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Chorro Creek Pikeminnow Management Plan

PREPARED FOR

The Bay Foundation of Morro Bay
601 Embarcadero
Morro Bay, CA 93442

PREPARED BY

Stillwater Sciences
895 Napa Ave, Suite B4
Morro Bay, CA 93442

Stillwater Sciences

For more information:
Ethan Bell, Stillwater Sciences, (805) 570-7499, ethan@stillwatersci.com

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Cover photo: San Luisito Creek, Chorro Creek Watershed.

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1 INTRODUCTION

1.1 Background

Two listed aquatic species occur in the Chorro Creek watershed: California red legged-frog (CRLF) (*Rana draytonii*), and steelhead (anadromous *Onchorhynchus mykiss*). CRLF are listed as threatened under the Federal Endangered Species Act. Existing information on CRLF in the Chorro Creek watershed is based mostly on annual surveys conducted by the California National Army Guard since 1996, which documents the annual distribution and relative abundance in the portion of the watershed within the Camp San Luis Obispo National Guard Property (Figure 1). Based on this data, CRLF are currently documented to occur within most the areas with the Chorro Creek watershed where surveys have been conducted (California National Army Guard 2016), and it is assumed CRLF potentially occur throughout the watershed.

Steelhead found in the Chorro Creek watershed belong to the South-Central California Coast Distinct Population Segment (DPS), which includes most streams in Monterey, San Benito, Santa Clara, Santa Cruz, and San Luis Obispo counties between the Pajaro River and the Santa Maria River (NMFS 1997, 2006). This DPS is listed as threatened under the Federal Endangered Species Act. Rainbow trout (resident *O. mykiss*) found in the watershed upstream of the Chorro Creek Reservoir (impassable fish passage barrier) have no listing status. Existing information on steelhead in the watershed is based on snorkel surveys in 20 pools in 2001 (TRPA 2001), a fish passage assessment in 2003 (Taylor and Associates 2003), infrequent habitat surveys (e.g., NEP unpubl. data), a two-year effort to survey and remove pikeminnow in the mainstem and lower tributaries (Halligan and Otte 2011), regular California Department of Fish and Wildlife (CDFW) electrofishing surveys in various pools in mainstem Chorro Creek (CDFW, unpubl. data), and snorkel surveys that have been conducted in 2012 and 2016 to document species distribution and relative abundance (California Conservation Corp, unpubl. Data 2016). Based on this research, the general distribution, size structure, and relative abundance of both steelhead and pikeminnow is generally known.

Chorro Creek is in the San Luis Obispo Terrace Biogeographic Population Group (BPG); steelhead in the watershed are classified as a “Core 2” population by National Marine Fisheries Service (NMFS). As defined by NMFS (2013), Core 2 populations are ranked slightly lower than Core 1 populations for recovery action priority, but form part of the overall recovery strategy and contribute to the set of populations necessary to meet recovery criteria, such as minimum numbers of viable populations needed within a BPG. As with Core 1 populations, Core 2 populations must meet biological recovery criteria described in the South-Central California Steelhead Recovery Plan (NMFS 2013).

