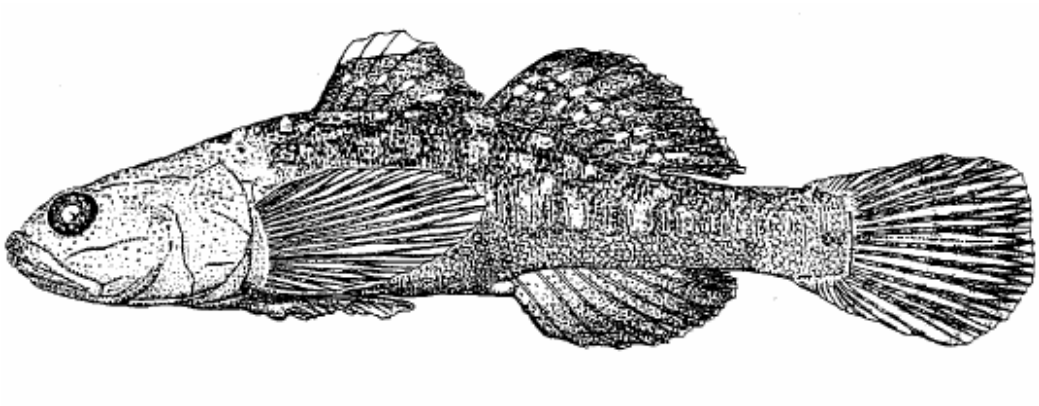
Draft Recovery Plan
For the
Tidewater Goby

(*Eucyclogobius newberryi*)

(October 2004)



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Portland, Oregon

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Recovery plans delineate reasonable actions that are believed to be required to recover and/or protect listed species. We, the U.S. Fish and Wildlife Service, publish recovery plans, sometimes preparing them with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than our own. They represent our official position **only** after they have been signed by the Regional Director, Director, or California/Nevada Operations Manager as **approved**. Approved Recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

***Literature citation should read as follows*:**

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An electronic version of this recovery plan will also be made available at http://www.r1.fws.gov/ecoservices/endangered/recovery/plans.html and http://endangered.fws.gov/recovery/index.html.

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EXECUTIVE SUMMARY

Current Species Status: The tidewater goby (*Eucyclogobius newberryi*) is listed as endangered. It is a small fish that inhabits coastal brackish water habitats entirely within California, ranging from Tillas Slough (mouth of the Smith River, Del Norte County) near the Oregon border south to Agua Hedionda Lagoon (northern San Diego County). The tidewater goby is known to have historically inhabited at least 124 localities. Presently 28 (23 percent) of the 124 documented localities are considered extirpated and 55 to 70 (45 to 55 percent) of the localities are naturally so small or have been degraded over time that long-term persistence is uncertain.

Habitat Requirements: Tidewater gobies are uniquely adapted to coastal lagoons and the uppermost brackish zone of larger estuaries, rarely invading marine or freshwater habitats. The species is typically found in water less than 1 meter (3.3 feet) deep and salinities of less than 12 parts per thousand. Principal threats to the tidewater goby include loss and modification of habitat, water diversions, predatory and competitive introduced fish species, habitat channelization, and degraded water quality.

Recovery Objective: Downlist to threatened status, then delist. The primary objective of this recovery plan is to eliminate the threats to and improve the population status of the tidewater goby sufficiently to warrant reclassification (from endangered to threatened status) or delisting.

Recovery Priority Number: The tidewater goby has a recovery priority number of 7C (on a scale of 1 to 18), per criteria published in the Federal Register (U.S. Fish and Wildlife Service 1983). This number indicates a species with moderate threats and a high potential for recovery. The letter C indicates that there is some degree of conflict between the species' recovery efforts and economic development.

Recovery Criteria: We subdivide the geographic distribution of the tidewater goby into 6 recovery units, encompassing a total of 26 Sub-Units defined according to genetic differentiation and geomorphology. The tidewater goby may be considered for downlisting when:

1) An analysis based on scientifically credible monitoring over a 10-year period projects a 75 percent chance of all Sub-Units within each recovery unit persisting for a minimum of 100 years. This projection would incorporate a metapopulation viability analysis using a complex suite of information. A partial list of information needed for the metapopulation viability analysis includes: presence/absence data; population estimates; observed rates of extirpation and natural recolonization; results of introduction efforts to new localities and reintroduction to sites of known or suspected extirpation; and the relationships between climate variation and extinction and recolonization probabilities. This projection will also require incorporating information on new threats at the time of downlisting, such as any new exotic predator introductions that may have occurred.

2) All goby metapopulations are managed so that threats from habitat destruction and alteration (e.g., coastal development, upstream diversion, channelization of rivers and streams, discharge of

agriculture and sewage effluents), introduced predators (e.g., centrarchid fishes), and competition with introduced species (e.g., yellowfin and chameleon gobies) are reduced to the extent that each metapopulation is not at risk of extirpation.

The tidewater goby may be considered for delisting when downlisting criteria have been met and:

1) An analysis based on scientifically credible monitoring over a 10-year period projects a 95 percent chance of all Sub-Units within each recovery unit persisting for a minimum of 100 years. This projection would incorporate a metapopulation viability analysis using a complex suite of information. A partial list of information needed for the metapopulation viability analysis includes: presence/absence data; population estimates; observed rates of extirpation and natural recolonization; results of introduction efforts to new localities and reintroduction to sites of known or suspected extirpation; and the relationships between climate variation and extinction and recolonization probabilities. This projection will also require incorporating information on new threats at the time of delisting, such as any new exotic predator introductions that may have occurred.

Actions Needed:

1. Monitor, protect and enhance currently occupied tidewater goby habitat.

2. Conduct biological research to enhance the ability to integrate land use practices with tidewater goby recovery and revise recovery tasks as pertinent new information becomes available.

3. Evaluate and implement translocation where appropriate.

4. Increase public awareness about tidewater gobies.

Estimated Total Cost of Recovery: $1,505,000 over the next 10 years, with costs yet to be determined for securing and protecting coastal wetlands and for assurance of successful establishment of additional populations of tidewater goby. Funding opportunities and management will need to be developed between landowners, regulatory agencies, nonprofit organizations, and other interested parties.

Date of Recovery: If recovery criteria are met, reclassification to threatened status could be initiated in 2015.

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I. BACKGROUND

A. Brief Overview

We, the U.S. Fish and Wildlife Service, listed the tidewater goby (*Eucyclogobius newberryi*) as endangered on March 7, 1994 (U.S. Fish and Wildlife Service 1994) and designated critical habitat on November 20, 2000 (U.S. Fish and Wildlife Service 2000). On June 24, 1999, we published a proposed rule to remove the northern populations* of the tidewater goby from the endangered species list (U.S. Fish and Wildlife Service 1999). The proposed rule was withdrawn on November 7, 2002 (U.S. Fish and Wildlife Service 2002).

The tidewater goby, a species endemic to California, is found primarily in waters of coastal lagoons*, estuaries*, and marshes. The species is benthic* in nature, and its habitat* is characterized by brackish, shallow lagoons and lower stream reaches where the water is fairly still but not stagnant (Miller and Lea 1972; Wang 1982; Irwin and Soltz 1984; Swift *et al*. 1989; Swenson 1999; Moyle 2002). Tidewater gobies prefer a sandy substrate for breeding, but they can be found on rocky, mud, and silt substrates as well. Tidewater gobies have been documented in waters with salinity* levels from 0 to 42 parts per thousand, temperature levels from 8 to 25 degrees Celsius (46 to 77 degrees Fahrenheit), and water depths from 25 to 200 centimeters (10 to 79 inches) (Irwin and Soltz 1984; Swift *et al*. 1989; Worcester 1992; Lafferty 1997; Smith 1998).

The tidewater goby appears to spend all life stages in lagoons, estuaries, and river mouths. Tidewater gobies may enter marine environments only when flushed out of lagoons, estuaries, and river mouths by normal breaching of the sandbars following storm events. The tidewater goby is typically an annual species, although some variation has been observed (Irwin and Soltz 1984; Swift *et al*. 1989; Swenson 1999). Reproduction occurs year-round although distinct peaks in spawning, often in early spring and late summer, do occur (Swenson 1999).

This recovery plan briefly describes the species and provides a history of its taxonomy and known distribution. Tidewater goby life history and habitat parameters are described. The factors responsible for the tidewater goby's decline are tabulated and actions that have been taken thus far to protect populations of this species are summarized.

B. Description and Taxonomy

The tidewater goby is a small, elongate, grey-brown fish rarely exceeding 50 millimeters (2 inches) standard length*. It is characterized by large pectoral fins (Figure 1). The pelvic or ventral fins are joined to each other below the chest and belly from below the gill cover back to just anteriorly* of the anus. Tidewater gobies have two dorsal fins set very close together or with a slightly confluent membrane. The first dorsal fin has five to seven slender spines, the second

* Technical terms are marked with an asterisk and defined below in the Glossary (Appendix A).

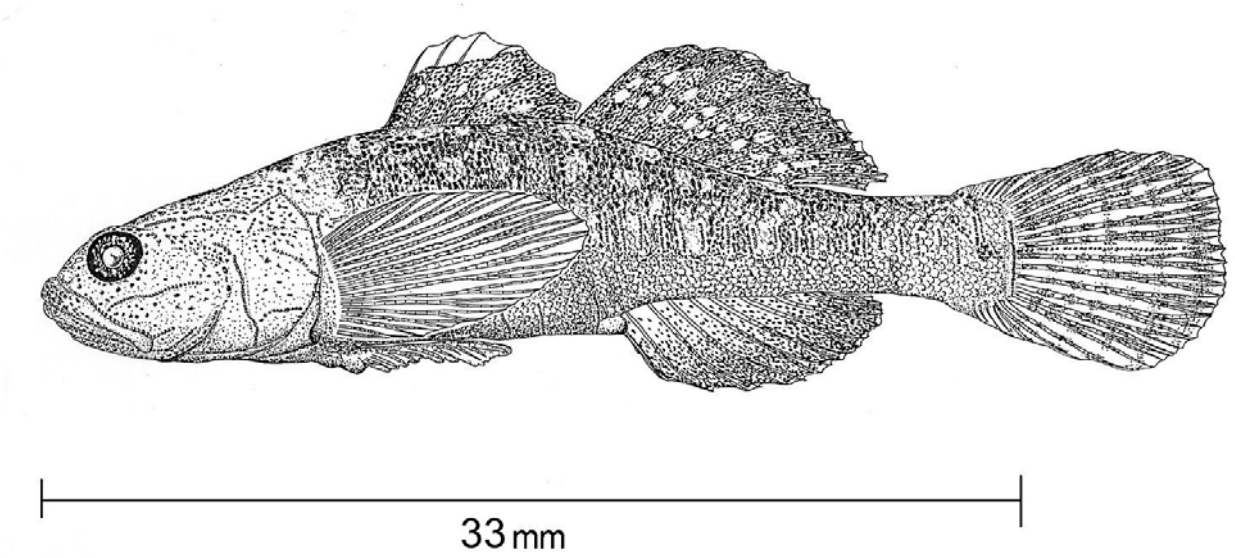

Figure 1. Tidewater Goby (*Eucyclogobius newberryi*)

11 to 13 soft, branched rays. The anal fin has 11 to 13 rays as well. The median fins are usually dusky, and the pectoral fin is transparent. Male tidewater gobies are nearly transparent, with a mottled brownish upper surface and generally remain near the burrows. Female tidewater gobies develop darker colors, often black, on the body and dorsal and anal fins. However, pectoral and pelvic fins, head and tail remain grey or brown.

Other native estuarine gobies that occur in California are the arrow goby (*Clevelandia ios*), cheekspot goby (*Ilypnus gilberti*), shadow goby (*Quietula cauda*), bay goby (*Lepidogobius lepidus*), and mudsucker (*Gillichthys mirabilis*). In addition, four introduced Japanese species of goby occur in California estuaries within the range of the tidewater goby: yellowfin goby (*Acanthogobius flavimanus*), chameleon goby (*Tridentiger trigonocephalus*), shokihaze goby (*Tridentiger barbatus*), and shimofuri goby (*Tridentiger bifasciatus*) (Dawson *et al*. 2001; Moyle 2002). Tidewater goby scales are very small and imbedded in the skin, and are only visible with magnification even on large specimens. This character separates the tidewater goby from the mudsucker, yellowfin goby, chameleon goby, and shimofuri goby. The latter four are well scaled, even as small juveniles (20 millimeters [0.75 inch] or more in length). The best field mark for tidewater gobies is the transparent, whitish or yellowish triangular area on the upper 1/4 to 1/3 of the first, spinous dorsal fin (Figure 1). Another characteristic unique to the tidewater goby is that the upper end of the gill opening stops a few fin rays below the upper end of the pectoral fin base (Miller and Lea 1972). Arrow gobies are much more slender, particularly at small sizes. They also have a much smaller spinous dorsal fin widely separated from the soft dorsal, rather than adjacent to it. The spinous dorsal fins on cheekspot and bay gobies are dusky or mottled throughout, or with only a narrow pale edge. Specimens of the last three species can be difficult to distinguish from tidewater gobies smaller than approximately 25 millimeters (approximately 1 inch) in standard length. Cheekspot and bay gobies inhabit deeper, more marine, tidal habitats and have been rarely collected with tidewater gobies. The species most likely to occur with tidewater gobies are the arrow goby, mudsucker, and possibly yellowfin goby, which are all easy to distinguish from the early juvenile stage onward.

The tidewater goby was first described as a new species by Girard (1857) as *Gobius newberryi*. Gill (1863) erected the genus *Eucyclogobius* for this distinctive species. The vast majority of scientists have accepted this classification (Jordan and Everman 1898; Miller and Lea 1972; Hubbs *et al*. 1979; Eschmeyer *et al*. 1983; Nelson *et al*. 2004). No other species has been described in this genus. A few older works and Ginsberg (1945), a gobiid systematist, put the tidewater goby and all the related eastern Pacific species into the genus *Lepidogobius*. This classification includes the currently recognized genera *Lepidogobius*, *Clevelandia*, *Ilypnus*, *Quietula*, and *Eucyclogobius*. These genera, which include the eastern Pacific species, are related to each other. Birdsong *et al*. (1988) recognized this relationship, and that these eastern Pacific gobies were phyletically related to several similar species in the northwestern Pacific. Birdsong *et al*. (1988) coined the informal Chasmichthys species group as a collective name for all of these northwestern and eastern Pacific species. Unpublished work by Camm Swift indicates that all the eastern Pacific genera noted above are closely related to each other. As a group, they are more distantly related to the species in the northwestern Pacific.

The intraspecific phylogeny* of the tidewater goby is highly geographically structured. Crabtree's (1985) genetic work on the tidewater goby shows fixed allelic* differences at the extreme northern (Lake Earl, Humboldt Bay, Appendix B and C) and southern (Cañada de Agua Caliente, Winchester Canyon, and San Onofre Lagoon, Appendix B and C) ends of the range and some variation in Corcoran Lagoon in Santa Cruz County, central California (Appendix B and C). Each of these northern and southern populations is distinct from each other and from those central populations that have been sampled. The other more centrally distributed populations are relatively similar to each other (Brush Creek, Estero Americano, Arroyo de Corral, Morro Bay, Santa Ynez River, and Jalama Creek (Appendix B and C). This study is based on 12 localities distributed over most of the range. The precise limits of allozyme* differentiation are not known. The results of this study indicate that there is a very low level of gene flow between the populations sampled. Many of the populations may be diverging genetically from each other due to discrete, seasonally closed estuaries, where tidewater gobies have low dispersal ability (Crabtree 1985).

Dawson *et al*. (2001) analyzed mitochondrial DNA* and cytochrome* *b* sequences of individual tidewater gobies collected from 31 locations between 1990 and 1999. Their study revealed six major phylogeographic* groups in four clusters – the San Diego clade* south of Los Angeles and Point Buchon, a lone Estero Bay group from central California, and San Francisco and Cape Mendocino groups from northern California – that genetically vary. Barriers to gene flow likely exist in the vicinities of Los Angeles, Seacliff, Point Buchon, Big Sur, and Point Arena (Figure 2). Finer scale phylogeographic structure within these regions is suggested by genetic differences between estuaries, but is poorly resolved by current analysis (Dawson *et al*. 2001).

Dawson *et al*. (2001) found that phylogenetic relationships between and patterns of molecular diversity within the six groups are consistent with repeated and sometimes rapid northward and southward range expansions out of central California, likely caused by Quaternary climate change. The modern geographic and genetic structure of the tidewater goby has probably also been influenced by patterns of expansion and contraction, colonization*, extirpation*, and gene flow linked to Pliocene*-Pleistocene* tectonism, Quaternary* coastal geography and hydrography, and historical human activities (Dawson *et al*. 2001).

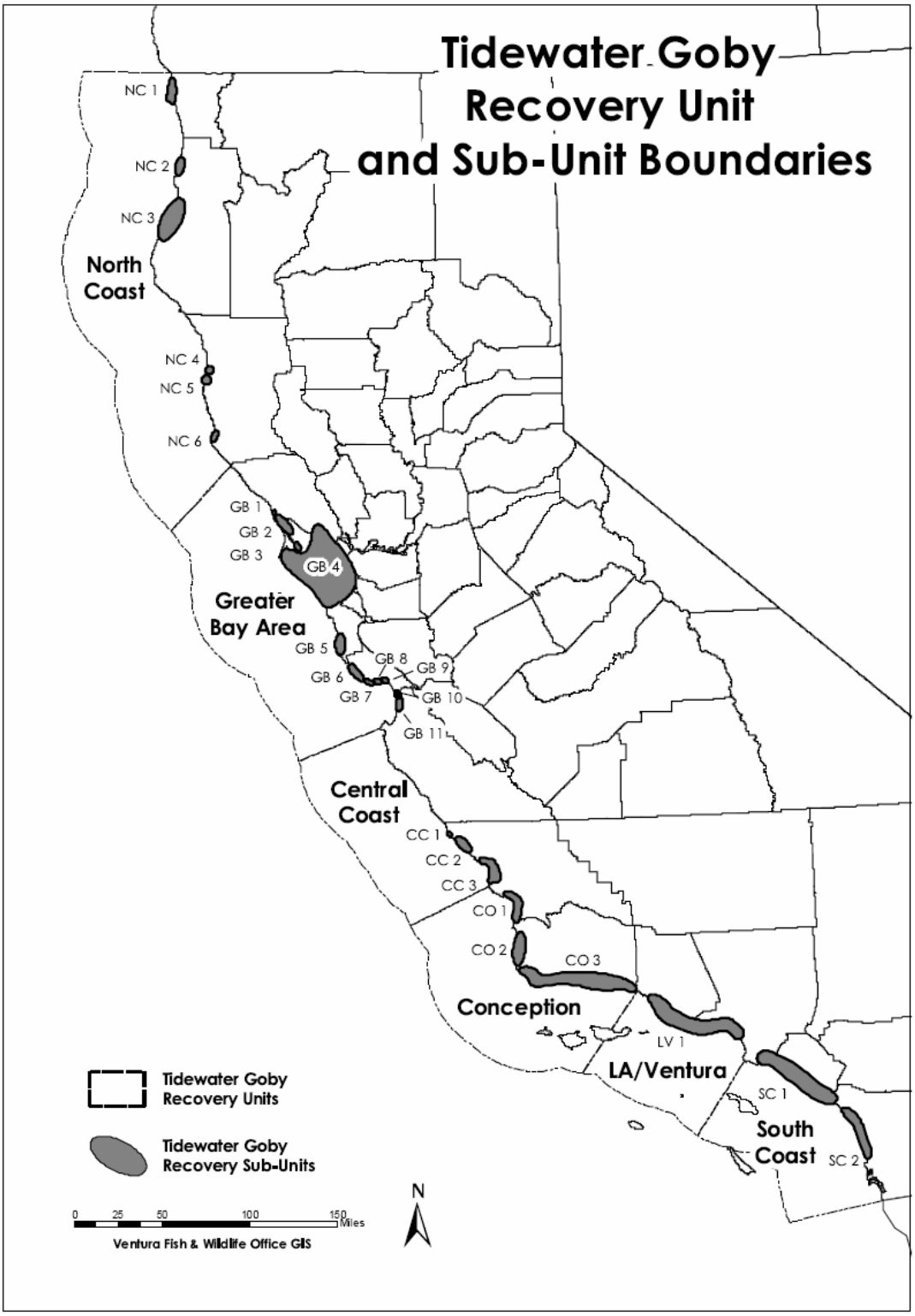

Figure 2. Tidewater Goby Rangewide Distribution with Recovery Unit and Sub-Unit Boundaries.

The deepest phylogenetic gap in *Eucyclogobius* coincides with phylogeographic breaks in several other coastal California taxa in the vicinity of Los Angeles, suggesting common extrinsic factors have had similar effects on different species in this region. In contrast, evidence exists in this species of gene flow across the biogeographic boundary at Point Conception (Dawson *et al*. 2001).

Figure 3. Tillas Slough, Del Norte County

C. Distribution and Habitat

Tidewater gobies are endemic* to California and historically ranged from Tillas Slough (mouth of the Smith River, Del Norte County; Figure 3) near the Oregon border to Agua Hedionda Lagoon (northern San Diego County), and are found today entirely within the original known range of the species. The known localities (Appendix B, C; Figure 2) are discrete lagoons, estuaries, or stream mouths separated by mostly marine conditions. Tidewater gobies are absent from areas where the coastline is steep and streams do not form lagoons or estuaries. Tributaries to Arcata Bay (northern Humboldt Bay) and Morro Bay are each treated as single localities. Inhabited localities are separated by as little as a few hundred meters up to tens of kilometers. North of Tomales Bay in Sonoma County, several large gaps in distribution are considered natural; no evidence has been found for historical occurrences in the intervening streams in this area. From Tomales Bay southward to San Francisco Bay, many populations are extirpated, leaving large unnatural gaps between remaining populations. Another apparently natural gap occurs south of San Francisco Bay to San Gregorio Creek, San Mateo County. A much larger natural gap occurs between the Salinas River, (Monterey County), southward to Arroyo del Oso (northern San Luis Obispo County), because of very steep shorelines preventing lagoon development. The only other large gap occurs in the Los Angeles Basin between city of Santa Monica (western Los Angeles County) and Aliso Creek (central Orange County). Habitat conditions ideal for the tidewater goby historically existed in the Los Angeles Basin (Swift *et al*. 1993). Literature records by Eigenmann and Eigenmann (1892) for collection of the tidewater goby in Santa Monica are supported by specimens (Camm Swift, Entrix Inc., pers. comm. 2004).

Swift *et al*. (1989) reported 87 localities where the tidewater goby was historically known to occur, although 124 localities are currently known (Appendix B, C; Figure 2) (U.S. Fish and Wildlife Service, unpublished data, 2004). Twenty-eight (23 percent) of the 124 documented locations are considered extirpated and 55 to 70 (45 to 55 percent) localities are naturally so small or have been degraded over time that long-term persistence is uncertain (C. Swift pers. comm. 2004).

Tidewater goby localities closely correspond to major stream drainages. Sediments provided by major drainages produce sandy beaches with low-lying coastal areas conducive to formation of coastal lagoons (Swift *et al*. 1989; Habel and Armstrong 1977). Recolonization of extirpated localities has been documented as occurring when extant populations are present within several kilometers (Holland 1992; Lafferty *et al*. 1999a, 1999b). More recently, tidewater gobies have been found in localities considered extirpated that are separated from the nearest tidewater goby locality by 10 to 20 kilometers (6.2 to 12.4 miles). In 1995, tidewater gobies were found for the first time in Cañada Honda, Santa Barbara County (Lafferty *et al*. 1996). Tidewater gobies had never been found in this locality during previous surveys. The locality was observed to go nearly dry during the drought of the late 1980's and early 1990's (C. Swift, pers. comm. 1995). The nearest locality to Cañada Honda is the Santa Ynez River, 10.5 kilometers (6.5 miles) to the north. These more recent records suggest that distant movement by tidewater gobies is possible. However, the source of these recolonizations may have been small numbers of individuals present in these localities that were missed by surveyors (K. Lafferty, U.S. Geological Survey, pers. comm. 1996).

Tidewater gobies generally select habitat in the upper estuary, usually within the fresh-saltwater interface. Tidewater gobies range upstream a short distance into fresh water, and downstream into water of up to about 75 percent sea water (28 parts per thousand). The species is typically found in salinities of less than 12 parts per thousand (Swift *et al*. 1989). These conditions occur in two relatively distinct situations: 1) the upper edge of tidal bays, such as Tomales, Bolinas, and San Francisco Bays near the entrance of freshwater tributaries, and 2) the coastal lagoons formed at the mouths of coastal rivers, streams, or seasonally wet canyons.

Tidewater gobies held at the Granite Canyon Fish Culture Facility were subject to a salinity tolerance test in hypersaline* water (45 to 54 parts per thousand) for 6 months, with no mortality (Worcester and Lea 1996). Holding temperatures (fresh water) varied annually from 4.0 to 21.5 degrees Celsius (39.2 to 70.7 degrees Fahrenheit). During the late 1980's and early 1990's, Karen Worcester (Morro Bay Estuary Program) conducted an investigation of habitat use in Pico Creek lagoon, and observed large numbers of tidewater gobies using the lower portion of the lagoon where highest salinities (up to 27 parts per thousand) were observed. In general, abundance did not appear to be associated with oxygen levels, which at times were quite low. Based on these studies it appears that the tidewater goby is adapted to a broad range of environmental conditions (Worcester and Lea 1996).

Like estuarine habitats in general, tidewater goby habitat is subject to considerable fluctuation of physical factors on both a daily and a seasonal basis. The lagoonal nature of many habitats tends to dampen short-term variation, but annual variation can still be wide. Winter rains and subsequent increased stream flows usually cause considerable flooding, breaching, and washing out of lagoonal waters, reducing salinity levels to near fresh water conditions (Figure 4). These flows may bring in considerable sediment. The finely divided mud and clay either moves through or settles out in backwaters, while the heavier sand is left in or near the lagoon. Initial high flows can scour out the lagoon bottom to lower levels, with sand building up again after flows decline. The sediments are usually spread quite evenly by the declining flows; lagoons

Figure 4. Santa Clara River, Ventura County, after a storm-breach-event

often end up only 1 to 2 meters (3.3 to 6.6 feet) deep despite a width of 30 to 150 meters (100 to 500 feet) or more (Habel and Armstrong 1977). This pattern holds true even in larger systems, such as the Santa Ynez River and Santa Margarita River. A central channel, excavated by brief winter flows in these larger streams, will be another meter (3.3 feet) or so deeper than most of the lagoon. Half or more of the substrate of the lagoon will be soft sand, with mud in backwaters. Elevated lateral backwaters often flood only in winter. Without these deeper, backwater habitats (*e.g.* lateral sloughs), tidewater gobies can be flushed out by heavy winter floods (Jerry Smith, Biology Department, San Jose State University, pers. comm. 2004), resulting in the extirpation of some populations (however, see next paragraph). Some rocks or gravel may be present, mostly at the upper (inlet) and lower (outlet) ends where constricted flow directly scours the channel. These rocks are exposed by high water flow. Declining flows continue to bring in sand that often covers the rocks by early spring.

Lafferty *et al*. (1999a) monitored post-flood persistence of 17 tidewater goby populations in Santa Barbara and Los Angeles Counties during and after the heavy winter floods of 1995. All 17 populations persisted after the floods, and no significant changes in population sizes were noted. In addition, gobies apparently colonized Cañada Honda after the flood. This information suggests that flooding, although generally negative, may sometimes have a positive effect by contributing to recolonization of extirpated habitats.

In general, water is least saline during the winter and spring rainy seasons because of precipitation and runoff. However, in north coast lagoons, the salinity level following breaching can be near marine levels, as the breach site remains low and open to high tides once or twice daily. This condition can last for weeks (Ray Bosch, U.S. Fish and Wildlife Service, pers. comm. 2004). Later in the year, occasional waves washing over the sandbars can introduce some sea water, but good mixing often keeps the lagoon water at a few parts per thousand or less. Summer salinity in the lagoon depends upon the amount of freshwater inflow at the time of sandbar formation. Time of sandbar closure, which usually occurs from spring to late summer, varies greatly between systems and years. The flow into the lagoon declines enough to allow the surf to build up the sandbar at the mouth of the lagoon. The sandbar closes the lagoon with the water at a relatively high and stable level. Typically, water level changes slowly, in response to the balance between inflow, evaporation, and outflow. In drier systems or in drought years the closed lagoons may remain brackish after bar formation. Also, in very wet years beach erosion due to storm waves may delay bar formation until stream flow is low, resulting in a brackish lagoon. Larger systems with greater tidal prisms may close later, but even this relationship is

often less important than beach processes, lagoon shape (especially width), and inflow. The role of waves washing over the sandbar also varies with the system. In some (usually small) lagoons with little inflow, overwash may be important in affecting lagoon volume and salinity. In others, overwash has insignificant effects on lagoon salinity or volume (J. Smith, pers. comm. 1996). Different degrees of mixing or stratification of fresh and salt water occur in systems open to the ocean, varying greatly with system surface area, depth, and wind. Small, narrow systems or wind-protected upper portions of lagoons may be stratified for salinity (and temperature and dissolved oxygen). In broad, shallow, open embayments wind gradually can mix the salt layers; in some systems the broad embayment by the sandbar may be mixed, but the narrow protected upper channels remain stratified (J. Smith, pers. comm. 1996). Lagoons in areas dominated by sand dunes usually fluctuate in tandem with the local water table. In summer, the fresh water seeps into the lagoon from the water table, exerting a strong freshening influence often absent in lagoons bounded by firmer substrate (Ferren *et al*. 1995).

The high water line in lagoons is usually 1 to 2 meters (3.3 to 6.6 feet) higher than local high tide levels, typically during the times of the year when the mouth is closed off. The perimeter of the lagoon usually is defined by a steeply inclined or vertical bank, typically 0.3 to 1.0 meter (1 to 3.3 feet) high. The position and location of these lateral banks is usually stable for years at a time. They often delineate the inland or upstream two-thirds to three-quarters of most lagoons. They are strongly cut into clay or rocky substrate and are usually stabilized along the top by *Salicornia* (pickleweed), *Distichlis* (salt grass), *Scirpus* (tules), *Spartina* (cordgrass) and other marsh vegetation. The banks on the seaward one-third to one-quarter are usually more gently sloping, unstable, mostly unvegetated and mostly sand. Even lagoons within large areas of sand dunes have their configuration carved into the underlying harder substrate. These banks maintain the integrity of the lagoon for years at a time.

The shallow, pan configuration of the lagoons means that normal vertical changes in water level have little effect on surface area. Only at extremely high or low water levels does surface area change dramatically. Conversely, once the water level drops below the base of the steep lateral banks, any further drop directly lowers the surface area. Once the water level surmounts the top of these banks, the surface area can double or triple because the flats adjacent to the lagoon suddenly become flooded. Only a much larger volume of water will enable the lagoon to occupy this much larger area, and such enlargements are infrequent events. For this reason, these flats are often muddy, anoxic*, or hypersaline, and are seldom, if ever, heavily utilized by tidewater gobies.

Water temperatures in lagoons closed to the ocean seldom exceed a range of 10 to 25 degrees Celsius (50 to 77 degrees Fahrenheit), and usually fall somewhere in between. North of Point Conception, where the ocean is consistently 9 to 11 degrees Celsius (48 to 52 degrees Fahrenheit), lagoons are almost always warmer than the ocean. South of Point Conception, winter temperatures are similar, but late summer ocean temperatures reach 19 to 21 degrees Celsius (68 to 72 degrees Fahrenheit). Shallow, stratified lagoons can act as solar collectors, with more saline bottom layers trapping heat and reaching 30 degrees Celsius (86 degrees Fahrenheit). Thus, in southern California, lagoons are usually warmer than the ocean in winter and cooler in summer (Swift *et al*. 1989). Often the surface is a few degrees warmer than the bottom if the salinity is uniform. Coastal fog and maritime influence often keep lagoon waters

several degrees cooler than stream waters just a few kilometers further upstream. In addition, heavy summer fog can block the sun's warming effect and cause a depression in water temperatures for a few weeks or months. The sunnier days in spring and fall result in bimodal peaks of higher water temperatures (Purer 1942; Swift and Frantz 1981). At localities open to tidal influence, temperature fluctuates more in parallel with the ocean, salinities stay mixed, and these microgeographic effects may not develop (Purer 1942; Swift and Frantz 1981).

Stable lagoons are often almost completely choked with aquatic* vegetation, usually with *Potamogeton pectinatus* (sago pond weed) and two species of *Ruppia* (widgeon grass), *R. maritima* and *R. cirrhosa*. *Ruppia cirrhosa* is more typical of the brackish zone inhabited by tidewater gobies (Wayne Ferren, Museum of Systematic Biology, University of California, Santa Barbara, pers. comm. 1995). The invasion of fall migrating waterfowl and winter washing out of lagoons often removes virtually all of this growth (Mason 1957). This vegetation rapidly regrows in the spring and summer and provides cover from predators and substrate for the invertebrates used as food by tidewater gobies. This role is particularly important in steep narrow lagoons with little or no vegetation along the lagoon margin, or even in wide lagoons if the water level falls below the level of the emergent vegetation.

The lagoons in which tidewater gobies are found range in size from a few square meters of surface area to about 800 hectares (2,000 acres). Most lagoons are much smaller, ranging from about 0.5 to 5 hectares (1.25 to 12.5 acres). Surveys of tidewater goby localities and historic records indicate that size, configuration, location, and access by humans are all factors in the persistence of populations of this species (Swift *et al*. 1989, 1994). Lagoons and estuaries smaller than about 2 hectares (about 5 acres) generally have histories of extinction*, extirpation, or population reduction to very low levels. Many of the records for smaller localities, less than about 0.5 hectare (1 acre), include one or a few large tidewater gobies with no evidence of reproduction. These small localities are also often within a kilometer or so of another locality from which recolonization could occur following catastrophic events (C. Swift, pers. comm. 2004).

The largest localities are not necessarily the most secure, as evidenced by the fact that San Francisco Bay and the Santa Margarita River have lost their populations of tidewater gobies. However, an exception is Lake Talawa, Del Norte County, which is several thousand acres in size (Figure 5). The most stable or largest populations today are in localities of intermediate sizes, 2 to 50 hectares (5 to 125 acres) that have remained relatively unaffected. In many cases these have probably provided the colonists for the smaller ephemeral sites (Lafferty *et al*. 1999b).

D. Critical Habitat

Figure 5. Lake Talawa, Del Norte County

Critical habitat, as defined by section 3 of the Endangered Species Act of 1973 (16 U.S.C. 1531 *et sec*.), as amended, and at 50 CFR Part 424, includes: 1) the specific areas, within the geographic area occupied by a species at the time of its listing in accordance with the provisions of section 4 of the Endangered Species Act on which are found those physical or biological features essential to the conservation of the species and which may require special management considerations or protection; and 2) specific areas outside the geographical area occupied by the species at the time it is listed* which are determined to be essential for the conservation of the species. Tidewater goby critical habitat (U.S. Fish and Wildlife Service 2000) includes 10 coastal stream segments in Orange and San Diego Counties, California. See Appendix D for a description of tidewater goby critical habitat.

Critical habitat includes the stream channels and their associated wetlands, flood plains, and estuaries. These habitat areas provide for the primary biological needs of foraging, sheltering, reproduction, and dispersal, which are essential for the conservation of the tidewater goby. Information exists suggesting that critical habitat boundaries should be revised (U.S. Fish and Wildlife Service 2002).

E. Life History

The life history of tidewater gobies is keyed to the annual cycles of the coastal lagoons and estuaries (Swift *et al*. 1989; Swenson 1995, 1999). Most tidewater goby collections occurred in water of approximately 1/3 sea salinity; *i.e*. 12 parts per thousand or less. Tidewater gobies are usually collected in areas with water less than 1 meter (3.3 feet) deep (Swenson 1999). Tidewater gobies often migrate upstream into tributaries, as far as 1.0 kilometer (0.5 mile) from the estuary. However, in Ten Mile River, Mendocino County, and San Antonio Creek and the Santa Ynez River, Santa Barbara County, tidewater gobies are often collected 5 to 8 kilometers (3 to 5 miles) upstream of the tidal lagoonal areas, sometimes in sections of stream impounded by beavers (*Castor canadensis*) (Irwin and Soltz 1984). Half-grown to adult tidewater gobies move upstream in summer and fall (Figure 6). Evidence demonstrates reproduction in these upstream tributaries.

Male tidewater gobies begin digging breeding burrows in relatively unconsolidated, clean, coarse sand (averaging 0.5 millimeter [0.02 inch] in diameter), in April or May after lagoons close to the ocean (Swift *et al*. 1989; Swenson 1995). Swenson (1995) has shown that tidewater gobies also prefer this substrate in the laboratory. Burrows are at least 70 to 100 millimeters (3 to 4 inches) from each other.

Female tidewater gobies aggressively spar with each other for access to males with burrows for laying their eggs. This rare female-dominant breeding system in vertebrates makes the tidewater goby evolutionarily interesting and almost unique among gobies (Swift *et al*. 1989; Swenson 1995).

Female tidewater gobies can lay 300 to 500 eggs per clutch, depending on the size of the individual female tidewater goby (Swift *et al*. 1989). Female tidewater gobies lay 6 to 12 clutches per year (Swenson 1999). Male tidewater gobies remain in the burrow to guard the eggs that are attached to sand grains in the burrow ceiling and walls. Egg clutches are laid approximately 2.5 centimeters (1 inch) below the entrance of the burrow (Swenson 1999). Field collections of egg clutches have demonstrated that male tidewater gobies may accept more than one clutch, but this behavior is uncommon (Swenson 1999). The male tidewater goby cares for the embryos for approximately 9 to 11 days until they hatch, rarely if ever emerging from the burrow to feed.

Tidewater gobies generally live for only 1 year, with few individuals living longer than a year (Moyle 2002). Reproduction occurs at all times of the year, as indicated by female tidewater gobies in various stages of ovarian development (Swenson 1999). The peak of spawning activity occurs during the spring and then again in the late-summer. Fluctuations in reproduction are probably due to death of breeding adults in early summer and colder temperatures or hydrological disruptions in winter (Swift *et al*. 1989). Reproduction takes place in water between 9 to 25 degrees Celsius (48 to 77 degrees Fahrenheit) and at salinities of 2 to 27 parts per thousand (Swenson 1999).

Tidewater gobies have successfully reproduced under laboratory conditions for at least two different investigators (Worcester and Lea 1996). Several thousand were raised at the Granite Canyon Hatchery facility of the California Department of Fish and Game, Carmel, California in the late 1980's and early 1990's (Worcester and Lea 1996). Swenson (1999) observed tidewater gobies spawning regularly in 8 to 15 parts per thousand and 17 to 22 degrees Celsius (62 to 71 degrees Fahrenheit). Larvae and juveniles have been successfully raised to reproductive maturity on green algae, rotifers, and brine shrimp larvae (*Artemia* nauplii).

Figure 6. Tidewater goby (*Eucyclogobius newberryi*)

Tidewater goby standard length at hatching is approximately 4 to 5 millimeters (0.17 to 0.25 inch). Tidewater

goby larvae are planktonic for 1 to 3 days and then become benthic from that point on. The average size of tidewater gobies tends to be significantly larger in marshes (43 to 45 millimeters [1.7 to 1.8 inches] standard length) when compared to tidewater gobies from lagoons or creek habitats (Swenson 1999). Swenson (1999) speculated that the more stable physical conditions of the marsh foster improved growth or a more consistent or abundant supply of prey.

Tidewater gobies feed mainly on small animals, usually mysid shrimp, gamarid amphipods*, ostracods*, and aquatic insects, especially chironomid midge larvae (Swift *et al*. 1989; Swenson 1995; Moyle 2002). Swenson (1996) found that juvenile tidewater gobies are generally day feeders, although adults mainly feed at night. Tidewater gobies use three different foraging styles to capture benthic prey: plucking prey from the substrate surface, sifting sediment in their mouth, and mid-water capture. Swenson and McCray (1996) suggested that the tidewater goby's food requirements are adaptable to a variety of habitats, an advantageous trait in a fluctuating estuarine environment.

Tidewater gobies are known to be preyed upon by native species such as small steelhead (*Oncorhynchus mykiss*), prickly sculpin (*Cottus asper*), and staghorn sculpin (*Leptocottus armatus*) (Swift *et al*. 1989). Predation by the tule perch (*Hysterocarpus traski*), and historically by the Sacramento perch (*Archoplites interruptus*), has probably prevented tidewater gobies from inhabiting the San Francisco Bay delta, an otherwise ideal habitat for tidewater gobies (C. Swift, pers. comm., 1995).

Tidewater gobies are also preyed upon by several nonnative fish species. Shapavalov and Taft (1954) documented the nonnative striped bass (*Morone saxatilis*) preying upon tidewater gobies in Waddell Creek Lagoon. Sunfishes (*Lepomis* spp.) and basses (*Micropterus* spp.), have been introduced in or near coastal lagoons and could prey heavily on tidewater gobies. Anecdotal observations indicate that tidewater gobies have disappeared at several localities, soon after centrarchids were introduced (Swift *et al*. 1989, 1994; Rathbun 1991). Other predatory fish such as catfish and bullheads (Ictaluridae) have been introduced into some localities, including the San Francisco Bay delta (Moyle 2002). In addition, the shimofuri goby, which has become established in the San Francisco Bay region (Moyle 2002), competes with and preys upon the smaller tidewater goby (Swenson and Matern 1995).

Many piscivorous* birds, including egrets (*Egretta* spp.), herons (*Ardea herodias*, *Butorides striatus*, *Nycticorax nycticorax*), cormorants (*Phalacrocorax* spp.), terns (*Sterna* spp.), mergansers (*Mergus* spp.), grebes (*Podiceps* ssp., *Podilymbus* spp., *Aechmophorus* spp.), and loons (*Gavia* spp.), frequent the coastal lagoon habitats, mainly in fall and winter, and may feed on tidewater gobies (Rathbun 1991). Garter snakes (*Thamnophis* spp.) also probably prey on tidewater gobies. Rathbun (1991) suggested that robust populations of tidewater gobies, as well as threespine stickleback and prickly sculpins, would provide food for the two-striped garter snake (*Thamnophis hammondii*) in Santa Rosa Creek Lagoon.

F. Abundance and Trends

No long-term monitoring program is available for the tidewater goby, and population dynamics are not well documented for this species. Deriving population size estimates for the tidewater goby is difficult because of the variability in local abundance. In addition, seasonal changes in distribution and abundance further hamper efforts to estimate population size, especially for a

short-lived species. Tidewater goby populations also vary greatly with the varying environmental conditions (*e.g.*, drought, El Niño) among years; this environmental variation is a normal phenomenon, but one that makes the determination of trends difficult.

Estimating tidewater goby population size is complicated because the populations are controlled by environmental conditions. For example, when lagoons are breached due to flood events during the rainy seasons, tidewater goby populations decrease and then recover during the following summer. Swift *et al*. (1989) estimated that individual tidewater gobies within a population at Aliso Creek Lagoon ranged from 1,000 to 1,500 in the late winter-early spring and 10,000 to 15,000 tidewater gobies in the late summer-early fall.

When present, tidewater gobies are frequently the most abundant fish species found at the site (Lafferty *et al*. 1999a). Worchester (1992) documented a patchy distribution within habitats using meter-square drop traps for fine scale sampling. The results indicated density at Little Pico Creek, San Luis Obispo County ranged from 0 to 67 tidewater gobies per square meter in May 1990, 0 to 138 tidewater gobies per square meter in November 1990, and 0 to 27 tidewater gobies per square meter in February 1991. Density ranges for the following locations at the Camp Pendleton Marine Corps Base, San Diego County in October 1996 included 2 to 11 tidewater gobies per square meter in San Mateo Creek, 1 to 102 tidewater gobies per square meter in the creek at San Onofre Lagoon (October 1996), 0 to 4 tidewater gobies per square meter in Los Flores Creek (November 1996), 0 to 6 tidewater gobies per square meter in Hidden Creek (November 1996), and 1 to 51 tidewater gobies per square meter in French Creek Lagoon (October 1996)(Swift and Holland 1998).

G. Reason for Decline and Current Threats

The tidewater goby is threatened by modification and loss of habitat as a result of coastal development, channelization of habitat, diversions of water flows, groundwater overdrafting, and alteration of water flows. Potential threats to the tidewater goby include discharge of agricultural and sewage effluents, increased sedimentation due to cattle grazing and feral pig activity, summer breaching of lagoons, upstream alteration of sediment flows into the lagoon areas, introduction of exotic* gobies (*e.g.*, yellowfin and shimofuri gobies) and rainwater killifish (*Lucina parva*), habitat damage, and watercourse contamination resulting from vehicular activity in the vicinity of lagoons. The following discussion is organized according to the five listing criteria under section 4(a)(1) of the Endangered Species Act.

1. *The present or threatened destruction, modification, or curtailment of its habitat or range.*

Coastal development projects that modify or destroy coastal brackish-water habitat are the major factor adversely affecting the tidewater goby. Coastal lagoons and marshes have been drained and reclaimed for residential and industrial developments. Waterways have been dredged for navigation and harbors, resulting in direct losses of wetland habitats as well as indirect losses due to associated changes in salinity. Coastal road and railroad construction have severed the connection between marshes and the ocean, resulting in unnatural temperature and salinity profiles (U.S. Fish and Wildlife Service 1994).

Bridging of coastal lagoons and consequent restriction of water flow probably began with the railroads; the early coastal highways always turned inland and crossed upstream of lagoons. The railroads along the coast often obliterated much or all of those lagoons traversed. Populations in San Luis Obispo, Santa Barbara, and San Diego Counties were probably lost before 1900 (Swift *et al*. 1993; U.S. Fish and Wildlife Service 1994; Moyle 2002). Many early highway bridges and trestles spanned the lagoons, leaving the lagoon habitat intact. Subsequently, highway builders adopted some of the methods used for building crossings for railroads near the coast. Later, some lagoons were obliterated by complete filling.

For several reasons, lagoons and their tributary streams have been partially or completely channelized to protect bridges, adjacent structures, and farmland. These efforts hasten the flow of water through the marsh to the sea and isolate the lateral marshes from the mainstream. Tidewater gobies depend on the cover and protection of the marshes for growth and as refugia from scouring winter flows. If they are denied access to the marsh, the possibility of losing a population to a major flood event increases. One such loss where channelization had been done was documented by Jack Nelson in 1972 and 1973 at Waddell Creek (Swift *et al*. 1989). The channelization upstream of San Onofre Lagoon on Camp Pendleton probably led to the washing out of the tidewater gobies during the "March miracle" storm of 1993 (Swift *et al*. 1994). Strong flood flows in January and March of 1995 severely reduced the population at the channelized Jalama Creek, Vandenberg Air Force Base, but some individuals survived (Swift *et al*.1997). In addition, channelization can increase scouring and deepen the narrow channels, leaving behind only rocks and gravel. Increased velocity of flow created by channelization transports sand into the ocean. Therefore, substrate required for breeding by the tidewater goby is reduced or eliminated.

Stream diversions have adversely affected the tidewater goby by altering downstream flows, thereby diminishing the extent of marsh habitats that occurred historically at the mouths of most rivers and creeks. Diversions are known to exacerbate the effects of natural deleterious events. In San Luis Obispo County alone, the effects of drought, exacerbated by upstream water diversions, were responsible for the extirpation of at least three populations between 1986 and 1990 (K. Worcester, pers. comm. 1991, as cited in U.S. Fish and Wildlife Service 1994). Alterations of flows upstream of coastal lagoons have changed the distribution of downstream salinity regimes. Changes in salinity distributions because of upstream water diversions may adversely affect both the size and distribution of tidewater goby populations (D. Holland, pers. comm. 1991, as cited in U.S. Fish and Wildlife Service 1994).

2. *Overutilization for commercial, recreational, scientific, or educational purposes.*

We do not believe overutilization is a threat to the tidewater goby.

3. *Disease or predation.*

The only parasite recorded on tidewater gobies is the fluke *Cryptocotyle lingua*, which occurred on the skin of many adults from Corcoran Lagoon and possibly Pescadero Lagoon (Swenson 1999; Swift *et al*. 1989). *Cryptocotyle lingua* is a common marine parasite in the family Heterophyidae. The infection can kill the host fish, particularly juveniles, at high intensities or facilitate secondary bacterial infections in the ruptured skin. In addition to pathological impacts,

infection could increase the fish's vulnerability to predation, either by increased visibility because of the black cysts, or by altered predator-avoidance behavior (Swenson 1999).

Tidewater gobies are vulnerable to introduced predators and exotic estuarine species of goby. Unauthorized illegal introductions of nonnative species are on the increase today for sport, bait, commercial, and aquaculture purposes (Baltz 1991; Courtenay and Williams 1992; Aquatic Nuisance Task Force 1993; Swift *et al*. 1993; Hastings and Henle 1995). Shapavalov and Taft (1954) documented predation on tidewater gobies by striped bass at Waddell Creek lagoon. The bass were introduced to San Francisco Bay and drifted down the coast to Waddell Creek. Since the early 1900's, several introductions of striped bass have been made to a variety of coastal lagoons and bays in central and southern California and are a threat to those populations (Swift *et al*. 1993). Nonnative African clawed frogs (*Xenopus laevis*) also prey upon tidewater gobies (Lafferty and Page 1997), although they are probably not a significant source of mortality due to the limited distribution of this species in tidewater goby habitat.

Although few brackish or estuarine fish species have been introduced to California, several freshwater species potentially affect the brackish zone also. Introduced centrarchid sunfishes and basses have long been a staple feature of California fresh waters. Studies in their native habitats in Mississippi and Florida show that, seasonally, they can be the major fish predators in the upper brackish portion of estuaries (Swift *et al*. 1977; Hackney and de la Cruz 1981). Only further seaward, in more saline water, do the major marine predators become abundant.

Introduced centrarchids occur in virtually all tributaries to tidewater goby habitats. It is not clear why more lagoons have not been invaded. A substantial downstream movement of centrarchids into upper Santa Margarita River Lagoon seems to have eliminated or severely reduced tidewater gobies there in the summer of 1993 (C. Swift, pers. comm. 1995). Tidewater gobies seem to have been eliminated by largemouth bass (*Micropterus salmoides*) at Old Lagoon, San Luis Obispo County in the late 1980's or early 1990's (D. Holland, pers. comm. 1992). Green sunfish (*Lepomis cyanellus*) dominated San Mateo Creek Lagoon, San Diego County in the late 1980's and early 1990's (Feldmuth and Soltz 1986; Swift *et al*. 1994) and tidewater gobies could not be found. Green sunfish were absent in the fall of 1993 and a small number of tidewater gobies were present. The sunfish may have been washed out during high flows or were eliminated by other factors such as changing salinity. Survival in lateral marshes or recolonization from other extant sites may explain the re-occurrence of tidewater gobies in San Mateo Lagoon following the elimination of the green sunfish.

