beautiful campsite for two nights for volunteers. We appreciated working with Interpretive Ranger Nicole Mercier, including her help arranging for ERRP to present to campers on Thursday evening at the amphitheater. Volunteer divers were treated to gourmet camp fare by ERRP Outdoor Coordinator Eric Stockwell who barbequed chicken and tri-tip for dinners and whipped up hearty, healthful breakfasts to fuel the team. Eric also deserves thanks and recognition for doubling as water Sherpa and deep diver as necessary during the two day 12 mile pikeminnow survey. Thanks also to Gary Ballard of the nearby Peg House who joined us for tritip dinner and brought oysters and their world famous brownies. ERRP all-star volunteer Dave Sopjes deserves mention for coming down to dive, but was unable to participate due to a bug. Thanks also to Tara Tompkins for helping with the shuttle on day 1.

The valid scientific trend data collected is as a result of having a high caliber dive team and these volunteers deserve the credit for the success of the project. Fish biologist Zane Ruddy of the U.S. Bureau of Land Management (BLM) and his assistant, Americorp Volunteer Emily Maloney, both had experience in fish dive counts and their enthusiasm for the activity was infectious. ERRP volunteer Willie Grover is now a seasoned diver who participated in last year's pikeminnow baseline data collection. We appreciate his dedication and he improves his skills with each dive he participates in. Doctoral candidate Phil Georgakakos from the University of California Berkeley joined the pikeminnow survey for the second year. This year he was joined by three undergraduates who had experience in fish counting and observation. Thanks to Kristin Shikella, Garbo Gan, and Victoria Uva who work under Dr. Mary Power with the Angelo Reserve project.

Thanks also to Diane Higgins for formatting and editing this document and assisting with posting results to the ERRP website, including adding the report to the electronic Eel River Library on-line at www.eelriverrecovery.org. Dr. Brett Harvey has offered guidance to ERRP in the past on pikeminnow monitoring and management and we thank him for his review of this report.

Bureau of Land Management Biologist Zane Ruddy and Americorp member Emily Maloney.

UC Berkeley Day 2 team: Phil Georgakakos, Kristin Shikella, Garbo Gin, and Veronica Uva.

Contents

Introduction/Background

Since its formation in 2011, the Eel River Recovery Project (ERRP) has been concerned with the potential impacts of the introduced Sacramento pikeminnow (*Ptychocheilus grandis*) on the Eel River's native fish community. Residents of the Eel River watershed would like to see this invasive, non-native species eliminated or at least controlled (Smalley and Higgins 2011). This report is the fourth in a series from ERRP that summarize the history of pikeminnow introduction to the Eel River (Brown and Moyle 1991), their proliferation and spread (Clancy 1993, Brown and Moyle 1997), and their more recent apparent population decline. The previous reports also describe in detail the pikeminnow life history and summarize previous work by U.S. Forest Service Redwood Sciences Laboratory researchers on behavior, diet and reproduction of pikeminnow in the Eel River (Harvey and Nakamoto 1999, White and Harvey 2001, Nakamoto and Harvey 2003, Reese and Harvey 2002, Harvey et al. 2002, 2004, Kinzinger et al. 2014) (Link to RSL articles: http://users.humboldt.edu/bcharvey/publications.html). The previous ERRP reports are:

- *Eel River 2012 Fall Chinook Run Distribution and Observations on Other Fish Species* (Higgins 2013),
- *Eel River Recovery Project Eel River Sacramento Pikeminnow Monitoring and Management Plan* (Higgins 2015), and
- *Monitoring Sacramento Pikeminnow in the Eel River: Summer 2016* (Higgins 2017).

Baseline data collected in the South Fork Eel River from Rattlesnake Creek to Standish Hickey State Recreation Area in 2016 (Higgins 2017) confirmed that adult pikeminnow greater than 18 inches in length were fewer than expected and mostly found in the deepest pool habitats. This reach was selected because Nakamoto and Harvey (2003) had found substantial predation by pikeminnow on steelhead there and recommended consideration of strategic pikeminnow population control in the upper South Fork Eel River. In 2016, of the 134 pikeminnow greater than 18 inches in length, 83% were found in just four very deep pools. This suggested that removal of large adults from just a few locations with scuba gear and spear guns could reduce predation significantly on at-risk Pacific salmon juveniles and other native fishes. The 2017 dives were, in part, to check whether this pattern of aggregation, with large adults in a restricted number of pools, would continue. We also wanted to see whether there was an appreciable change in overall numbers or in the demographics of the pikeminnow population in the index reach.

Time, Location and Conditions of Surveys

The June 29-30, 2017 dive survey of the South Fork Eel River was the same 12 miles reach as in 2016, extending from the U.S. Bureau of Land Management access at the Hermitage above the mouth of Rattlesnake Creek to Standish Hickey State Recreation Area (Figure 1), with the halfway point of the survey the Gomde Monastery at the mouth of Cedar Creek. The flow of the South Fork Eel at Leggett according to the U.S. Geologic Survey flow gauge reading varied between 85-87 cubic feet per second (cfs) during the two days of the survey (Figure 2) and the water temperature varied from 18 C to 21 C. Higher flows made it easier on divers, who could swim through riffles and runs they had to walk around in 2016, but flows were not so swift as to disrupt dive formations. Visibility was 20-25 feet; optimal survey conditions.

