California Fish and Game 86(4):244-258 2000

A LIST OF FRESHWATER, ANADROMOUS, AND EURYHALINE FISHES OF CALIFORNIA

PETER B. MOYLE
Department of Wildlife, Fish, and Conservation Biology
University of California, Davis
1 Shields Avenue
Davis, California 95616
e-mail: pbmoyle @ ucdavis.edu

LIAM H. DAVIS
California Department of Fish and Game
7329 Silverado Trail
Yountville, California 94558

The freshwater fishes of California include 67 native resident or anadromous species, 53 non-native species, and 5 marine species that occur in fresh water, for a total of 125 species. Within these species, 100 taxa at lower levels (subspecies, Evolutionary Significant Units, runs of anadromous fish) are recognized. The number of freshwater fish species in California is increasing due to invasions of non-native fishes, which are becoming established at a rate of about 1 species every 3 years. Of the native fishes, 5 full species are extinct in California. Thus, the actual number of species maintaining populations in the state is 120. Of extant native species, 15 (22%) are threatened with extinction in the near future. Only 27 native species (40%) can be regarded as having secure populations.

INTRODUCTION

The fishes of California's inland waters are a mixture of resident, anadromous, and euryhaline species, both native and non-native. The first attempt to compile a comprehensive list of these species was Evermann and Clark (1931), who listed 78 native species and 32 introduced species. Native species included an anomalous Pacific hagfish, *Epatretus stouti*, from the Eel River, 14 forms all now considered to be rainbow trout, and 18 other forms that are either no longer recognized as species or were mistakenly considered to be part of the California fish fauna. Of the 32 non-native species listed, 9 did not become established and brown trout were listed as 2 species. Thus only 67 (45 native, 22 non-native) of the 120 species of Evermann and Clark would be recognized in the fauna today. However, many of their species are now recognized as subspecies, a concept not in wide use by ichthyologists of that era.

The next official list (Shapovalov and Dill 1950) included 101 species (64 native, 26 non-native, and 11 euryhaline marine), 89 of which are on the present list (although not necessarily by the same common or scientific names). This list also included

47 subspecies. Of the 12 species no longer recognized: 9 are now listed as subspecies, 1 (bigmouth buffalo, *Ictiobus cyprinellus)* is a non-native species no longer found in California, 1 (woundfin, *Plagopterus argentissimus)* is based on a questionable record, and 1 is a marine species (surf smelt, *Hypomesus pretiosus)* that, to our knowledge, has never been found in fresh water. This list was expanded in 1959 (Shapovalov et al. 1959) to include 110 species (64 native, 32 non-native, 14 euryhaline marine), 100 of which are recognized in the present list; 45 subspecies were also listed. Moyle (1976) largely followed this list, but his total was 130 species (81 native, 49 non-native), reflecting taxonomic changes and new introductions. Hubbs et al. (1979) published a list of all California fishes and included about 120 freshwater species (90 native, 30 non-native). A number of their native forms were undescribed species listed without explanation. The revised list of Shapovalov et al. (1981) included 124 species (66 native, 45 non-native, 13 euryhaline marine), with 58 subspecies listed as well. Mentioned in these lists, but not included in the total for freshwater species, were 4 marine species introduced into the Salton Sea: *sargo, Anisotremus davidsoni;* gulf croaker, *Bairdiella icistia;* orangemouth corvina, *Cynoscion xanthulus;* and shortfin corvina, C. *pawipinnis.* The shortfin corvina apparently is no longer present in the sea, whereas the other 3 species are being stressed by increasing salinities (S. Keeney, California Department of Fish and Game [CDFG], personal communication). These species are not included on this list as well.

The following list is essentially an updated version of Shapovalov et al. (1981), taking into account new information on southern California fishes presented in Swift et al. (1993), on introduced fishes by Dill and Cordone (1997), and on all fishes by Moyle (2001). The order of families and species reflect evolutionary relationships as described in Moyle and Cech (2000) and Moyle (2001). The purposes of this list are to 1) provide a handy checklist for freshwater, anadromous, and euryhaline fishes likely to be found in the inland waters of California; 2) promote uniformity in both common and scientific names, especially for subspecies and other categories below the species level; and 3) summarize current status and legal protection afforded each species. The names for species follow that of the American Fisheries Society (Robins et al. 1991), while the names for subspecies follow Moyle (2001) in describing geographic regions in which each form is found. Discussions of the taxonomy of each species, which are the basis for the names, can be found in Moyle (2001). At the species level, only forms that have been formally recognized as species are included; at the subspecies level, forms that are likely to be formally described in the future are included along with described forms. The following forms are included in the list:

1. native species that have reproducing populations in California,
2. native species once found in the state that are now extinct,
3. euryhaline marine species regularly collected in fresh water (defined as <3‰ salinity),
4. non-native species with reproducing populations in the state,
5. subspecies recognized in Moyle (2001), and

6. Evolutionary Significant Units (ESUs) recognized by the National Marine Fisheries Service (NMFS) for anadromous salmonids.