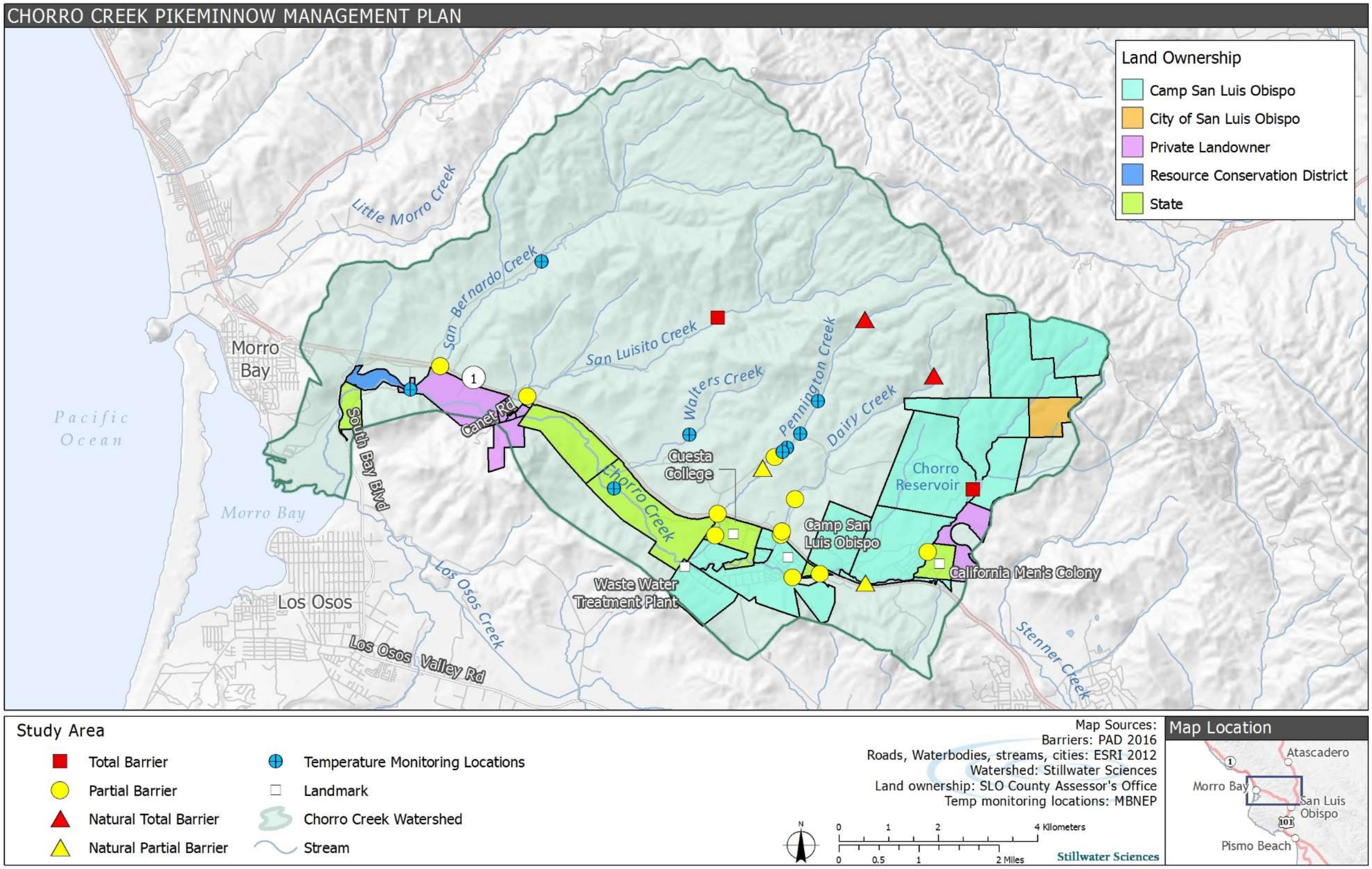

Figure 1. Chorro Creek watershed.

The Chorro Creek watershed has several resiliency factors that provide a higher potential for steelhead recovery than in other watersheds in the DPS, including perennial and continuous flows in the mainstem downstream of the Waste Water Treatment Plan (Figure 1) that provide year-round migratory connectivity to a productive estuary (Morro Bay), good riparian canopy, moderate summer water temperatures, suitable winter rearing habitat, and a relatively small urban footprint. However, the presence of an invasive population of Sacramento pikeminnow (*Ptychocheilus grandis*; hereafter referred to as pikeminnow) in the Chorro Creek watershed inhibits steelhead recovery by reducing juvenile abundance and survival through predation and competition for food and habitat. Pikeminnow are regularly observed in mainstem Chorro Creek (Figure 1), and have been documented to prey on steelhead based on stomach analysis (Halligan and Otte 2011). Fish larger than 200 mm feed almost exclusively on fish and crayfish (Brown and Brasher 1995). In the Eel River, Nakamoto and Harvey (2003) reported 44% of Sacramento pikeminnow >250 mm standard length (SL) captured from one location on the South Fork Eel River contained juvenile salmonids (n=43). Predation by northern pikeminnow (*Ptychocheilus oregonensis*) was estimated to account for the mean annual loss of more than 2 million juvenile salmonids per year in the John Day Reservoir (Rieman et al. 1991). Mean daily consumption rates of northern pikeminnow were estimated to range from approximately 0.14 up to 2.0 juvenile salmonids per northern pikeminnow in John Day Reservoir on the Columbia River (Vigg et al. 1991). Moreover, as juveniles, pikeminnow have a similar diet to juvenile steelhead putting them in direct competition for resources. Reese and Harvey (2002) found steelhead growth was reduced by more than 50% when pikeminnow were present compared to growth without pikeminnow.

Sacramento pikeminnow have also been reported to prey heavily on frogs from locations where California red-legged frogs occur, although the species of frog consumed by pikeminnow were not specified in the literature reviewed. For example, Brown and Moyle (1996) reported that in the Eel River adult frogs and tadpoles were common prey for pikeminnow. Nakamoto and Harvey (2003) studied feeding habits of Sacramento pikeminnow and suggest that ranids (including CRLF) in particular may be significantly affected by pikeminnow due to the susceptibility of tadpoles and adults during egg deposition.

Chorro Reservoir has been identified as the upstream most source of pikeminnow in the watershed (Figure 1); in surveys conducted in tributaries upstream, no pikeminnow have been documented (HTC 2008). Moyle (2002) reports that Sacramento pikeminnow were introduced into the Chorro Creek drainage sometime in the mid-1970s via the aqueduct system from the Salinas River drainage, although others have speculated that anglers may have introduced them around the same time (HTC 2008). Under current conditions, the reservoir does not receive water from the aqueduct, and heavy security prevents angler access; thus additional transfer of pikeminnow to the reservoir by anglers is unlikely. Pikeminnow are expected to wash downstream into Chorro Creek during high flow events when water is flowing over the spillway. There is no upstream passage at Chorro Reservoir Dam, which prevents fish from moving from Lower Chorro Creek into the reservoir. Largemouth bass (*Micropterus salmoides*) occur within the reservoir, and are documented predators on pikeminnow and frogs. Largemouth bass are infrequently observed in Chorro Creek downstream of the reservoir in low abundance, and don't appear to have an established population there (D. Michniuk, CDFW, pers. comm. 2017).

Sacramento Pikeminnow are more tolerant to warm water temperatures than steelhead (Cech et al. 1990). Conversely, cool water temperatures may limit pikeminnow distribution and reduce competition between juvenile steelhead and juvenile pikeminnow (Harvey et al. 2002, Reese and Harvey 2002). The Morro Bay National Estuary Program (NEP) has conducted water temperature monitoring in the Chorro Creek watershed using continuous monitoring thermographs. Water temperatures in the mainstem Chorro Creek are often more than 20°C during summer (and cool in a downstream gradient), while water temperatures in tributaries are generally less than 19°C (Kitajima 2016). Reese and Harvey (2002) found that in a laboratory stream steelhead had high growth rates and a competitive advantage over Sacramento pikeminnow at water temperatures 15–18°C, advantages that were lost when water temperatures were 20–23°C and growth of steelhead was reduced by more than 50%. Increasing steelhead access to quality habitat in cool water tributaries by providing fish passage at existing migration barriers (see Taylor and Associates 2003) was identified as one of the highest priority recovery actions by NMFS (2013), and would provide steelhead a competitive advantage over pikeminnow. Hilderbrand and Kershner (2000) found that native cutthroat populations competing with non-native species have increasingly greater likelihood of persistence with increasing access to habitat. Access to substantial tributary habitat is critical to the maintenance of steelhead populations in areas where both pikeminnow and steelhead coexist (e.g., Sacramento River). In a study of a tributary to the Sacramento River (Deer Creek), Dettman (1973) found that as temperatures decreased upstream in the tributary, *O. mykiss* density increased, while Sacramento pikeminnow density decreased. Similarly, Harvey et al. 2002 looked at fifteen tributaries to the Eel River and found juvenile steelhead abundance was greater than juvenile pikeminnow in cool tributaries. Overall, cold water tributaries may limit pikeminnow distribution while providing high quality habitat for steelhead. No comprehensive surveys have been conducted in tributaries to Chorro Creek, but infrequent observations indicate generally low abundance of pikeminnow in tributaries. Barrier removal to increase access for steelhead to tributaries within the Chorro Watershed is considered a high priority restoration action and would increase their resistance to disturbance, including pressure from pikeminnow. However, management agencies have been hesitant to fund habitat restoration until a long-term plan for managing pikeminnow is developed.