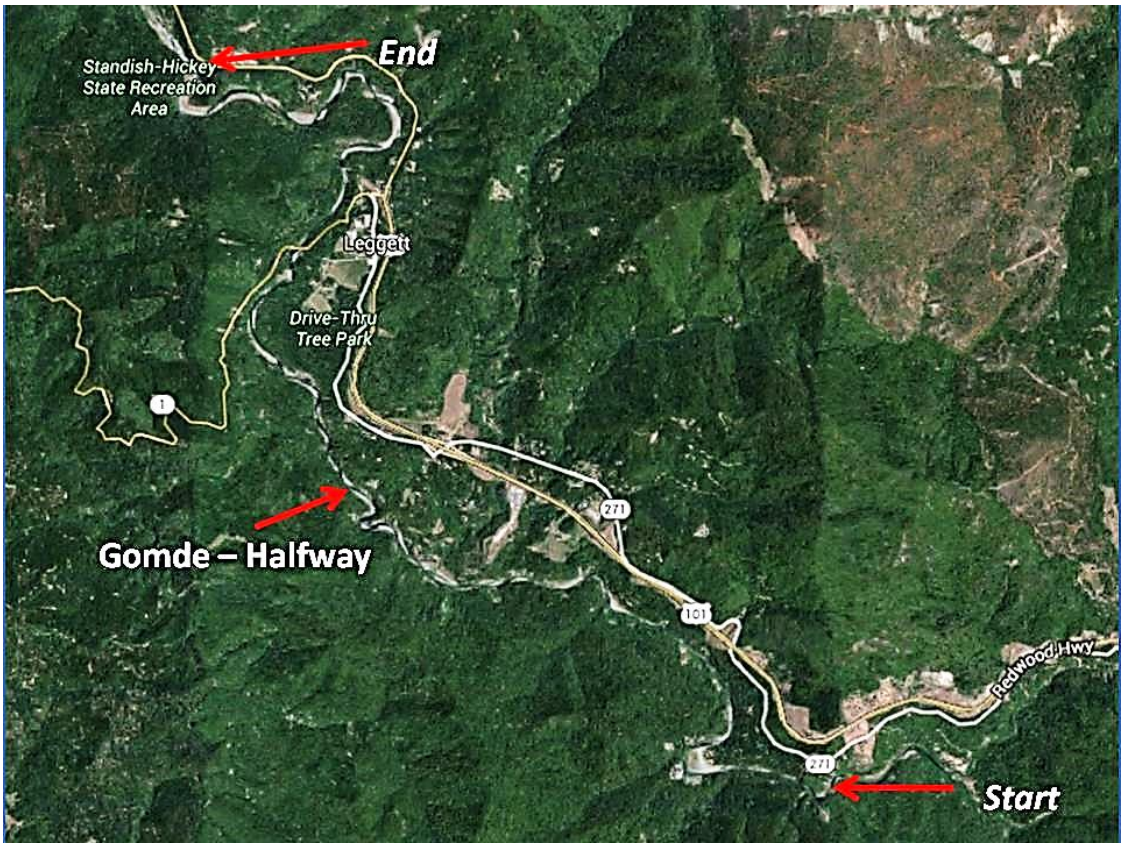


Figure 1. Map of June 29-30, 2017 South Fork Eel River ERRP Sacramento pikeminnow survey. Base map from Google Earth.

