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Status of Aquatic Habitat Types

ABSTRACT

Sixty-six aquatic habitat types were described for the Sierra Nevada, based on the system of Moyle and Ellison (1991). Three aspects of each habitat type were rated on a scale of 1 to 5: rarity, amount of disturbance, and amount of protection it currently enjoys. The ratings were added to provide a measure of the status of each habitat type. Eighteen (27%) were rated as secure, thirty-three (50%) as of special concern, fourteen (21%) as threatened, and one (2%) as extirpated. Most of the secure habitat types were characteristic of high-mountain areas, while most of the threatened habitat types were found in lowland areas. The decline and loss of habitat types, especially rare or unusual habitat types, is one of the principal reasons that so many species of invertebrates, fish, and amphibians in the Sierra Nevada are in decline.

INTRODUCTION

The decline of native fishes, amphibians, and aquatic invertebrates in the Sierra Nevada (Erman 1996; Jennings 1996; Moyle et al. 1996) reflects, to a large extent, the deterioration in the quality of the range's aquatic habitats. Factors contributing to this deterioration are multiple, cumulative, and synergistic. They include changes in the amount and timing of stream flows, changes in water quality, reduction in structural complexity (from loss of riparian trees, channelization, and other factors), changes in stream channels, siltation, and invasions of non-native species (Meehan 1991). Not all Sierra Nevada habitats, of course, are affected equally by human influences. The unique alkaline lake habitats that once existed in the Owens Lake basin disappeared completely once the lake became dry as the result of diversion of inflowing water. In contrast, small, fishless alpine ponds and streams exist by the hundreds, many little changed from pristine conditions.

In order to evaluate the relative state of aquatic habitats around California, Moyle and Ellison (1991) devised a classification system for aquatic habitat types. The term habitat type means a readily recognizable set of habitats or environmental conditions that is home to a distinctive assemblage of organisms. Moyle and Ellison used only the word habitat for this definition, rather than habitat type. Although their use of habitat in a broad context is consistent with the deliberately vague definitions in standard ecology texts (e.g., Rickleffs 1993), many of the "habitats" of Moyle and Ellison 1991 contain multiple habitats under more conventional classification schemes. For example, Lake Tahoe is usually considered to contain multiple habitats (deep water, shallow water, open water, etc.), rather than being only one habitat as defined by Moyle and Ellison. Habitats are also usually defined largely on the basis of their physical and chemical characteristics, including vegetation types (e.g., Cowardin et al. 1979). While the habitat types described here have distinct physical and chemical characteristics, animal assemblages, especially those containing endemic fishes and amphibians, are key parts of their descriptions. The habitat types have fairly recognizable boundaries, although stream habitat types often tend to blend into one another.

In devising their classification system, Moyle and Ellison (1991) tried to make sure that it

- covered all aquatic habitats
- was easy to use without being either too general or too specific
- took into account patterns of endemism in aquatic organisms

Sierra Nevada Ecosystem Project: Final report to Congress, vol. II, Assessments and scientific basis for management options. Davis: University of California, Centers for Water and Wildland Resources, 1996.

- was expandable, so that new categories could easily be added
- was based on a combination of physical, chemical, and biological aspects of each habitat type
- was predictive, so that once a site had been classified users could have a reasonably good idea as to what organisms were likely to be present

Fish and amphibian distribution patterns were used as the basis for the classification system, mainly because vertebrates are the best-known aquatic organisms. However, the system includes many habitat types that contain mainly invertebrates and can be expanded to include others. Thus, the first level in the classification system consists of the five ichthyological provinces (regions of endemism) found in California. The second level (within each province) is standing versus flowing waters. Within these waters, the first division is ephemeral versus permanent, followed by waters with and without fish. Further subdivisions are usually based on the size of the body of water and on the species present.

This chapter presents a classification system of Sierra Nevada aquatic habitat types, modified from Moyle and Ellison (1991), and then evaluates how much protection and management each habitat type (and its associated flora and fauna) needs if examples are to persist in the Sierra Nevada in the near future.

METHODS

The classification system of Moyle and Ellison (1991) was expanded and revised according to new knowledge obtained from personal observations, various forest management plans, consultation with other biologists, and other sources. Each habitat type was then rated by the author in three categories: rarity, degree of disturbance, and existing protection (table 32.1).