In recognition of the role that pikeminnow play, both in suppressing the steelhead population through competition and predation and being an obstacle to funding important habitat restoration projects, design and implementation of an efficient and effective pikeminnow control strategy is included as a high priority action in the NMFS (2013) recovery plan.

The threat to CRLFs from non-native fish is discussed in the Recovery Plan for the California Red-legged Frog (USFWS 2002), including actions targeting the reduction and/or removal of non-native fish from watersheds that support California red-legged frog. Specifically, Recovery Action 4 in the recovery plan is listed as, “Control/eliminate non-native species/predators (plants, vertebrates, invertebrates) using methods that are determined to be the most effective.” Furthermore, the action goes on to state, “Watersheds that support the California red-legged frog should be allowed to revert to either a fishless system or a community of native aquatic species, depending on the historic conditions (USFWS 2002).” Efforts to reduce predatory fish have resulted in increased densities of CRLF and Mountain yellow-legged frog following suppression efforts (Gilliland 2010, Knapp et al. 2007).

1.2 Goals and Criteria for Success

The goal of the Chorro Creek Pikeminnow Management Plan described herein is to develop and implement a comprehensive program to control the pikeminnow population in the watershed to a level that results in a measurable and meaningful increase in the survival of steelhead. The goal is to implement the plan in a manner that also benefits CRLF by reducing the pikeminnow population using methods that do not harm CRLF.

It is not realistic to expect complete eradication of pikeminnow in the Chorro Creek watershed due to the inability to remove all individuals (especially smaller size classes), but it is likely possible to control the population sufficiently to decrease the impact exerted by pikeminnow on the native steelhead population. The implicit question is, at what point is the pikeminnow population controlled *enough* to implement the remaining high priority actions of the steelhead recovery plan? Numerous invasive species management programs have been initiated throughout the United States to help restore impacted native species (Table 1). In many cases, the success of programs is evaluated based on long-term population monitoring of the target species (e.g., sea lamprey management program in the Great Lakes; Steeves et al. 2012). Within the Columbia River, a northern pikeminnow management program has been in place for several years, with an annual target reduction rate of 10–20%. This reduction rate of northern pikeminnow population is estimated to equate to a 50% annual reduction in predation to juvenile salmonids (Rieman and Beamesderfer 1990).

Table 1. Summary of metrics for success in invasive fish management programs.

Location	Aquatic invasive species	Methods employed	Metrics for success	Reference
Columbia River	Northern pikeminnow	Primarily angler catch	10–20% annual population reduction; estimated to reduce predation on juvenile salmonids by 50%	Rieman and Beamesderfer (1990)
Colorado River	Northern pike, walleye, smallmouth bass, etc.	Barriers, fishing tournaments, increase angler harvest, flow alteration	None specified, goals include reduction or eradication	Martinez et al. 2014
Great Lakes	Sea lamprey	Lampricide and other control measures primarily focused on reducing reproduction rates	Summaries of current spawning-phase sea lamprey abundance, counts of sea lamprey marks on lean lake trout >533 mm, and lake trout relative abundance in each lake are the primary metrics used to gauge success of the sea lamprey control program. The status of sea lampreys in each of the Great Lakes is measured by comparing annual abundance	Steeves et al. 2012
Lake Tahoe	Warm water fish species (Bass and sunfish)	Mechanical fish removal	Quantification of areal coverage and density of warm water fish and native fish are monitored before and after removal efforts from within treatment and control areas.	Wittmann and Chandra 2015
Dolores River Colorado	Brown trout and smallmouth bass	Electrofishing, seining, and peak flow releases	Densities of brown trout at or below 50 fish per mile Decreasing smallmouth bass abundance and size structure.	American Whitewater et al. 2012

Location	Aquatic invasive species	Methods employed	Metrics for success	Reference
Upper Mississippi River	Asian carp	Barriers, introduction of sterile carp to produce sterile offspring, increase native predators to eradicate carp	Complete eradication	Conover et al. 2007
Yellowstone Lake	Lake Trout	Primarily gill netting and trap netting	For Lake trout: declining catch rates based on population growth rate targets (e.g. catch rates should decline relative to declining population) For Cutthroat: target CPUE based on historic data, strong recruitment,	Gresswell et al. 2015

Ultimately, success will be achieved if the smolt production of anadromous steelhead in the Chorro Creek watershed increases in response to suppression efforts. An "acceptable" target population for pikeminnow will eventually be based on assessing bioenergetics of pikeminnow to estimate the population's potential annual steelhead consumption potential compared with the estimated steelhead smolt production potential in the watershed. Initially, a definition of success will be defined as suppressing the adult pikeminnow population in the reservoir sufficiently to ensure it has minimal ability to reproduce and contribute progeny to downstream habitat, and secondly, suppressing the adult population of pikeminnow in the watershed downstream of the reservoir sufficiently to ensure it has minimal ability for direct mortality on juvenile steelhead. Specifically, initial targets for success are:

- Less than 3 adult (> 200 mm SL) pikeminnow captured annually in Chorro Reservoir with an annual effort of at least 200 net-hours[1] of sampling;
- Less than 20 sub-adult/adult (> 200 mm SL)[2] pikeminnow observed annually in comprehensive snorkel surveys in Chorro Creek and tributaries; and
- Ratio of steelhead (all ages) to pikeminnow (all ages) of ≥1:1 in habitat units sampled with multiple pass electrofishing.

