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Storing Water for the Environment

Technical Appendix A: California's Freshwater Fishes: Conservation Status, Impacts of Dams, and Vulnerability to Climate Change

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Introduction

Freshwater fishes in California are in decline. The causes of this decline are many, including loss of habitat due to land use changes, construction and operation of water supply and flood management infrastructure, changes in water quality, and introduction of invasive species. Superimposed on this is rapid climate change, including increasing warming and drought intensity.

The status and vulnerability of California's freshwater fishes are one of the most robust indicators of freshwater ecosystem conditions. As highlighted in earlier PPIC publications (Mount et al. 2017, 2019), the decline of these fishes is a measure of our failure to adequately manage these ecosystems and to adapt to changing conditions.

This appendix builds upon previous work to assess the status of freshwater fishes. It provides an update on the level of concern over the viability of 129 native fishes. To inform the main report, this appendix includes an assessment of the impact of dam construction and operation on their conservation status. Finally, it includes information from an earlier climate change vulnerability assessment (Moyle et al. 2013) to highlight challenges associated with managing reservoirs to maximize ecosystem protection and recovery.

Conservation Status of California Fishes

The conservation status scores of California's fishes are summarized in Table A1. The scores were developed using the California Method for Status Evaluation of Fishes (Leidy and Moyle 2021; Moyle et al. 2011, 2013). The approach relies upon a mix of professional expertise and published reports to estimate the area occupied by each species, their abundance, dependence upon human intervention for persistence, environmental tolerance under natural conditions, genetic risks, vulnerability to climate change, and anthropogenic threats. See Moyle et al. (2015, 2017) for examples of application to individual species.

Using these metrics, a scoring system was established with the accompanying narrative.

TABLE A1
Description of Conservation Status Categories

Score	Class	Description	# of Species
0	Extinct	Globally extinct or extirpated from inland waters of California	7
1.0–1.9	Critical Concern	High risk of extinction in the wild; range seriously reduced or greatly restricted in California; population abundance critically low or declining; threat projected to reduce remaining California habitat and population in the short term (<10 generations)	33
2.0–2.9	High Concern	High risk of becoming a critical concern species; range and abundance significantly reduced; existing habitat and populations continue to be vulnerable in the short-term (<10 generations).	32
3.0–3.9	Moderate Concern	Declining; fragmented and/or small populations possibly subject to rapid status change; management actions needed to prevent increased conservation concern.	34
4.0–5.0	Low Concern	California populations do not appear to be in decline; abundant and widespread	23
		Total	**129**

SOURCES: Leidy and Moyle (2021) and Moyle et al. (2015, 2017), updated by P.B. Moyle in August 2021.

Vulnerability of Native Fishes to Climate Change

Climate change—including warming temperatures, reduced snowpack, longer dry seasons and increasing volatility (see discussion in main report)—is having drastic effects on the native fishes of California, increasing the likelihood of extinction for many species. Climate change vulnerability of native fishes—defined as the likelihood of extinction during the 21st century—was assessed by Moyle et al. (2013) for 129 fish species. This approach used 20 metrics to develop a vulnerability score. To establish a baseline measure of vulnerability, 10 metrics were evaluated:

- Current population size
- Long-term population trend
- Current population trend (10 years)
- Long-term range trend
- Current range trend
- Future vulnerability to stressors other than climate change
- Life span and reproductive plasticity
- Vulnerability to stochastic events
- Current dependence on human intervention

Based on assessment of these metrics, each species was then evaluated using 10 climate change vulnerability metrics:

- Physiological/behavioral tolerance to temperature increase
- Physiological/behavioral tolerance to precipitation change
- Vulnerability to frequency or degree of extreme weather events
- Dispersive capability
- Degree of physical habitat specialization
- Likely future habitat change because of climate change
- Ability of species to shift at same rate as habitat
- Availability of habitat within new range
- Dependence on exogenous factors
- Vulnerability to alien species

Each species was assigned a climate change vulnerability score, with an accompanying narrative (Table A2).

