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Limnology, Vegetation, and Classification of Coast Range Slump-formed Ponds

Abstract

Slump-formed ponds afford scarce riparian and aquatic habitats in north coastal California. This study provides information and a classification system for their management. Fourteen slump-formed ponds were studied in the Coast Range of northwestern California during 1975-1976 for limnological and vegetation characteristics. The ponds averaged 2.4 m maximum depth and 0.56 ha surface area. Subsurface contours and hypsographic curves suggested various stages of basin fill-in. Water quality (dissolved oxygen and temperature) and the presence of algae species (Nygaard's trophic index) provided evidence that the ponds were typically mesotrophic to eutrophic. Algal, submergent, emergent, and riparian vascular plant species were identified. Ponds were classified based on water permanence (ephemeral, astatic, and stable) and successional stage (degree of basin fill-in). Pond classes corresponded to unique combinations of limnological and vegetation characteristics. The pond classification system is useful for guiding management activities to rehabilitate, maintain, and enhance riparian and aquatic habitats associated with the ponds.

Introduction

Little is known of the physical and biological characteristics of slump-formed ponds in the Coast Range of the Pacific states, although the total area of wetland and fresh-water aquatic habitats is relatively small and has been declining in recent years in the west (e.g., Sands and Howe 1977). Specifically, the riparian habitat in the coastal foothills of Humboldt County in the Coast Range of northern California comprises 0.2 percent of the county's total acreage, but is the most valuable habitat as a concentration point for many floral and faunal species (California Department of Fish and Game 1965, Thomas *et al.* 1979).

This study was prompted by the need for understanding the limnological and vegetational characteristics of Coast Range slump-formed ponds as a basis for developing management criteria. The objectives of the study were to (1) describe physical and chemical limnological characteristics, (2) describe aquatic and riparian vegetation, and (3) develop a classification system, based on limnological and vegetation characteristics, for describing and predicting both physical and biological attributes.

Study Area

During 1975-1976, 17 ponds were located and studied on Six Rivers National Forest in the Coast Range of northwestern California. The ponds were identified from aerial photos (scale 1:15,840) and from field surveys and were chosen to represent a cross-section of physical and biological conditions. The steep slopes on which the ponds were found were typically composed of unstable regolith and mass-wasting was fairly common throughout the region.

The general study area is characterized by warm dry summers and cool wet winters. Average annual rainfall is 64-165 cm; average monthly precipitation is as high as 25-40 cm during November to January, and as low as 0-2 cm during July and August (data from Lower Trinity Ranger District office, Six Rivers National Forest, Willow Creek, California). Mean minimum monthly temperatures range 0-4°C during winter and 7-11°C during summer, and maximum temperatures range from 7-13°C during winter and 30-35°C during summer. Summer weather during the study was drier and warmer than average.

All ponds were within the Mixed Evergreen Forest with Chinquapin (*Castanopsis chrysophylla*) or Rhododendron (*Rhododendron macrophyllum*) vegetation types (Küchler 1977). Dominant tree species in these types are Douglas-fir (*Pseudotsuga menziesii*), tanoak (*Lithocarpus densiflora*) and Pacific madrone (*Arbutus menziesii*).

Methods

Limnological Surveys. Pond maximum length (l), breadth, surface area (A), and shoreline length (L) were measured on all ponds with a planimeter on aerial photos or on surface maps developed

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in the field by using an alidade and plane table (Welch 1948, Lind 1974). Mean breadth (A/1) and shoreline development indices ($L/2\cdot\sqrt{[\pi A]}$) were calculated for each pond. The shoreline development index describes shape of each pond by comparing the shoreline length to a circle with the same area as the pond. The smallest possible value is 1.0, representing a circle, and index values increase as the shape becomes more irregular (Cole 1975, Lind 1974).

Maximum depth and percent relative depth of all ponds were measured by soundings from a raft. Hypsographic curves were estimated from benthic contours drawn for four ponds representing early and late stages of basin fill-in (Bee, Red Mountain, Onion, and Broken Rib Lakes). Calculations of morphologic parameters followed Cole (1975) and Welch (1948). Poles marked in 0.2 m intervals were placed in each pond and water permanence was measured by recording changes in surface elevations biweekly during 1975 and 1976 summers and bimonthly during the 1975-1976 year. Sediment depth was probed in all ponds during summer 1975 with a telescopic pole.