Abbotts Lagoon on Pt. Reyes National Recreation Area appears to be ideal tidewater goby habitat but is inhabited by introduced Sacramento perch that may have eliminated them. The proximity of these Sacramento perch possibly threatens other local populations of tidewater gobies at Estero San Antonio, Estero Americano, and Rodeo Lagoon on Golden Gate National Recreation Area.

4. *The inadequacy of existing regulatory mechanisms*.

Section 10 of the Rivers and Harbors Act, section 404 of the Clean Water Act, the National Environmental Policy Act, the California Environmental Quality Act, and the California Coastal

Act are regulatory mechanisms that may be used to manage tidewater goby habitat. We have the authority to comment on notifications from these Acts. However, our comments are only advisory, although procedures exist for elevation when disagreements between agencies arise. Therefore, the agencies' (*i.e*. U.S. Army Corps Of Engineers, Environmental Protection Agency, U.S. Fish and Wildlife Service, California Department of Fish and Game, California Coastal Commission) actions under the legislation discussed above may be insufficient to protect the tidewater goby.

5. *Other natural or manmade factors affecting its continued existence*.

The brackish zone, preferred by the tidewater goby, is often modified or eliminated by human created barriers (*e.g.*, dikes and levees), typically at the upstream terminus of channelization. These barriers are typically built to create water reservoirs or provide flood protection to farm or grazing land, residential or commercial development. In several areas, including the mouth of the Santa Maria River, Ballona Marsh, and the Los Angeles-Long Beach Harbor area, subsurface oil and water extraction causes the land to sink below sea level in areas just behind the beaches. This subsidence makes surrounding dikes and levees necessary to keep the salt water from flooding those areas. In all of these cases the fresh water flowing downstream toward the lagoon reaches the dike or levee and falls over or seeps through into relatively high salinity water on the downstream side. The water downstream tends to be saltier than it would be in the absence of the dikes and levees because of reduced freshwater inflow, evaporation, opening of the barrier sandbar to the ocean, and sometimes saltwater intrusion underground from the ocean as the freshwater volumes decline underground. The net result is to narrow or eliminate the broad low salinity zones of the downstream brackish lagoons and estuaries (Ferren *et al*. 1995).

In addition to the loss of coastal marsh caused by water diversions and alteration of flows, as noted above, water diversions and alterations of water flows may negatively affect the species' breeding and foraging activities. Reductions in water flows may allow aggressive plant species to colonize the otherwise bare sand/mud substrates of lagoon margins, thus degrading the open sand/mud substrate needed by the tidewater goby for breeding (Holland 1992). Decreases in stream flows also reduce the depth of streams, preventing tidewater gobies from venturing upstream from lagoons.

As the size of the human population and use of many coastal areas increases, more wells are dug and the increasing demand on the water supply can result in groundwater overdrafting. Groundwater overdrafting decreases the amount of fresh water reaching the lagoons (Moyle and Williams 1990; Swift *et al*. 1993), thus contributing to a reduction or elimination of the brackish zone. During the drought of the late 1980's and early 1990's, many small lagoons in San Luis Obispo, Santa Barbara, and Santa Cruz Counties went dry or nearly so. This natural drought was often made worse by water tables lowered from additional water withdrawal upstream (Rathbun 1991). The degree to which some of these populations survived is not known. In San Antonio Creek, Santa Barbara County, 5 to 6 kilometers (3.2 to 3.8 miles) of stream upstream of the lagoon that historically held tidewater gobies were dry until the rains in January 1995. Additional water withdrawal will further reduce tidewater goby habitat.

A trend in southern California is for more water to be available all year in streams that receive municipal waste discharges. Today many streams (*e.g.*, Santa Ynez River and Malibu Creek) are flowing with much more water in the dry season than probably occurred historically. This water is high in nutrients that contribute to enrichment of lagoon water and the associated decreases in dissolved oxygen. This extra water can cause the lagoon to rise and increase the frequency of breaching experienced under natural conditions, causing erratic fluctuations in water level. These erratic fluctuations result in decreases in habitat that increase chances of predation and leave spawning burrows exposed to the air. The sudden draining of a lagoon in late spring or summer also can allow marine water to dominate the lagoon for months until winter rains return (Swift *et al*. 1989).

Many current drainages to coastal lagoons are contaminated with animal wastes (manure, dairy washings, lime from stalls), agricultural runoff (both chemicals and soil), and oil field runoff (C. Swift, pers. comm. 1995) (see Appendix B for water quality information for each location if available). Oil field runoff consists of petroleum products and various well slurries, salts, and chemicals. The larger the drainage, the greater the possibility that more of these factors may be present. The Santa Maria River Lagoon lies in an active oil field. The Ventura River drains the area of extensive productive oil fields. Many smaller lagoons receive local septic tank effluent, particularly in winter when flooding overwhelms or washes out some systems.

Estero San Antonio, Arroyo del Oso, Pismo Creek, Santa Ynez River, and other localities show clear signs of extensive anoxia in the summer and fall, due to oxidation of the excess nutrients and phytoplankton* blooms. The enrichment stimulates macroalgae* growth. The excessive consumption of oxygen by the algae at night can make lagoon waters anoxic. Excessive nutrients are also implicated in the increasing frequency of toxic algae blooms in estuaries (Lewitus *et al*. 1995). Anecdotal evidence indicates that the algal blooms and deoxygenation resulting from agricultural and sewage effluent enrichment reduce the habitable area of lagoons in summer (Swift *et al*. 1989). The extirpation of tidewater gobies in the Salinas River probably occurred during the period when poorly treated sewage was discharged into the lagoon (J. Smith, pers. comm. 2004).

Several small, potentially competitive or predatory estuarine fishes have been introduced into tidewater goby habitat. Rainwater killifish, chameleon goby, and yellowfin goby appeared in the 1960's in San Francisco Bay, coincident with the last collections of tidewater gobies there (Hubbs and Miller 1965; Haaker 1979; Swift *et al*. 1989). Rainwater killifish have become widespread in San Francisco Bay, and have recently become established in Upper Newport Bay, but have not become established elsewhere (Moyle 2002; C. Swift, pers. comm. 2004). Yellowfin gobies have slowly spread to many of the larger, tidal and muddy California estuaries. They have seldom been collected in the smaller brackish, nontidal systems where tidewater gobies are found (Swift *et al*. 1993). However, in 1992 and 1993 yellowfin gobies were collected in the Santa Clara River and Santa Margarita River lagoons (K. Lafferty, pers. comm. 1994; Swift *et al*. 1994). The recent appearance of yellowfin gobies in southern California and the coincident disappearance of the tidewater goby in the Santa Margarita River in late 1993 suggest that the species is slowly spreading to brackish habitats and may be eliminating tidewater gobies.

Chameleon gobies have been locally abundant on hard substrates in San Francisco and Los Angeles harbors since the 1960's and 1970's, respectively (Haaker 1979). Recently, shimofuri gobies made an upstream invasion into the San Francisco Bay Delta that allowed them to move down the California Aqueduct into Pyramid Reservoir and Piru Creek in southern California. The shimofuri goby is a more freshwater adapted taxon*, as described by Akihito and Sakamoto (1989). Thus, marine invasions from bilge water of marine ships and downstream or inland invasions with imported water are possible now in southern California. California Aqueduct water is soon to be piped into central coastal California, and the potential invasion of exotic gobies with this water poses a potential threat to tidewater gobies in this area (C. Swift, pers. comm. 1995).

Initial experiments by Swenson and Matern (1995) indicated that shimofuri gobies aggressively intimidate, outcompete and prey upon tidewater gobies in the laboratory. However, like the chameleon goby, the shimofuri goby prefers hard substrates. It was found almost exclusively on rocky shores and around boulders of levees and breakwaters in Pyramid Lake (Wade Sinnen and Janice Curl, California Department of Fish and Game, pers. comm. 1992). Thus it might be expected to remain in such habitats in coastal lagoons, and perhaps not interact extensively with tidewater gobies. However, any increase in hard substrate in lagoons inhabited by tidewater gobies should be carefully considered because this substrate would provide the habitat that could result in the establishment of the shimofuri goby. If lagoons were breached or other conditions lowered the water level, the shimofuri gobies could potentially move from the rocky areas and establish themselves in the tidewater goby habitat, to the detriment of tidewater gobies. To date, the possible effects of interactions in the wild between these exotic goby species and tidewater gobies are largely conjectural.

Anthropogenic breaching of lagoons during the dry season occurs to: 1) ameliorate real or imagined stagnation and attendant odors of the water; 2) prevent flooding of adjacent structures or agricultural fields built within the flood plain of the lagoon; 3) remedy a mosquito problem by reducing the vegetated marsh adjacent to lagoons (thought to reduce breeding habitat for mosquitos); and 4) cause a new spread (or fan) of fresh deposited sediment in the surf, improving the break of the waves for surfing (Tom Evan, Department of Biology, University of California, Santa Barbara, pers. comm. 1993). The extent of anthropogenic breaching to improve the break of waves for surfing is not well known.

Anthropogenic breaching of lagoons during the dry season may adversely affect tidewater gobies in a variety of ways. After a lagoon has been breached it reforms in a week or so, but often stabilizes at a lower level. Usually the level of the lagoon falls a meter (3.3 feet) or more, which can strand many tidewater gobies in shallow pools and leave breeding burrows above the water level, subject to desiccation and predation. The salinity increases considerably because freshwater inflow is low or absent in the dry season at many sites. Higher salinity can be tolerated, but is suboptimal for tidewater gobies (Swenson 1994). Adjacent marshes, which are used by tidewater gobies for protection from predators and as productive areas in which to grow, become unavailable. Tidewater gobies have been found to grow faster and larger in adjacent marshes when compared with those in the open waters (Swenson 1994). Because adjacent marshes are shallower than the lagoon, small changes in the lagoon water levels can have major effects on the amount of this habitat that is available for tidewater gobies.

The barrier sandbar and sand content of the lagoon are dependent on sediment supplies from upstream. Interruption of sediment flow by upstream barriers is a cause of wasting away of sandy beaches (Bascom 1980). Lack of sediment flow into lagoons hinders formation of barrier bars and helps cause many of the attendant difficulties of anthropogenic breaching during the dry season by allowing tidal influence to alter the breeding substrate and salinity levels.

Several introduced mammal and plant species have become established in tributaries and lagoons along the California coast. The presence of beaver , *Arundo donax* (giant reed), *Tamarix pentandra* (saltcedar), and *Spartina alterniflora* (smooth cordgrass) has the potential to change the natural characteristics of tidewater goby habitat (Figure 7). Beaver ponds trap nutrients in bottom sediments, preventing them from reaching lagoons (Naiman *et al*. 1993) and potentially affecting the composition of sediments and nutrient levels in lagoons. Beaver ponds seemed to provide slow water for tidewater gobies in at least one drainage, San Antonio Creek on Vandenberg Air Force Base, until the drought of the early 1990's, which dried up much of the lower creek above the lagoon. Both plant species are rapidly expanding their range in southern California. *Tamarix* is known to exacerbate the channelization of streams by stabilizing banks and forcing water to flow in a more restricted channel (Ohmart *et al*. 1988). *Tamarix* thus has the effect of contributing to the degradation of tidewater goby habitat associated with channelization. In 1993, large windrows of *Arundo* stems were massed throughout the Santa Margarita River Lagoon, and may provide substrate for shimofuri gobies if they gained access to this area. Providing habitat conducive to this exotic species could prevent the tidewater goby from reestablishing itself in this locality. *Spartina alterniflora*, another estuarine plant from the eastern United States, was intentionally introduced into San Francisco Bay. It is rapidly spreading and also alters channel forming characteristics of flowing tidal and nontidal areas that could degrade habitat conditions for tidewater gobies (Daehler and Strong 1995).

Vehicular activity in the vicinity of lagoons threatens tidewater goby habitat by disturbing wetland vegetation, as well as contaminating the watercourse with petroleum. Toxic spills from highway or railway accidents are a threat when it occurs in the vicinity of tidewater goby habitat. The presence of recreational vehicles close to lagoons also poses a threat because of dumping of waste and grey-water tanks (Appendix E) (Holland 1992).

Figure 7. *Arundo* in Santa Clara River Estuary Ventura County

H. Conservation Measures

Since the 1994 listing of the tidewater goby, several conservation efforts have been undertaken by various Federal, State, and local agencies and private organizations. The following briefly describes some regulatory protection and conservation measures accomplished to date.

Federal Regulatory Protection. We identified the tidewater goby as a Category 2 candidate species in 1982, and a Category 1 candidate species in 1991. It was listed as a federally endangered species effective March 7, 1994, and is protected under the provisions of the Endangered Species Act (U.S. Fish and Wildlife Service 1994).

Section 9 of the Endangered Species Act of 1973, as amended, prohibits any person subject to the jurisdiction of the United States from taking (*i.e*., harassing harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, or collecting) listed wildlife species. It is also unlawful to attempt such acts, solicit another to commit such acts, or cause such acts to be committed. Regulations implementing the Endangered Species Act (50 CFR 17.3) define "harm" to include significant habitat modification or degradation that results in the killing or injury of wildlife, and intentional or negligent "harassment" as acts that significantly impair essential behavioral patterns (*i.e*., breeding, feeding).

Section 10(a)(1)(A) of the Endangered Species Act and related regulations provide for permits that may be granted to authorize activities otherwise prohibited under section 9, for scientific purposes or to enhance the propagation or survival of a listed species. Section 10(a)(1)(B) of the Endangered Species Act allows permits to be issued for take that is "incidental to, and not the purpose of, carrying out an otherwise lawful activity" if we determine that certain conditions have been met that will minimize the impacts to the listed species. Under this section, an applicant must prepare a habitat conservation plan that specifies the impacts of the proposed project and steps the applicant will take to minimize and mitigate the impacts.

Section 7(a)(2) of the Endangered Species Act requires Federal agencies, including us, to ensure that actions they fund, authorize, or carry out do not destroy or adversely modify critical habitat. Individuals, organizations, states, local governments, and other non-Federal entities are affected by the designation of critical habitat only if their actions occur on Federal lands, require a Federal permit, license, or other authorization or involve Federal funding.

Since the listing, we have entered into section 7(a)(2) consultations with other Federal agencies on numerous project proposals per the requirements of the Endangered Species Act. Examples include interagency section 7(a)(2) consultations on proposed road construction and maintenance, channel construction and maintenance, effluent treatment plans, and other activities within the current and historic range of the species.

Measures Implemented by California State Resource Agencies. The State of California listed the tidewater goby as a species of special concern in 1980 and subsequently elevated its status to fully protected in 1987 (Swift *et al*. 1997). The California Water Quality Resources Control Board regulates water appropriation from streams that potentially affects most if not all tidewater goby populations. A permit from the California Coastal Commission is also required for breaching sandbars. Breaching lagoons in the summer has become controversial at many localities given the various interests noted above. Winter breaching has been allowed to prevent flooding for the Pajaro and Salinas Rivers (Monterey County) and Soquel Creek (Santa Cruz County) after development of management plans, which specify criteria for breaching and methods (J. Smith, pers. comm. 1996). The California Coastal Commission issues Coastal

Development Permits for all developments within the Commission's area of retained jurisdiction, which includes many historic state tide-lands, encompassing most coastal estuaries. The California Water Resources Control Board issues both waste discharge permits for liquid waste discharges, and 401 Water Quality Certifications for discharges to navigable waters that require a Federal permit or license. The California State Lands Commission issues permits for developments on State tide and trust lands, which include many coastal estuaries. California Department of Fish and Game issues Stream and Lake Alteration Agreements under Sections 1600-1605 of the California Fish and Game Code for the alteration of any stream or water course depicted as a blue-line channel on U.S. Geological Survey topographic maps.

Survey and Research. We have developed a survey protocol to facilitate the determination of presence or absence of the tidewater goby in habitats that have potential to support it (Appendix F). The primary use for this protocol is for project-level surveys in support of requests for consultation under section 7 of the Endangered Species Act of 1973, as amended. Additionally, this protocol may also be used for section 10(a)(1)(B) permit applications, and to determine general presence-absence for other management purposes.

Regional studies of tidewater goby biology have been completed for Rodeo Lagoon, Marin County (Wang 1982; Swenson 1994); Shuman and San Antonio Lagoons, Santa Barbara County (Irwin and Soltz 1984); San Gregorio Lagoon, San Mateo County (Swenson 1993a, 1993b, 1994); seven lagoons on Camp Pendleton, San Diego County (Holland *et al*. 2001); lagoons in central San Luis Obispo County (Worcester 1992); Vandenberg Air Force Base (Swift *et al*. 1997); and some occurrence data for Santa Barbara and Ventura Counties were reported by Lafferty *et al*. (1999a, b).

Ramona Swenson (The Nature Conservancy, Cosumnes River Preserve, Galt, California) has worked on many aspects of the biology and behavior of tidewater gobies, primarily at San Gregorio Lagoon in central California. She has elucidated many details of the ecology of the species, confirming some previous findings and expanding on many of these.

Crabtree (1985) did the only genetic study of the species, based on allozyme studies. Dan Holland collected more materials for a DNA study, which were analyzed by Dawson *et al.* (2001). Dawson *et al*. (2001) conducted an analysis of mitochondrial genetic material from tidewater goby populations ranging from Del Norte to San Diego Counties.

Two introductions of tidewater gobies were made in 1991, one to Waddell Creek and another into Malibu Creek. Both of these have been successful at least through the summer of 1996. Only 52 fish were placed in Malibu Creek and slightly over 200 at Waddell. In each case it is unlikely that all individuals were able to reproduce, so the founding populations were somewhat less. The Malibu Creek population has increased to several thousand individuals. The Waddell Creek population numbers increased to several thousand individuals by 1994 but was again extirpated by the high flows resulting from 1998 winter storms (J. Smith, pers. comm. 2004).

Redwood National and State Park have been assessing the status of tidewater goby populations at Redwood Creek estuary and Freshwater Lagoon in Humboldt County for the purpose of implementing protective measures. The Golden Gate National Recreation Area has funded three

status surveys of the tidewater goby population in Rodeo Lagoon. The Monterey County Water Resources Agency is developing a management plan for the lagoon of the Salinas River. The plan included a proposal to reintroduce the tidewater goby as an experimental, nonessential population, and to manage the lagoon to optimize tidewater goby habitat. However, the proposal to reintroduce the tidewater goby was deleted from the management plan, due to opposition by agricultural groups. The City of San Buenaventura, California Department of Parks and Recreation, and California State Coastal Conservancy have developed a habitat enhancement plan for the Ventura River estuary, which includes provisions for managing the habitat that could provide optimal conditions for the tidewater goby.

Lafferty *et al*. (1999a) monitored post-flood persistence of 17 tidewater goby populations in Santa Barbara and Los Angeles Counties during the heavy winter floods of 1995. All 17 populations persisted and no significant changes in population sizes were determined.

At the time of the listing in 1994, tidewater gobies were known to have occurred in at least 87 of California's coastal lagoons. Approximately 50 percent of these populations were considered extirpated (U.S. Fish and Wildlife Service 1994). The assessment for listing of the tidewater goby occurred after the prolonged drought of the late 1980's and early 1990's, when conditions in many habitats were at a low level. Presently, 28 of the known historic populations are considered extirpated. Some of the re-discovered populations are located in habitats that became dry or nearly so during the drought. In addition, new populations continue to be discovered, increasing the number of known historic populations to 124. The increased understanding of the tidewater goby's tolerance for a range of habitat conditions, its resiliency and recovery following catastrophic events (*e.g.*, the recolonization of Laguna Creek and Moore Creek, Santa Cruz County, following extirpations during the drought of the late 1980's and early 1990's), and the growing number of known extant populations suggests that the threat of extinction is likely less severe than originally thought.

II. RECOVERY STRATEGY

Presently, the natural diversity and ecological integrity of coastal lagoon and estuary habitats to which the tidewater goby is uniquely adapted are threatened primarily by habitat modification and loss, decreased freshwater inflow, exotic species, and habitat channelization, compounded by degraded water quality, anthropogenic dry season breaching, and excessive sedimentation. The extirpation and decline of tidewater goby populations occurs as a direct result of these threats or by their exacerbating the effects of natural deleterious events. As the number of populations extirpated or in decline increases, there is a decrease in the ability for recolonization and gene flow, which based on present information is necessary for the continued persistence of the species. Therefore, the strategy for recovery of the tidewater goby is designed to:

1. preserve the diversity of tidewater goby habitats throughout the range of the species;

2. preserve the natural processes of recolonization and population exchange that enable population recovery following catastrophic events; and

3. preserve the genetic diversity as it is understood now and in the future.

Recovery of the tidewater goby should take into consideration the variation of genetic diversity that exists throughout the species' range and the recolonization and gene flow processes that allow recovery of populations following natural extirpations. An example of the metapopulation* dynamic aspect of the tidewater goby is the fact that extirpated populations located in central and southern California have been recolonized from nearby extant populations following storm events (Lafferty *et al*. 1999a, 1999b). In the metapopulation model of populations, several subpopulations* survive or remain viable* by way of continual exchange of individuals and recolonizations after occasional extirpations (Doak and Mills 1994). Rates of genetic interchange or recolonization depend on the degree of isolation between subpopulations, physical distance, and character of the intervening habitat (Gilpin 1987). Solitary subpopulations separated from other extant subpopulations by large geographic distances probably cannot be naturally recolonized after a local extinction from weather or other factors. As subpopulations become isolated recolonization rates decrease, local extinction becomes permanent, and an entire metapopulation can move incrementally toward extinction (Rieman and McIntyre 1993).

Past and current land use practices have degraded tidewater goby habitat. If the tidewater goby's current habitat conditions are secured or enhanced, recovery of the species would likely be ensured. However, there continues to be competing demands on limited resources that directly and/or indirectly affect the quality of tidewater goby habitat (*e.g*., upstream water diversions, pumping of groundwater, erosion, *etc*.). Furthermore, other anthropogenic activities and stochastic events are known to adversely affect tidewater gobies (*e.g.*, introduction of exotic predators/competitors). To ultimately define the management requirements for the tidewater goby in light of the continuing resource demands and perturbations, additional research is necessary to determine the tidewater goby's tolerance levels of water quality and flow, and optimal habitat diversity. With this additional information, we can more precisely describe the

range and extent of activities that can occur without threatening the continued survival of the species and habitat conditions that would continue to support tidewater gobies even with the occurrence of stochastic events that might otherwise threaten a population.

III. RECOVERY GOALS AND CRITERIA

The goal of this plan is to conserve and recover the tidewater goby throughout its range by perpetuating viable metapopulations within each Recovery Unit* while maintaining its genetic diversity. Implementation of this plan would allow reclassification and ultimately removal of this species from the Federal list of "Endangered and Threatened Wildlife and Plants" (50 CFR 17.12). The tidewater goby may be considered for reclassification to threatened status and ultimately delisting as the recovery criteria outlined below are met.

A. Recovery Units

1. Criteria for Designating Recovery Units/Sub-Units

Six regional clades based on genetic work done by Dawson *et al*. (2001) have been used to define the Recovery Units. In situations where genetic work is lacking, recovery units are based on geomorphology. Recovery Units are further divided into Sub-Units*, which are defined as regions that are genetically different from each other. There are 124 Recovery Sub-Units and 23 potential introduction sites described in this plan. The following describes criteria used to establish Recovery Units and Sub-Units. For a more detailed description and recommended primary recovery tasks of each Recovery Unit and Sub-Unit see Appendix G.

The tidewater goby occupies lagoon and estuarine habitats that are often closed. Little documentation exists of recovery of larval or adult tidewater gobies outside these specialized habitats. The tidewater goby exhibits: 1) genetic differentiation into regional clades based on mitochondrial sequence (Dawson *et al*. 2001); 2) regional morphological differentiation in degree and frequency of reduction of the supraorbital canal* (David Jacobs, University of California at Los Angeles, pers. comm. 2004); and 3) regional differences in metapopulation dynamics. In some regions sequence data document long term isolation of local populations (Barlow 2002), while in other regions population survey data support source/sink* type metapopulations. High historic frequencies of extirpation and recolonization have been observed (Lafferty *et al*. 1999b). Thus, the tidewater goby appears to have more regional and local genetic differentiation than other coastal marine vertebrates. These regional distinctions in metapopulation process are a highly unusual feature of considerable scientific and conservation interest.

The genetic isolation and metapopulation differences observed in tidewater gobies can reasonably be explained by inferring limitations on dispersal consistent with this taxon's habitat preference and life history. Reproduction occurs in the summertime when most estuaries/coastal lagoons are closed by sand berms. This knowledge of life history, combined with genetic data, argues strongly that tidewater goby larvae do not generally have access to the sea or at least do not exhibit the long distance marine dispersal often associated with larval fish. On the other

hand some populations are known to have recolonized, documenting that dispersal does occur. The available evidence suggests that: 1) adult tidewater gobies rather than larvae are involved in dispersal; 2) dispersal occurs in association with high stream-flow events that open estuaries to the sea during the winter rainy season (Lafferty *et al*. 1999a), and 3) dispersal along the coast is greatly facilitated by sandy substrate and is limited by rocky coastal substrate. This last inference is consistent with the preference of this benthic fish for sandy bottoms for reproduction and is supported by mitochondrial sequence data (Dawson *et al*. 2001; Barlow 2002). This limited dispersal by tidewater goby contrasts with dispersal in the closely related arrow goby, which lives in open marine habitats permitting larval dispersal and exhibits minimal regional genetic differentiation (Dawson *et al*. 2002).

Understanding of the dispersal potential, based on regions in which the genetics have been studied in detail (Barlow 2002) or where recolonization has been observed (Lafferty *et al*. 1999b), provides a basis of inference to define units along the coast where there is limited or incomplete genetic data available. Regions where estuaries are separated by sandy beaches located in low-lying coastal settings composed of Holocene* alluvium are grouped together. Populations in habitats separated by long distances (*e.g*., Arcata /Humboldt Bay, Humboldt County, to the Ten Mile River, Mendocino County), especially where habitat consists of steep harder rocky substrate, are presumed to be separate genetic entities. This pattern is evident in the regional phylogeographic scale (Dawson *et al.* 2001) and locally within the regions extending from Salmon Creek to the Salinas Valley and from the Ventura River to Topanga where the degree of genetic isolation of populations has been examined in far greater detail (Barlow 2002).

2. Regional Genetic Structure and Recovery Units

Dawson *et al.* (2001) provided a broad-brush phylogeographic basis for subdivision of tidewater gobies into regional entities. This examination of 1,300 base pairs of mitochondrial sequence from 88 individuals from 31 localities examines the entire range of the tidewater goby from Smith River in Del Norte County to Camp Pendleton in San Diego County. This work identifies six regional clades that have been used to define the Recovery Units: 1) north of southern Mendocino County line - North Coast Unit; 2) Salmon Creek in Sonoma County to Bennett's Slough in the Salinas Valley- Greater Bay Unit; 3) Arroyo del Oso to Morro Bay in San Luis Obispo County - Central Coast Unit; 4) San Luis Creek in San Luis Obispo County to Rincon Creek in Santa Barbara County - Conception Unit; 5) Ventura River in Ventura County to Santa Topanga Creek in Los Angeles County – LA/Ventura Unit; and 6) San Pedro in Los Angeles County to Los Peñasquitos in San Diego County- South Coast Unit (Figure 2).

3. Regional Morphologic Data

Until recently, we presumed that tidewater gobies were not significantly morphologically differentiated; however, this is not the case. The degree of reduction of the supraorbital canal portion of the lateral line system was examined in 546 museum specimens of tidewater gobies from 26 localities (D. Jacobs pers. comm. 2004). Although sample sizes are uneven, several of the regional clade differences evident in the mitochondrial sequence data are supported, including North Coast /Greater Bay, Greater Bay/Central Coast and Ventura LA/South Coast. In

addition there is local variation, which may indicate selective forces operating in different habitats. Collections from sites such as Malibu Creek and Artesian Wells in Santa Monica, Los Angeles County, and Aliso Creek, Orange County, (sites that were extirpated after museum collections were made, but before appropriate samples were recovered for molecular work) can be assigned to groups or units on the basis of morphology. Examination of these samples supports the placement of a break between the LA/Ventura Recovery Unit and the South Coast Recovery Unit at the Palos Verdes Peninsula, as morphological analysis groups historic Malibu/Santa Monica samples with samples to the north and historic Aliso Creek samples with those to the south in San Diego County (D. Jacobs pers. comm. 2004). The data also suggest additional morphological differences, possibly related to system size or gradient. Differences in the lateral line structure, which involves sensing relative movement associated with locomotion or current flow, are likely to be a consequence of differences in selection. From a conservation perspective, evidence of selective or adaptive differences in tidewater gobies complements evidence of genetic isolation. Both genetic isolation and evidence of adaptive difference are thought to be critical to defining recovery units.

4. Local Differentiation

Barlow (2002) sequenced the mitochondrial control region from approximately 15 tidewater gobies from each of 15 localities across the Greater Bay Unit. In a separate study, 30 control region sequences were generated from each of 5 localities constituting the existing populations in the LA/Ventura Unit. In the Greater Bay Unit, rocky headlands isolate populations. Sets of closely spaced localities show significant genetic differentiation. Interestingly, in the Greater Bay Unit, using data resampling to generate significance values based on F_{ST}^{*}, only a few localities fail to demonstrate a highly statistically significant difference from all others (Barlow 2002). This result emphasizes the degree of isolation of these populations in coastal estuaries and the lack of frequent dispersal within the Greater Bay Unit. In the LA/Ventura Unit, sandy shores separate the naturally occurring populations and, although genetic variation is limited, it is sufficient for statistical analysis. In this unit, the only statistical differences were associated with the loss of variation in the recently recolonized Topanga sample, highlighting the distinction between sandy and rocky coasts. Substantially greater dispersal is evident over sand than rock. It also suggests that statistical differences due to the loss of variation in recolonization might not be an appropriate rationale for designation of a unit. This information about the substrate specific nature of dispersal is used to infer the relationship between Sub-Units in the North Coast Unit, the Central Coast Unit and the Conception Unit where genetic information available is minimal to moderate.

In general, where sufficient genetic information is available, Sub-Units are defined as regions that are not only statistically different (highly significant at the $P = 0.01$ level) from entities elsewhere, but also contain genetic resources not found elsewhere. Evidence for local genetic resources takes the form of dominant endemic haplotypes*, fixed differences, endemic clades of haplotypes suggestive of *in situ* sequence evolution, and in some case localities where all haplotypes form a single clade. The above approach can only be applied in cases where there is sufficient genetic information; 10 mitochondrial control region sequences would be considered a minimum.

The only case where we support a more restrictive definition of units is in the South Coast Unit. The tidewater gobies in this region form a monophyletic* clade that is 4 percent sequence divergent from all other tidewater gobies (Dawson *et al*. 2002). Tidewater gobies in the South Coast Unit are also the most morphologically distinct as all the supraorbital canals are substantially reduced (D. Jacobs pers comm. 2004). This unit also exhibits a very high rate of extirpation/recolonization (Lafferty *et al*. 1999b). Based on the limited mitochondrial sequencing, it appears that very little genetic variation is present in the unit. This situation is probably not natural, but likely results from the elimination of many more stable habitats to the north and south of Camp Pendleton where the only remaining localities are small and seemingly extirpation prone. In this context of reduced genetic variation two units are defined on a modest geographic distance between northern and southern localities in Camp Pendleton. The available genetic evidence differentiating these units involves a small sample size of microsatellites*. Thus, a genetic difference between the Sub-Units is yet to be confirmed.

5. Summary of Units from North to South

See Appendix B for more detailed description of recovery units.

North Coast Unit (NC)

This Recovery Unit extends from Smith River near the Oregon border to the southern end of Mendocino County. It has the greatest geographic extent along the coast (approximately 150 miles) of any of the proposed recovery units.

Sub-Units

The **NC1** Sub-Unit extends from the Smith River south to Lake Earl/Talawa. This stretch of coast is characterized by low-lying sandy shores. The NC1 Sub-Unit consists of two occupied tidewater goby localities. This Sub-Unit is located within Del Norte County.

The **NC2** Sub-Unit extends from north of Patrick's Point and is isolated from other regions by steep coasts. The northernmost site, Redwood Creek estuary, is a seasonally breached freshwater estuary with sloughs. The other three sites are large open lagoons. The NC2 Sub-Unit consists of four occupied tidewater goby localities. This Sub-Unit is located within Humboldt County.

The **NC3** Sub-Unit consists of about 25 miles from the mouth of the Mad River in the north across Arcata /Humboldt Bay to the Eel River to the south. The NC3 Sub-Unit consists of five occupied tidewater goby localities. This Sub-Unit is located within Humboldt County.

The **NC4** Sub-Unit consists of the Ten Mile River, a large relatively pristine locality that is seasonally closed. This site is separated by at least 60 miles of steep coast and Cape Mendocino from locations in NC3 to the north. The NC4 Sub-Unit consists of one occupied tidewater goby locality. This Sub-Unit is located within Mendocino County.

The **NC5** Sub-Unit consists of Virgin and Pudding Creeks. These small closed stream habitats near Fort Bragg are separated by less than 10 miles from Ten Mile River. The NC5 Sub-Unit

consists of two occupied tidewater goby localities. This Sub-Unit is located within Mendocino County.

The **NC6** Sub-Unit consists of three small localities, Davis Pond, Brush Creek and Lagoon Creek located on a low sandy shore north of Pt. Arena (Manchester State Beach). It is separated by about 25 miles of rocky coast to the north. The NC6 Sub-Unit consists of two occupied tidewater goby localities. This Sub-Unit is located within Mendocino County.

Greater Bay Unit (GB)

This Recovery Unit extends from Salmon Creek just north of Bodega Head in Sonoma County to the Salinas River Valley in Monterey County.

Sub-Units

The **GB1** Sub-Unit is located immediately north of Bodega Head and includes Salmon Creek. The GB1 Sub-Unit consists of one occupied tidewater goby locality. This Sub-Unit is located within Sonoma County.

The **GB2** Sub-Unit includes the "Esteros" (Estero Americano and Estero San Antonio) where tidewater gobies are generally present, and extirpated sites in Bodega Bay (Cheney Gulch) and Walker Creek in northern Tomales Bay. The GB2 Sub-Unit consists of two occupied tidewater goby localities. This Sub-Unit is located within Marin County.

The **GB3** Sub-Unit is located in southern Tomales Bay and includes Lagunitas Creek. The GB3 Sub-Unit consists of one occupied tidewater goby locality. This Sub-Unit is located within Marin County.

The **GB4** Sub-Unit includes sites on the outer coast from Point Reyes, south to Point San Pedro, as well as sites within San Francisco Bay. The GB4 Sub-Unit consists of one occupied tidewater goby locality. This Sub-Unit is located in Marin, San Francisco, Contra Costa, San Mateo, and Alameda Counties.

The **GB5** Sub-Unit includes San Gregorio, Pescadero, and Bean Hollow Creeks. The GB5 Sub-Unit consists of three occupied tidewater goby localities. This Sub-Unit is located within San Mateo County.

The **GB6** Sub-Unit is the first of a number of Sub-Units that are relatively closely spaced along the steep intermittently rocky shores from north of Santa Cruz to the Salinas Valley. The GB6 Sub-Unit consists of two occupied tidewater goby localities. This Sub-Unit is located within Santa Cruz County.

The **GB7** Sub-Unit consists of a suite of closely spaced localities including Baldwin Creek, Lombardi Creek, Old Dairy Creek, Wilder Creek, Younger Lagoon and Moore Creek. The GB7 Sub-Unit consists of six occupied tidewater goby localities. This Sub-Unit is located within Santa Cruz County.

The **GB8** Sub-Unit includes Moran Lake and Corcoran Lagoon. The GB8 Sub-Unit consists of three occupied tidewater goby localities. This Sub-Unit is located within Santa Cruz County,

The **GB9** Sub-Unit includes Soquel and Aptos Creek. The GB9 Sub-Unit consists of one occupied tidewater goby locality. This Sub-Unit is located Santa Cruz County.

The **GB10** Sub-Unit includes the Pajaro River, which is isolated from other tidewater goby localities in the region. The GB10 Sub-Unit consists of no occupied tidewater goby localities. The Pajaro River serves as the boundary between Santa Cruz and Monterey Counties.

The **GB11** Sub-Unit includes Bennett's Slough, which is the only locality where tidewater gobies have been recovered recently in the Salinas Valley/Monterey Coastal Plain. The GB11 Sub-Unit also includes the Salinas River. This Sub-Unit is located within Monterey County.

Central Coast Unit (CC)

This Recovery Unit is bounded on the north by the steep Big Sur Coast from Point Pinos, Monterey County, and on the south by Point Buchon immediately south of Morro Bay, San Luis Obispo County.

Sub-Units

The **CC1** Sub-Unit is immediately north of Piedras Blancas, and consists of Arroyo del Oso, which is extirpated, and Arroyo del Corral. The CC1 Sub-Unit consists of one occupied tidewater goby locality. This Sub-Unit is located within San Luis Obispo County.

The **CC2** Sub-Unit consists of shallow coast with multiple small estuaries south of Piedras Blancas and north of the Point Estero Coast. The CC2 Sub-Unit consists of seven occupied tidewater goby localities. This Sub-Unit is located within San Luis Obispo County.

The **CC3** Sub-Unit extends south of Estero Point into Morro Bay. The CC3 Sub-Unit consists of seven occupied tidewater goby localities. This Sub-Unit is located within San Luis Obispo County.

Conception Unit (CO)

This Recovery Unit begins south of the promontory of Point Buchon and extends all the way around Point Conception and is bounded to the south and east of the Santa Barbara coast ending at the southern Ventura County line. This Recovery Unit is divided into three Sub-Units on the basis of promontories at Point Sal and Point Arguello. There is considerable sandy shore north of Point Arguello. Along the south - facing coast to the southeast of Point Conception there are many closely spaced habitats with potential rocky shore barriers that are limited in scale.

Sub-Units

The **CO1** Sub-Unit extends between Point San Luis and Point Sal and is a largely sandy shore-line. The CO1 Sub-Unit consists of three occupied tidewater goby localities. This Sub-Unit is

located within San Luis Obispo County. The Santa Maria River serves as the boundary between San Luis Obispo and Santa Barbara Counties.

The **CO2** Sub-Unit extends from Point Sal to Point Arguello over generally sandy coast. The CO2 Sub-Unit consists of four occupied tidewater goby localities. This Sub-Unit is located within Santa Barbara County.

The **CO3** Sub-Unit extends from Point Arguello to the southeastern terminus of the unit in the steep Seacliff region. This Sub-Unit is a fairly long stretch of coast and contains a large number (28) of small habitats, which are located within Santa Barbara County. The CO3 Sub-Unit consists of 24 occupied tidewater goby localities. Rincon Creek serves as the boundary between Santa Barbara and Ventura Counties.

LA/Ventura Unit (LV)

This Recovery Unit is bounded on the north by the steep region at Seacliff and is not subdivided into Sub-Units. The southern terminus is here treated as the Palos Verdes Peninsula. This Recovery Unit is located within Ventura and Los Angeles Counties.

South Coast Unit (SC)

This Recovery Unit is bounded on the north by San Pedro Harbor, Los Angeles County, and on the south by Los Pensaquitos Creek, San Diego County.

Sub-Units

The **SC1** Sub-Unit includes San Pedro, Bolsa Chica, Aliso Creek, San Juan Creek, and San Onofre Creek. San Juan and San Onofre Creek are located on Camp Pendleton. The SC1 Sub-Unit consists of two occupied tidewater goby localities. This Sub-Unit is located within Los Angeles, Orange, and San Diego Counties.

The **SC2** Sub-Unit includes locations from Camp Pendleton as well as sites located to the south. The SC2 Sub-Unit consists of six occupied tidewater goby localities. This Sub-Unit is located within San Diego County.

B. Recovery Criteria

The complex genetics of the tidewater goby, the genetic metapopulation structure of its populations, the 1-year lifespan of most individuals, large swings in population size from season to season and year to year, the limited amount of scientific research on the species, and the difficulties in determining population size make the goal of conservation and recovery more complex. The current state of research does not yet allow the development of metapopulation-based recovery objectives for tidewater gobies. Until data on demography and dynamics of tidewater goby metapopulations are available, interim objectives emphasize consistent occupancy of habitat capable of sustaining viable tidewater goby populations. Recovery

strategies and tasks include acquiring research data necessary to begin evaluating metapopulation viability.

Although tidewater gobies face a variety of threats, 45 to 65 percent of historical localities are viable and support tidewater goby populations (C. Swift pers. comm. 2004). Small populations have been declining over time, independent of climate changes (Lafferty *et al*. 1999b). Consequently, downlisting criteria will focus on protecting existing tidewater goby populations, monitoring, and reintroducing tidewater gobies to formerly occupied and restored habitat. See Table G-1 in Appendix G for tidewater goby reintroduction and introduction suggestions. These factors apply at several levels, but particularly at the recovery Sub-Unit level, as this level denotes the best available evidence for metapopulations with potential for genetic exchange.

1. Reclassification to Threatened

The tidewater goby may be considered for downlisting when:

> a) An analysis based on scientifically credible monitoring over a 10-year period projects a 75 percent chance of all Sub-Units within each recovery unit persisting for a minimum of 100 years. This projection would incorporate a metapopulation viability analysis using a complex suite of information. A partial list of information needed for the metapopulation viability analysis includes: presence/absence data; population estimates; observed rates of extirpation and natural recolonization; results of introduction efforts to new localities and reintroduction to sites of known or suspected extirpation; and the relationships between climate variation and extinction and recolonization probabilities. This projection will also require incorporating information on new threats at the time of downlisting, such as any new exotic predator introductions that may have occurred.
>
> b) An individual management plan has been developed and implemented that addresses the specific threats, such as habitat destruction and alteration (e.g., coastal development, upstream diversion, channelization of rivers and streams, discharge of agriculture and sewage effluents), introduced predators (e.g., centrarchid fishes), and competition with introduced species (e.g., yellowfin and chameleon gobies), to each metapopulation.

2. Delisting

The tidewater goby may be considered for delisting when downlisting criteria have been met and:

> a) An analysis based on scientifically credible monitoring over a 10-year period projects a 95 percent chance of all Sub-Units within each recovery unit persisting for a minimum of 100 years. This projection would incorporate a metapopulation viability analysis using a complex suite of information. A partial list of information needed for the metapopulation viability analysis includes: presence/absence data; population estimates; observed rates of extirpation and natural recolonization; results of introduction efforts to new localities and reintroduction to sites of known or suspected extirpation; and the relationships between climate variation and extinction and recolonization probabilities. This projection will also require incorporating information on new threats at the time of delisting, such as any new exotic predator introductions that may have occurred.

Downlisting and delisting criteria provide a basis for considering a change in the status of the tidewater goby, but would not trigger automatic downlisting or delisting. Such decisions are made by us through a rule-making process that involves public review and comment. Before delisting may occur, we must evaluate the following five listing factors and determine that the species is neither threatened or endangered with extinction: (1) the present or threatened destruction, modification, or curtailment of the species' habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease and predation; (4) inadequacy of existing regulatory mechanisms (*e.g.*, laws, existing land use); and (5) other human-made or natural factors affecting the continued existence of the species. We may revise the recovery criteria as appropriate as new information pertinent to these topics becomes available. Revisions must be based on the best available data.

IV. RECOVERY PROGRAM

A. Recovery Action Outline

1. Protect and enhance currently occupied tidewater goby habitat.

    1.1. Assess the current status of extant tidewater goby populations and their habitats.

        1.1.1. Standardize and implement survey, sampling, and monitoring procedures for tidewater goby populations.
        1.1.2. Standardize and implement protocols for assessing nonnative predator populations.
        1.1.3. Standardize and implement protocols for assessing impacts and source of sedimentation in tidewater goby habitat.

    1.2. Manage extant tidewater goby habitat.

        1.2.1. Develop and implement management strategies to avoid further direct net loss/modification of habitat.
        1.2.2. Develop and implement strategies for managing freshwater inflow within current or enhanced parameters.
        1.2.3. Develop and implement strategies for managing deleterious exotic species at current or reduced levels.
        1.2.4. Develop and implement strategies for managing adverse effects resulting from channelization at current or reduced levels.
        1.2.5. Develop and implement strategies for managing water quality within current or enhanced parameters.
        1.2.6. Develop and implement strategies for minimizing anthropogenic breaching of lagoons.
        1.2.7. Develop and implement strategies for managing excessive sedimentation in tidewater goby habitat within current or enhanced parameters.
        1.2.8. Monitor tidewater goby population status and trends, and habitat conditions.
        1.2.9. Develop an umbrella Safe Harbor Agreement or obtain financial incentives for landowners to maintain or enhance tidewater goby habitat.
        1.2.10. Implement regional ecosystem strategies through coordination, exchanging information, and existing regulatory processes to maximize the protection of tidewater goby habitat.
        1.2.11. Standardize and implement protocols for rescue of tidewater goby populations.

2. Conduct biological research to enhance the ability to integrate land use practices with tidewater goby recovery and revise recovery tasks as pertinent new information becomes available.

2.1. Determine water quality parameters for tidewater goby habitat.
2.2. Determine freshwater inflow parameters.
2.3 Investigate the interactions of exotic species with tidewater gobies.
2.4. Conduct studies to determine how to minimize the threats from nonnative predators.
2.5. Conduct studies to determine how to minimize the effects of channelization.
2.6. Conduct studies to determine how to minimize the effects of sedimentation.
2.7. Conduct studies to determine how to minimize the effects of anthropogenic breaching.
2.8. Describe optimal tidewater goby habitat characteristics.
2.9. Determine the genetic diversity and intraspecific phylogeography of the tidewater goby.
2.10. Determine population demography characteristics for the tidewater goby.
2.11. Develop a metapopulation viability analysis.
2.12. Conduct annual aerial surveys to quantify habitat losses, identify areas that have high potential for habitat creation/restoration, and acquire electronic imagery for GIS applications.
2.13 Practice adaptive management* in which we revise recovery tasks as pertinent new information becomes available.
2.13.1 Reevaluate recovery criteria.
2.13.2 Keep recovery plan current and useful.
2.13.3 Revise maps on recovery Sub-Units as new genetic data become available.

3. Evaluate and implement translocation where appropriate.

3.1 Develop and refine protocols and guidelines for translocation.
3.1.1 Develop protocols, guidelines and selection criteria for translocation.
3.1.2 Incorporate research findings into protocols.
3.2 Implement translocation in subunits.

4. Increase public awareness about tidewater gobies.

4.1. Prepare and distribute brochures and educational materials on the tidewater goby.
4.2. Develop a website that will educate the public on the tidewater goby and recovery actions.

B. Recovery Action Narrative

The recovery of the tidewater goby and its habitat will require implementation of four primary tasks: 1) monitor, protect, and enhance current habitat conditions for extant populations; 2) conduct research to acquire additional information needed for management; 3) restore degraded habitats to suitable conditions and reintroduce or introduce tidewater gobies to those habitats; and 4) develop and implement an information and education program.

In the first task, habitat conditions at occupied sites should be stabilized and protected by developing strategies to maintain or enhance, as needed, current habitat conditions, including managing freshwater inflow and water quality, and reducing threats from exotic species, channelization, sedimentation, and mechanical anthropogenic dry season breaching. These strategies should be developed and implemented in management plans specific for each recovery Sub-Unit that optimizes flexibility between recovery of the tidewater goby and local land use. Annual monitoring of populations is essential. Paramount importance should be placed on determining the compatibility of tidewater goby management strategies with other listed and sensitive species (California red-legged frog [*Rana aurora draytonii*], California least tern [*Sterna antillarum browni*], western snowy plover [*Charadrius alexandrinus nivosus*], light-footed clapper rail [*Rallus longirostris levipes*], Belding's savannah sparrow [*Passerculus sandwichensis beldingi*], brown pelican [*Pelecanus occidentalis californicus*], steelhead trout [*Oncorhynchus mykiss*], *etc*.) that utilize the same or adjacent habitat.

For the second task, biological research should be conducted to develop the parameters within which the habitat conditions and threats can be managed for recovery. Data specific to the water quality (including dissolved oxygen, pH*, and the contaminants commonly entering tidewater goby habitat) and freshwater inflow requirements and tolerances of the different tidewater goby life stages should be acquired. Research should also identify the characteristics of optimal habitat diversity that enhances the tidewater goby's ability to persist in an already degraded environment. In addition, metapopulation viability models should be developed and genetic diversity studies should be conducted. Information from these tasks would then be used to validate the number and distribution of populations needed for population viability and long-term persistence. These studies should be initiated concurrent with the first task.

Where research or monitoring finds that current conditions should be improved for the tidewater goby, the existing management plans should be revised. Monitoring of the tidewater goby populations and habitat conditions begun during the first task of recovery should continue to be conducted on at least an annual basis to assess the efficacy of management actions in meeting the recovery parameters and accomplishing the recovery objectives. The numbers and distribution of metapopulations required for recovery should also be evaluated and redefined, if necessary, based on the outcome of the genetic and population demographic research studies. This is particularly important for providing the best available determination of recovery Sub-Units.

For the third task, the first step is to determine what Sub-Units would significantly increase their long-term probability of persistence by the addition of new populations. These Sub-Units are most likely to be those consisting of a small number of populations, or of small populations. A reintroduction plan would consist of the following: 1) identify potential sites where, through a combination of restoration and recolonization, tidewater gobies could be introduced; and 2) determine a strategy for reintroducing gobies to locations where they have been recently extirpated; this would involve a strategy for determining criteria for concluding extirpation, a time to wait for natural colonization, and a determination of the most appropriate donor population.

For the fourth task, public support, cooperation and contribution are essential to accomplishing the recovery of the tidewater goby. During the course of recovery, activities should be organized

to increase public awareness about tidewater gobies. Recovery activities will have a greater chance of success if the public, landowners, and other potentially affected parties are provided information about the tidewater goby, its habitat requirements, its threats, and the actions necessary to conserve its habitat and recover the species. Preparation and distribution of brochures and educational materials and public meetings will facilitate a better public awareness and understanding of the actions needed for the recovery of the tidewater goby.

1. Monitor, protect, and enhance currently occupied tidewater goby habitats. Management actions should be taken to maintain current habitat conditions and ensure that the number and severity of threats currently affecting extant habitats do not increase. Protocols for assessing the current status of the tidewater goby populations and their habitat conditions and threats should first be standardized and implemented. The baseline information collected on the current status of the extant tidewater goby populations and the habitat threats should then be the basis for a management plan for each metapopulation. The management plan should describe the management actions that will be taken to stabilize habitat conditions and, if needed restore historic natural conditions to which the species is adapted.

    1.1. Assess the current status of extant tidewater goby populations and their habitats. The current status of the tidewater goby populations and habitat conditions should be assessed to provide the baseline information for determining the management actions needed to prevent further habitat degradation and loss. Protocols for assessing the present status (relative abundance) of the tidewater goby populations and the threats to their habitats (water inflow, exotic species, water quality, sedimentation) should be standardized and implemented to assure consistent, comparable evaluations.