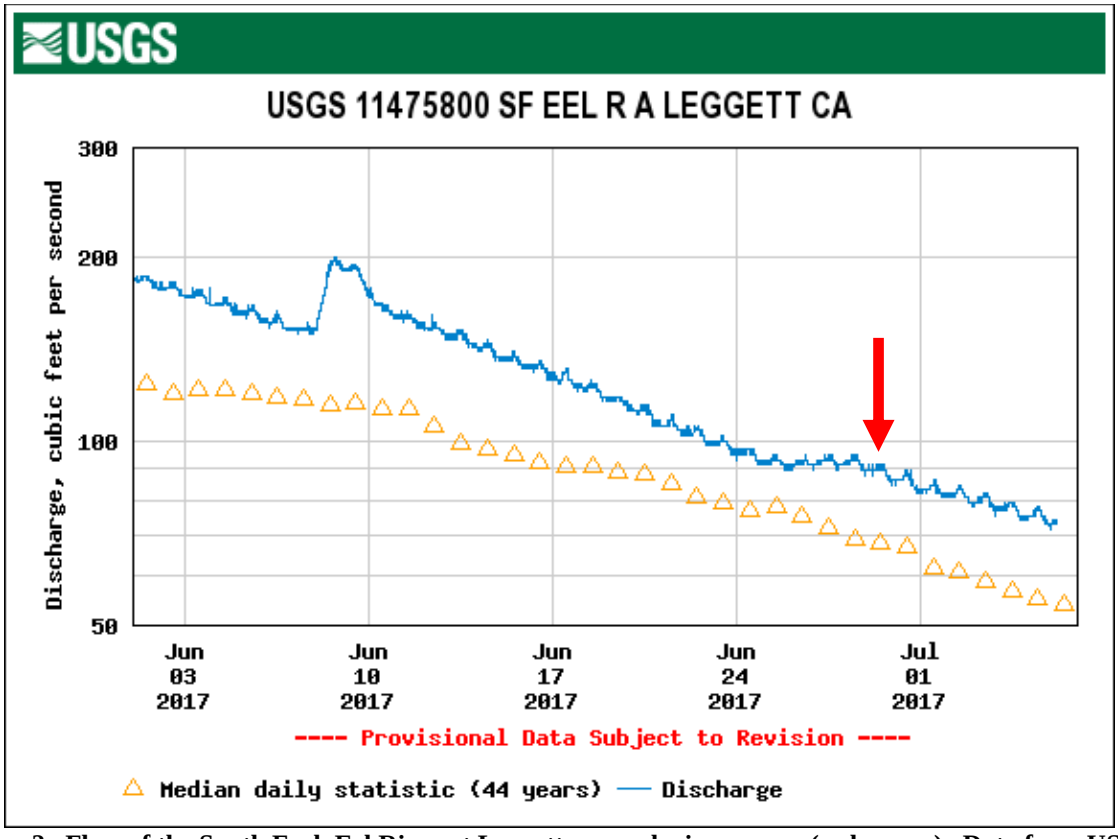


Figure2. Flow of the South Fork Eel River at Leggett gauge during survey (red arrow). Data from USGS.

Scour of willows below Camp St. Michael was evident with last winter's bedload transport creating a distinct South Fork Eel River channel, where in 2016 willows had spanned the channel (Figure 3). Major river morphology changes at a number of locations were also evident. The Highway 1 slide at Leggett was directly over the mouth of Hollow Tree Creek, several hundred feet upslope. Although Caltrans removed a great deal of the sediment that had been intercepted by the road bed, a substantial amount was still delivered and contributed to a delta at the mouth of the creek and to filling of a bedrock pool downstream that had existed in 2016 (Figure 4).

A bedrock pool just above a popular recreation access and not far downstream of Highway 1 was filled with coarse bedload and the river channel switched to the center of the floodplain and formed a cobble dominated riffle. The most dramatic shift was just above Standish Hickey, where there is a debris torrent that re-activated and massive amounts of sediment were delivered to the South Fork Eel River channel. The slide forced the river against the west bank and caused an opposing landslide. Debris deposited in the channel formed a cascade at the site and the delta of the torrent caused a pool to form upstream (Figure 5).

Despite the major indications of bedload movement, there were no large deposits of fine sediment on terraces that would indicate major sediment over-supply. Instead the bed of the active channel is coarse, in recovery, and providing good spawning substrate for salmon, steelhead, and Pacific lamprey. There were only a few patches where cyanobacteria growth was obvious and Cladophora appeared luxuriant but not excessive; therefore, there was no indication of nutrient pollution.

Figure 3. Top of South Fork Eel high gradient riffle looking downstream with opening in dense willow growth scoured by winter flows between Camp St Michael and Rattlesnake Creek. 6/29/17.

Figure 4. Hollow Tree Creek joining the South Fork, with delta from the creek extending downstream and filling what was a bedrock scour pool in 2016. 6/30/17.

Figure 5. Dive team running into pikeminnow in pool formed by delta of debris torrent. 6/30/17.

Methods

The 2017 South Fork Eel River Sacramento pikeminnow survey used exactly the same methods as in 2016 (Higgins 2017). This standard dive technique is used by the U.S. Forest Service for summer steelhead surveys in the Trinity River basin (Everest 1997), and by the California Department of Fish and Wildlife for Butte Creek spring Chinook counts in the Central Valley (Garmin 2012). Divers swim in a line in a downstream direction (Figure 6) and count only those fish that pass upstream of them. Size classes employed are the same as those applied by CDFG (1996) except that pikeminnow under four inches were not counted; ranges are from 4-8", 8-14", 14-18" and greater than 18". No effort was expended on fish less than four inches or to discern between California roach (*Hesperoleucus symmetricus*) and juvenile pikeminnow less than four inches because the latter are not predatory at that size and their survival to adulthood may be low. Since flows allowed divers to swim downstream in runs and even some riffles in 2017, counts were conducted in these habitats in addition to pools (Figure 7). Large pikeminnow adults showed a strong affinity for deep pools in the 2016 survey (Higgins 2017); therefore, divers were deployed in pools 25 feet deep or more in order to observe fish at depth that might not be visible from the surface (Figure 8).

Figure 6. Second day dive team in formation in pool just above Standish Hickey. 6/30/17

Figure 7. Dive team was able to stay abreast and check for pikeminnow in SF Eel River run. 6/30/17

Figure 8. Phil Georgakakos goes deep in a South Fork Eel River pool on day 2 of the ERRP pikeminnow survey at the Highway 1 pool in Leggett. 6/30/17.

