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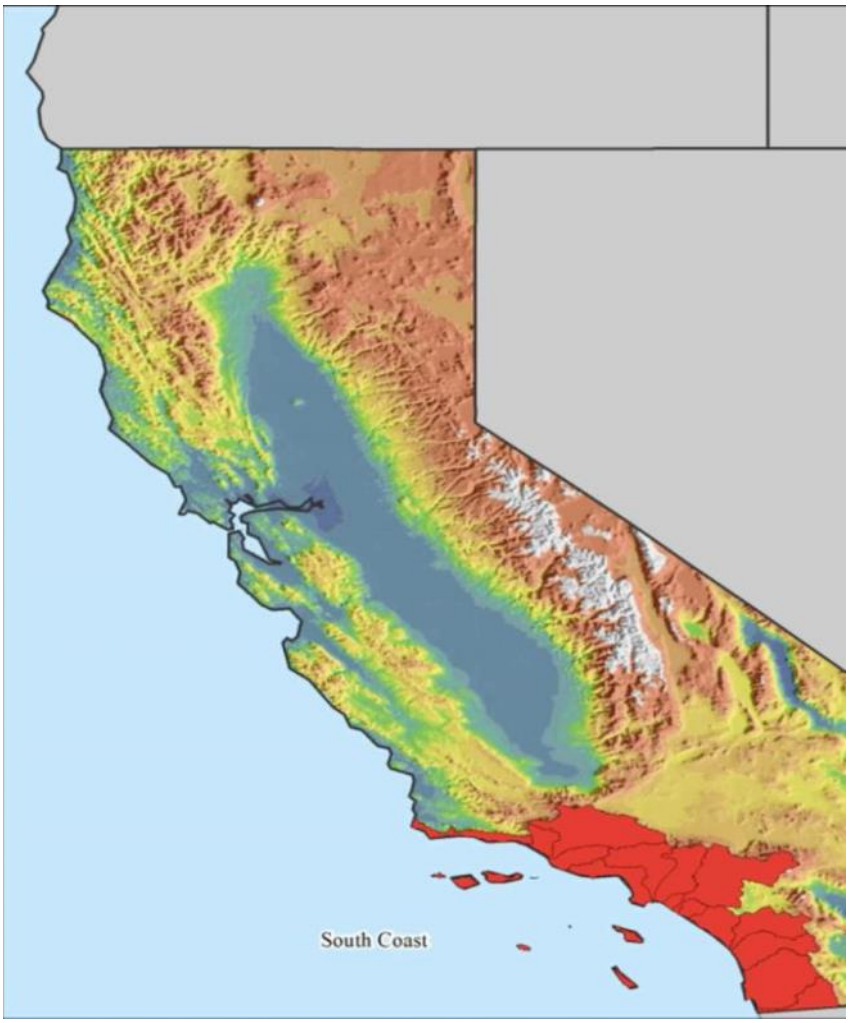
Regional Implementation Plan for Measures to Conserve Pacific Lamprey (*Entosphenus tridentatus*), California – South Coast Regional Management Unit

Damon H. Goodman and Stewart B. Reid



U.S. Fish and Wildlife Service
Arcata Fish and Wildlife Office
1655 Heindon Road
Arcata, CA 95521
(707) 822-7201

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key words: Pacific Lamprey, Conservation Measures, Natureserve, Limiting Factors

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Affiliation	Individual
California Department of Fish and Wildlife	Russell Barabe
Chumash Tribe	Jason Weiner
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Acronym List

BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
CalTrans	California Department of Transportation
CDFW	California Department of Fish and Wildlife
DO	Dissolved oxygen
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FY	Fiscal Year
GIS	Geographic Information System
HUC	Hydrologic Unit Code
IUCN	International Union for Conservation of Nature
MOA	Memorandum of Agreement
mtDNA	Mitochondrial DNA
NMFS	National Marine Fisheries Service (NOAA)
NOAA	National Oceanographic and Atmospheric Administration
P.G.&E	Pacific Gas and Electric Company
PLCI	Pacific Lamprey Conservation Initiative
RKM	River Kilometer
RM	River Mile
RMU	Regional Management Unit
SWCD	Soil and Water Conservation District
USACE	U.S. Army Corp of Engineers
USBR	U.S. Bureau of Reclamation
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

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Damon H. Goodman[1] And Stewart B. Reid[2]

[1] *U.S. Fish and Wildlife Service*
Arcata Fish and Wildlife Office
1655 Heindon Road, Arcata, California
Damon_Goodman@fws.gov

[2] *Western Fishes*
2045 East Main Street
Ashland, OR, 97520
WesternFishes@opendoor.com

Introduction

Pacific Lamprey, Entosphenus tridentatus, were historically widely distributed from Mexico north along the Pacific Rim to Japan. They are culturally important to indigenous people throughout their range, and play a vital role in the ecosystem: cycling marine nutrients, passing primary production up the food chain as filter feeding larvae, promoting bioturbation in sediments, and serving as food for many mammals, fishes and birds. Recent observations of substantial declines in the abundance and range of Pacific Lamprey have spurred conservation interest in the species, with increasing attention from tribes, agencies, and others.

In 2003 the U.S. Fish and Wildlife Service (USFWS) was petitioned by 11 conservation groups to list four species of lamprey in Oregon, Washington, Idaho, and California, including the Pacific Lamprey, under the Endangered Species Act (ESA) (Nawa et al. 2003). The USFWS review of the petition indicated a likely decline in abundance and distribution in some portions of the Pacific Lamprey's range and the existence of both long-term and proximate threats to this species, but the petition did not provide information describing how the portion of the species' petitioned range (California, Oregon, Idaho, and Washington) or any smaller portion is appropriate for listing under the ESA. The USFWS was therefore unable to define a listable entity based on the petition and determined Pacific Lamprey to be ineligible for listing (USFWS 2004).

It is the USFWS's strategy to improve the status of lampreys by proactively engaging in a concerted conservation effort. This collaborative effort, through the development and implementation of the Pacific Lamprey Conservation Initiative (PLCI) initiated in 2004, will facilitate opportunities to address threats, restore habitat, increase our knowledge of Pacific Lamprey, and improve their distribution and abundance in the United States portion of their range. The approach of the PLCI is to use the best scientific and empirical information available to assess current issues affecting the viability of Pacific Lamprey throughout its range in the western United States, to resolve knowledge gaps that limit our ability to conserve the species and to identify the specific conditions that must be addressed in order to conserve both regional and local populations. This document reviews risks identified by Goodman and Reid (2012) and introduces implementation actions to aid in conservation of the species. Neither document represents analyses required by the Endangered Species Act to determine if a species is warranted for listing as a threatened or endangered.

The 2012 Assessment and Template for Conservation Measures in California (Goodman and Reid 2012) includes introductory chapters describing the overall assessment and conservation strategy of the PLCI, general biology of and threats to Pacific Lamprey, and methodology. Successive chapters focus on Pacific Lamprey in the California Region as a whole and in seven specific geographic subregions (Regional Management Units - RMUs) within California. Each RMU is further examined at the watershed level, using 4th field Hydrologic Unit Code watersheds (HUC). Habitat conditions, population status and threats are evaluated for each HUC. The demographic information and identified threats were then used to qualitatively assess the relative risks of extirpation for Pacific Lamprey within each HUC using a NatureServe Assessment Model (NatureServe 2009).

Implementation Plans

In this stage of the PLCI, we use the combined results of viability and threats assessments in the 2012 California Assessment to develop implementation plans for each of seven RMUs (Figure 1); identifying conservation efforts, knowledge gaps and key implementation projects that will reduce risks to Pacific Lamprey within each RMU and its HUCs, thereby promoting conservation and management of the species range-wide.

Figure 1. Map of seven California Regional Management Units (RMUs).