        1.1.1. Standardize and implement survey, sampling, and monitoring procedures for tidewater goby populations. Protocols for surveying, sampling, and monitoring the relative abundance of tidewater goby populations should be standardized to ensure consistent evaluation of each extant population. The protocols should specify the time of year and methods required. The methods should be low-cost and easily replicated to encourage/facilitate annual monitoring of the populations and have low-impact to the species. Each probable extant tidewater goby population should be surveyed to determine its current size and status using these protocols. Surveys should be rigorous enough to detect tidewater gobies when population numbers are very low. In addition, surveys should be conducted, when possible, in tidewater goby habitats currently considered extirpated to investigate possible changes in status.

        1.1.2. Standardize and implement protocols for assessing nonnative predator populations. Protocols for assessing the abundance and distribution of exotic species should be standardized. The current abundance and distribution of deleterious exotic species should be determined for each extant tidewater goby habitat using these protocols. Protocols should be

developed so as to minimize impacts to tidewater gobies and other listed species.

1.1.3. Standardize and implement protocols for assessing impacts and source of sedimentation in tidewater goby habitat. Protocols for assessing levels of sedimentation should be standardized. Where excessive sedimentation has been identified as a known or potential threat for a tidewater goby habitat, the source(s) and severity of the current level of sedimentation should be evaluated using these protocols.

1.2. Manage extant tidewater goby habitat. Management plans should be developed that are specific for each Sub-Unit. The management plans should include provisions for managing the threats listed in Appendix E for the habitats such that they are managed within current or improved levels, (*e.g.*, total habitat area, water inflow, nonnative predators, water quality, anthropogenic breaching of lagoons, *etc*). The management plans should also include provisions for monitoring of the tidewater goby populations and habitat conditions on at least an annual basis to assess the efficacy of management actions in halting and decreasing habitat threats and in enhancing habitat quality. If habitat quality or quantity continues to decline, or if a tidewater goby metapopulation is found to be declining, the management plan should be modified to ameliorate the causal factor(s). Management plans should take into consideration the relationships between climate variation and extinction and recolonization probabilities. Information derived from Action 2 should be incorporated as appropriate.

1.2.1. Develop and implement management strategies to avoid further direct net loss/modification of habitat. Management strategies should be developed and implemented, to avoid, minimize or mitigate direct and indirect loss and adverse modification of tidewater goby habitat due to dredging, draining and filling of wetlands. Additional management actions should be taken to restore historic locations and potential habitats as opportunities become available to eliminate, minimize, or mitigate, the effects of existing structures and past activities that have destroyed or degraded tidewater goby habitat.

1.2.2. Develop and implement strategies for managing freshwater inflow within current or enhanced parameters. Management strategies should be developed and implemented, if necessary, to prevent further decrease in freshwater inflow, water depth, and surface area at each extant tidewater goby habitat due to dams, water diversions and groundwater pumping. As opportunities become available to enhance the freshwater inflow into tidewater goby habitats, additional management actions should be implemented.

1.2.3. Develop and implement strategies for managing deleterious exotic species at current or reduced levels. Based on the findings of action 1.1.2 or the

best available information, management strategies should be developed and implemented, if necessary, to prevent further increases in the abundance and distribution of exotic fish (*e.g.*, largemouth bass, striped bass, yellowfin goby, *etc*.) and frogs (*e.g.*, African clawed frogs) in each extant tidewater goby habitat. As opportunities become available to decrease the abundances of exotic species, additional management actions should be taken.

1.2.4. Develop and implement strategies for managing adverse effects resulting from channelization at current or reduced levels. Management strategies should be developed and implemented to minimize the adverse effects due channelization that can eliminate crucial backwater habitats or other flood refuges. As opportunities become available to reduce adverse effects resulting from channelization, additional management actions should be taken.

1.2.5. Develop and implement strategies for managing water quality within current or enhanced parameters. Management strategies should be developed and implemented to prevent further degradation of the water quality at each extant tidewater goby habitat resulting from agricultural runoff and effluent, municipal runoff, golf course runoff, sewage treatment effluent, cattle grazing, development, oil spills, oil field runoff, toxic waste, and gray water dumping once we have developed tolerance levels for the tidewater goby to these contaminants. Furthermore management strategies should be developed and implemented, to prevent further degradation of the water quality due to dikes, tidal gates and other impedances to the natural freshwater/saltwater interface alter the salinity regime of some tidewater goby habitats. As opportunities become available to enhance water quality, additional management actions should be implemented.

1.2.6. Develop and implement strategies for minimizing anthropogenic breaching of lagoons. Strategies to avoid anthropogenic breaching of lagoons (*e.g.*, use of pumping and other water control structures to regulate water levels) should be developed and implemented to provide conditions during the summer and fall, when reproduction is at its highest and freshwater inflow is at its lowest.

1.2.7. Develop and implement strategies for managing excessive sedimentation in tidewater goby habitat within current or enhanced parameters. Based on the findings of action 1.1.3 or the best available information, develop strategies and management actions should be taken, to prevent further increases in sedimentation in extant tidewater goby habitat due to cattle grazing, development, channel modification, recreational activity, and agricultural practices. As opportunities become available to decrease the levels of sedimentation, additional management actions should be taken.

1.2.8. Monitor tidewater goby population status and trends, and habitat conditions. Tidewater goby habitat conditions can undergo dramatic changes on a yearly basis that are largely dependent on levels of precipitation. Tidewater goby populations and habitat conditions should be monitored (using the protocols developed in actions 1.1.1 through 1.1.4) for abundance and trends on a minimum of an annual basis to evaluate management activities and assess recovery at each extant locality.

All survey data should be submitted to the California Department of Fish and Game's Natural Heritage Program for input into their natural diversity database system on a yearly basis. All individuals that conduct research or survey activities that may result in the killing or injury of a tidewater goby must be authorized pursuant to section 10(a)(1)(A) of the Endangered Species Act of 1973, as amended. Researchers and surveyors should, as a term and condition for holding a section 10(a)(1)(A) scientific take permit, provide survey and monitoring information to the California Department of Fish and Game, and the U.S. Fish and Wildlife Service for input into appropriate databases. Furthermore, all individuals that conduct research or survey activities that may result in the killing or injury of a tidewater goby must have the appropriate permits and be in compliance with other applicable laws (*e.g.*, California Fish and Game Code).

The California Department of Fish and Game's Natural Heritage Program should input survey data into their natural diversity database system on a yearly basis. In addition, population monitoring data and habitat condition information should be consolidated into a database, and maintained by our Arcata Fish and Wildlife Office. This database should be accessible to all interested parties including planning agencies and the general public.

1.2.9. Develop an umbrella Safe Harbor Agreement or obtain financial incentives for landowners to maintain or enhance tidewater goby habitat. Landowners should be informed of conservation measures such as Safe Harbor Agreements for tidewater goby habitat that are available to them. Landowners should be encouraged to streamline the permitting process by applying for an umbrella Safe Harbor Agreement. Private landowners should be assisted in their efforts to obtain economic incentives for maintaining or enhancing suitable habitat and working towards the recovery of the tidewater goby. Land owners should be informed of various grant opportunities and incentives.

1.2.10. Implement regional ecosystem strategies through coordination, exchanging information, and existing regulatory processes to maximize the protection of tidewater goby habitat. Our partners involved with recovery activities in the region covered by this recovery plan include California Department of Fish and Game, California Department of Parks

and Recreation, U.S. Army Corps of Engineers, National Oceanic Atmospheric Administration Fisheries, Environmental Protection Agency, California Department of Transportation, university and research departments, property owners, and other individuals knowledgeable about the species and their habitats. Existing plans, data, and information pertinent to the recovery of the tidewater goby must be synthesized and shared effectively by promoting information exchange and discussion between all agencies, groups, and individuals. In addition, management strategies must incorporate conservation needs for other listed species and species at risk. Support from local lead agencies for the protection of habitat for the tidewater goby is essential for its recovery.

1.2.11. Standardize and implement protocols for rescue of tidewater goby populations. Protocols should be standardized for rescuing populations of tidewater gobies suddenly threatened by catastrophes like toxic spills or anoxic conditions, and anthropogenic breaching events. Such protocols could be particularly important for recovery where only one stable population exists that is genetically important to the recovery of the species and is isolated from other populations by large geographic distances. Protocols should include the facilities needed to hold tidewater gobies during catastrophic events (*e.g.*, aquariums, fish hatcheries, habitat partitioning). The isolated localities are as follows: northern Arcata Bay, Brush Creek and environs, Rodeo Lagoon, Pajaro River, San Luis Obispo Creek, Pismo Creek, Santa Maria River, Carpinteria Creek, Ventura River, Santa Clara River, Malibu Creek, Aliso Creek, San Onofre Creek, San Mateo Creek, Las Flores Creek, and Santa Margarita River.

2. Conduct biological research to enhance the ability to integrate land use practices with tidewater goby recovery. Data specific to tidewater goby optimal water quality and freshwater inflow conditions and tolerances need to be acquired, as well as a description of optimum habitat conditions. Research should also identify how to minimize the threat posed by exotic species, sedimentation, channelization, and anthropogenic lagoon breaching. These latter threats may best be minimized by managing for optimal habitat conditions based on the best available research. This research should be used to fully implement management actions (Action 1) needed for recovery to accommodate situations where habitat conditions should be enhanced and/or in determining to what extent proposed land used practices can occur consistent with recovery of the species, while minimizing adverse effects to the tidewater goby. In addition, population demographics and genetic diversity data are needed to validate the number and distribution of populations needed for population viability and long term persistence.

2.1. Determine water quality parameters for tidewater goby habitat. Studies should be conducted that determine tidewater goby water quality requirements (*e.g.*, dissolved oxygen and pH) and tolerances (*e.g.*, nitrogen, phosphorus, petroleum products, and pesticides and herbicides commonly found in agricultural, urban, oil field, and golf course runoff). These studies should also identify strategies for

achieving these parameters in the event that ongoing monitoring indicates that current habitat conditions should be enhanced and/or to address future land use practices that may affect tidewater goby habitat.

2.2. Determine freshwater inflow parameters. Optimal parameters for water velocity, water depth and water surface area should be established at each extant tidewater goby habitat. The level of inflow necessary to maintain suitable tidewater goby habitat within these parameters and the parameters for water quality should be determined in the event that ongoing monitoring indicates that current habitat conditions should be enhanced and/or to address future land use practices that may affect tidewater goby habitat.

2.3. Investigate the interactions of exotic species with tidewater gobies. Interactions can include, but are not limited to, predation, competition, and habitat alteration.

2.4. Conduct studies to determine how to minimize the threats of nonnative predators. Studies should be conducted to provide information needed in developing and implementing strategies that will minimize the level of predatory and competitive threat posed by exotic species (*e.g.*, habitat enhancement). These strategies should be determined in the event that ongoing monitoring indicates that predation/competition from exotic species is threatening the survival of a population and/or to address future anticipated increases in exotic species inhabiting tidewater goby habitats.

2.5. Conduct studies to determine how to minimize the effects of channelization. Studies should be conducted to provide information needed in developing and implementing strategies that will minimize the deleterious effects of channelization. These strategies should be determined in the event that ongoing monitoring indicates that current levels of channelization are threatening the survival of a population and/or to address future anticipated increases in channelization.

2.6. Conduct studies to determine how to minimize the effects of sedimentation. Studies should be conducted to provide information needed in developing and implementing strategies that will minimize the effects of sedimentation. Because excessive sedimentation may particularly degrade substrate conditions needed for reproduction, the studies should include assessments of the effects of sedimentation on the reproductive success of the tidewater goby. The strategies for minimizing the effects of sedimentation should be determined in the event that ongoing monitoring indicates that current levels of sedimentation are threatening the survival of a population and/or to address future anticipated increases in sedimentation where mitigation for the source of sedimentation is not possible.

2.7. Conduct studies to determine how to minimize the effects of anthropogenic breaching. Studies should be conducted to provide the information needed in developing and implementing strategies for minimizing the threat of

anthropogenic season breaching. The strategies for minimizing the deleterious effects of anthropogenic breaching should be determined in the event that ongoing monitoring indicates that current levels of anthropogenic breaching are threatening the survival of a population and/or to address future anticipated increases in such breaching.

2.8. Describe natural tidewater goby habitat characteristics. Studies should be conducted that will provide the information necessary to describe natural tidewater goby habitat characteristics. These studies should be conducted using habitats where tidewater goby populations are stable or improving. It may be of value to compare sites where threats are minimal or nonexistent with sites that have threats (*e.g.*, exotic species). Characteristics to be described should include, at least, substrate gradient and composition, proportion of habitat comprising lateral marsh, and abundance/distribution/composition of aquatic vegetation. These data on optimal habitat characteristics, along with those for freshwater inflow and water quality determined in actions 2.1 and 2.2, should be used in developing and implementing management strategies needed for minimizing threats in the event that ongoing monitoring indicates that current habitat conditions should be enhanced and/or to address future land use practices that may affect tidewater goby habitat.

2.9. Determine the genetic diversity and intraspecific phylogeography of the tidewater goby. A thorough study of the genetic diversity within the tidewater goby's range where data are lacking should be conducted, including a phylogenetic analysis. The resulting hierarchy will provide a definition of the genetic variability between localities and geographic areas in this species, and provide a firm basis for evaluating the number and distribution of populations needed for recovery. The genetic studies should include as many of the extant populations as possible, spanning the whole range of the species.

2.10. Determine population demography characteristics for the tidewater goby. Research is needed on dispersal mechanisms, rates, and distances, and the numbers of populations needed for long-term persistence. This information, combined with the information gathered in action 2.9, will provide the basis for evaluating the sizes, numbers, and distribution of populations necessary for the implementation of action 2.10 and the recovery of the species.

2.11. Develop a metapopulation viability analysis. Using the demographic and dispersal information gathered for the tidewater goby, a metapopulation viability analysis should be conducted that estimates the likelihood of extinction of tidewater goby metapopulations, assesses relative threats of various factors (predators, habitat loss, disease, *etc.*), and compares alternative management strategies. This Recovery Plan would be revised as needed based on the results of this analysis.

2.12. Conduct annual aerial surveys to quantify habitat losses and identify areas that have high potential for habitat creation/restoration and acquire electronic imagery for GIS applications. Annually review the California coastline for habitat losses to learn how and if the goal of tidewater goby recovery is being achieved. This assessment should be accomplished by reviewing aerial photographs or by conducting aerial surveys. Update aerial imagery as needed.

2.13 Practice adaptive management in which we revise recovery actions as pertinent new information becomes available. We should offer periodic updates to the press and general public regarding the status of the tidewater goby and recovery efforts. The scientific validity of the recovery criteria and recovery plan should be reviewed and revised as more information become available. The criterion of maintaining sufficient populations or conservation areas should be examined. Additionally, the success or failure of management actions should be evaluated.

2.13.1. Reevaluate recovery criteria. The criteria for downlisting and delisting the tidewater goby in this recovery plan should be evaluated based on future information gathered from life history studies, research, monitoring, and management actions. If necessary, downlisting or delisting criteria should be refined.

2.13.2. Keep recovery plan current and useful. The recovery plan should be updated, amended, or revised based on the expanded knowledge from research and monitoring results and evaluation of the relative success and failure of the management programs in attaining recovery goals every 5 years. Management responses should be incorporated into the revised recovery program when potential threats are found to be actual threats.

2.13.3. Revise maps of management units as new genetic data become available. We should work with biologists and consultants to revise management unit maps if new genetic data become available. Revised maps should be distributed to all who received a Recovery Plan.

3. Evaluate and implement translocation where appropriate. Translocation efforts include introduction, accelerated dispersal and reintroductions. The reintroduction tidewater goby to historic locations and translocation to new location or areas with low population densities (accelerated dispersal) within developing metapopulations (with an extant tidewater goby population) are anticipated to enhance or accelerate the rangewide recovery effort. Protocols and guidelines should be developed and refined to ensure that translocation procedures are both appropriate and likely to be successful.

3.1 Develop and refine protocols and guidelines for translocation. Before translocation of tidewater gobies occurs, the conditions necessary for ensuring metapopulation viability should be assessed. Moving tidewater gobies in the absence of suitable habitat or adequate habitat is not a wise use of resources. Before these relatively drastic measures are attempted, there should be a realistic

expectation of long-term success based on the presence of adequate tidewater goby habitat, ongoing habitat management and restoration efforts, and the capacity for tidewater goby/habitat management and monitoring. For example, factors causing the failure of the native population should be remedied, following the methods identified above under actions 1 and 2, prior to any translocation effort. See Appendix G for further discussion of specific localities with respect to translocation and reintroduction.

3.1.1 Develop protocols, guidelines and selection criteria for translocation. Locations identified as potential translocation sites should meet certain minimum habitat quality and management criteria. A protocol detailing the assessment of these minimum criteria needs to be developed to ensure that sites are suitable before actions are taken.

3.1.2 Incorporate research findings into protocols. As ecological data are generated, and experience with translocation accumulates, timely refinements should be incorporated into the standardized translocation protocols.

3.2 Implement translocation in sub-units. The habitats and tidewater goby numbers in some Sub-Units have declined to the point that the tidewater gobies persistence is very precarious. In these cases, actions such accelerated dispersal to expand the metapopulation and translocation to boost tidewater goby numbers may be required to prevent metapopulation decline. These tools may be useful for speeding recovery in a metapopulation, by increasing metapopulation densities and accelerating dispersal faster than might otherwise occur. Reintroductions to historic habitat are necessary in Sub-Units to re-establish metapopulations that have been extirpated.

4. Increase public awareness about tidewater gobies. Recovery activities will have a greater chance of success if the public, landowners, and other potentially affected parties are educated about the tidewater goby, where it lives, its unique and special attributes, why it is in jeopardy, and the actions necessary to protect its habitat and recover the species. Preparation and distribution of brochures and educational materials and public meetings will facilitate a better public awareness and understanding of the actions needed for the recovery of the tidewater goby, and increase public support and participation in the recovery efforts.

4.1. Prepare and distribute brochures and educational materials on the tidewater goby. A brochure and other educational materials in layperson's terms about the tidewater goby will provide education to the public and landowners unfamiliar with the technical literature. These brochures and other educational materials should be distributed to public parks, beaches, and other sites associated with tidewater goby habitats. This information should also be made available through Federal, State, and local agencies associated with the protection and improvement of tidewater goby localities.

4.2. Develop website that will educate the public on the tidewater goby and recovery actions. Recovery information regarding the tidewater goby and its habitat should be available to the public to better inform parties potentially affected by tidewater goby recovery efforts as to the issues involved and why the actions are being taken.

V. IMPLEMENTATION SCHEDULE

The table that follows is a summary of scheduled actions and costs for recovery of the tidewater goby. It is a guide for meeting the objectives discussed in Parts II, III, and IV of this recovery plan. The table includes the following five elements:

1. Priority. The actions identified in the implementation schedule are those that, in our opinion, are necessary to bring about the recovery of these species. However, the actions are subject to modification as dictated by new findings, changes in species status, and the completion of recovery actions. The priority for each action is given in the first column of the implementation schedule, and is assigned as follows:

Priority 1:	An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.
Priority 2:	An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.
Priority 3:	All other actions necessary to provide for full recovery of the species.

2. Action Number and Description (from narrative outline). The action number and description are extracted from the stepdown narrative found in Part IV of the recovery plan. Please refer back to this narrative for a more detailed description of each action.

3. Action Duration. The action duration column indicates the number of years estimated to complete the action if it is a discrete action, or whether it is a continual or ongoing action. Continual and ongoing actions are defined as follows:

Continual:	Action will be implemented on a regularly scheduled basis once it is begun.
Ongoing:	Action is currently being implemented and will continue until no longer necessary for recovery.

4. Responsible Parties. In the table, we have identified agencies and other parties that we believe are primary stakeholders in the recovery process. Stakeholders are those agencies who may voluntarily participate in any aspect of implementation of particular actions listed within this recovery plan. Stakeholders may willingly participate in project planning, funding, provide technical assistance, staff time, or any other means of implementation. The list of potential stakeholders is not limited to the list below; other stakeholders are invited to participate. In some cases, the most logical lead agency (based on authorities, mandates, and capabilities) has been

identified as the "responsible party" with an asterisk (*). The following abbreviations are used to indicate the stakeholder for each recovery action for the tidewater goby:

Agencies: refers to the local lead agencies with planning authority for actions that may affect the listed species

NPS	National Park Service
USGS	U.S. Geological Survey
CDFG	California Department of Fish and Game
FWS	U.S. Fish and Wildlife Service
EPA	U.S. Environmental Protection Agency
CORPS	U.S. Army Corps of Engineers
NOAA	NOAA Fisheries
CLTRNS	California Department of Transportation
NGO	Nongovernmental organizations (*e.g.*, The Surfrider Foundation, The Nature Conservancy, *etc*.)
PVT	Private parties
TBD	To be determined
MULTI	Multiple stakeholders involved
UNIV	University or academic researchers

5. Cost Estimates. Cost estimates are shown for some of the recovery actions, both for the first 5 years after release of the recovery plan and for the total estimated cost of recovery. Costs of some recovery actions cannot be estimated at this time. Costs of developing and implementing management and protection plans will vary with local circumstances and details of individual plans. Sites for introduction and re-introduction of tidewater gobies have not yet been determined, so costs of assessment and restoration cannot be estimated. The scope of necessary contaminants studies depends on results of ongoing research. Cost estimates are as follows:

Year 1: $370,000 + to be determined
Year 2: $215,000 + to be determined
Year 3: $195,000 + to be determined
Year 4: $140,000 + to be determined
Year 5: $140,000 + to be determined

TOTAL: $1,505,000 + to be determined

Implementation Schedule for the Tidewater Goby Draft Recovery Plan										
Action Priority	**Action Number**	**Action Description**	**Action Duration**	**Responsible Parties**	**Cost Estimate (in $1,000 units)**					
					Total Costs	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
1	1.2.1	Develop and implement management strategies to avoid further direct net loss/modification of habitat.	2 years	MULTI	70		30	40		
1	1.2.5	Develop and implement strategies for managing water quality within current or enhanced parameters.	Continual	MULTI	180	40	30	5	5	5
1	1.2.8	Monitor tidewater goby population status and trends, and habitat conditions.	5 years	FWS*	170	40	40	30	30	30
1	2.1	Determine water quality parameters for tidewater goby habitat.	2 years	FWS*	20		10	10		
1	2.9	Determine the genetic diversity and intraspecific phylogeny of the tidewater goby.	Ongoing	UNIV*	TBD					
1	2.10	Determine population demography characteristics for the tidewater goby.	5 years	USGS*, FWS, UNIV*, CDFG	25	5	5	5	5	5

Implementation Schedule for the Tidewater Goby Draft Recovery Plan										
Action Priority	**Action Number**	**Action Description**	**Action Duration**	**Responsible Parties**	**Cost Estimate (in $1,000 units)**					
					Total Costs	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
1	2.11	Develop a metapopulation viability analysis.	10 years	FWS, USGS*, UNIV*	250			25	25	25
1	3.1.1	Develop and refine protocols and criteria for translocation	1-3 years	FWS*, USGS, CDFG	30	10	10	10		
2	1.1.1	Standardize and implement survey, sampling, and monitoring procedures for tidewater goby populations.	1 year	FWS*	50	50				
2	1.1.2	Standardize and implement protocols for assessing nonnative predator populations.	1 year	FWS*, MULTI	60	60				
2	1.1.3	Standardize and implement protocols for assessing impacts and source of sedimentation in tidewater goby habitat.	2 years	FWS*, TBD	20	20				
2	1.2.3	Develop and implement strategies for managing deleterious exotic species at current or reduced levels.	Continual	FWS*	125				25	25
2	1.2.11	Standardize and implement protocols for rescue of tidewater goby populations.	1 year	FWS*	10		10			
2	2.3	Investigate the interactions of tidewater gobies with exotic species.	3 years	USGS*	40	20	10	10		
2	2.4	Conduct studies to determine how to minimize the threats of deleterious exotic species.	Continual	FWS*	TBD					

Implementation Schedule for the Tidewater Goby Draft Recovery Plan										
Action Priority	**Action Number**	**Action Description**	**Action Duration**	**Responsible Parties**	**Cost Estimate (in $1,000 units)**					
					Total Costs	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
2	2.6	Conduct studies to determine how to minimize the effects of sedimentation.	Continual	MULTI	TBD					
2	2.7	Conduct studies to determine how to minimize the effects of natural and anthropogenic breaching.	Continual	FWS*	TBD					
2	2.8	Describe natural tidewater goby habitat characteristics.	1 year	FWS*	10	10				
2	2.12	Conduct annual aerial surveys to quantify habitat losses and identify areas that have high potential for habitat creation/restoration.	Continual	USGS*, CDFG	TBD					
2	2.13.1	Reevaluate recovery criteria.	Ongoing	FWS*	125	5	5	5	5	5
2	2.13.2	Keep recovery plan current and useful.	Continual	FWS*	TBD					
2	2.13.3	Revise maps on recovery Sub-Units as new genetic data become available.	Ongoing	FWS*, UNIV*	TBD					
2	3.1.2	Incorporate research findings into protocols	1-3 years	FWS*, USGS, CDFG	30	15	10	5		
2	3.2	Implement translocation in subunits	5 years	FWS*, USGS*, CDFG	TBD	TBD	TBD	TBD	TBD	TBD

Implementation Schedule for the Tidewater Goby Draft Recovery Plan										
Action Priority	**Action Number**	**Action Description**	**Action Duration**	**Responsible Parties**	**Cost Estimate (in $1,000 units)**					
					Total Costs	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
2	4.1	Prepare and distribute brochures and educational materials on the tidewater goby.	1 year	MULTI	30	30				
2	4.2	Develop a website that will educate the public on the tidewater goby and recovery actions.	1 year	MULTI	40	40				
3	2.5	Conduct studies to determine how to minimize the effects of channelization.	Continual	FWS*, CORPS, NOAA	50	25	25			
3	1.2.2	Develop and implement strategies for managing freshwater inflow within current or enhanced parameters.	2 years	MULTI	TBD					
3	1.2.4	Develop and implement strategies for managing adverse effects resulting from channelization at current or reduced levels.	Continual	FWS*, CORPS, NOAA	50			20	15	15
3	1.2.6	Develop and implement strategies for minimizing anthropogenic breaching of lagoons.	Continual	FWS*	TBD					
3	1.2.7	Develop and implement strategies for managing excessive sedimentation in tidewater goby habitat within current or enhanced parameters.	Continual	MULTI	120		30	30	30	30
3	1.2.9	Develop umbrella Safe Harbor Agreement or obtain financial incentives for landowners to maintain or enhance tidewater goby habitat.	Continual	FWS*, NOAA	TBD					
3	1.2.10	Implement regional ecosystem strategies through coordination, exchanging information, and existing regulatory processes to maximize the protection of tidewater goby habitat.	Continual	MULTI	TBD					

Implementation Schedule for the Tidewater Goby Draft Recovery Plan										
Action Priority	**Action Number**	**Action Description**	**Action Duration**	**Responsible Parties**	**Cost Estimate (in $1,000 units)**					
					Total Costs	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
3	2.2	Determine freshwater inflow parameters.	2 years	MULTI	TBD					
Total estimated cost of recovery over 10 years: $1,505,000 plus additional costs that cannot be estimated at this time.										

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Appendix A. Glossary

adaptive management	a method of using known information, hypotheses, and information gained while managing a system to alter management practices so that the management objectives can be more readily attained. Adaptive management may be used to improve the management system in a relatively risk-free way, it can be used to reduce management risk and uncertainty, or it can be used to choose among management alternatives with unknown or uncertain effects.
allele	one of two or more alternative forms of a gene which occupy corresponding loci in homologous chromosomes.
allozyme	form of an enzyme that differs in amino acid sequence, as shown by electrophoretic mobility or some other property, from other forms of the same enzyme and is encoded by one allele at a single locus.
amphipods	a variety of small aquatic crustacean, used by fish for food.
anoxic	lacking oxygen.
anterior	toward the head or front end of an organism.
aquatic	of or in water; streams, lakes, rivers, ponds, and marshes are aquatic habitats.
benthic	a bottom dwelling community of organisms.
bottleneck	a relatively short period of time during which the size of a population becomes unusually small, resulting in a random change in gene frequencies.
clade	a branch of biological taxa or species that share features inherited from a common ancestor.
colonization	the act or process of establishing a new colony or population.
cytochrome	any of group of iron heme enzymes or carrier proteins in the oxidative and photosynthetic electron transport chains used in the study of heredity and variation.

DNA	deoxyribonucleic acid, the genetic material of all organisms (except RNA viruses); in eukaryotes DNA is confined to the nucleus, mitochondria, and plastids.
endemic	native to or confined to a certain region.
estuary	a partially enclosed coastal water body that is connected to the ocean. Salinity here is measurably reduced by the freshwater flow of rivers and streams.
exotic	not native to the area, introduced from another region or country.
extinct	no longer existing. Can refer to a species in its entirety, or in a particular part of the range.
extirpated	extinct in a particular area.
founder effect	the possibility that a new, small, isolated population may diverge genetically because the founding individuals are a random sample from a large, main population.
F_{ST}	a statistical measure used to reflect the history of small populations created from colonization events.
habitat	the environment in which a species or population lives and grows. Different types of habitats may be used for different life stages.
haplotype	a set of closely linked genetic markers present on one chromosome which tend to be inherited together.
Holocene	the geological period comprising approximately the last 10,000 years.
hypersaline	term to characterize waters with salinity greater that 40 parts per thousand.
lagoon	a shallow sound, channel, or pond near or communicating with a larger body of water.
listed	species recognized by Federal or State governments as endangered or threatened.
macroalgae	algal plants large enough either as individuals or communities to be readily visible without the aid of optical magnification.

metapopulation	several to many subpopulations for tidewater gobies that are close enough to one another that dispersing individuals could be exchanged.
microsatellite	a microsatellite consists of a specific sequence of DNA bases or nucleotides which contains mono, di, tri, or tetra tandem repeats.
mitochondria	one of the minute, spherical, rod-shaped or filamentous organelles present in all cells.
monophyletic	organisms in a group are known to have developed from a common ancestral form, and all descendants of that form are included in the group.
pH	a common measure of the acidity or alkalinity of a liquid.
phylogeographic	the geographic distributions of genealogical lineages, especially those within and among closely related species.
phylogeny	the evolutionary interrelatedness of an organism or group of organisms.
phytoplankton	photosynthesizing planktonic organisms.
piscivorous	fish eating animal.
Pleistocene	an epoch of the Quaternary period beginning about 1.6 million years ago and ending about 10,000 years ago. Best known as a time of extensive continental ice sheets.
Pliocene	the last epoch of the Tertiary period, during which man and most species of modern mammals came into existence.
population	in the wider sense, all tidewater gobies throughout their range. In the narrower sense, used to refer to the tidewater gobies in one particular locality; a collection of individuals that share a common gene pool.
ostracod	a variety of small aquatic crustacean, used by fish for food.
Quaternary period	a geological period which includes both the Pleistocene and Holocene periods comprising the second portion of the Cenozoic ere, characterized by the rise of man and modern mammals.
recovery units	regions of the species' distribution that are distinct from one another based on geomorphology and genetic diversity.

riparian	terrestrial areas adjacent to aquatic habitats; on the bank of a stream, river, estuary, lagoon, or lake.
salinity	the concentration of salt in a solution.
singleton population	an individual population that is distinct from others grouped with it.
source/sink	characterizing a metapopulation consisting of actively breeding source subpopulations (which have average birth rates exceeding average death rates, and thus produce an excess of juveniles that may disperse to other areas) and sink subpopulations (with death rates exceeding birth rates, thus functioning to absorb dispersers).
standard length	a fish measurement from the tip of the snout to the hypural bone (approximately origin of caudal fin).
subpopulation	a group of tidewater gobies using a particular breeding site or area; several to many subpopulations constitute a metapopulation.
Sub-Unit	an area within a recovery unit that supports a tidewater goby population showing significant differences in genetics from other populations.
supraorbital canal	that portion of the lateral line system on the tidewater gobies head which begins at its junction with the lateral canal behind mid-eye, courses up and over the eye, and continues forward nearly to the tip of the snout.
taxon	a level in the classification system, such as species, genus, family, or order.
UTM	Universal Transverse Mercator projection.
viability	capability to survive; for populations, the ability to survive into the foreseeable future.