Excluded from this list are:

1. non-native species that do not have populations established in California as of 2000 and non-native species that once had breeding populations in the state but no longer exist here, and
2. marine species for which there are no or questionable records for prolonged or repeated presence in water with salinity of <3‰.

Numerous marine species occur in estuaries at moderate salinities, but do not occur, except by accident, in fresh water. Swift et al. (1993), for example, list 23 species that have been collected in estuaries of southern California, only 11 of which are included in this list.

CHANGES TO THE LIST

The following are changes to the list compiled by Shapovalov et al. (198 1) reflected in the present list.

Petromyzontidae

Our understanding of the complex of lampreys in the Klamath basin is still confused, but the best evidence indicates that the Modoc brook lamprey, *Lampetra folletti,* of the 1981 list is not a valid species, whereas the Klamath River lamprey should be added to the list (Moyle 2001). The Pacific brook lamprey, *L. pacifica,* of the 1981 list appears to be similar enough to the western brook lamprey to be treated as the same species for now, although the western brook lamprey probably represents multiple species (Moyle 2001). The Goose Lake lamprey of the present list is probably a distinct species, but pending clarification of its status, it is treated as an undescribed subspecies of the Pacific lamprey.

Acipenseridae

The 1981 list calls the green sturgeon a subspecies, *A. medirostris medirostris,* with presumably the other subspecies being the Asian green sturgeon, *A. m. mikadoi.* Best evidence indicates that the 2 forms are separate species, so the subspecies name is no longer needed (Moyle 2001).

Clupeidae

The Pacific herring is now regarded as a species rather than as a subspecies of *Clupea harengeus,* as indicated in the 1981 list. It is common in estuaries but rarely occurs in water of low salinity so is marginal as a species on this list.

Cyprinidae

The various undescribed subspecies of tui chub, California roach, and speckled

dace that are listed are the result of re-evaluation of the various geographic forms of the species by a number of researchers (Moyle 2001).

The woundfin, *Plagopterus argentissimus,* was on most early lists, but was removed without explanation by Shapovalov et al. (1959). W.L. Minckley (Arizona State University, personal communication) indicates it could be regarded as an extinct member of the California fauna because it occurs in the Gila River, Arizona, and in other Colorado River tributaries in upstream states. Thus, a short section of the Colorado River that borders California is within the historic range of woundfin. However, in the absence of California records, we leave it off the list.

Catostomidae

The flannelmouth sucker is added to the list as an extinct native species because historic and archaeological records indicate it was once present in the lower Colorado River. In recent years, it has become re-established below Davis Dam, Nevada-Arizona, just above the California reach of the river (G. Mueller, U.S. Geological Survey, Denver, Colorado, USA, personal communication).

Esocidae

The northern pike was illegally introduced and has established a population in Davis Lake (Plumas County), a reservoir on Grizzly Creek, a tributary of the Feather River. As of 2000, efforts to eradicate the population had failed.

Osmeridae

The surf smelt, *Hypomesus pretiosus,* is removed from the list because it is primarily a marine species and does not occur in water <10‰.

Salmonidae

Salmon and Steelhead

Chinook salmon, coho salmon, and steelhead are subdivided into the units widely recognized for management by state and federal agencies, with each unit recognizable by a combination of genetic, ecological, and life history traits. Evolutionary Significant Units were developed by NMFS for the purpose of defining distinct population segments under the Endangered Species Act of 1973. “An ESU is a population (or group of populations) that is 1. substantially reproductively isolated from other conspecific population units and 2. represents an important component in the evolutionary legacy of the species” (Waples 1991: 12). For chinook salmon, beneath each ESU, we have listed the runs that are or were native to each river system because they are recognized as distinct management units, presumably with a genetic basis. These runs are more geographically isolated from one another than are stream-specific runs of coho salmon, steelhead, or coastal cutthroat trout. For steelhead, aside from ESUs, we only list summer steelhead. Whereas summer

steelhead are genetically very close (but not identical) to winter-run steelhead in the same regions, their life history and distribution patterns are so distinct they merit recognition as separate taxa. For coastal cutthroat trout, only 1 ESU is recognized by NMFS for southern Oregon and northern California, so the ESU is not listed as such (Johnson et al.[1] 1999).