Results

The total number of Sacramento pikeminnow over 4" in length counted over the two day survey was 1,173. The number of fish by size class was 241 in the 4 to 8 inch size class, 453 fish in the 8-14" range, 389 fish from 14-18" long, and 90 larger than 18" (Table 1) (Figure 9).

Table 1. Number of pikeminnow per size class in June 29-30 South Fork Eel River survey with convention similar to CDFG (1996).

Pikeminnow Size Class	Total Number Counted
4-8 in.	241
8-14 in.	453
14-18 in.	389
>18 in.	90
Grand Total	**1173**

Large adult pikeminnow greater than 18" were distributed more widely than in 2016, with more fish counted in shallow pools, runs and even riffle habitats. Complete count results by habitat unit are available as Appendix A. The high flow year allowed water temperatures to remain optimal or suitable for juvenile salmonid rearing and there were abundant steelhead (*Oncorhynchus mykiss)* juveniles of all age classes, including significant numbers of yearling and two year old fish (Figure 10). Not only were they more numerous than pikeminnow in runs and riffles, they were also more numerous in the majority of pools surveyed. Phil Georgakakos counted more than 100 yearling steelhead in one pool alone.

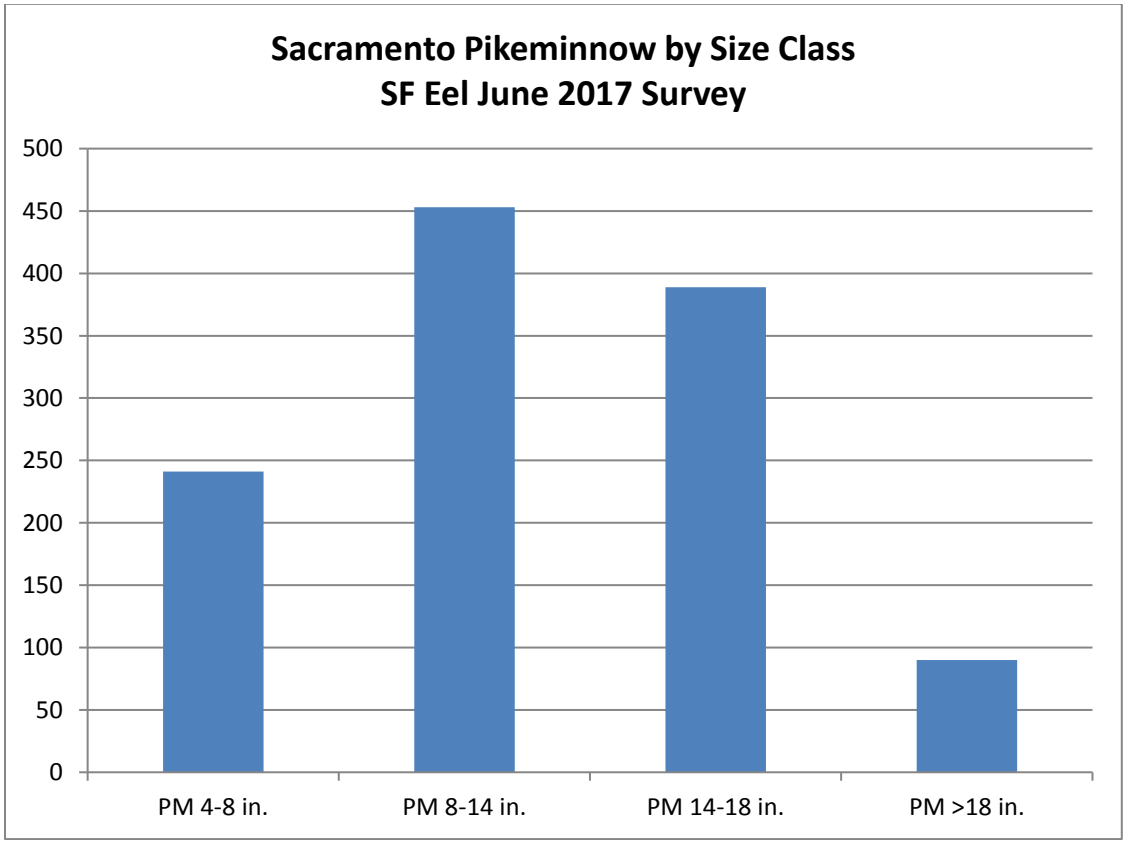


Figure 9. Sacramento pikeminnow by size class counted during June 29-30 ERRP pikeminnow survey from the Hermitage to Standish Hickey State Recreation Area. Size classes similar to CDFG (1996).

