

A Phytogeographic Comparison of the Vascular Flora of the Wetlands of Fish Slough with the Floras of Neighboring Desert Basins

**J. Robert Haller
Wayne R. Ferren, Jr.
Ragan M. Callaway**

Department of Biological Sciences
University of California
Santa Barbara, California 93106

**Dennis C. Odion
Frank W. Davis**

Department of Geography
University of California
Santa Barbara, California 93106

Abstract. Fish Slough is an extensive wetland ecosystem in the Owens Valley just north of Bishop. It has a readily apparent high diversity of vascular plants for a salt-affected desert wetland. We compared the wetland floras of Fish Slough and neighboring basins to determine how unique and diverse the Fish Slough vegetation is in a regional context. As part of ongoing research at Fish Slough, we have developed a comprehensive species list. We obtained species lists from two other sites and sampled an additional nine ourselves. Even allowing for more intensive sampling at Fish Slough, it is clearly outstandingly diverse. Ash Meadows in Nevada is the only comparable site. Mojavean and Great Basin species are equally represented at Fish Slough, unlike other sites. The wetland flora of Fish Slough is most similar to that of Fish Lake Valley and Deep Springs Valley to the east. Wetlands at Fish Slough support 8 species of special concern, many more than other sites, except Ash Meadows, which has 10.

INTRODUCTION

This study was undertaken to determine the phytogeographical relationships of the wetland flora of Fish Slough to those of other desert wetlands east of the Sierra Nevada. Taxonomic richness, presence of species of special concern, and levels of phytogeographic similarity have been assessed in order to show to what extent the flora of Fish Slough is unique and to what extent it shares components with either Great Basin or Mojave Desert wetlands.

METHODS

This analysis was limited to the wetland component of the vegetation of the study sites, because using only wetlands made comparisons between different localities more meaningful, and because desert wetlands are highly interesting, relatively rare habitats.

Most of the data for the Fish Slough wetlands were compiled by Forbes *et al.* [1988]. We surveyed eight additional wetlands, and data available from two others have been incorporated, providing a total

of eleven sites for comparison. These sites may be grouped into three major geographic/vegetational categories:

(A) Mojave Desert—Great Basin Transition

Zonal vegetation: Shadscale Scrub

- (1) *Fish Slough*, Inyo and Mono counties, California; elevation 4,200 ft (1,280 m).
- (2) *Fish Lake Valley*, Esmeralda Co., Nevada; elevation 4,800 ft (1,460 m); 25 mi (40 km) NE of Fish Slough.
- (3) *Deep Springs Valley*, Inyo Co., California; elevation 4,800 ft (1,460 m); 20 mi (32 km) SE of Fish Slough.
- (4) *Klondike Lake*, Owens Valley, Inyo Co., California; elevation 3,900 ft (1,200 m); 15 mi (24 km) S of Fish Slough.
- (5) *Owens Lake*, Inyo Co., California; elevation 3,600 ft (1,100 m); 70 mi (112 km) S of Fish Slough.

(B) Great Basin Zonal vegetation: Sagebrush Scrub

- (6) *Long Valley*, Mono Co., California; elevation 6,900 ft (2,100 m); 23 mi (37 km) NW of Fish Slough.
- (7) *Adobe Valley*, Mono Co., California; elevation 6,500 ft (1,980 m); 30 mi (48 km) NNW of Fish Slough. Data only for sensitive species provided by P. Novak (Los Angeles Department of Water and Power, pers. comm.). This site deserves further study.
- (8) *Bridgeport*, (Warm Spring Flat—Travertine Springs); Mono Co., California; elevation 6,600 to 7,400 ft (2,000 to 2,500 m); 65 mi (105 km) NW of Fish Slough.

(C) Mojave Desert Zonal vegetation: Creosote Bush Scrub

- (9) *Little Lake*, Inyo Co., California; elevation 3,100 ft (945 m); 100 mi (160 km) S of Fish Slough.
- (10) *Saline Valley*, Inyo Co., California; elevation 1,100 ft (335 m), 60 mi (100 km) SE of Fish Slough.
- (11) *Ash Meadows*, Nye Co., Nevada; elevation 2,200 ft (670 m); 130 mi (210 km) SE of Fish Slough. Data from Knight and Clemmer [1987], Nevada Natural Heritage Program [1990], and Beatley [1976].