Rarity is essentially a rating of the frequency of the habitat type in the Sierra Nevada. Some habitat types, such as Mono Lake, are one of a kind; others are naturally rare (e.g., sphagnum bogs); and others are widespread (e.g., alpine lakes).

Disturbance is a subjective rating of the degree to which the habitat type as a whole has been disturbed by human activity, including fish introductions. The most disturbed habitat types are at low elevations such as rivers in which chinook salmon spawn, which are now largely modified or cut off by dams. Examples of habitat types having the lowest disturbance overall included small rainbow trout streams, found in many areas, and small, fishless glacial streams or ponds.

Existing protection was determined by examining maps and estimating the extent to which each habitat type is found in national parks, wilderness areas, and other categories of formal protection. Streams or lakes on national forest land were rated as having only moderate protection. The lowest protection ratings were generally for habitat types that occur mostly on private land.

Each factor was rated on a scale of 0 to 5 or 1 to 5 (table 32.2), and the scores were added. Habitat types with the lowest total scores are most likely to need special protection and management in the immediate future if they are to persist.

TABLE 32.1

A rating system for aquatic habitat types of the Sierra Nevada to determine how much special protection and management is likely to be needed in the immediate future for persistence.

Rating	Description
Rarity	
1	Unique: only one or two examples exist/remain in the Sierra Nevada
2	Rare: probably only 2-5 examples exist in Sierra Nevada or a formerly common habitat type in which most examples have been irreversibly altered
3	Unusual: scattered or infrequent examples in the Sierra Nevada
4	Common: examples easy to find
5	Widespread: a major existing habitat type
Disturbance	
0	All known examples highly disturbed, not recoverable
1	All known examples highly disturbed/altered but some are recoverable to a defined desirable state
2	All known examples moderately to highly disturbed or altered but most are recoverable
3	Most examples disturbed but some relatively undisturbed examples exist or all known examples moderately to lightly disturbed (recoverable with minimal effort)
4	Fairly even mixture of disturbed and relatively undisturbed areas OR all known examples lightly disturbed
5	Most examples in good condition (relatively undisturbed)
Existing Protection	
1	No known examples in protected areas (national park, wilderness area, research natural area, etc.)
2	No known examples in protected areas but mostly on public land or just one or two protected examples
3	3-5 protected examples exist but most unprotected or a rare habitat type with partial protection
4	Moderately secure: several protected examples, many with de facto protection because of location, etc., or a rare habitat type with de facto protection
5	Secure: many examples in protected areas or with de facto protection or a rare habitat type in protected area
Status (Rarity + Disturbance + Protection)	
12–15	Secure: widespread, with many examples in good condition
8–11	Special concern: declining in abundance and quality but many examples still exist or a habitat type with only one or two examples in existence
4–7	Threatened: being lost/degraded rapidly
<4	Extirpated or likely to disappear soon if protective action is not taken

TABLE 32.2

Status of sixty-six habitat types in the Sierra Nevada, determined by subjectively rating rarity, degree of disturbance, and amount of formal protection. See table 32.1 for rating system. The confidence rating indicates the confidence the author has in his subjective ratings.