These targets are anticipated to be achieved within five years, assuming full implementation of this plan. In Chorro Reservoir the target of capturing less than three adult pikeminnow annually is anticipated to be achieved within four years, assuming that the pikeminnow population has fully rebounded to 40 pikeminnow since the last removal effort in 2008, and based on the reduction rate of previous reservoir gill netting efforts (HTC 2008).

In Chorro Creek and tributaries, the target of observing less than 20 pikeminnow >200 mm annually is anticipated to be achieved within five years. This assumes that the population has fully rebounded to 450 pikeminnow > 200 mm since reduction efforts ceased in 2010 (Halligan and Otte 2011), and an annual reduction rate of 50% which is similar to what was observed by Halligan and Otte 2011 (53-58%).

[1] Net hours equals the number of hours of sampling multiplied by the number of nets used (e.g., 200 net hours equals 20 hrs x 10 nets)

[2] 200 mm corresponds with the length at which pikeminnow diet becomes almost exclusively comprised of fish and crayfish (Brown and Brasher 1995) and it is below the length of reproductive age fish (220-250mm) reported in Moyle 2002.

The target for success of ≥1:1 ratio of steelhead (all ages) to pikeminnow (all ages) is expected to take one year based on observations of steelhead reported in Halligan and Otte (2011), which result in ratios for steelhead to pikeminnow ranging from 0.8:1.0 up to 1.6:1.0 using the average number of steelhead observed during the three-year effort compared with annual numbers of pikeminnow removed.

This management plan is intended to be adaptive, where methods and target efforts are periodically refined based on survey results and changes in technology. These success targets will be refined through this adaptive management process as more information on pikeminnow and steelhead population size and dynamics is gained. This plan is not intended to provide detailed methodology for specific field efforts. Instead, it is anticipated that detailed work plans describing the field methods needed for achieving each objective will be developed as appropriate.

1.3 Objectives

The program will be implemented in a manner that addresses the data gaps listed above and sufficiently demonstrates success, so that recovery actions to benefit steelhead, such as barrier removal, can be implemented in the watershed. The objectives of this plan include:

1. Suppress the pikeminnow population to meet success criteria defined in Task 1.2; and
2. Monitor the effect of control efforts on pikeminnow and steelhead.
3. Identify tributary restoration (e.g., barrier removal) priorities based on locations where water temperature would prevent pikeminnow use while benefiting steelhead.

Achieving these three objectives will involve collecting specific data and analysis, including:

- Accurately estimating abundance and density of steelhead and pikeminnow;
- Determining the distribution of pikeminnow in Chorro Creek downstream of the reservoir (especially spawning locations);
- Assessing the relationship between species distribution and environmental factors (e.g., water temperature);
- Estimating annual consumption of steelhead by pikeminnow;
- Estimating the potential smolt production in the watershed;
- Evaluating the response of both populations to control efforts, including abundance, size, and age structure of pikeminnow and steelhead populations; and
- Determining the amount of management effort required to control pikeminnow enough to benefit the steelhead population.

1.4 Program Leadership

This plan was developed in coordination with various watershed stakeholders. Successful adoption of this long-term plan will be overseen by the Morro Bay NEP which will provide project coordination and oversight, reporting, and outreach including landowner access, and coordination. Implementation of management efforts, including data collection and suppression efforts, will be by several potential partners, including the Morro Bay NEP, California Conservation Corps (CCC), WSP, NOAA, Central Coast Salmon Enhancement (CCSE), the Coastal San Luis Resource Conservation District (RCD), and contracted technical expertise as appropriate. Funding for plan implementation will come from various sources primarily through grant opportunities which will be pursued by the Morro Bay NEP.

1.5 Adaptive Management

This plan is intended to guide management of pikeminnow in the Chorro Creek watershed for five years, from 2017 through 2021, consistent with the federal and state permits currently in place for the project. An annual effort is required to successfully control pikeminnow, because a one-time removal may actually lead to an increase in reproduction (similar to population response after natural disturbance), and increased survival of young pikeminnow in the absence of a cannibalistic predator (Rieman and Beamesderfer 1990). However, the level of effort required each year is likely to vary. Therefore, this plan is intended to be implemented with monitoring in an adaptive management framework. The monitoring and adaptive management framework is based on general scientific principles, where uncertainties are identified and then evaluated in a practical manner through focused monitoring, leading to a progressive improvement in understanding of the issue over time. The resulting improved understanding is then used to refine monitoring and implementation to improve effectiveness (i.e., the number of target predators removed) and efficiency (i.e., cost per predator removed) in meeting project goals and reducing uncertainty. Annual reporting of the monitoring results and success of the program will allow regular revisions of this plan to refine implementation strategies based on new information. After the five-year timeframe, a comprehensive report will be completed that reviews all efforts to date and develops a management plan for future efforts (over the next five years) based on the state of pikeminnow population (distribution, abundance, and age structure).

1.5.1 Technical Advisory Committee

Implementation of this adaptive management program will involve regional stakeholders through the continued engagement of a Technical Advisory Committee (TAC). To date, the TAC includes a diversity of agency, academic and non-governmental organizations (Table 2). The continuing role of the TAC under this program will include providing technical input on the approach and work plans, providing insight during implementation of the project, and reviewing all final deliverables. In this capacity the TAC will review annual monitoring results and assist in the adaptation of methods and approach to increase the effectiveness and efficiency of the program. In addition to the TAC, outreach to landowners in the watershed will occur, and is considered critical to project success.

Table 2. Pikeminnow Technical Advisory Committee.