Appendix B. Maps of Recovery Units

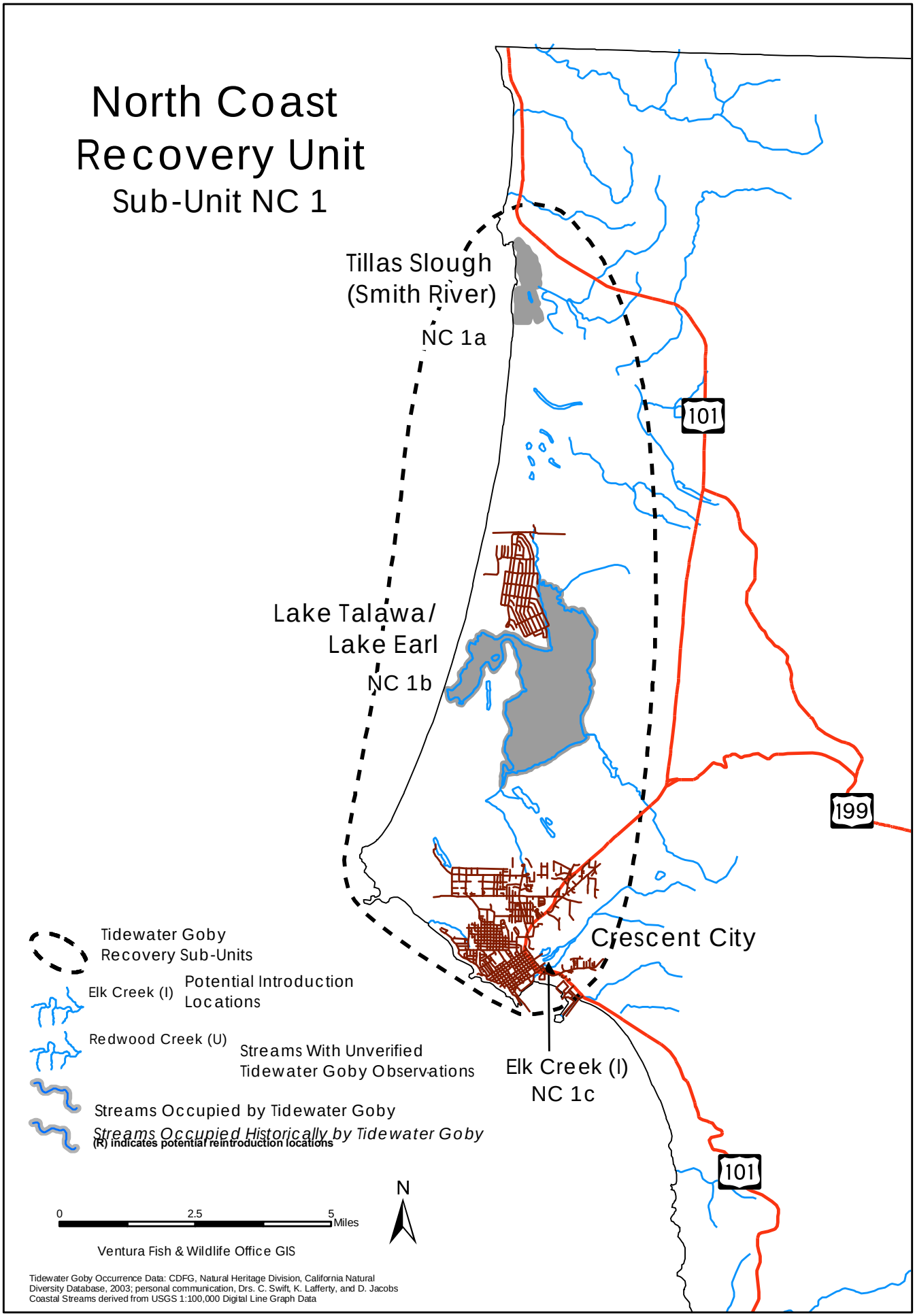

Figure B-1. North Coast Recovery Unit, Sub-Unit NC-1

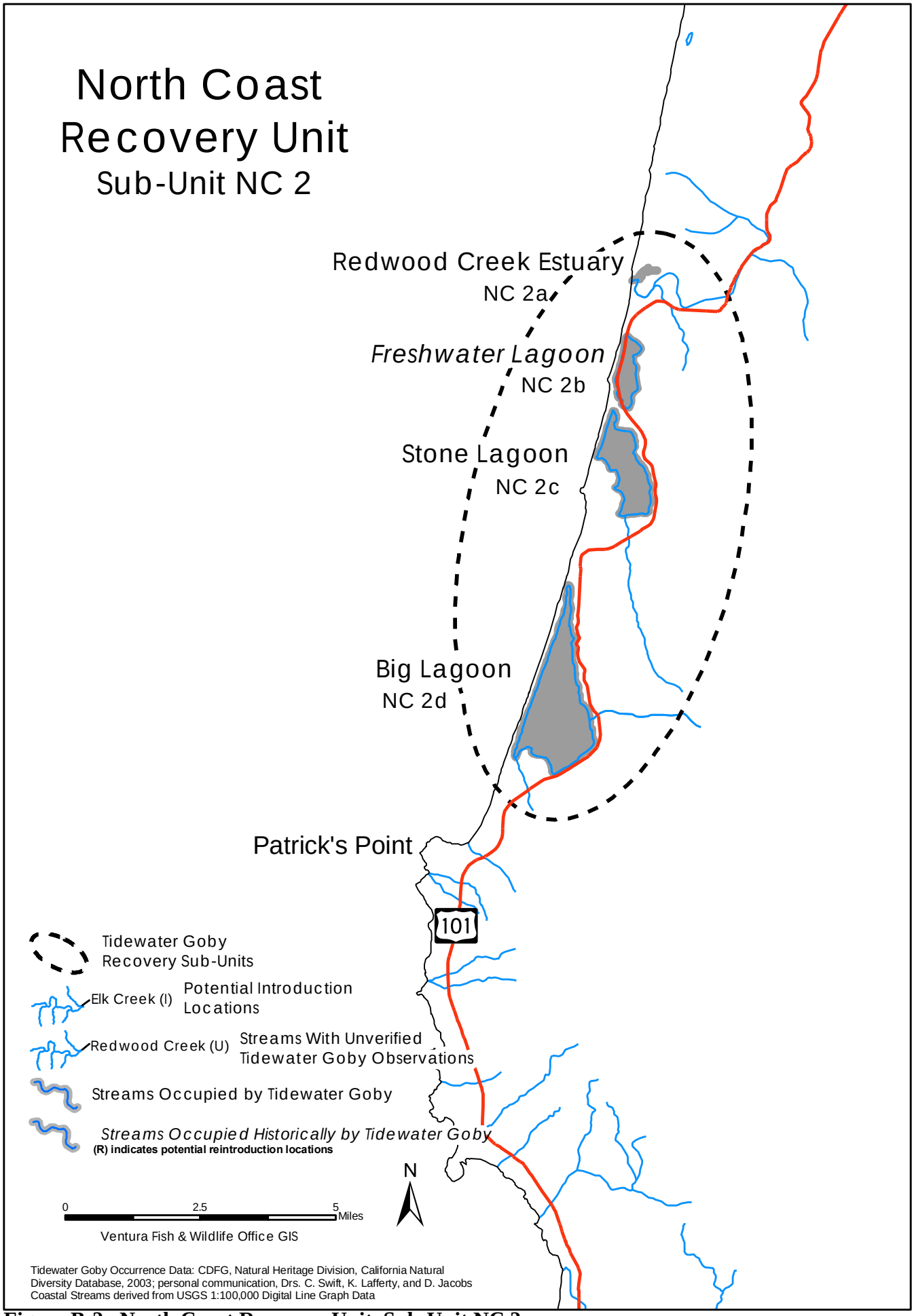

Figure B-2. North Coast Recovery Unit, Sub-Unit NC 2

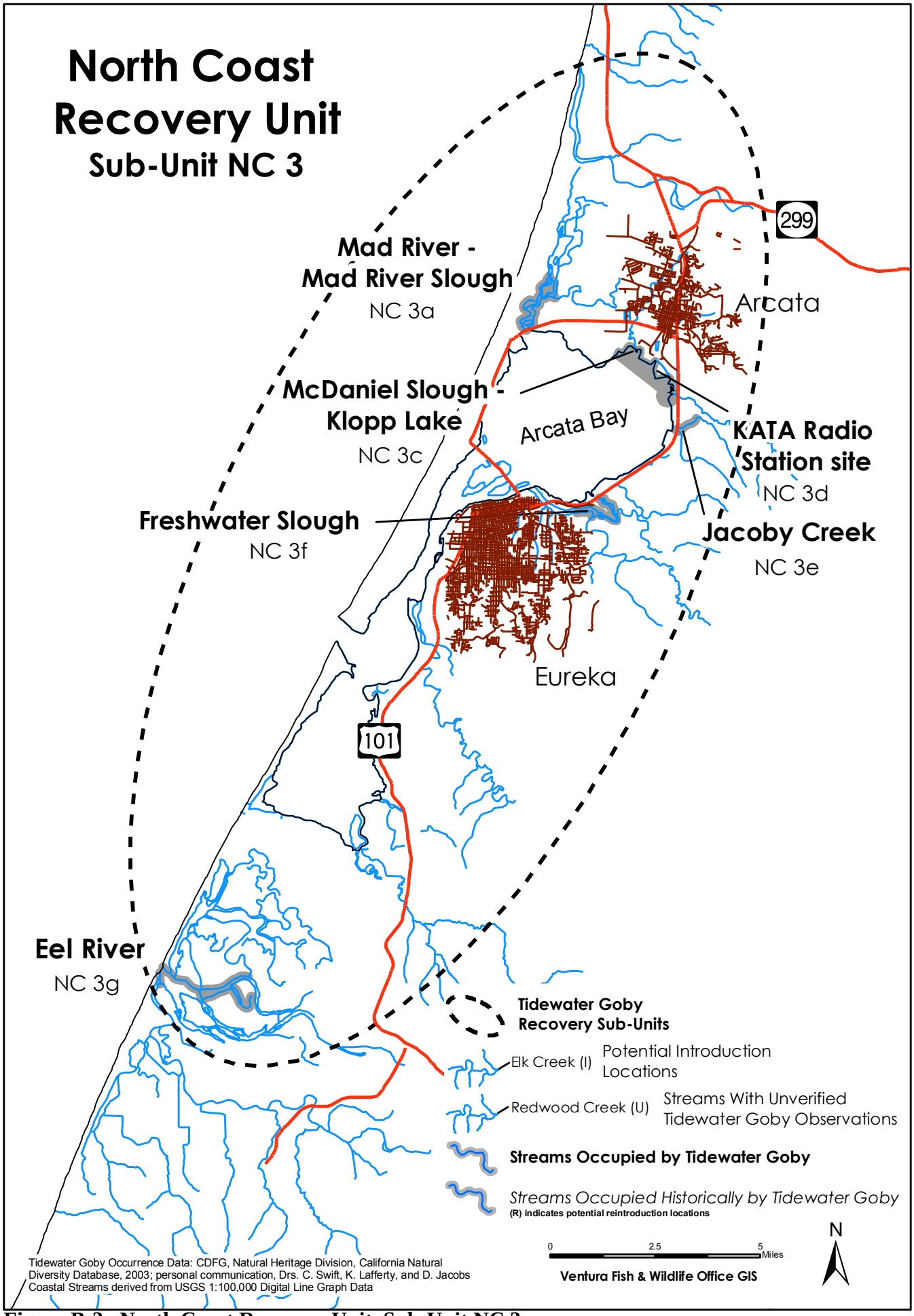

Figure B-3. North Coast Recovery Unit, Sub-Unit NC 3

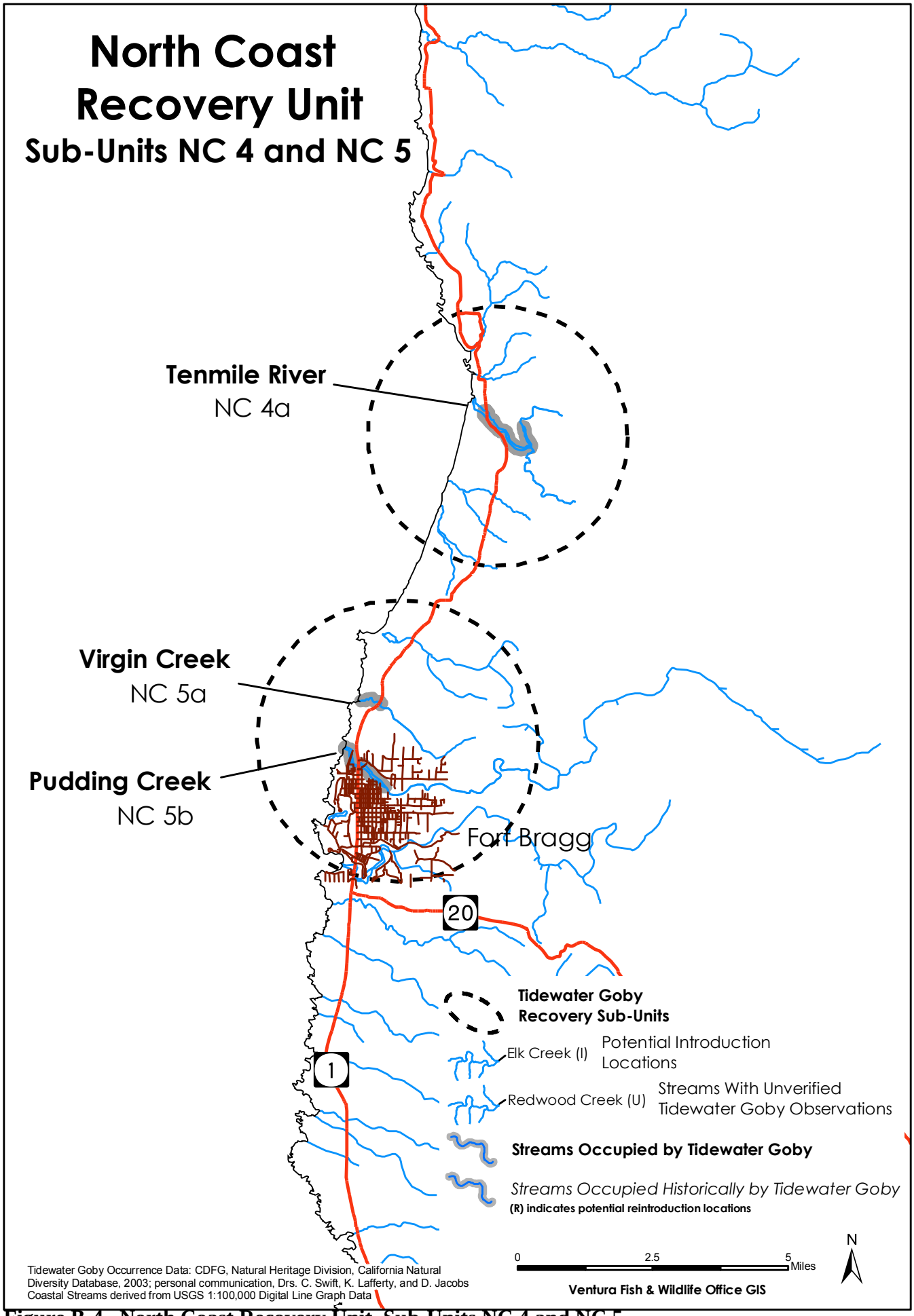

Figure B-4. North Coast Recovery Unit, Sub-Units NC 4 and NC 5

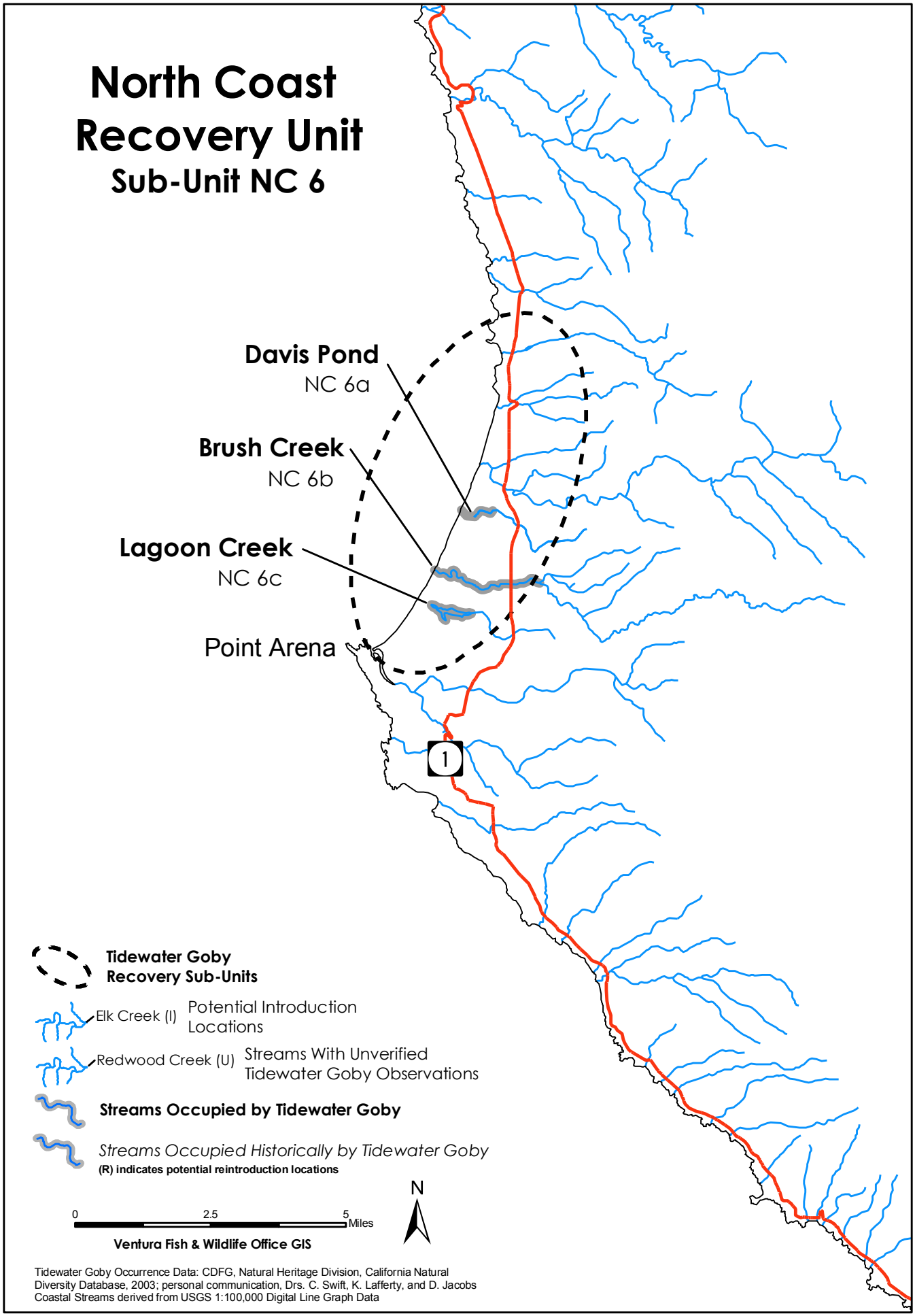

Figure B-5. North Coast Recovery Unit, Sub-Unit NC 6

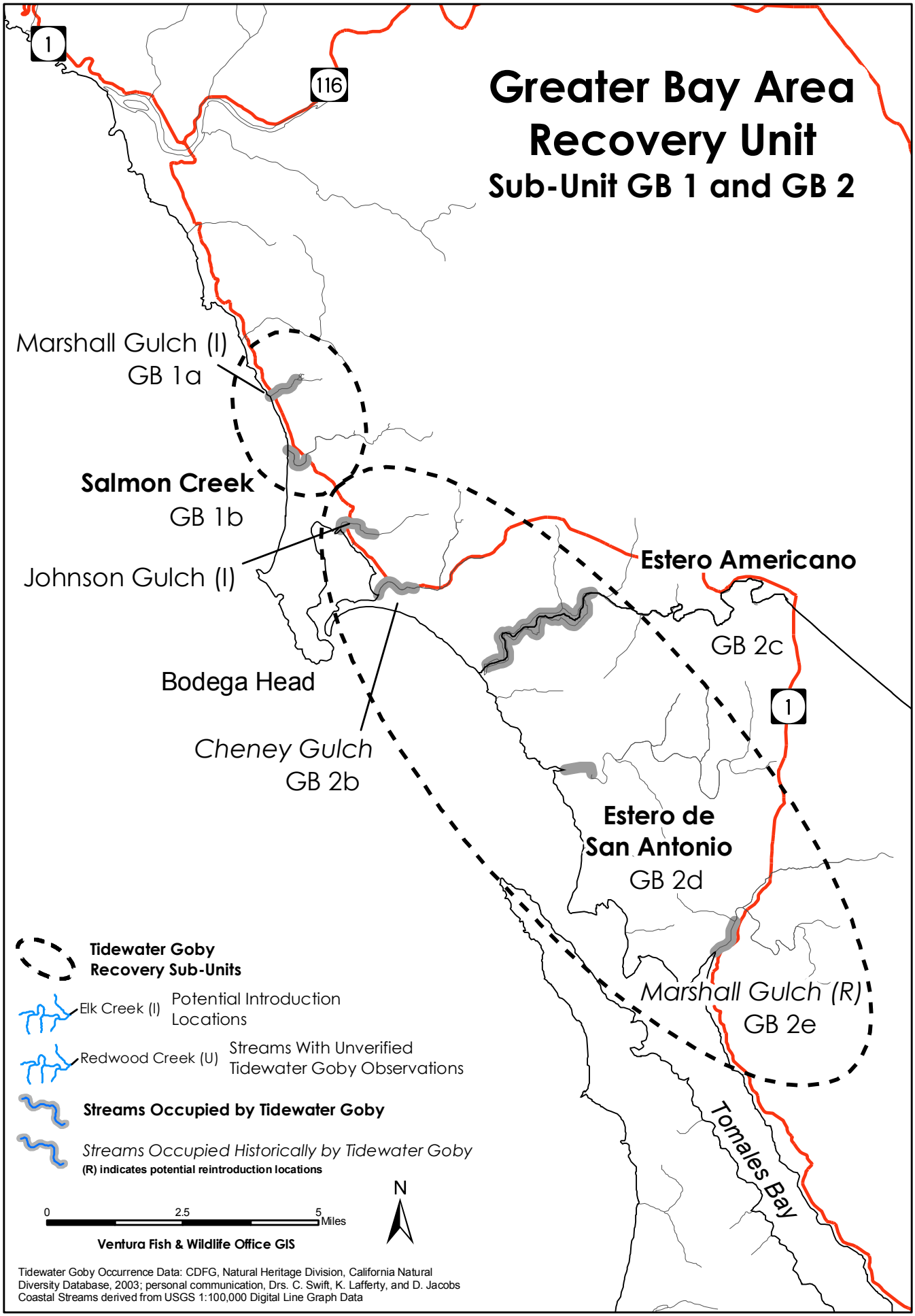

Figure B-6. Greater Bay Area Recovery Unit, Sub-Units GB 1 and GB 2

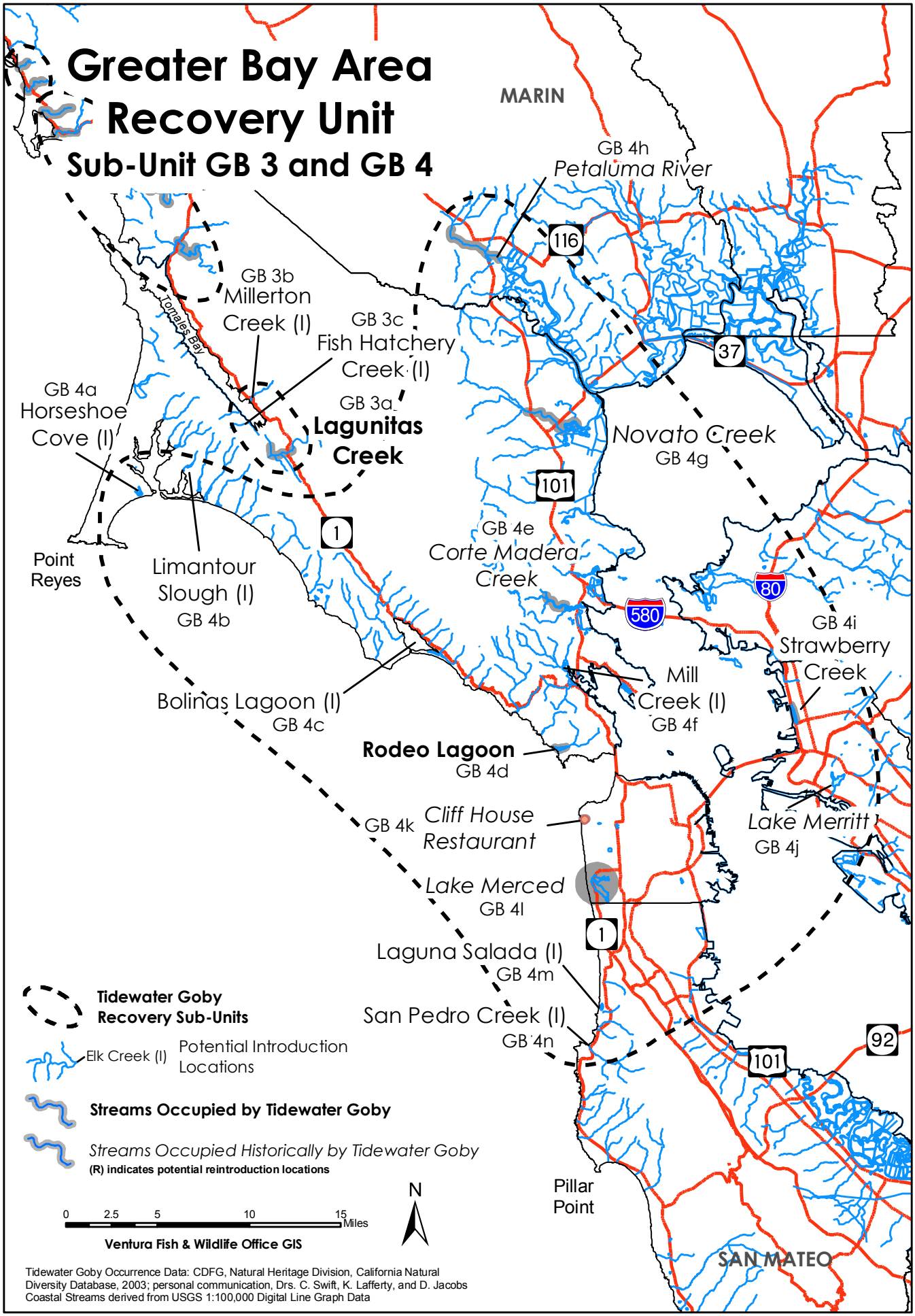

Figure B-7. Greater Bay Area Recovery Unit, Sub-Units GB 3 and GB 4

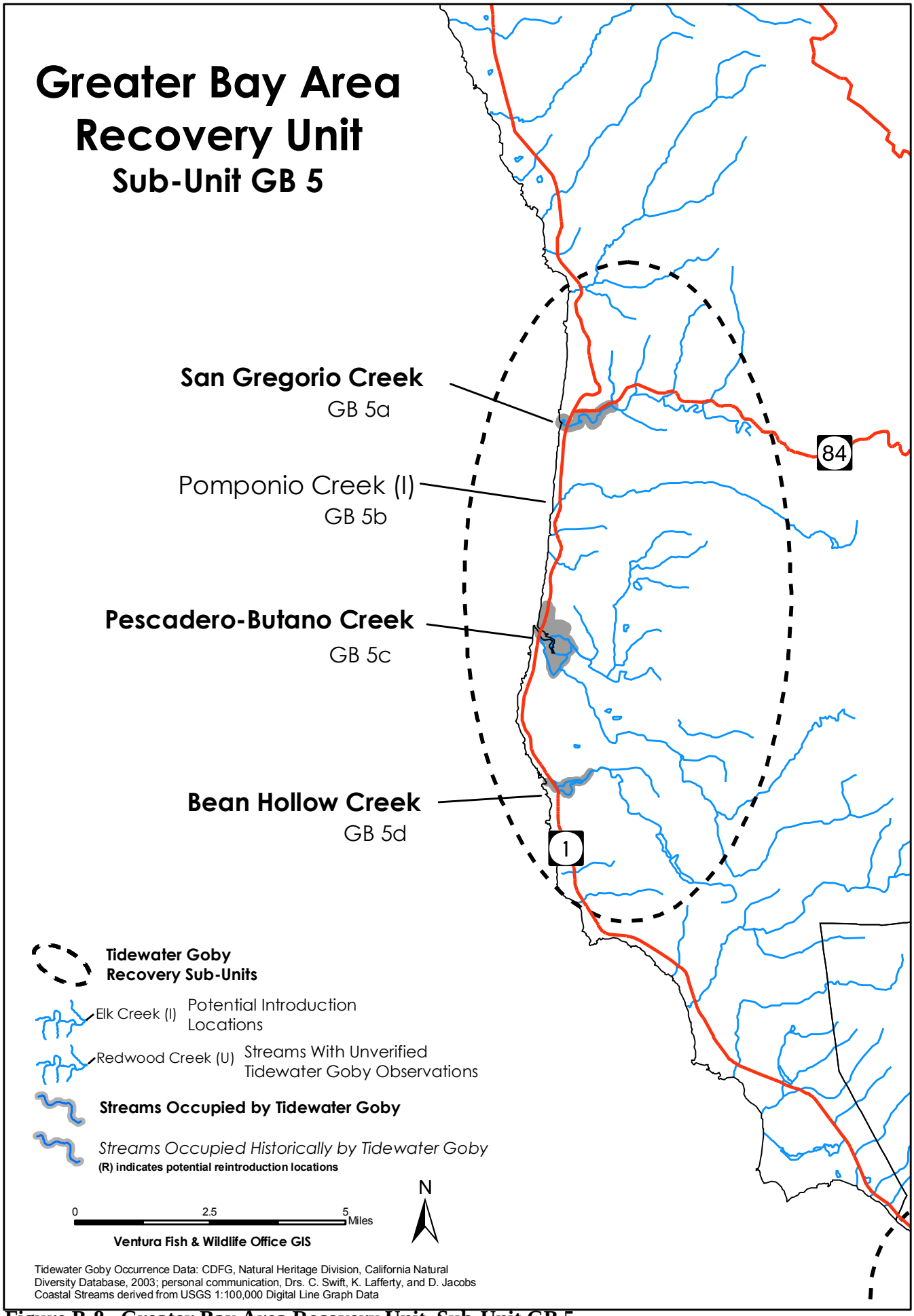

Figure B-8. Greater Bay Area Recovery Unit, Sub-Unit GB 5

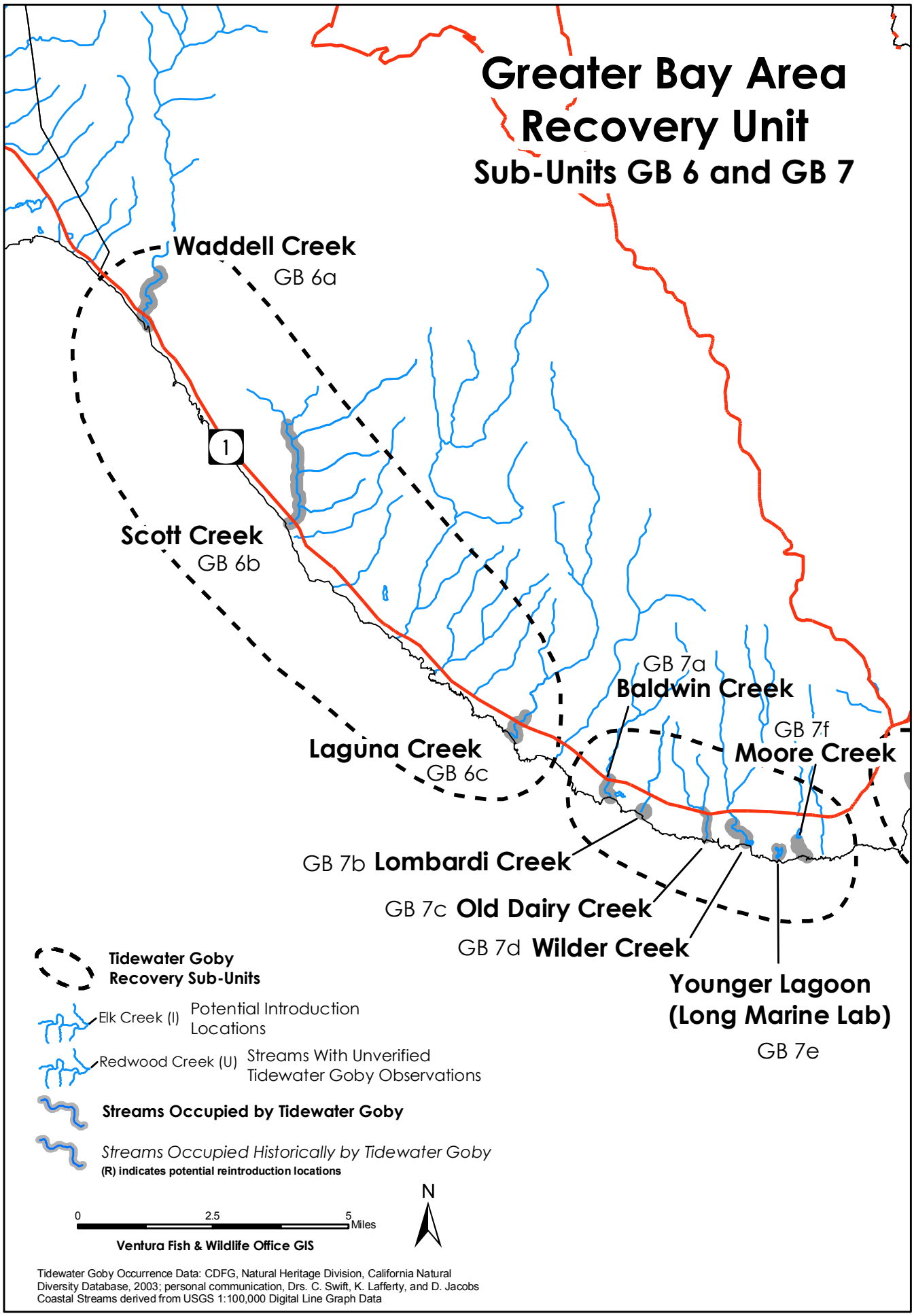

Figure B-9. Greater Bay Area Recovery Unit, Sub-Units GB 6 and GB 7

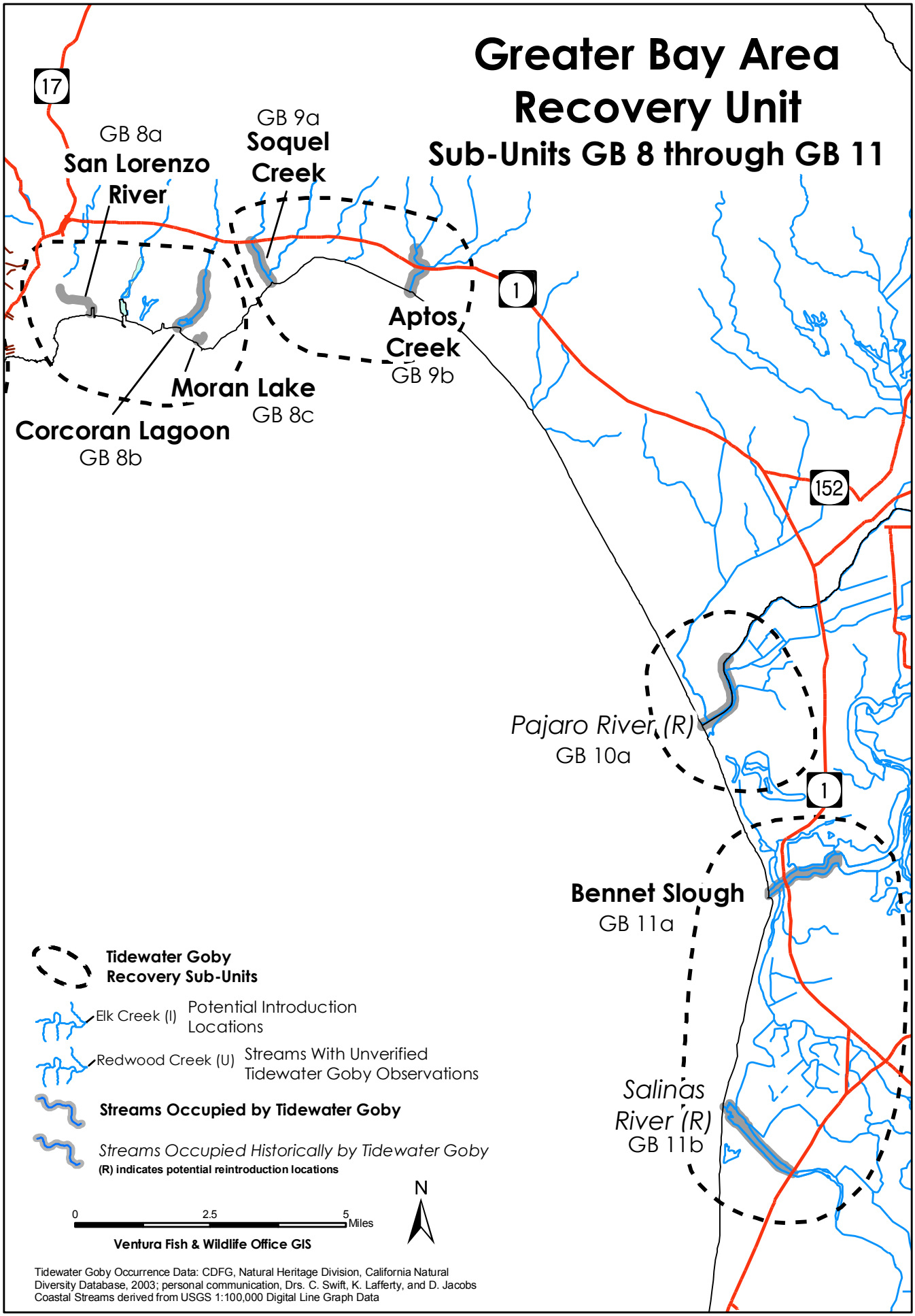

Figure B-10. Greater Bay Area Recovery Unit, Sub-Units GB 8 through GB 11

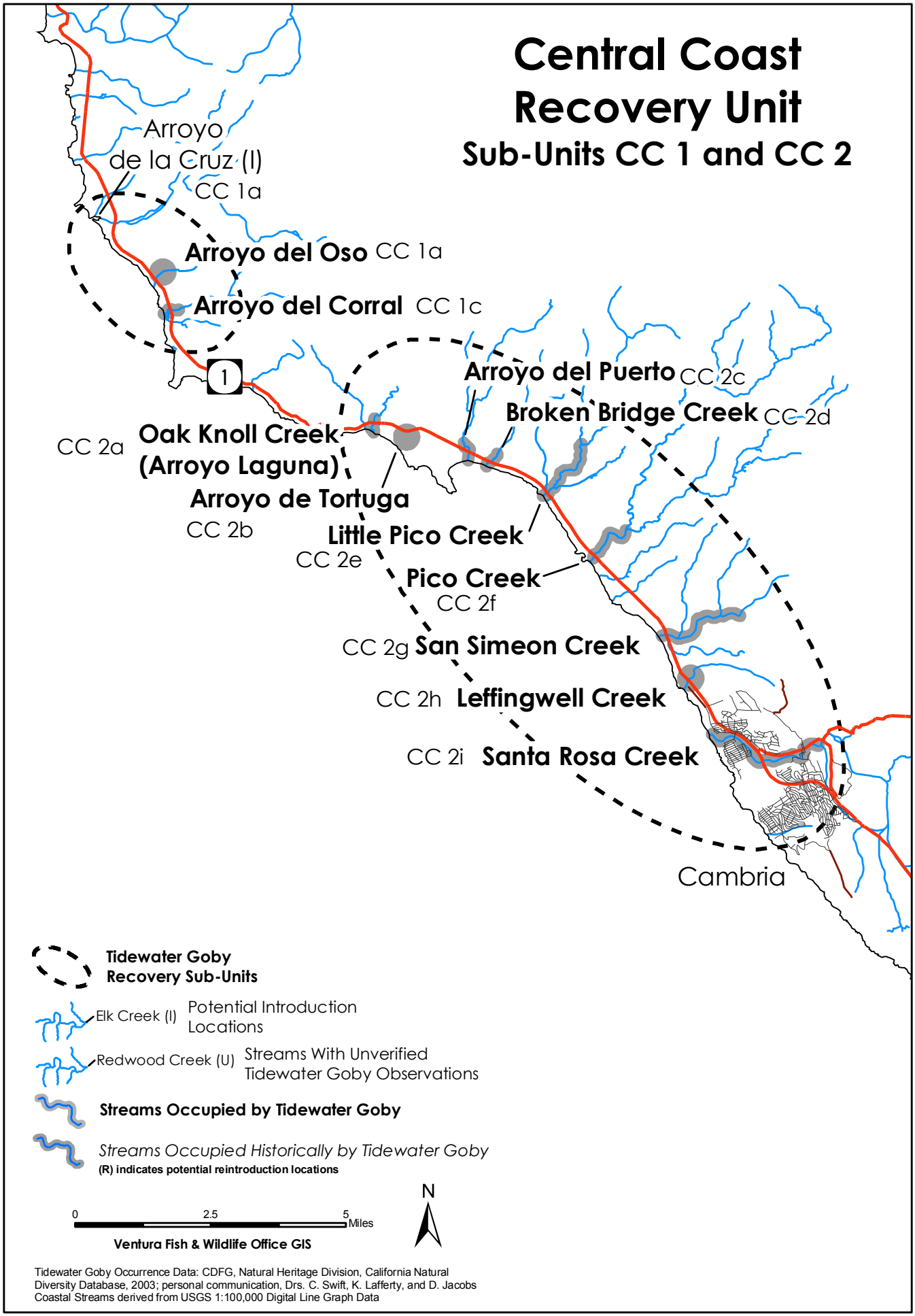

Figure B-11. Central Coast Recovery Unit, Sub-Units CC 1 and CC 2

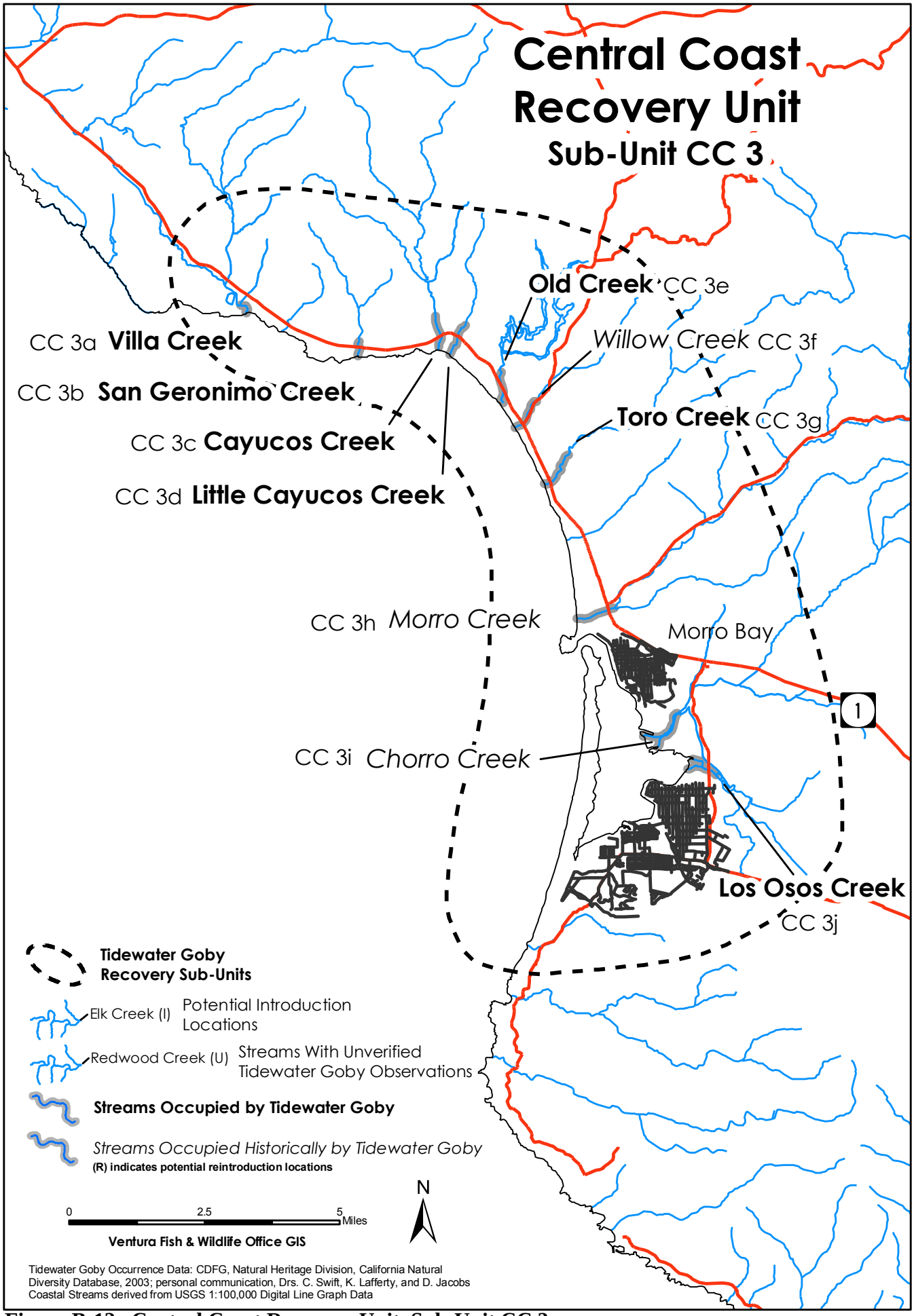

Figure B-12. Central Coast Recovery Unit, Sub-Unit CC 3

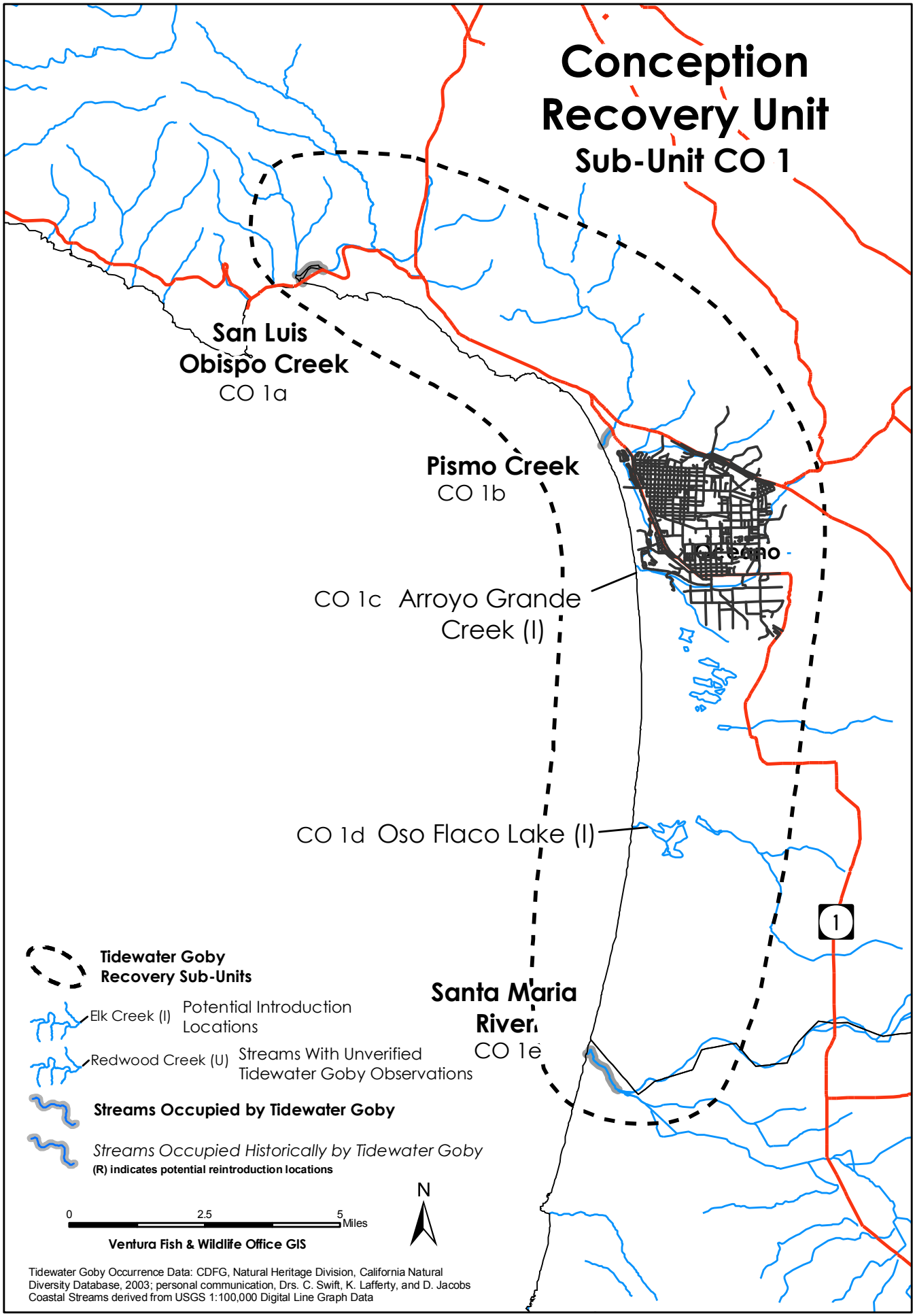

Figure B-13. Conception Recovery Unit, Sub-Unit CO-1

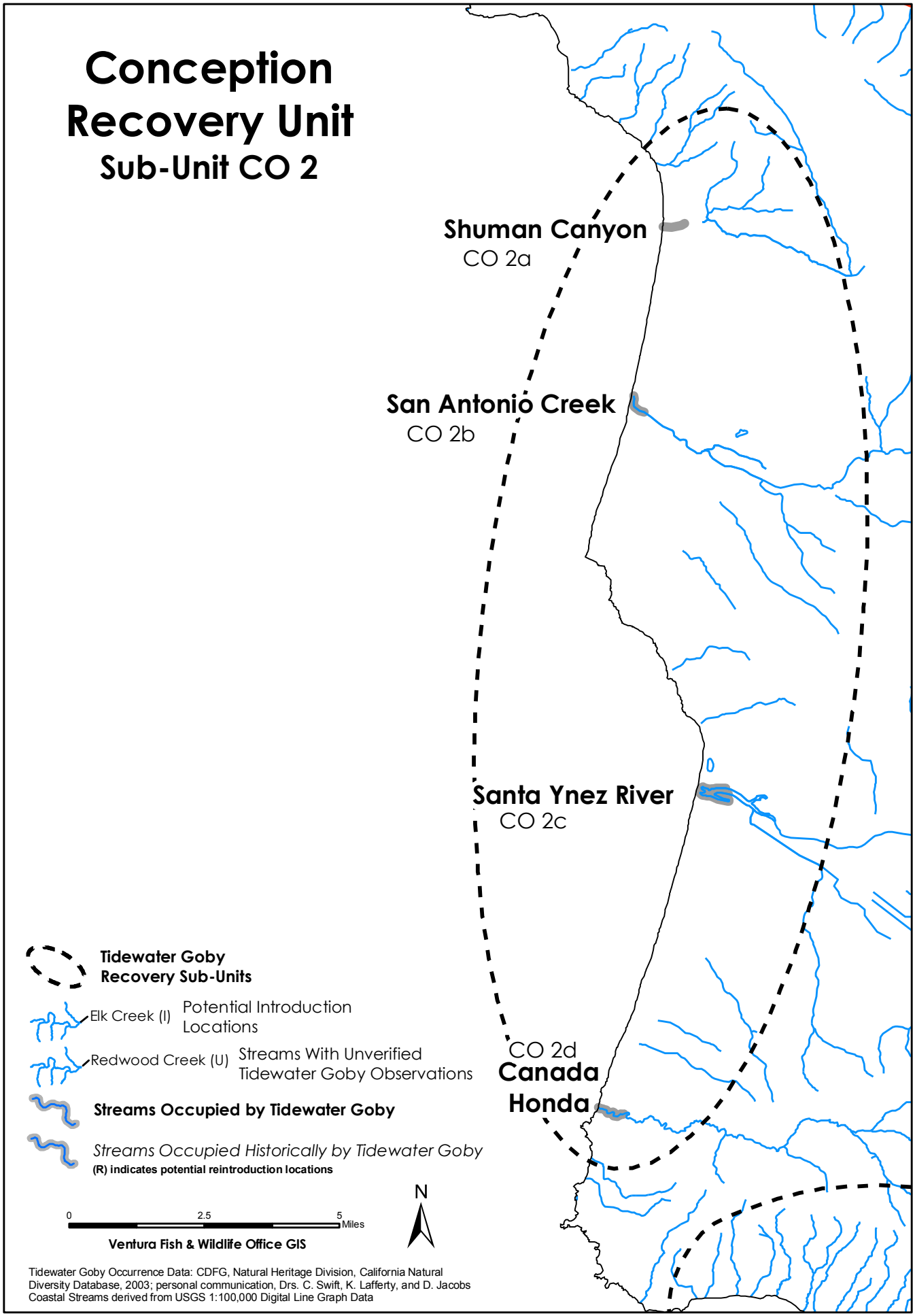

Figure B-14. Conception Recovery Unit, Sub-Unit CO 2

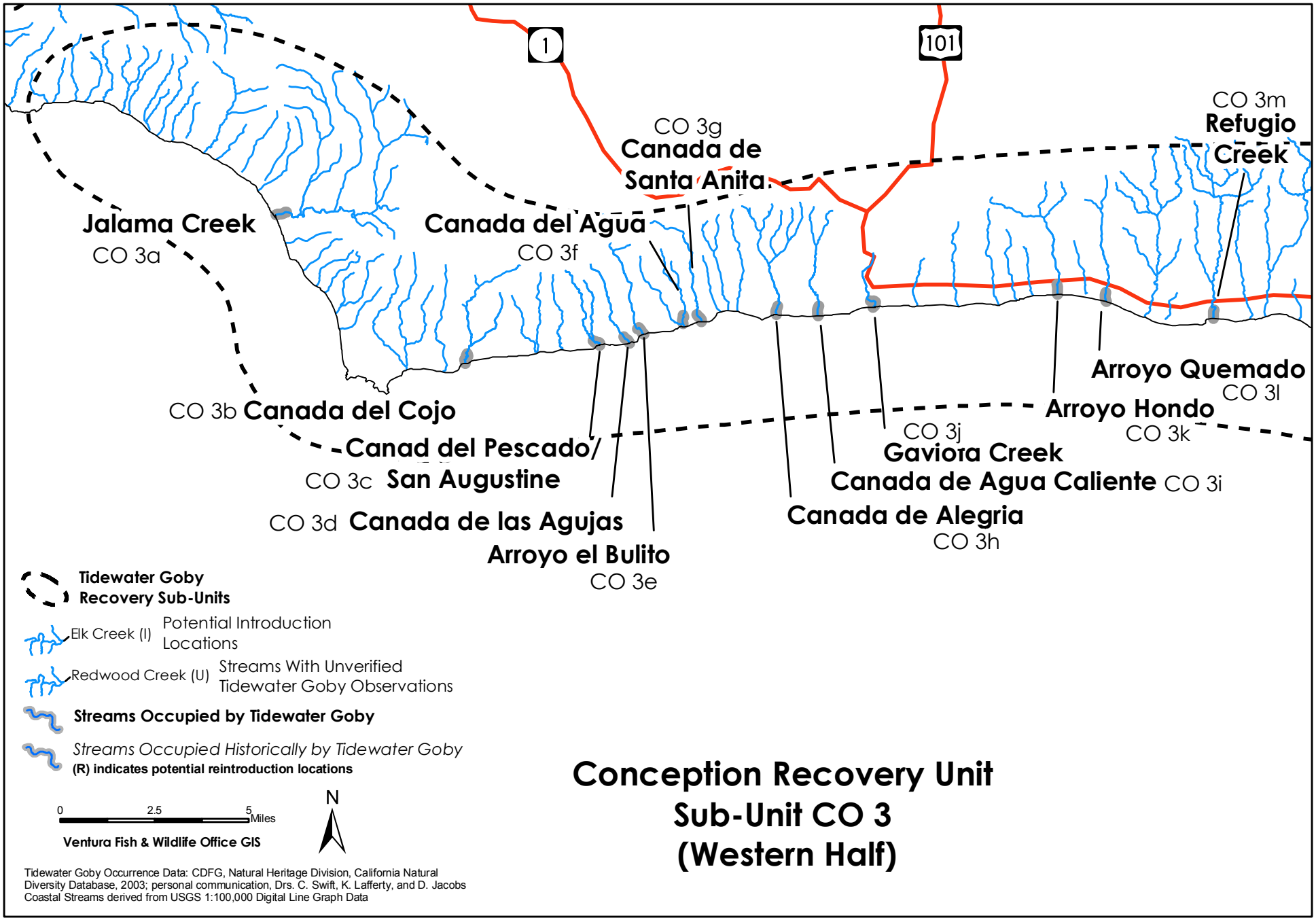

Figure B-15. Conception Recovery Unit, Sub-Unit CO 3 (Western Half)

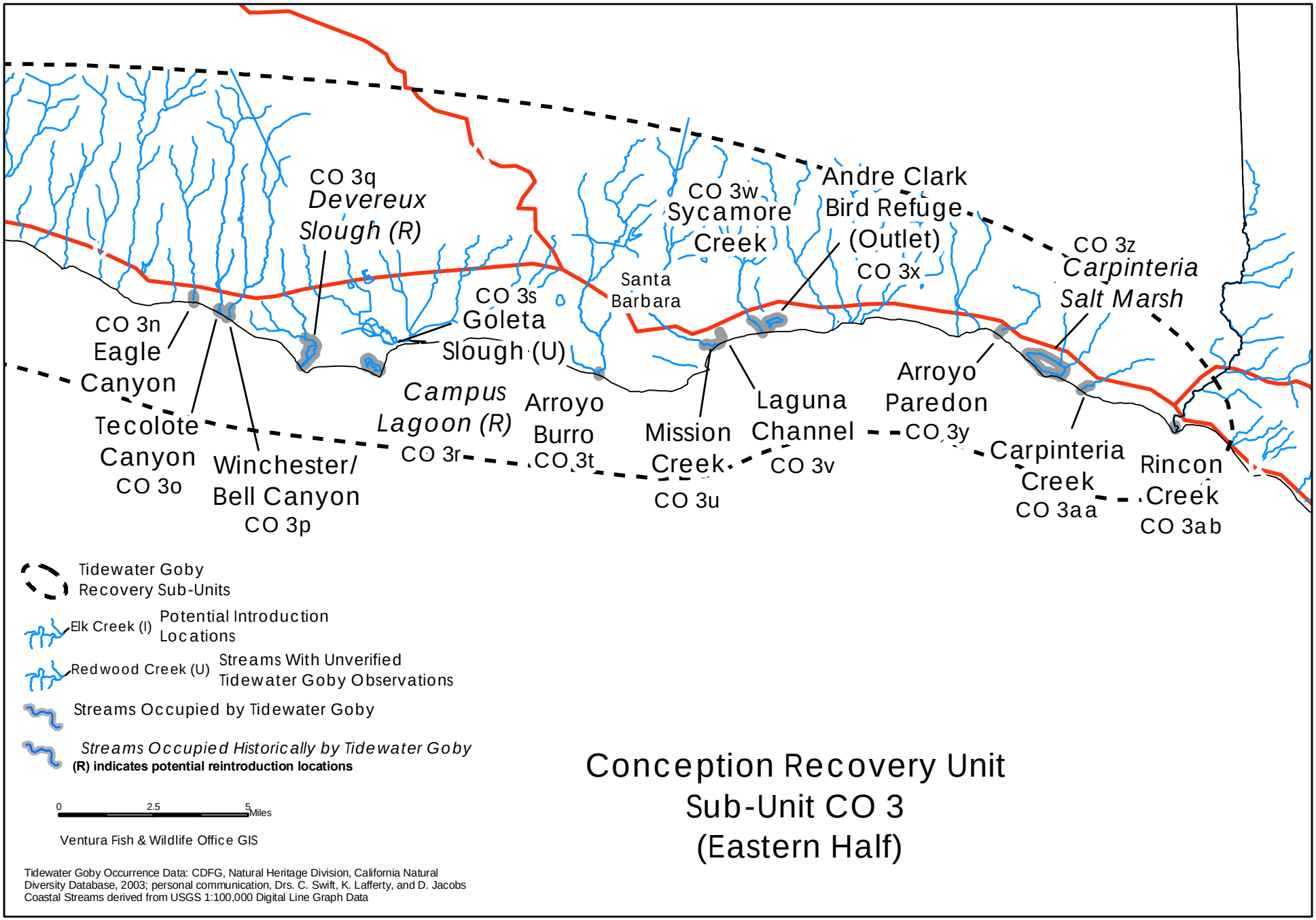

Figure B-16. Conception Recovery Unit, Sub-Unit CO 3 (Eastern Half)

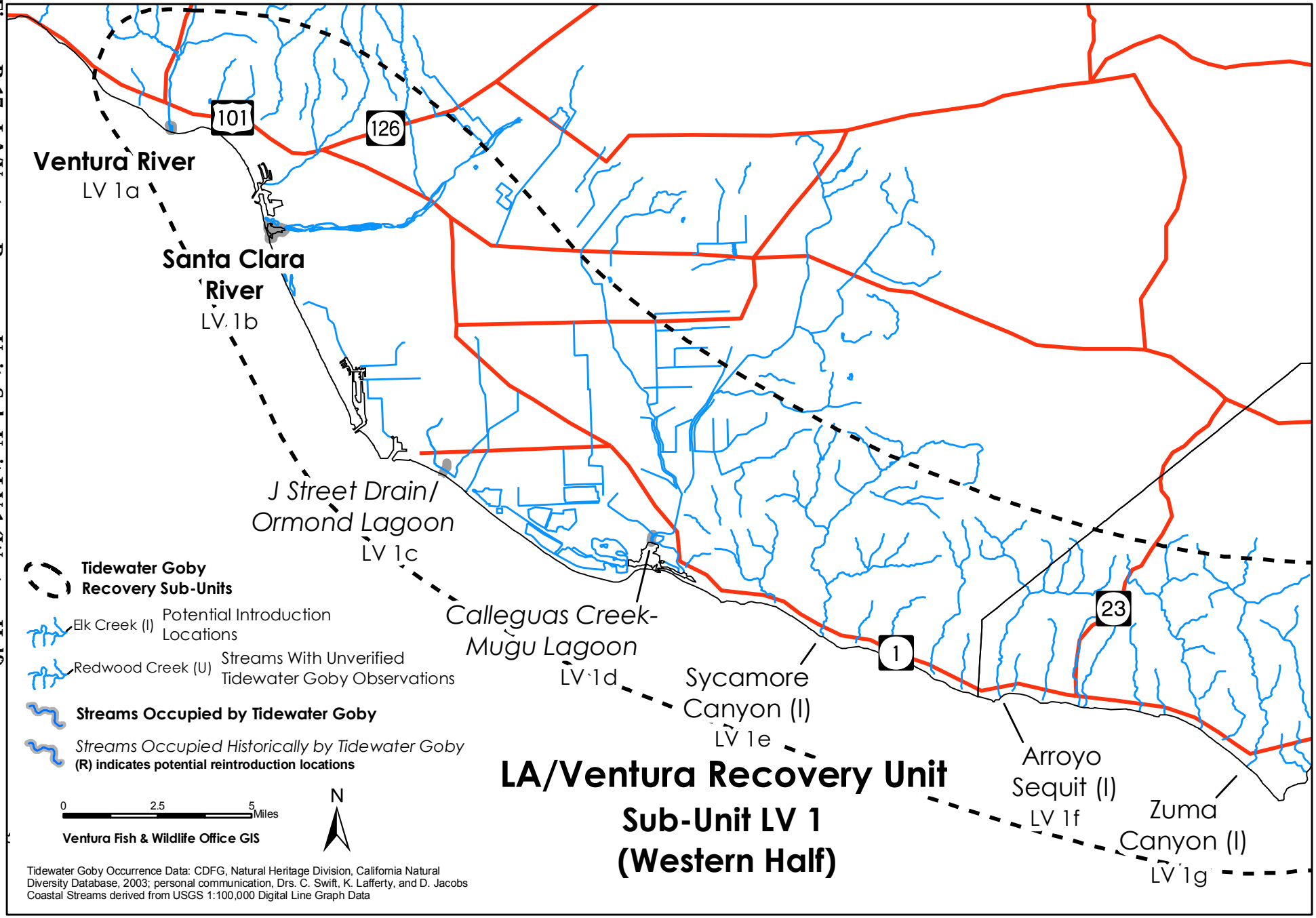

Figure B-17. LA/Ventura Recovery Unit, Sub-Unit LV 1 (Western Half)

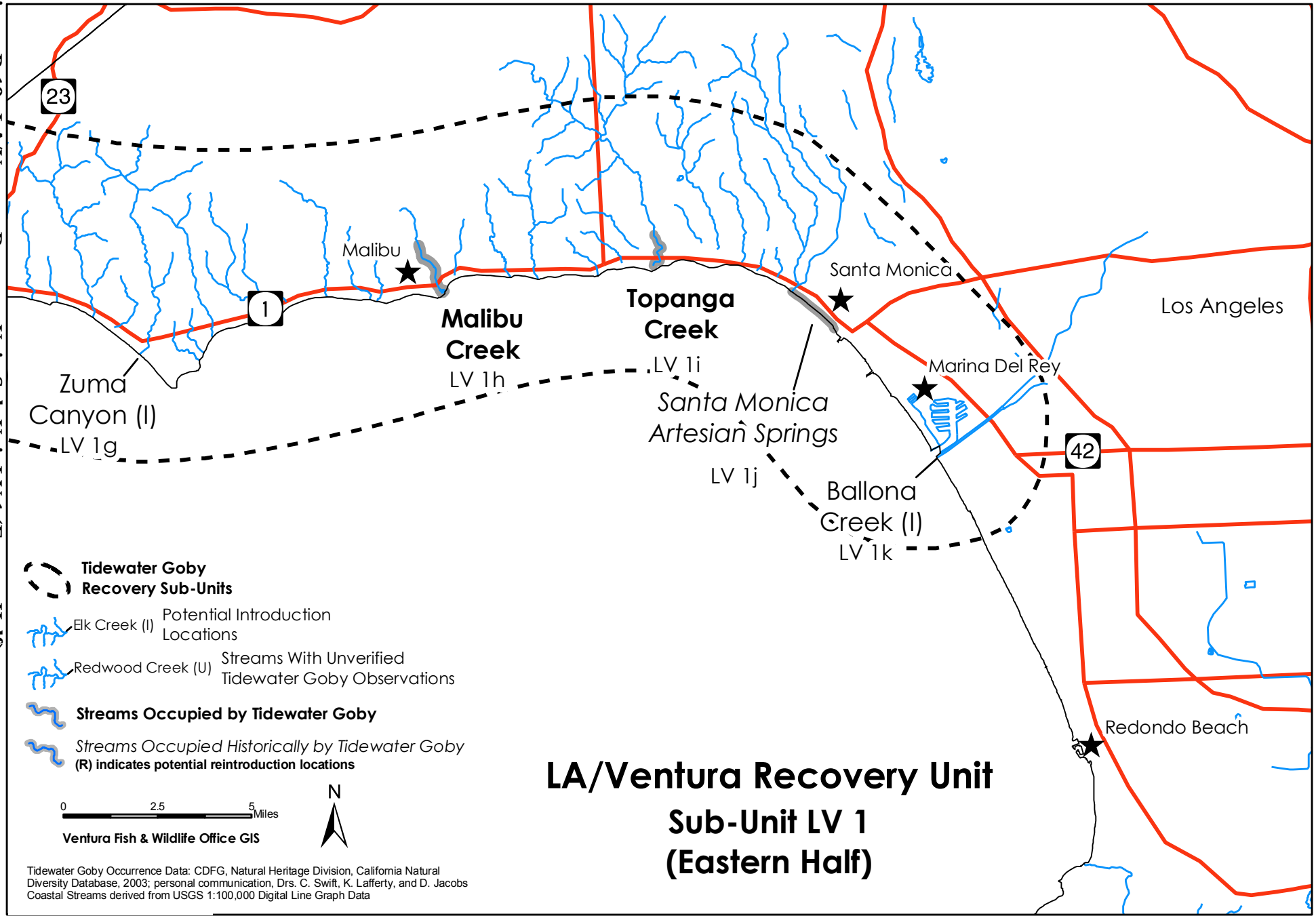

Figure B-18. LA/Ventura Recovery Unit, Sub-Unit LV 1 (Eastern Half)