TABLE A2

Descriptions of categories of climate change vulnerability scores based on Moyle et al. (2011).

Score	Class	Description	# of Species
0	Extinct		7
<17	Critically Vulnerable	The species is extremely likely to be driven to extinction by year 2100 without conservation measures.	36
17–22	Highly Vulnerable	The species is on a path towards extinction as the result of climate change	64
23–37	Less Vulnerable	The species is likely to decline or become more limited in distribution but extinction unlikely by 2100	21
28–32	Least Vulnerable	The species is likely to be relatively unaffected by climate change, with range and populations remaining stable	0
>32	Likely to Benefit	The species is likely to increase in range and abundance as the result of climate change.	0

SOURCES: Moyle et al. 2013.

NOTES: Unlike the analyses of conservation status (Table A1) and influence of dams (Table A3), this analysis covered 128 species rather than 129, because Central Valley steelhead lacks a score due to complexities in defining its species status (see Moyle et al. 2017 for discussion).

Impacts of Dams

The construction and operation of water storage facilities in California has major effects on the conservation status of native fishes and their vulnerability to climate change (see discussion in main report). The decline of many of these fishes can be traced to the impacts of dams blocking access to critical habitat, and to changes in flow and water quality that interfere with their food supply, health, and behavior cues. In the absence of widespread dam removal, efforts to conserve many native fish species will be tied indefinitely to the way dams are operated.

Building upon the status and climate change vulnerability assessments, we have developed a simplified approach to evaluating the relative impact of water projects on native fishes. The information used to inform this evaluation and develop ranking systems is based principally on professional judgement informed by the status and climate change vulnerability assessments. Each species was assigned a category, including a narrative description (Table A3).

TABLE A3
Description of categories of impacts of water projects on native California fishes

Score	Class	Description	# of Species
0–1	None	Effects positive, minor, indirect or species not in serious decline. In general, dams and reservoirs are not an issue in their status. Example: Sacramento sucker	47
2	Limited	Decline caused in part by small dams and diversions, plus alien species etc., but not by big dams & reservoirs. Example: Goose Lake lamprey	28
3	Moderate	About half of major populations in decline/have declined because of dam and reservoir construction and management OR species in major decline but reservoir management is one of several major interacting factors. Example: Pacific lamprey, delta smelt	30
4	High	Most major populations in decline because dam and reservoir management and construction have major negative impacts on populations. Example: Southern green sturgeon	13
5	Critical	Large-scale decline caused by major dams and diversions blocking upstream access and changing downstream flow regimes, habitat, etc. Fate of species completely depends on water project operations or on artificial rearing to make up for effects of dams. Examples: Sacramento winter-run Chinook salmon, bonytail	11

SOURCES: Moyle (2002), Moyle et al. (2015, 2017), author knowledge.

Several examples that illustrate the approach include:

Score: 1. Sacramento sucker. This species is still widespread and abundant, both above and below dams. It is one of the few natives that thrives in reservoirs. It is physiologically robust, living at a wide range of temperature and salinity, is omnivorous, exhibits high fecundity, and has a long life span. Adults can reach 50+ cm. total length. Sacramento sucker spawn from February through April, in response to short increases in flows in streams ranging from regulated to seasonal.

Score: 1. Eagle Lake tui chub. This has many of the same characteristics as Sacramento sucker but is confined to a single lake which is not affected by dams or reservoirs. It is threatened in part by water management during severe drought.

Score: 2. Goose Lake lamprey. This undescribed species occurs only in Goose Lake and tributaries on the California-Oregon border. It appears to be in severe decline due to heavy grazing along streams and diversions of water from the streams for alfalfa growing, especially during years of drought. This species, however, scored a 2 because its populations are not affected by dam and reservoir management. The minor exception lies in a couple of small dams in Oregon (but even here, the lampreys may persist in reservoir pools with tui chubs and other native fishes).