Regional Conservation Strategy

The California regional conservation strategy uses the combined results of the viability and threats assessments in the 2012 California Assessment, collaborative input from partners and stakeholders, and drainage specific needs assessments to develop implementation plans for each Regional Management Unit (RMU). These plans will identify specific conservation efforts, knowledge gaps and key implementation projects that will reduce risks to Pacific Lamprey within each of California's seven RMUs and their component Hydrologic Unit Code (HUC) watersheds, thereby promoting the conservation and management of Pacific Lamprey both locally and range-wide through collaborative solutions. They are intended to provide a tool for managers and conservation biologists to guide conservation efforts, prioritize projects, and monitor progress. Ultimately, the various subregional plans will be incorporated into a regional plan for the whole of California and coordinated with implementation efforts in other regions.

Our current understanding of the biology and conservation needs of the Pacific Lamprey is relatively limited. Unlike western salmonids, which have long commercial management histories and have been extensively studied, little attention has been given to Pacific Lampreys in the past. Therefore, key conservation needs include the incorporation of lampreys into existing conservation and restoration projects, education of stakeholders and the general public, as well as filling major gaps in our basic understanding of their life history, distribution, behavior, habitat utilization and sensitivity to environmental factors such as temperature, flow regimes, and eutrophication. Nevertheless, it is also a primary goal of this implementation strategy to move forward with prioritized on-the-ground projects and recognized conservation needs that can be rapidly addressed over the next five years to directly benefit Pacific Lamprey.

Crucial to the success of this strategy is the collaboration of multiple and diverse stakeholders working together proactively to promote the conservation of a keystone species integral to the health and ecological function of western rivers. Both the Conservation Assessment and this Implementation Plan are intended as living documents that will be updated as we develop new information and understanding of lamprey conservation status and as implementation progresses. Already, many of the proposed implementation projects have been initiated or are well underway.

Implementation Planning Methods

The initial phase of this implementation planning was to assess population status and identify threats within individual 4th field HUC watersheds through the 2012 California Assessment process (Goodman and Reid 2012). These results are incorporated into the implementation plans, where they serve to prioritize populations of particular concern and specific threats that need to be addressed by proposed implementation actions. The results of the 2012 California Assessment are summarized herein, but the Assessment itself contains additional detail and

background for the reader, including introductory chapters describing the overall assessment and conservation strategy of the PLCI, general biology of and threats to Pacific Lamprey, and methods. Successive chapters focus on Pacific Lamprey throughout the species' range in California and describe conditions, population status and threats at the watershed level for specific geographic subregions. The demographic information and identified threats were then used to qualitatively assess the relative risks of extirpation for Pacific Lamprey within each watershed using a NatureServe Assessment Model (See Reid and Goodman (2012).

Collaborative stakeholder meetings and site visits were held for each HUC to seek out local experience, conservation concerns and suggestions for information needs and conservation actions (see Figure 2 and Appendix A for stakeholder meetings and workshops). Outreach and information gathering included 15 stakeholder meetings or workshops and included 20 different stakeholders. Stakeholder meetings also provided an opportunity to increase collaboration, raise general awareness and promote participation in lamprey conservation, as well as to inform the PLCI team of ongoing conservation actions in local watersheds.

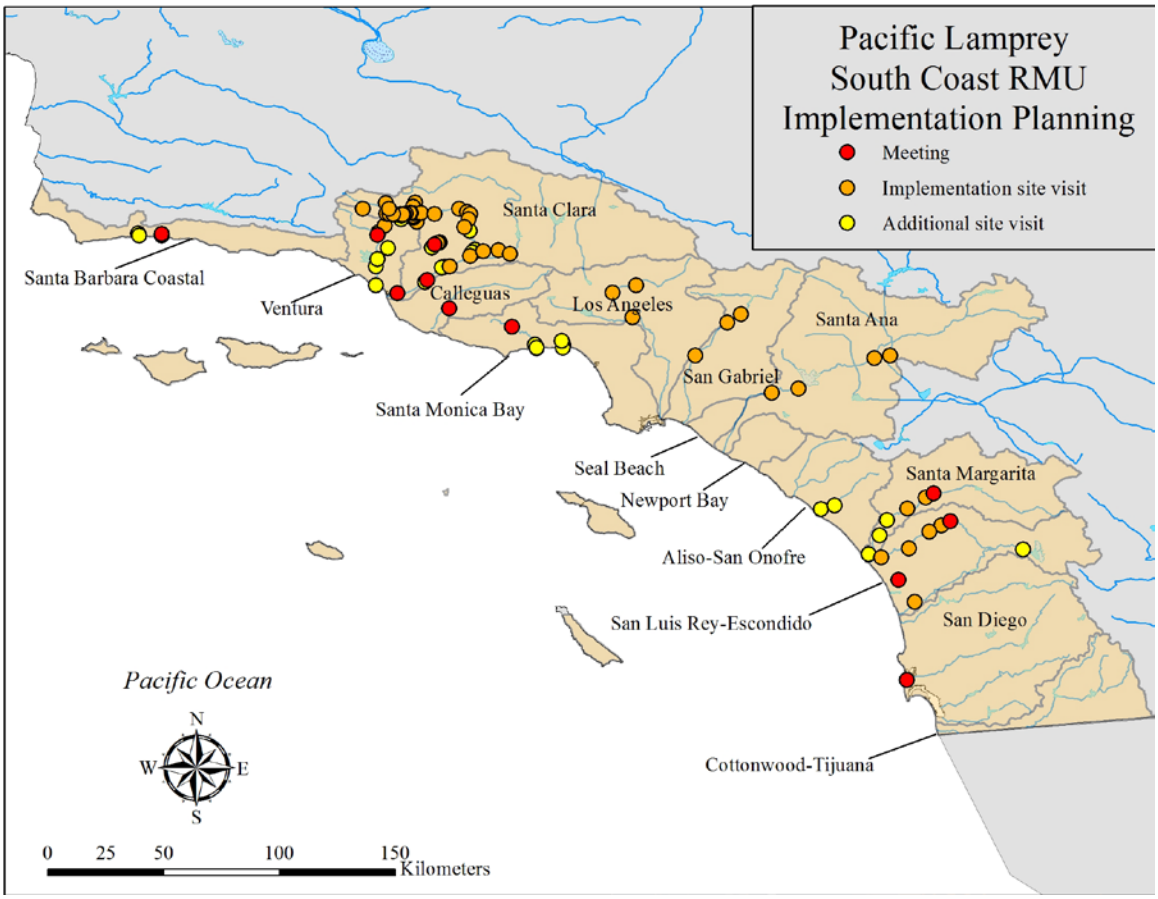

Figure 2. Map of stakeholder meetings, workshops and site visits which informed the development of the South Coast implementation plan.

The development of specific information needs and actions to be incorporated into the present implementation plan was guided by the 2012 California threat assessment and drew upon various sources of information. For each recognized threat, actions were developed to specifically address that threat, or to provide information needed for further assessment and development of mitigation measures. Final development of proposed actions incorporated the results of stakeholder meetings, workshops, ongoing conversations with stakeholders and local biologists, site visits, and the experience of the PLCI team. The principal goal of the implementation plans is to identify specific conservation efforts, knowledge gaps and key implementation projects that will reduce risks to Pacific Lamprey within each RMU and its component watersheds (HUC). However, there were also certain conservation efforts that are universal within the RMU, and often the broader region as well. These include outreach, education, coordination and incorporation of lampreys into existing aquatic conservation efforts, as well as basic research into aspects of lamprey life-history that directly relate to their conservation needs.