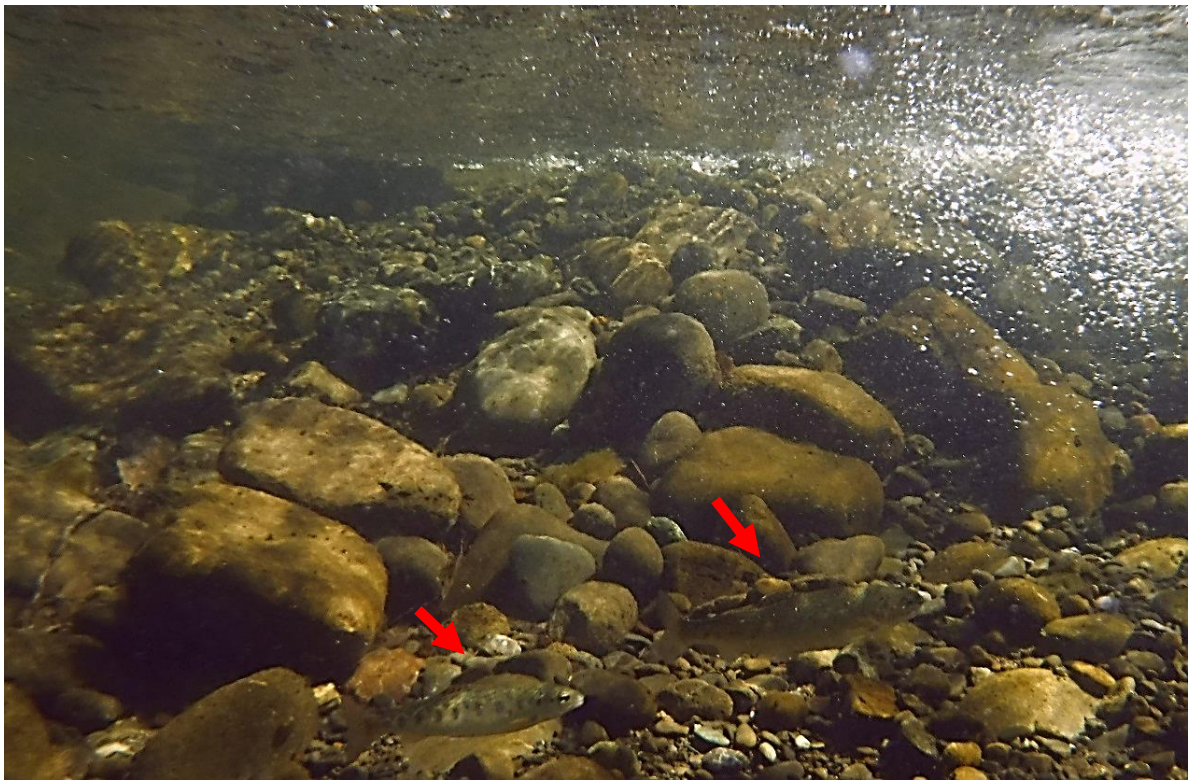


Figure 10. Two very fit 2 year old steelhead trout (red arrows) feeding in the SF Eel River at the convergence with Rattlesnake Creek. 6/29/17.

Although California roach (*Hesperoleucus symmetricus*) were widely distributed and numbered in the thousands, the patches of luxuriant Cladophora that form ideal complex habitat (Figure 11) were in fewer locations in 2017 and less extensive, likely as a result of antecedent scour. These habitats are also favored by pikeminnow under 4" in length, although there were fewer pikeminnow in proportion to roach in all habitats.

Only two native Sacramento suckers (*Catostomus occidentalis*) from 2-6 inches were seen in two days of diving, but several dozen tiny suckers (<1 inch) were observed just below Cedar Creek (Figure 12). No sculpin species (*Cottus sp*.) were noted, but several three-spined stickleback (*Gasterosteus aculeatus*) were observed in edge waters of the South Fork Eel River during the two day survey.

As in 2016, there were many Pacific lamprey redds, with hundreds observed in the 12 mile reach. The spawning season was obviously over, because there were dead lampreys in every state of decay, from recently dead and floating, to the string-like notochords lying on the bottom of pools.

A pool not far below Cedar Creek harbored a largemouth bass (*Micropterous salmoides*) of about a pound. One small green sunfish (*Lepomis cyanellus*) was also observed.

Three western pond turtles (*Actinemys marmorata*) were also noted over the two days. They were small adults with carapace diameter of approximately six inches. Rough skinned newts (*Taricha granulosa*) were seen throughout the survey in slower Edgewater habitats. No otters were seen and less otter scat was observed than in 2016.