Temperature and dissolved oxygen (DO) were monitored at 0.3 m intervals with a portable DO and temperature meter (Model 1010 Delta Scientific Corporation) four times during late summer 1957 in four ponds representing variable or stable water conditions. The meter was calibrated immediately before each measurement. Five water samples were taken at random depths and locations from each pond and analyzed in the Six Rivers National Forest laboratory for pH, conductivity, and turbidity (Model 7 pH Meter, Corning Scientific Instruments; Model RB3 Conductivity Meter, Bechman Instruments; Model 2100A Turbidimeter, Hach Scientific Equipment).

Vegetation Sampling. Algae were sampled during summer at four ponds (Primal Pond, Bushwack Pond, Sucker Lake, and Big Lake) chosen because they varied greatly in physical characteristics (especially water permanence) and would provide a wide variety of species. The ponds sampled represented the wide range of ponds (except for the early successional ephemeral class) included in the classification system that was ultimately developed. Three algae samples were taken from each pond by plankton net tow, squeezings from submergent flora (tychoplankton), and skimming the water surface. Algae were identified to species and trophic state of each pond was indexed by the relative proportions of various species in the samples (Nygaard 1949).

Submergents, emergents, and riparian vegetation were sampled during summer at six ponds (Underwood, Bushwack, Primal, Greater Twin, Lesser Twin, and Duckweed Ponds) chosen to represent a spectrum of depth, surface area, degree of basin fill-in, and water permanence.

Submergent vegetation was sampled in each of the six ponds with 80 scoops of a rake at even intervals along two transects across each pond. Frequency of each species was determined (no. scoops a species was observed in/80 total scoops) and a descriptive scale for frequency of submergents was used (available from author). For purposes of this study, duckweeds were considered as submergents because they occurred in the scoop samples. Density (no. stems/m^2) of each stand of emergent vegetation was estimated by averaging the number of stems within a wire frame (1 x 1 m) placed randomly at 20 locations within each emergent stand.

Riparian vegetation was sampled by use of fixed-area plots, the size of which was determined from species-area curves derived from nested quadrats (Dosting 1958). Plot shapes were rectangular (sides 3:1, the longer running parallel to the shoreline). Twenty plots were distributed evenly around each shoreline and vegetation was assessed by using the Braun-Blanquet cover-abundance scale (Mueller-Dombois and Ellenberg 1974). Percent frequency was calculated and modal cover determined of species over 10 percent frequent.

Quantitative descriptions of submergent, emergent, and shoreline vegetation from the six ponds were supplemented by qualitative observations of pond basins and vegetation made at all 17 ponds. Descriptions included pond basin topography, and frequency and cover of vegetation species estimated by eye.

Pond Classification. The purpose of developing a classification system was to identify unique structural and floristic attributes of different types of ponds to help predict physical and biological responses to management activities and guide management strategies. Classification based on vegetation characteristics alone was not sufficient for this purpose. The intent was to devise a system by which vegetation characteristics could be predicted from other, physical attributes of the ponds.

To devise the classification system, results of the vegetation samples and qualitative descriptions of all ponds were related to the chemical, physical, and trophic attributes of the ponds. Since most ponds were mesotrophic to eutrophic, trophic state was not a helpful criterion to distinguish among ponds. Water quality (pH, conductivity, turbidity, dissolved oxygen content) seemed to vary in response to physical conditions of the pond basins and associated vegetation.

Ultimately, the ponds were classified based on water permanence and successional stage (Table 1). Following Cole (1975), successional stage was defined as degree of basin fill-in. Successional stage was described qualitatively as "early" if the pond basin was relatively steep and had only a shallow muck depth, and "late" if the pond basin was gently sloped and had a deep amount of muck and sediment. In this classification, degree of basin fill-in did not necessarily correlate with trophic condition. Water permanence classes included stable, astatic, and ephemeral ponds. Also, successional stages (early and late stages) of ephemeral ponds correlated with diagnostic characteristics. Limnological and vegetation characteristics were related to each of the pond classes.