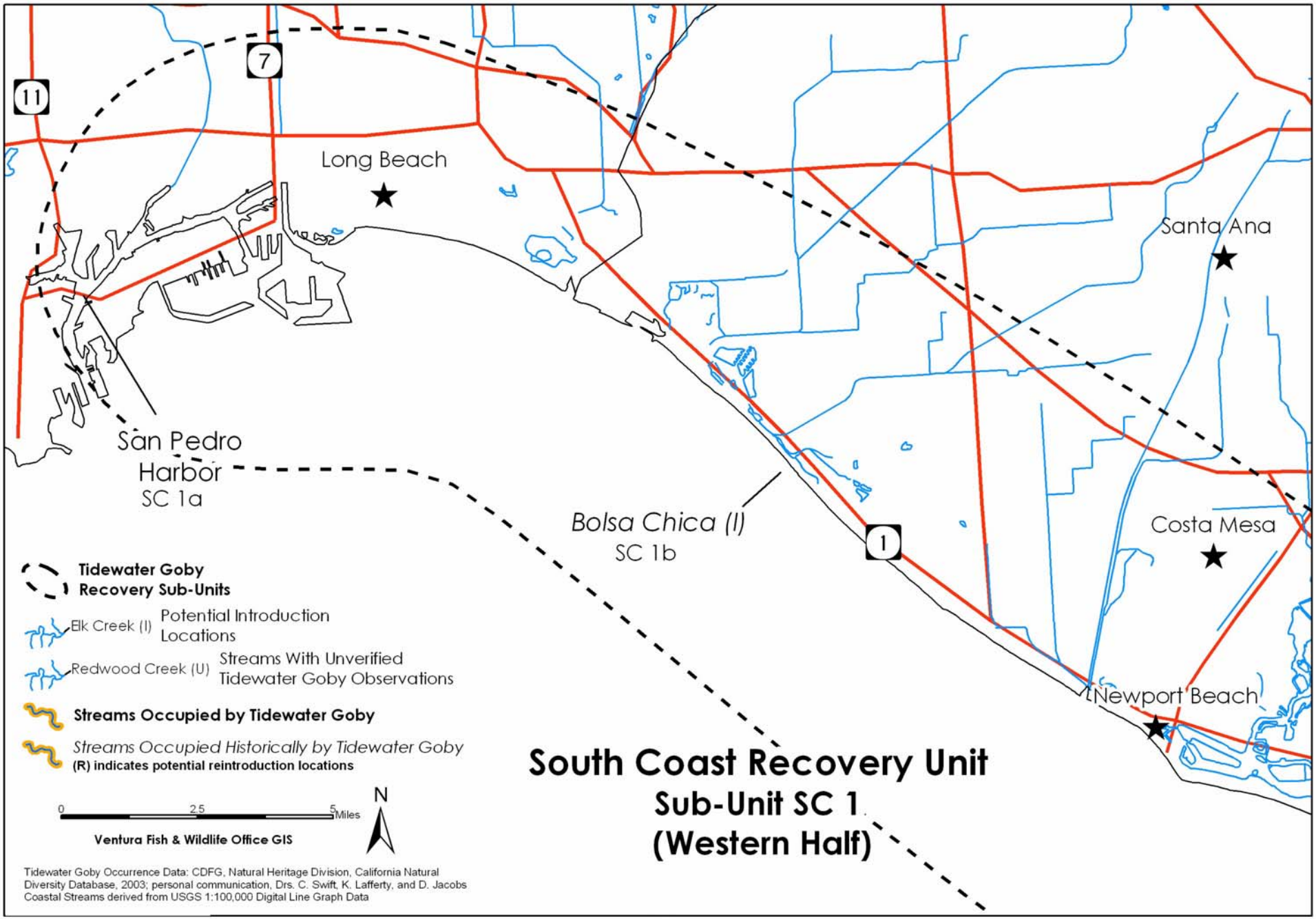

Figure B-19. South Coast Recovery Unit, Sub-Unit SC 1 (Western Half)

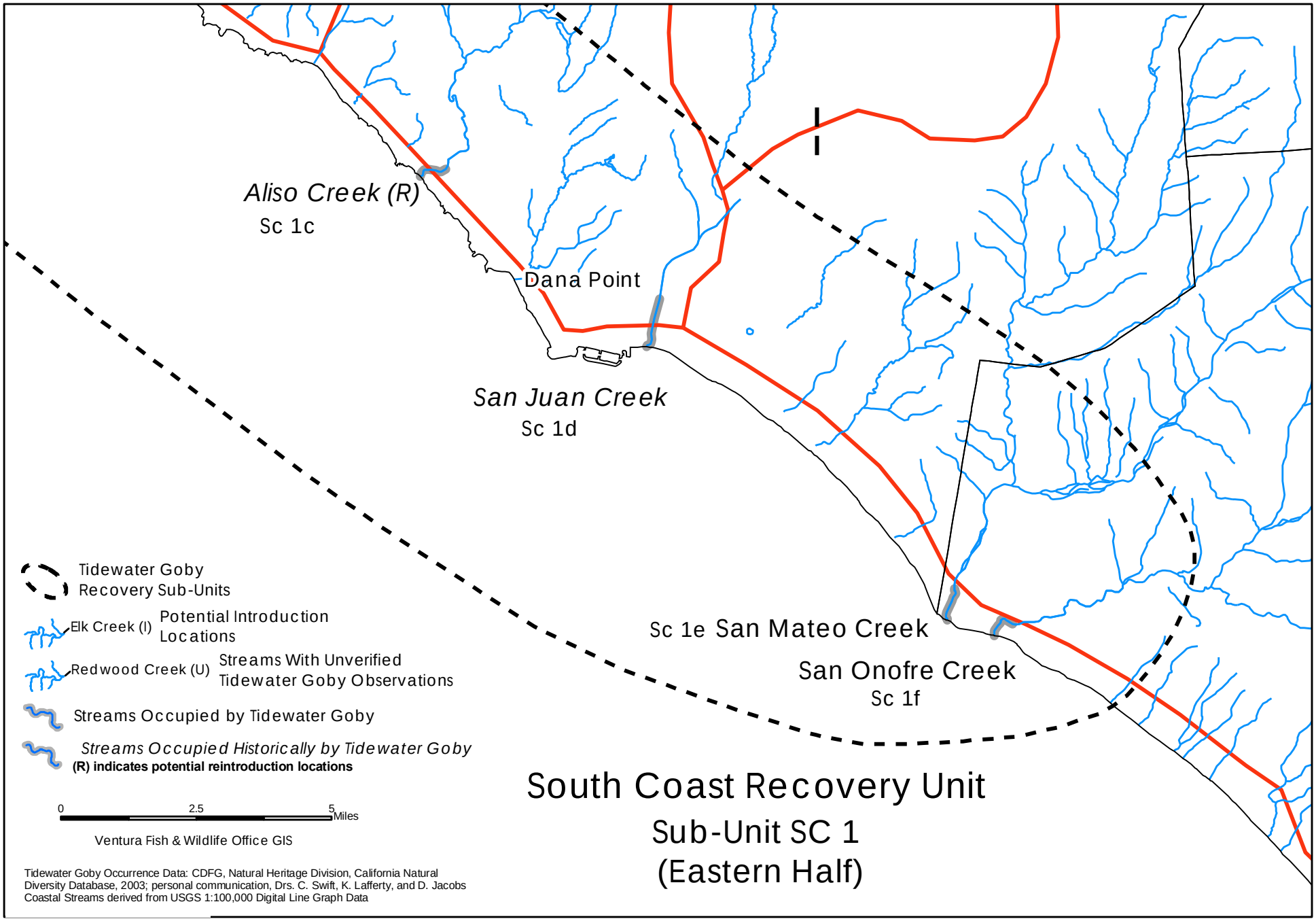

Figure B-20. South Coast Recovery Unit, Sub-Unit SC 1 (Eastern Half)

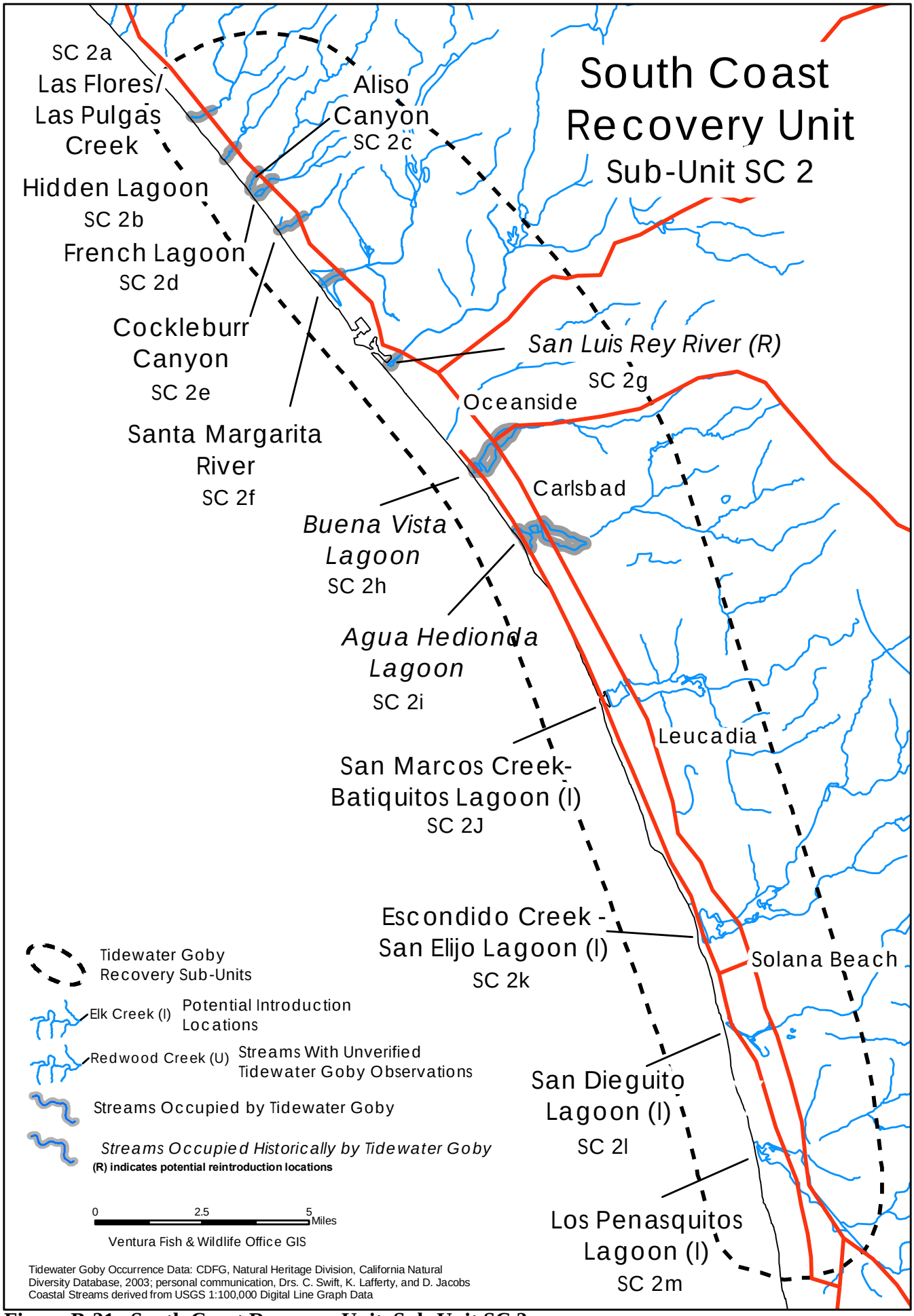

Figure B-21. South Coast Recovery Unit, Sub-Unit SC 2

Appendix C. Status of Recovery Sub-Units

This list of 149 localities is current to June 2004; all are represented on Figures B-1 to B-21 in Appendix B. This list includes 124 locations where tidewater gobies either occur or are known historically to have occurred, and 23 locations where tidewater gobies are not known to occur, but could potentially be introduced. More detailed original data are in Swift *et al*. (1989); additional data are given for new localities, or those that have changed. The localities are organized geographically in order from north to south, and are grouped by unit and Sub-Unit (*e.g.*, North Coast Unit, Sub-Unit NC 1). County names are included with the Sub-Unit headings and, as necessary, with specific localities. The localities are separated by distinctly marine habitats, usually open coastline of the Pacific Ocean or lower San Francisco Bay. Closely located tributaries in more estuarine situations, such as within Humboldt Bay, are treated as one locality. For each locality, we present the following information: 1) The surface area of the body of water, based on estimates from topographic sheets and notes taken during visits over the last 25 years, and based on a relatively high water mark at or near the maximum surface area within the relatively steep shores typical of the upper two-thirds or more of the lagoons at most localities, 2) land ownership, 3) the most recent year (for locations where tidewater gobies are known to occur) when tidewater gobies were collected or observed to be present or absent, and 4) water quality description, based upon the State Water Resources Control Board's 2002 Clean Water Act Section 303(d) List of Water Quality Limited Segments.

NORTH COAST UNIT

Sub-Unit NC1 (Del Norte County)

Tillas Slough **-** The available tidewater goby habitat encompasses approximately 2 to 3 hectares (5 to 7.5 acres) minimum, but there may be as much as 200 hectares (500 acres) of habitat in the Smith River estuary. All land adjacent to Tillas Slough is privately owned. Tidewater gobies were collected in 1996 (C. Chamberlain, graduate student, Humboldt State University, pers. comm., 1996), and the species was considered common here in 1988. Tidewater gobies were collected in October 1999 by C. Swift (February 2000 recovery permit report). Tidewater gobies were not found there during a 2003 survey by G. Goldsmith. Threats at this site include pollution from pasture runoff, and disturbance/modification of drainage pattern. The area supporting tidewater gobies is small, and immediately down channel from a metal culvert crossing a trail/road with access to people staying at nearby lodging. Although connected to the Smith River estuary, this site is the only recorded location of tidewater gobies in the Smith River watershed. Tidewater gobies appear to be associated with the structure near the culvert, which has included a large root wad. The population is vulnerable to any catastrophic event in this small area that would alter water quality, stream flow regime, or connectivity to other habitats. An event such as dredging or filling the area, chemical spills, stream channelization could quickly extirpate the population. Tillas Slough and the Smith River estuary are not designated as "Water Quality Limited" by the State Water Resources Control Board.

Lake Earl/Lake Talawa **-** Lake Earl and Lake Talawa constitute two connected coastal lagoons that range in size from several hundred to a few thousand acres depending on the season, time

since breaching, and current water level. Much of this lagoon is within the Lake Earl Wildlife Area, managed by the California Department of Fish and Game, and a California State Parks. This site is also adjacent to Pacific Shores Association land development. Tidewater gobies are always present, possibly in the millions (C. Chamberlain, pers. comm. 1999). Tidewater gobies were collected during extensive surveys in 1999 by C. Page and in October 1999 by C. Swift (February 2000 recovery permit report). Gobies were also collected by G. Goldsmith and California Department of Fish and Game personnel in February 2002 and March 2003. Threats include artificial breaching of Lake Talawa, causing a rapid emptying of the lagoon which transports many thousands of gobies into the Pacific Ocean. Stranding of tidewater gobies within Lake Talawa and Lake Earl is well documented after breach events, as well as the presence of gobies at the breach site immediately prior to breaching. Despite annual breaching for several years, the population of gobies has recovered and persisted in these lagoons in large numbers. Lake Earl and Lake Talawa are not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Elk Creek* -** The available tidewater goby habitat encompasses approximately 0.4 hectare (1.0 acre). Elk Creek empties into Crescent City Harbor. This locality is entirely encompassed by private land. There are no historic tidewater goby records for this locality, which is a potential introduction site. Tidewater gobies were supposedly found by a Caltrans biologist; however, this account is undated and unsubstantiated. C. Page surveyed the site in May of 1999 with no detections. Tidewater gobies were not found during surveys in 2003 by G. Goldsmith. Threats include sedimentation from upstream development and local channelization and culverting. Elk Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Sub-Unit NC2 (Humboldt County)

***Redwood Creek Estuary, North Slough* -** The available tidewater goby habitat encompasses 1.0 to 4.0 hectares (2.5 to 10 acres). The site is managed by Redwood National and State Parks and private landowners. Tidewater gobies were collected February to December 1980 by T. Salamunovich (M.S. thesis, Humboldt State University). Collected specimens were deposited at Natural History Museum of Los Angeles County (LACM). Tidewater gobies have not been detected since 1980. Gobies were not found here in 1996 (D. Anderson, pers. comm. 2004), or in 1997 or 1998 (C. Chamberlain, pers. comm. 1998). Tidewater gobies are assumed extirpated here due to anoxic conditions in prior habitat, following a thorough search by D. Anderson that yielded no detections. Threats include channelization of Redwood Creek, separation of North Slough from main channel, and severe alteration of natural flood flow regime in slough and channel immediate upstream of slough. Redwood Creek is designated as "Water Quality Limited" by State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include sedimentation/siltation (range grazing, silviculture, restoration, residue management, logging road construction/maintenance, land development, removal of riparian* vegetation, streambank modification/destabilization, erosion/siltation, natural sources) and temperature (logging road construction/maintenance, removal of riparian vegetation, streambank modification/destabilization, erosion/siltation, natural sources, nonpoint source).

***Freshwater Lagoon* -** Total size of lagoon encompasses approximately 100 hectares (250 acres). Redwood National and State Parks controls about 10 percent of the area, Caltrans controls sand spit and highway separating Freshwater Lagoon from the ocean, with remaining area in private ownership. Tidewater gobies were last collected in 1951; none have been detected during several recent surveys. No tidewater gobies were collected in 1996 (C. Chamberlain, pers. comm. 1996). Threats include the elimination of the natural breaching cycle due to construction of State Route 101, and the introduction of centrarchids and salmonids for recreational fishing. The reestablishment and maintenance of tidewater goby populations within this lagoon in the future are unlikely due to the more or less permanently altered breaching regime, elimination of salt water intrusion into the former lagoon, and naturally reproducing populations of introduced predatory fishes. Freshwater Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Stone Lagoon* -** Total size encompasses approximately 270 to 300 hectares (675 to 750 acres). Dry Lagoon State Park controls about 60 percent of the area, with about 40 percent in private ownership. Tidewater gobies have always been present during past surveys, and were most recently collected in 1997 (C. Chamberlain, pers. comm. 1997) and in 2003 by G. Goldsmith (U.S. Fish and Wildlife Service). Threats include past history of planting coastal cutthroat trout, the possibility of a catastrophic chemical spill from adjacent State Route 101, and the potential future alteration of breaching regime. Stone Lagoon is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Big Lagoon* -** This locality is a large coastal lagoon, measuring 700 to 800 hectares (1750 to 2000 acres). Big Lagoon County Park controls about 5 percent, Big Lagoon Rancheria about 5 percent, Dry Lagoon State Park about 30 percent; the remaining is private or corporate ownership. Tidewater gobies were detected during surveys in 2004 by G. Goldsmith. Threats include native salmonids, and potential threats include nonnative predatory fish and amphibians. Big Lagoon is not designated as "Water Quality Limited" by the State Water Resources Control Board.

<u>Sub-Unit NC3</u> (Humboldt County)

***Northern Arcata Bay* (*Humboldt Bay*) -** This locality encompasses approximately 200 to 400 hectares (500 to 1000 acres), included in several small lagoons and estuaries of coastal streams. About 20 percent owned by the City of Eureka, 30 percent by the City of Arcata, and 50 percent private. A tidewater goby observation was recorded in 1982 for Arcata Marsh/Klopp Lake (Humboldt State University Fisheries Museum). No tidewater gobies were found in surveys of Arcata Marsh, Mad River Slough, and Freshwater Slough in Humboldt Bay in 1996, but they were found in Jacoby Creek, a tributary to Arcata Bay, (C. Chamberlain, pers. comm. 1996), (G. Goldsmith, 2003). Tidewater gobies also have been found in Liscom Slough, a tributary to Mad River Slough, collected October 1999 by C. Swift (Feb. 2000 recovery permit report), report of collection from Liscom Slough by C. Swift, 2001. Tidewater gobies were not found in Liscom Slough during a survey by G. Goldsmith (U.S. Fish and Wildlife Service) in 2003. Surveys conducted by G. Goldsmith in ditches tributary to Eureka Slough, 2001, and in Butchers Slough (lower Jolly Giant Creek), 2002 found no tidewater gobies in those small sites. Threats at numerous sites with suitable habitat in Humboldt Bay include operation of tide gates to control

water flow, grazing, oil spill contamination, contamination from adjacent paper and lumber mill sites, highway construction and maintenance, alteration of stream flood flows, and possibly sedimentation. Humboldt Bay is designated as "Water Quality Limited" by State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include PCBs (source unknown).

Eel River **-** The available tidewater goby habitat encompasses approximately 22 hectares (55 acres). This location is owned by the California Department of Fish and Game, as part of the Eel River Wildlife Area. The Eel River delta is designated as "Water Quality Limited" by State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include sedimentation/siltation (range grazing, silviculture, nonpoint source) and temperature (removal of riparian vegetation, nonpoint source).

<u>Sub-Unit NC4</u> (Mendocino County)

Ten Mile River **-** The available tidewater goby habitat encompasses approximately 30 to 50 hectares (75 to 100 acres). This locality is all privately owned, except for highway right-of-way and small portion of State parks. Tidewater gobies were collected in 1997 (C. Chamberlain, pers. comm. 1997), October 1999 by C. Swift (February 2000 recovery permit report), and in 2003 (G. Goldsmith, U.S. Fish and Wildlife Service). Threats include highway construction and maintenance, dry season artificial breaching, and potential chemical contamination from highway accidental spills. Ten Mile River is designated as "Water Quality Limited" by State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include sedimentation/siltation (silviculture, road construction and maintenance) and temperature (habitat modification, removal of riparian vegetation, nonpoint source).

<u>Sub-Unit NC5</u> (Mendocino County)

Virgin Creek **-** The available tidewater goby habitat encompasses approximately 0.5 to 0.7 hectare (1.2 to 1.7 acres). The coastal one-third portion of this locality lies within McKerricher State Beach. There are several small residential property owners directly above State land adjacent to the creek. Tidewater gobies collected there in 1996 by California Department of Fish and Game, in October 1999 by C. Swift (pers. comm. and recovery permit report), and in 2003 by G. Goldsmith. Threats include highway construction and maintenance, sewage contamination, residential development. Virgin Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Pudding Creek **-** The available tidewater goby habitat encompasses approximately 5 to 6 hectares (12.5 to 15 acres). About 45 percent of this locality occurs in McKerricher State Beach, 45 percent is managed by the City of Fort Bragg, and 10 percent is privately owned. Tidewater gobies were collected in 1997 (C. Chamberlain, pers. comm. 1997), Jan. 1998 by C. Page, and in 2003 by G. Goldsmith. Threats include water diversion directly upstream of the State Route 1 bridge, highway construction and maintenance, development, and recreational use. Pudding Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Sub-Unit NC6 (Mendocino County)

Davis Pond/Lake Davis **-** The available tidewater goby habitat encompasses approximately 1.0 to 3.1 hectares (2.6 to 7.7 acres). This locality occurs approximately 1.0 miles north of Brush Creek, on the edge of Manchester State Park. Davis Pond is located approximately 250 feet south of Lake Davis, which is the terminus for an unnamed creek. Davis Pond is likely contiguous with Lake Davis during periods of high water levels. Tidewater gobies were found in Davis Pond in a July, 1996 survey (C. Chamberlain, pers. comm. 1997), and in 2003 by G. Goldsmith. Davis Pond is not designated as "Water Quality Limited" by the State Water Resources Control Board. Threats include exotic species; more research is needed at this locality to determine other potential threats.

Brush Creek **-** The available tidewater goby habitat encompasses approximately 0.2 to 0.5 hectare (0.5 to 1.2 acres). Approximately 75 percent of this locality occurs in Manchester State Beach and about 25 percent is privately owned. Tidewater gobies were last collected in 1990. No tidewater gobies were found in a July 1996 survey. Threats include highway construction and maintenance, and development. Brush Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Lagoon Creek **-** The available tidewater goby habitat encompasses approximately 20.5 hectares (50.6 acres). This locality occurs on privately owned land adjacent to Manchester Beach State Park, and is the terminus of Lagoon Creek, called Hunter's Lagoon. No tidewater gobies were found during sampling in 2003 by G. Goldsmith. Lagoon Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

GREATER BAY AREA UNIT

Sub-Unit GB1 (Sonoma County)

Marshall Gulch **-** The available tidewater goby habitat encompasses approximately 0.2 to 0.5 hectares (0.5 to 1.2 acres). There are no historic tidewater goby records for this locality, which is a potential introduction site. Exotic fish species are a threat to the tidewater goby at this location. Marshall Gulch is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Salmon Creek **-** The available tidewater goby habitat encompasses approximately 9 to 12 hectares (22.5 to 36 acres). Approximately 75 percent of this locality is owned by Sonoma Beach State Park, and the rest is privately owned. Habitat degradation resulting from sandbar breaching, water diversions, and groundwater pumping is a threat to the tidewater goby at this location. Tidewater gobies were collected here in October of 1999 (C. Swift February 2000 permit report). Salmon Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

<u>Sub-Unit GB2</u> (Sonoma and Marin Counties)

Johnson Gulch - (Sonoma County) The available tidewater goby habitat encompasses approximately 0.2 to 0.5 hectare (0.5 to 1.2 acres). There are no historic tidewater goby records for this locality, which is a potential introduction site. Johnson Gulch is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Cheney Gulch - (Sonoma County) The available tidewater goby habitat encompasses approximately 2 to 5 hectares (5 to 10 acres). Approximately 90 percent of this locality occurs in Doran County Park, and the rest is privately owned. Tidewater gobies were collected here in 1948, but were not found in 1996 (C. Chamberlain pers. comm. 1999). Cheney Gulch is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Estero Americano - (Marin County) The available tidewater goby habitat encompasses approximately 300 to 400 hectares (750 to 1000 acres). All of the adjacent lands are privately owned. Tidewater gobies were collected here in October of 1999 (C. Swift February 2000 permit report). The State Water Resources Control Board considers Estero Americano to be "Water Quality Limited" due to excess nutrients and sedimentation/siltation. The excess nutrients are due to by pasture grazing and riparian and upland manure ponds. The sedimentation/siltation is due to riparian and upland grazing, hydromodification, removal of riparian vegetation, streambank modification and destabilization, erosion and siltation, and nonpoint source runoff. The tidewater goby is also threatened by exotic fish species at this location.

Estero de San Antonio - (Marin County) The available tidewater goby habitat encompasses approximately 200 to 300 hectares (500 to 750 acres). All of the adjacent lands are privately owned. Tidewater gobies were collected here in 1997 (C. Chamberlain, pers. comm. 1997). The State Water Resources Control Board considers Estero de San Antonio to be "Water Quality Limited" due to excess nutrients and sedimentation. The excess nutrients are due to agriculture, irrigated crop production, riparian and upland pasture grazing, riparian range grazing, intensive animal feeding operations, concentrated animal feeding operations, agricultural runoff, land development, hydromodification, channelization, removal of riparian vegetation, streambank modification/destabilization, drainage and filling of wetlands, channel erosion, and natural sources. The sedimentation is due to agriculture, grazing, land development, erosion and siltation, and nonpoint sources. The tidewater goby is also threatened at this location by exotic fish species, habitat degradation due to sandbar breaching, water diversions, and groundwater pumping.

Walker Creek - The available tidewater goby habitat encompasses approximately 10 to 20 hectares (25 to 50 acres). All of the adjacent lands are privately owned. Tidewater gobies were collected here in 1897 (USNM 67297), but were not found in 1996 or 1999 (C. Chamberlain, pers. comm. 1999; C. Swift Feb. 2000 recovery permit report). The State Water Resources Control Board considers Walker Creek to be "Water Quality Limited" due to mercury from surface mining and mine tailings, and nutrients and sedimentation/siltation from agriculture. The TMDL ranges from 2,002 to 2,007.

<u>Sub-Unit GB3</u> (Marin County)

***Lagunitas* (*Papermill*) *Creek* -** The available tidewater goby habitat encompasses approximately 10 to 20 hectares (25 to 50 acres). All of the adjacent lands are privately owned. Tidewater gobies were collected here in 1953, but were not found in 1996 (C. Chamberlain pers. comm. 1999). Tidewater gobies were found in lower Tomasini Creek, a tributary of the Lagunitas Creek delta, during surveys in 2003 (C. Swift, pers. comm. 2004). The State Water Resources Control Board considers Lagunitas Creek to be "Water Quality Limited" due to excess nutrients, pathogens, and sedimentation/siltation due to agriculture, urban runoff, and storm sewers. The TMDL ranges from 2,002 to 2,007.

***Millerton Gulch* -** The available tidewater goby habitat encompasses approximately 1.0 to 3.0 hectares (2.5 to 7.4 acres). There are no historic tidewater goby records for this locality, which is a potential introduction site. Millerton Gulch is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Fish Hatchery Creek* -** The available tidewater goby habitat encompasses approximately 1.0 to 3.0 hectares (2.5 to 7.4 acres). There are no historic tidewater goby records for this locality, which is a potential introduction site. Fish Hatchery Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

<u>Sub-Unit GB4</u> (Marin, Alameda, Contra Costa, San Francisco and San Mateo Counties)

***Horseshoe Lagoon* -** (Marin County) The available tidewater goby habitat encompasses approximately 8 to 10 hectares (20 to 25 acres). There are no historic tidewater goby records for this locality, which is a potential introduction site. Horseshoe Lagoon is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Estero de Limantour* -** (Marin County) The available tidewater goby habitat encompasses approximately 40 to 121 hectares (100 to 300 acres). There are no historic tidewater goby records for this locality, which is a potential introduction site. Estero de Limantour is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Bolinas Lagoon* -** (Marin County) The available tidewater goby habitat encompasses approximately 240 hectares (593 acres). There are no historic tidewater goby records for this locality, which is a potential introduction site. Bolinas Lagoon is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Rodeo Lagoon* -** (Marin County) The available tidewater goby habitat encompasses approximately 15 to 20 hectares (37.5 to 50 acres) and is located entirely within the Golden Gate National Recreation Area. Tidewater gobies were collected here in October of 1999 (C. Swift February 2000 recovery permit report). Threats to the tidewater goby at this location include reduction or modification of habitat, and exotic fish species.

***Corte Madera Creek* -** (Marin County) The available tidewater goby habitat encompasses approximately 20 to 25 hectares (50 to 62.5 acres). Approximately 70 percent of the adjacent

lands are in public and private ownership in the City of Larkspur, 20 percent are owned by the College of Marin, and ownership of 10 percent is unknown. Tidewater gobies were collected here in 1961. The State Water Resources Control Board considers Corte Madera Creek to be "Water Quality Limited" due to the pesticide Diazinon. High Diazinon levels can cause water column toxicity. Diazinon is applied by homeowners principally in the late spring and early summer, and enters Corte Madera Creek with urban runoff and through storm sewers.

***Mill Creek* -** (Marin County) The available tidewater goby habitat encompasses approximately 0.2 to 0.5 hectare (0.5 to 1.2 acres). There are no historic tidewater goby records for this locality, which is a potential introduction site. Mill Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Novato Creek* -** (Marin County) The available tidewater goby habitat encompasses approximately 10 to 20 hectares (25 to 50 acres) and is located mostly in the City of Novato. Tidewater gobies were collected here in 1945. Recent survey data for tidewater gobies at this locality are not available. The State Water Resources Control Board considers Novato Creek to be "Water Quality Limited" due to the pesticide Diazinon. High Diazinon levels can cause water column toxicity. Diazinon is applied by homeowners principally in the late spring and early summer, and enters Novato Creek with urban runoff and through storm sewers. Tidewater gobies were collected here in 1945.

***Petaluma River* -** (Marin County) The available tidewater goby habitat encompasses approximately 30 to 40 hectares (75 to 100 acres) and is located mostly in the City of Petaluma. The only collection of tidewater gobies was by E. Samuels, before 1857, National Museum of Natural History (USNM) specimen 360. No tidewater gobies were found during recent surveys for a flood control project near Washington and Lynch Creeks (B. Cox, fishery biologist, pers. comm. 2004). Petaluma River is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Strawberry Creek* -** (Alameda County) The available tidewater goby habitat encompasses approximately 3 to 5 hectares (7.5 to 10 acres) and is located in the City of Berkeley. Tidewater gobies were collected here in 1950. Recent survey data for tidewater gobies at this locality are not available. Strawberry Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Lake Merrit* -** (Alameda County) The available tidewater goby habitat encompasses approximately 64.8 hectares (160 acres). This locality occurs within the City or Oakland. Recent survey data for tidewater gobies at this locality are not available. The State Water Resources Control Board considers Lake Merrit to be "Water Quality Limited" due to low dissolved oxygen, organic enrichment, and trash from urban runoff and storm sewers.

***Cliff House* (*Sutro Baths*) -** (San Francisco County) The available tidewater goby habitat encompasses approximately 0.2 hectare (0.5 acre). This locality is Federally owned and managed by the National Park Service. No tidewater gobies were found during surveys here in 2003 (M. McGowan, pers. comm. 2004). Sutro Baths is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Lake Merced **-** (San Francisco County) The available tidewater goby habitat encompasses approximately 200 to 300 hectares (500 to 750 acres) and is located within the City and County of San Francisco. Two golf courses occur adjacent to this locality. Tidewater gobies were collected here in 1895. No recent survey data are available, but M. McGowan (Associate Professor, California State University, San Francisco) is initiating a fish study at this locality (M. McGowan, pers. comm. 2004). The State Water Resources Control Board considers Lake Merced to be "Water Quality Limited" due to low dissolved oxygen and pH.

Laguna Salada **-** (San Mateo County) The available tidewater goby habitat encompasses approximately 5.0 hectares (12.3 acres). This locality occurs adjacent to a golf course. There are no historic tidewater goby records for this locality, which is a potential introduction site. Laguna Salada is not designated as "Water Quality Limited" by the State Water Resources Control Board.

San Pedro Creek **-** (San Mateo County) The available tidewater goby habitat encompasses approximately 0.2 to 0.5 hectare (0.5 to 1.2 acres). There are no historic tidewater goby records for this locality, which is a potential introduction site. San Pedro Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

<u>Sub-Unit GB5</u> (San Mateo County)

San Gregorio Creek **-** The available tidewater goby habitat encompasses approximately 5 to 10 hectares (12.5 to 25 acres). Approximately 25 percent of this locality occurs within San Gregorio State Beach. The remaining adjacent lands are privately owned. Tidewater gobies were abundant here in 1995 through 1997 (J. Smith, pers. comm. 1998), August 1997 (J. Smith, APR for 1997, 1998), and October 1999 (C. Swift, pers. comm. 1999). The State Water Resources Control Board considers San Gregorio Creek to be "Water Quality Limited" due to the high coliform levels and sedimentation/siltation from nonpoint sources. The tidewater goby is also threatened at this location by sandbar breaching, stream channelization, and recreational activity in or in the vicinity of the lagoon.

Pompino Creek **-** The available tidewater goby habitat encompasses approximately 0.2 to 0.5 hectare (0.5 to 1.2 acres). The creek mouth occurs within Pompino State Beach. There are no historic tidewater goby records for this locality, which is a potential introduction site. Pompino Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Pescadero-Butano Creek **-** The available tidewater goby habitat encompasses in excess of 30 hectares (greater than 75 acres). Almost 100 percent of the habitat is located within the Pescadero State Beach and Pescadero Marsh Natural Preserve. Tidewater gobies were collected here in 1996 (J. Smith, pers. comm. 1998). The State Water Resources Control Board considers Pescadero Creek to be "Water Quality Limited" due to the sedimentation/siltation from nonpoint sources. The tidewater goby is also threatened at this location by sandbar breaching, encroaching development, and stream channelization.

***Bean Hollow Creek* (*Arroyo de Los Frijoles*) -** The available tidewater goby habitat encompasses approximately 1.5 to 2 hectares (3.75 to 5 acres). All of the adjacent lands are privately owned. Tidewater gobies were abundant here in 1996 (J. Smith, pers. comm. 1998). Threats to the tidewater goby at this location include vehicular or railroad contamination, water diversions, groundwater pumping, changes to the salinity regime, and reduction or modification of habitat. Bean Hollow Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

<u>Sub-Unit GB6</u> (Santa Cruz County)

***Waddell Creek* -** The available tidewater goby habitat encompasses approximately 5.0 to 7.0 hectares (10 to 17.5 acres). The north side of the lagoon is in Rancho del Oso State Park; the south side is privately owned. The original population was considered extirpated by Swift, *et al*. (1989), but tidewater gobies were re-introduced from 1991 through 1996 (from Scott Creek) by J. Smith (Associate Professor, San Jose State University). Tidewater gobies were present but in low numbers in 1996 (J. Smith, pers. comm. 1996), and were absent during surveys from 1997 to 2000 (J. Smith, pers. comm. 2004). Waddell Creek is designated as "Water Quality Limited" by State Water Resources Control Board. Pollutants and stressors include nutrients, potentially from municipal point sources.

***Scott Creek* -** The available tidewater goby habitat encompasses approximately 4.0 hectares (10 acres). Scott Creek bisects the Swanton Pacific Ranch, owned by California Polytechnic State University, San Luis Obispo. The creek dried to low levels in the early 1990's, but the fresh or brackish pond to the south has been considered a refuge during floods and drought. Tidewater gobies were not found during limited sampling in 1996, in either the lagoon or pond, and their status was described as uncertain (J. Smith, Biology Department, pers. comm. 1996). Tidewater gobies were present during surveys in 2003 (J. Smith, pers. comm. 2004). Scott Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Laguna Creek* -** The available tidewater goby habitat encompasses approximately 1.0 to 1.5 hectares (2.5 to 3.75 acres). Ownership at the estuary is private but committed to California Department of Parks and Recreation (State Parks). State Parks owns the creek on the east side of Highway 1, upstream of the estuary. Limited farming occurs on adjacent land. Laguna Creek was dry during the 1988-92 droughts and the tidewater goby population here was considered extirpated. However, tidewater gobies were found here in 1996 (J. Smith, pers. comm. 1996). Tidewater gobies were present during surveys in 2000 (J. Smith, pers. comm. 2004). Laguna Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

<u>Sub-Unit GB7</u> (Santa Cruz County)

***Baldwin Creek* -** The available tidewater goby habitat encompasses approximately 0.7 to 1.0 hectare (1.75 to 2.5 acres). Wilder Ranch State Park owns the creek and estuary; limited cattle grazing still occurs upstream of the estuary. J. Smith collected tidewater gobies in two freshwater ponds upstream of the lagoon that connect with the creek (J. Smith, pers. comm. 1996). Tidewater gobies were present during surveys in 2004 (J. Smith, pers. comm. 2004).

Baldwin Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Lombardi Creek **-** The available tidewater goby habitat encompasses approximately 0.2 hectare (0.49 acre). State Parks (Wilder Ranch State Park) owns the creek and estuary; limited cattle grazing still occurs upstream of the estuary. Tidewater gobies were present during surveys in 2002 (J. Smith, pers. comm. 2004). Lombardi Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Old Dairy Creek **-** The available tidewater goby habitat encompasses approximately 0.4 hectare (1 acre). The creek mouth occurs within Wilder Ranch State Park. A small population was found here during surveys in 2003 (J. Smith, pers. comm. 2004). Old Dairy Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Wilder Creek **-** The available tidewater goby habitat encompasses approximately 1.5 to 2.5 hectares (3.7 to 6.2 acres). Wilder Ranch State Park owns the creek and estuary; limited cattle grazing still occurs upstream of the estuary. Tidewater gobies were present during surveys in 2000 (J. Smith, pers. comm. 2004). Wilder Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Younger Lagoon **-** The available tidewater goby habitat encompasses approximately 6 to 8 hectares (15 to 20 acres). Younger Lagoon Reserve was accepted as a reserve in the University of California Natural Reserve System in 1986. The lagoon is located adjacent to the Long Marine Lab, managed by the University of California, Santa Cruz. Tidewater gobies were present during surveys in 2004 (C. Swift, pers. comm. 2004). Younger Lagoon is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Moore Creek **-** The available tidewater goby habitat encompasses approximately 0.3 to 0.7 hectare (0.75 to 1.7 acres). State Parks (Natural Bridges State Beach) owns the creek mouth. Portions of the creek drainage upstream include Moore Creek Preserve (246 acres), a City of Santa Cruz park, and University of California, Santa Cruz property. Antonelli's pond, upstream of the lagoon, captures most of the runoff in drought years. The tidewater goby population at Moore Creek mouth was considered extirpated during the drought of the late 1980's. However, tidewater gobies were again collected in 1992 and 1996 by Dr. Jerry Smith (J. Smith, pers. comm. 1996). Tidewater gobies were present during surveys in 2000 (J. Smith, pers. comm. 2004). Moore Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

<u>Sub-Unit GB8</u> (Santa Cruz County)

San Lorenzo River **-** The available tidewater goby habitat encompasses approximately 26.7 hectares (66 acres). The river flows through the City of Santa Cruz, and drains into Santa Cruz Harbor. City beaches are adjacent to the lagoon. C. Swift and G. Kittleson observed tidewater gobies at this locality for the first time on May 11, 2004, during seining for a fish relocation effort associated with a U.S. Army Corps of Engineers project (Riverbend Project)(G. Kittleson, pers. comm. 2004). The San Lorenzo River Lagoon is designated as "Water Quality Limited" by

State Water Resources Control Board. Pollutants and stressors in the San Lorenzo River Lagoon include pathogens; potential sources of stressors include urban runoff/storm sewers, and natural sources.

Corcoran Lagoon **-** The available tidewater goby habitat encompasses approximately 6 to 8 hectares (15 to 20 acres). Twin Lakes State Beach comprises approximately 10 to 20 percent of land adjacent to the lagoon; the remaining adjacent land is owned by the community of Twin Lakes. Tidewater gobies were present during surveys in 2000 (J. Smith, pers. comm. 2004). Corcoran Lagoon is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Moran Lake **-** The available tidewater goby habitat encompasses approximately 2 to 2.5 hectares (5 to 6 acres). This locality occurs within a 9.2 acre regional park (Moran Lake Park). The adjacent "26th Avenue Beach" is owned by Santa Cruz County, and private homes are adjacent to the beach and park. Tidewater gobies were not present during surveys in 2000, but were present in 2001, and it is possible that gobies from Corcoran Lagoon recolonized Moran Lake (J. Smith, pers. comm. 2004). Moran Lake is not designated as "Water Quality Limited" by the State Water Resources Control Board.

<u>Sub-Unit GB9</u> (Santa Cruz County)

Soquel Creek **-** The available tidewater goby habitat encompasses approximately 2 to 3 hectares (5 to 7.5 acres). This locality occurs in the City of Capitola. Tidewater gobies were discovered here by J. Smith in late 1980's and intermittently collected by J. Smith and Don Alley (consultant in Santa Cruz). Tidewater gobies were present during surveys in 1992, and absent during surveys in 1994; tidewater gobies here may recolonize from Corcoran Lagoon (J. Smith, pers. comm. 2004). One individual tidewater goby was found during surveys in 1997, and no tidewater gobies were not found during subsequent surveys in 1998 through 2002 (Alley 2002). Soquel Creek is designated as "Water Quality Limited" by State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include: nutrients (septic disposal, nonpoint source); pathogens (urban runoff/storm sewers, natural sources nonpoint source); and sedimentation/siltation (construction/land development).

Aptos Creek **-** The available tidewater goby habitat encompasses approximately 2 to 3 hectares (5 to 7.5 acres). This locality occurs within the City of Capitola. Tidewater gobies were present during surveys in 1999 (C. Swift, pers. comm.). Aptos Creek is designated as "Water Quality Limited" by State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include pathogens (urban runoff/storm sewers), and sedimentation/siltation (disturbed sites through land development, and channel erosion).

<u>Sub-Unit GB10</u> (Santa Cruz and Monterey Counties)

Pajaro River **-** The available tidewater goby habitat encompasses approximately 50 to 60 hectares (125 to 150 acres), plus 10 hectares (25 acres) more if Watsonville Slough is included. Approximately 5 percent of this locality occurs in Sunset State Beach; the rest is privately owned. The Pajaro River occurs at the boundary Santa Cruz and Monterey Counties. Tidewater

gobies were assumed extirpated (Swift *et al.* 1989), but were rediscovered by J. Smith in 1991. The Pajaro River population was probably not extirpated, but was still present in the deeper portions of the lagoon and nearby Watsonville Slough where sampling is difficult (J. Smith, pers. comm. 1996). The Pajaro River is designated as "Water Quality Limited" by State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include nutrients (irrigated crop production, agricultural subsurface drainage, agricultural irrigation tailwater, agricultural return flows, urban runoff/storm sewers, wastewater, channelization, removal of riparian vegetation, nonpoint source) and sedimentation/siltation (agriculture, irrigated crop production, grazing, agricultural runoff, resource extraction, surface mining, hydromodification, channelization, habitat modification, removal of riparian vegetation, streambank modification/destabilization, channel erosion).

Sub-Unit GB11 (Monterey County)

Bennett Slough **-** The available tidewater goby habitat encompasses approximately 10 to 20 hectares (25 to 50 acres). Lands adjacent to this locality include the Moss Landing Wildlife Area, managed by the California Department of Fish and Game, and privately owned agricultural lands. Tidewater gobies were present during surveys in 1999 (C. Swift, pers. comm., 2004). Bennett Slough is not designated as "Water Quality Limited" by the State Water Resources Control Board. However, land use patterns adjacent to Bennett Slough are similar to those adjacent to nearby Moro Cojo Slough, which is designated as "Water Quality Limited" by State Water Resources Control Board. In Bennett Slough, pollutants and stressors and their respective potential sources could be similar to those described in Moro Cojo Slough, and include: low dissolved oxygen (source unknown); pesticides (agriculture, irrigated crop production, agricultural storm runoff, agriculture return flows, nonpoint source); and sedimentation/siltation (agriculture, irrigated crop production, agricultural storm runoff, nonpoint source).

Salinas River **-** The available tidewater goby habitat encompasses approximately 100 hectares (250 acres). Approximately 20 percent of the adjacent land is owned and managed by the Salinas National Wildlife Refuge; the remaining adjacent lands are privately owned. Tidewater gobies were last collected here in 1951. Gobies were not present during surveys in 1991 and 1992 (J. Smith, pers. comm. 2004). The Salinas River estuary is designated as "Water Quality Limited" by State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include: fecal coliform (past sewage discharge); pesticides (agriculture, irrigated crop production, agricultural storm runoff, agricultural irrigation tailwater, agricultural return flows, nonpoint source); nutrients (agriculture); salinity/chlorides (agriculture, natural sources, nonpoint source); and sedimentation/siltation (agriculture, irrigated crop production, range grazing-riparian and/or upland, agricultural storm runoff, road construction, land development, channel erosion, nonpoint source).

CENTRAL COAST UNIT

Sub-Unit CC1 (San Luis Obispo County)

Arroyo de la Cruz **-** The available tidewater goby habitat encompasses approximately 0.9 hectare (2.2 acres). This locality is privately owned. There are no historic tidewater goby records for

this locality, which is a potential introduction site. Arroyo de la Cruz is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Arroyo del Oso* -** The available tidewater goby habitat encompasses approximately 0.1 hectare (0.25 acre). This locality is privately owned by the Hearst Corporation. Upstream activities include horse and cattle ranching. Tidewater gobies were last collected here in 1988. Arroyo del Oso is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Arroyo de Corral* -** The available tidewater goby habitat encompasses approximately 1 to 2 hectares (2.5 to 5.0 acres). This locality is privately owned by the Hearst Corporation. Adjacent beaches will retain some type of public access as condition of a draft conservation easement and agreement with the American Land Conservancy. Upstream activities include horse and cattle ranching. Tidewater gobies were last collected here in 1995. Arroyo de Corral is not designated as "Water Quality Limited" by the State Water Resources Control Board.

<u>Sub-Unit CC2</u> (San Luis Obispo County)

***Oak Knoll Creek* (*Arroyo Laguna*) -** The available tidewater goby habitat encompasses approximately 4 to 5 hectares (10 to 12.5 acres). This locality is privately owned by the Hearst Corporation. Adjacent beaches will retain some type of public access as condition of a conservation easement. Upstream activities include horse and cattle ranching. Tidewater gobies were last collected in 1995. Oak Knoll Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Arroyo de Tortuga* -** The available tidewater goby habitat encompasses approximately 0.2 to 0.3 hectare (0.5 to 0.7 acre). This locality is privately owned by the Hearst Corporation. Tidewater gobies were last collected here in 1991. Arroyo de Tortuga is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Arroyo del Puerto* -** The available tidewater goby habitat encompasses approximately 0.5 to 1.0 hectare (1.2 to 2.5 acres). This locality is privately owned by the Hearst Corporation, and flows through the village of Old San Simeon. Tidewater gobies were last collected here in 1995. Arroyo del Puerto is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Broken Bridge Creek* -** The available tidewater goby habitat encompasses approximately 0.1 to 0.2 hectare (0.25 to 0.5 acre). This locality is privately owned by the Hearst Corporation. Tidewater gobies were last collected here in 1995. Broken Bridge Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Little Pico Creek* -** The available tidewater goby habitat encompasses approximately 0.2 to 0.5 hectare (0.5 to 1.2 acres). This locality is privately owned by the Hearst Corporation. Adjacent beaches will retain some type of public access as condition of a conservation easement. Tidewater gobies were last collected here in 1995. Little Pico Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Pico Creek **-** The available tidewater goby habitat encompasses approximately 1 to 1.5 hectares (2.5 to 3.7 acres). This locality is privately owned by the Hearst Corporation. Tidewater gobies were last collected here in 1995. Pico Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board. Development along this creek would be restricted, according to a draft conservation agreement with the American Land Conservancy.