Golden Trout

In previous lists, golden trout have been treated as a separate species from rainbow trout, a distinction that is not justified genetically (Behnke 1992), although the 3 recognized subspecies of golden-type trout found in the upper Kern River basin are placed together in our list. Likewise, the 3 recognized forms of redband-type trout from the upper Sacramento River and Eagle Lake drainages are placed together because of geographically based relationships. Resident rainbow trout found throughout California, but not in the golden or redband trout clusters, are either offshoots of regional steelhead populations (and can be considered part of the ESU as a consequence) or are the result of planting fish of various origins. Kamloops rainbow trout are listed mainly to symbolize the widespread rearing and planting of rainbow trout strains that originated from other regions of western North America.

Dolly Varden

Shapovalov et al. (1981) include Dolly Varden, *Salvelinus malma,* on their list based on an 1877 record from the McCloud River, even though they expressed skepticism about the validity of the record. We agree with their skepticism and remove the species from the list.

Poeciliidae

The western mosquitofish, recognized as a subspecies in the 1981 list, is now recognized as a full species (Wooten et al. 1988). As far as is known, the eastern mosquitofish, *Gambusia holbrooki,* has not been successfully introduced into California.

Gasterosteidae

The brook stickleback was introduced into the Scott River (Siskiyou County), tributary to the Klamath River, around 1990 and is well established there (Moyle 2001). The unarmored and resident threespine sticklebacks represent multiple evolutionary descents from anadromous threespine sticklebacks, so are not really geographic subspecies (Moyle 2001). The names of the 3 forms are retained here for convenience until stickleback ESUs are recognized as they are for salmon. The Shay Creek stickleback, on the other hand, is a distinctive form isolated at a single locality

[1] Johnson, O.W. and 7 others. 1999. Status review of coastal cutthroat trout from Washington, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-37.

in the San Bernardino Mountains and may deserve species status.

Syngnathidae

Shapovalov et al. (1981) added bay pipefish, *Syngnathus Zeptorhynchus,* to the list without explanation, but presumably because Moyle (1976) reported pipefish at salinities as low as 9‰. However, occurrences outside of marine eel grass beds are rare and there seems little reason to consider pipefish part of California's freshwater fish fauna.

Cottidae

The sharpnose sculpin, *Clinocottus acuticeps,* is omitted from the list because its previous inclusion was based on a single collection from "freshwater rills on the beach at Crescent City, Del Norte County" (Shapovalov et al. 1959:168). There is no indication it regularly occurs in the lower reaches of coastal streams. The 3 undescribed subspecies of prickly sculpin are listed because they seem to be distinctive in distribution and ecology (Moyle 2001). The 3 subspecies of marbled sculpin are added based on Daniels and Moyle (1984).

Centrarchidae

Shapovalov et al. (1959) list 2 subspecies each of bluegill, largemouth bass, and spotted bass. We omit them here because there seems little point in identifying subspecies introduced outside their normal geographic range that are presumably freely hybridizing with one another.

Cichlidae

The 3 *Oreochromis* species of tilapia are included because there is reasonable evidence of their establishment in southern California. However, the forms present bear little resemblance to their wild ancestors, presumably as a result of genetic bottlenecks during the introduction process and hybridization with each other (Costa-Pierce and Doyle 1997, Dill and Cordone 1997). Costa-Pierce and Doyle (1997) found that Nile and Mozambique tilapia were so different from their African ancestors that they recommended calling them regional strains labeled "California Nile tilapia" and "California Mozambique tilapia."

Gobiidae

Three species of *Tridentiger* have been introduced into California and 2 have been added to the list. The shimofuri goby lives and breeds in freshwater (Mater-n and Fleming 1995). Records of chameleon goby, *T. trigonocephalus,* in fresh water are undoubtedly this species because chameleon goby are largely marine. The shokihaze goby is a recent (ca. 1997) invader of the San Francisco Bay Estuary, where it is apparently established, living in water ranging from fresh to brackish

(K.A. Hieb, CDFG, personal communication).