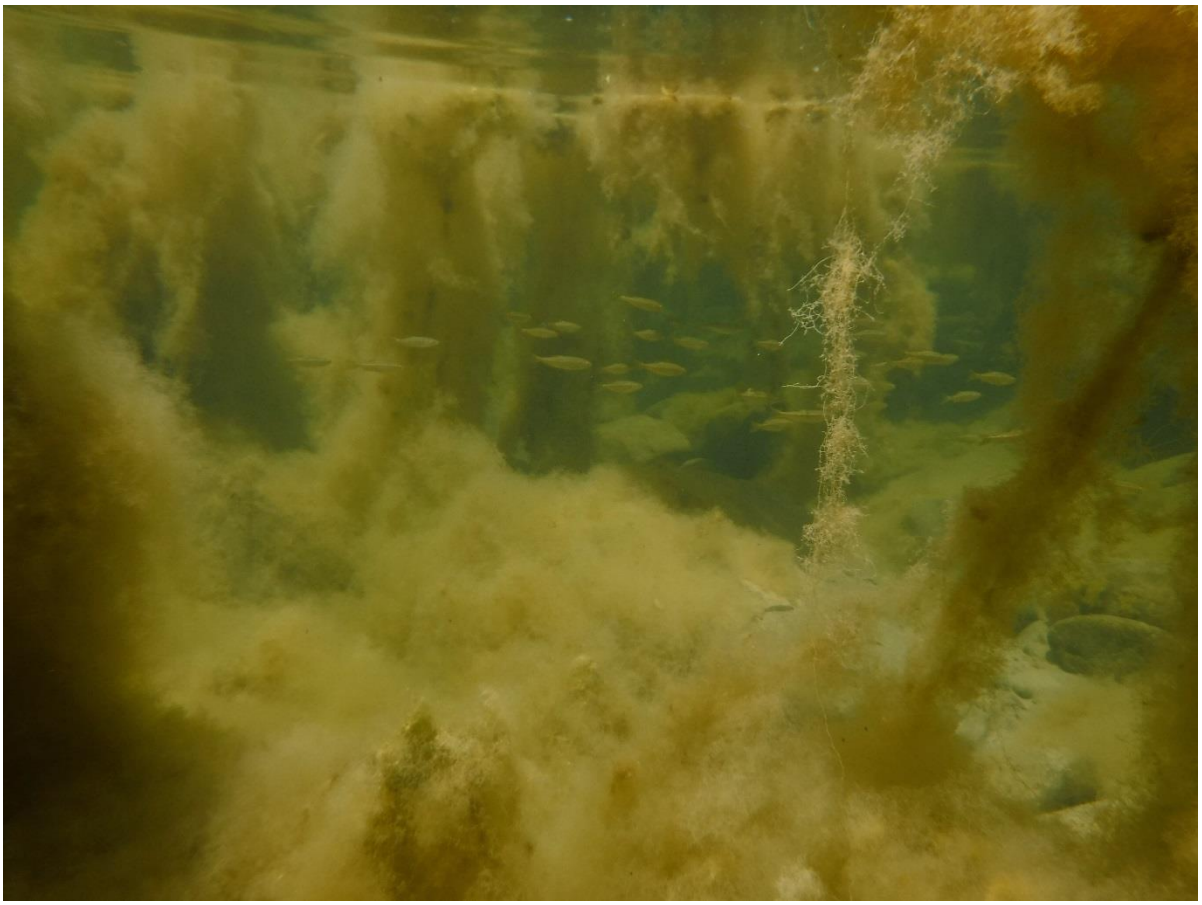


Figure 11. California roach schooling in a South Fork Eel River cove with dense algae growth. 6/29/17...

Figure 12. Fish identified as tiny Sacramento sucker in the South Fork Eel River below Cedar Creek. 6/30/17.

Discussion

The total number of pikeminnow over 4 inches in length decreased this year to 1173 as compared to 1414 fish in the 2016 baseline survey. Large adults were also fewer, with 90 counted in 2017 versus 134 last year. While smaller pikeminnow in the 4-8" category decreased substantially between the two years, 8-14" fish were similar in abundance proportionally to 2016, but the 14-18" size class increased considerably (Figure 13). The two recent wet years appear to have been very poor for recruitment of young pikeminnow. The small number of fish in the smaller size class would be consistent with weak year classes being produced. Conversely, the relative increase in the 14-18" size class probably reflects good recruitment in drought years from 2013-2015.

The dive team found only one adult pikeminnow in a very deep bedrock formed pool not far below Rattlesnake Creek, where 26 large adults greater than 18" were seen in 2016 and 56 fish over 14 inches were counted. Surface divers could see the bottom in most of the pool and Eric Stockwell dove deep twice to make sure the team wasn't missing fish. Other pools where there were large numbers of adults in 2016 had fewer in 2017. Large adults were commonly seen in what are likely ambush locations in runs and even in riffles in 2017. Pikeminnow were even noted holding, and probably feeding, in a cascade (Figure 14). This behavior may be owing to the very high number of steelhead trout that could be providing a forage. Flows were double those of 2016 and sufficient for large adult pikeminnow to move around; consequently, pikeminnow may retreat to deeper pools as the South Fork flows drop.