San Simeon Creek **-** The available tidewater goby habitat encompasses approximately 2 to 3 hectares (5 to 7.5 acres). The creek mouth occurs within San Simeon State Park, and the Park borders approximately 1.5 miles of the creek upstream of the estuary. Tidewater gobies were last collected here in 2002 (Alley 2003). Tidewater gobies have been detected throughout the dry season, and the lagoon does not go dry during the summer (Alley 2003). San Simeon Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Leffingwell Creek **-** The available tidewater goby habitat encompasses approximately 0.1 hectare (0.25 acre) or less. The creek mouth occurs within San Simeon State Park. Upstream of the creek mouth, lands adjacent to the creek are privately owned. Tidewater gobies were last collected here in 1981. Leffingwell Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Santa Rosa Creek **-** The available tidewater goby habitat encompasses approximately 2 to 3 hectares (5 to 7.5 acres). The creek mouth occurs within San Simeon State Park, and within the Santa Rosa Creek Preserve, an area of approximately 40 acres that also includes riparian forests and coastal wetlands. Tidewater gobies could not be found here in the early 1990's, but were collected again in 1995, and 1998 through 2003 (Alley 2003). Poor rainfall seasons may result in the lower Santa Rosa Lagoon going completely dry. Additionally, tidewater goby populations may have been eliminated from this locality in the past, and re-colonized from San Simeon Creek (Alley 2003). D. Alley recommends re-establishment of riparian trees along the south side of Santa Rosa Creek to shade the Shamel Park pool. Santa Rosa Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

<u>Sub-Unit CC3</u> (San Luis Obispo County)

Villa Creek **-** The available tidewater goby habitat encompasses approximately 4 to 5 hectares (10 to 12.5 acres). Most of the land adjacent to the creek is privately owned. The Cayucos Land Conservancy has been granted a perpetual conservation easement over the Estero Bluffs, adjacent to and south of Villa Creek, and which stretch nearly four miles south to Cayucos Creek. Estero Bluffs is managed by the California Department of Parks and Recreation. Tidewater gobies were last collected here in 1995. Villa Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

San Geronimo Creek **-** The available tidewater goby habitat encompasses approximately 0.2 to 0.5 hectare (0.5 to 1.2 acres). The creek mouth occurs within Estero Bluffs, a conservation easement that is managed by the California Department of Parks and Recreation. Upstream of the creek mouth, lands adjacent to the creek are privately owned. The locality was discovered by Dan Holland in the late l980's. Tidewater gobies were last collected here in 1991. San

Geronimo Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Cayucos Creek **-** The available tidewater goby habitat encompasses approximately 0.8 to 1.5 hectares (2 to 1.2 acres). Most of the creek mouth occurs within Cayucos State Beach. Tidewater gobies were last collected here in 1995. Cayucos Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Little Cayucos Creek **-** The available tidewater goby habitat encompasses approximately 0.2 to 0.5 hectare (0.5 to 1.2 acres). Most of the creek mouth occurs within Cayucos State Beach. This locality was discovered by Dan Holland in the late 1980's. Tidewater gobies were last collected here in 1991. Little Cayucos Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Old Creek **-** The available tidewater goby habitat encompasses approximately 2 to 4 hectares (5 to 10 acres). The creek mouth occurs within Morro Strand State Beach. Upstream of the creek mouth, land adjacent to the creek is privately owned. This population of tidewater gobies was extirpated by largemouth bass in late 1980's (Dan Holland, Department of Biology, Southwestern Louisiana University, Monroe, pers. comm. 1992). Old Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Willow Creek **-** The available tidewater goby habitat encompasses approximately 0.2 to 0.5 hectares (0.5 to 1.2 acres). The creek mouth occurs within Morro Strand State Beach. Upstream of the creek mouth, land adjacent to the creek is privately owned. This locality was discovered by Dan Holland in the late 1980's, and tidewater gobies were last collected here in 1991. Willow Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Toro Creek **-** The available tidewater goby habitat encompasses approximately 0.1 to 0.2 hectare (0.25 to 0.5 acre). The creek mouth occurs within Morro Strand State Beach. Tidewater gobies were discovered here in 1995 by Ramona Swenson. Toro Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Morro Creek **-** The available tidewater goby habitat encompasses approximately 0.8 to 1.5 hectares (2 to 3.75 acres). The creek mouth occurs within Atascadero State Beach. Public and private owned in the City of Morro Bay. Record discovered after Swift *et al.* (1989). Tidewater gobies were last collected here in 1916 (Field Museum of Natural History, FMNH 9121). Morro Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Chorro Creek **-** The available tidewater goby habitat encompasses approximately 100 hectares (250 acres). This locality occurs in Morro Bay State Park and Morro Estuary Natural Preserve. Tidewater gobies have not been seen here since 1981 and may be extirpated. Chorro Creek was last surveyed in 1990-1991, and no tidewater gobies were found. Chorro Creek is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include: fecal coliform (source unknown); nutrients (municipal point sources, agriculture, irrigated crop production, agriculture-storm

runoff); and sedimentation/siltation (agriculture, irrigated crop production, grazing, construction/land development, road construction, resource extraction, hydromodification, channelization, streambank modification/destabilization, channel erosion, erosion/siltation, natural sources, golf course activities, nonpoint source).

***Los Osos Creek* -** The available tidewater goby habitat encompasses approximately 100 hectares (250 acres). This locality occurs in the Morro Estuary Natural Preserve. Tidewater gobies have not been seen here since 1981 and may be extirpated. Los Osos Creek is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include: fecal coliform (source unknown); low dissolved oxygen (agriculture, grazing, urban runoff/storm sewers, natural sources); nutrients (same as in above account for Chorro Creek); and sedimentation/siltation (same as in above account for Chorro Creek).

CONCEPTION UNIT

Sub-Unit CO1 (San Luis Obispo and Santa Barbara Counties)

***San Luis Obispo Creek* -** (San Luis Obispo County) The available tidewater goby habitat encompasses approximately 20 hectares (50 acres). Ownership at this locality includes the City of Avila Beach and private landowners. No tidewater gobies were collected from 1916 until 1989 to 1990, when T. Pafford found them abundant. Specimens occur in the Natural History Museum of Los Angeles County (LACM 44824-1). These were missed by many collectors that surveyed this area in the intervening years. Tidewater gobies were present during surveys in 1999 (C. Swift, pers. comm. 2004). San Luis Obispo Creek is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include nutrients (municipal point sources, agriculture, irrigated crop production, agricultural storm runoff) and pathogens (source unknown).

***Pismo* (*Price*) *Creek* -** (San Luis Obispo County) The available tidewater goby habitat encompasses approximately 3 to 5 hectares (7.5 to 10 acres). Approximately 25 percent of this locality occurs in Pismo State Beach; the remainder is privately owned and owned by the City of Pismo Beach. Tidewater gobies were present during surveys in 1999 (C. Swift, pers. comm. 2004). Pismo Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Arroyo Grande* -** (San Luis Obispo County) The available tidewater goby habitat encompasses approximately 3 to 5 hectares (7.5 to 10 acres). Threespine sticklebacks (*Gasterosteus aculeatus*) were observed in the portion of the creek within the city limits of Arroyo Grande (J. Shuler, California Department of Fish and Game, pers. obs. 1972). J. Shuler described Arroyo Grande as "slowly deteriorating as a steelhead stream." The water entering Arroyo Grande Creek comes from Lopez Lake (artificial), northeast of the town of Arroyo Grande. Arroyo Grande Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Oso Flaco Lagoon **-** (San Luis Obispo County) The available tidewater goby habitat encompasses approximately 3 to 5 hectares (7.5 to 10 acres). This locality occurs within the Guadalupe-Nipomo National Wildlife Refuge. Oso Flaco Lagoon is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include fecal coliform (source unknown) and nitrates (source unknown).

Santa Maria River **-** (Santa Barbara County) The available tidewater goby habitat encompasses approximately 30 to 50 hectares (75 to 100 acres). This locality occurs within the Guadalupe-Nipomo National Wildlife Refuge. Tidewater gobies were present during surveys in 1999 (C. Swift, pers. comm. 2004). The Santa Maria River is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include: fecal coliform (agriculture, pasture grazing [riparian and/or upland], urban runoff/storm sewers, natural sources), and nitrates (agriculture, pasture grazing [riparian and/or upland], urban runoff/storm sewers).

Sub-Unit CO2 (Santa Barbara County)

Shuman Creek **-** The available tidewater goby habitat encompasses approximately 0.6 to 1.0 hectare (1.5 to 2.5 acres). This locality is owned by Vandenberg Air Force Base. Tidewater gobies were present during surveys in 2001 (C. Swift, pers. comm. 2004). Shuman Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board. There are concerns by the U.S. Geological Survey about water-quality for the Shuman Creek basin, due to the potential effects of discharges from a private chemical landfill adjoining the Base's northern border.

San Antonio Creek **-** The available tidewater goby habitat encompasses approximately 2.0 to 3.0 hectares (4.9 to 7.4 acres). This locality is owned by Vandenberg Air Force Base. Tidewater gobies were present during surveys in 1999 (C. Swift, pers. comm. 2004). San Antonio Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Santa Ynez River **-** The available tidewater goby habitat encompasses approximately 300 hectares (750 acres). The mouth of the river occurs on Vandenberg Air Force Base. Tidewater gobies were present during surveys in 2002 (C. Swift, pers. comm. 2004). The Santa Ynez River is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include: nutrients (nonpoint source); salinity/chlorides (agriculture); and sedimentation/siltation (agriculture, urban runoff/storm sewers, resource extraction).

Cañada Honda **-** The available tidewater goby habitat encompasses approximately 0.1 to 0.2 hectare (0.2 to 0.5 acre). Cañada Honda is owned and managed by Vandenberg Air Force Base. C. Swift observed this site as just a trickle during the late 1980's and early 1990's with no tidewater gobies present; the creek's current size is larger. Tidewater gobies were present during surveys in 2001 (C. Swift, pers. comm. 2004). Cañada Honda Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

<u>Sub-Unit CO3</u> (Santa Barbara County)

Jalama Creek **-** The available tidewater goby habitat encompasses approximately 0.4 to l.2 hectares (0.8 to 3.0 acres). Approximately 80 to 90 percent of Jalama Creek is owned by Vandenberg Air Force Base, and approximately 10 to 20 percent is privately owned. Adjacent Jalama Beach is leased or its use permitted to Santa Barbara County Parks. Tidewater gobies were present during surveys in 2002 (C. Swift, pers. comm. 2004). The Pacific Ocean at Jalama Beach is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include fecal coliform (agriculture, pasture grazing (riparian and/or upland), natural sources, nonpoint source).

Cañada del Cojo **-** The available tidewater goby habitat encompasses approximately 0.2 to 0.7 hectare (0.5 to 1.75 acres). This locality is owned by the Bixby Ranch Company. No recent information on this locality and possible I category. Tidewater gobies were last collected here in 1987 (K. Lafferty, pers. comm. 1996). The creek at Cañada del Cojo is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Cañada del Pescado/San Augustine **-** The available tidewater goby habitat encompasses approximately 0.2 to 0.5 hectare (0.5 to 1.0 acre). Hollister Ranch. Tidewater gobies were last collected here in 1981. Two intermittent creeks at Arroyo San Augustine and Cañada del Pescado join upstream to form this locality. Neither of these creeks is designated as "Water Quality Limited by the State Water Resources Control Board.

Cañada de las Agujas **-** The available tidewater goby habitat encompasses approximately 0.2 to 0.5 hectare (0.5 to 1.0 acre). This locality is privately owned by the Hollister Ranch. Tidewater gobies were last collected here in 1989. No tidewater gobies were found during sampling in 1998 (K. Lafferty, pers. comm. 2004). Cañada de las Agujas Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Arroyo El Bulito **-** The available tidewater goby habitat encompasses approximately 0.5 to 1.0 hectare (1.2 to 2.5 acres). This locality is privately owned by the Hollister Ranch. Tidewater gobies were last collected here in 1995. No tidewater gobies were found during sampling in 1998 (K. Lafferty, pers. comm. 2004). Arroyo El Bulito is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Cañada del Agua **-** The available tidewater goby habitat encompasses approximately 0.2 to 0.5 hectare (0.5 to 1.0 acres). This locality is owned by the Hollister Ranch. Tidewater gobies were last collected here in 1981. Two intermittent creeks at Cañada de las Panoches and Cañada del Agua join upstream to form this locality. Neither of these creeks is designated as "Water Quality Limited" by the State Water Resources Control Board.

Cañada de Santa Anita **-** The available tidewater goby habitat encompasses approximately 2 to 3 hectares (5 to 7.5 acres). This locality is owned by the Hollister Ranch. Tidewater gobies were last collected here in 1998 (K. Lafferty, pers. comm. 2004). Cañada de Santa Anita Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Cañada de Alegria **-** The available tidewater goby habitat encompasses approximately 0.2 to 0.5 hectare (0.5 to 1.0 acre). This locality is owned by the Hollister Ranch. Tidewater gobies were last collected here in 1998 (K. Lafferty, pers. comm. 2004). Cañada de Alegria Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Cañada de Agua Caliente **-** The available tidewater goby habitat encompasses approximately 0.2 to 0.5 hectare (0.5 to 1.2 acres). This locality is owned by the Hollister Ranch. Tidewater gobies were last collected here in 1998 (K. Lafferty, pers. comm. 2004). Cañada de Agua Caliente is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Gaviota Creek **-** The available tidewater goby habitat encompasses approximately 5 to 8 hectares (12.5 to 20 acres). This locality is owned and managed by Gaviota Creek State Park. Tidewater gobies were last collected here in 1999 (C. Swift, pers. comm. 2004). The Pacific Ocean at Gaviota Beach (mouth of Cañada de la Gaviota Creek) is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include coliform (source unknown).

Arroyo Hondo **-** The available tidewater goby habitat encompasses approximately 0.1 to 0.3 hectare (0.2 to 0.7 acre). This locality is privately owned. No tidewater gobies were found during sampling in 1995 (K. Lafferty, pers. comm. 2004). Tidewater gobies were present during surveys in 2003 (C. Swift, pers. comm., 2004). Arroyo Hondo is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Arroyo Quemado **-** The available tidewater goby habitat encompasses approximately 0.2 to 0.4 hectare (0.5 to 1.0 acre). Arroyo Quemado Creek flows through County-owned agricultural (orchards) land. The lower portion of the watershed is developed with private residences of the beachside Arroyo Quemada community. Tidewater gobies were last collected here in 1986. No tidewater gobies were found during sampling in 1989 (K. Lafferty, pers. comm. 2004). Arroyo Quemado is not designated as "Water Quality Limited" by the State Water Resources Control Board. A study conducted by the Santa Barbara County Public Health Department (*Bacteria Source Study for the Lower Arroyo Quemado Creek Watershed*) in the spring of 2001 showed elevated levels of bacteria in the lagoon, from the following sources: avian (49 percent), wildlife (18 percent), human/pet (16 percent), and agriculture (17percent).

Refugio Creek **-** The available tidewater goby habitat encompasses approximately 0.3 to 0.6 hectare (0.7 to 1.5 acres). This locality occurs at and is managed by Refugio Creek State Beach. Tidewater gobies discovered here by Rosemary Thompson and Tom Taylor in late 1980's. Specimens occur in the Santa Barbara Museum of Natural History. Tidewater gobies were present during surveys in 1999 (C. Swift, pers. comm. 2004). The Pacific Ocean at Refugio Beach is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include coliform (source unknown).

Eagle Canyon **-** The available tidewater goby habitat encompasses approximately 0.2 to 0.6 hectare (0.5 to 1.5 acres). Land adjacent to this locality is privately owned. Information on

presence/absence of tidewater gobies at this location is not known. Eagle Canyon Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Tecolote Canyon* -** The available tidewater goby habitat encompasses approximately 0.2 to 0.6 hectare (0.5 to 1.5 acres). Land adjacent to this locality is privately owned. Tidewater gobies were last collected here in 1995. Tidewater gobies were present during surveys in 2002 (C. Swift, pers. comm. 2004). Tecolote Canyon Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Winchester* (*Ellwood/Bell*) *Canyon* -** The available tidewater goby habitat encompasses approximately 0.2 to 0.6 hectare (0.5 to 1.5 acres). This locality is located immediately west of the community of El Encanto Heights, and lands adjacent to this locality are privately owned. Tidewater gobies were present during surveys in 1999 (C. Swift, pers. comm. 2004). Winchester and Ellwood Canyons merge to form Bell Canyon, less than a mile upstream of this locality. The creeks flowing from these canyons are not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Devereux Slough* -** The available tidewater goby habitat encompasses approximately 13 to 15 hectares (32.5 to 37.7 acres). Adjacent land is privately owned by the Devereux Ranch School. Oil tanks and a golf course occur on land adjacent to this locality. Tidewater gobies were last collected here in 1968. No tidewater gobies were found during sampling in 1993 (K. Lafferty, pers. comm. 2004). Devereux Slough is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Campus Lagoon* -** The available tidewater goby habitat encompasses approximately 13 to 15 hectares (32.5 to 37.7 acres). This locality occurs on the campus of the University of California, Santa Barbara. No tidewater gobies were found during sampling in 1993 (K. Lafferty, pers. comm. 2004). Campus Lagoon is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Goleta Slough* -** The available tidewater goby habitat encompasses approximately 2 to 5 hectares (5 to 12.5 acres). No tidewater gobies were found during sampling in 1993 (K. Lafferty, pers. comm. 2004). Goleta Slough is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include: metals (industrial point sources); pathogens (urban runoff/storm sewers); priority organics (nonpoint source); and sedimentation/siltation (construction/land development).

***Arroyo Burro* -** The available tidewater goby habitat encompasses approximately 1.0 to 3.0 hectares (2.5 to 7.4 acres). Ownership at or near this locality includes the City of Santa Barbara, as well as public and private. Tidewater gobies were present during surveys in 2004 (C. Swift, pers. comm. 2004). The Pacific Ocean at Arroyo Burro Beach is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include coliform (source unknown).

***Mission Creek* -** The available tidewater goby habitat encompasses approximately 0.2 to 0.6 hectare (0.5 to 1.5 acres). The City of Santa Barbara owns this locality. This site discovered and

collected by Ambrose and Lafferty (1993). Tidewater gobies were present during surveys in 2002 (C. Swift, pers. comm. 2004). The Pacific Ocean at the mouth of Mission Creek is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include fecal coliform (agriculture, urban runoff/storm sewers, natural sources, nonpoint source, unknown nonpoint source).

Laguna Channel **-** The available tidewater goby habitat encompasses approximately 0.1 to 0.4 hectare (0.2 to 1.0 acre). Ownership at or near this locality includes the City of Santa Barbara, as well as public and private. This locality was discovered and collected by Ambrose and Lafferty (1993). Tidewater gobies were present during surveys in 2002 (C. Swift, pers. comm. 2004). Laguna Channel is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Sycamore Creek **-** Sycamore Creek. The available tidewater goby habitat encompasses approximately 0.1 to 0.4 hectare (0.2 to 1.0 acre). Ownership at or near this locality includes the City of Santa Barbara, as well as public and private. Tidewater gobies were present during surveys in 2002 (C. Swift, pers. comm. 2004). The Pacific Ocean at the mouth of Sycamore Creek is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include coliform (source unknown).

Andree Clark Bird Refuge **-** The available tidewater goby habitat encompasses approximately 0.1 to 0.4 hectare (0.2 to 1.0 acre). Ownership at or near this locality includes the City of Santa Barbara, as well as public and private. This locality was discovered and collected by Ambrose and Lafferty (1993). Tidewater gobies were present during surveys in 2002 (C. Swift, pers. comm. 2004). Andree Clark Bird Refuge is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Arroyo Paredon **-** The available tidewater goby habitat encompasses approximately 0.1 to 0.4 hectare (0.2 to 1.0 acre). The mouth of Arroyo Paredon occurs in Serena Park, a local park. Tidewater gobies were present during surveys in 2002 (C. Swift, pers. comm. 2004). Arroyo Paredon is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Carpinteria Salt Marsh **-** The available tidewater goby habitat encompasses approximately 2.0 to 5.0 hectares (4.9 to 12.3 acres). Ownership of this locality includes the City of Carpinteria, as well as public and private. Tidewater gobies not found in 1995 or 2003 surveys (K. Lafferty, pers. comm. 2004). Tidewater gobies were last collected here in 1923. Carpinteria Salt Marsh (El Estero) is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include: nutrients (agriculture); organic enrichment/low dissolved oxygen (agriculture); priority organics (urban runoff/storm sewers); and sedimentation/siltation (agriculture construction/land development, storm sewers).

Carpinteria Creek **-** The available tidewater goby habitat encompasses approximately 0.4 to 1.0 hectare (1.0 to 2.5 acres). Ownership at this locality includes Carpinteria State Beach and private. Tidewater gobies were not recorded at this site 1940-1993 (Swift *et al.* 1989; Ambrose *et al.* 1993). Tidewater gobies were present during surveys in 1999 (C. Swift, pers. comm. 2004). The Pacific Ocean at the mouth of Carpinteria Creek is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include coliform (source unknown).

Rincon Creek **-** The available tidewater goby habitat encompasses approximately 0.4 to 1.0 hectare (1.0 to 2.5 acres). No tidewater gobies were found during sampling in 1993 (K. Lafferty, pers. comm. 2004). Tidewater gobies were present during surveys in 2002 (C. Swift, pers. comm. 2004). The Pacific Ocean at the mouth of Rincon Creek is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include coliform (source unknown).

LOS ANGELES/VENTURA UNIT

Sub-Unit LV1 (Ventura and Los Angeles Counties)

Ventura River **-** (Ventura County) The available tidewater goby habitat encompasses approximately 2 to 10 hectares (2 to 25 acres). The mouth of the Ventura River occurs at a public beach, owned by the City of Ventura. Upstream of the estuary, much of the land adjacent to the river is privately owned. Tidewater gobies were last collected here in 1998 (K. Lafferty, pers. comm. 2004). The Ventura River estuary is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include: algae (nonpoint/point source), eutrophism (nonpoint/point source), fecal coliform (nonpoint source), and trash (nonpoint/point source).

Santa Clara River **-** (Ventura County) The available tidewater goby habitat encompasses approximately 30 to 50 hectares (75 to 125 acres). McGrath State Beach owns approximately 10 to 20 percent of this locality; the rest privately owned, or owned by the City or County of Ventura. Tidewater gobies were present during surveys in 2004 (C. Swift, pers. comm. 2004). The Santa Clara River estuary is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include: "chemA" (source unknown), coliform (nonpoint source), and toxophene (nonpoint source).

J Street Drain/Ormond **-** (Ventura County) The available tidewater goby habitat encompasses approximately 0.3 to 1.0 hectare (0.7 to 2.5 acres). Ownership at this locality includes the City of Oxnard, as well as public and private. Tidewater gobies were first collected here by Ambrose and Lafferty in 1993 (K. Lafferty, pers. comm. 2004). Tidewater gobies were present during surveys in 2004 (C. Swift, pers. comm. 2004). The J Street Drain is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Calleguas Creek/Mugu Lagoon **-** (Ventura County) The available tidewater goby habitat encompasses approximately 50 hectares (150 acres). This locality is owned by the Naval Base

Ventura County (formerly Point Mugu Naval Air Weapons Station). Tidewater gobies were not found during surveys in 2002 (C. Swift, pers. comm. 2004). Calleguas Creek (Reach 1, formerly Mugu Lagoon) is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include: chlordane (nonpoint source); copper (nonpoint source); DDT (nonpoint/point source); endosulfan (nonpoint/point source); mercury (nonpoint/point source); nickel (nonpoint/point source), nitrogen (nonpoint/point source); PCBs (nonpoint/point source); sediment toxicity (nonpoint/point source); sedimentation/siltation (agriculture, natural sources); and zinc (nonpoint/point source).

***Sycamore Canyon* -** (Ventura County) The available tidewater goby habitat encompasses approximately 0.9 hectare (2.2 acres). This locality occurs within Point Mugu State Park. There are no historic tidewater goby records for this locality, which is a potential introduction site. Sycamore Canyon Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Arroyo Sequit* (*Leo Carillo State Beach*) -** (Los Angeles County) The available tidewater goby habitat encompasses approximately 0.9 hectare (2.2 acres). This locality occurs within Leo Carillo State Park. There are no historic tidewater goby records for this locality, which is a potential introduction site. Arroyo Sequit is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Zuma Canyon* -** (Los Angeles County) The available tidewater goby habitat encompasses approximately 2.4 hectares (6 acres). This locality occurs within Zuma Beach County Park. There are no historic tidewater goby records for this locality, which is a potential introduction site. Zuma Beach is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include DDT (nonpoint source) and PCBs (nonpoint source).

***Malibu Creek* -** (Los Angeles County) The available tidewater goby habitat encompasses approximately 6 to 10 hectares (15 to 25 acres). Ownership at the creek mouth includes Malibu Creek State Park, and also private (less than 10 percent). Tidewater gobies were extirpated in the early 1960's but re-introduced in 1991. Tidewater gobies were present during surveys in 2003 (C. Swift, pers. comm. 2004). Malibu Creek is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include: coliform (nonpoint/point source), algae (nonpoint/point source), scum/foam (nonpoint/point source), sedimentation/siltation (source unknown), and trash (nonpoint source).

***Topanga Creek* -** (Los Angeles County) The available tidewater goby habitat encompasses approximately 0.8 hectare (2 acres). The creek mouth occurs within Topanga State Beach. Tidewater gobies were present during surveys in 2002 (C. Swift, pers. comm. 2004). Topanga Creek is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include lead (nonpoint source).

Santa Monica Artesian Springs **-** (Los Angeles County) The amount of available tidewater habitat is unknown. Ownership at the springs is not known. Santa Monica Artesian Springs is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Ballona Creek **-** (Los Angeles County) The available tidewater goby habitat encompasses approximately 0.8 to 2.0 hectares (2.0 to 5.0 acres). Ownership at this locality includes Dockweiler Beach State Park, and the cities of Venice and Los Angeles. No tidewater gobies were found during sampling in 2001 (K. Lafferty, pers. comm. 2004). There are no historic tidewater goby records for this locality, which is a potential introduction site. The Ballona Creek estuary is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (nonpoint/point source) include chlordane, DDT, coliform, lead, PAHs, PCBs, and zinc.

SOUTHERN COAST UNIT

<u>Sub-Unit SC1</u> (Los Angeles, Orange and San Diego Counties)

San Pedro Harbor **-** (Los Angeles County) The available tidewater goby habitat encompasses approximately 0.8 to 2.0 hectares (2.0 to 5.0 acres). Ownership at this locality includes the cities of Los Angeles and Long Beach. San Pedro Bay is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (nonpoint/point source) include chromium, copper, DDT, PAHs, PCBs, and zinc.

Bolsa Chica **-** (Orange County) The available tidewater goby habitat encompasses approximately 0.8 to 2.0 hectares (2.0 to 5.0 acres). The title to the Bolsa Chica wetlands is held by the California State Lands Commission. There are no historic tidewater goby records for this locality, which is a potential introduction site. Bolsa Chica is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Aliso Creek **-** (Orange County) The available tidewater goby habitat encompasses approximately 0.5 to 1.0 hectare (1.25 to 2.5 acres). Ownership at this locality includes: Laguna Beach Country Club (25 percent), Aliso Beach County Park (25 percent), City of South Laguna, public and private (50 percent), and Aliso Creek Golf Course (5 percent). Tidewater gobies were last collected here in 1978. This site was dry in 1990. Tidewater gobies were not found in 1994 surveys (K. Lafferty, pers. comm. 2004). Aliso Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

San Juan Creek **-** (Orange County) The available tidewater goby habitat encompasses approximately 4 to 10 hectares (10 to 25 acres). Ownership includes Doheny State Beach (approximately 30 percent); the remainder includes the City of Dana Point, and public and private. Tidewater gobies were last collected here in 1968. No tidewater gobies were found during sampling in 1994 (K. Lafferty, pers. comm. 2004). San Juan Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

San Mateo Creek **-** (San Diego County) The available tidewater goby habitat encompasses approximately 4 to 6 hectares (10 to 15 acres). This locality occurs on Camp Pendleton Marine

Corps Base. The population here was considered extirpated by Swift *et al.* (1989), but tidewater gobies were collected here in fall of 1993 (Swift *et al.* 1994). Subsequently, the tidewater gobies were extirpated during the 1998 El Niño storm events and the North County Transit emergency bridge protection activities (C. Swift pers. comm. 2004). Camm Swift and Merkel and Associates reintroduced tidewater gobies to San Mateo Creek in January of 2000. Tidewater gobies were found during surveys in 2003 (K. Lafferty, pers. comm. 2004). San Mateo Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***San Onofre Creek* -** The available tidewater goby habitat encompasses approximately 2 to 4 hectares (5 to 10 acres). This locality occurs on Camp Pendleton Marine Corps Base. Tidewater gobies were extirpated here in spring of 1993 (Swift *et al.* 1994), but gobies were rediscovered in 1996 by Dan Holland. Tidewater gobies were last collected here in 2003 (K. Lafferty, pers. comm. 2004). San Onofre Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Sub-Unit SC2 (San Diego County)

***Las Flores/Las Pulgas Creek* -** The available tidewater goby habitat encompasses approximately 1 to 3 hectares (2.5 to 7.5 acres). This locality occurs at Camp Pendleton Marine Corps Base. Tidewater gobies were last collected here in 2003 (K. Lafferty, pers. comm. 2004). Las Flores Creek is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Hidden Lagoon* -** The available tidewater goby habitat encompasses approximately 0.5 to 1.0 hectare (1.25 to 2.5 acres). This locality occurs at Camp Pendleton Marine Corps Base, and was discovered by Slader Buck (Camp Pendleton Marine Corps Base) and C. Swift in 1993 (Swift *et al.* 1994). Tidewater gobies were last collected here in 2003 (K. Lafferty, pers. comm. 2004). Hidden Lagoon is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Aliso Canyon* -** The available tidewater goby habitat encompasses approximately 0.4 to 0.8 hectare (1.0 to 2.0 acres). This locality occurs at Camp Pendleton Marine Corps Base, and was discovered by Dan Holland in 1996. Tidewater gobies were last collected here in 2003 (K. Lafferty, pers. comm. 2004). The creek at Aliso Canyon is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include bacteria (nonpoint/point source).

***French Lagoon* -** The available tidewater goby habitat encompasses approximately 3 to 4 hectares (7.5 to 10 acres). This locality occurs at Camp Pendleton Marine Corps Base, and was discovered by Dan Holland in 1996. No tidewater gobies were observed here during sampling in 2003 (K. Lafferty, pers. comm. 2004). French Lagoon is not designated as "Water Quality Limited" by the State Water Resources Control Board.

***Cockleburr Canyon* -** The available tidewater goby habitat encompasses approximately 0.1 to 0.4 hectare (0.2 to 1.0 acre). This locality occurs at Camp Pendleton Marine Corps Base, and was discovered by Dan Holland in 1996. Tidewater gobies were last collected here in 2003 (K.

Lafferty, pers. comm. 2004). The creek mouth at Cockleburr Canyon is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Santa Margarita River **-** The available tidewater goby habitat encompasses approximately 10 to 70 hectares (25 to 175 acres). This locality occurs at Camp Pendleton (U.S. Marine Corps). Tidewater gobies were not found here during surveys in late 1993 (Swift *et al.* 1994). Tidewater gobies were last collected here in 2000 (C. Swift, pers. comm. 2004). No tidewater gobies were observed during sampling in 2003 (K. Lafferty, pers. comm. 2004). The Santa Margarita Lagoon is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include eutrophism (nonpoint/point source).

San Luis Rey River **-** The available tidewater goby habitat encompasses approximately 6 to 10 hectares (15 to 25 acres). Ownership includes the City of Oceanside, as well as public and private. Tidewater gobies were last collected here in 1958. No tidewater gobies were observed during sampling in 2003 (K. Lafferty and C. Swift, pers. comm. 2004). The San Luis Rey River mouth is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (in parentheses) include bacteria indicators (nonpoint/point source).

Buena Vista Lagoon **-** The available tidewater goby habitat encompasses approximately 40 to 100 hectares (100 to 250 acres). Ownership includes the cities of Carlsbad (75 percent) and Oceanside (25 percent). Tidewater gobies were last collected here in 1955 (K. Lafferty, pers. comm. 1996). Buena Vista Lagoon is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (nonpoint/point source) include bacteria indicators, nutrients, and sedimentation/siltation.

Agua Hedionda Lagoon **-** The available tidewater goby habitat encompasses approximately 35 to 120 hectares (87.5 to 300 acres). Ownership includes the City of Carlsbad, as well as public and private. Tidewater gobies were last collected here in 1940 (K. Lafferty, pers. comm. 1996). Tidewater gobies not found during 1994 surveys. Agua Hedionda Lagoon is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (nonpoint/point source) include bacteria indicators and sedimentation/siltation.

Batiquitos Lagoon **-** The available tidewater goby habitat encompasses approximately 0.8 to 2.0 hectares (2.0 to 5.0 acres). There are no historic tidewater goby records for this locality, which is a potential introduction site. Batiquitos Lagoon is not designated as "Water Quality Limited" by the State Water Resources Control Board.

San Elijo Lagoon **-** The available tidewater goby habitat encompasses approximately 0.8 to 2.0 hectares (2.0 to 5.0 acres). There are no historic tidewater goby records for this locality, which is a potential introduction site. San Elijo is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (nonpoint/point source) include bacteria indicators, nutrients, and sedimentation/siltation.

***San Diegito Lagoon* -** The available tidewater goby habitat encompasses approximately 0.8 to 2.0 hectares (2.0 to 5.0 acres). There are no historic tidewater goby records for this locality, which is a potential introduction site. San Diegito Lagoon is not designated as "Water Quality Limited" by the State Water Resources Control Board.

Los Peñasquitos Lagoon - The available tidewater goby habitat encompasses approximately 0.8 to 2.0 hectares (2.0 to 5.0 acres). There are no historic tidewater goby records for this locality, which is a potential introduction site. Los Peñasquitos Lagoon is designated as "Water Quality Limited" by the State Water Resources Control Board. Pollutants and stressors and their respective potential sources (nonpoint/point source) include sedimentation/siltation.

Appendix D. Tidewater Goby Critical Habitat Description

Map Unit 1: Orange County, California. From U.S. Geological Survey 7.5' quadrangle map Laguna Beach, California, and San Juan Capistrano, California. San Bernardino Principal Meridian, California, T. 7 S., R 8 W., beginning at a point on Aliso Creek in SW sec. 32 and at approximately 33 deg.30'46" N latitude and 117 deg.44'37" W longitude, UTM* coordinates 430853.4 E, 3708395.9 N, and proceeding downstream (westerly) to the Pacific Ocean covering approximately 1.0 kilometer (0.6 mile), including the stream, its 50-year flood plain, and associated lagoons and marsh.

Map Unit 2: San Diego County, California. From U.S. Geological Survey 7.5' quadrangle map San Clemente, California. San Bernardino Principal Meridian, California, T. 9 S., R. 7 W., beginning at a point on San Mateo Creek in NW sec. 14 and at approximately 33 deg.23'46" N latitude and 117 deg.35'20" W longitude, UTM coordinates 445152.5 E, 3695369.7 N, and proceeding downstream (southerly) to the Pacific Ocean covering approximately 1.3 kilometer (0.9 mile), including the stream, its 50-year flood plain, and associated lagoons and marsh.

Map Unit 3: San Diego County, California. From U.S. Geological Survey 7.5' quadrangle map San Clemente, California. San Bernardino Principal Meridian, California, T. 9 S., R. 7 W., beginning at a point on San Onofre Creek in SE sec. 14 and at approximately 33 deg.23'05" N latitude and 117 deg.34'30" W longitude, UTM coordinates 446450.2 E, 3694074.4 N, and proceeding downstream (southwesterly) to the Pacific Ocean covering approximately 0.6 kilometer (0.4 mile), including the stream, its 50-year flood plain, and associated lagoons and marsh.

Map Unit 4: San Diego County, California. From U.S. Geological Survey 7.5' quadrangle map Las Pulgas Canyon, California. San Bernardino Principal Meridian, California, T. 10 S., R. 6 W., beginning at a point on Las Flores Creek in the middle of sec. 13 and at approximately 33 deg.17'32" N latitude and 117 deg.27'20" W longitude, UTM coordinates 457495.3 E, 3683780.1 N, and proceeding downstream (westerly) to the Pacific Ocean covering approximately 0.8 kilometer (0.5 mile), including the stream, its 50-year flood plain, and associated lagoons and marsh.

Map Unit 5: San Diego County, California. From U.S. Geological Survey 7.5' quadrangle map Las Pulgas Canyon, California. San Bernardino Principal Meridian, California, T. 10 S., R. 5 W., beginning at a point on Hidden Creek in W sec. 30 and at approximately 33 deg.16'46" N latitude and 117 deg.26'48" W longitude, UTM coordinates 458321.5 E, 3682362.9 N, and proceeding downstream (southwesterly) to the Pacific Ocean covering approximately 0.8 kilometer (0.5 mile), including the stream, its 50-year flood plain, and associated lagoons and marsh.

Map Unit 6: San Diego County, California. From U.S. Geological Survey 7.5' quadrangle map Las Pulgas Canyon, California. San Bernardino Principal Meridian, California, T. 10 S., R. 5 W., beginning at a point on Aliso Creek in NE sec. 31 and at

approximately 33 deg.16'13" N latitude and 117 deg.26'19" W longitude, UTM coordinates 459521.7 E, 3680981.1 N, and proceeding downstream (southwesterly) to the Pacific Ocean covering approximately 0.7 kilometer (0.4 mile), including the stream, its 50-year flood plain, and associated lagoons and marsh.

Map Unit 7: San Diego County, California. From U.S. Geological Survey 7.5' quadrangle map Las Pulgas Canyon, California. San Bernardino Principal Meridian, California, T. 10 S., R. 5 W., beginning at a point on French Creek in E sec. 31 and at approximately 33 deg.16'01" N latitude and 117 deg.26'01" W longitude, UTM coordinates 459078.8 E, 3681354.4 N, and proceeding downstream (westerly) to the Pacific Ocean covering approximately 0.7 kilometer (0.4 mile), including the stream, its 50-year flood plain, and associated lagoons and marsh.

Map Unit 8: San Diego County, California. From U.S. Geological Survey 7.5' quadrangle map Las Pulgas Canyon, California. San Bernardino Principal Meridian, California, T. 11 S., R. 5 W., beginning at a point on Cockleburr Creek in NE sec. 5 and at approximately 33 deg.15'16" N latitude and 117 deg.25'21" W longitude, UTM coordinates 460570.4 E, and 3679563.4 N, and proceeding downstream (westerly) to the Pacific Ocean covering approximately 1.0 kilometer (0.6 mile), including the stream, its 50-year flood plain, and associated lagoons and marsh.

Map Unit 9: San Diego County, California. From U.S. Geological Survey 7.5' quadrangle map Oceanside, California. San Bernardino Principal Meridian, California, T. 11 S., R. 5 W., beginning at a point on the Santa Margarita River in NW sec. 2 and at approximately 33 deg.15'08" N latitude and 117 deg.22'38" W longitude, UTM coordinates 464774.9 E, 3679326.9 N, and proceeding downstream (westerly) to the Pacific Ocean covering approximately 5.0 kilometers (3.1 miles), including the river's 50-year flood plain, associated lagoons and marsh.

Map Unit 10: San Diego County, California. From U.S. Geological Survey 7.5' quadrangle map San Luis Rey, California. San Bernardino Principal Meridian, California, T. 12 S., R. 4 W., beginning at a point on Agua Hedionda Creek in the middle of Section 9 and at approximately 33 deg.08'44" N latitude and 117 deg.18'19" W longitude, UTM coordinates 471444.4 E, 3667474.6 N, and proceeding downstream (southwesterly) to the Pacific Ocean covering approximately 3.7 kilometers (2.3 miles), including the creek, its 50-year flood plain, Agua Hedionda Lagoon, and associated marsh.

Appendix E. Tidewater Goby Threats Table

The following table lists known and possible threats affecting known and potential tidewater goby habitats.

Table legend:

Habitat Size
Large = Large water bodies are those meeting at least one of the following general physical parameters: streams with channel bankful widths in excess of 20 meters (66 feet) at any point and/or with estuarine (areas with salt water intrusion) habitats exceeding 1 kilometer (0.6 mile) in length; or lagoons and ponds larger than 2 hectares (5 acres) surface area.

Medium = Medium sized water bodies include smaller streams less than 20 meters bankful width and/or estuaries longer than 100 meters (328 feet) but less than 1 kilometer in length. Medium sized lagoons and ponds are those with a surface area less than 2 hectares, but larger than 0.4 hectare (1 acre).

Small = Small water bodies are the remaining streams, ditches, sloughs, lagoons, and ponds of lesser dimension than as described for the medium size range.

NA = Not applicable, water body is altered beyond the point of restoration.

Population Density
Rare
Variable
Abundant
- = no record

Presence
Extirpated = population undetected for three or more consecutive years
Regular = population detected annually
Intermittent = population detected irregularly
- = no record

Source of Population
Historic = preserved population from the past
Introduced = population relocated from a source location
Recolonized = a naturally reestablished population
- = no record

Threats
● = Known threat
* = Possible threat
NT = Not a threat

Non-Point Source Pollution
AG = Agricultural run-off or effluent
MR = Municipal run-off
OL = Oil contamination, oil fields in vicinity of habitat
GC = Golf course run-off
CO = Vehicular or railroad contamination
RA = recreational activity in or in vicinity of lagoon

Point Source Pollution
ST = Sewage treatment effluent
OL = Oil contamination, oil fields in vicinity of habitat
TW = Toxic waste

Habitat Degradation
BR = Breaching
DV = Development encroaching on habitat
CH = Stream channelization
GR = Cattle grazing
WD = Water diversions/groundwater pumping
SR = Salinity regime affected: dikes, levees, dams, *etc*.
RH = Reduction or modification of habitat
ER = Soil erosion in vicinity of habitat, sedimentation of habitat
RA = Recreational activity in or in vicinity of lagoon
CL = Complete loss of habitat

Predators-Competitors
NP = Native Predators
FI = Exotic fish species
FR = Exotic frog species

Recovery Unit	Sub-Unit	Site Code	Locality	Location Status[1]						Known and Potential Threats																					
				Habitat Size	Population Density	Presence	Source of population	Approximate Distance from Nearest Extant Population (miles)	Habitat Restoration Needed	Non-Point Source Pollution						Point Source Pollution			Habitat Degradation										Predators-competitors		
										AG	MR	OL	GC	CO	RA	ST	OL	TW	BR	DV	CH	GR	WD	SR	RH	ER	RA	CL	NP	FI	FR
NORTH COAST UNIT	NC1	a	Tillas Slough (Smith River)	Small	Variable	Intermittent	Historic	8	Some	●											●	●		●	●				●		
		b	Lake Earl-Lake Talawa	Large	Abundant	Regular	Historic	8	Some	*									●	*		*		●	*		●		●	*	●
		c	Elk Creek[2]	Medium	-	-	-	10	Some																						
	NC2	a	Redwood Creek Estuary	Medium	-	Extirpated	Historic	3	Much	*									*		●	●		●	●			●	●		*
		b	Freshwater Lagoon	Large	-	Extirpated	Historic	2	Much	NT														●	●		*		●	●	*
		c	Stone Lagoon	Large	Abundant	Regular	Historic	2	None																		*		●	*	*
		d	Big Lagoon	Large	Abundant	Regular	Historic	2	None																				●	*	*
	NC3	a	Mad River[2]	Large	-	-	-	20	Some																						
		b	Mad River Slough	Medium	Rare	Intermittent	Historic	3	Some	*														●	*				●		*
		c	Klopp Lake (McDaniel)	Medium	Rare	Intermittent	Recolonized	0.5	Some							*								*	*				●		
		d	Jacoby Creek	Small	Variable	Intermittent	Historic	0.5	Some	*											●			●					●	*	*
		e	KATA Station Site	Small	Rare	Intermittent	Historic	0.5	Some		*													*	*				*		*
		f	Freshwater Slough	Medium	-	Intermittent	Historic	6	Some	*												●		●	●	●			●		
		g	Eel River	Large	Rare	Regular	Historic	20	Some																						
	NC4	a	Ten Mile River	Large	Abundant	Regular	Historic	6	None																				●		*
	NC5	a	Virgin Creek	Medium	Abundant	Regular	Historic	1	None		*									●									●		*
		b	Pudding Creek	Medium	Abundant	Regular	Historic	1	Much											*			*	●	●		*		●		*
	NC6	a	Davis Pond	Medium	-	-	-	1	Some																						
		b	Brush Creek	Medium	-	-	Historic	1	None										●				*							●	
		c	Lagoon Creek	Medium	-	-	Historic	1	None										●				*							●	
GREATER BAY UNIT	GB1	a	Marshall Gulch[2]	Small	-	-	-	2	Some																					●	
		b	Salmon Creek	Medium	Abundant	Regular	Historic	12	Some						●				●			●	●				●		●		
	GB2	a	Johnson Gulch[2]	Small	-	-	-	9	Some																						
		b	Cheney Gulch	Small	-	Extirpated	Historic	9	Some	NT				●																	
		c	Estero Americano	Large	Variable	Regular	Historic	15	Some	●						*						●	*	●						●	
		d	Estero de San Antonio	Large	Abundant	Regular	Historic	15	Some	●						●			●			●	●			●			●	●	
		e	Walker Creek	Large	-	Extirpated	Historic	8	Some	NT											●		●						●	●	
	GB3	a	Lagunitas Creek	Medium	Rare	Regular	Historic	16	Much	●	*										●	●		●					●	●	
		b	Millerton[2]	Small	-	-	-	14	Some																						
		c	Fish Hatchery Creek[2]	Small	-	-	-	0.75	Some																						
	GB4	a	Horseshoe Cove[2]	Large	-	-	-	30	Some																						
		b	Estero de Limantour[2]	Large	-	-	-	29	Some																						
		c	Bolinas Lagoon[2]	Large	-	-	-	10	Some																						
		d	Rodeo Lagoon	Medium	Abundant	Regular	Historic	43	Some	*		*													●				●	●	
		e	Corte Madera Creek	Medium	-	Extirpated	Historic	15	Much	NT											●			●							
		f	Mill Creek[2]	Medium	-	-	-	10	Much												●			●							
		g	Novato Creek	Medium	-	Extirpated	Historic	30	Much	NT											●			●							
		h	Petaluma Creek	Large	-	Extirpated	Historic	30	Much	NT											●			●							
		i	Strawberry Creek	Small	-	Extirpated	Historic	14	Much												●			●				●			
		j	Lake Merrit	Large	-	Extirpated	-	18	Much												●			●							
		k	Cliff House	NA	-	Extirpated	Historic	5	Much																			●			
		l	Lake Merced	Large	-	Extirpated	-	11	Much	NT														●						●	
		m	Laguna Salada[2]	Medium	-	-	-	18	Some																						
		n	San Pedro Creek[2]	Small	-	-	-	20	Some																						
	GB5	a	San Gregorio Creek	Medium	Abundant	Regular	Historic	4	None										●		●						*		●		
		b	Pompino Creek[2]	Medium	-	-	-	2	Some																						
		c	Pescadero-Butano Creek	Medium	Variable	Intermittent	Historic	4	Much	●									●	●	●					*					
		d	Bean Hollow Creek	Small	Variable	Intermittent	Historic	4	Much					*									●	●	●						
	GB6	a	Waddell Creek	Medium	-	Extirpated	Historic	5	Some	●					●						●								●	●	
		b	Scott Creek	Medium	Variable	Intermittent	Recolonized	6	Some	●											●		*						●		
		c	Laguna Creek	Small	Abundant	Regular	Historic	3	Some	●	NT												●						●		
	GB7	a	Baldwin Creek	Small	Abundant	Regular	Historic	0.7	Some	●													●								
		b	Lombardi Creek	Small	Rare	Intermittent	Historic	0.7	Some	●																					
		c	Old Dairy Creek	Small	Rare	Intermittent	Historic	0.8	Some	●																					

Recovery Unit	Sub-Unit	Site Code	Locality	Location Status[1]						Known and Potential Threats																					
				Habitat Size	Population Density	Presence	Source of population	Approximate Distance from Nearest Extant Population (miles)	Habitat Restoration Needed	Non-Point Source Pollution						Point Source Pollution			Habitat Degradation										Predators-competitors		
										AG	MR	OL	GC	CO	RA	ST	OL	TW	BR	DV	CH	GR	WD	SR	RH	ER	RA	CL	NP	FI	FR
GREATER BAY UNIT	GB7	d	Wilder Creek	Small	Variable	Intermittent	Recolonized	0.7	Some	NT													●								
		e	Younger Lagoon	Medium	Rare	Intermittent	Recolonized	0.5	Some	●													●								
		f	Moore Creek	Small	Variable	Intermittent	Recolonized	0.5	Some	NT	●												●								
	GB8	a	San Lorenzo River	Large	Rare	Intermittent	Recolonized	1	Some		●										●		●						●		
		b	Corcoran Lagoon	Large	Abundant	Regular	Historic	1	Some		●								●	●									●	*	*
		c	Moran Lake	Large	Variable	Regular	Historic	1	Some	NT	●																		●		
	GB9	a	Soquel Creek	Large	Variable	Intermittent	Recolonized	2	Much	NT	●										●			●					●		
		b	Aptos Creek	Small	Variable	Intermittent	Recolonized	4	Much		●								●	●	●				●				●		
	GB10	a	Pajaro River	Large	-	Extirpated	Historic	5	Much	●	●										●					●			●	●	
	GB11	a	Bennett Slough	Large	Rare	Intermittent	Historic	14	Much	●											●		●	●					●		
		b	Salinas River	Large	-	Extirpated	Historic	5	Much	●	●										●		●	●					●	●	
CENTRAL COAST UNIT	CC1	a	Arroyo de la Cruz[2]	Small	-	-	-	1.5	Some																						
		b	Arroyo del Oso	Small	Variable	Intermittent	Recolonized	0.5	Some	*				*								●		●	●						
		c	Arroyo de Corral	Small	Variable	Intermittent	Recolonized	5	Some													●	*	●	●	●					
	CC2	a	Oak Knoll Creek	Small	Abundant	Regular	Historic	2	Some					*							●	*			●						
		b	Arroyo de Tortuga	Small	Rare	Regular	Historic	0.3	Some					*								●									
		c	Broken Bridge Creek	Small	Rare	Intermittent	Recolonized	0.3	Some	NT															●						
		d	Little Pico Creek	Small	Abundant	Regular	Historic	1	Some					*								●	*								
		e	Pico Creek	Medium	Abundant	Regular	Historic	2	Some					*						*		●	●							*	
		f	San Simeon Creek	Medium	Abundant	Regular	Historic	2	Some	*				*		●						●	●				*			*	●
		g	Leffingwell Creek	Small	-	Extirpated	Historic	1	Much				●												●						
		h	Santa Rosa Creek	Medium	Variable	Intermittent	Historic	2	Some	*										*			●							●	●
	CC3	a	Villa Creek	Medium	Abundant	Regular	Historic	3	Some	●				*								●	●	●						●	●
		b	San Geronimo Creek	Small	Rare	Regular	Historic	2	Some					*								●	*								*
		c	Cayucos Creek	Medium	Variable	Intermittent	Recolonized	0.2	Some		*			*						●			●							*	*
		d	Little Cayucos Creek	Small	-	Intermittent	Recolonized	0.2	Some	NT													●								
		e	Old Creek	Medium	Variable	Intermittent	Recolonized	1	Much														●						●	●	●
		f	Willow Creek	Small	Rare	Intermittent	Recolonized	0.6	Much		●									●											
		g	Toro Creek	Small	Rare	Intermittent	Recolonized	2	Much	NT							●				●				●						
		h	Morro Creek	Small	-	Extirpated	Historic	2	Much	NT	●										●						●			
		i	Chorro Creek	Medium	-	Extirpated	Historic	1	Some		●					●					●		●	●					●	●	●
		j	Los Osos Creek	Medium	Variable	Intermittent	Recolonized	1	Some		●					●					●		●	●					●	●	●
CONCEPTION UNIT	CO1	a	San Luis Obispo Creek	Large	Variable	Intermittent	Recolonized	6	Some		●		●			●	●			●	●			●	●	●			●	●	
		b	Pismo Creek	Small	Abundant	Regular	Historic	6	Much	●	●					●				●	●					●				*	●
		c	Santa Maria River	Large	Rare	Regular	Historic	11	Much			●				●	●		●			●	●		●				●		
	CO2	a	Shuman Canyon	Small	Abundant	Regular	Historic	3	None									●				●							●		
		b	San Antonio Creek	Large	Abundant	Regular	Historic	3	None	●						●						●	●						●		●
		c	Santa Ynez River	Large	Abundant	Regular	Historic	6	Some							●			●		●		●						●	●	●
		d	Canada Honda	Small	Rare	Intermittent	Recolonized	6	Much					*											●						
	CO3	a	Jalama Creek	Medium	Variable	Intermittent	Recolonized	8	Much		●			*		●			●		●	●							●	●	●
		b	Canada del Cojo	Medium	Rare	Intermittent	Historic	3	Some	●				●								●	*								
		c	Canada del Pescado	Medium	Rare	Intermittent	Historic	1	Some	●				●																	
		d	Canada del las Aqujas	Small	Abundant	Regular	Historic	0.5	Much	●				●											●						
		e	Arroyo el Bulito	Small	Rare	Intermittent	Recolonized	0.5	Much	●				●											●						
		f	Canada del Aqua	Small	Rare	Intermittent	Recolonized	0.5	Much	●				●											●						
		g	Canada de Santa Anita	Medium	Abundant	Regular	Historic	0.5	Some	●				●								*									
		h	Canada de Alegria	Small	Abundant	Regular	Historic	1	Some	●				●								●	●	●	●					*	
		i	Canada de Aqua Caliente	Small	Abundant	Regular	Historic	1	Some	●				●											●						
		j	Gaviota Creek	Medium	Variable	Regular	Historic	1	Some		●			●	*				●		●	●		●	●	*	●		●		
		k	Arroyo Hondo	Small	Rare	Intermittent	Recolonized	1	Much					*										●	●				●		
		l	Arroyo Quemado	Small	Rare	Intermittent	Recolonized	1	Much	U	●			*				●					●		●						
		m	Refugio Creek	Small	Variable	Intermittent	Recolonized	3	Much	●	●			*	●						●				●		●				
		n	Eagle Canyon	Small	Rare	Intermittent	Historic	0.7	Some					*											●						
		o	Tecolote Canyon	Small	Variable	Intermittent	Recolonized	0.3	Some					*						*			*		●						
		p	Winchester Canyon	Small	Abundant	Regular	Historic	0.3	Some	●		●	●	*			*						*								