STATUS

The native freshwater fishes of California are in a general state of decline (Moyle and Williams 1990) and many species have been given special status designations as a result. Fish found in California have been classified as threatened or endangered by the California Fish and Game Commission (state status) (CDFG[2] 2000a; California Fish and Game Code[3] 2000; California Code of Regulations, Title 14[4] 2000) or by the federal government under the Endangered Species Act of 1973 (Federal Register 1996, USFWS[6] 1997). California Species of Special Concern is a CDFG designation (CDFG[7] 2000b) given to species that appear to be vulnerable to extinction because of declining populations, limited ranges, or continuing threats (Moyle et al.[8] 1995). California Protected and California Fully Protected fishes may not be taken or possessed without a permit (California Fish and Game Code[3] 2000; California Code of Regulations, Title 14[4] 2000). The following are the symbols used in the list for the various official status designations, along with the number of species in each category.

CSC	California Species of Special Concern	48 species
CCE	California Candidate Endangered	1 species
CT	California Threatened	4 species
CE	California Endangered	14 species
FT	Federal Threatened	12 species
FE	Federal Endangered	16 species

Because legal status does not always reflect actual status of a species, evaluations of status found (and justified) in Moyle (2001) are also included, for both native and introduced species, as follows:

Native Species

---

[2] CDFG. 2000a. State and federally listed endangered and threatened animals of California. California Department of Fish and Game, Sacramento, California, USA.

[3] California Fish and Game Code. 2000. LawTech Publishing Company, Ltd., San Clemente, California, USA.

[4] California Code of Regulations, Title 14. 2000. California Department of Fish and Game, Sacramento, California. 95814.

[5] Federal Register. February 28, 1996. 61(40):7596-7613.

[6] USFWS. 1997. Endangered and threatened wildlife and plants. 50CFR17.11 ans 17.12, October 31, 1997. USDI Fish and Wildlife Service, Washington, D.C., USA.

[7] CDFG. 2000b. Special animals. California Department of Fish and Game, Sacramento, California, USA.

[8] Moyle, P.B., R.M. Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. Fish species of special concern in California, 2nd edition. California Department of Fish and Game, Sacramento, Califomia, USA.

N1 Extinct. The species is extirpated from California; some species are globally extinct.

N2 Threatened or endangered. The species is likely to become extinct in the near future (<50 years) unless steps are taken to save it. An endangered species is on a more rapid path to extinction than a threatened species. Most of these species are formally listed by either the state or federal government.

N3 Special concern. The species is in decline or has a very limited distribution, so special management is needed to keep it from becoming threatened or endangered.

N4 Watch list. The species appears to be declining but is not yet in serious trouble. Its populations need to be monitored to see if special protective action is necessary.

N5 Stable or increasing. The species is abundant or increasing in population.

EM Euryhaline marine species regularly, if uncommonly, found in water <3‰ salinity.

Introduced (Non-native) Species

I1 Extinct. The species was once established, but the introduction failed. No species in this category is included on this list.

I2 Small, highly localized populations. The species is established, but only in a handful of localities, and is stable or declining in numbers.

I3 Localized and likely to become more widespread or already widespread, but not abundant in most areas. Alternately, it may be fairly common, but is declining. The species is usually a recent introduction and is just starting to expand its range or is a long-established species that tends to be only locally abundant.

I4 Widespread and stable. The species is widely distributed, but seems to have reached the limits of its range. Presumably it is integrated into local ecosystems.

I5 Widespread and expanding. The species is still expanding its range to all suitable habitats in the state.

THE LIST

PETROMYZONTIDAE (lampreys)

river lamprey, *Lampetra ayersii*	N4, CSC
Kern brook lamprey, *Lumpetra hubbsi*	N3, CSC
western brook lamprey, *Lampetra richardsoni*	N4
Pacific lamprey, *Lampetra tridentata*	
coastal Pacific lamprey, *L. t. tridentata*	N4
Goose Lake lamprey, *L. t.* ssp.	N3, CSC
Pit-Klamath brook lamprey, *Lampetra lethophaga*	N5
Klamath River lamprey, *Lampetra similis*	N4, CSC