The wetland flora of Fish Slough was sampled relatively intensively by Forbes *et al.* [1988] and again for the current study. Each of the eight other localities surveyed for this study was visited once by a team of three or four workers. Fish Lake Valley, Deep Springs Valley, Long Valley, and Bridgeport were surveyed in October, 1989. Klondike Lake, Owens Lake, Little Lake, and Saline Valley were surveyed in July, 1990. The field teams included all of the authors at various times, as well as Mark

Bagley and Sally Manning of Bishop, California. Portions of Fish Slough have been surveyed by the use of formal sampling methods (see Odion *et al.* [1992]). The other eight areas were surveyed by seeking out the lowest and wettest portions of each basin and proceeding, usually on foot, in several directions to the upper limits of the wetlands. Any other accessible spots within each wetland that appeared to be interesting were also checked. Vouchers for this study are deposited in the Herbarium at the Department of Biological Sciences, University of California, Santa Barbara (UCSB).

The habitats included as wetlands for this study are permanently inundated lakes, ponds, streams and springs, seasonally inundated meadows (usually with alkali deposits), and seasonally wet (below the soil surface) alkali flats with herbaceous vegetation and alkali scrub with woody and herbaceous vegetation.

The phytogeographic categories discussed below are those of Forbes *et al.* [1988], and are arranged in order of increasing inclusiveness. A species was assigned to the smallest category that encompassed its entire native range, with the obvious exception of non-native species. The Inyo category is the narrowest one employed here, and has not generally been used elsewhere. However, it is useful for separating out the narrow endemic species of this region (primarily at Fish Slough and Ash Meadows) from the larger Mojavean and Great Basin regions.

RESULTS AND DISCUSSION

Species Richness

Fish Slough, with 126 wetland taxa, has the richest flora of any of the nine areas that we surveyed. Deep Springs Valley has 52 taxa and Fish Lake Valley has 42 (Table 1). Considerable allowance must be made for the more intensive sampling at Fish Slough than at the other sites. Even with this allowance (the richness of the Fish Slough flora was apparent even from preliminary sampling), Fish Slough must be seen as outstanding, and our surveys have not uncovered any additional sites of comparable diversity. Ash Meadows, surveyed by Knight and Clemmer [1987], with additions by the Nevada Natural Heritage Program [1990], has 83 wetland species and appears to be comparable in richness to Fish Slough. Differing sizes of these two areas as well as different sampling methods made a close comparison of their floras impossible at this time.

Phytogeographic Relationships

The majority of wetland species at Fish Slough are widely distributed over western North America (37 percent) or are native species with a cosmopolitan distribution (25 percent) (Tables 2 and 3). These data contrast with those of McLaughlin [1986], which indicate a much more restricted distribution for most of the species that are native to the southwestern U.S. However, wide distributions are characteristic of wetland plants generally, and Forbes *et al.* [1988] showed a higher

proportion of wide-ranging species in the wetlands of Fish Slough than in the uplands. Species with primarily Mojavean (8 percent) and Great Basin (10 percent) distributions are about equally represented in the Fish Slough wetlands, confirming the transitional status of the Fish Slough flora. This is the only area surveyed with such an even representation of these species (Table 2). McLaughlin's [1986] analysis also demonstrates a large representation of both Mojavean and Great Basin floristic elements in the northern Owens Valley Region, with relatively abrupt losses of Mojavean species occurring to the north and Great Basin species to the south. The highest proportion of Great Basin species in our survey (18 percent) occurs at Bridgeport, the northernmost site, and the highest proportion of Mojavean species (14 percent) is at Ash Meadows, the southeasternmost site (Table 3). If the Inyo category is treated as a subset of the Mojavean and added to that category, the Mojavean element reaches 24 percent at Ash Meadows. Fish Slough has the most even spread of species, across the entire array of phytogeographic categories, of any of the sites. Based on coefficients of similarity, the wetland flora of Fish Slough is most similar to those at Fish Lake Valley (0.44) and Deep Springs Valley (0.43), across the White Mountains to the east, and at elevations close to that of Fish Slough. Also relatively similar are Klondike Lake (0.37) in the Owens Valley and Ash Meadows (0.38) east of Death Valley. Least similar to the flora of Fish Slough is that of Saline Valley (0.15), in a much hotter and drier climate. Thirty-four percent of the species tallied at Fish Slough do not occur in any other area (Table 1).