All proposed actions and conservation needs were entered into an implementation database that incorporates:

1) Information on the threat addressed
2) Description of the action and its rationale
3) Scale and location of the action
4) Prioritization factors
5) Feasibility factors
6) Additional benefits of the project
7) General status and details of the project

Actions are grouped into the following categories:

1) Assessment - assessment of potential threats or project needs
2) Coordination - including, outreach, collaboration and incorporation of lampreys into existing conservation efforts
3) Research - information needs that directly relate to their conservation needs or are needed to assess general threats
4) Survey/monitor - distribution of lampreys, suitable habitat, monitor populations or mapping of point threats (e.g., diversions, barriers)
5) Instream/on the ground projects

See Appendix B for specific fields and details of the database structure.

Prioritization of conservation actions is facilitated through the implementation database by inclusion of separate factors that may guide selection of individual projects. Priorities will be influenced by such factors as the specific needs of Pacific Lamprey in an area (region or HUC), the level of threat addressed (scale, scope or severity), habitat gained, specific funds available, capabilities of participants, and

stakeholder or program goals. Therefore, actions in the database were not prioritized explicitly, allowing for flexibility to accommodate a broad suite of applications. Instead, a framework is provided with a series of factors ranked independently that may contribute to a prioritization scheme. Factors evaluated for each action include the scope, scale and severity of threats addressed, effectiveness in addressing the threat, and quantity of habitat gain. These factors may be used in combination to guide strategic conservation measures in a variety of implementation scenarios.

The implementation database is intended as a living document that evolves with our understanding of threats to Pacific Lamprey, their conservation needs and the status of specific conservation projects. It is intended to provide a tool to managers and conservation biologists to address the specific needs of Pacific Lamprey, guide conservation efforts, prioritize projects and monitor progress. See Appendix C for contact information.

South Coast RMU - Status and Distribution of Pacific Lamprey

The South Coast Subregion includes all drainages from Point Conception south to the Mexican border, including the Ventura-San Gabriel, Santa Ana and Laguna-San Diego coastal USGS accounting units (Figure 3). It includes 18 watersheds (4th field HUCS), ranging from 233 - 4,403 km2 (Table 1). The subregion occupies the Southern California Mountain and Southern and Central Californian Chaparral / Oak Woodlands ecoregions.

Historical Range Extent

Pacific Lamprey are assumed to have been distributed historically in most, if not all, the larger South Coast drainages based on available habitat and lack of natural barriers. Historical records of lampreys exist from the following rivers: Ventura, Santa Clara, Malibu, Los Angeles, San Gabriel, Santa Ana, Santa Margarita, and San Luis Rey. However, it is not known how abundant specific populations were, or if there was cyclical variability in populations due to climatic conditions. Southern California approaches the southern natural distribution of Pacific Lamprey in freshwater (Río Santo Domingo, Baja California). Abundances may have historically been low in the arid southern HUCs. However, we have no records of population abundance before recent declines and losses of these populations, except in the Santa Clara in the 1990s (see below).

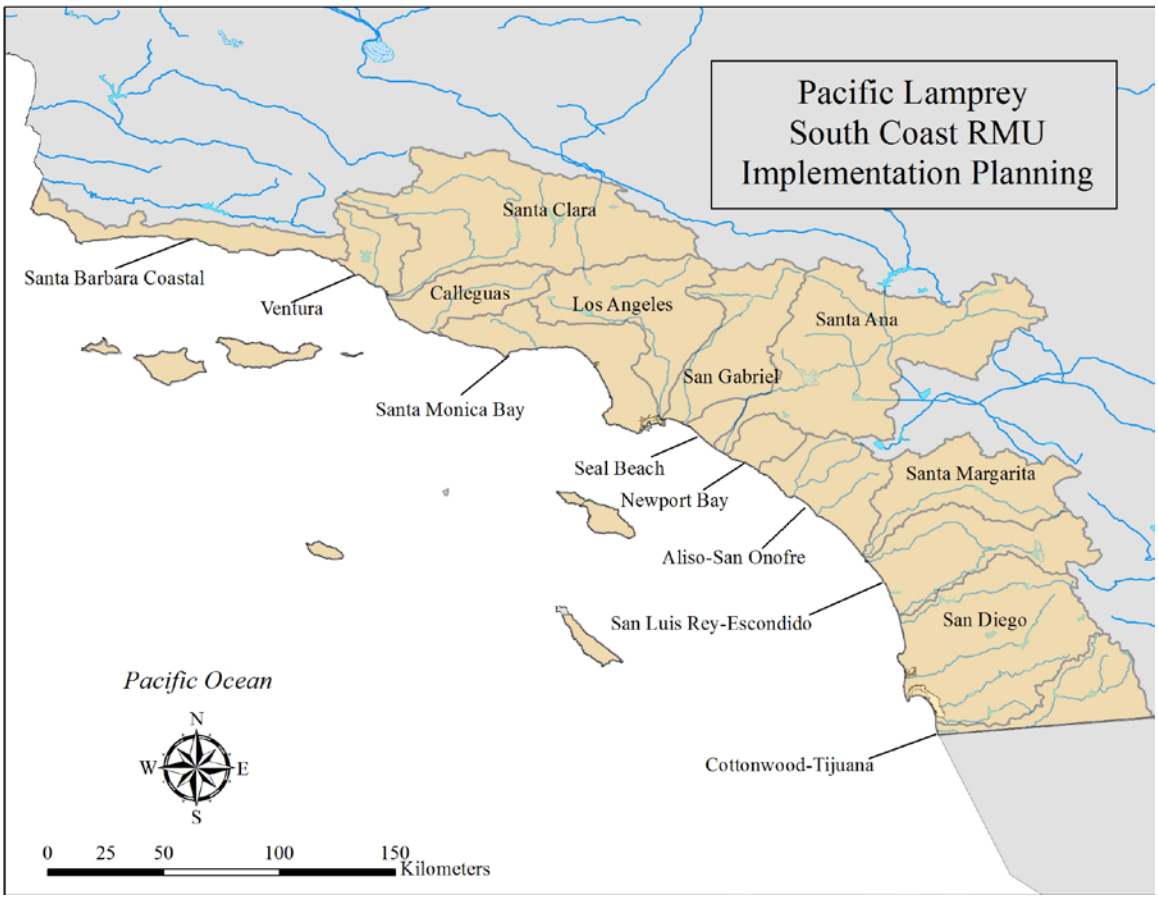

Figure 3. Map of the South Coast Regional Management Unit (RMU) and its watersheds (4th field HUCs).

Current Occupancy

Pacific Lampreys have apparently disappeared from all South Coast HUCs at this time. The only substantial population documented in this region in the last 27 years was in the Santa Clara drainage. Adult lampreys have not been encountered in the Santa Clara since 2001, and the last lamprey seen was a single juvenile in 2006, in spite of extensive surveying/monitoring in the region (Swift and Howard 2009, Reid 2015, Reid and Goodman unpub. data). Scattered individuals have been encountered in the Ventura (2005), Malibu (1993), Santa Ana (1991) and San Luis Rey (1997) HUCs over the last 27 years, but none more recently than 2005 (Swift and Howard 2009). This represents a general range contraction of Pacific Lamprey northward from historically-occupied drainages, with the southernmost population currently occupying the Big Sur River (Reid and Goodman, in review). Although some extirpations can be attributed to specific factors such as water quality, passage or dewatering, the threats affecting other extirpated drainages are less clear. This suggests the potential for either a lack of understanding of threats leading to local extirpations within specific drainages or outside factors, such as ocean conditions, declining prey stocks, or regional metapopulation dynamics affecting multiple streams.

Table 1. Population status, maximum threat level and NatureServe ranks for Pacific Lamprey in the South Coast RMU. Unoccupied HUCs are included for reference - historically non-anadromous HUCs are indicated by "N/A", drainages (HUCs) isolated by impassable dams, desiccated, or thought to be unoccupied based on recent surveys are indicated as Extinct? NatureServe ranks: SX, Extinct; SH, Believed extinct; S1 - Critically imperiled, S2 - Imperiled, S3 - Vulnerable, S4 - Apparently secure, and S5 - Secure. [from Goodman and Reid 2012]. HUCs with historical records of Pacific Lamprey are identified with an asterisk (*).