ACIPENSERIDAE (sturgeons)

green sturgeon, *Acipenser medirostris*	N3, CSC
white sturgeon, *Acipenser transmontanus*	N5
ELOPIDAE (tenpounders)	
machete, *Elops afinis*	EM
CLUPEIDAE (herrings)	
Pacific herring, *Clupea pallasi*	EM
threadfin shad, *Dorosoma petenense*	I4
American shad, *Alosa sapidissima*	I3
CYPRINIDAE (minnows)	
tui chub, *Gila bicolor*	
Mohave tui chub, *G. b. mohavensis*	N2, CE, FE
Lahontan creek tui chub, G. *b. obesa*	N5
Lahontan lake tui chub, *G. b. pectinifer*	N3, CSC
Owens tui chub, G. *b. snyderi*	N2, CE, FE
Goose Lake tui chub, *G. b. thalassina*	N3, CSC
Cowhead Lake tui chub, *G. b. vaccaceps*	N2, CSC
Eagle Lake tui chub, G, *b.* ssp.	N4, CSC
High Rock Spring tui chub, G. *b.* ssp.	N1, CSC
Pit tui chub, G. *b.* ssp.	N5
Klamath tui chub, *G. b. bicolor*	N5
blue chub, *Gila coerulea*	N3
Thicktail chub, *Gila crassicauda*	N1
bonytail chub, *Gila elegans*	N1, CE, FE
arroyo chub, *Gila orcutti*	N3, CSC
hitch, *Lavinia exilicauda*	
Clear Lake hitch, *L. e. chi*	N3, CSC
Sacramento hitch, *L. e. exilicauda*	N4
Monterey hitch, *L. e. harengus*	N4
California roach, *Lavinia symmetricus*	
Sacramento roach, *L. s. symmetricus*	N4
San Joaquin roach, *L. s.* ssp.	N3, CSC
Red Hills roach, *L. s.* ssp.	N2
Tomales roach, *L. s.* ssp.	N4, CSC
Pit roach, *L. s. mitrulus*	N3, CSC
Navarro roach, *L. s. navarroensis*	N5, CSC
Gualala roach, *L. s. pawipinnis*	N4, CSC
Monterey roach, *L. s. subditus*	N4
Sacramento blackfish, *Orthodon microlepidotus*	N4
Clear Lake splittail, *Pogonichthys ciscoides*	N1
Sacramento splittail, *Pogonichthys macrolepidotus*	N3, CSC, FT
hardhead, *Mylopharodon conocephalus*	N4, CSC
Sacramento pikeminnow, *Ptychocheilus grandis*	N5
Colorado pikeminnow, *Ptychocheilus lucius*	N1, CE, FE
speckled dace, *Rhinichthys osculus*	

Klamath speckled dace, *R. o. klamathensis*	N5
Sacramento speckled dace, *R. o.* ssp.	N5
Lahontan speckled dace, *R. o. robustus*	N5
Santa Ana speckled dace, *R. o.* ssp.	N2, CSC
Amargosa speckled dace, *R. o. nevadensis*	N2, CSC
Owens speckled dace, *R. o.* ssp.	N2, CSC
Long Valley speckled dace, *R. o.* ssp.	N2
Lahontan redside, *Richardsonius egregius*	N5
golden shiner, *Notemigonus crysoleucas*	I5
red shiner, *Cyprinella lutrensis*	I5
fathead minnow, *Pimephales promelas*	I5
tench, *Tinca tinca*	I2
goldfish, *Carassius auratus*	I4
common carp, *Cyprinus carpio*	I4
grass carp *Ctenopharyngodon idella*	I3
CATOSTOMIDAE (suckers)	
mountain sucker, *Catostomus platyrhynchus*	N3, CSC
Santa Ana sucker, *Catostomus santaanae*	N2, CSC, FT
Sacramento sucker, *Catostomus occidentalis*	
Humboldt sucker, *C. o. humboldtianus*	N4
Goose Lake sucker, *C. o. Zacusanserinus*	N3, CSC
Monterey sucker, *C. o. mniotiltus*	N5
Sacramento sucker, *C. o. occidentalis*	N5
Klamath largescale sucker, *Catostomus snyderi*	N3, CSC
Tahoe sucker, *Catostomus tahoensis*	N5
Owens sucker, *Catostomus fimeiventris*	N4, CSC
flannelmouth sucker, *Catostomus Zatipinnis*	N1
Modoc sucker, *Catostomus microps*	N2, CE, FE
Klamath smallscale sucker, *Catostomus rimiculus*	N5
shortnose sucker, *Chasmistes brevirostris*	N2, CE, FE
Lost River sucker, *Deltistes luxatus*	N2, CE, FE
razorback sucker, *Xyrauchen texanus*	N2, CE, FE
COBITIDAE (loaches)	
oriental weatherfish, *Misgurnus anguillicaudatus*	I2
ICTALURIDAE (bullhead catfishes)	
white catfish, *Ameiurus catus*	I4
black bullhead, *Ameiurus melas*	I5
yellow bullhead, *Ameiurus natalis*	I3
brown bullhead, *Ameiurus nebulosus*	I4
blue catfish, *Ictalurus furcatus*	I3
channel catfish, *Ictalurus punctatus*	I4
flathead catfish, *Pylodictis olivaris*	I3
ESOCIDAE (pikes)	
northern pike, *Esox lucius*	I3