Number	Type	Rarity	Disturbance	Protection	Status Score	Rating	Confidence
A0000	***Sacramento-San Joaquin Province***						
A1151	Outcrop pool	4	4	5	13	Secure	Moderate
A1152	Mountain pond	5	5	5	15	Secure	Moderate
A1210	Alpine lake	5	3	5	13	Secure	High
A1220	Northeast volcanic lake	3	3	4	10	Special concern	Moderate
A1240	Dystrophic ponds/lake	3	4	4	11	Special concern	Low
A1260	Valley marsh	2	1	3	6	Threatened	Low
A1280	Sphagnum bog	2	3	4	9	Special concern	Moderate
A1290	Fen	3	4	3	10	Special concern	Low
A2110	Alpine snowmelt stream	5	5	5	15	Secure	High
A2120	Conifer forest snowmelt stream	5	4	5	14	Secure	High
A2130	Foothill/valley ephemeral stream	3	2	3	8	Special concern	High
A2140	Foothill canyon ephemeral stream	4	4	3	11	Special concern	Moderate
A2411	Alpine stream	5	3	5	13	Secure	High
A2412	Forest stream	5	3	5	13	Secure	High
A2413	Spring	4	3	3	10	Special concern	Moderate
A2414	Meadow stream	5	2	3	10	Special concern	High
A2415	Glacial melt stream	3	5	5	13	Secure	High
A2416	Hot springs outflow	2	4	5	11	Special concern	High
A2421	Resident rainbow trout stream	5	5	4	14	Secure	High
A2422	Rainbow trout/cyprinid stream	4	4	4	12	Secure	High
A2423	Kern golden trout stream	2	3	3	8	Special concern	High
A2431	Spring chinook stream	2	3	4	9	Special concern	High
A2441	Valley floor river	2	1	1	4	Threatened	High
A2442	Fall chinook salmon spawning stream	4	1	1	6	Threatened	High
A2443	Hardhead/squawfish stream	4	3	3	10	Special concern	High
A2444	Hitch stream	3	2	1	6	Threatened	High
A2445	California roach stream	4	3	2	9	Special concern	High
A2446	Squawfish-sucker stream	4	3	3	10	Special concern	Moderate
C0000	***Great Basin Province***						
C1110	Alkalai playa lake	2	4	2	8	Special concern	Moderate
C1120	Mountain pond	5	5	5	15	Secure	Moderate
C1130	Great Basin scrub pool	4	3	4	11	Special concern	Moderate
C1140	Rock pool	3	4	4	11	Special concern	Low
C1210	Alpine lake/pond	5	3	5	13	Secure	High
C1221	Great Basin scrub perennial pool	3	3	3	9	Special concern	Low
C1222	Spring pool	2	2	2	6	Threatened	Low
C1232	Mono Lake	1	3	3	7	Threatened	High
C1233	Owens Lake	1	0	1	2	Extirpated	High
C1241	Fen	3	3	3	9	Special concern	Moderate
C1242	Sphagnum bog	1	4	4	9	Special concern	Moderate
C1311	Alpine lake/pond	3	3	2	8	Special concern	Moderate
C1312	Lake Tahoe	1	3	3	7	Threatened	High
C1313	Caldera lake	2	1	3	6	Threatened	Moderate
C1320	Eagle Lake	1	5	2	8	Special concern	High
C1330	Honey Lake	1	3	2	6	Threatened	Moderate
C1341	Lahonton desert spring	2	2	1	5	Threatened	Moderate
C1343	Owens desert spring	1	1	4	6	Threatened	Moderate
C2110	Alpine snowmelt stream	5	5	5	15	Secure	High
C2120	Conifer forest snowmelt stream	5	4	5	14	Secure	High
C2130	Great Basin scrub snowmelt stream	4	2	3	9	Special concern	Low
C2140	Desert wash	4	3	3	10	Special concern	Low
C2211	Glacial melt stream	3	5	5	13	Secure	High
C2212	Exposed alpine stream	5	3	5	13	Secure	High
C2213	Spring	4	3	3	10	Special concern	Moderate
C2214	Conifer forest stream	5	3	5	13	Secure	High
C2215	Meadow stream	5	2	3	10	Special concern	High
C2216	Hot springs outflow	2	3	3	8	Special concern	Moderate
C2221	Desert scrub stream	3	3	4	10	Special concern	Low
C2310	Trout headwater	4	3	4	11	Special concern	Moderate
C2320	Trout/sculpin stream	3	3	4	10	Special concern	Low
C2331	Sucker/dace/redside stream, with trout	4	3	2	9	Special concern	Moderate
C2332	Sucker/dace/redside stream, without trout	3	3	2	8	Special concern	High
C2333	Pine Creek (Lassen County)	1	2	3	6	Threatened	High
C2340	Speckled dace stream	3	3	2	8	Special concern	Moderate
C2350	Whitefish/trout/sucker stream	5	3	2	10	Special concern	Moderate
C2360	Tui chub stream	1	1	2	4	Threatened	Moderate
C2374	Owens River	1	1	2	4	Threatened	Moderate

RESULTS

Sixty-six major habitat types were identified as occurring within the Sierra Nevada (appendix 32.1). Eighteen (27%) were found to be secure, thirty-three (50%) were rated as being of special concern, fourteen (21%) were rated as threatened (in rapid decline, with more extreme cases likely to disappear soon), and one (2%) was gone (table 32.2; figure 32.1). Of the eighteen habitat types designated as secure, fifteen were high-elevation habitat types, while eleven of the thirteen habitat types rated as being threatened were characteristic of low-land areas (e.g., Owens Valley, Central Valley). Most (79%) of the midmountain (foothill) habitat types were found to be in moderate decline (special concern). Although high-elevation habitat types were generally regarded as secure, this was mainly because of their wide distribution and abundance and their presence in national parks. In fact, most are degraded to a greater or lesser degree, especially by the introduction of trout and the grazing of livestock (both of which are allowed in wilderness areas).