Results and Discussion

Limnology

The ponds were likely formed by the mass-wasting process of soil creep, a slumpage that created small basins that filled with snow-melt, seep springs, or runoff. On average, the ponds measured 133 m maximum length, 71 m maximum breadth, and 38 m average breadth (Table 2). Surface area averaged 0.56 ha and shoreline length averaged 328 m. Most ponds were roughly oval in shape (average shoreline development index of 1.33).

Water permanence varied among the ponds, although maximum depth averaged only 2.4 m. Seven ponds were relatively stable over the summer, varying less than 10 percent from their maximum depth. Four ponds were more astatic and varied in surface elevation over the year by as much as 55 percent from their maximum depth. For example, Sucker Lake varied 2.5-5.6 m

TABLE 1. Classification characteristics of Coast Range slump-formed ponds.

	Slump pond class			
			Ephemeral	
Feature	Stable	Astatic	Early successional	Late successional
Surface elevation variation	<10% from max. depth; never dries	>10% from max. depth; dries infrequently	dries regularly	
Emergent stands	discrete, dense	little or none	none	dispersed
Floating mats	peripheral	few or none	none	central
Shoreline evaporation zone	narrow, little "feather edge," with shrubs	broad; with annuals, lush sedge and/or mud recently flooded or exposed	very narrow or absent	narrow to broad, with exposed mud
Substrate	deep, soft muck	moderately deep mud and peat	steep; mud or gravel	shallow; gently sloped or level; deep mud
Floating logs	typically many, with lush veg. growth	several; sparse to mod. veg. growth	few; no veg. growth	several; sparse to mod. veg. growth
Inflow	perennial; spring-fed	perennial or seasonal; spring- or runoff-fed	seasonal; runoff-fed	

TABLE 2. Physical limnological characteristics of Coast Range slump-formed ponds.

Pond	Surface measures: Maximum length (m)	Breadth (m)	Mean breadth (m)	Surface area (ha)	Shoreline length (m)	Shoreline development index	Subsurface measures: Maximum depth (m)	Percent mean slope	Pond class[a]
Broken Rib L.	81	30	15	0.12	189	1.51	3.5	18	Early Stable
Blue L.	175	75	54	0.94	474	1.37	5.6	1	Early Stable
Bee L.	279	152	27	0.74	369	1.21	1.8	4	Late Stable
Red Mt. L.	213	68	37	0.78	503	1.60	2.0	4	Late Stable
Onion L.	124	71	47	0.59	318	1.17	2.0	5	Late Stable
Primal Pond	101	64	39	0.39	337	1.52	5.0	14	Late Stable
Bushwack Pond	113	50	31	0.35	280	1.34	2.4	7	Late Stable
Sucker L.	176	50	23	0.41	402	1.77	2.5	7	Early Astatic
Duckweed Pond	84	64	43	0.36	213	1.00	1.5	4	Late Astatic
Underwood Pond	56	39	27	0.15	156	1.14	3.0	14	Late Astatic
Greater Twin P.	70	48	40	0.28	195	1.04	1.1	4	Late Astatic
Hidden Pond	70	40	nd[b]	nd	250	nd	4.0	nd	Early Ephemeral
Lesser Twin Pond	66	39	29	0.19	175	1.14	1.8	7	Early Ephemeral
Big L.	251	201	81	2.04	731	1.45	1.5	2	Late Ephemeral
MEANS	133	71	38	0.56	328	1.33	2.4[c]	7	

[a]Successional stage (early, late) or degree of basin fill-in and degree of water permanence (stable, astatic, ephemeral). See text for descriptions.
[b]nd = no data.
[c]Based on 17 ponds (three additional ponds measured 0.8, 1.1, and 1.1 m maximum depth).

maximum depth from summer to winter. One pond (Hidden Pond, Table 2) measured 4.0 m maximum depth during spring but dried in a period of 24 days (17 June to 10 July). Water permanence varied probably because of differences in water sources and permeability of substrates. Because of the shallowness, all ponds studied are probably polymictic, i.e., characterized by many or continual overturn periods (Cole 1975).