OSMERIDAE (smelts)	
wakasagi, *Hypomesus nipponensis*	I5
delta smelt, *Hypomesus transpacificus*	N2, CT, FT
longfin smelt, *Spirinchus thaleichthys*	N3, CSC
eulachon, *Thaleichthys pacificus*	N3, CSC
SALMONIDAE (salmon and trout)	
mountain whitefish, *Prosopium williamsoni*	N4
coho salmon, *Oncorhynchus kisutch*	
northern California/southern Oregon ESU	N2, CSC, FT
central California ESU	N2, CE, FT
chinook salmon, *Oncorhynchus tshawytscha*	
California coastal ESU	FT
Smith River fall run	N4
lower Klamath fall run	N3
Redwood Creek fall run	N2
Little River fall run	N2
Mad River fall run	N2
Bear River fall run	N2
Mattole River fall run	N2
Humboldt Bay tributaries fall run	N2
Eel River fall run	N2
Russian River fall run	N1
upper Klamath and Trinity rivers ESU	
upper Klamath-Trinity fall run	N3
Klamath-Trinity spring run	N2, CCE
Klamath late fall run	N1
Central Valley fall run ESU	N4
Sacramento late fall run ESU	N2
Sacramento spring run ESU	N2, CT, FT
Sacramento winter run ESU	N2, CE, FE
pink salmon, *Oncorhynchus gorbuscha*	N1, CSC
chum salmon, *Oncorhynchus keta*	*N2*, CSC
sockeye salmon, *Oncorhynchus nerka*	
anadromous form	EM
kokanee	I4
rainbow trout, *Oncorhynchus mykiss*	
coastal rainbow trout, *O. m. irideus*	
Klamath Mountains Province steelhead ESU	N4
Klamath winter-run steelhead ESU	N4
Klamath summer steelhead	N3, CSC
northern California steelhead ESU	
north coast winter-run steelhead	N3, FT
north coast summer steelhead	N2, CSC, FT
Central Valley steelhead ESU	N2, FT

central coast steelhead ESU	N4, FT
south/central coast steelhead ESU	N2, FT
southern steelhead ESU	N2, FE
upper Kern rainbow trout	
California golden trout, *O. m. aguabonita*	N2, CSC
Little Kern golden trout, *O. m. whitei*	N2, FE
Kern River rainbow trout, *O. m. gilberti*	N2, CSC
upper Sacramento redband trout	
McCloud River redband trout, *O. m. stonei*	N2, CSC
Goose Lake redband trout, *O. m.* ssp.	N2, CSC
Eagle Lake rainbow trout, *O. m. aquilarum*	N2, CSC
Kamloops rainbow trout, *O. m. "gairdneri"*	I4
cutthroat trout, *Oncorhynchus clarkii*	
coast cutthroat trout, *O. c. clarkii*	N3, CSC
Lahontan cutthroat trout, *O. c. henshawi*	N2, FT
Paiute cutthroat trout, *O. c. seleniris*	N2, FE
Colorado River cutthroat trout, *O. c. pleuriticus*	I2
brown trout, *Salmo trutta*	I5
bull trout, *Salvelinus confluentus*	N1, CE
brook trout, *Salvelinus fontinalis*	I4
lake trout, *Salvelinus namaycush*	I4
CYPRINODONTIDAE (pupfishes)	
desert pupfish, *Cyprinodon macularius*	N2, CE, FE
Amargosa pupfish, *Cyprinodon nevadensis*	
Amargosa pupfish, *C. n. amargosae*	N2, CSC
Tecopa pupfish, *C. n. calidae*	N1
Saratoga Springs pupfish, *C. n. nevadensis*	N2, CSC
Shoshone pupfish, *C. n. shoshone*	N2, CSC
Owens pupfish, *Cyprinodon radiosus*	N2, CE, FE
Salt Creek pupfish, *Cyprinodon salinus*	
Cottonball Marsh pupfish, *C. s. milleri*	N2, CT
Salt Creek pupfish, *C. s. salinus*	N2, CSC
FUNDULIDAE (killifishes)	
California killifish, *Fundulus parvipinnis*	N5
rainwater killifish, *Lucania parvu*	I4
POECILIIDAE (livebearers)	
western mosquitofish, *Gambusia afinis*	I5
sailfin molly, *Poecilia latipinna*	I3
shortfin molly, *Poecilia mexicana*	I2
porthole livebearer, *Poeciliopsis gracilis*	I2
ATHERINOPSIDAE (silversides)	
topsmelt, *Atherinops afinis*	EM
inland silverside, *Menidia beryllina*	I5