Nine of the aquatic habitat types were unique or extremely rare, which automatically gave them at least special concern status. This is appropriate because such habitat types tend to contain endemic organisms and to be subject to degradation. Examples include large lakes such as Eagle Lake, Lake Tahoe, Mono Lake, and Owens Lake.

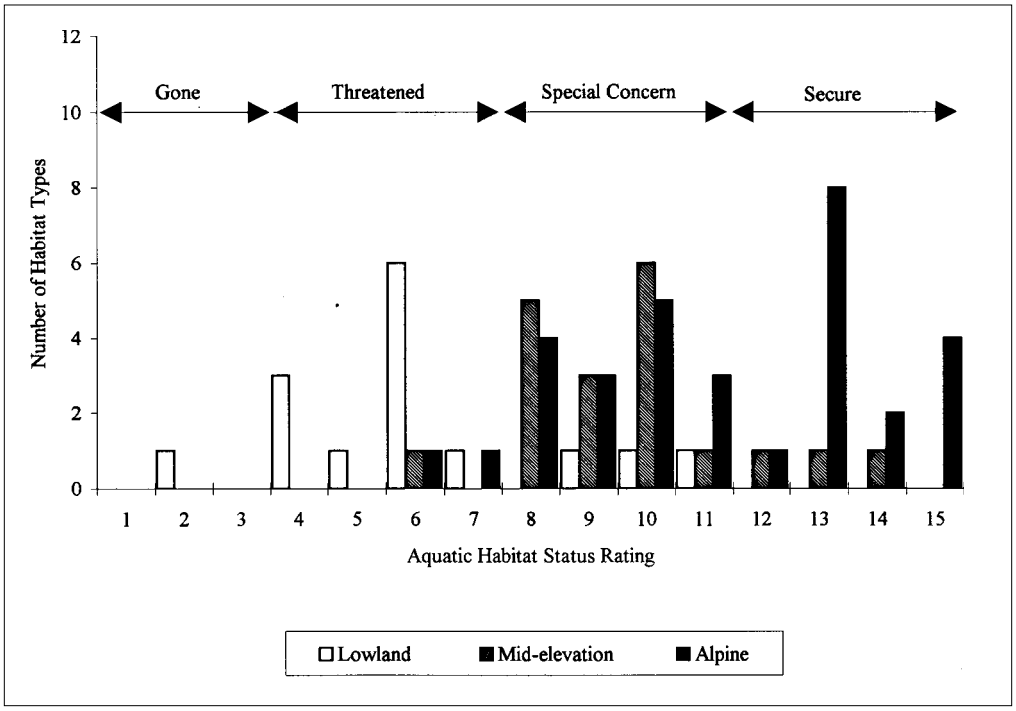
CONCLUSIONS

The diversity of natural aquatic habitat types in the Sierra Nevada is in the process of being diminished. As distinctive habitat types disappear, endemic or unusual native aquatic organisms disappear along with them. Habitat types in low-land regions, many of which just touch on the Sierra Nevada proper (e.g., valley lowland rivers), seem to be particularly degraded, presumably because they largely occur outside areas with formal protection, such as national parks, or are downstream of major dams. It is likely that the condition of aquatic habitat types in the Sierra Nevada is even worse than projected here, especially for fishless habitat types. This is because

- The classification system is based largely on vertebrates and so probably misses important habitat types dominated by invertebrates.
- Some of the habitat types are rather broad, especially the stream habitat types, and may therefore include special habitats (side channels, seeps, etc.) that are more vulnerable to degradation than the habitat type overall.
- The widespread disappearance of frogs and other amphibians may reflect subtle but widespread changes to common habitat types as well as increased fragmentation of aquatic habitats.

FIGURE 32.1

Status of aquatic habitats in the Sierra Nevada.



Although it is clear that many aquatic habitat types in the Sierra Nevada are in decline, the habitat type classification system presented here should be used with caution and the results obtained from the analysis regarded as conservative. The reason for this is that the habitat type classification system often makes arbitrary subdivisions of continuous habitat types that change with elevation or other factors. Also, not all habitat types have been rated by the author with high confidence (table 32.2), reflecting limited knowledge of the particular habitat types.