SOUTH COAST		Distribution				Max. Threats		
Watershed	HUC	Maximum Historical (km^2)	Ratio Current/ Historical	Population Size (#)	Short-Term % Decline	Scope	Severity	Risk Rank
Santa Barbara Coastal	18060013	964	0.001	Extinct?	70 - 99%	High	High	SH
Ventura *	18070101	708	0.001	Extinct?	70 - 99%	High	High	SH
Santa Clara *	18070102	4,170	0.001	Extinct?	70 - 99%	High	High	SH
Calleguas	18070103	989	0.001	Extinct?	-	High	High	SH
Santa Monica Bay *	18070104	1,504	0.001	Extinct?	70 - 99%	High	High	SH
Los Angeles *	18070105	2,171	0.001	Extinct?	-	High	High	SH
San Gabriel *	18070106	1,861	0.001	Extinct?	-	High	High	SH
Seal Beach	18070201	233	0.001	Extinct?	-	High	High	SH
San Jacinto	18070202	NA	-	-	-	-	-	-
Santa Ana *	18070203	4,403	0.001	Extinct?	70 - 99%	High	High	SH
Newport Bay	18070204	414	0.001	Extinct?	-	High	High	SH
Aliso-San Onofre	18070301	1,287	0.001	Extinct?	-	High	High	SH
Santa Margarita *	18070302	1,920	0.001	Extinct?	-	High	High	SH
San Luis Rey-Escondido *	18070303	2,021	0.001	Extinct?	70 - 99%	High	High	SH
San Diego	18070304	3,658	0.00	Extinct	-	-	-	SX
Cottonwood-Tijuana	18070305	1,216	0.00	Extinct	-	-	-	SX

Many smaller coastal streams (< 100 km^2 drainage area) in California are not currently occupied, and there is evidence that there may be a natural tendency of lamprey to avoid smaller coastal drainages south of San Francisco Bay (Reid and Goodman 2015; unpub. data). This may have been the case prior to the 1950s as well (Shapovalov and Taft 1954; Swift and Howard 2009), and is currently being explored by the authors.

Ratio of Current Occupancy to Historical Range Extent

As a result of no recent observations of Pacific Lamprey, the ratio of current to historical habitat is zero in all South Coast HUCs.

Population Size

Population size (adults) in the subregion, similar to all other areas, is poorly understood and has generally not been monitored. The Santa Clara, an exception, was monitored from 1991 to 2006 at the Freeman Diversion, with the highest count of 908 adults at the fish ladder in 1994 (Chase 2001, Swift and Howard 2009). However, these counts were highly variable in period and protocol of monitoring, so counts were conservative. Active monitoring of the Santa Clara drainage is continuing, including extensive surveys in 2014 (Reid 2015), in order to determine whether lampreys return to reestablish the population. However, barring recolonization, all available information indicates that Pacific Lamprey are functionally absent in all South Coast HUCs at this time. Continued monitoring of key drainages will be necessary to determine if they recolonize.

Short Term Trend

The limited historical monitoring of adult migrations makes any quantification of population trends impossible. Even the Santa Clara, apparently the strongest historical population, has declined from a viable population in the 1990s to apparent extinction in the last decade (Reid 2015).

NatureServe Risk Ranks

All South Coast HUCs have NatureServe risk ranks of Extinct (SX) or Possibly Extinct (SH). See discussion of threats below.

South Coast RMU - Threats and Limiting Factors to Pacific Lamprey

Threats and limiting factors to Pacific Lamprey in the South Coast RMU are provided in Table 2 for the principal five threats and are also discussed below. The remaining threat categories were either of low risk throughout the RMU or were not considered in this assessment due to lack of information (see discussion under Goodman and Reid 2012, Chap. 4 - California Regional Summary: Small Population Size, Disease, Lack of Awareness, Ocean Conditions, and Climate Change). Populations in all HUCs are subject to metapopulation declines caused by regional threats that may exist outside the watershed.

Table 2. Principal threat rankings, maximum threat level and NatureServe risk ranks for Pacific Lamprey within the South Coast RMU.See map, Figure 3. Historically non-anadromous HUCs are indicated by "N/A" and included for reference. Individual threat rankings for Scope and Severity: 1 to 4, Insignificant to High; U = Unknown. NatureServe ranks (Natureserve 2009): SX, Extinct; SH, Believed extinct; S1 - Critically imperiled, S2 - Imperiled, S3 - Vulnerable, S4 - Apparently secure, and S5 - Secure. Maximum threat ranks: X, Extinct due to dams (prior to 1985); and A to H, substantial and imminent threat to unthreatened. HUCs with historical records of Pacific Lamprey are identified with an asterisk (*).

SOUTH COAST			**Individual Threats (Scope - Severity)**				
Watershed	**Risk Rank**	**Maximum Threat**	**Passage**	**Dewatering /Flow**	**Stream Degradation**	**Water Quality**	**Predation**
Santa Barbara Coastal *	SH	A	2 - 2	2 - 2	1 – 1	3 - 2	2 - 1
Ventura *	SH	A	4 - 3	3 - 3	3 – 2	3 - 2	2 - 1
Santa Clara *	SH	A	4 - 3	2 - 3	1 – 1	3 - 2	3 - 1
Calleguas	SH	A	1 - 2	3 - 4	3 – 3	4 - 4	3 - 1
Santa Monica Bay *	SH	A	3 - 2	2 - 2	1 – 1	4 - 4	3 - 1
Los Angeles *	SH	A	4 - 3	4 - 3	4 – 2	4 - 4	3 - 1
San Gabriel *	SH	A	3 - 3	4 - 3	4 – 2	4 - 4	3 - 1
Seal Beach	SH	A	2 - 2	4 - 3	4 – 2	4 - 4	3 - 1
Santa Ana *	SH	A	2 - 2	4 - 3	4 – 2	4 - 4	3 - 1
Newport Bay	SH	A	2 - 2	4 - 3	2 – 2	4 - 4	3 - 1
Aliso-San Onofre	SH	A	2 - 2	4 - 3	2 – 2	4 - 4	3 - 1
Santa Margarita *	SH	A	2 - 2	4 - 3	2 – 2	4 - 4	3 - 1
San Luis Rey-Escondido *	SH	A	2 - 2	4 - 3	2 – 2	4 - 4	3 - 1
San Diego	SX	X	X	-	-	-	-
Cottonwood-Tijuana	SX	X	X	-	-	-	-

Pacific Lampreys currently have disappeared from or are functionally absent in all South Coast HUCs, including those that were historically occupied. Therefore, this subregion was assessed for threats that would prevent lampreys from recolonizing or affect populations were they to become reestablished. The principal threats to lampreys in southern California are obstructed passage, dewatering of streams due to the extensive use of water for agricultural and urban purposes, as well as natural aridity, and poor water/habitat quality, primarily associated with higher temperatures and low or seasonal flows. Recolonization of southern HUCs may be influenced by multiple factors, including the absence of resident lamprey populations to provide ammocoete pheromones attractive to migrating adults, low adult numbers that reduce the probability of encounter with potential mates, low attraction flows during extended drought, and unknown factors relating to ocean conditions, including an altered prey base.