Score: 2. Coastal cutthroat trout. This under-appreciated salmonid is anadromous like steelhead, but stays close to its home river rather than taking long trips out into the ocean. In California it occurs in north coast streams that are typically lined with redwood and Douglas fir. Its populations have suffered long-term declines due to logging and other land uses, but it persists as long as forest shades the stream and a lagoon or estuary is present at the mouth. While many factors threaten this species (e.g., proposed mines, diversions for marijuana growing), the streams it inhabits lack large dams that alter flow regimes. Current management also seems to have minimized the decline.

Score: 3. Sacramento hitch. This species has been extirpated from much of its range in the Central Valley but is present in a few reservoirs, some stream reaches, and scattered ponds and lagoons. Causes of its decline are uncertain, but inadequate releases of water from dams is certainly a contributing factor. Better understanding of its distribution and population dynamics could send the score to 2 (unlikely) or push it up to 4 (more likely).

Score: 3. California roach. California roach still has many populations in small streams off Central Valley rivers, but dams and reservoirs have fragmented the populations, so they can go extinct one at a time, unnoticed. The recent drought has probably resulted in extirpation of many populations.

Score: 4. Southern green sturgeon. This species is listed as threatened because of its low numbers and its dependence on Sacramento River and Feather River flows for spawning and rearing. Dams have reduced its historical range in the rivers. Successful spawning depends on dam releases that are not too cold (preferred by salmon) and not too warm, for incubation of eggs and rearing of juveniles. Juveniles go out to sea in 1–2 years, passing through the San Francisco Estuary. Green sturgeon spend most of their life in the ocean so conditions in the river need to be just right for spawning when they return every few years. Adults can live 50–60 years, which improves their likelihood for spawning successfully. If their range were not so restricted, they could arguably score 3 on the scale.

Score: 4. Sacramento splittail. The splittail is a unique California fish that was once abundant in Central Valley rivers. It is now largely confined to the upper San Francisco Estuary, from which it migrates in large numbers every spring to spawn on flooded fields and farmlands—especially those in the Yolo Bypass. The juveniles rear on the flooded areas for a few weeks before returning to the estuary. The success of splittail depends on adequate river flows to flood spawning areas with enough residual water to carry the juveniles back down stream. The splittail population is still small compared to what it once was, but improved management of Yolo Bypass flooding has resulted in increased abundance.

Score: 5. Razorback sucker. This species is endangered because of dam and reservoir management in the Colorado River basin, which have largely extirpated it from California. The population in the lower river exists because of hatchery production. Dams have created optimal habitats for non-native species which prey on or compete with all life history stages (but especially larvae).

Score: 5. Winter-run Chinook salmon. This species is on the verge of extinction, as a result of severe drought combined with some unfortunate decisions regarding management of water from Shasta Reservoir. This anadromous fish is adapted for spawning and rearing in the cold spring-fed waters of the McCloud River, incubating its eggs in the gravel during the hot summer months. The construction of Shasta Dam and reservoir denied this endemic species access to their ancestral habitat. So, to allow these fish to survive in the Sacramento River, cold water has to be released from the dam, which can retain cold water through the summer if properly managed. However, during the summers of 2014, 2015, and 2021, when Shasta reservoir was low from the drought, much of the cool water was released for downstream users and not enough was left for the fish, so most of the eggs and young fish died. Survival of this species is now increasingly dependent on spawning and rearing fish in a hatchery, which has its own set of problems.

While the emphasis of this technical appendix is on the effects of large dams and reservoirs, there are many native fishes that are threatened with extinction independent of large dams, or that are thriving despite—or even because of—dams. These fishes have dam effect scores of 0, 1, or 2. Examples include:

- All the species of pupfish (*Cyprinodon*), which live in isolated desert springs and are threatened mainly with groundwater withdrawals and introductions of non-native species.
- Long Valley and Amargosa speckled dace, with similar problems as pupfish.
- Paiute cutthroat trout, which suffer from invasions of non-native trout into their limited high-elevation stream habitat.
- Coastal rainbow trout, which are perhaps the most widely distributed fish in California, thanks to introductions outside their native range. They thrive above, below, and in reservoirs.
- Klamath tui chub, which is widely distributed in upper Klamath River basin, in reservoirs, lakes, streams, ponds, and canals.
- Coastal prickly sculpin, which is found in most coastal streams and estuaries, as well as in regulated streams and reservoirs through the Central Valley.