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APPENDIX 32.1

A Classification System for Aquatic Habitat Types of the Sierra Nevada Region

This classification system is based on Moyle and Ellison (1991). Only habitat types within the Sierra Nevada proper were evaluated in this study (i.e., habitat types in the Modoc Plateau and some peripheral areas were not evaluated, although they are presented in the classification system).

A0000 SACRAMENTO–SAN JOAQUIN PROVINCE

A1000 Standing Waters

A1100 Ephemeral Waters
- A1100-A1140 Not in Sierra Nevada
- A1150 Alpine pond
  - A1151 Outcrop pool
  - Clear, oligotrophic pools found in shallow depressions on granitic outcrops at high elevations in which both freezing and drying are limiting factors; seasonally filled with snowmelt or rain water. Support communities of seasonal organisms such as fairy shrimp *(Brachinecta* sp., *Strepotocephalus seali)* and larvae of long-toed salamanders *(Ambystoma macrodactylum).*
  - A1152 Mountain pond
  - Shallow (<1.5 m deep) ponds or small (<1 ha) lakes in alpine areas that periodically dry up, freeze solid, or become deoxygenated in winter; often associated with meadows and/or cirques.

A1200 Permanent Fishless Waters
- A1210 Alpine lake
- Clear, oligotrophic lakes found in cirques and other depressions carved out by glaciers. Historically, virtually all of these lakes were without fish and were dominated by aquatic insects, fairy shrimp and other crustaceans, and the larvae of frogs, principally *Rana muscosa.* Most of these lakes today contain one or more introduced species of salmonid fishes which have altered the native biotic communities considerably.
- A1220 Volcanic lake
- Permanent, isolated ponds and lakes created by old lava flows and landslides, especially in Lassen National Park area. Most now contain introduced fishes and original fauna is poorly known.
- A1230 Caldera lake—no examples in drainage
- A1240 Dystrophic pond/lake
- Shallow alpine waters with boggy edges, presumably in the natural successional process of becoming bogs. Acidic and fishless.
- A1250 Saline pond/lake—not in Sierra Nevada
- A1260 Valley marsh
- The floor of the Central Valley once supported extensive tule and cattail marshes that flooded seasonally and were permanently wet. Primarily fishless, but seasonally important for spawning and major habitat types for aquatic birds, including migratory waterfowl.
- A1270 Northern volcanic pool—not in Sierra Nevada
- A1280 Sphagnum bog
- True bog containing marshy vegetation, including carnivorous plants, and ranid frogs. Example: Mt. Pleasant RNA, Plumas NF.
- A1290 Fen
- Minerotrophic, spongy, spring-fed peatlands located on hillsides and dominated by non-sphagnum mosses and sedges.
- A1300 Permanent Lakes with Fish—none in drainage

A2000 Flowing Waters

A2100 Ephemeral Streams
- A2110 Alpine snowmelt stream
- Small, exposed, high gradient streams mainly above the timberline that exist only while snow is melting.
- A2120 Conifer forest snowmelt stream
- Small intermittent streams in conifer forest areas that also exist primarily while snow is still melting but have flows enhanced by seepage from bogs and meadows. Occasionally important as spawning areas for trout (*Oncorhynchus* spp.).
- A2130 Foothill/valley ephemeral stream
- Low elevation streams in oak woodland/valley grassland areas that flow primarily in response to winter and spring rainfall, although some water may be semi-permanent in bedrock pools. Have a distinctive succession of invertebrates and may be important for spawning of fishes from more permanent streams.
- A2140 Foothill canyon ephemeral stream
- High gradient seasonal tributary plunging down sides of steep canyons of foothill streams e.g., unnamed tributaries of lower Mill Creek, Tehama County.

A2200 Permanent Streams, Goose Lake Drainage
- A2210 Fishless alpine stream
- Small high-gradient streams in the Warner Mountains that are too steep or inaccessible to be colonized by native trout. Dominant fauna is aquatic insects.
- A2220 Redband trout/lamprey spawning stream
- Mid-elevation reaches of larger tributary streams (e.g., Willow and Lassen Creeks, Modoc County) to Goose Lake that contain enough gravel and spring flows to support spawning runs of redband trout and Goose Lake lamprey from the lake.
- A2230 Resident redband trout stream
- Small tributary streams (including tributaries that form A2220 streams) that support self-sustaining populations of redband trout.
- A2240 Goose Lake sucker/speckled dace stream
- Lower reaches of tributaries used for spawning by suckers and dace but are frequently dry in summer.
- A2250 Valley tui chub stream
- Streams reaches with low enough gradients to support Goose Lake tui chubs and other lake fishes. Typically warm and slightly turbid in late summer.