Passage (dams, culverts, water diversions, tide gates, other barriers)

Passage is a substantial threat in larger drainages in the RMU, whereas in smaller drainages passage is generally represented by minor obstructions such as culverts, road crossings and channelized reaches. Notable exceptions were the Santa Margarita and San Luis Rey rivers, and many of the larger rivers had lower reaches that might still provide some suitable habitat. Passage in the Santa Clara River is impeded by a diversion dam (Freeman Diversion; United Water Conservation District) 10 miles from the estuary with substantial passage (upstream and downstream) issues that are currently under review and mitigation as part of a habitat conservation plan (United Water Conservation District). However, some lampreys have historically passed the diversion dam so it does not represent a complete barrier. Two principal tributaries, Santa Paula and Piru creeks, have dams; however, neither has historical records of lamprey, and the Santa Paula does not contain substantial upstream habitat (Reid 2015). Piru Creek has not been assessed for potential habitat suitability upstream of the dam. Sespe Creek, the principal Santa Clara tributary with historical lamprey occupancy, is unimpeded. In the Ventura Basin, Matilija Dam blocks substantial potential habitat that was apparently occupied historically. Removal of the dam is under consideration by local stakeholders. The two southernmost HUCs (San Diego and Cottonwood-Tijuana) have large impassable mainstem dams that block any suitable habitat were lampreys to attempt to recolonize.

Dewatering and Stream Flow Management (reservoirs, water diversions, instream projects)

Southern California is naturally arid and the extensive use of water for agricultural and urban purposes further exacerbates the adverse conditions in local streams. Low flows in lower reaches except during periodic storm events limit access to migrating adults and can prevent emigrating juveniles from reaching the sea. At times, flows are insufficient to open sand bars at the mouths of some rivers, completely blocking passage. Alternatively, some systems have benefited from streamflow management, such as water imports, creating artificially perennial conditions and opportunities for conservation (e.g. Santa Margarita).

Stream and Floodplain Degradation (channelization, loss of side channel habitat, scouring)

Many Southern California streams are highly modified and often denuded or channelized in urban areas. Nevertheless, there remains considerable habitat in most HUCs that would be relatively suitable for lampreys.

Water Quality (Water temperature, chemical poisoning and toxins, accidental spills, chemical treatment, sedimentation, non-point source)

Southern California's extensive agricultural and urban areas have contributed to water quality issues caused by point and non-point source pollutants. The effect of contaminants on the area's historical lamprey populations has not been evaluated. However, higher water temperatures, low flow conditions, eutrophication, high algal

density and associated dissolved oxygen problems, especially in sediments occupied by ammocoetes, were ranked as major threats to potential habitat for lampreys and resulted in high threat ranks for most HUCs.

Predation

Non-native predatory fishes are present in most southern California HUCs. Nevertheless, while there is certainly predation on larval and juvenile lampreys by introduced centrarchids (bass and sunfish) and catfishes, they have generally occupied the system since the late 1800s and were not considered to be a major threat to lamprey populations.

Small Population Size

Small effective population size was ranked as a substantial threat (high scope and severity) in southern populations due to the apparent absence, or extremely low abundance, of ammocoetes in all southern HUCs. Absence of ammocoete pheromones reduces or eliminates attraction of migrating adult Pacific Lampreys into the drainage (see Chap. 2 Biology), hindering reestablishment of the population. Extremely low adult numbers reduce the probability of encounter with potential mates if an adult does enter the drainage.

South Coast RMU - Implementation Plan

This plan is intended to identify conservation efforts, knowledge gaps and implementation projects that will reduce risks to Pacific Lamprey within the South Coast RMU and its component HUCs, thereby promoting the conservation and management of the species range-wide. A summary of the plan is provided below, with details available in the Implementation Database (Appendix C).

General Conservation Needs within the South Coast RMU

Within the South Coast RMU there are some general conservation needs that pertain to all HUCs. These include coordination efforts (outreach, education, and incorporation of lampreys into existing aquatic conservation efforts or streamflow management strategies), as well as basic research into aspects of lamprey life-history that directly relate and are applicable to their conservation needs region-wide, as well as development of appropriate conservation measures (e.g. passage). There are also common needs for population monitoring (document recolonization), habitat assessments, barrier mapping, streamflow management approaches to benefit lampreys and consideration of reintroduction strategies.

Coordination

As in most of the region, the lack of awareness, understanding and consideration of lampreys by the general public, resource managers and restoration projects in the South Coast RMU has resulted in the conservation needs of Pacific Lamprey being

ignored or actively imperiled. A major goal of the PLCI implementation is to increase awareness of Pacific Lamprey, attract more participation by stakeholders and promote consideration of its conservation needs by providing outreach, training and local education to stakeholders, resource managers, and community members.

A specific regional focus is proposed for coordination with other passage stakeholders (e.g., USBR, CalTrans, CDFW, USACE, P.G.&E, NMFS and USFWS) to ensure lamprey consideration in existing passage structures, as well as for current and future projects. Passage obstruction has been identified as one of the primary threats to Pacific Lamprey region-wide, isolating over 40% of potential anadromous habitat and eliminating the ecological role of Pacific Lamprey in reaches above barriers. Furthermore, active passage programs/projects focusing on salmonids often ignore the needs of, or actively block lampreys due to their design and/or management.

A specific regional focus is also proposed for increasing awareness of adverse impacts caused by surface diversions, groundwater pumping and nutrient inputs by agricultural activities in the South Coast RMU. Unregulated water withdrawals reduce flows in or even fully dry up both mainstems and smaller tributaries. Even short term loss of surface flow is lethal to ammocoete and over summering adult populations, resulting in the local loss of up to eight year classes. Higher temperatures caused by lower flows and increased nutrient loading promoting algal blooms in mainstem rivers further degrade habitat used by over-summering adults and ammocoetes, who cannot tolerate anoxic sediments. In some South Coast drainages, loss of surface flow may prevent emigrating juveniles from reaching the ocean and results in major mortality events.

General Research Needs

Passage. Although passage obstruction is identified as a primary threat to Pacific Lamprey region-wide, there is limited information on how lampreys move past barriers and how to design instream structures to facilitate lamprey passage. Therefore, a number of basic research goals will investigate and develop designs or management approaches for passage at culverts, low-head dams or weirs, and fish ladders. Other projects include investigation of entrainment risk from small-scale (< 4") unscreened pumping stations and development of downstream passage/screening criteria for ammocoetes and emigrating juveniles. General survey and assessment of potential instream barriers (including low-head dams, diversions and road crossings) is recommended for all HUCs to assess and prioritize local conservation needs related to lamprey passage and/or entrainment.

Streamflow management. Streamflow conditions in many South Coast RMU streams have been highly modified by large storage dams and significant diversions. Streamflow is managed primarily to supply water for agriculture or human consumption with substantial deviation from historical conditions. Pacific Lamprey migrations rely on environmental cues inherent to natural streamflow conditions that

may not be lacking due to management approaches (Goodman et al. 2015). Streamflow at management should be assessed in South Coast RMU drainages in respect to Pacific Lamprey life history strategies. In addition, research is needed to develop approaches for incorporating Pacific Lamprey life history needs into streamflow management.

Reintroduction

The loss of Pacific Lamprey from their southern range suggests the need for consideration of active reintroduction to historically occupied habitat, as is occurring in the Columbia River Basin. Therefore, consideration of effective strategies and methods for reintroducing lampreys is a regional need for the Southern California RMU. Possible approaches may include translocation of adults, translocation of multiple age-classes of ammocoetes, local hatchery rearing, or use of attractant pheromones. Reintroduction would require a careful evaluation and planning effort and also involve stakeholder collaboration, community outreach, habitat assessment for selection of suitable reintroduction sites and long-term monitoring.

Ammocoete habitat. Ammocoetes are highly dependent on the habitat provided by fine sediments during their 5-7 year instream development. We know little about fine-scale habitat selection by ammocoetes, nor about the effect of sediment conditions on ammocoete populations or system carrying capacity. Therefore, a number of basic research goals will investigate sediment habitat needs of ammocoetes, the role of temperature and dissolved oxygen levels in sediment habitat quality, the impact of eutrophication and associated algal blooms on sediment conditions, and mitigation measures for use during in-channel projects to reduce mortality of ammocoetes.