Summary

Over half (51%) the native fish species included in this report (and in Moyle et al. 2011 and 2013) have a conservation status (high or critical) that indicates they are headed for extinction in the wild unless there are serious efforts to protect/restore habitats (Figure A1, Table A4). Seven species (5%) have already gone extinct. The fate of many of California's fishes is intrinsically tied to dams. Dams have transformed the riverscape, physically, ecologically, and hydrologically, and declines in 24 of the species (19%) can be directly attributed to large dams and water operations (scores of high or critical). Of these 24 species, 2 are extinct, 19 have high or critical conservation status, and 23 are highly or critically vulnerable to the effects of climate change. Twenty species were of high concern across all three metrics, including two species that are already extirpated from California.[1] Such "threat intersections" leave these species particularly vulnerable to the combined effects of water projects, land use changes, and climate change.

Given California's "coequal goals" of providing water supply reliability and protecting ecosystem health, the removal of large dams is rarely an option, but with an overhaul of river management that prioritizes ecosystem health (e.g., careful shaping of reservoir releases, habitat restoration across current and future ranges, safeguarding/storing water for dry periods), it may be possible to conserve these vulnerable species. It can be argued, in fact, that California law and the public trust doctrine *require* that such measures be taken, giving dam management for native fish a higher priority than many other water management measures (Börk et al. 2012). Conservation of native fishes, however, requires proper, thoughtful management of *all* aquatic habitats in California and the biota they support, not just those affected by the major water projects.

It is worth noting that a standard approach to mitigating the effects of dams on fishes is to build hatcheries to rear declining fishes in captivity, for release in the wild. Hatcheries are already in place for most of the 24 species in the most trouble (Moyle 2002, Moyle et al. 2017). But hatcheries are proving to be at best partial solutions because

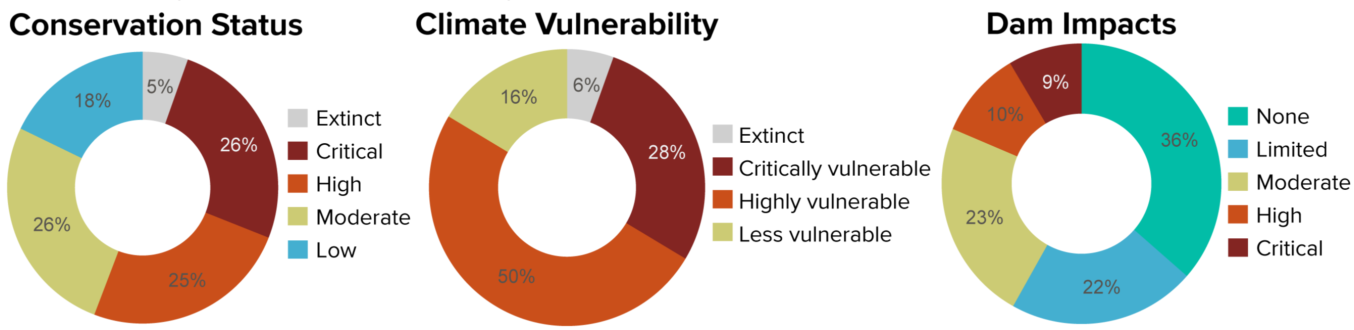
[1] Kern brook lamprey, northern green and white sturgeons, shortnose and razorback suckers, Upper Klamath-Trinity fall and spring Chinook salmon, Central Valley winter, spring, fall, late fall Chinook salmon, Central coast and Southern Oregon Northern California coast coho salmon, Lahontan cutthroat trout, and Central Valley, South Central California coast, Southern California and Klamath Mountains Province summer steelhead, and two species that are already extirpated from California—Colorado pikeminnow and Bonytail.

hatchery-reared fish are subject to domestication selection and often have poor survival rates in the wild. Modernizing hatcheries and hatchery practices to produce fish that survive better in the wild is very costly and has limited productivity, making such hatcheries problematic for sustaining fisheries.