A2300 Permanent Streams, Pit River Drainage
- A2310 Fishless streams
- A2311 Glacial melt stream
- Streams that drain melting glaciers on Mt. Shasta. Color is typically a milky brown from “rock flour” created by the grinding action of the glaciers. Biotic diversity low.

A2312 Alpine stream
Most streams above 3000 m elevation in the Sacramento-San Joaquin Basin contained no fish until various salmonids were introduced starting in the late 19th century. Originally dominated by aquatic insects and amphibian larvae.
A2313 Spring stream
Outflows of small springs too small or with too high gradients to be colonized by fish.
A2314 Forest stream
Small streams in forested areas with high gradients.
A2320 Low order trout streams
A2321 Pit River rainbow/redband trout stream
Typically, second, third, or fourth order tributaries to the Pit River with high enough gradients to exclude all fish but rainbow trout.
A2322 McCloud River redband trout stream
The upper McCloud River (above Upper Falls) and tributaries; the endemic McCloud River redband trout (*Oncorhynchus mykiss* ssp.) is the sole native fish.
A2330 Pit River tributaries
A2331 Speckled dace/Pit sculpin stream
Low elevation tributaries to the Pit River characterized by rocky substrates and large populations of speckled dace and Pit sculpin *(Cottus pitensis).* Juveniles of the large cyprinids and catostomids characteristic of A2350 are often found here as well as they may use these streams for spawning.
A2332 Squawfish/sucker stream
The Pit River and the lower reaches of tributary streams (e.g., Ash Creek) in Big Valley, Modoc/Lassen/Shasta Counties. Gradient is low, water muddy and warm; dominant fishes are Sacramento squawfish *(Ptychocheilus grandis)* and Sacramento sucker *(Catostomus occidentalis).*
A2333 Modoc sucker stream
Small, moderate gradient streams in Modoc County containing Modoc sucker *(C. microps)* but dominated numerically by speckled dace.
A2334 Rough sculpin/Shasta crayfish spring stream
Cold, clear, spring waters in lava areas that support a highly endemic fauna, including rough sculpin *(Cottus asperrimus)* and Shasta crayfish *(Pascifasticus fortis).* Biggest examples are Fall River and its spring tributaries and lower Hat Creek.
A2340 Canyon rivers
A2341 Lower Pit River (Hardhead/tule perch river)
The Pit River proper as it flows through its canyon from Pit Falls to its confluence with the Sacramento River. Characterized by deep rocky pools containing hardhead *(Mylopharodon conocephalus)* and tule perch. Deep, swift riffles and runs contain rainbow trout.
A2342 Lower McCloud River
The McCloud River below Lower Falls was a cold, slightly milky river flowing through a deep canyon and characterized by deep pools that housed winter run chinook salmon *(Oncorhynchus tshawystscha)* and bull trout *(Salvelinus confluentus);* both are now extinct in the river.
A2400 Permanent Streams, Central Valley Drainage
A2410 Fishless low-order tributaries
A2411 Alpine stream
Most streams above 3000 m elevation in the Sacramento-San Joaquin Basin contained no fish until various salmonids were introduced starting in the late 19th century. Originally dominated by aquatic insects and amphibian larvae.
A2412 Forest stream
Second or third order streams in fir, pine, or deciduous forest areas that are too small or too high in gradient to support fish.