Adult holding habitat. Many adult lamprey hold over in freshwater stream and rivers during the summer/winter to spawn the following spring. Observations of dead adults in summer months prior to the expected spawning period indicate that high water temperatures and low dissolved oxygen (DO) may seriously impact adult survival during the holding period. Research is proposed to determine thermal and DO tolerances for adult lamprey during summer holding period.

Due to our currently limited understanding of the specific historic distribution and population dynamics of Pacific Lamprey in the South Coast RMU, we recommend assessment of historic records and potential habitat (i.e., rearing, spawning and adult holding) to determine potential areas of concern should lamprey return to southern California. Although these surveys are common to all HUCs, they are specified individually for each in the database due to differences in threat level, stakeholders and project development, and to facilitate progress monitoring within HUCs.

Implementation Needs and Proposed Projects:

Below are brief summaries of principal implementation needs and proposed projects in each of the South Coast HUCs. Details are available in the Implementation Database.

- General description and significance of HUC
- Major threats
- Major implementation focus/projects
- Additional implementation projects and goals

*Santa Barbara Coastal**. The Santa Barbara Coastal HUC is composed of numerous small coastal watersheds draining relatively arid hills from Point Conception to just north of the Ventura River. A number of these streams have suitable habitat, but most of the streams in the HUC are so small that they likely did not contain lampreys in the past (Reid and Goodman, in review). The two largest drainages are Jalama (66 km^2) and Gaviota (52 km^2) creeks. Goleta Slough in Santa Barbara area drains a total of 135 km^2; however, it is split between various small drainages with the largest, Atascadero, only about 51 km^2. Channelization, urbanization and agriculture in the Goleta drainages exacerbate naturally arid conditions. Arroyo Hondo (36 km^2), although small, is managed as a nature reserve by Santa Barbara Land Trust and contains a small natural population of Rainbow Trout, *Onchorhynchus mykiss*.

An anecdotal Pacific Lamprey record exists in Jalama Creek, a known historical steelhead stream located just north of Point Conception (Swift et al. 1993; Swift and Howard 2009). On March 15, 2000, Brad Lundberg, foreman of Jalama Creek Ranch, remembered an "old timer" (87 years old in 2000) who fished for steelhead near the railroad trestle at the upper end of the lagoon on lower Jalama Creek and occasionally observed "eels" that were probably adult Pacific lampreys. These observations were most likely in or before the 1960s.

The principal goals for this HUC are to raise awareness in the local community, so that if they encounter lampreys, people will recognize the significance, and will avoid project designs that would impede or adversely impact lampreys were Pacific Lamprey to attempt to return, especially in the larger drainages.

*Ventura**. The Ventura River drainage contained Pacific Lamprey as recently as 2005 (Swift and Howard 2009). The mainstem contains perennial reaches, in part sustained by treatment water in the lower section, and seasonally dry reaches, particularly during drought years. Groundwater withdrawals further reduce surface flow in the lower reaches. The upper reaches of the mainstem and major tributaries (Coyote and Matilija creeks) are perennial and support Rainbow Trout populations.

The principal goals for this HUC are to provide access to the upper reaches past two currently impassable dams (Figure 4; Casitas on Coyote Creek and Matilija on Matilija Creek), to explore management measures that will maintain continuous flow in the mainstem Ventura River and lower San Antonio Creek, and to raise awareness in the local community, so that if people encounter lampreys they will recognize the significance, and will avoid project designs that would impede or adversely impact lampreys were Pacific Lamprey to attempt to return.

*Santa Clara**. The Santa Clara River drainage contained Pacific Lamprey as recently as 2006 and had a substantial population in the 1990's (Chase 2001; Swift and Howard 2009). However, extensive recent surveys in the drainage did not encounter lampreys (Reid 2015). The mainstem naturally contains both perennial reaches and seasonally dry reaches, particularly during drought years. Groundwater withdrawals further reduce surface flow in the lower reaches. The principal lamprey habitat is in the extensive and relatively undisturbed Sespe drainage and the perennial of the Santa Clara River in the vicinity of the Santa Paula bridge (12th Street). The principal constraint to lampreys in the drainage is the Freeman Diversion, which obstructs the mainstem at RM 11 and diverts water to recharge the groundwater basin. Operations affect flow timing and magnitude in the mainstem down to the mouth, the timing and duration of estuary open periods, upstream passage by adults, and possible entrainment of outmigrants. Additional passage

Figure 4. Matilija Dam is the current extent of anadromy on Matilija Creek and is located 16 miles upstream from the Ventura River estuary. This 168-ft tall dam is being considered for removal and would increase the extent of anadromy for Pacific Lamprey and Steelhead, as well as provide a more natural streamflow regime. (Photo taken by Anthony Plascencia of the Ventura County Star).

barriers exist in smaller tributaries upstream of the Freeman Diversion (e.g. Santa Paula Creek). However, these tributaries contain less suitable and extensive habitat than Sespe Creek. The Piru Drainage is mostly blocked by the impassable Santa Felicia Dam (200' tall). Potential upstream lamprey habitat has not been assessed. The Santa Clara Drainage, due to its recent support of a relatively substantial population of Pacific Lamprey, extensive habitat and lack of major anthropogenic changes in habitat conditions (Sespe Creek), is considered a keystone drainage for Pacific Lamprey in southern California and has potential for either natural recolonization or a reintroduction of Pacific Lamprey (Figure 5).

The principal goals for this HUC are to provide access to the Sespe Drainage past the Freeman Diversion and to develop appropriate flow management procedures to ensure viable conditions in the mainstem for upstream and downstream passage through the migration corridor below the diversion to the mouth. As a keystone drainage, the Santa Clara is also proposed for monitoring to detect natural recolonization and development of a reintroduction strategy. Additional projects include assessment and modification of passage barriers in Santa Paula Creek, assessment of potential habitat in the upper Piru Drainage, and raising awareness in

Figure 5. The relatively pristine habitat in the Sespe River canyon and perennial pool habitat within the canyon (inset).Although currently devoid of Pacific Lamprey, this drainage recently supported populations and could again in the future.

the local community, so that if they will avoid project designs that would impede or adversely impact lampreys were Pacific Lamprey to return and if people encounter lampreys, they will recognize the significance.

Calleguas. The Calleguas HUC is primarily composed of small coastal plain streams and arid uplands with extensive urban and agricultural impacts. Do its character, the HUC is not thought to have supported Pacific Lamprey in the recent past, and there are no historical records of Pacific Lamprey. Therefore, the principal goals for this HUC are to raise awareness in the local community, so that if people encounter lampreys they will recognize the significance, and will avoid project designs that would impede or adversely impact lampreys were Pacific Lamprey to attempt to colonize.

Santa Monica Bay.* The Santa Monica Bay HUC is composed of numerous small coastal watersheds draining relatively arid coastal hills from Point Mugo to just north of the Los Angeles River. A number of these streams have suitable habitat, but most are so small that they probably did not contain lampreys in the past (Reid and Goodman, in review.). The four largest drainages are Big Sycamore (55 km^2), Malibu (285 km^2), Topanga (51 km^2) and Ballona (340 km^2) creeks. Of these, Malibu Creek has the greatest potential to support lampreys. Big Sycamore does not appear to contain sufficient perennial reaches. Topanga Creek has some suitable perennial habitat and supports Rainbow Trout as well as other native fishes; however, it is relatively high gradient and at the lower drainage size limit for Pacific Lamprey south of San Francisco Bay. Ballona Creek and its tributaries are highly channelized and urbanized, exacerbating naturally arid conditions. The only historical records of Pacific Lamprey for this HUC are from Malibu Creek (as recently as 1993; Swift and Howard 2009) and an adult from near the mouth of Ballona Creek, possibly on the coast (Hyperion) in 1916 (museum specimen LACM-3).