Name	Representation	Email
David Boughton	NMFS	David.boughton@noaa.gov
Anthony Spina	NMFS	Anthony.spina@noaa.gov
Stacie Smith	NMFS	Stacie.smith@noaa.gov
Freddy Otte	City of San Luis Obispo	fotte@slocity.org
Meredith Hardy	CCC	Meredith.hardy@ccc.ca.gov
Dennis Michnuik	CDFW	Dennis.michniuk@wildlife.ca.gov
Dave Highland	CDFW	Dave.highland@wildlife.ca.gov
Anna Halligan	Trout Unlimited	ahalligan@tu.org
Ross Taylor	Ross Taylor and Associates	rossntaylor@sbcglobal.net
Crow White	Cal Poly	cwhite31@calpoly.edu
Bret Harvey	USFS	Bch3@humboldt.edu
Jen Nix	Coastal San Luis RCD	jnix@coastalrcd.org

Name	Representation	Email
Peter Moyle	UC Davis	pbmoyle@ucdavis.edu
Paige Farrell	CA Army National Guard	paige.k.farrell.nfg@mail.mil
Michael Moore	CA Army National Guard	michael.l.moore15.nfg@mail.mil
Stephnie Wald	Morro Bay NEP	Swald@mbnep.org
Devin Best	Upper Salinas-Las Tablas RCD	devin@us-ltrcd.org
Brian Dugas	Terra Verde Consulting	bdugas@terraverdeweb.com

2 APPROACH

2.1 General Approach

The general approach to achieve program objectives will be conducting annual, scalable, suppression/control efforts in an adaptive management framework. The target of removal efforts will be large, piscivorous adults, with the goal of removing adults prior to spawning, consistent with the guidance of Rieman and Beamesderfer (1990) and Nakamoto and Harvey (2003). Pikeminnow suppression efforts will focus on the identified source population in Chorro Reservoir. Chorro Reservoir is considered the source population since it is the uppermost extent of pikeminnow distribution in the watershed. It is assumed that pikeminnow are periodically washed downstream over the spillway during wet years. There is no upstream passage from Chorro Creek into the reservoir only downstream passage and no native fish occur within the reservoir. Therefore, methods used there will be more intensive (while maintaining sensitivity to protect CRLF).

Suppression efforts will also be conducted from within mainstem and tributaries locations downstream of the reservoir with the following approach: (1) conduct annual snorkel surveys to identify current distribution and abundance of steelhead, pikeminnow, and CRLF to monitor the effect and guide the future of suppression efforts; and (2) conduct targeted suppression efforts in areas with either spawning and/or abundant pikeminnow using methods sensitive to native species. Recommended field methods for implementing the general approach are outlined below, assuming funding is available for a full annual implementation of this plan. However, in the case that only partial funding is available, discussions with the TAC of the current data and priorities will direct the most appropriate effort with available resources.

2.2 Study Area

Efforts to control pikeminnow will occur throughout the entire Chorro Creek watershed (Figure 1). Relevant locations are discussed below.

2.2.1 Chorro Reservoir

Depending on water levels, Chorro Reservoir (Figure 2) has a surface area of approximately seven to nine acres, with water depths on the margins of around six to nine feet, and a maximum depth of approximately 12 feet (HTC 2008). The width of the reservoir is typically around 300 feet when the reservoir is full. There are also two sediment basins upstream of the reservoir, which have been dry in recent years. Likely methods to be implemented for pikeminnow control and population monitoring in the reservoir and sediment basins, and required landowner access approvals, are discussed in Section 2.4.1.

Figure 2. Chorro Reservoir.

2.2.2 Chorro Creek

Suppression and population monitoring efforts in Chorro Creek will be conducted in the mainstem from Chorro Reservoir downstream to the tidal extent of Morro Bay. Although high abundance of pikeminnow has not been documented to occur within tributaries, monitoring surveys will also be conducted within certain tributaries to determine if rearing or spawning is occurring there. Dairy Creek, Pennington Creek, Walters Creek, San Luisito Creek, and San Bernardo Creek will be included for monitoring and potentially suppression.

2.3 Habitat Typing

Habitat typing data will support monitoring the distribution and relative abundance of both steelhead and pikeminnow, as well as evaluating patterns in habitat use, and will be used to estimate abundance within mainstem Chorro Creek. During representative summer low-flow conditions, all stream habitat from the tidal extent of Morro Bay upstream to Chorro Reservoir (14 miles of habitat) and the lower reaches of accessible tributaries (approximately 18 miles total of tributary habitat) will be habitat typed at the mesohabitat unit scale (e.g., pools, riffles, runs, and others). Habitat typing protocols will be consistent with those specified in the California Department of Fish and Game Salmonid Habitat Restoration Manual (Flosi et al. 2010). Each mesohabitat unit type will be documented, along with length, width, and depth. Habitat unit boundaries will be marked with flagging in the field to facilitate unit identification during subsequent fish sampling efforts. Habitat typing will be repeated if high flows result in significant changes to channel morphology. In addition, habitat unit flagging will be maintained on an annual basis.

2.4 Fish Monitoring/Suppression

A variety of methods will be used to monitor fish populations in Chorro Creek watershed, and to suppress pikeminnow to meet the objectives of this plan. Details of the proposed methods are described below, for both Chorro Reservoir and Chorro Creek. All of the methods are covered by a California State Scientific Collection Permit (Scientific Collecting Permit #4518), which is valid through 19 August 2017. All of the methods proposed within steelhead habitat (Chorro Creek watershed downstream of Chorro Reservoir Dam) are covered by a Federal 10(a) 1(a) permit (#20085), which is valid through fall 2020. Both permits will be renewed prior to expiration. Stillwater Sciences currently is covered by both permits, although other entities could become covered as well.

These efforts will be led by Stillwater Sciences, with support from project partners, including the NEP, Watershed Stewards Project (WSP), California Conservation Corps (CCC), National Oceanic and Atmospheric Administration (NOAA)/CCC Veterans Fisheries Crew, CCC Fish Tech, and CCC Fish Habitat Specialist.

2.4.1 Chorro Reservoir

As described above, Chorro Reservoir has been identified as the most upstream source of pikeminnow in the watershed. No control of the population will be possible without first controlling the population of potential spawners in the reservoir. Methods to address the pikeminnow population in the reservoir and associated sediment basins are described below.