A2413 Spring
Springs with constant temperature and flows, fine substrates, and clear water; can support unusual/endemic invertebrates. Several can unite to form a meadow stream (A2414).
A2414 Meadow stream
First or second order stream through subalpine meadows, low gradient with sinuous braided channel. Where not heavily grazed, abundant frogs. May have introduced trout populations.
A2415G lacial melt stream
Streams that drain melting glaciers; water is typically milky brown in color and biotic diversity is low.
A2416 Hot Springs Outflow
Streams created by outflows of large hot springs, containing no or highly specialized life forms in the high-temperature sections. Example: Mill Creek below Bumpass Hell, Lassen NP.
A2420 Resident trout stream
A2421 Resident rainbow trout stream
Low order, cold, high gradient streams, dominated by rainbow trout and, often, riffle sculpin.
A2422 Rainbow trout/cyprinid stream
Small streams of moderate gradient supporting rainbow trout and one or two species of cyprinids (mostly California roach, *Lavinia symmetricus*) and/or Sacramento sucker.
A2423 Kern golden trout stream
The upper Kern River (Kern County) and its branches and tributaries that support golden trout *(Oncorhynchus mykiss aquabonita; O. m. whitei; O. m. gilberti).*
A2430 Salmon-steelhead streams
A2431 Spring chinook stream
Third to fifth order streams at elevations of 500-1500 m with deep canyons containing deep, cold pools that can sustain spring chinook salmon through the summer. Examples: upper San Joaquin River, Fresno County (formerly); Deer and Mill Creeks, Tehama County.
A2440 Low elevation streams
A2441 Valley floor river
The main channels of the Sacramento and San Joaquin rivers, plus the lower reaches of their tributaries. Much of the water sluggish in summer and considerable cover is provided by logs etc. from riparian forests. Floods seasonally. Fauna complex mixture of resident deep-bodied fishes, warmwater stream fishes, and anadromous fishes.
A2442 Fall chinook salmon spawning stream
Low elevation, low gradient tributaries to major rivers that dry up in summer but are used for spawning by both anadromous species and resident stream fishes in spring. Example: lower Deer Creek, tributary to Sacramento River (Tehama County).
A2443 Hardhead/squawfish stream
Low- to mid-elevation streams characterized by deep, bedrock pools, clear water, and cool temperatures (<25°C); characteristic fishes are hardhead, Sacramento squawfish, and Sacramento sucker, although typically 5–6 species are present.
A2444 Hitch stream
Warm, low-elevation streams with low to moderate current and long reaches with sandy bottoms. Typical fishes are hitch *(Lavinia exilicauda),* Sacramento squawfish, Sacramento sucker. Example: Fresno River
A2445 California roach stream
Small, clear, mid-elevation second, third, or fourth order tributaries that typically contain deep pools in canyons and are often intermittent in flow by late summer. Dominant fish numerically are California roach, but juveniles of Sacramento squawfish and Sacramento sucker are often present.
A2446 Squawfish-sucker stream
Small low to mid-elevation streams with few deep pools that are dominated by Sacramento sucker, Sacramento squawfish and, often, California roach. Example: Deer Creek, Tulare County.