Malibu Creek.* The principal goals for this HUC are to enhance conditions in Malibu Creek to facilitate natural recolonization by Pacific Lamprey, including removal of Ringe Dam, as well as flow and water quality management to promote oxygenated sediments for rearing ammocoetes and over summering adults (Figure 6). Additional, HUC-wide goals are to raise awareness in the local community, so that if people encounter lampreys, they will recognize the significance and avoid project designs that would impede or adversely impact lampreys were Pacific Lamprey to attempt to return, especially in the larger drainages.

Figure 6. Dense algal blooms are common in many South Coast streams.Algal blooms likely result in low dissolved oxygen concentrations in substrates that may be detrimental for rearing lamprey ammocoetes and holding adults. Rosi Dagit (Resource Conservation District of the Santa Monica Mountains) discusses the conservation opportunities on the bank of Malibu Creek.

*Los Angeles**. Pacific Lamprey have not been detected in the Los Angeles River since 1925. The entire basin is highly modified and urbanized, with the lower 25 miles of the river constrained to a concrete channel. Nevertheless, there is a ten mile reach of soft-bottom from I-5 to the Griffith Park area that has some potential to support Pacific Lamprey were they to reach it (Figure 7). The primary local constraints are associated with water quality in this reach.

The principal goals for this HUC are to incorporate lamprey needs into the LA River revitalization and restoration planning (US Army Corps of Engineers and City of Los Angeles), focusing on the 10 mile "soft-bottom" reach and ensuring passage up the lower river. Additional, HUC-wide goals are to raise awareness in the local community, so that if people encounter lampreys, they will recognize the significance, and will avoid project designs that would impede or adversely impact lampreys were Pacific Lamprey to attempt to return to the mainstem.

Figure 7. The Los Angeles River at Griffith Park during the end of summer in an extremely dry year (October 2014).Ground water recharge results in perennial streamflow in this reach and opportunities to support Pacific Lamprey. This reach will be subject to a large-scale restoration effort aimed at improving riverine habitats and water quality.

San Gabriel.* Pacific Lamprey have not been detected in the San Gabriel River since 1945, prior to construction of the extensive system of flood control dams and basins. The entire basin is highly modified and urbanized, with the lower 21 miles of the river below the Whittier Narrows Dam (impassable) unobstructed but highly channelized. This reach is the only habitat accessible to anadromy in the drainage.

The principal goals for this HUC are to incorporate lamprey needs into the management of the lower river and to raise awareness in the local community, so that if they encounter lampreys they will recognize the significance and avoid project designs that would impede or adversely impact lampreys were Pacific Lamprey to attempt to return to the mainstem.

Seal Beach. The Seal Beach HUC is primarily composed of small coastal plain streams and arid uplands with extensive urban and agricultural impacts. Due to its character, the HUC is not thought to have supported Pacific Lamprey in the recent past, and there are no historical records of Pacific Lamprey in the watershed.

Therefore, the principal goals for this HUC are to raise awareness in the local community, so that if people encounter lampreys they will recognize the significance and avoid project designs that would impede or adversely impact lampreys were Pacific Lamprey to attempt to colonize.

*Santa Ana**. Pacific Lamprey were recorded in the Santa Ana River (at the mouth) as recently as 1991, subsequent to construction of the extensive system of flood control dams and basins. The Prado Dam, located at about RM 31, blocks access to the upper drainage. The lower reach, though accessible, is highly modified and urbanized, with the lower 31 miles of the river below the Prado Dam unobstructed but channelized (Figure 8). This reach is the only habitat accessible to anadromy in the drainage.

The principal goals for this HUC are to incorporate lamprey needs into the management of the lower river and to raise awareness in the local community, so that if people encounter lampreys, they will recognize the significance and avoid project designs that would impede or adversely impact lampreys were Pacific Lamprey to attempt to return to the mainstem.

Figure 8. Surveying for Pacific Lamprey in off-channel habitat of the lower Santa Anna River. Pacific Lamprey occurred in the Santa Anna as recently as 1991 however, none have been detected since.

Newport Bay. The Newport Bay HUC is primarily composed of small coastal plain streams and arid uplands with extensive urban and agricultural impacts. Due to its character, the HUC is not thought to have supported Pacific Lamprey in the recent past, and there are no historical records of Pacific Lamprey. Therefore, the principal goals for this HUC are to raise awareness in the local community, so that if people encounter lampreys, they will recognize the significance and avoid project designs that would impede or adversely impact lampreys were Pacific Lamprey to attempt to colonize.

Aliso-San Onofre. The Aliso-San Onofre HUC is composed of coastal watersheds draining relatively arid coastal hills from Newport Bay to just north of the Santa

Margarita River. A number of these streams may have suitable habitat, but most are so small or arid that they probably did not contain lampreys in the past (Reid and Goodman, in review.). The four largest drainages are Aliso (93 km^2), San Juan (459 km^2), San Mateo (346 km^2) and San Onofre (ca. 100 km^2) creeks. Due to its character, the HUC is not thought to have supported Pacific Lamprey in the recent past, and there are no historical records of Pacific Lamprey. Therefore, the principal goals for this HUC are to raise awareness in the local community, so that if people encounter lampreys, they will recognize the significance and avoid project designs that would impede or adversely impact lampreys were Pacific Lamprey to attempt to return to the mainstem.

Santa Margarita.* Pacific Lamprey were last observed in the Santa Margarita River (De Luz Creek) in the 1930s-40s. Nevertheless, the drainage contains suitable habitat in extensive perennial reaches from the mouth to about Temecula, about 30 mi up from the mouth, including properties managed by Camp Pendleton Marine Base and the San Diego State Ecological Reserve (Figure 9).

The principal goals for this HUC are to assess possible minor barriers (Arizona crossings), to incorporate lamprey needs into the management of the lower river and to raise awareness in the local community, so that if people encounter lampreys, they will recognize the significance and avoid project designs that would impede or adversely impact lampreys were Pacific Lamprey to attempt to return to the mainstem.

San Luis Rey-Escondido.* This HUC extends from the San Luis Rey in the north to Escondido Creek in the south. Most coastal drainages in the HUC are relatively small and arid.

The two largest drainages are the San Luis Rey River (1,451 km^2) and Escondido Creek (221 km^2). However, historical records of lamprey are limited to the San Luis Rey, where an ammocoete was found in 1997 (Swift and Howard 2009), and three adults were apparently observed near I-15 "a few years later" (Alan Greenwood, pers. com.). The mainstem San Luis Rey contains suitable habitat in perennial reaches from the mouth to around the town of Pala, CA.

Figure 9. A perennial reach of the Santa Margarita River at the San Diego State Ecological Reserve. A good example of habitats in the South Coast RMU that could support Pacific Lamprey.

The principal goals for this HUC are to assess possible minor barriers in the San Luis Rey and to incorporate lamprey needs into the management of the lower river, as well as raising awareness in the local community throughout the HUC, so that if people encounter lampreys, they will recognize the significance and avoid project designs that would impede or adversely impact lampreys were Pacific Lamprey to attempt to return to the mainstem.

San Diego. The San Diego HUC extends from the San Dieguito in the north to the Otay River in the south, just above the border. Pacific Lamprey have never been recorded from this HUC (or the Tijuana HUC to the south), although they have been found 160 miles further south in the Río Santo Domingo. The largest five drainages are the San Diego (1,129 km^2), San Dieguito (897 km^2), Sweetwater River (572 km^2), Otay River (376 km^2) and Penasquitos (245 km^2) rivers. Mainstem dams obstruct much habitat in the HUC, and poor water quality or intermittent flow impair habitat in the lower reaches. The remaining coastal drainages are generally small, arid and intermittent. Additional impacts include extensive urbanization, poor water quality and water withdrawals.