GASTEROSTEIDAE (sticklebacks)	
brook stickleback, *Culaea inconstans*	I3
threespine stickleback, *Gasterosteus aculeatus*	
anadromous threespine stickleback, *G. a. aculeatus*	N5
resident threespine stickleback, *G. a. microcephalus*	N5
unarmored threespine stickleback, *G. a. williamsoni*	N2, CE, FE
Shay Creek threespine stickleback, G. a. ssp.	N2, CSC
COTTIDAE (sculpins)	
Coast Range sculpin, *Cottus aleuticus*	N5
prickly sculpin, *Cottus asper*	
Central Valley prickly sculpin, C. a. ssp.	N5
Clear Lake prickly sculpin, C. *a.* ssp.	N4
coastal prickly sculpin, C. a. ssp.	N5
Paiute sculpin, *Cottus beldingi*	N5
riffle sculpin, *Cottus gulosus*	N5
Pit sculpin, *Cottus pitensis*	N5
marbled sculpin, *Cottus klamathensis*	
upper Klamath marbled sculpin, *C. k. klamathensis*	*N5*
lower Klamath marbled sculpin, *C. k. polyporus*	N5
bigeye marbled sculpin, *C. k. macrops*	N4, CSC
reticulate sculpin, *Cottus perplexus*	N4, CSC
rough sculpin, *Cottus asperrimus*	N4, CT
Pacific staghom sculpin, *Leptocottus armatus*	
northern Pacific staghom sculpin, *L. a. armatus*	N5
southern Pacific staghom sculpin, *L. a. australis*	N5
MORONIDAE	
white bass, *Morone chrysops*	I4
striped bass, *Morone saxatilis*	I5
CENTRARCHIDAE (sunfish, bass, crappies, and relatives)	
Sacramento perch, *Archoplites interruptus*	N2, CSC
green sunfish, *Lepomis cyanellus*	I5
pumpkinseed, *Lepomis gibbosus*	I5
w&mouth, *Lepomis gulosus*	I3
bluegill, *Lepomis macrochirus*	I4
redear sunfish, *Lepomis microlophus*	I4
redeye bass, *Micropterus coosae*	I3
smallmouth bass, *Micropterus dolomieu*	I4
spotted bass, *Micropterus punctulatus*	I5
largemouth bass, *Micropterus salmoides*	I5
white crappie, *Pomoxis annularis*	I4
ck crappie, *Pomoxis nigromaculatus*	I4
PERCIDAE (perches)	
yellow perch, *Perca flavescens*	I3
bigscale logperch, *Percina macrolepida*	I5

EMBIOTOCIDAE (surfperch)	
shiner perch, *Cymatogaster aggregata*	EM
tule perch, *Hysterocarpus traski*	
Clear Lake tule perch, *H. t. Zagunae*	N4
Russian River tule perch, *H. t. porno*	N3, CSC
Sacramento tule perch, *H. t. traski*	N5
CICHLIDAE (cichlids)	
Mozambique tilapia, *Oreochromis mossambicus*	I5
blue tilapia, *Oreochromis aurea*	I3
Nile tilapia, *Oreochromis nilotica*	I3
redbelly tilapia, *Tilapia zilli*	I3
MUGILIDAE (gray mullets)	
striped mullet, *Mugil cephalus*	N5
GOBIIDAE (gobies)	
yellowfin goby, *Acanthogobiusflavimanus*	I3
arrow goby, *Clevelandia ios*	EM
tidewater goby, *Eucyclogobius newberryi*	N2, CSC, FE
longjaw mudsucker, *Gillichthys mirabilis*	N5
shimofuri goby, *Tridentiger bifasciatus*	I5
shokihazi goby, *Tridentiger barbatus*	I3
PLEURONECTIDAE (righteye flounders)	
starry flounder, *Platichthys stellatus*	N5