B0000 KLAMATH PROVINCE

C0000 GREAT BASIN PROVINCE

C1000 Standing Waters

C1100 Ephemeral Waters
C1110 Alkali playa lake
Shallow lakes in isolated desert basins that dry up annually (except during exceptionally wet years).
C1120 Mountain pond
See A1152
C1130 Great Basin scrub pool
Pools that form from seasonal rainfall or snowmelt in hardpan areas of the desert and rarely last more than a month or two.
C1140 Rock pool
Natural holes in rocks (often in washes) that fill with water seasonally and may be semipermanent if deep enough. Important sources of water for desert bighorn and other animals.
C1200 Permanent Fishless Waters
C1210 Alpine lake/pond
Small, usually isolated, oliogotrophic lakes in high mountain areas formed by the action of glaciers or by cones of volcanos.
C1220 Desert pool and pond
C1221 Great Basin scrub perennial pool
Small isolated ponds in lowland or sub-alpine areas formed by the

damming action of lava flows or landslides and dominated by predatory insects and amphibian larvae.
C1222 Spring pool
Isolated small springs in desert or scrub areas.
C1230 Desert lake
C1231 Playa lake
Terminal lakes, often large, that occupy desert basins, are too alkaline to support fish life, and may dry up during severe drought periods. Example: upper and lower Alkaline Lakes in Surprise Valley (Modoc County).
C1232 Mono Lake
A distinctive, permanent alkaline lake in Mono County with an endemic invertebrate fauna (e.g., *Artemia mona*).
C1233O wens Lake
A large lake at the terminus of the Owens River that probably was similar in many of its characteristics to Mono Lake (C1232) but now dry due to diversion of inflowing water.
C1240 Fen and bogs
C1241 Fens
See A1290. Example: Mason Fen, Nevada County.
C1242 Sphagnum bog
See A1280. Example: Grass Lake
C1300 Permanent Waters with Fish
C1310 Alpine lake
C1311 Alpine lake/pond
Oligotrophic, permanent alpine lakes with connections to streams with fish. Example: Independence Lake (Sierra and Nevada Counties).
C1312 Lake Tahoe
A large, deep, extraordinarily clear alpine lake containing a complex fish fauna and unusual deepwater invertebrates.
C1313 Caldera lake
Lakes occupying calderas of extinct volcanos Example: Crater Lake, Lassen County.
C1320 Eagle Lake
An alkaline, permanent terminal lake in Lassen County that is productive of fish and fish-eating birds; contains Eagle Lake rainbow trout *(Oncorhynchus mykiss aquilarum)* and tui chubs.
C1330 Honey Lake
A large, shallow, terminal alkaline lake in Lassen County that fluctuates greatly in size, even drying up occasionally, but supports abundant fish life in whatever water it contains.
C1340 Desert Springs
C1341 Lahontan desert spring
Isolated desert springs and associated pools containing fish, usually tui chubs. Example: High Rock Springs, Lassen County.
C1342 Amargosa desert spring (not in Sierra Nevada)
C1343 Owens desert spring
Spring fed pools containing Owens pupfish *(C. radiosus).*

C2000 Flowing Waters

C2100 Ephemeral Streams
C2110 Alpine snowmelt stream
See A2110
C2120 Conifer forest snowmelt stream
See A2120
C2130 Great Basin scrub snowmelt stream
Small streams flowing seasonally through desert scrub carrying local snowmelt as well as that from higher elevations to permanent streams or terminal lakes.
C2140 Desert wash
Moderate-to-high gradient desert stream courses that mainly carry flood flows from usual rain or snow melting events.
C2200 Permanent Fishless Streams
C2210 Alpine stream
C2211 Glacial melt stream
See A2415
C2212 Exposed alpine stream
See A2411
C2213 Spring
See A2413
C2214 Conifer forest stream
See A2412
C2215 Meadow stream
See A2414
C2216 Hot spring outflow
See A2416
C2220 Desert stream
C2221 Desert scrub stream
Small streams in lowland areas, fed by mountain run-off.
C2300 Permanent Streams with Fish
C2310 Trout headwater
Small alpine streams with meadow systems; originally containing Lahontan *(Oncorhynchus clarki henshawi)* or Paiute cutthroat trout *(O. c. seleneris)* but now usually containing non-native trout. Example: By-Day Creek (Mono County).
C2320 Trout/sculpin stream
Alpine streams of sufficient size and low enough gradient to contain both cutthroat trout and Paiute sculpin *(Cottus beldingi).*
C2330 Sucker/dace/redside stream
C2331 With trout
Coldwater streams containing the typical Lahontan drainage stream fish community (5–6 species, including Lahontan cutthroat trout).
C2332 Without trout
Lower gradient reaches of C2231 that are too warm in summer to support cutthroat trout. Example: Willow Creek, Lassen County.
C2333 Pine Creek (Lassen County)
This is the only large tributary to Eagle Lake and the principal spawning stream of Eagle Lake trout, Tahoe sucker *(Catostomus tahoensis),* and Lahontan redside *(Richardsonius egregius);* it contains a community dominated by the juveniles of these three species, plus speckled dace.
C2340 Speckled dace stream
Small meadow streams, usually spring fed, that contain mainly speckled dace but occasionally Tahoe suckers and cutthroat trout. Example: Papoose Creek (Lassen County).
C2350 Whitefish/trout/sucker stream
Mainstem rivers (e.g., Truckee River, Walker River) and their larger tributaries that contain the complete Lahontan fish fauna including mountain whitefish *(Prosopium williamsoni)* as well as large adults of cutthroat trout and Tahoe sucker. Cutthroat trout now replaced by non-native trout species.
C2360 Tui chub stream
Low gradient streams, usually close to their confluence with lakes, that contain large populations of tui chubs and speckled dace but little else. Examples: Cowhead Lake Slough (Modoc County).
C2370 Desert streams
C2371-C2373 Not in Sierra Nevada
C2374 Owens River
The Owens River and the lower reaches of its tributary streams originally contained an endemic community of Owens tui chub *(Gila bicolor snyderi),* Owens sucker *(Catostomus fumeiventris),* Owens speckled dace, and Owens pupfish *(Cyprinodon radiosus).*

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