Recovery Unit	Sub-Unit	Site Code	Locality	Location Status[1]						Known and Potential Threats																					
				Habitat Size	Population Density	Presence	Source of population	Approximate Distance from Nearest Extant Population (miles)	Habitat Restoration Needed	Non-Point Source Pollution						Point Source Pollution			Habitat Degradation										Predators-competitors		
										AG	MR	OL	GC	CO	RA	ST	OL	TW	BR	DV	CH	GR	WD	SR	RH	ER	RA	CL	NP	FI	FR
CONCEPTION UNIT	CO3	q	Devereux Slough	Large	-	Extirpated	Historic	2	Much		●	●	●							*				●	●	●					
		r	Campus Lagoon	Medium	-	Extirpated	Historic	4	Much															●							
		s	Goleta Slough	Large	-	Extirpated	-	6	Much		●			*	*					*	●			●					●		
		t	Arroyo Burro	Medium	Abundant	Regular	Historic	4	Some		●				●				●	*	●			●	●		*				
		u	Mission Creek	Large	Variable	Regular	Historic	0.1	Some	NT	●				*				●	●	●			●	●						
		v	Laguna Channel	Small	Abundant	Regular	Historic	0.1	Much	NT	●				*				●	●	●			●							
		w	Sycamore Creek	Small	Abundant	Intermittent	Recolonized	0.2	Much	NT	●				*					●	●			●							
		x	Andree Clark Bird Refuge	Small	Abundant	Intermittent	Recolonized	0.2	Much	NT	●				*					*				●							
		y	Arroyo Paredon	Small	Abundant	Intermittent	Recolonized	3	Much					*				●		●			●								
		z	Carpinteria Salt Marsh	Medium	-	Extirpated	Historic	1	Much	●	●			●										●	●						
		aa	Carpinteria Creek	Medium	Abundant	Intermittent	Historic	3	Some	NT	●			*							●				●						
		ab	Rincon Creek	Small	Variable	Intermittent	Recolonized	3	Much		●			*	*	*					●										
LA/VENTURA UNIT	LV1	a	Ventura River	Large	Variable	Regular	Historic	4	Some	●	●	●		*	*				●		●		●							●	●
		b	Santa Clara River	Large	Variable	Regular	Historic	4	Some	●		●			*	●			●	*	●		●							●	●
		c	J Street Drain/Ormond	Large	Variable	Intermittent	Recolonized	8	Much	●	●				*	●		●	●		●			●					●	●	
		d	Calleguas Creek/Mugu	Large	-	Extirpated	Historic	7	Much	●	*					*			●				●		●				●		
		e	Sycamore Canyon[2]	Small	-	-	-	12	Some																						
		f	Arroyo Sequit[2]	Small	-	-	-	17	Some																						
		g	Zuma Canyon[2]	Small	-	-	-	11	Some		●			*	*					●											
		h	Malibu Creek	Large	Abundant	Intermittent	Recolonized	6	Some	●	●			*	●	●			●	●	●		●	●	●		●		●		
		i	Topanga Creek	Small	Abundant	Intermittent	Recolonized	6	Much		●			*	*	●				●	●		●		●						
		j	Santa Monica Artesian Spr.	NA	-	Extirpated	Historic	-	Much																			●			
		k	Ballona Creek[2]	Large	-	-	-	10	Much		●			*	●	●	●			●	●		●	●	●				●	●	
SOUTHERN COAST UNIT	SC1	a	San Pedro Harbor	NA	-	Extirpated	-	40	Much		●	●		*						●					●			●			
		b	Bolsa Chica[2]	Large	-	-	-	42	Much		●			●							●				●				●		
		c	Aliso Creek	Medium	-	Extirpated	Historic	14	Some		●		●	●	*	●			●	●	●				●		●			●	
		d	San Juan Creek	Large	-	Extirpated	Historic	7	Much																						
		e	San Mateo Creek	Medium	Variable	Intermittent	Recolonized	1	Some	●	●			*					●		●		●				●		●	●	●
		f	San Onofre Creek	Medium	Variable	Intermittent	Recolonized	1	Some		●			*							●					●	●		●	●	
	SC2	a	Las Pulgas Creek	Large	Abundant	Regular	Historic	1	Some					*	*				●				●		●		●			●	●
		b	Hidden Lagoon	Large	Variable	Intermittent	Historic	0.2	Some	NT																					
		c	Aliso Canyon	Small	Variable	Intermittent	Recolonized	1	Some	NT																					
		d	French Lagoon	Large	Variable	Intermittent	Recolonized	0.2	Much	NT																					
		e	Cockleburr Canyon	Small	Variable	Intermittent	Recolonized	0.05	Much															●					●	●
		f	Santa Margarita River	Large	Variable	Intermittent	Recolonized	2	Much	*	●			*		●					●		●						●		
		g	San Luis Rey River	Large	-	Extirpated	Historic	3	Much	*	●									●	●			●		*			●	●	●
		h	Buena Vista Lagoon	Large	-	Extirpated	Historic	3	Much	NT	●									●				●		*			●	●	●
		i	Aqua Hedionda Lagoon	Large	-	Extirpated	Historic	3	Much	NT	●				*	*				●			●	●	●	*			●		
		j	Batiquitos Lagoon[2]	Large	-	-	-	5	Much		●		*							●				●		*			●		
		k	San Elijo Lagoon[2]	Large	-	-	-	3	Much	*	●									●				●		*			●		
		l	San Diegito Lagoon[2]	Large	-	-	-	3	Much		●		*							●	●			●	●	*			●		
		m	Las Peñasquitos Lagoon[2]	Large	-	-	-	4	Much		●													●					●	●	

[1] reflects status in year 2004

[2] indicates a potential introduction site (no historic tidewater goby record)

Appendix F. Tidewater Goby Survey Protocol

1. Introduction

The tidewater goby (*Eucyclogobius newberryi*), a species of fish endemic to California, has undergone substantial reduction in population size and distribution within its range in recent years. Surveys for the species have been conducted using a variety of methods over the past 2 to 4 decades. We, the U.S. Fish and Wildlife Service, seek to increase the scientific information available upon which to base future management and conservation of the species, including efforts for recovery. Through the survey protocol recommended in this document, we intend to promote survey methods and intensities that ensure sound and supportable presence/absence determinations of species locations, leading to better management decisions based on the best available scientific data.

We provide the following guidance to facilitate the determination of presence or absence of the species in habitats with potential to support it. We anticipate that the primary use for this protocol will be for project-level surveys in support of requests for consultation under section 7 of the Endangered Species Act of 1973, as amended. Additionally, this protocol may also be used for section 10(a)(1)(B) permit applications, and to determine general presence-absence for other management purposes.

In general, surveys for wildlife and fish species may be done to meet a variety of management objectives, including but not limited to: 1) confirming the presence or absence of a species at a particular location, 2) identifying habitats potentially occupied, 3) estimating population size, and 4) determining population trends. For the purposes of this protocol, we have focused primarily on the first objective, determining presence/absence of a species at particular sites. The protocol is also likely to provide supporting information in identifying locations and habitat types currently occupied by the species. It is not the intent of this protocol to estimate population size or determine population trends.

Section 9 of the Endangered Species Act of 1973, as amended, and Federal regulations pursuant to Section 4(d) prohibit the take[1] of endangered and threatened species fish and wildlife species without special exemption. Virtually all methods to survey for gobies require the surveyor to enter the species' habitat, resulting in an unavoidable risk of take of the species should it occur there. Therefore, a final objective of this survey protocol is to minimize the incidental take of

[1] **Take** is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct." [ESA §3(19)] **Harm** is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. **Harass** is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. [50 CFR §17.3]

gobies by implementing survey methods and intensities that are likely to minimize the take of gobies through the survey methodology itself.

2. Background

Habitat Affinity

The tidewater goby inhabits primarily waters of coastal lagoons, estuaries, and marshes. The species is benthic in nature as an adult (Swift 1980). Its habitat is characterized by brackish shallow lagoons and lower stream reaches where the water is fairly still, but not stagnant (Miller and Lea 1972; Moyle 2002; Swift *et al*.1989; Wang 1982; Irwin and Soltz 1984). Tidewater gobies exhibit a preference for a sand substrate component for breeding, but they are also found on rocky, mud, and silt substrates as well. Tidewater gobies have been documented in waters with salinity levels from 0 to 42 parts per thousand, temperature levels from 8 to 25 degrees Celsius (46 to 77 degrees Fahrenheit), and water depths from 25 to 200 centimeters (10 to 79 inches) (Irwin and Soltz 1984; Swift *et al*. 1989; Worcester 1992; Lafferty 1997; Smith 1998).

In their study, Trihey and Associates (1996) report tidewater gobies concentrated within 30 meters of the shore and in waters between 0.5 and 1.0 meter deep. In addition, higher densities of tidewater gobies were found in areas containing submerged aquatic vegetation than those containing only emergent vegetation or no vegetation.

Tidewater gobies have been reported from estuaries in California ranging from Tillas Slough at the mouth of the Smith River (northern Del Norte County) to Agua Hedionda Lagoon (northern San Diego County). The distribution of the tidewater goby corresponds to the distribution of sand deposition within the littoral cells along the California coast (Capelli 1997). Apparently, none have ever been found in Mexico or Oregon, based on extensive surveys outside of California.

The tidewater goby appears to spend all life stages in lagoons, in tidally influenced portions of coastal waters, or in freshwater habitats adjacent to these water bodies. Tidewater gobies may enter marine environments when flushed out of the estuary/lagoon by breaching of the sandbars following storm events or human manipulation. The tidewater goby generally lives to about 1 year of age, although some variation has been observed (Swift 1989; Wang 1982; Irwin and Soltz 1984). During this single year, it is able to complete its life cycle.

Reproduction occurs year-round, although a distinct peak in spawning occurs in April and May (Moyle *et al*. 1989). Detailed information regarding the biology of the tidewater goby can be found in Wang (1982), Irwin and Soltz (1984), Swift *et al*. (1989), Worcester (1992), Swenson (1995), Lafferty *et al*. (1999), and Swenson (1999).

Swenson (1995) reported that field studies of tidewater gobies in central California revealed different patterns in population ecology among different habitats. Feeding ecology differed for gobies in lagoon, creek and marsh habitats. Tidewater gobies in the marsh were significantly larger, more fecund and potentially longer-lived than tidewater gobies in the lagoon or creek. However, sandy lagoons may be more important than muddy marshes as spawning habitat

because males in lab studies preferred to dig spawning burrows in sand rather than mud. Although lagoons are considered the typical habitat of tidewater gobies, brackish marshes can also be important, perhaps due to better food resources or reduced disturbance regimes. Marshes may serve as refugia, providing a source population for recolonization of the creek and lagoon habitats after high-flow events.

Developing monitoring programs to assess abundance patterns can be difficult because tidewater gobies can be patchily distributed within habitats.

2.1 Legal Status

On March 7, 1994, we listed the tidewater goby as endangered throughout its range under the Act (U.S. Fish and Wildlife Service 1994). We designated critical habitat on November 20, 2000, for the southern California populations (U.S. Fish and Wildlife Service 2000). On June 24, 1999, we published a proposed rule to remove the northern populations of the tidewater goby from the endangered species list (U.S. Fish and Wildlife Service 1999). The proposed rule to delist was withdrawn on November 7, 2002 (U.S. Fish and Wildlife Service 2002), following significant public and species expert comments. Therefore, the current status of the species remains listed as endangered throughout its range, and critical habitat remains as designated in 2000. A recovery plan is in development.

The tidewater goby was listed as a species of special concern by the California Department of Fish and Game in 1980, and was elevated to fully protected status in 1987 (Swift *et al*. 1997).

2.3 Methods Applied to Prior Surveys

This section provides a brief summary of survey methods used in the past, their success, and the recommendations for improvement by those who used them. This information is provided to assist the reader in understanding the effectiveness of those methods, and the relative efficiency of each. In addition, this information assists the reader in understanding why we recommend the methods in the protocol, described later in this document, rather than other methods that to the uninitiated might seem better or more cost effective. We believe that this information adequately supports our proposed protocol, thus promoting consistency among all surveyors. However, any and all methods proposed to conduct surveys for tidewater goby should receive our consideration, as appropriate.

Tidewater goby abundance and distribution can be affected by habitat characteristics such as vegetation, substrate and depth (Swift *et al*. 1989, Worcester 1992, Swenson 1995). These factors can also influence the efficiency of sampling methods. Tidewater gobies have been successfully collected with both seines (Swift *et al.* 1989, Swenson 1995) and meter-square throw traps (Worcester 1992, Swenson 1995). Other reported methods include dip nets, minnow traps, ichthyoplankton net, snorkeling/direct observation, and plastic tubes. Each is described in more detail below.

2.3.1 Seine Netting

Seine netting is one of the most common methods utilized in tidewater goby surveys (Wang 1984; Holland 1992; Swift 1994; Swenson 1994; Swenson 1996a, 1996b; Lafferty *et al*. 1997; Fong 1997; Swift 1997) throughout the species range. The technique can be applied over a variety of habitats, but does have limitations in areas with dense emergent vegetation (Trihey and Associates 1996). Seining is a commonly used collecting method, well suited for near-shore areas with smooth bottoms and little vegetation.

Seine nets used for goby surveys ranged in length from as short as 1.2 meter (Wang 1984; Swenson 1996b; Swift 1997; Wang and Keegan 1998) to 7.3 meter (Swenson 1994; Swenson 1995). Other commonly used lengths include 1.8 meter (Holland 1992; Swift 1997), 2.1 meters (Swenson *et al*. 1996a), 3 meters (Lafferty *et al.* 1997; Wang 1984), and 5 meters (Swift 1997). The nets ranged in height from 1.0 meter to 1.8 meter.

Various mesh sizes have been used. Reported mesh sizes ranged from 0.5 millimeter to greater than 6 millimeters. Commonly used mesh sizes included those near 3 millimeters (Wang 1982; Wang 1984; Fong 1997, Lafferty *et al*. 1997; Swift 1997; Wang and Keegan 1998), 4 millimeters (Swenson 1995; Swenson 1996b), 4.5 meters (Swift 1994), 4.8 millimeters (Fong 1997), and greater than 6 millimeters (Holland 1992; Trihey and Associates 1996; Fong 1997). Due to their small size, especially when in the larval or subadult form, tidewater gobies can easily escape from the seine if the mesh size is too large. Fong (1997) selected a 3.2-millimeter delta mesh because gobies were observed squeezing through the 6.4-millimeter mesh and 4.8-millimeter mesh.

Swift (1997) used 28.5-gram (1-ounce) weights centered 15.2 centimeters (6 inches) apart on the lead line, to ensure the bottom of the seine remain in close contact with the subsurface, preventing gobies from escaping.

Wang (1982, 1984) used 1.2 x 1.0 meter beach seine with 1.0 millimeter mesh to sample eggs, larvae, and juveniles in the inshore zones with vegetation. Wang and Keegan (1998) collected specimens with a beach seine with 500 micron (0.5 millimeter) mesh to sample juvenile and adult tidewater goby and other fish species.

Swenson (1994) used a seine (7.3 meters x 1.2 meter, 4 millimeter-square mesh) in shallow water (5 to 80 centimeters deep) to sample adults and juveniles. Swenson (1995) sampled in water 20 to 120 centimeters deep to capture adults and juveniles.

The distance of each seine haul varied with researcher and application. Holland (1992) used a minimum of three stations to be sampled within the available aquatic habitat. Each station consisted of five sweeps, each sweep was 10 meters in length, and all sweeps were 2 to 3 meters apart. Wang and Keegan (1998) hauled their seines from 3 to 10 meters along the shoreline, depending on the size of the station. Trihey and Associates (1996) hauled the seine perpendicular to the shoreline and landed the net on shore, where possible. Swenson (1995) reported a total linear distance sampled as approximately 150 meters, but did not report the length of each haul. Trihey and Associates (1996) recommended shortening the seine's width to approximately 3 meters to reduce total catch and time for net clearing and to minimize stress to captured fish.

2.3.2 Drop or Throw Traps

Drop or throw trapping is an effective method for sampling small fishes in vegetated areas or in open water sites that are difficult to seine (Kushlan 1981; Rozas and Odum 1988; Chick *et al*. 1992; Swenson 1996a). Tidewater gobies have been successfully collected with meter-square throw traps (Worcester 1992, Swenson 1995).

Trihey and Associates (1996) sampled with throw trap consisting of two l meter square plastic frames (polyvinyl chloride pipe, 1.27 centimeter diameter) connected with net sides (1.6 millimeter Delta mesh) (Worcester 1992). The lower frame is weighted with water and metal reinforcing bars, and a skirt of netting enclosing a chain is attached to the lower frame to seal the bottom over uneven substrate. Swenson (1995) constructed the drop net with one frame's corners closed to trap air (the floating top frame) and the other frame's comers left open to fill with water when in use (the heavy bottom frame). These frames were attached to the top and bottom edges of 1.2 meter wide fine netting (1.6 millimeter Delta mesh) to form a square tube.

Setting the drop trap is a two-person task. The two polyvinyl chloride pipe frames are held together and tossed approximately 1 meter away. The two people then moved quickly to the trap to help secure the lower frame to the bottom with their feet. After estimating vegetative cover, fish are cleared from the trap with fine-meshed dipnets. The trap is swept until five consecutive passes of the dipnet yield no additional fish (Trihey and Associates 1996). Worcester (1992) constructed drop nets entirely of 1/16 inch mesh knotless nylon netting or fiberglass screening to prevent larval fish from being lost.

Throw traps are easier to use in vegetated areas than the beach seine and are capable of capturing smaller fish due to the finer mesh size. A seine with finer mesh could capture smaller fish, although the smaller mesh would increase water resistance, which could affect seine effectiveness (Trihey and Associates 1996).

Drop nets and traps have been used to sample nursery habitats (Kahl 1963; Kjelson and Johnson 1973; Kushland 1974; Turner and Johnson 1974; Kjelson 1977). Kushlan (1974) discussed the difficulties and advantages of various drop trap designs with respect to size, portability, and effectiveness. Chamberlain (1988) designed and constructed 2 m x 2 m traps with wood frames and transparent plastic panels to avoid attracting or frightening fish by shadow casting. Trihey and Associates (1996) reported results indicating higher variability among drop trap samples than among seines. Worcester (1992) reported 1/8 inch Delta mesh style knotless nylon netting as too large to contain larval fish. The entire trap was lined with fiberglass window screening to ensure that no fish would be lost through the netting.

Fong (1997) recommended a sample area of roughly 10 square meters seemed as optimal; it balanced the variability associated with small sample area that plagued the drop traps against greater than 1 hour processing times needed for sample areas much greater than 10 square meters.

2.3.3 Dip Net

Worcester (1992) used dip nets to remove fish from within the drop traps, both by visual observation and by blind sweeps of the net. Irwin *et al.* (1984) employed dip nets where the use of seines was impractical. Swift *et al*. (1997) used fine-meshed dip nets on occasion. Goldsmith (pers. comm.) found dip nets to be effective where submergent and emergent vegetation or the small size of the water body makes the use of seine nets difficult.

2.3.4 Hand-towed ichthyoplankton net

Wang (1982) and Wang and Keegan (1998) report successful use of a hand-towed ichthyoplankton net with 0.5-meter mouth and 0.5-millimeter mesh to collect fish eggs, larvae, and juveniles. Planktonic larvae were captured in the shallow areas with an ichthyoplankton net and a fine-meshed beach seine. Juvenile and adult tidewater goby inhabit the benthic level. Wang and Keegan (1998) attached the net to a bridle 2 meters in length and hand-towed it along an approximate 10 meter course at each station.

2.3.5 Minnow Traps

Lafferty *et al.* (1997) sampled using Gee's minnow traps. Six minnow traps (6millimeter mesh), baited with dry dog-food, were set in the evening in 0.5-2 meter water and inspected the following morning. Swift (1997) occasionally collecting with Gee's minnow traps with either 1/4 inch (6 millimeters) or 1/8 inch (3 millimeters) mesh and fine-meshed dip nets. Although tidewater gobies sometimes occur in unbaited traps with 3 millimeters mesh, it is extremely unusual to find them in the baited traps with 6 millimeters mesh, even in areas where they are extremely abundant Swift (1997), suggesting that gobies escape easily from the larger mesh.

2.3.6 Snorkeling and Direct Observation

Worcester (1992) concluded snorkeling is not feasible for the tidewater goby due to its small size, schooling tendencies, and cryptic nature. The variable nature of the habitat, often with very murky or heavily vegetated water, also precludes direct observational techniques (Worcester 1992). Swenson (1995) reported some success in observing gobies from the shore in shallow water (40 to 100 centimeters) or while snorkeling, but turbidity prevented extensive field studies using these methods. Holland (1992) conducted snorkeling surveys to qualitatively assess the numbers and distribution of gobies in standing water ranging from a maximum depth of 0.9 to 1.0 meter in 1990 to a maximum of 0.75 meter in 1991. Water turbidity was high in 1990 and effectively precluded snorkeling, but visibility was greater than 0.6 meters in 1991 and a snorkeling survey was successful (Holland 1992). However, Worcester (1992) observed at least 100 tidewater gobies in water approximately 3 inches deep on top of a concrete bridge abutment during a snorkeling survey in February, 1990.

Swift *et al*. (1994) examined some areas by swimming transects about 1.0 meter wide with mask and snorkel. A snorkeled transect 270 meters long and 1.0 meter wide recorded 2 tidewater gobies. However, the resulting density of 0.0074 tidewater gobies per square meter and an estimate of 126 fish in the sampled lagoon was much lower than documented with seine hauls.

They also report other localities as too turbid for snorkeling. Estimates based on snorkeling were found to be much lower than those based on seining. All population estimates in their repot are based on seine collections.

2.3.7 Plastic tubes

Swenson (1995, 1996b) collected adult tidewater gobies in artificial burrows made of polyvinyl chloride pipe tubes (13 millimeter inner diameter, 13 centimeters long). Plastic Dura-lenem, 13.0 centimeter by 5.5 centimeters, was rolled up inside the tube as a liner to collect the adhesive eggs. McGehee (1989) and Bechler *et al*. (1990) report gobies readily adopt plastic tubes as artificial burrows, both in lab aquaria and in the field. "Tube trapping" is a useful method to collect breeding fish, to quantify reproductive output, and to determine the timing and intensity of spawning. The open-ended tubes are shoved into the sediment at an angle of approximately 30 degrees until the lower lip rested at the surface of the substrate (Swenson 1995). Sets of 10 tubes are placed in the sediment in shallow water (less than 1 meter deep, preferably 20 to 50 centimeters deep) at each habitat site (Swenson 1995). Tubes are spaced up to 1 meter apart to minimize territorial interactions by males. Tubes are left in the substrate 14 to 28 days to allow colonization by nesting males.

2.3.8 Sample Size

Fong (1997) estimated 48 and 33 beach seine hauls would be required for two sample regions to obtain density estimates within 20 percent of the mean with 90 percent confidence, based on data reported in Trihey and Associates (1996). Assuming that each seine haul would take an average of 45 minutes, a total of 61 sampling hours would be required for just two regions. In addition to the amount of time involved, this heavy sampling intensity would result in impacts to the tidewater goby habitat. For their purposes, the sampling effort was generally less than 5 seine hauls per region. Trihey and Associates (1996) recommended that sampling effort should consist of 3 to 5 seine hauls per site and 5 to 10 drop trap samples. Swift (1997) recommended that to detect seasonal changes in populations, collections in lagoons be repeated bimonthly.

2.3.9 Sampling Season and Timing

Fong (1997) reported that October sampling indicates higher fish abundance occurs in the fall rather than the winter sampling period. Overall, mean densities of gobies increased from 1.7 per square meter to 35 per square meter.

Swenson (1995) conducted sampling in the morning at high tide (plus 4.7 feet). Because the water was too deep to effectively sample the main creek, a second survey was conducted in the morning during low tide (plus1.8 feet), using a bag seine.

To detect seasonal changes in populations, Swift (1997) collected in lagoons bimonthly. Upstream tributaries were sampled for gobies intermittently to assess the degree to which tidewater gobies utilized these areas.

2.3.10 Density

Trihey and Associates (1996) reported tidewater goby density as extremely variable both across and within most sampling factors: method, location, vegetation and substrate. Mean density was 12.5 tidewater gobies per square meter for throw traps (standard deviation = 22.6, range 0 to 91, n = 70) and 2.0 tidewater gobies per square meter for seine samples (standard deviation = 3.6, range = 0 to 14.2, n = 26). Although the capture method alone did not significantly affect tidewater goby densities, the project's main objective was to test sampling methods and therefore the authors decided to treat trap and seine data separately for further analyses. Location within the lagoon significantly affected tidewater goby density for both methods. Substrate type and vegetation significantly affected densities of tidewater gobies caught with the throw traps but not with seine. Depth and distance from the shoreline also affected tidewater goby density. Tidewater gobies were more abundant in waters 50 to 100 centimeters deep and within 30 meters of the shore. Tidewater gobies were not collected in waters less than 20 centimeters deep or from nearshore sites. Swenson (1995) reported tidewater goby density varied tremendously among the five samples (0 to 198 tidewater gobies per square decimeter). Density was greater in vegetated areas; the difference was not significant but the small sample size may have been too low to reject the null hypothesis (Swenson 1995).

2.3.11 Salinity

Swenson (1994) reported on the use of an Atago hand refractometer to measure salinity. Water temperature (degrees Celsius) and salinity (parts per thousand) were measured at the surface and on the bottom (approximately 50 to 70 centimeters deep).

2.4 Suitability of Habitat

Lafferty *et al*. (1999) reported known locations where apparent extirpations were followed by evidence of recolonization (Lafferty *et al*. 1999). Based on this information, we assume that all sites known to be previously occupied by gobies will be considered suitable and occupied without clear evidence that the site has been modified to the point where recolonization is highly unlikely, barring habitat restoration that successfully restores habitat conditions and ecosystem functions to conditions similar to a time of known tidewater goby occupancy.

3. Application of the Recommended Protocol

3.1 General Intent of the Protocol

The general intent of the protocol described in section 4 of this document is to provide a methodology of surveying for tidewater gobies in likely natural and human-made habitats at an intensity and effectiveness that ensures a high level of confidence in finding gobies should they currently exist at the site. A secondary intent of the protocol is to prescribe a sampling regime or methodology that avoids placing an onerous and unreasonable burden on any project proponent who seeks to work in habitats likely to be suitable to the species.

The methodology described below is intended to document the presence or absence of tidewater gobies to a reasonable level of certainty, and to provide basic information on habitat affinity of the species. This methodology is not intended to be of sufficient intensity to estimate population levels, recruitment rates, or survival rates; habitat affinities more appropriate for research studies; population viability analyses; or other parameters associated with research-level activities. The parameter of interest in these surveys is a high likelihood of detecting gobies should they exist at the site.

We believe the following protocol will provide consistent results with a reasonable amount of effort. However, while we strongly recommend that potential surveyors adopt and implement our proposed protocol, we may consider other methods, on a case by case basis. The action agency or project proponent has the discretion to use any appropriate survey methodology to determine the presence or absence of tidewater gobies, provided they meet three conditions. First, any proposed protocol must meet or exceed the intended level of survey intensity and effectiveness of the protocol described herein. Second, surveyors proposing methods or intensities other than as prescribed here should seek concurrence on the proposed changes from our field office having jurisdiction over the proposed survey area. The proponent should seek this concurrence as early in the survey design as possible, and definitely prior to beginning actual field surveys. Finally, the surveyors must obtain any and all applicable Federal (described below) and State permits in advance of conducting the surveys.

3.2 Application of the protocol to projects

These guidelines are not intended for long-term monitoring or research projects or for determining the overall status of populations; guidelines for such monitoring and research efforts should be developed with our assistance on a case-by-case basis. We have worked with, and will continue to work with Federal, State, and local biologists; scientific and academic institutions; commercial organizations; and other interested parties to collect additional data on the distribution, ecology, and biology of the tidewater goby. We will revise this survey protocol as needed, using the best available data.

This protocol should fulfill the needs of landowners and managers to complete pre-disturbance surveys for tidewater gobies that provide a reasonable basis upon which to make effects determinations. Projects resulting in direct or indirect effects to tidewater gobies or their habitats should conduct surveys consistent with this protocol to document the presence or absence of tidewater gobies at their proposed project site. In addition, surveys conducted under this protocol may provide useful information on the overall distribution of tidewater gobies within their range.

Extreme care must be taken when conducting surveys to avoid inadvertently injuring or killing tidewater gobies, or damaging their habitat (see Appendix F-3).

3.3 Peer Review of the Recommended Protocol

This protocol has been developed in conjunction with and reviewed by the Tidewater Goby Science Team, a group of agency and independent experts in tidewater goby biology and

research. The protocol includes their comments. Any survey that uses a different methodology from this protocol should include a detailed description of the procedures used and an evaluation as to whether the conclusions drawn constitute the best available scientific and commercial information.

4. Recommended Protocol

We recommend the following survey guidelines be used to determine, with some reasonably high level of confidence, the presence or absence of tidewater gobies in habitat deemed suitable for the species.

4.1 Section 10(a)(1)(A) Recovery Permit Requirements

The survey methods prescribed in the following protocol require work within habitat likely to be occupied by tidewater gobies, and involves the handling of individuals for identification purposes. Although there is no requirement to preserve voucher specimens or otherwise directly kill individuals, the capture and handling of individuals has some risk of incidental mortality. Also, the methods proposed here require the surveyors to enter suitable habitat, and an unavoidable consequence of such activity is the trampling or other damaging of occupied burrows and mortality of eggs and possibly individuals. Therefore, all surveyors must obtain a recovery permit issued by us under section 10(a)(1)(A) of the Endangered Species Act of 1973, as amended. The permit application form and instructions for completion are available at the website http://forms.fws.gov/3-20055.pdf.

4.2 Survey Equipment

Surveys should be conducted using appropriate equipment. If other equipment is to be used, surveyors should contact our appropriate field office to determine if the other equipment is suitable for use under this protocol. The following equipment is the minimum necessary for conducting tidewater goby surveys under this protocol:

- U.S. Geological Survey quadrangle 7.5 minute series (topographic) map(s);
- global positioning system unit or other method to identify latitude/longitude of tidewater goby and sampling locations to within 10 meters of actual location on topographic maps or aerial photos;
- refractometer or electronic salinity meter;
- a fish identification guidebook or field-ready identification card with pictures of similar species;
- long handled dipnet with a frame opening greater than 0.1 square meter and mesh size less than 3 millimeters;
- 3 meters length by 1 meter deep seine (approximately 3 millimeters mesh), recommended for small habitats (described below);
- 5 meters length by 1 meter deep seine (approximately 3 millimeters mesh), recommended for medium to large habitat areas;
- minnow traps with approximately 3 millimeters mesh, unbaited;
- field notebook;

- camera;
- thermometer;
- meter stick; and
- a goby viewing device (*e.g.*, clear plastic bag or small jar).

In order to prevent the unintentional introduction of nonnative organisms or disease, sampling gear should be thoroughly cleaned, and dried if possible, prior to use in different watersheds.

4.3 Site Assessment

The area to be sampled for tidewater gobies should include appropriate habitat consisting of slow moving water bodies, generally less than 3 meters (10 feet) in depth, with suitable substrate and appropriate water quality parameters. The size of the discrete water body (lagoon, pond, stream, ditch) under investigation will be used to determine the corresponding sampling effort to be carried out.

For the purpose of selecting appropriate equipment, and determining sampling effort, water bodies are categorized by size as large, medium, and small. Large water bodies are those meeting at least one of the following general physical parameters: streams with channel bankful widths in excess of 20 meters (66 feet) at any point and/or with estuarine (areas with salt water intrusion) habitats exceeding 1 kilometer (0.6 mile) in length; or lagoons and ponds larger than 2 hectares (5 acres) surface area. Medium sized water bodies include smaller streams less than 20 meters bankful width and/or estuaries longer than 100 meters (328 feet) but less than 1 kilometer in length. Medium sized lagoons and ponds are those with a surface area less than 2 hectare, but larger than 0.4 hectare (1 acre). Small water bodies are the remaining streams, ditches, sloughs, lagoons, and ponds of lesser dimension than as described for the medium size range.

Immediately prior to conducting in-water goby sampling activities, surveyors should complete the following actions:

1. Take one or more overview photos from a vantage point that provides an oblique view of the sampled habitat (when possible). The location(s) should be consistent from year to year if future surveys are anticipated.
2. Record the percent cover of aquatic vegetation and identify common plant species present in the area actually surveyed.
3. Categorize the water body, including size (as defined above).
4. Measure the average depth of the water using the meter stick for each sampling effort.
5. Record water temperature at a depth of half the average water depth in the survey area.
6. Take salinity measurements at both surface and bottom depths with the salinity meter or refractometer.
7. Note any unusual characteristics of the environment.
8. Record all other pertinent information describing date, time, location, names of surveyors, *etc*.

4.4 In-water Sampling for Tidewater Gobies

Before sampling, we recommend the surveyors review the literature and agency records for historical information and other available resources, and including communication with species experts. This review should determine whether populations have been previously identified at or near the site to be sampled, or whether suitable habitat for tidewater goby exists at the site. This information should be summarized in the survey report (see section 5, below).

In the absence of recent survey data, any site known historically to have been populated with tidewater goby should be assumed to be currently occupied by the species, unless clear evidence indicates that the habitat has been so modified as to be uninhabitable.

For the purpose of this protocol, the presence of one individual tidewater goby resulting from surveys constitutes evidence of an extant population. This determination is based on the annual life cycle of the species, the difficulty in detecting tidewater gobies, and the low likelihood of only one individual to be present in a watershed.

4.5 Survey Methods

Several methods can be effective in identifying, or capturing tidewater gobies. The following methods are recommended for conducting surveys, and each one is best suited to particular types of water bodies.

To maximize the probability of capture, and to ensure that the highest quality habitat within the area of interest is surveyed, sampling should be segmented into multiple locations within any water body. For purposes of this protocol, the "area of interest" is defined as that portion of the water body wherein the presence or absence of gobies is to be documented. For general surveys, the area of interest is likely to be the entire water body. For water bodies proposed to be altered by a project or other action, the area of interest is that portion of the water body likely to be affected (adversely or beneficially) by habitat loss, alteration, disturbance, sedimentation, or any other physical or biological factor directly or indirectly affecting suitable habitat of the species.

When surveying large water bodies, surveys should adequately cover all suitable habitat within the area of interest. We recommend surveying in a minimum of five distinct separate areas throughout the suitable habitat in large water bodies. When surveying small and medium water bodies, at least three distinct areas within suitable habitat should be sampled. In all water bodies, the saltwater/freshwater interface should be included in sampling locations, because gobies are often located in this zone. The following information should be used as a guide to complete the required amount of sampling effort. The effort categorized in the table below represents minimum acceptable numbers. In all size categories of water bodies, it is important to sample in

Water Body Size	Number of Minnow Traps per 24 hour sampling period/ number of sampling periods	Seine hauls (minimum effort required)	Dip Netting (minutes of effort)	
			Supplemental	Sole Method
Large	12/2 (minimum)	25 per 10 hectares	20	120 per 10 hectares
Medium	Not required	15 per water body	10	90 per water body
Small	Not required	15 per water body	5	60 per water body

the area where the impacts from the proposed project would be significant, and especially important in the large water bodies, where only a small percentage of the water body is surveyed. If the water body supports fishes, surveyors may begin sampling with the dip net if and where appropriate. Surveyors should record the presence of other identifiable fish and invertebrate taxa captured or observed, as part of general comments for each water body surveyed. Dip nets are especially important in those portions of suitable habitat where emergent and submergent vegetation or substrate limits or precludes the use of seine nets. For those habitats where seine nets cannot be used effectively, dip nets may be the only method that can be effectively employed. The table above indicates the amount of time that should be dedicated to the use of dip nets. Where seine nets can be used effectively, the amount of dip netting required is identified in the column labeled "Supplemental." In those water bodies where seine nets cannot be used, the dip netting may be the sole method that can be used effectively. The minimum time allocated to dip netting for sole method sampling is identified in the above table. For instructions in minimizing effects to gobies from sampling see Appendix F-3.

Where site conditions allow effective use of a seine, surveyors should attempt to cover a minimum of 30 square meters per seine haul, with a recommended average of 50 square meters per seine haul. The number of seine hauls may be limited by suitable sites, and is dependent on the size of the water body.

For small and medium water bodies, conduct enough seine hauls to adequately cover suitable habitat. A minimum of 15 seine hauls is suggested to adequately cover these areas. Although some overlap between seine hauls is effective, they should have no more than 20 percent overlap in area. For any size water body, once tidewater gobies are detected, sampling may cease. In cases where the amount of suitable habitat within a water body can be covered completely by fewer than the prescribed number of seine hauls, sampling may cease when the water body is essentially 100 percent covered, or when tidewater gobies are first captured.

For large water bodies (as defined above), the number of seine hauls completed should be adequate to effectively sample the suitable habitat of interest. Since large water bodies may range from two to several hundred or more hectares, these water bodies only need to be sampled in the area of interest (as described above). Within the area of interest, the water body should be generally delineated into 10 hectare blocks of suitable habitat. The following survey recommendations apply within each 10 hectare block. We recommend a minimum of 25 seine hauls throughout a minimum of five sampling areas in each block. These 25 seine hauls should be distributed approximately uniformly across the five sampling areas (*i.e.*, five or more seine hauls across each of five or more sampling areas), or otherwise distributed among the five sampling areas to optimize the likelihood of detecting gobies within the suitable habitat of interest. For example, if two sampling areas are high quality habitat and three are lesser habitat, it may be best to complete eight seine hauls in each of the two best habitat areas, and three seine hauls in each of the three lesser habitat areas. Since conducting additional seine hauls in a sampling area represents relatively little additional work above that already necessary to do the minimum, additional seine hauls are encouraged whenever a question remains as to the possibility of tidewater gobies occupying the habitat.

If small fishes suspected to be tidewater gobies are found, surveyors should place them in viewing device and confirm the identification of tidewater goby (or other species) by looking for the clear tip of the first dorsal fin. If surveyors are in doubt, they should confirm fish identification by using a fish identification guidebook, and if possible, take photographs. Surveyors should record the location where gobies were sampled and the sampling effort expended to find them, to the nearest 10 meters. Surveyors should release the gobies promptly at site of capture and discontinue sampling (vouching new records or collections for other scientific purposes are appropriate if in accordance with the biologist's permits). Surveyors should also record the location of positive and negative survey results.

4.6 Sampling Period

Tidewater goby abundance fluctuates spatially and seasonally (Swenson 1999), due in part to their predominantly annual life cycle (see Background). Surveys must be conducted in two sampling periods between July 1 and October 31, due to this period being the time of highest abundance for the species in general, and therefore, the period of highest detection. The two sampling periods must be separated by at least 30 days to accommodate situations where changes in water level, seasonal movements, or other functions result in movement of gobies within the survey area. All surveys should be recorded and reported, including surveys that do not detect tidewater gobies. Surveyors should return to the same sites in sampling period 2 where tidewater gobies were not found in sampling period 1, but also include any suitable habitat that may have not been suitable during the first survey period due to changes in water level, *etc*. If tidewater gobies are found during the first visit, sites do not need to be sampled during the second period.

For surveys conducted as part of a project clearance, additional sampling may be needed prior to initiation of those project activities that may affect the tidewater goby. If gobies are not found within the two survey periods, and the project will not be completed within 60 days of the last survey, a pre-project survey may be required for any part of the proposed project area that may affect the tidewater goby. The need for this survey will be evaluated on a case-by-case basis between the applicant and our field office that has jurisdiction over the area of interest.

4.7 Area to Which Survey Protocol is Applicable

The survey protocol may be applied throughout the species range. Survey results are specifically applicable only to the actual body of water to which the survey is applied, but may be generally applied to similar water bodies contiguous to or immediately adjacent to the sampled habitats, provided a reasonable likelihood of connectivity between the sampled site and the sites to which the information is being extrapolated.

4.8 Effective Duration of Survey Results

Survey results are valid for 1 year. Based on input from several tidewater goby research scientists, due to the annual life cycle of the tidewater goby, documented population fluctuations, and their recolonizing ability, survey results are valid for a maximum of 1 year from the date surveys end.

Five consecutive years of negative survey results are needed to establish a history of absence. Proposed actions that span more than 1 year must be surveyed for each year of activity. Contact our appropriate field office (see Appendix F-1, below) for additional information before conducting surveys.

Surveys are not needed if surveys completed during the prior 10 years have confirmed the presence of gobies in waters with habitat contiguous to the habitat identified for survey AND the habitat where gobies were earlier found have not been substantially modified or impacted by human activities or natural events. That is, we presume that habitat previously occupied by gobies continues to be occupied unless clear evidence indicates that gobies have been extirpated.

The converse is not necessarily true. Habitats that have undergone sampling in the past, regardless of intensity, and been shown to be absent of gobies does not necessarily mean those habitats are currently devoid of the species. We will, however, consider the merits of scientific analyses on a case-by-case basis to analyze presumed absence of the species in otherwise suitable habitat. Those analyses should consider any past surveys done in that habitat, the intensity and coverage of those surveys, any modifications to the habitat since last known occupancy by the species, and the potential for the habitat to be recolonized by adjacent populations.

4.9 Other Permits and Permissions

Because this protocol (and tidewater goby surveys in general) involves capture, surveyors must have "take" authorization pursuant to section 7 or 10(a) of the Act to be exempt from the take prohibitions under section 9 of the Act. Surveys must be conducted by individuals possessing a 10(a)1(A) recovery permit from the Fish and Wildlife Service, specific to the tidewater goby. In addition, there may be permit requirements from the California Department of Fish and Game as well as other agencies to conduct surveys for gobies. Finally, surveyors should seek appropriate permissions from landowners or their managers to access or cross properties for their goby survey work, as needed. Nothing within this protocol should be construed as permission to enter, access, or cross any lands or waters not under the immediate control of the surveyor without specific permission from the affected landowner(s).

5. Reporting Requirements

Any permitted biologist observing a tidewater goby under this protocol is to notify our appropriate field office by phone (see Appendix F-1 for contact numbers) within 24 hours of such observation. Within 5 business days, the surveyor should fax or e-mail a copy of a U.S. Geological Survey quadrangle 7.5 minute series (topographic) map to the recovery permit coordinator in our appropriate field office, with the observation site clearly marked. Include a detailed description of the precise location of the tidewater goby(ies).

The permittee shall notify our appropriate field office in writing, at least 10 working days prior to the anticipated start date of survey work and receive approval prior to beginning work. Surveyors also should prepare a final report within 45 days that includes the following:

- Recovery permit number(s)
- Names of surveyors
- Location information, including county, watershed, GPS coordinates in either Latitude/Longitude or UTM NAD27 or indicated on a copy of a U.S. Geological Survey 7.5 minute topographic quadrangle map
- Photographs of the project site (photo points [locations and general direction] should be indicated on a map)
- A typed summary providing survey dates and times (both begin and end times)
- Habitat description (amount and quality of suitable habitat)
- The area sampled by a particular method (indicated on a map)
- Justification for areas not surveyed
- Effectiveness of seine hauls
- Number of tidewater gobies captured
- Photographs of tidewater gobies detected on site to verify species identification, (collection is not permitted without prior authorization)
- Other species detected
- Water temperature
- Salinity
- Whether area is currently tidally influenced
- A description of possible threats to tidewater gobies observed at the site including nonnative and native predators.

The report should be provided to our appropriate field office (see Appendix F-1).

Based on the results of surveys, we will provide guidance on how tidewater gobies should be addressed. If tidewater gobies are found, we will work with the project proponent through the section 7 (for Federal actions) or section 10 (for non-Federal actions) process. If tidewater gobies are observed but not identified to species, additional survey efforts may be recommended. If tidewater gobies are not found during the field surveys (conducted according to this protocol), we will consider the tidewater goby not likely to be currently present on the project site.

We may not accept the results of field surveys conducted under this protocol for any of the following reasons: 1) if our appropriate field office was not contacted prior to field surveys being conducted; 2) if field surveys were incomplete, or conducted in a manner that was inadequate for the area to be surveyed; or 3) if the reporting requirements were not fulfilled**.**

We encourage all surveyors to send any information on tidewater goby distribution resulting from surveys to the California Natural Diversity Data Base administered by the California Department of Fish and Game. Information about how to submit information to the California Natural Diversity Data Base is provided in Appendix F-2. Copies of the California Natural Diversity Data Base form should mailed in a timely manner to the California Department of Fish and Game, as well as our appropriate field office.

These individual survey reporting results are separate from, and do not replace or supersede, the annual report required of each endangered species recovery [section 10(a)(1)(A)] permit holder to report activities conducted each year under his/her permit.

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Appendix F-1. USFWS Field Office and Regional Office Contacts

Please contact the appropriate Fish and Wildlife Service field office, for the counties indicated below, to obtain local information about the tidewater goby or application of this survey protocol:

For San Diego or Orange County, or Los Angeles County south of the Santa Monica Pier, contact:

Carlsbad Fish and Wildlife Office
Attn: Recovery Permit Coordinator
6010 Hidden Valley Road
Carlsbad, California 92009
Phone: (760) 431-9440
Fax: (760) 930-0846

For Sonoma, Marin, Solano, Contra Costa, Alameda, Santa Clara, San Mateo, or San Francisco County, contact:

Sacramento Fish and Wildlife Office
Attn: Recovery Permit Coordinator
2800 Cottage Way, Suite W-2605
Sacramento, California 95825
Phone: (916) 414-6600
Fax: (916) 414-6713

For Santa Cruz, Monterey, San Luis Obispo, Santa Barbara, or Ventura County, or Los Angeles County northwest of the Santa Monica Pier, contact:

Ventura Fish and Wildlife Office
Attn: Recovery Permit Coordinator
2493 Portola Road, Suite B
Ventura, California 93003
Phone: (805) 644-1766
Fax: (805) 644-3958

For Del Norte, Humboldt, or Mendocino County, contact:

Arcata Fish and Wildlife Office
Attn: Recovery Permit Coordinator
1655 Heindon Road
Arcata, California 95521
Phone: (707) 822-7201
Fax: (707) 822-8411

For information on ESA section 10(a)(1)(A) recovery permits, please contact:

Region 1, USFWS
Attn: Recovery Permit Coordinator
Eastside Federal Complex
911 N.E. 11th Avenue
Portland, OR 97232-4181
Phone: (503) 231-6241
Fax: (503) 231-6243

Appendix F-2. General instructions for filling out California Natural Diversity Data Base field survey forms

The California Natural Diversity Data Base is the largest, most comprehensive database of its type in the world. It presently contains more than 33,000 site specific records on California's rarest plants, animals, and natural communities. The majority of the data collection effort for this has been provided by an exceptional assemblage of biologists throughout the state and the west. The backbone of this effort is the field survey form. We are enclosing copies of California Natural Diversity Data Base field survey forms for species and natural communities. We would greatly appreciate you recording your field observations of rare, threatened, endangered, or sensitive species and natural communities (elements) and sending them to us on these forms.

We are interested in receiving forms on elements of concern to us; refer to our free publications: *Special Plants Lis*t, *Special Animals List,* and *Natural Communities List* for lists of which elements these include. Reports on multiple visits to sites that already exist in the California Natural Diversity Data Base are as important as new site information as it helps us track trends in population/stand size and condition. Naturally, we also want information on new sites. We have enclosed an example of a field survey form that includes the information we like to see. It is especially important to include a photo copied portion of a U.S. Geological Survey topographic quad with the population/stand outlined or marked. Without the map, your information will be mapped less accurately, as written descriptions of locations are frequently hard to interpret. Do not worry about filling in every box on the form; only fill out what seems most relevant to your site visit. Remember that your name and telephone number are very important in case we have any questions about the form. If you are concerned about the sensitivity of the site, remember that the California Natural Diversity Data Base can label your element occurrence "Sensitive" in the computer, thus restricting access to that information.

The California Natural Diversity Data Base is only as good as the information in it, and we depend on people like you as the source of that information. Thank you for your help in improving the California Natural Diversity Data Base.

Appendix F-3. Techniques to Minimize Effects to Tidewater Goby from Surveys

General Guidelines

When conducting sampling for tidewater gobies, particular care should be taken when walking in suitable habitat to minimize disturbance to the area, especially during breeding periods, when gobies in burrows could be crushed as a result of being stepped on. Entry to the water should be slow, and where possible, visually scan for gobies before entry. This precaution should also be taken when launching and retrieving of boats as part of sampling efforts. When captured, tidewater gobies should never be completely removed from water, and should remain completely wetted at all times. All individuals captured should be released immediately after identification at the point of capture. Any tidewater gobies exhibiting signs of physiological stress shall be immediately released. As part of the presence/absence survey, measuring gobies is neither required nor recommended. Tidewater gobies shall not be anaesthetized, stained, dyed, or otherwise marked at any time. Electrofishing is not an authorized sampling method for tidewater gobies.

Seining

Disturbance and damage to burrows, eggs, and young should be minimized through use of the smallest and lightest weight seines practicable that meet protocol guidelines. It is important to avoid accidental injury or mortality to tidewater gobies, which may be caught and suffocated in vegetation such as algal mats or other debris when using seines. Rocks should be removed from seines immediately, otherwise tidewater gobies may be crushed by rocks tumbling and rolling in the seine. Bagged portions of seines must remain in the water until all tidewater gobies are removed. Temporary holding containers, if used, should be shallow, filled with clean water, and be placed in a location that will not result in exposure to extreme temperatures.