The percent hypsographic curves of the three late successional, stable ponds (Bee, Red Mountain, and Onion Lakes) were concave in form (Figure 1). This shape represented gently sloping shorelines and broad, shallow, flat bottoms, characteristic of ponds in late stages of basin fill-in. The curve of the early successional, stable pond (Broken Rib Lake) was more convex in shape, representing steeper basin walls and a more angular bottom. Over all ponds, basin slope was moderately gentle; relative slope of the bottom averaged 7 percent (Table 2). Basin shapes were likely a result of (1) topographic contours of the slump concavity and (2) degree of siltation

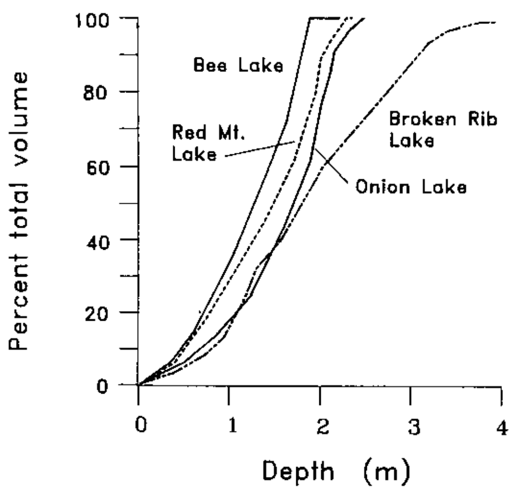

Figure 1. Percent volume hypsographic curves of four stable, slump-formed ponds in the north Coast Range of California. Broken Rib Lake is in an early successional stage of basin fill-in; the others are in late stages.

or fill-in (successional stage). In general, the ponds that were in a later stage of fill-in (e.g.,

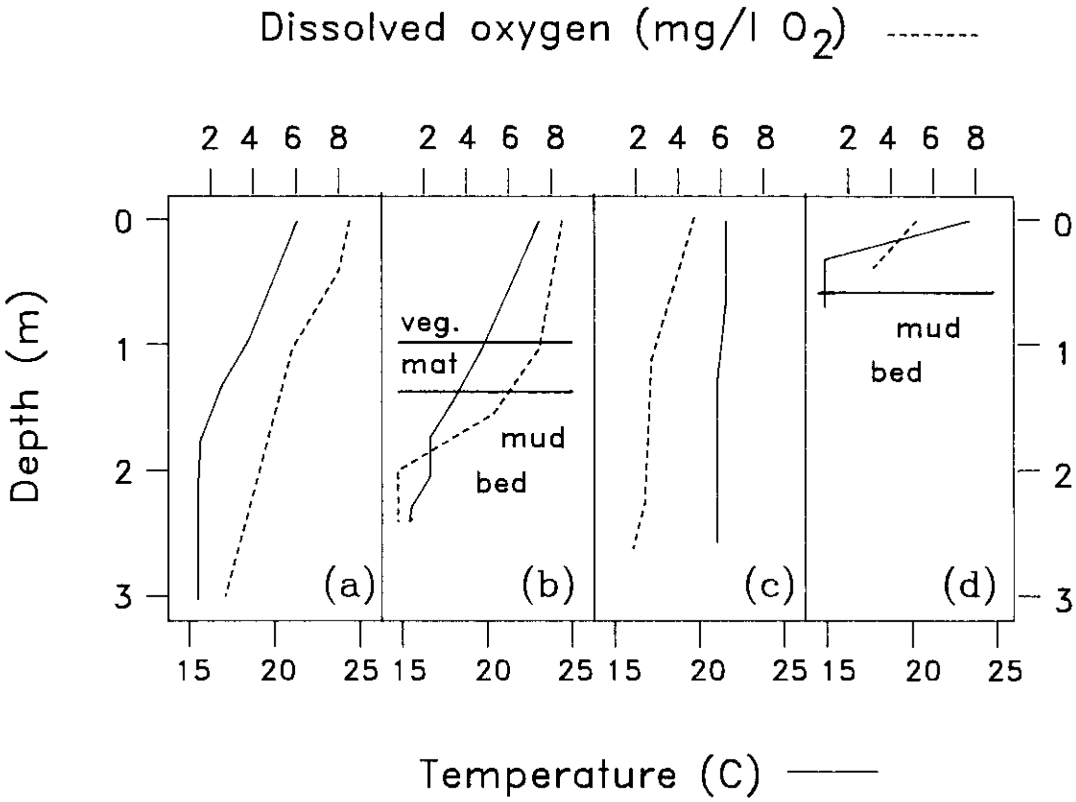

Figure 2. Temperature (T) and dissolved oxygen (DO) profiles of pond classes during summer. (a) Late-successional stable pond (29 June, Primal Pond [see Table 2 for other pond characteristics]). (b) Late successional stable pond with subsurface mat of *Myriophyllum exalbescens* ssp. *exalbescens* (22 July, Bushwack Pond). (c) Early successional astatic pond (5 August, Sucker Lake). (d) Late-successional ephemeral pond (24 August, Big Lake).