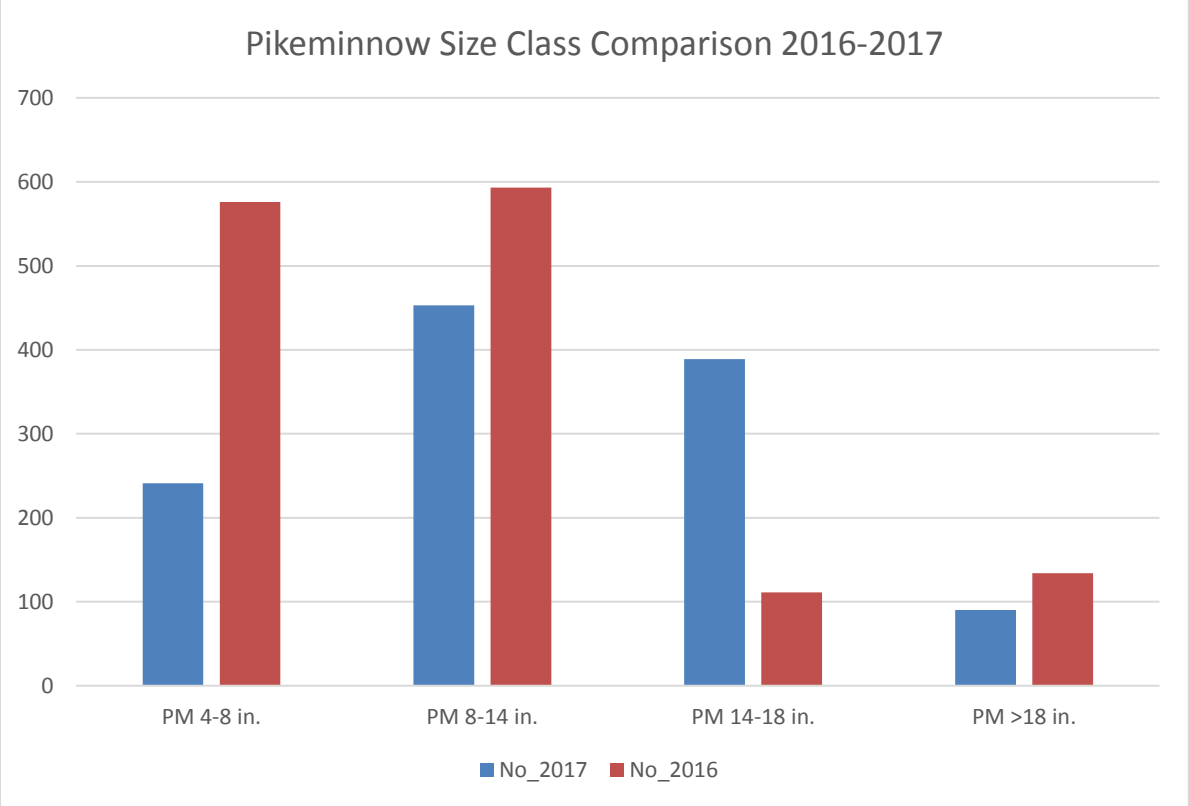


Figure 13. Comparison of pikeminnow counted in 2017 versus 2016 by size class.

Figure 14. Three 14-18" pikeminnow milling in the South Fork Eel River near cover of algae coated wood. 6/30/17.

Figure 15. Pikeminnow in the 8-14 inch size class holding under a bubble curtain in a cascade.

No adult otters were seen during the 2017 pikeminnow survey and much less otter scat was evident than in 2016, suggesting possibly less active predation in the survey reach. However, on July 1, 2017, the day after the pikeminnow dive, Ann Constantino (personal communication) photographed two otters dragging a very large pikeminnow onto the beach on the South Fork Eel near Garberville (Figure 16 & 17). The fish's underside is exposed in one photo and an extruded ovipositor indicates it was a large, gravid female or one that had just spawned. The pikeminnow is nearly as long as the adult otter and appears to be approaching three feet in length. The largest Sacramento pikeminnow ever measured was 46 inches in length and some as old as 16 years have been recorded (Fishbase 2017).

Figure 16. Otters dragging large pikeminnow on to bank near Garberville. The protruding ovipositor is highlighted (red oval). Photo by Ann Constantino. 7/1/17.

Figure 17. Otter eating large pikeminnow on SF Eel near Garberville. Photo by Ann Constantino. 7/1/17.

Studies of piscivory by the closely related Northern Pikeminnow in the Columbia River and the potential benefits of population control to limit predation (Rieman and Beamesderfer 1990) apply in the Eel River. Simulation modeling conducted by Rieman and Beamesderfer (1990) suggests that long-term pikeminnow removal efforts that take 10 - 20% of pikeminnow longer than about 12 inches total length could decrease predation on juvenile salmonids by 50% or more in John Day Reservoir. They stressed that predation by individuals greater than 16 inches (400 mm) was the most problematic. Given that growth conditions for Sacramento pikeminnow in the Eel River may be less favorable than for Northern pikeminnow in John Day Reservoir, and that greater reductions of large pikeminnow may be possible in the former, persistent pikeminnow removal efforts in the South Fork Eel River could significantly reduce predation on native fishes. Therefore, ERRP will be seeking to attempt just such a "press disturbance" (Glasby and Underwood 1996) where large adults are annually removed for a period of 10 years beginning in 2019.

Although 86% of adult pikeminnow counted during the 2017 were in pools, they were not just found in four deep pools, but rather were spread out in 21 pools in the 12 mile reach. This would make pikeminnow removal more challenging than if the largest adult fish were in just a few pools. Otter predation and harassment of large adult pikeminnow in the survey reach may vary as families work different reaches of the river and its tributaries for different food resources during periods of varying flow. The recent huge lamprey run has been providing a major foraging opportunity (Figure 18) and the attention of the otters may shift back to pikeminnow after lamprey spawning and carcass decay is completed. This might, therefore, also be a factor in forcing the large pikeminnow back into deep pools or into pools with large wood jams.