Dams and reservoirs in California are largely responsible for declines of many California fishes, but especially anadromous salmonids. For many species they may not be the sole cause of declines but are often an important contributing factor, by supporting invasions of non-native fishes and altering water quality and habitat for long distances below the dams. Delta smelt, for example, have been negatively affected by the combination of upstream dam operations and water diversions in the Delta. But water projects are one of a host of interacting factors causing their decline, including invasive species, habitat alteration, changes in water quality, and toxins. Inadequate flow releases from dams create—or interact with these other factors to create—an environment hostile to the smelt (and other native fishes).

FIGURE A1

Status, dam impacts, and climate vulnerability of California native fishes



SOURCE: See Table A4.

TABLE A4

Conservation status, influence of dams, and climate change vulnerability of California native fishes

Species	Conservation Status Level of Concern	Climate Change Vulnerability	Influence of Dams and Operations
Petromyzontidae			
Pacific lamprey, *Entosphenus tridentata*	Moderate Concern (3.4)	Highly Vulnerable (17)	Moderate (3)
Goose Lake lamprey, *Entosphenus sp.*	High Concern (2.6)	Critically Vulnerable (15)	Limited (2)
Klamath River lamprey, *E. similis*	Moderate Concern (3.9)	Highly Vulnerable (18)	None (1)
River lamprey, *Lampetra ayersi*	Moderate Concern (3.6)	Highly Vulnerable (19)	High (4)
Kern brook lamprey, *L. hubbsi*	High Concern (2)	Critically Vulnerable (15)	Critical (5)
Western brook lamprey, *L. richardsoni*	Moderate Concern (3.1)	Highly Vulnerable (18)	Limited (2)
Pit-Klamath brook lamprey, *L. lethophaga*	Moderate Concern (3.6)	Highly Vulnerable (18)	Limited (2)
Acipenseridae			
Northern green sturgeon, *Acipenser medirostris*	2.4	18	4

Southern green sturgeon, *A. medirostris*	1.6	25	4
White sturgeon, *A. transmontanus*	2	18	4
Cyprinidae			
Thicktail chub, *Siphatales crassicauda*	0	0	0
Goose Lake tui chub, *S. t. thalassinus*	3.4	17	2
Pit River tui chub, *S. thalassinus subsp.*	4	24	1
Cow Head tui chub, *S. t. vaccaceps*	2.1	16	2
Klamath tui chub, *S. b. bicolor*	4.1	27	0
High Rock Springs tui chub, *S. b. subsp.*	0	0	0
Lahontan lake tui chub, *S. b. pectinifer*	2.4	19	3
Lahontan stream tui chub, *S. b. obesus*	4.7	25	2
Eagle Lake tui chub, *S. b. subsp.*	3.3	18	1
Owens tui chub, *S. b. snyderi*	1.4	17	2
Mojave tui chub, *S. mohavensis*	1.4	17	1
Bonytail, *Gila elegans*	0	0	5
Blue chub, *Gila coerulea*	3.4	26	2
Arroyo chub, *Gila orcutti*	2.3	26	3
Lahontan redside, *Richardsonius egregius*	4.8	24	1
Sacramento hitch, *Lavinia e. exilicauda*	3.3	25	3
Clear Lake hitch, *Lavinia e. chi*	1.9	14	2
Monterey hitch, *L. e. harengeus*	2.7	20	3
California roach, *H. s. symmetricus*	3.4	24	3
Red Hills roach, *H. s. serpentinus.*	2	16	3
Russian River roach, *H. v navarroensis DPS*	3	22	2
Clear Lake roach, *H. venustus x symmetricus.*	3.1	20	2
Southern coastal roach, *H. v. subditus*	3.3	21	4
Northern coastal roach, *H. v. navarroensis*	3	24	2
Tomales roach, *H. v. navarroensis DPS*	3	18	3
Gualala roach, *H. parvipinnis*	3	18	2
Northern Roach, *H. mitrulus*	2.9	17	3
Sacramento blackfish, *Orthodon microlepidotus*	4.4	29	2