Big Lake, Greater Twin Pond and Duckweed Pond, Table 2) were shallower (lower maximum depth), more gently sloped (lower percent mean slope), and had greater sediment depths than ponds in an earlier stage (e.g., Primal Pond, Broken Rib Lake). Late successional ponds accumulated sediments of up to 1.8 m depth, whereas early successional ponds had sediment depths of 0-0.5 m.

Temperature and DO profiles (Figure 2) revealed marked differences among the four ponds sampled, owing to various maximum depths, vegetation composition, and basin shapes. None of the ponds that were measured exhibited thermal stratification. DO levels varied from 8 mg/l at the surface to less than 2 mg/l at the bottom. DO curves typically exhibited an orthograde profile (Figures 2a, 2c), characterizing an even oxygen distribution during overturn (Cole 1975).

Both temperature and DO curves in one pond (Bushwack Pond; Figure 2b) resulted from the presence of a sub-surface vegetation mat of water milfoil (*Myriophyllum spicatum* ssp. *exalbescens*) and an underlying organic matter bed. The DO curve exhibited a clinograde profile, characterizing a stratified eutrophic lake with a large vegetation biomass in the epilimnion and a stagnant hypolimnion (Cole 1975). However, the near-linear temperature curve and shallow maximum depth (2.4 m) suggested that thermal stratification was unlikely.

Temperature and DO curves in one pond (Sucker Lake) that lacked emergent rooted vegetation were nearly vertical (Figure 2c). This was probably because of the lake's shallow depth (2.5 m) and openness to variable winds (located on a ridge) and thus continual overturn. DO levels were quite low. The temperature curve was nearly isothermal, with a surface-bottom gradient of only 1.2°C.

The temperature profile in one shallow ephemeral pond (Big Lake) was quite steep (Figure 2d). The presence of a thick mat of yellow pond-lily (*Nuphar polysepalum*) extending from the surface to the maximum testable depth of 0.6 m was the probable cause of a temperature gradient of 11.5°C over that depth.

The pH varied from neutral to slightly basic (mean 7.1, range 7.0 to 7.4). Conductivity values ranged 130-500 (mean 274) micromhos/cm. Turbidity values ranged widely among the ponds, 68-560 JTUs (mean 217) (Table 3).

TABLE 3. Water quality characteristics of four Coast Range slump-formed ponds. Five water samples were taken from each pond during August and September 1975.

Pond	pH	Conductivity (micromhos/cm)	Turbidity (JTU's)
Primal Pond			
range:	6.95-7.05	370-500	68-110
mean:	7.00	406	86
Bushwack Pond			
range:	6.95-7.15	230-260	71-140
mean:	7.06	250	87
Sucker Lake			
range:	7.20-7.30	260-300	230-420
mean:	7.24	290	284
Big Lake			
range:	7.05-7.35	130-180	240-560
mean:	7.17	149	410

Vegetation

Algae species. Although the ponds were sampled during summer—a season which exhibits the greatest number of eutrophic indicators (e.g., blue-greens and Chlorococcales)—and pulses of different algae groups only a few days apart could greatly alter the indices, some generalizations can be made.

All four ponds sampled exhibited a well-rounded series of algal communities (list of algae species is available from the author upon request). A total 105 species were directly identified or inferred. The total number of species in any one pond ranged as high as 25 from the plankton tow samples, 36 from the tychoplankton samples, 25 from the surface skim samples, and 59 from all samples combined.