Cottonwood-Tijuana. The Cottonwood-Tijuana HUC is composed of the extensive Tijuana River drainage, much of which is in México. The lower reaches are heavily urbanized by the city of Tijuana and surrounding communities. All passage is blocked about eleven miles east of Tijuana by the Rodríguez Dam, and the river is fully channelized through the city of Tijuana, where it receives high levels of urban sewage before flowing intermittently to the estuary (Tijuana River National Estuarine Research Reserve). While the Tijuana River may have supported Pacific Lamprey in the past, there are no historical records of Pacific Lamprey. Therefore, due to its character, no specific implementation actions are proposed.

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Appendices

Appendix A. Stakeholder implementation meetings and workshops.

Meeting Type	Location	Date
Risk assessment	Sacramento	Sept. 1-2, 2009
	Santa Paula	May 17, 2011
	Santa Barbara Land Conservancy	May 18,2011
	Agoura Hills	May 19, 2011
Implementation plan	Ventura	Sept. 11, 2012
	Ventura	Sept. 12, 2012
	Santa Paula	Jan. 10, 2013
	Camarillo	Jan. 10, 2013
	Pala Reservation	Jul. 17, 2014
	Ojai	Sept. 15, 2014
	Temecula	Oct. 1, 2014
	Ocean Beach	Oct. 1, 2014
	Carlsbad	Oct. 2, 2014
Lamprey summit	Portland	Jun. 20-21, 2012

Appendix B. Data fields and criteria / coding used in Implementation tables.

HUC IDENTIFIER

FID - Feature ID ESRI
HUC - USGS Hydrologic Unit Code Levels 1-4
Name - HUC Name (USGS)

THREAT

Threat_Category:

- Passage
- Dewatering/Flow
- StreamDegradation
- Water Quality
- Predation
- Population
- Other

Subcategory- depends on threat category

- T_Scope- from Calif. Conservation Assessment (Goodman & Reid 2012)
- T_Severity- from Calif. Conservation Assessment (Goodman & Reid 2012)
- T_Overall- from Calif. Conservation Assessment (Goodman & Reid 2012)
- Threat- brief description of the threat addressed.

ACTION and RATIONALE

Description- short description of proposed action
Type- type of action proposed

- Assessment - assessment of potential threats or project needs.
- Coordination - including, outreach, collaboration and incorporation of lampreys into existing conservation efforts.
- Research - information needs that directly relate to their conservation needs or are needed to assess general threats.
- Survey/monitor - distribution of lampreys, suitable habitat, monitor populations or mapping of point threats (e.g., diversions, barriers).
- Instream - on the ground projects
- Rationale- rationale for action or benefit to lampreys
- Habitat gain- in linear miles of suitable habitat
- Adult- lifestage addressed (checked)
- Juv- lifestage addressed (checked)
- Larvae- lifestage addressed (checked)

SCALE and LOCATION

Scale- area impacted or addressed by action:

- Point (Lat/Long)
- Stream
- Mainstem
- Watershed
- HUC
- Basin
- Subregion
- Region - CA

Location - description, as specific as possible, depends on scale
Lat - Decimal degrees NAD83
Long - Decimal degrees NAD83

PRIORITIZATION

Scale of threats addressed

4 - Regional: Action addresses threat in >50% of region (action's impact, not overall threat)
3 - Multi-HUC: Action addresses a threat in multiple HUCs (<50% of region)
2 - HUC: Action addresses a threat in a single HUC
1 - Drainage: Action addresses threat within a drainage, reach or site, w/o broader impacts

Scope of threats addressed

4 - High: 71-100% of total population, occurrences, or area affected
3 - Medium: 31-70% of total population, occurrences, or area affected
2 - Low: 11-30% of total population, occurrences, or area affected
1 - Insignificant: <10% of total population or area affected

Severity of threats addressed

4 - High: 71-100% degradation or reduction of habitat/habitat function, and/or 71-100% reduction of population within scope
3 - Medium: 31-70% degradation or reduction of habitat/habitat function, and/or 31-70% reduction of population within scope
2 - Low: <30% degradation or reduction of habitat/habitat function, and/or <30% reduction of population within scope
1 - Unknown or n/a: Severity of threat unknown, or assessment and severity not applicable

Effectiveness of action

4 - High: Removes or causes threat to be insignificant; or provides all information needed to address threat (ie. Assessments, Coord., Research, Survey)

3 - Medium: Substantially reduces threat; or provides substantial information/collaboration

2 - Low: Has some effect on threat, but does not reduce it substantially; or provides minimal information/collaboration

1 - Insignificant: Minimally effective or not targeted at a known threat

Feasibility

Technical difficulty

4 - Simple: Utilizes simple technology or readily achievable methods

3 - Moderate: Moderately complex, but utilizes existing technology and standard methods

2 - Difficult: Requires high level of engineering, assessment, development or multiple stakeholder support development

1 - Unfeasible: Not likely to be possible at this time (5 years) due to excessive technical difficulty or complicated economic or political issues

Duration to implement

4 - Short: 0-2 years

3 - Medium: 3-5 years

2 - Long: > 5 years

1 - Extended: extended time frame or perpetual

Readiness

4 - Underway: Already underway or funded

3 - High: Can be initiated in the next two years.

2 - Medium: Could be initiated in the next 3-5 years.

1 - Low: May take five or more years for additional assessment and planning

Cost

4 - Inexpensive: $ < 10 k

3 - Moderate: $ 10-50 k

2 - Expensive: $ 50-250 k

1 - Very Expensive: $ 250 k - millions

Funding Source

4 - Funded: Funding has been obtained

3 - Identified: Appropriate funding sources identified and likely to participate

2 - Unspecified: Various appropriate funding sources exist but have not been selected
1 - Uncertain: Funding is uncertain

Partner participation
4 - High: All potential stakeholders are supportive
3 - Medium: Necessary stakeholders are supportive
2 - Low: Additional stakeholders need to be incorporated
1 - Problematic: Necessary stakeholders are not supportive

Prerequisites: Brief description of additional actions needed.

Additional Benefits

Prerequisite for other actions: Is action necessary prior to other implementation actions?
1 - Yes
2 - No

Additional benefits
4 - High: Will have substantial benefits beyond the specific goals of the action (e.g., outreach, technology, precedent setting)
3 - Medium: Will provide additional benefits to conservation efforts outside the drainage
2 - Low: Localized benefits to species or stakeholders
1 - Insignificant: Benefits restricted to action purpose only

Public awareness
4 - High: High public awareness and positive outreach benefit
3 - Medium: Increased stakeholder awareness and benefit outside of action area
2 - Low: Unlikely to come to attention of public outside action area
1 - Insignificant: Will probably not be noticed by anyone except those carrying out the action

Status

Status
- 'No status'
- Proposed
- Funded
- Underway
- Ongoing

- Completed

Work in Progress: Brief description of current work underway or completed

Implementing Entity: Lead entity, and partners
Contact: Primary contact for threat or action
Cost: Approximate
Funding Source: Current or potential
Funds available: Percent (%) of total cost
Stakeholders: Involved/effected parties - not necessarily implementer or funder

Appendix C. Proposed implementation tasks and needs - South Coast

The Implementation Database is intended as a living document that will be updated as we develop new information and improve our understanding of lamprey conservation status and as implementation progresses and the status of individual projects changes. A current version of the Implementation Database is maintained at the Arcata USFWS Field Office. Interested stakeholders can contact us either for electronic access to the implementation database, to provide updated information or to recommend additional projects.

Please contact:
Damon H. Goodman, Fish Biologist
USFWS Arcata Fish and Wildlife Field Office
1655 Heindon Road, Arcata, CA, 95521
707-825-5155 (office), damon_goodman@fws.gov