2.4.1.1 Reservoir management

The most direct method for controlling pikeminnow within Chorro Reservoir without harming CRLF or other species would be to empty the reservoir, or draw it down to a very low level, and remove fish from the remaining area of inundation. The California Men's Colony (CMC) currently manages the reservoir, and the NEP is working to facilitate opportunities to participate in creative opportunities to manage the reservoir to reduce pikeminnow abundance. If, for example, the reservoir were to be dredged, that would be an ideal opportunity to remove pikeminnow during the drawdown process.

2.4.1.2 Gill netting

Consistent with previous successful sampling efforts (HTC 2008), sampling in Chorro Reservoir will be conducted using gillnets. Steelhead do not occur in Chorro Reservoir, and thus methods will not affect steelhead. Although CRLF and Western Pond Turtle occur in the vicinity of the reservoir they were not captured during previous CDFW gill netting efforts (D. Highland. Personal communication). Nonetheless, approaches will be used to avoid interacting with frogs and turtles, including setting nets away from the reservoir margins, and using gill nets with a large enough net size to avoid capture of CRLF. Gill netting has been successfully used to benefit California Mountain yellow-legged frogs and California red-legged frogs by eradicating non-native predatory fish from lakes and pounds in California (Knapp et al. 2007, Gilliland 2010). Sampling will be conducted during fall when the reservoir is at its lowest level, as well as spring to target potential spawners. The nets will be placed throughout the reservoir, but concentrated in the shallower north end where pikeminnow have been observed to be frequent during nighttime foraging activities. Nets will be set in place and checked after periods of 60–120 minutes. Longer set times may be used if initial efforts show no impacts to non-target species (i.e., CRLF and western pond turtle). Any bass or other warm-water fish that are likely predators on pikeminnow that are captured will be released to allow continued pressure on pikeminnow. Although bass and other warm-water fish that are likely predators on pikeminnow are also potential predators on steelhead if they pass downstream, conditions in Chorro Creek are not expected to support other warm-water predatory fish based on previous sampling results which found very low numbers of bass or other warm water predatory fish in Chorro Creek (Halligan and Otte 2011).

The total number of pikeminnow removed will be recorded, stomach analysis will be conducted on all captured fish, all females will be examined for the presence of eggs, size distribution will be recorded, soak times, and locations of all methods used. Total sampling time will be calculated based on the number of nets, multiplied by the soak time of each net. The Catch Rate (CR) will be calculated to compare with previous and ongoing efforts to evaluate the long-term success of reservoir sampling. Pikeminnow catch by season and location will be assessed to determine the most effective times and locations to direct future efforts in order to optimize fish captured efficiency, with an emphasis on determining spawning timing and locations.

2.4.1.3 Seining

Beach seining may be conducted during the spring of some years to target larval pikeminnow and to assess spawning in lower tributaries and sediment basins. A series of short seine hauls will be made with particular focus near the upstream end of the reservoir where larval pikeminnow are expected to be most abundant. Based on the habitat preferences and timing of spawning pikeminnow, spring sampling near the upstream end of Chorro Reservoir may help confirm the success of pikeminnow removal efforts by lack of larval fish following the spawning season. In addition, beach seining will allow for the removal of smaller fish that may not be effectively captured using gill nets. If spawning of pikeminnow is determined to be occurring in lower tributaries and/or sediment basins, techniques may be adjusted to better target that habitat.

2.4.1.4 Angling

Hook-and-line capture (angling) was previously successful at catching large pikeminnow by Halligan and Otte (2011), and would be used by biologists or fisheries technicians who are experienced anglers and specifically target pikeminnow using proven lures.

2.4.2 Chorro Creek and Tributaries

2.4.2.1 Snorkel Dives

The relative abundance and distribution of steelhead and pikeminnow will be monitored annually within Chorro Creek using snorkel dives during the late summer of each year. The goal will be to assess the relative abundance (i.e., ratio of observed steelhead to observed pikeminnow), size/age structure, and distribution of pikeminnow and steelhead. Teams of divers (two per team) will survey select locations within the mainstem of Chorro Creek and tributaries during the late summer prior to suppression efforts, recording the abundance, size distribution, and location of all species observed. Comparisons between daytime and nighttime observations may be conducted to determine optimal snorkel conditions which maximize observations. Locations within the lower reach of each tributary downstream of the first barrier, will be surveyed. If pikeminnow are observed within any tributary, surveys will be extended upstream to determine the limit of distribution. Spring snorkel surveys may also be used to identify potential pikeminnow spawning distribution, focusing on tributary habitat.

Subsequent suppression efforts will be guided by the results of the snorkel dives, to target those areas with the highest observed abundances of large (>200 mm) pikeminnow. Although few adult steelhead are expected to occur in Chorro Creek during the sampling period, if any are observed, the GPS coordinates of their location will be recorded.

Snorkel monitoring data will allow for an annual assessment of the effectiveness of the program at achieving its objectives, which can also be compared with similar historical monitoring efforts. Snorkel dives will also be conducted following suppression efforts in a sub-sample of locations where efforts are conducted to test the short-term effectiveness at removing pikeminnow.

2.4.2.2 California Red Legged Frog Surveys

CRLF surveys are conducted annually during May by the California Army National Guard on Camp San Luis Obispo property (California Army National Guard 2016). The results of these surveys will be provided to the NEP each year as a spatial file with specific global positioning system (GPS) coordinates of all CRLF observations. In addition, during the snorkel surveys described above, the GPS coordinates of all observations of CRLF adults, tad-pools, or egg masses will be recorded. All observations of CRLF will be used to direct pikeminnow suppression efforts, as described below.