Samples were taken during late summer, accounting for the high number of taxa (27) of blue-green algae present. The presence of *Aphanizomenon flosaquae* and *Microcystis aeruginosa* in the samples at low levels of abundance indicated fairly healthy environments. Monitoring these eutrophic indicators as well as the desmids and flagellates over the year could reveal much about the annual trophic health of each pond and degree of input of organic material from the local watershed. The abundance of *Mougeotia* and *Spirogyra,* and populations of epiphytic and tychoplanktonic diatoms which accompany them, also indicated healthy environments with a moderate diversity denoting mesotrophy or early eutrophy. Values of Nygaard's Trophic Index (Nygaard 1949) also suggested mesotrophic to eutrophic conditions (Table 4).

TABLE 4. Trophic state of Coast Range slump-formed ponds (results of applying Nygaard's Trophic Index [Nygaard 1949]). All ponds were sampled on 1 September 1975.

Pond	Indices[a]				
	MYX	CHL	DIA	EUG	COM
Primal Pond	2.5—E	0.5—E	0.1—M	0.2—M	4.0—E
Bushwack Pond	1.0—E	3.0—E	0/5—M	0.1—M	4.5—E
Sucker Lake	3.0—E	5.0—E	0/10—M	0/8—M	8.0—E
Big Lake	0/1—M	0/1—M	0/6—M	0/0—M	0/1—M

[a]MYX = Myxophycean = Myxophyceae/Desmideae
CHL = Chlorophycean = Chlorococcales/Desmideae
DIA = Diatom = Centrales/Pennales
EUG = Euglenine = Euglineae/(Myxophyceae + Chlorococcales)
COM = Compound = (Myxophyceae + Chlorococcales + Centrales + Euglenineae)/Desmideae
M = mesotrophic
E = eutrophic

The presence of *Eremoshaera viridis* in Primal Pond may be a new record for the western U.S. This range extension is previously undocumented. Also, it was noticeably smaller in size than those found in eastern U.S. and Europe.

Submergents. A total of nine submergent vascular species and two submergent rooted algae (*Chara* spp.) were identified (list of species and vegetation associations is available from the author upon request). Submergent vegetation richness varied from 3 to 7 species in any one pond. Frequency and dominance varied among submergent species within and among ponds. The pondweed *Potamogeton natans*, found in all ponds surveyed for vegetation, was never dominant in frequency or density. The dominant submergents were star duckweed (*Lemna trisulca*), lesser duckweed (*L. minor*), stonewort, and water milfoil. Other submergents occurred as subdominants and at lower frequencies and densities. Buttercup (*Ranunculus aquatilis*) was observed only in ponds that varied at least 10 percent from maximum depth over a year's time.

One species of bulrush (*Scirpus subterminalis*) was observed in a stable pond. The species was growing erect as a submergent in up to 0.3 m water and as an emergent in as little as 6 cm water. This is the first specimen from the Coast Range of California (herbaria searched: UC, HSC, CAS, JEPS).

Emergents. Four emergent macrophytes were recorded. The richest emergent flora at any one pond consisted of three species. Densities of emergent stands varied among the ponds. Yellow pond-lily was as dense as 20-50 stems/m^2 and soft-stemmed bulrush (*Scirpus validus*) was as dense as 50-300 stems/m^2. Dominance of emergents also varied considerably. Ponds in advanced stages of fill-in typically had lush stands of pond-lily, bulrush, or broad-leafed cattail (*Typha latifolia*); these stands were widely dispersed across surfaces of ponds that varied considerably in surface elevation, and were in discrete stands in the more stable ponds.

Also creating an interspersion with open water in stable ponds were floating logs with lush vegetational growth of grasses, sedges (*Carex* spp.), and sundry herbs. Among all species of macrophytes, cinquefoil (*Potentilla* sp.) was observed only in stable ponds, whereas foxtail (*Alopecurus* sp.) was observed only in ephemeral ponds.

Shoreline evaporation zone. Shoreline riparian vegetation showed high variation among ponds. Riparian vegetation was floristically rich. The dominant shrubs were nine-bark (*Physocarpus capitatus*), willow (*Salix sitchensis* and *S. lasiandra* var. *lancifolia*), red alder (*Alnus rubra*), and poison oak (*Toxicodendron diversiloba*). The dominant herbs were water hemlock (*Cicuta douglasii*), mint (*Mentha arvensis*), and sedge (*Carex exsiccata*). Sedge often formed lush shoreline belts around ponds that varied seasonally in water level more than 10 percent of maximum depth. Other shrubs and herbs occurred as subdominants in the shoreline zone. Panic grass (*Panicum capilare*) was found only at ephemeral ponds which typically lacked riparian shrubs. Several riparian species were found only at stable ponds: cinquefoil, sedge (*Carex hindsii*), sundew (*Drosera rotundifolia*), water hemlock, poison oak, and berry (*Rubus ursinus*).