Figure 18. Otter eating a large Pacific lamprey on the South Fork Eel River at Piercy, with younger otter hoping to share the kill. Photo by Talia Rose. 7/6/17.

Recommendations

- Continue Sacramento pikeminnow trend data collection in 2018 on the South Fork Eel River from Rattlesnake Creek to Standish-Hickey State Park.
- Expand volunteer surveys to other Eel River reaches and encourage volunteers to collect data and supply photo and video documentation of the distribution and abundance of large adult pikeminnow in 2017 and 2018.
- Obtain permits from the California Department of Fish and Wildlife and NMFS for strategic removal of large adult pikeminnow as a pilot project on the upper South Fork Eel River in 2019.
- Continue to explore opportunities for collaboration with the University of California and Humboldt State University to study Eel River otters and interaction with pikeminnow, and also population trends of non-game native fish, such as the Sacramento sucker and sculpin species.

Conclusion

Although the 2017 total number of pikeminnow over four inches long declined somewhat to 1173 from 1414 in 2016, additional data are needed to discern whether we are discerning population trends. However, the fewer number of small pikeminnow and the relative increase in the 14-18" size group do suggest demographic shifts, with poor recruitment in the last two wet years and better recruitment in the 2013-2015 drought. Large adult pikeminnow were often in locations that were shallower than during the baseline survey, and it is likely they were actively predating upon juvenile salmonids. Spot checks later this year when flows drop to 55 cfs or lower will be used to see if larger pikeminnow once again concentrate in only the deepest pools once flows drop. Dives beginning in 2019 to remove large pikeminnow should probably be held later in summer when flows are at their lowest.

The National Marine Fisheries Service (NMFS 2014) *Southern Oregon/Northern California Conservation (SONCC) Coho Salmon Recovery Plan* notes that "predation by Sacramento pikeminnow is a significant concern in the South Fork Eel River population area, as well as throughout the Eel River watershed." The *SONCC Coho Recovery Plan* (NMFS 2014) also ranks pikeminnow removal among its top priorities. Eel River fisheries planning documents and restoration plans for nearly 40 years have identified the pikeminnow as a problem for salmonids and native fishes and most have called for their suppression and removal (Upper Eel River Task Force 1992, USFS and BOR 1995, NMFS 2002).

ERRP will seek appropriate permits and resources to begin a pilot pikeminnow removal project in the South Fork Eel index reach in 2019, continue suppression for at least 10 years, and expand to other river reaches, if justified and feasible. Annual removal efforts will be preceded by trend monitoring counts for the purpose of adaptive management.

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Appendix 1. Sacramento pikeminnow data from ERRP June 29-30, 2017 South Fork Eel River – Rattlesnake Creek to Standish Hickey State Recreation Area survey.

Hab Unit	_4_8	8_14	14_18	_18_Over	Hab_Type
Unit 1	6	0	0	1	P
Unit 2	0	20	4	1	R
Unit 3	0	12	10	0	R
Unit 4	2	1	0	0	R
Unit 5	0	0	0	1	R
Unit 6	0	0	1	0	R
Unit 7	8	0	0	1	P
Unit 8	0	0	0	1	P
Unit 9	0	48	48	8	P
Unit 10	0	0	1	1	R
Unit 11	0	1	2	1	P
Unit 12	0	8	6	1	P
Unit 13	0	14	1	0	P
Unit 14	4	3	1	0	P
Unit 15	12	38	16	0	R
Unit 16	50	0	8	5	P
Unit 17	0	0	3	0	P
Unit 18	6	17	15	12	P
Unit 1 D2	0	1	0	0	P
Unit 2 D2	36	1	0	0	R
Unit 3 D2	0	99	13	4	P
Unit 4 D2	0	0	1	1	P
Unit 5 D2	20	2	1	0	P
Unit 6 D2	0	0	1	0	R
Unit 7 D2	0	9	23	8	P
Unit 8 D2	1	0	0	0	P
Unit 9 D2	36	30	36	13	P
Unit 10 D2	1	0	0	0	R
Unit 11 D2	7	0	1	1	P
Unit 12 D2	8	0	2	1	P
Unit 13 D2	7	3	1	0	P
Unit 14 D2	5	7	3	1	P
Unit 15 D2	14	1	0	0	P
Unit 16 D2	14	12	23	7	P
Unit 17 D2	0	0	0	3	P
Unit 18 D2	2	1	0	0	R
Unit 19 D2	0	11	7	1	P
Unit 20 D2	0	0	0	3	R
Unit 21 D2	0	0	40	2	R
Unit 22 D2	0	0	40	2	P
Unit 24 D2	0	0	1	0	R

Hab Unit	_4_8	8_14	14_18	_18_Over	Hab_Type
Unit 25 D2	0	0	2	0	R
Unit 26 D2	0	34	11	0	R
Unit 27 D2	0	29	53	5	R
Unit 28 D2	2	1	0	0	R
Unit 29 D2	0	28	5	2	P
Unit 30 D2	0	22	9	3	P
Grand Total	**241**	**453**	**389**	**90**	**1173**