CONCLUSIONS

The present list of freshwater, anadromous, and euryhaline marine fishes of California includes 67 native resident or anadromous species, 53 non-native species, and 5 marine species that occur in freshwater, for a total of 125 species. In addition, the list contains 100 taxa at lower levels (subspecies, ESUs, runs of anadromous fish). In 1959, the number of native resident or anadromous species recognized was 64, while the number of non-native species was 32. In 1981, the numbers were 66 and 45, respectively, indicating in the past 20 years non-native fishes have become established in California at a rate of about 1 species every 3 years. At least 30 non-native species are widespread in the state (categories 14 or 15). Of the native fishes, 5 full species are extinct, as are 4 lower taxa. Thus, the fish fauna numbers 120 extant species. Among the extant native species, 15 (22%) are threatened with extinction in the near future (N2). Only 25 (40%) of the native resident or anadromous species can be regarded as being secure (N5). Clearly, the freshwater fish fauna of California is continuing to change as native fishes become less abundant and diverse, while non-native fishes increase in species and numbers.

LITERATURE CITED

Behnke, R.J. 1992. Native trout of western North America. Monograph 6, American Fisheries Society, Bethesda, Maryland, USA.

Costa-Pierce, B.A. and R.W. Doyle. 1997. Genetic identification and status of tilapia regional strains in southern California. Pages 1-17 in: B.A. Costa-Pierce and J.E. Rakocy, editors. Tilapia aquaculture in the Americas, volume 1. World Aquaculture Society, Baton Rouge, Louisiana, USA.

Daniels, R.A. and P.B. Moyle. 1984. Geographic variation and a taxonomic reappraisal of the marbled sculpin, *Cottus klamathensis.* Copeia 1984:949-959.

Dill, W.A. and A.J. Cordone. 1997. History and status of introduced fishes in California, 1871-1996. California Department of Fish and Game Fish Bulletin 178.

Evermann, B.W. and H.W. Clark. 1931. A distributional list of the species of freshwater fishes known to occur in California. California Department of Fish and Game Fish Bulletin 35.

Hubbs, C.L., W.I. Follett, and L.J. Dempster. 1979. List of the fishes of California. Occasional Papers of the California Academy of Sciences 133.

Matern, S.A. and K.J. Fleming. 1995. Invasion of a third Asian goby, *Tridentiger bifasciatus,* into California. California Fish and Game 81:71-76.

Moyle, P.B. 1976. Inland fishes of California, 1st edition. University of California Press, Berkeley, California, USA.

Moyle, P.B. 2001 (In press). Inland fishes of California, 2nd edition. University of California Press, Berkeley, California, USA.

Moyle, P.B. and J.J. Cech Jr. 2000. Fishes: An introduction to ichthyology, 4th edition. Prentice-Hall, Upper Saddle River, New Jersey, USA.

Moyle, P.B. and J.E. Williams. 1990. Loss of biodiversity in the temperate zone: Decline of the native fish fauna of California. Conservation Biology 4:275-284.

Robins, CR. and 6 others. 1991. A list of common and scientific names of fishes from the United States and Canada, 5th edition. Special Publication 20, American Fisheries Society, Bethesda, Maryland, USA.

Shapovalov, L., A.J. Cordone, and W.A. Dill. 1981. A list of the freshwater and anadromous fishes of California. California Fish and Game 67:4-38.

Shapovalov, L. and W.A. Dill. 1950. A check list of fresh-water and anadromous fishes of California. California Fish and Game 36:382-391

Shapovalov, L., W.A. Dill, and A.J. Cordone. 1959. A revised check list of fresh-water and anadromous fishes of California. California Fish and Game 45:159-180.

Swift, C.C., T.R. Haglund, M. Ruiz, and R.N. Fisher. 1993. The status and distribution of the freshwater fishes of southern California. Bulletin of Southern California Academy of Sciences 92:101-167.

Waples, R.S. 1991. Pacific salmon, *Oncorhynchus* spp., and the definition of "species" under the Endangered Species Act. U.S. National Marine Fisheries Service Marine Fisheries Review 53: 11-22.

Wooten, M.C., K.T. Scribner, and M.H. Smith. 1988. Genetic variability and systematics of Gambusia in the southeastern United States. Copeia 1988:283-289.

Received: 15 June 2000
Accepted: 24 August 2000