One riparian species (*Dulichium arundinaceum*) was found in a late-successional pond (Big Lake) on a muddy floating mat. This species is rare in California (Mason 1969, Munz 1968). Only two previous specimens from Humboldt County and 10 specimens in other California counties were discovered in four herbaria searched (UC, HSC, CAS, JEPS). (Voucher specimens of *Scirpus subterminalis* and *Dulichium arundinaceum* are deposited at Humboldt State University, Arcata, California herbarium.)

Classification

Ponds were classified based on degree of water permanence and degree of basin fill-in, as follows (Table 1).

Stable ponds. Surface level varied approximately 10 percent or less from maximum depth. Stable ponds can be recognized by discrete stands of bulrush, cattail, and other emergents; peripheral floating mats; an interspersion of open water and submergent vegetation; a substrate of deep, soft muck; a narrow shoreline evaporation zone with little "feather edge" exposed mud; lush vegetational growth on numerous floating logs; and by being perennially spring-fed.

Astatic ponds. Surface level varied more than 10 percent from maximum depth; the ponds dried infrequently. Astatic ponds can be recognized by little or no perennial emergent vegetation; few or no floating mats; a recently flooded or exposed shoreline belt of vegetation; a substrate of moderately deep mud and peat; a broad shoreline evaporation zone with annual species, lush sedge, and/or exposed mud; floating logs being less numerous than in stable ponds and with sparse to moderate vegetational growth; and by being fed perennially or seasonally by springs or runoff.

Ephemeral ponds. These ponds dry regularly. Those in an early successional stage can be recognized by the absence of emergent vegetation; no floating mats; a very narrow or absent shoreline evaporation zone; a steeply-walled substrate of mud or gravel; few floating logs with no vegetational growth; and by usually being fed seasonally by runoff. Ephemeral ponds in a late successional stage can be recognized by emergent vegetation occurring in more or less dispersed stands; central floating mats; a narrow to broad shoreline evaporation zone and exposed mud areas; a shallow and gently sloped or level bottom of deep mud; floating logs being less numerous than in stable ponds and with sparse to moderate vegetational growth; and by usually being fed seasonally by runoff.

Indicator plant species were identified for each pond class by growth form (submergent, emergent, and shoreline riparian) (Table 5). The recognition of pond classes in the field, based on physiognomic and floristic features, may aid in formulating management plans. For example, if a pond has characteristics of an ephemeral system, objectives for habitat management or use of the pond as a water source may differ than if the characteristics suggest a stable system. Natural draw-downs of unstable ponds are probably beneficial for seeding desirable food or cover plant species for wildlife, for consolidating oozy bottoms for a better substrate to support rooted vegetation, for exposing an aquatic prey base for wildlife predators, and for encouraging beneficial changes of water and soil chemistry (Marcot 1978).

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TABLE 5. Indicator plant species identified for pond classes (see Table 1 for descriptions of pond classes).

	Pond Class		
	Stable	Astatic	Ephemeral
Submergents	(no indicators)	*Ranunculus aquatilus*[a]	*Ranunculus aquatilus*[a]
Emergent	*Potentilla* sp.	(no indicators)	*Alopecurus* sp.
Shoreline zone	*Potentilla* sp. *Carex hindsii* *Drosera rotundifolia* *Cicuta douglasii* *Toxicodendron diversiloba* *Rubus ursinus* In general, forest influence in the thin shoreline zone.	*Mentha arvensis*[a] *Rorippa curvisiliqua*[a] *Carex athrostachya*[a] *Trichostema laxum*[a]	*Alopecurus* sp. *Panicum capilare* *Mentha arvensis*[a] *Rorippa curvisiliqua*[a] *Carex athrostachya*[a] *Euphorbia serpyllifolia*[b] *Trichostema laxum*[ab]
		In general, dry site species in the receding shoreline zone.	

[a]Indicator species for either astatic or ephemeral ponds.
[b]Indicator species for early-successional ephemeral ponds.

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