Sacramento splittail, *Pogonichthys macrolepidotus*	2.9	21	3
Clear Lake splittail, *P. ciscoides*	0	0	0
Hardhead, *Mylopharodon conocephalus*	3.4	15	3
Sacramento pikeminnow, *Ptychocheilus grandis*	4.7	23	1
Colorado pikeminnow, *P. lucius* (extirpated from CA)	0	0	5
Sacramento speckled dace, *Rhinichthys klamathenesis subp.*	4.1	21	1
Lahontan speckled dace, *R. o. robustus*	4.8	25	1
Klamath speckled dace, *R. k. klamathensis*	4.8	24	1
Owens speckled dace, *R. o. nevadensis DPS.*	1.9	14	3
Long Valley speckled dace, *R. o. subsp.*	1	13	1
Amargosa speckled dace, *R. o. nevadensis*	1.6	15	1
Santa Ana speckled dace, *R. sp.*	1.6	17	3
Catostomidae			
Tahoe sucker, *Catostomus tahoensis*	5	26	1
Owens sucker, *C. fumeiventris*	3.9	24	1
Mountain sucker, *C. platyrhynchus*	3.3	20	3
Sacramento sucker, *C. o. occidentalis*	5	23	1
Goose Lake sucker, *C. o. lacusanserinus*	2.1	22	2
Monterey sucker, *C. o. mnioltiltus*	4.1	20	2
Humboldt sucker, *C. o. humboldtianus*	4.3	22	1
Modoc sucker, *Catostomus microps*	1.6	16	2
Klamath smallscale sucker, *C. rimiculus*	4.1	28	1
Klamath largescale sucker, *C. snyderi*	2	15	3
Lost River sucker, *C. luxatus*	1.7	19	3
Santa Ana sucker, *C. santaanae*	1.7	17	3
Shortnose sucker, *Chasmistes brevirostris*	1.6	20	4
Razorback sucker, *Xyrauchen texanus*	2	14	5
Osmeridae			
Eulachon, *Thaleichthys pacificus*	1.6	20	1
Longfin smelt, *Spirinchus thaleichthys*	2	15	2

Delta smelt, *Hypomesus pacificus*	1.4	12	3
Salmonidae			
Mountain whitefish, *Prosopium williamsoni*	3.9	21	3
Bull trout, *Salvelinus confluentus*	0	0	5 (Extirpated)
Upper Klamath-Trinity fall Chinook salmon, *Oncorhynchus tshawytscha*	2.4	18	4
Upper Klamath-Trinity spring Chinook salmon, *O. tshawytscha*	1.6	14	5
Southern Oregon Northern California coast fall Chinook salmon, *O. tshawytscha*	3.7	17	3
California Coast fall Chinook salmon, *O. tshawytscha*	2.4	18	3
Central Valley winter Chinook salmon, *O. tshawytscha*	2	12	5
Central Valley spring Chinook salmon, *O. tshawytscha*	2	13	5
Central Valley late fall Chinook salmon, *O. tshawytscha*	1.7	12	5
Central Valley fall Chinook salmon, *O. tshawytscha*	2	16	5
Central coast coho salmon, *O. kisutch*	1.1	16	4
Southern Oregon Northern California coast coho salmon, *O. kisutch*	1.6	15	4
Pink salmon, *O. gorbuscha*	1.3	16	1
Chum salmon, *O. keta*	1.6	18	1
Northern California coast winter steelhead, *O. mykiss*	3.3	17	3
Northern California coast summer steelhead, *O. mykiss*	1.9	14	3
Klamath Mountains Province winter steelhead, *O. mykiss*	3.9	21	4
Klamath Mountains Province summer steelhead, *O. mykiss*	1.7	11	4
Central California coast winter steelhead, *O. mykiss*	2.7	19	3
Central Valley steelhead, *O. mykiss*	2.4		4
South Central California coast steelhead, *O. mykiss*	2.4	19	5
Southern California steelhead, *O. mykiss*	1.7	14	5
Coastal rainbow trout, *O. m. irideus*	4.7	21	0
McCloud River redband trout, *O. m. stonei*	1.9	12	3
Goose Lake redband trout, *O. m. subsp.*	3.3	17	1
Eagle Lake rainbow trout, *O. m. aquilarum*	1.4	13	2
Kern River rainbow trout, *O. m. gilberti*	1.9	13	3
California golden trout, *O. m. aguabonita*	2	14	1