2.4.2.3 Electrofishing Surveys

Based on the results of the snorkel dives, specific habitat units having a high abundance of pikeminnow will be sampled with electrofishing surveys. Electrofishing is an efficient means of pikeminnow removal in Chorro Creek (Halligan and Otte 2011), and the data generated from these efforts will be used to provide unit specific pikeminnow abundance estimates to evaluate the success of the program. Consistent with previous removal efforts (Halligan and Otte 2011), sampling/removal efforts will be conducted when stream flows are at their lowest and pikeminnow are concentrated in pools. The majority of the habitat during this time of year is less than four feet in depth, which facilitates efficient removal with a backpack electrofisher (Adams et al. 2011). Initial efforts will target at least 75% of all habitat, with subsequent efforts focused on high priority locations.

Within the units selected for targeted sampling, multiple-pass depletion methods will be used. Selected habitat units will be block-netted on downstream and upstream boundaries, and electrofished using multiple passes (Pollock and Otto 1983) to: (a) increase capture effectiveness and (b) estimate habitat-unit specific density from which to determine the abundance of both steelhead and pikeminnow.

All electrofishing will follow the 10(a)(1)(A) permit constraints (Permit #20085), and will follow the NMFS guidelines for coldwater species (2000). Adult steelhead were rarely observed during previous surveys and are expected to be uncommon throughout the implementation of this plan. Electrofishing will not occur in units if adult steelhead are observed. In addition, no electrofishing will be conducted in the presence of CRLF, or in habitat units where water depth or habitat complexity is expected to limit the effectiveness of electrofishing.

2.4.2.4 Seining

Halligan and Otte (2011) found that at times there was a great abundance of very small pikeminnow in some habitat units that were minimally affected by electrofishing. For this reason, habitat units where small (<100 mm SL) pikeminnow are observed may be sampled with a seine net to capture additional pikeminnow. In locations where seining is identified to be the most effective method of pikeminnow removal, habitat units will be block-netted and sampled with at least three consecutive seine hauls with a pole seine.

2.4.2.5 Methods for Deep Pools

In previous efforts (Halligan and Otte 2011), several large pools and woody debris jams limited the team's ability to remove pikeminnow completely from those habitat units using electrofishing or other methods. In such deep and complex pools other methods will be used, potentially including hook-and-line and/or spearfishing. Hook-and-line capture (angling) was successful at catching large pikeminnow previously, and would be used by biologists or fisheries technicians who are experienced anglers and specifically target pikeminnow using proven lures in their preferred habitats. Spearfishing may also be conducted in deep pools where large pikeminnow are observed during snorkel surveys. Spearfishing will specifically target large (> 200 mm) pikeminnow and avoid all sensitive species. Spearfishing has proven successful in selective capture and has been used to target large pikeminnow in pools in the Eel River (Nakamoto and Harvey 2003), and to reduce lake trout abundance (Lockhard et al. 2014). No angling or spearfishing will occur in units where adult steelhead are recently observed. The need for these methods will be assessed based on the results of the annual snorkel surveys and will be initiated when pikeminnow >200 mm are observed in deep pools. Deep pools supporting large pikeminnow are considered a priority habitat for sampling, and all deep pools will be mapped and sampled each year.

2.4.3 Locate and Target Spawners

Sacramento pikeminnow are a highly fecund species (Moyle 2002). Spawning typically occurs during spring, and HTC (2008) observed gravid females with over 85,000 eggs each in the reservoir in May. It is critical for successful control of the pikeminnow population to determine where pikeminnow are spawning, and implement methods to target those individuals. Spawning in the reservoir occurs during spring, and is assumed to occur on the margin of the reservoir, and possibly within Chorro Creek and tributaries.

Little is known about if and where pikeminnow spawning could be occurring downstream of the reservoir, but based on habitat and temperature requirements, likely locations include the warm sections of the mainstem Chorro Creek downstream of the water treatment facility discharge. High concentrations of juvenile pikeminnow have been observed in the area around the Chorro Creek Ecological Reserve (CCER) (F. Otte, pers com, 1 February 2017). Habitat and temperature data will be reviewed to identify and rank suitable pikeminnow spawning locations. Spring snorkel efforts will be conducted in tributaries and the mainstem to look for concentrations of larval pikeminnow as evidence of spawning locations. Areas that are identified will be targeted for suppression efforts, and potentially subsequent larval sampling to monitor effectiveness.

2.5 Fish Processing

All captured fish will be identified to species and measured for length. Stomach analysis will be conducted on all pikeminnow of sufficient size to evaluate diet. Tissue samples, otoliths, and scales will be collected from a subsample of captured pikeminnow for potential future analysis of age, growth, diet, and life history. All pikeminnow will be euthanized, and all other species will be released into their original habitat.

2.6 Ancillary Data

In addition to monitoring fish abundance and distribution, ancillary environmental data will also be collected, including water temperature, instream flows, and habitat data.

2.6.1 Water Temperature

Water temperature data will be collected at <1 hour intervals using thermographs placed in representative pools throughout Chorro Creek and within at least one location in each tributary to monitor water temperature throughout the year. Existing thermograph locations are shown on Figure 1. Additional thermographs will be placed in San Luisito Creek, Dairy Creek, and the mainstem Chorro Creek upstream of the water treatment facility.

Temperature data will be assessed to identify suitable pikeminnow spawning locations and priority steelhead restoration areas. Temperature data will be compared with steelhead and pikeminnow distribution, and may also be used for bioenergetic modeling. In addition, temperature data from tributaries will help determine if any locations are cool enough to limit pikeminnow distribution. A maximum weekly average temperature (MWAT) less than 20°C will be used as a threshold to identify locations where suitable steelhead habitat is available and pikeminnow distribution is expected to be limited. This threshold (MWAT < 20°C) is based on observations of low densities of pikeminnow and high densities of steelhead within Eel River tributaries where MWAT was less than 20°C (Harvey et al. 2002), and it is based on competition and growth results within a laboratory setting which found steelhead growth was reduced by more than 50% when pikeminnow were present and temperatures exceeded 20°C while growth of steelhead was not reduced at temperatures between 15–18°C (Reese and Harvey 2002).