Dip Netting

When using dip nets, a container of water collected from the immediate vicinity of the tidewater goby capture should be available to immediately transfer gobies into when captured.

Traps

When setting minnow traps, place them in areas where anticipated tidal or upstream water volume fluctuations will not dewater the trap, or expose it to poor water conditions as a result of location. When checking traps, all contents should immediately be transferred to a container of water from the immediate vicinity before identifying fish species.

Appendix G. Description of Recovery Units and Sub-Units

The six Recovery Units and 26 Sub-Units are described below. Information reviewed includes each Recovery Unit's and Sub-Units distinguishing phylogeographical features, location, geological characterization, and tidewater goby morphological descriptions. Primary recovery tasks are also described for each location. In some cases, where data and research are lacking, descriptions are brief or incomplete. Table G-1, provided below, lists source populations for potential tidewater goby reintroduction and introduction sites.

North Coast Unit (NC)

This Recovery Unit extends from Smith River near the Oregon border to the southern end of Mendocino County. It has the greatest geographic extent along the coast (approximately 150 miles) of any of the proposed recovery units. This unit forms a discrete clade in phylogeographic analysis (Dawson *et al.* 2001) and is also differentiated from other units in that all fish observed have complete supraorbital canal structures (D. Jacobs pers comm. 2004). South of Mendocino County for approximately 70 miles to Salmon Creek the coast is rocky and steep, and there appear to be few of the small estuarine habitats preferred by tidewater gobies. No tidewater gobies have been captured or detected within the estuaries, lagoons, and river mouths along this stretch of coast, further supporting our assumption that it is a significant barrier to tidewater goby dispersal.

Only a limited number of mitochondrial sequences have been generated from within the North Coast Recovery Unit. These data alone are insufficient to define Sub-Units in the region. Therefore, Sub-Units are based on distance between sites and on coastal geomorphology, where differential dispersal over sand and rock, as observed elsewhere (Dawson *et al.* 2001; Barlow 2002; Lafferty *et al*. 1999) and discussed above, comes into play.

Sub-Units

The **NC1** Sub-Unit is delineated by the extent of the Holocene alluvial surface along the coast in the Region of Smith River and Lake Earl/Talawa. This stretch of coast is characterized by low-lying sandy shores. Lake Earl, a large dune-dammed lagoon, likely sustains the largest tidewater goby population in the species range. However, Lake Earl is a single locale and is subject to breaching, which affects the population. In addition, the only other known habitat in the area in Tillas Slough of the Smith River has been difficult to collect at times, implying scarcity or intermittency of this population. Given the proximity and soft substrate, it is unlikely that these sites are genetically distinct except perhaps for potential loss of genetic variation in Tillas Slough due to bottlenecks* or recolonization. Tidewater gobies are not known from the steeper coast extending 30 miles to the south, suggesting that these populations are genetically isolated from the next Sub-Unit to the south. Thus, there is reason to be concerned given the presence of only two populations. It is possible that locations in the Smith River Estuary other than Tillas Slough might make viable tidewater goby habitat or that fish could be transplanted to Elk Creek or other small drainages just to the south on contiguous coastal lowlands.

Primary tasks recommended for recovery:

1) Monitor
2) Establish degree of genetic isolation of the Sub-Unit.
3) Confirm that Lake Earl is the source of genetic variation in the region.
4) Transplant Tillas Slough with tidewater gobies from Lake Earl after 3 years of recorded absence.
5) Establish populations in Elk Creek.

The **NC2** Sub-Unit consists of four occupied tidewater goby localities along approximately 15 miles of low-lying coast associated with Holocene alluvium. This region, extending north of Patrick's Point, is isolated from other regions by steep coasts. NC2 is primarily defined on the basis of the natural extent of the species range and geomorphology. The northernmost site, Redwood Creek estuary, is a seasonally breached freshwater estuary with sloughs. The other three sites are large open lagoons. Tidewater gobies have often proved difficult to locate in Redwood Creek estuary. One lagoon (Freshwater Lagoon) has high populations of introduced predators (centrarchids) and populations of tidewater gobies have not been observed there in over 50 years. The other two lagoons (Stone Lagoon, Big Lagoon) have a more continuous population history although frequency of sampling has been limited.

Primary tasks recommended for recovery:
1) Monitor
2) Establish degree of genetic isolation of the Sub-Unit.
3) Confirm that Stone and Big Lagoons are the most genetically variable potential source populations in the region.
4) Restore and transplant Redwood Creek estuary with tidewater gobies from Stone Lagoon after 3 years of recorded absence (Table G-1).

The **NC 3** Sub-Unit consists of a region of sandy coast and coastal Holocene alluvium about 25 miles in length from the mouth of the Mad River in the north across Arcata /Humboldt Bay to the Eel River to the south. Again, this Sub-Unit is defined largely by the isolation of this sandy shoreline limited by rocky shores to the north and south. Tidewater gobies have been recovered from the margin of Arcata/Humboldt Bay. Here they occupy high marsh channels. In the case of the Mad River Slough (not the Mad River proper) the habitat appears to be a long abandoned tide-gated irrigation channel marginal to the Slough, which in turn empties into Arcata Bay. This elevated habitat appears to be isolated from tidal action except perhaps during spring tides. This site is atypical in that it is not in a typical seasonally closed coastal setting (although the population in Lagunitas Creek that debouches into Tomales Bay and extirpated populations around San Francisco Bay may represent similar bay margin habitats). It seems likely that geomorphologic modification of this region may have led to less seasonally closed habitat over time. Dredging and jetties may also serve to maintain the open condition of Arcata Bay. Agricultural and transportation activity have also greatly modified the bay margins, likely eliminating tidewater goby habitat.

The Mad River Slough is the only location where collections have been predictably successful in recent years. This habitat is small and potentially subject to further modification. Tidewater gobies have also recently been reported from southern Arcata Bay in Jacoby Creek, KATA Station, and Freshwater Slough, all of which are similar small habitat. Nevertheless, the status of the tidewater goby in the NC3 region seems particularly precarious. Thus, a proactive effort to

place tidewater gobies in similar closed high-marsh-channel/bay-margin habitats seems appropriate. To this end, other localities such as Klopp Lake, Hookton Slough, and White Slough have been mentioned as potential tidewater goby habitat. These sites tend to be small, and it can be argued that, due to the small size and precarious nature of these habitats, a larger number of sites should be identified in which reintroductions should be attempted. Successive reintroductions should be attempted after observation of absence in 2 rather than 3 years. This is merited by the small size of sites that permit greater certainty of absence and the precarious nature of the suite of populations (metapopulation) that comprises the unit.

Tidewater gobies have been recently reported from the Eel River (G. Goldsmith, pers. comm.. 2004) . The Eel River has a more open system than tidewater gobies generally prefer; however, this river is part of the low alluvial plain that constitutes NC3. It is very likely that the Eel River and for that matter the Mad River were connected with the Humboldt/Arcata Bay system at various times in the Holocene either through flooding or channel migration. In short, it is worthwhile transferring tidewater gobies to the Mad River to see if it can sustain populations despite what appear to be less than perfect conditions.

Primary tasks recommended for recovery:
1) Monitor
2) Establish degree of genetic isolation of the Sub-Unit.
3) Tidewater gobies should be transferred to the Mad River Estuary, Klopp Lake, Hookton Slough, and White Slough from the Mad River Slough, Jacoby Creek, KATA Station, and Freshwater Slough.
4) Consider other sites around the margin of Humboldt Bay for transfer of tidewater gobies.
5) Localities should be considered for transfer from persisting sites after 2 years of absence (see Table G-1).

The **NC4** Sub-Unit consists of Ten Mile River, a large relatively pristine locality that is seasonally closed. This site is separated by at least 60 miles of steep coast and Cape Mendocino from locations in NC3 to the north. The two small sites of Virgin and Pudding Creek, constituting NC5, are located less than 10 miles to the south, albeit over rocky substrate. These units may be isolated due to the rocky shore, or they could be sink populations supplied by Ten Mile River. Genetic analysis to assess the relationship between these units is necessary. As the lagoon is large, transplanting should probably not be conducted until extensive presence/absence surveys have not detected tidewater gobies over 4 years.

Primary tasks recommended for recovery:
1) Monitor
2) Establish degree of genetic isolation of the Sub-Unit.
3) Ten Mile River should have gobies transferred to it from Virgin or Pudding Creek after 4 years of recorded absence (see Table G-1).

The **NC5** Sub-Unit consists of Virgin and Pudding Creeks. These small closed stream habitats near Fort Bragg are separated by less than 10 miles from Ten Mile River. As discussed above, they may or may not be genetically isolated from this Sub-Unit (NC4). If after genetic analysis NC4 and NC5 are determined to be identical with Ten Mile River, or if they are determined to be operating as an interacting metapopulation with Ten Mile River, they should be conjoined and

managed as a single unit. It may be that once the genetic issues have been addressed, other small habitats in the region could be identified to raise the number of habitats in the unit to support recovery. Virgin Creek and Pudding Creek should have tidewater gobies transferred (one from the other) after 2 years of recorded absence as they are small easily surveyed habitats.

Primary tasks recommended for recovery:
1) Monitor
2) Establish degree of genetic isolation of the Sub-Unit.
3) Virgin and Pudding Creek should be recolonized after 2 years (see Table G-1).
4) Other streams suitable for recolonization in the Fort Bragg region should be identified.

The **NC6** Sub-Unit consists of three small localities, Davis Pond, Brush Creek and Lagoon Creek, located on a low sandy shore north of Pt. Arena (Manchester State Beach). It is separated by about 25 miles of rocky coast to the north. This stretch of coast between NC5 and NC6 is of interest as it contains a number of modest size streams suggesting the possibility of tidewater goby habitat. However, streams such as the Noyo and Navarro may not close in the summer due to the lack of sandy sediment buildup at their mouths. Thus they may not be adequate tidewater goby habitat or they may only serve as tidewater goby habitat intermittently. The North Coast Unit is separated to the south of Point Arena by about 60 miles of steep coast where tidewater gobies have not been found. This break in distribution corresponds to a clade break in the Dawson *et al*. (2001) analysis between the North Coast Unit and the Greater Bay Area Unit. Given the small size and isolation of the NC6 habitats, their likelihood of persistence seems small. As yet, there is no evidence that they are genetically distinct. If such evidence were forthcoming, it could prove important to establish still other nearby populations to sustain the viability of this Sub-Unit.

Primary tasks recommended for recovery:
1) Monitor
2) Establish degree of genetic isolation of the Sub-Unit.
3) Davis Pond, Virgin and Pudding Creek should be recolonized after 2 years (see Table G-1).
4) Identify other streams suitable for recolonization in the Manchester Beach region.

Greater Bay Unit (GB)

This Recovery Unit extends from Salmon Creek just north of Bodega Head in Sonoma County to the Salinas River Valley in Monterey County. It is separated from the North Coast Unit by 60 miles of steep coast and a clade break is evident in some analyses (Dawson *et al*. 2001). To the south, this unit is separated from the Central Coast Unit by the steep 100 mile long Big Sur Coast which supports little estuarine habitat appropriate for tidewater gobies. Again a clade break between the Greater Bay and Central Coast Units is evident in the Dawson *et al*. (2001) analysis. David Jacobs (pers comm. 2004) reported that the Greater Bay Unit has a low frequency of modest reduction of the supraorbital canal, as opposed to the North Coast Unit where no such reduction is observed, and units to the south where such reduction is more pervasive and instances of reduction are more substantial.

In the North Coast Unit discussed above, genetic information in hand is limited and there is no evidence for genetic differentiation. In contrast, in the Greater Bay Unit approximately 240

tidewater gobies from 16 collection localities have mitochondrial control regions sequenced (D. Jacobs pers. comm. 2004; Barlow 2002). There are still a few localities in the region such as Scott Creek and Waddell Creek where interpolation is required. Nevertheless, a reasonably comprehensive pattern has emerged. This pattern is one of substantial and very local genetic differentiation, which is presumed to be a consequence of lack of dispersal around rocky promontories. Of the 15 localities examined by Barlow (2002) only a few closely spaced samples are not highly significantly different from all others in the region on the basis of an AMOVA (Analysis of Molecular Variance) and F_{ST} where significance is established by iterative resampling techniques. David Jacobs (pers. comm. 2004) infers that many of these locations have been isolated for much of the Holocene in a scenario where sea level rise at the beginning of the Holocene flooded many small valleys creating large numbers of closely spaced habitats. Subsequently, shoreline retreat due to coastal erosion eliminated many of these habitats. The remaining populations were then more widely spaced and evolved in long-term genetic isolation from one another.

Given the degree of differentiation and the possibility of statistically significant differences due to loss of genetic variation that may have occurred as a result of recolonization events (in the few places where they occur), we are conservative in the definition of Sub-Units in this region. Sub-Units are only defined in cases of long term isolation as evidenced by lack of shared haplotypes with other sites, unique fixed or nearly fixed differences, or the presence of endemic clades of haplotypes exclusive to the Sub-Unit. Endemic clades of haplotypes strongly support a history of *in situ* evolution and thus are strongly indicative of long periods of isolation. Despite the application of this relatively strict criterion 11 Sub-Units are defined in the region are discussed below.

Sub-Units

The **GB1** Sub-Unit is located immediately north of Bodega Head in Sonoma County. Salmon Creek is the only site known to be occupied and fish from Salmon Creek are highly statistically significant from all other in an AMOVA analysis, contain related endemic haplotypes (endemic clade) and share no haplotypes with other localities. No other occupied tidewater localities have been reported north of Bodega Head and south of the North Coast Unit as discussed above. However, there is a small stream valley, Marshall Gulch, located a couple of miles north of Salmon Creek. As Salmon Creek is a unique singleton population*, establishment at this additional site would provide some safeguards. However, due to small size, Marshall Gulch may prove to be marginal habitat. It is also in private hands.

Primary tasks recommended for recovery:
1) Monitor
2) Survey Marshall Gulch for the presence of tidewater gobies. Assuming they are absent, attempt to arrange for transfer to there from Salmon Creek. This should include arrangements with landholders, and possibly enhancement to the habitat.
3) Tidewater gobies should be transferred regularly from Salmon Creek to Marshall Gulch in order to maintain the genetic variation of this “backup population”.

The **GB2** Sub-Unit includes the "Esteros" (Estero Americano and Estero San Antonio), Marin County, where tidewater gobies are generally present, and extirpated sites in Bodega Bay (Cheney Gulch) and Walker Creek in northern Tomales Bay, Marin County. Estero Americano and Estero San Antonio are dominated by a diverse clade of haplotypes endemic to this unit. Two other clades of haplotypes are present, one of which is exclusive to Estero Americano. This set of haplotypes is similar, but not identical to those in tidewater gobies from Salmon Creek. Perhaps because of the presence of these haplotypes in Estero Americano and not in Estero San Antonio, F_{ST} analysis documents that the Esteros are distinct from each other at the 5 percent level. Thus even though they are adjacent to each other gene flow between them does not appear to be continuous. Nevertheless they are treated in the same unit here.

Given the subtle differences between the Esteros, any attempt to recolonize sites around Bodega Harbor should come from Estero Americano. Bodega Harbor has been dredged since World War II, and a jetty to stabilize the opening was provided circa 1970. This likely increased the tidal variation in the inner reaches of the Bodega Harbor, which was separated by shallow flats from the opening. In addition, during the 1970's a large road was built along the north and west margins of the Bay in preparation for a nuclear plant that was never constructed. This alteration of high marsh habitat may have eliminated tidewater gobies. Water wells in the dune fields north of the bay may also lower the water table and limit freshwater input, further constraining tidewater goby breeding habitat. Given these factors it is not clear how much potential there is for tidewater gobies to persist in Bodega Harbor. However, there seems to be little reason not to place tidewater gobies in potential habitats in the harbor on an experimental basis. The end of Cheney Gulch is one possible location for transfer. Another possibility is a ditch/marsh area near the north end of the harbor, which was isolated from the harbor by the construction of the shoreline road mentioned above.

Walker Creek is located just inside Tomales Bay. Tomales Bay is fully tidal. At the entrance to the Bay are two sand spits extending from the east side of the Bay. These spits presumably accreted successively in the Holocene as a consequence of southward transport of sediment along the Bodega Bay shore. As these features are sand, presumably tidewater gobies could have readily moved around these features from the Esteros. Thus it is assumed that Walker Creek would have had greater contact with the Esteros than with the Lagunitas/Papermill locality at the southern terminus of Tomales Bay, as much of the shoreline within the bay is rocky and potentially precludes dispersal. However, it could be argued that mitochondrial sequences from museum specimens of tidewater gobies from Walker Creek should be generated to unequivocally establish that these historic populations were like those now in the Esteros. The reason for concern in this regard is that the Lagunitas tidewater gobies are genetically distinct from all other localities (discussed below), and the distinction between the north and south ends of the bay is based on our general assumption of exclusively adult dispersal over sand. There may be, or may have been historically more sand at depth in the bay than is evident today. In addition the argument for lack of larval dispersal may not apply to bays to the same degree as to seasonally closed sites on the outer coast. Lenses of freshwater could transport tidewater goby larvae around the bay following the first significant rains in the fall. Thus examination of the genetic affinities of Walker Creek museum samples may be merited even though this is relatively difficult to do.

At the mouth of Walker Creek, the creek itself seems to be isolated from a marsh by a flood-generated or possibly man-made levy. Thus the flow of the stream may be effectively channelized and separated from shallow tidewater goby habitat in the marsh area and a railroad trestle to the south of the creek. Due to this separation it is not clear whether good tidewater goby habitat is present. However tidewater gobies could be placed in the adjacent marsh or behind an abandoned railroad trestle adjacent to the marsh.

Primary tasks recommended for recovery:
1) Monitor
2) "Experimental" introduction of Estero Americano tidewater gobies into Bodega Harbor habitats should be conducted at Cheney Gulch and the north end of the harbor.
3) In the case of 4 years of monitored absence in either of the Esteros they should be recolonized from the other.
4) The genetics of Walker Creek museum samples should be investigated, and, if appropriate, Estero San Antonio tidewater gobies should be introduced into Walker Creek. Some modifications to the habitat may be necessary to improve the habitat.

The **GB3** Sub-Unit is located in southern Tomales Bay, Marin County. Southern Tomales Bay is exceptionally muddy, presumably as a result of a phase of erosion and agricultural exploitation following the Gold Rush. The tidal exchange in the bay takes over two weeks to turn the water column, hence the retention of fine grained sediment. Until recently the Lagunitas/Papermill Creek population was considered extirpated. However, this last year a population of tidewater gobies was discovered by Darren Fong in a small distributary (Tomasini Creek) of Lagunitas Creek. Ten mitochondrial control region sequences were obtained from this population (D. Jacobs pers. comm. 2004). They are all identical and distinct by several base changes from tidewater gobies in other habitats. This population is isolated and appears to have suffered a bottleneck. This genetically distinct population appears to be in a precarious state. We would recommend immediate action to locate other habitats in Southern Tomales Bay to establish these fish. Fish Hatchery Creek on the west side of the Bay might be appropriate. Habitat, immediately south of Millerton Point might also be appropriate. Plans to improve habitat are currently being generated. These plans should be implemented in a way that allows this genetically unique population to persist.

The **GB4** Sub-Unit includes sites on the outer coast from Point Reyes, Marin County, south to Point San Pedro, San Mateo County, as well as sites within San Francisco Bay, San Francisco, Contra Costa, and Alameda Counties. Tidewater gobies have only persisted in Rodeo Lagoon, presumably due to a history of extensive shoreline modification in the region. This population is highly statistically distinct from all others; it shares no haplotypes with other localities and is dominated by a clade of related haplotypes. It is presumed to be representative of tidewater gobies from a large number of extirpated localities in the region.

Immediately south of Point Reyes in Point Reyes National Seashore, Horseshoe Lagoon and Estero de Limantour appear to provide good protected habitat. The absence of historic records of tidewater gobies in these localities may relate to early habitat modification for grazing (tide-gating for cattle ponds) and introduction of exotic sport fish. However, these problems are no longer an issue and placement of tidewater gobies in these localities would be merited.

Many localities in San Francisco Bay and along the outer coast may be no longer viable due to habitat modification. Others may currently be suitable, but lack a source of recruits in the bay. As tidewater gobies are abundant at Rodeo Lagoon, there is little reason not to place gobies in a large number of habitats on an experimental basis. Thus it seems reasonable to survey the habitat in the region (GB4c and e through n, in Figure B-7) to identify localities most likely to provide tidewater goby habitat. This might include sites in addition to those listed in Table G-1. Some historic sites may be judged to be completely nonviable. In some cases habitat modification or elimination of exotics may be merited to improve suitability for tidewater gobies.

Primary tasks recommended for recovery:
1) Monitor
2) Introduction of tidewater gobies into Horseshoe Lagoon and Estero de Limantour from Rodeo Lagoon.
3) Survey coast and bay habitats in the unit for currently viable tidewater goby habitat.
4) Introduce tidewater gobies to suitable habitats on an experimental basis.

The **GB5** Sub-Unit includes three currently occupied sites: San Gregorio, Pescadero, and Bean Hollow, in San Mateo County. Haplotypes in the region form a single diverse monophyletic clade of haplotypes. All three sites are highly statistically distinct from all other tidewater goby sites in a resamples F_{ST} approach (Barlow 2002). San Gregorio Creek and Bean Hollow are not statistically differentiated from each other, but the intervening site, Pescadero Creek is. Presumably this is a consequence of extinction/recolonization dynamics between the sites. Despite this local heterogeneity there seems little reason to not to treat all three sites as a single unit as they are all on a relatively continuous sandy coast isolated by steeper coast to the north and south and share many haplotypes. Much of this coast is protected in State Parks. One additional estuary in this area, Pompino Creek, might support tidewater gobies if they were introduced.

Primary tasks recommended for recovery:
1) Monitor
2) Introduce tidewater gobies into Pompino Creek from Pescadero Creek.
3) Reintroduce tidewater gobies after 4 years of monitoring (see Table G-1).

The **GB6** Sub-Unit is the first of a number of Sub-Units that are relatively closely spaced along the steep intermittently rocky shores from north of Santa Cruz to the Salinas Valley, Santa Cruz County. Despite the close spacing of many of these habitats, steep shores and minor promontories are associated with genetically distinct entities. There is no genetic information from the most northerly samples in this Sub-Unit, Scott and Waddell Creeks. Although they are grouped here with Laguna Creek, the next site to the south, the genetic relationship between the sites needs to be determined.

Laguna Creek is highly significantly distinct from all other sites examined in the Greater Bay Unit (Barlow *et al*. 2002). It is dominated by an endemic clade of haplotypes. The most common haplotype found in Laguna Creek has also been observed once in Moran and once in Corcoran Lagoon. A common haplotype from the Sub-Unit GB7 also occurs once in Laguna Creek (n=16). Based on current sampling, several other haplotypes present in Laguna Creek are

unique to the locality. These haplotypes could also be present in Scott or Waddell Creek to the north.

Primary tasks recommended for recovery:
1) Monitor
2) Waddell Creek, which is currently extirpated, should be supplied with tidewater gobies from Scott Creek.
3) Scott Creek should be sampled genetically to determine if it is genetically distinct from Laguna Creek, which is substantially to the south.

The **GB7** Sub-Unit consists of a suite of closely spaced localities including Baldwin Creek, Lombardi Creek, Old Dairy Creek, Wilder Creek, Younger Lagoon and Moore Creek, Santa Cruz County. Mitochondrial sequence data are available for Baldwin Creek, Wilder Creek and Moore Creek. In addition it is known that both Younger Lagoon and Moore Creek have been extirpated and recently recolonized. Baldwin Creek and Wilder Creek are not differentiated by the iterated F_{ST} test. Moore Creek is actually statistically distinct from all other samples and shares some haplotypes with Moran/Corcoran in Sub-Unit GB8, but a greater number of haplotypes are shared with Wilder Creek and Baldwin Creek. Hence we place it with this group (Barlow 2002). Given its known extirpation, it appears that Moore Creek received recruits from both sites, Wilder Creek to the north and Moran Lake to the south. In these small sites extirpation and recolonization appear to be ongoing.

Primary tasks recommended for recovery:
1) Monitor
2) Assess additional tidewater goby extirpation and recolonization dynamics in the region.
3) Reintroduce tidewater gobies after 4 years of monitoring (see Table G-1).

The **GB8** Sub-Unit includes Moran Lake and Corcoran Lagoon, Santa Cruz County, which are not statistically distinct from each other using an iterated resampling of data and calculation of F_{ST} (Barlow 2002). They are highly significantly different from all other sites, and Corcoran Lagoon contains some smaller clades of endemic haplotypes. Tidewater gobies recently recovered from the San Lorenzo River, which located west of Corcoran Lagoon, are most likely related to this unit.

Primary tasks recommended for recovery:
1) Monitor
2) Assess additional tidewater goby extirpation/recolonization dynamics in the region. In particular the genetics of fish from the San Lorenzo River need to be assessed,
3) Improvement of other small habitats in the region so that they can sustain tidewater goby populations.
4) Reintroduce tidewater gobies after 2 years of monitoring (see Table G-1).

The **GB9** Sub-Unit includes Aptos Creek and Soquel Creek, Santa Cruz County. Aptos Creek is highly statistically distinct from all other localities and it is dominated by a clade of endemic haplotypes suggesting *in situ* evolution. Soquel Creek is a historic tidewater goby site. If it is modified to support them, tidewater gobies should be reintroduced there.

Primary tasks recommended for recovery:

1) Monitor
2) Reintroduce tidewater gobies into Soquel Creek from Aptos Creek population. Reintroduction should take place regularly to maintain a backup population.

The **GB10** Sub-Unit includes the Pajaro River, Santa Cruz County, which is isolated from other tidewater goby localities in the region. A concerted effort should be made to determine if tidewater gobies continue to reside there. If they do, it should be determined whether or not theses tidewater gobies are distinct from tidewater gobies in Bennett Slough to the south. If no tidewater gobies are recovered or if they prove to be sufficiently similar to those in Bennett Slough, then the GB10 Sub-Unit should be joined with GB11 Sub-Unit. If tidewater gobies are determined to be absent from the Pajaro River, then tidewater gobies should be transplanted from Bennett Slough.

Primary tasks recommended for recovery:
1) Monitor
2) Survey intensively to confirm status of the tidewater goby.
3) If not present, then improve habitat and introduce tidewater gobies from Bennett's Slough.

The **GB 11** Sub-Unit includes Bennett's Slough, Monterey County, which is the only locality where tidewater gobies have been recovered recently in the Salinas Valley/Monterey Coastal Plain. These tidewater gobies are highly significantly differentiated from all other tidewater gobies in the unit and contain a clade of endemic haplotypes implying long term *in situ* evolution.

Given the range of interconnected waterways including coastal lagoons as well as agricultural features in the Salinas Valley, it seems that tidewater gobies may persist in other localities in this area. A survey of potential localities in the Salinas Valley/Monterey Coastal Plain should be made to ascertain whether tidewater gobies are present and what other habitat would be appropriate for their reintroduction.

Primary tasks recommended for recovery:
1) Monitor
2) Survey intensively to identify additional tidewater goby habitat in the Salinas Valley.
3) Reintroduce Bennett Slough tidewater gobies into other appropriate tidewater goby habitat in the Salinas Valley including, but not limited to the Salinas River.

Central Coast Unit (CC)

This Recovery Unit is bounded on the north by the steep Big Sur Coast and on the south by Point Buchon immediately south of Morro Bay, and is differentiated by a clade break in the Dawson *et al.* 2001 data. This unit contains 21 localities from which tidewater gobies have been found at various times. Twenty-nine mitochondrial sequences (D. Jacobs pers. comm. 2004; Dawson *et al*. 2001) have been obtained. Due to the limited number of samples relative to populations, these data are suggestive, but not conclusive, of subdivision in the region. On the basis of headlands at Point Piedras Blancas and north of Estero Point the region is subdivided into three low coastal regions considered to be Sub-Units. In most cases these Sub-Units support many small closely spaced coastal estuaries. One important objective is to understand the degree of

genetic differentiation of the three Sub-Units, and whether the genetic data support this number of units.

Sub-Units

The **CC1** Sub-Unit is located north of Piedras Blancas, San Luis Obispo County, and consists of two sites, one of them currently extirpated. If genetic studies support the differentiation of these sites, an effort should be made to supply Arroyo del Oso and perhaps other sites in the region with tidewater gobies.

Primary tasks recommended for recovery:
1) Monitor
2) Substantiate Sub-Unit with genetic study.
3) Reintroduce Arroyo del Corral tidewater gobies to Arroyo del Oso.
4) Examine other sites for potential introduction.

The **CC2** Sub-Unit consists of shallow coast line with multiple small estuaries south of Piedras Blancas and north of the Point Estero Coast. Of the eight small sites here one seems to be currently extirpated. Given the number of sites and the lack of obvious threats little management may be required.

Primary tasks recommended for recovery:
1) Monitor
2) Substantiate Sub-Unit with genetic study.
3) Consider reintroductions if 50 percent of populations are extirpated.

The **CC3** Sub-Unit extends south of Estero Point into Morro Bay, San Luis Obispo County. This area again involves closely spaced populations similar to CC2. However, it is distinct in that sites in the south adjacent to and within Morro Bay appear to have been adversely affected by human activity. Currently, Morro and Chorro Creek immediately outside and within Morro Bay have been extirpated, and Los Osos Creek within the Bay may have been recently recolonized. These sites appear to have been adversely affected, by channelization in the case of Morro Creek. Sites in Chorro Creek and Los Osos Creek in Morro Bay may have been affected by dredging and jetty construction that increase tidal amplitude as well as the effects of marina construction and other development. This again suggests that bay populations are more subject to extirpation, perhaps due to greater modification of these habitats (***e.g.*** Humboldt/Arcata Bay, Bodega Bay, Tomales Bay, San Francisco Bay). There are six currently viable localities in the area immediately to the north of Morro Creek. An assessment of habitat quality and threat removal in Morro Creek and Morro Bay would seem appropriate as the tidewater gobies appear to have naturally recolonized within Morro Bay (Lafferty *et al*. 1999).

Primary tasks recommended for recovery:
1) Monitor
2) Substantiate Sub-Unit with genetic study.
3) Improve tidewater goby habitat in Morro Creek and Morro Bay.
4) Consider reintroductions if number of occupied sites falls below four.

Conception Unit (CO)

This Recovery Unit begins south of the promontory of Point Buchon and extends all the way around Point Conception and is bounded to the south and east of the Santa Barbara coast ending at the southern Ventura County line. Both of these termini are supported by clade breaks in the Dawson *et al.* (2001) analysis. It is at first surprising that Point Conception does not form a significant barrier. However, unlike other promontories along the coast such as Bodega Head, Point Reyes or the Big Sur Coast, which are made of Sierran type granite, or a number of other promontories such as Estero Point, which are made of Mesozoic Franciscan material, Point Conception is composed of Miocene age sedimentary rocks, which erode rapidly and supply sediment locally. In addition there is likely a substantial supply of sand from the north at Point Conception. In any case, examination of coastal photos documents that the shoreline at Point Conception and Point Arena does not have any long rocky stretches but is regularly interspersed with sand. This combination of substrates does not appear to limit tidewater goby migration to the same degree as harder substrates. In terms of genetic data, research currently being conducted at the University of California at Los Angeles is in the process of dramatically increasing the amount of mitochondrial sequence from the region surrounding the City of Santa Barbara (D. Jacobs pers. comm. 2004). There is some suggestion, but not confirmation due to small sample sizes, of endemic clades of haplotypes to the north of Point Conception especially in the Pismo Creek Area. Another issue of concern is Hollister Ranch. In this region to the south and east of Point Conception access has been difficult to obtain and no tidewater goby samples have been recovered for genetic analysis.

This Recovery Unit is divided into three Sub-Units on the basis of promontories at Point Sal and Point Arguello. There is considerable sandy shore north of Point Arguello. Along the south - facing coast to the southeast of Point Conception there are many closely spaced habitats with potential rocky shore barriers that are limited in scale. Thus barriers to dispersal appear to be modest.

Sub-Units

The **CO1** Sub-Unit extends between Point San Luis and Point Sal and is a largely sandy shore-line. Three localities currently have tidewater gobies: San Luis Obispo Creek, Pismo Creek and the Santa Maria River. Given the apparent distinction of populations in the region, effort should be made to reestablish tidewater gobies in coastal habitat in the Arroyo Grande region immediately south of Pismo Creek and in Oso Flaco Lake.

Primary tasks recommended for recovery:
1) Monitor
2) Substantiate Sub-Unit with genetic study.
3) Improve habitat and reduce threats to tidewater gobies in Arroyo Grande and Oso Flaco Lake.
4) Reintroduce tidewater gobies into Arroyo Grande and Oso Flaco (see Table G-1).

The **CO2** Sub-Unit extends from Point Sal to Point Arguello over generally sandy coast. The unit consists of four tidewater goby habitats ranging from large systems, such as the Santa Ynez River, to Cañada Honda, a frequently extirpated population.

Primary tasks recommended for recovery:
1) Monitor
2) Substantiate Sub-Unit with genetic study.
3) Improve habitat and remove threats as there only four tidewater goby habitats in the unit.
4) Recolonize (see Table G-1).

The **CO3** Sub-Unit extends from Point Arguello to the southeastern terminus of the unit in the steep Seacliff region. This Sub-Unit is a fairly long stretch of coast and contains a large number (28) of small habitats. With the available geographic and genetic data it is not clear that there is any place where the unit should be subdivided. It is possible that Jalama Creek, which lies between Point Arguello and Point Conception, belongs more appropriately with CO2. An additional complication is lack of access to Hollister Ranch, where eight populations reside but no monitoring or recovering of tidewater goby samples is currently possible.

Primary tasks recommended for recovery:
1) Monitor
2) Substantiate Sub-Unit with genetic study (including Hollister Ranch).
4) Consider recolonization if there is a 25 percent reduction in number of inhabited locations.

LA/Ventura Unit (LV)

This Recovery Unit is bounded on the north by the steep region at Seacliff and is not subdivided into Sub-Units. The southern terminus is the Palos Verdes Peninsula. The northern terminus is a clade break in Dawson *et al.* (2001). This region at Seacliff is unusual in that it is formed by a rapidly uplifted Pleistocene sediment. The cliffs themselves are not indurated. What appears to cause the break is the presence of cobbles rather than sand in the intertidal and shallow subtidal, which in turn support algal cover. This appears to have been sufficient to isolate this region so that clade formation (coalescence) and reciprocal monophyly could be established. The southern end of this clade has been hard to define because of anthropogenic elimination of habitats. The continuity of this group from the Ventura/Santa Clara flood plain around to the Santa Monica Bay is supported by the morphology of classic museum specimens as discussed above. Tidewater gobies in Ormond/J Street Drain site are naturally recolonized, those in Malibu Creek are the product of artificial introduction, and those in Topanga Creek are naturally recolonized, presumably from Malibu Creek. Barlow (2002) in her thesis examined 30 mitochondrial sequences from each of the five currently inhabited sites in the region. Given this history it is perhaps not surprising that this region has significantly reduced genetic variation relative to those to the north and that the populations are not genetically differentiated from each other. The only statistically significant result identified Topanga Creek as having even greater reduction in genetic variation, presumably due to founder effect*. Given the history of impact in the region it would be beneficial to establish or reestablish additional sites. Possibilities include the "duck ponds" region of Mugu Lagoon, Big Sycamore Canyon, Arroyo Sequit, Zuma Creek, and perhaps Ballona Creek. Big Sycamore Creek and possibly Zuma Creek might currently support tidewater gobies. But all these sites would benefit from restoration - primarily the removal of fill to make space for lagoon development, as in many cases Pacific Coast Highway and State Parks are built on artificially filled lagoon areas.

Primary tasks recommended for recovery:

1) Monitor
2) Substantiate Sub-Unit with genetic study.
3) Improve habitat and remove threats to tidewater gobies followed by reintroduction to reconstruct this highly degraded unit.
4) Recolonize (see Table G-1).

South Coast Unit (SC)

This Recovery Unit is 4 percent sequence divergent (Dawson *et al.* 2001), and is morphologically distinct in that all tidewater gobies observed in the region have substantial reduction of the supraorbital canal. Thus these tidewater gobies have been isolated for a substantial period of time, perhaps in excess of the 2 million year duration of the Pleistocene. Thus this unit would appear to be distinct at the subspecific or perhaps even the species level from all the other tidewater goby units. This unit also presents a considerable conservation challenge as tidewater gobies appear to have been extirpated from much of the region by urban development. It seems likely that they occupied estuarine habitat from San Pedro, south of Palos Verdes, to La Jolla. Tidewater gobies now occur only on Camp Pendleton, where they undergo frequent extirpation and recolonization, and from the limited mitochondrial sequence data in hand they appear to be severely bottlenecked (Dawson *et al*. 2002). From the few observations with microsatellites that we have (D. Jacobs pers. comm. 2004) it appears that there may be a subtle distinction between the two locations in northern Camp Pendleton and the several locations towards the south of the base. These data need to be corroborated by a formal microsatellite study. At the moment, the north and the south are treated as separate Sub-Units to facilitate the maintenance of suspected genetic variation. In order to aid recovery of the species the tidewater goby should be reintroduced into as many localities as possible to the north and south of Camp Pendleton. These localities tend to be larger than those on Camp Pendleton, and before their modification they were the likely stable source populations in this regional metapopulation. Unfortunately lagoon management has tended toward complete isolation from the sea or, more frequently, deep dredging for recreational use. This management makes recolonization difficult at some known historical tidewater goby sites such as San Pedro or Agua Hedionda. Thus sites that have no historic records, but which show every likelihood of having been prime tidewater goby habitat prior to human modification of the systems, are included as prospective tidewater goby reintroduction sites - *e.g*., Bolsa Chica to the north and San Elijo Lagoon, San Diegito Lagoon, Los Peñasquitos Lagoon. These sites should be actively pursued for improvement and reintroduction to augment the number of tidewater goby habitats in this unit as these locations better approximate the natural semi-closed state than do some of the others.

SC1 and SC2
Primary tasks recommended for recovery:
1) Monitor
2) Substantiate Sub-Unit with genetic study (microsatellite).
3) Improvement habitat and remove threats to tidewater gobies followed by reintroduction to reconstruct this highly degraded unit.
4) Recolonize (see Table G-1).

Table G-1. Tidewater Goby Reintroduction Sites

Recovery Unit	Sub-Unit	Site Code	Recipient population*	Source population(s) if restorable	Years to wait from extirpation to re-introduction**
NORTH COAST UNIT	NC1	a	Tillas Slough (Smith River)	NC1b	3
		b	Lake Earl-Lake Talawa	NC1a	3
		c	Elk Creek	NC1b	0/3
	NC2	a	Redwood Creek estuary	NC2b, c	3
		b	Freshwater Lagoon	NC2c	3
		c	Stone Lagoon	NC2d	3
		d	Big Lagoon	NC2c	3
	NC3	a	Mad River	NC3a	0/2
		b	Mad River Slough	NC3c-g	2
		c	Klopp Lake	NC3b	0/2
		d	Jacoby Creek	NC3b	0/2
		e	KATA Station Site	NC3f	0/2
		f	Freshwater Slough	NC3b	2
		g	Eel River	NC3b,f	0/2
	NC4	a	Ten Mile River	NC5a	5
	NC5	a	Virgin Creek	NC5b	2
		b	Pudding Creek	NC5a	0/2
	NC6	a	Davis Pond	NC6b	2
		b	Brush Creek	NC6c	2
		c	Lagoon Creek	NC6b	2
GREATER BAY UNIT	GB1	a	Marshall Gulch	GB1b	2
		b	Salmon Creek	GB1a	3
	GB2	a	Johnson Gulch	GB2c	0/2
		b	Cheney Gulch	GB2c	0/2
		c	Estero Americano	GB2d	4
		d	Estero de San Antonio	GB2c	4
		e	Walker Creek	GB2d	0/2
	GB3	a	Lagunitas Creek	GB3b,c	3
		b	Millerton	GB3a	0/2
		c	Fish Hatchery Creek	GB3a	0/2
	GB4	a	Horseshoe Lagoon	GB4d	0/3
		b	Estero de Limantour	GB4d	0/3
		c	Bolinas Lagoon	GB4a	0/3
		d	Rodeo Lagoon	GB4d	4
		e	Corte Madera Creek	GB4d	0/2
		f	Mill Creek	GB4d	0/2
		g	Novato Creek	GB4d	0/2
		h	Petaluma Creek	GB4d	0/2
		i	Strawberry Creek	GB4d	0/2
		j	Lake Merrit	GB4d	0/2
		k	Cliff House/Golden Gate Park	GB4d	0/2

Recovery Unit	Sub-Unit	Site Code	Recipient population*	Source population(s) if restorable	Years to wait from extirpation to re-introduction**
		l	Lake Merced	GB4d	0/2
		m	Laguna Salada	GB4d	0/2
		n	San Pedro Creek	GB4d	0/2
	GB5	a	San Gregorio Creek	GB5d	4
		b	Pompino Creek	GB5c	0/3
		c	Pescadero-Butano Creek	GB5b	4
		d	Bean Hollow Creek	GB5a	4
	GB6	a	Waddell Creek	GB6b	0/2
		b	Scott Creek	GB6a	3
		c	Laguna Creek	GB6a	3
	GB7	a	Baldwin Creek	GB7b	3
		b	Lombardi Creek	GB7a	4
		c	Old Dairy Creek	GB7b	4
		d	Wilder Creek	GB7a	4
		e	Younger Lagoon	GB7d	4
		f	Moore Creek	GB7d	4
	GB8	a	San Lorenzo River	GB8b	3
		b	Corcoran Lagoon	GB8c	3
		c	Moran Lake	GB8b	3
	GB9	a	Soquel Creek	GB9b	0/2
		b	Aptos Creek	GB9a	2
	GB10	a	Pajaro River	GB10a	5
	GB11	a	Bennett Slough	GB11b	2
		b	Salinas River	GB11a	0/2
CENTRAL COAST UNIT	CC1	a	Arroyo del la Cruz	CC1b	0/2
		b	Arroyo del Oso	CC1a	0/2
		c	Arroyo de Corral	CC1a	2
	CC2	a	Oak Knoll Creek	CC2b	TBD
		b	Arroyo de Tortuga	CC2a	TBD
		c	Broken Bridge Creek	CC2a	TBD
		d	Little Pico Creek	CC2e	TBD
		e	Pico Creek	CC2d	TBD
		f	San Simeon Creek	CC2d	TBD
		g	Leffingwell Creek	CC2f	TBD
		h	Santa Rosa Creek	CC2f	TBD
	CC3	a	Villa Creek	CC3c	TBD
		b	San Geronimo Creek	CC3a	TBD
		c	Cayucos Creek	CC3a	TBD
		d	Little Cayucos Creek	CC3c	TBD
		e	Old Creek	CC3d	TBD
		f	Willow Creek	CC3e	TBD
		g	Toro Creek	CC3i,j	TBD
		h	Morro Creek	CC3i,j	TBD

Recovery Unit	Sub-Unit	Site Code	Recipient population*	Source population(s) if restorable	Years to wait from extirpation to re-introduction**
		i	Chorro Creek	CC3j	TBD
		j	Los Osos Creek	CC3i	TBD
CONCEPTION UNIT	CO1	a	San Luis Obispo Creek	CO1b	4
		b	Pismo Creek	CO1a	4
		c	Arroyo Grande	CO1b	0/2
		d	Oso Flaco Lagoon	CO1b	0/2
		e	Santa Maria River	CO1b	3
	CO2	a	Shuman Canyon	CO2b	3
		b	San Antonio Creek	CO2c	3
		c	Santa Ynez River	CO2b	4
		d	Canada Honda	CO2c	2
	CO3	a	Jalama Creek	CO3b	TBD
		b	Canada del Cojo	CO3a	TBD
		c	Canada del Pescado	CO3b	TBD
		d	Canada del las Agujas	CO3b	TBD
		e	Arroyo el Bulito	CO3b,d	TBD
		f	Canada del Agua	CO3d,e	TBD
		g	Canada de Santa Anita	CO3d,e	TBD
		h	Canada de Alegria	CO3g	TBD
		i	Canada de Aqua Caliente	CO3h	TBD
		j	Gaviota Creek	CO3i	TBD
		k	Arroyo Hondo	CO3j	TBD
		l	Arroyo Quemado	CO3j	TBD
		m	Refugio Creek	CO3j,l	TBD
		n	Eagle Canyon	CO3m	TBD
		o	Tecolote Canyon	CO3m,p	TBD
		p	Winchester Canyon	CO3o	TBD
		q	Devereux Slough	CO3p	TBD
		r	Campus Lagoon	CO3p	TBD
		s	Goleta Slough	CO3p	TBD
		t	Arroyo Burro	CO3u	TBD
		u	Mission Creek	CO3t	TBD
		v	Laguna Channel	CO3u	TBD
		w	Sycamore Creek	CO3u	TBD
		x	Andree Clark Bird Refuge	CO3u	TBD
		y	Arroyo Paredon	CO3u	TBD
		z	Carpinteria Salt Marsh	CO3u,y	TBD
		aa	Carpinteria Creek	CO3u,y	TBD
		ab	Rincon Creek	CO3aa	TBD
LA/VENTURA UNIT	LV1	a	Ventura River	LV1b	3
		b	Santa Clara River	LV1a	3
		c	J Street Drain/Ormond	LV1a	3
		d	Calleguas Creek/Mugu	LV1b	0/3

Recovery Unit	Sub-Unit	Site Code	Recipient population*	Source population(s) if restorable	Years to wait from extirpation to re-introduction**
		e	Sycamore Canyon	LV1c	0/3
		f	Arroyo Sequit	LV1c	0/3
		g	Zuma Canyon	LV1c	0/3
		h	Malibu Creek	LV1a	3
		i	Topanga Creek	LV1h	4
		j	Santa Monica Artesian Springs	LV1a,b	TBD
		k	Ballona Creek	LV1h	3
SOUTHERN COAST UNIT	SC1	a	San Pedro Harbor	SC1f	0/2
		b	Bolsa Chica	SC1f	0/2
		c	Aliso Creek	SC1f	0/2
		d	San Juan Creek	SC1f	0/2
		e	San Mateo Creek	SC1f	2
		f	San Onofre Creek	SC1e	2
	SC2	a	Las Pulgas Creek	SC2c	2
		b	Hidden Lagoon	SC2d	2
		c	Aliso Canyon	SC2a	2
		d	French Lagoon	SC2b	2
		e	Cockleburr Canyon	SC2d	2
		f	Santa Margarita River	SC2e	2
		g	San Luis Rey River	SC2a-e	0/2
		h	Buena Vista Lagoon	SC2a-e	0/2
		i	Aqua Hedionda Lagoon	SC2a-e	0/2
		j	Batiquitos Lagoon	SC2a-e	0/2
		k	San Elijo Lagoon	SC2a-e	0/2
		l	San Diegito Lagoon	SC2a-e	0/2
		m	Los Peñasquitos Lagoon	SC2a-e	0/2

*see Appendix E threats table for location status as of 2004.

**TBD = to be determined, contact appropriate U.S. Fish and Wildlife Field Office for further direction.

Literature Cited for Appendix G

Barlow, M. 2002. Phylogeographic structure of the tidewater goby, *Eucyclogobius newberryi* (Teleostei: Gobiidae), in the San Francisco Bay area and Ventura County: Implications for Conservation Management. A thesis submitted in partial satisfaction of the requirements for the degree Master of Arts in Biology, University of California at Los Angeles.

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Appendix H. Summary of Threats and Recommended Recovery Actions.

LISTING FACTOR	THREAT	RECOVERY CRITERIA	RECOVERY ACTION NUMBERS
A	Loss of marsh habitat due to drainage for coastal development projects and dredging	I.a, I.b, II	1.2.1, 1.2.4, 1.2.8, 1.2.9, 1.2.10, 2.8, 2.12, 3.1, 3.2
A	Changes in temperature and salinity regimes due to upstream water diversions, groundwater overdrafting, dikes and levees in subsidence zones, blockage of connections between marsh and ocean by roads or railroads, or summer breaching of lagoons	I.a, I.b, II	1.2.2, 1.2.5, 1.2.6, 1.2.8, 1.2.9, 1.2.10, 2.2, 2.7, 2.8, 2.12, 3.1, 3.2
A	Invasion of plants on bare lagoon substrates due to upstream water diversions	I.a, I.b, II	1.2.2, 1.2.8, 1.2.9, 1.2.10, 2.2, 2.8, 3.1, 3.2
A	Water quality reduction due to siltation, oil field runoff, animal wastes, and agricultural or sewage effluent	I.a, I.b, II	1.1.3, 1.2.5, 1.2.8, 1.2.9, 1.2.10, 2.1, 2.6, 2.8, 3.1, 3.2
A	Sedimentation and habitat degradation due to cattle grazing and feral pig activity	I.a, I.b, II	1.1.3, 1.2.5, 1.2.7, 1.2.8, 1.2.9, 1.2.10, 2.1, 2.6, 2.8, 3.1, 3.2
A, E	Winter floods, exacerbated by river channelization, scouring out sandy habitat and washing gobies out of lagoons	I.a, I.b, II	1.2.4, 1.2.8, 1.2.9, 1.2.10, 2.5, 2.8, 3.1, 3.2
B	Not applicable		
C	Predation by introduced predatory fishes (centrarchids, striped bass, etc.), amphibians, or crayfish	I.a, I.b, II	1.1.2, 1.2.3, 2.3, 2.4, 3.1, 3.2

LISTING FACTOR	THREAT	RECOVERY CRITERIA	RECOVERY ACTION NUMBERS
C	Infestation by parasitic flukes (*Cryptocotyle lingua*)	I.a, I.b, II	
D	Inadequacy of Clean Water Act, National Environmental Policy Act, and California Environmental Quality Act to protect the species	Not applicable	Beyond scope of recovery plan.
E	Deterioration of coastal and riparian habitat due to drought	I.a, II	1.2.2, 1.2.8, 1.2.9, 1.2.10, 2.2
E	Competition with introduced species (rainwater killifish, exotic goby species)	I.a, I.b, II	1.2.3, 2.3, 3.1, 3.2
E	Small population size, stochastic extinction risk and loss of genetic distinctiveness for recovery units and sub-units	I.a, II	1.1.1, 1.2.11, 1.2.12, 2.9, 2.10, 2.11, 4.1, 4.2, 4.3

Listing Factors:
A. The Present or Threatened Destruction, Modification, or Curtailment Of Its Habitat or Range
B. Overutilization for Commercial, Recreational, Scientific, Educational Purposes (not a factor)
C. Disease or Predation
D. The Inadequacy of Existing Regulatory Mechanisms
E. Other Natural or Manmade Factors Affecting Its Continued Existence

Recovery Critera:

I.a. Metapopulation viability analysis projects 75% chance of all sub-units persisting for 100 years.

I.b. Individual management plans developed and implemented that address specific threats to each metapopulation.

II. Metapopulation viability analysis projects 95% chance of all sub-units persisting for 100 years.