Little Kern golden trout, *O. m. whitei*	2	15	1
Coastal cutthroat trout, *O. clarki clarki*	3.4	16	2
Paiute cutthroat trout, *O. c. seleneris*	1.7	14	1
Lahontan cutthroat trout, *O. c. henshawi*	2.1	17	4
Fundulidae			
California killifish, *Fundulus parvipinnis*	4.1	22	0
Cyprinodontidae			
Desert pupfish, *Cyprinodon macularius*	1.9	19	2
Owens pupfish, *C. radiosus*	1.4	18	2
Saratoga Springs pupfish, *C. n. nevadensis*	2.1	19	1
Amargosa River pupfish, *C. n. amargosae*	2.3	22	1
Tecopa pupfish, *C. n. calidae*	0	0	1
Shoshone pupfish, *C. n. shoshone*	1.1	14	1
Salt Creek pupfish, *C. s. salinus*	2.6	18	0
Cottonball Marsh pupfish, *C. s. milleri*	2.4	16	0
Cottidae			
Rough sculpin, *Cottus asperrimus*	3.4	17	2
Bigeye marbled sculpin, *C. klamathensis macrops*	2.7	22	2
Lower Klamath marbled sculpin, *C.k. polyporus*	3.3	20	3
Upper Klamath marbled sculpin, *C. k. klamathensis*	3	19	3
Coastal Prickly sculpin, *C. asper subsp.*	4.7	28	0
Clear Lake prickly sculpin, *C. a. subsp.*	3.1	21	1
Coastrange sculpin, *C. aleuticus*	4.4	22	1
Riffle sculpin, *C. gulosus*	3.4	17	3
Pit sculpin, *C. pitensis*	4.3	18	2
Paiute sculpin, *C. beldingi*	4.4	20	1
Reticulate sculpin, *C. perplexus*	3.9	20	1
Staghorn sculpin, *Leptocottus armatus*	4.7	31	0

Gasterosteidae			
Coastal threespine stickleback, *Gasterosteus a. aculeatus*	4.6	24	1
Inland threespine stickleback, *G. a. microcephalus*	4.1	21	1
Unarmored threespine stickleback, *G. a. williamsoni*	1.9	12	3
Shay Creek stickleback, *G. a. subsp.*	1.3	12	0
Centrarchidae			
Sacramento perch, *Archoplites interruptus*	1.6	18	1
Embiotocidae			
Sacramento tule perch, *Hysterocarpus t. traski*	3.4	17	2
Russian River tule perch, *H. t. pomo*	3.1	20	2
Clear Lake tule perch, *H. t. lagunae*	3	20	1
Gobiidae			
Tidewater goby, *Eucyclogobius newberryi*	2.9	19	2

NOTES: Central Valley steelhead lacks a climate change vulnerability score due to complexities in defining its species status (see Moyle et al. 2017 for discussion).

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