2.6.2 Instream Flows

Instream flows will be regularly monitored in the mainstem Chorro Creek upstream of the water treatment facility and two locations downstream. Instream flow results will be compared with annual abundance of steelhead and pikeminnow populations.

2.7 Optional Experimental Approaches

The core elements of this management program are to suppress the pikeminnow population while collecting data to both direct future efforts and modify approaches to increase effectiveness. Based on availability of funding and permitting, it may be possible to also implement experimental trials to better understand the population dynamics of pikeminnow and steelhead and thus more carefully refine management approaches. An experimental evaluation could include a direct test of the effectiveness of pikeminnow control by establishing treatment units where pikeminnow are removed, and control units where pikeminnow are monitored but not removed. Evaluated response variables could include the density, abundance, age structure, and growth of juvenile steelhead. Marking and tracking of individuals would be included to ensure the independence of treatment and control units.

As additional data are collected, it would also be possible to more accurately develop a population dynamics model of both pikeminnow and steelhead populations in the watershed. Modeling the population dynamics in conjunction with the bioenergetics analysis would allow the establishment of pikeminnow control targets to achieve specific juvenile steelhead population outcomes.

3 ANALYSIS

Analysis will be conducted annually to monitor the effectiveness of suppression efforts, and to support modifications to the approach during subsequent efforts. Analysis will focus on summarizing fish distribution and relative abundance in the reservoir and riverine areas; comparisons with previous efforts; and assessments of fish growth, age structure, and evaluations of habitat relationships.

Results from reservoir sampling will be analyzed for CR, which will be based on the number of fish captured per net, per day.

Within riverine reaches, results from electrofishing will be analyzed to estimate abundance and density from within specific habitat units. Each year the ratio of steelhead to pikeminnow will be calculated for all habitat units with multiple-pass depletion estimates. Comparisons of results between years from the same habitat units will be analyzed to assess trends in the abundance of fish species, and assess the effectiveness of suppression efforts.

The size and age structure of both steelhead and pikeminnow will be analyzed, as well as the diet of the pikeminnow population. Based on measured growth rates and water temperature data, a bioenergetics analysis of pikeminnow will be conducted to estimate their seasonal consumption, and evaluate likely annual consumption of juvenile steelhead in the watershed.

Stream temperature data will be analyzed to estimate the maximum weekly average temperature (MWAT) for all locations; and compared with fish distribution. All results will be summarized and used to identify high priority actions, including additional suppression efforts, habitat restoration project types and locations, and opportunities for barrier removal.

4 REPORTING

Annual reports will be prepared to communicate the progress of monitoring and suppression efforts to the TAC and others. All methods and results will be presented, including spatial analysis of distribution, relative abundance, and size structure of both pikeminnow and steelhead. All methods used will be evaluated, and comparisons with previous years will be included. The TAC will be engaged in an adaptive framework, where the results reported each year will be used to determine the methods and areas of focus for the subsequent year of monitoring and control. After five years of monitoring, a comprehensive five-year status report will be developed to evaluate program success, and develop a strategy for the following five years.

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Appendices

Appendix A

Landowner Access Approvals

Based on previous efforts (Halligan and Otte 2011, subsequent unpublished CCC snorkel dives) several high-priority areas have been identified in the Chorro Creek watershed (Table A-1). The NEP has determined the relevant landowners (Table A-1), each requiring specific considerations discussed below.

Table A-1. Chorro Creek Priority Sampling locations.

Map location	Description	Landowner/Manager (DRAFT*)
A	Lower Chorro Creek just upstream of the tidal influence	State Parks
B	Chorro flats	Coastal San Luis RCD
C	Large pools on John Jones' property	John Jones
D	Canet Road	(other private landowners)
E	Chorro Creek Ecological Reserve (CCER) up to the waste water treatment facility	CA Department of Fish & Wildlife (CDFW), State of CA, Cal Poly
F	Upstream of the waste water treatment facility	State of CA Military Department
G	Camp San Luis Obispo	State of CA Military Department
H	Behind the California Men's Colony (CMC)	State of CA
I	Chorro Reservoir	State of CA

* Landowners may be augmented/revised based off of sampling needs.

Private Landowners

Six private property owners are located immediately upstream and downstream of Canet Road and need to be contacted prior to site access.

Camp San Luis Obispo

For site access, contact Paige Farrell (paige.k.farrell.nfg@mail.mil), Mike Moore (michael.l.moore15.nfg@mail.mil), and Pete Waldburger (peter.j.waldburger.ctr@mail.mil). Camp San Luis Obispo requires information on personnel conducting surveys (e.g., date of birth, driver's license number), vehicle make/model, and updated vehicle registration for entry.

Men's Colony

Contact Colleen Donald (Colleen.Donald@cdcr.ca.gov) or Rae Holmes (rae.holmes@cdcr.ca.gov) for access to the Men's Colony. Ensure enough time for the Men's Colony to complete a background check on all personnel assisting with surveys. Personnel information is needed for background surveys including: contact information, driver's license number, social security number, list of gear needed, etc. Men's Colony will send a letter of gate clearance once background checks are approved.

Also, for access to Chorro Creek near the wastewater treatment plant, contact Scott Buffaloe (scott.buffaloe@cdcr.ca.gov).

Cuesta College

Terry Reece (treece@cuesta.edu) will need to be contacted for access along Cuesta College property.

Cal Poly

Kevin Piper (klpiper@calpoly.edu) will need to be contacted for access along Cal Poly property.

CDFW

Contact Bob Stafford (Bob.Stafford@wildlife.ca.gov) prior to accessing property along the Chorro Creek Ecological Reserve, owned by CDFW.

State Parks

Prior to accessing State Park lands, Vince Cicero (Vince.Cicero@parks.ca.gov) will need to be informed and a collection permit needs to be completed. Allow at least two weeks for review of the permit.

Coastal San Luis Resource Conservation District

Contact Jen Nix (jnix@coastalrcd.org) to access to Chorro Flats property owned by the Coastal San Luis Resource Conservation District. There is an access form that will need to be completed prior to conducting surveys.aooenbd