Species of Special Concern

The wetlands of Fish Slough include 8 species of special concern (Table 4). Ash Meadows has 10, Adobe Valley has 3 (P. Novak, pers. comm.), Fish Lake Valley has 3, and Deep Springs Valley and Long Valley have 2 each. None of these species were found in any of the other areas surveyed. Fish Slough shares only 2 of its 8 species of special concern with Ash Meadows, but that should be expected, because the majority of these taxa are narrow endemic species.

Although the wetlands of Fish Slough have a higher proportion of wide-ranging species than the uplands [Forbes *et al.*, 1988], it is noteworthy that 8 of the 10 species of special concern that occur in the entire Fish Slough study area are wetland species. However, these wetland plants all occur in seasonally wet or flooded alkali habitats rather than in permanently flooded ponds or springs. At Ash Meadows, which has at least two more species of special concern than Fish Slough, these species also are concentrated in moist, alkaline habitats [Beatley, 1976]. Preservation of such wetland habitats is essential for the survival of a high proportion of the species of special concern in the Inyo region.

Distribution maps of the species of special concern at Fish Slough, as well as additional observations are found in Ferren [1991].

TABLE 1

Table 1. Comparison of Fish Slough to neighboring basins. Localities (columns): **FS**=Fish Slough, **FLV**=Fish Lake Valley, **DSV**=Deep Springs Valley, **KL**= Klondike Lake, **OL**=Owens Lake, **LV**=Long Valley, **B**=Bridgeport-Travertine Springs Area, **LL**=Little Lake, **SV**=Saline Valley, and **AM**=Ash Meadows. Geographic affinities (following species names): **I**=Inyo region, **M**=Mojave Desert, **GB**=Great Basin, **WNA**=Western North America, **NA**=North America, **CN**=Cosmopolitan native, and **CE**=Cosmopolitan exotic. Thirty-four percent of the species found at Fish Slough were not found in any other basin investigated.

	FS	FLV	DSV	KL	OL	LV	B	LL	SV	AM
<i>Agrostis exarata</i> (WNA)	x	.	.	.	.	.	.	.	.	.
<i>Agrostis stolonifera</i> (CE)	.	x	x	.	.	.	.	.	.	.
<i>Allenrolfea occidentalis</i> (WNA)	x	x	.	x	.	.	.	.	x	.
<i>Ambrosia acanthicarpa</i> (WNA)	x	.	.	.	.	.	.	.	.	.
<i>Anemopsis californica</i> (WNA)	x	.	.	x	x	.	.	x	.	x
<i>Apocynum cannabinum</i> (NA)	x	.	.	.	.	.	.	.	.	x
<i>Artemisia dracuncululus</i> (WNA)	.	.	x	.	.	.	.	.	.	.
<i>Asclepias fascicularis</i> (GB)	x	.	.	x	.	.	.	.	.	x
<i>Asclepias speciosa</i> (NA)	x	.	.	.	.	.	.	.	.	x
<i>Aster eatonii</i> (WNA)	.	x	.	.	.	.	.	.	.	x
<i>Aster exilis</i> (NA)	.	.	.	.	.	.	.	.	.	x
<i>Aster frondosus</i> (GB)	x	x	.	.	.	.	.	.	.	.
<i>Aster intricatus</i> (M)	x	.	x	x	x	.	.	x	.	.
<i>Aster hesperius</i> (WNA)	x	.	.	.	.	.	.	.	.	.
<i>Aster pauciflorus</i> (WNA)	.	.	.	.	.	.	.	.	.	x
<i>Astragalus argophyllus</i> (GB)	x	.	.	.	.	.	.	.	.	.
<i>Astragalus lentiginosus</i> (M,I)	x	.	.	.	.	.	.	.	.	.
<i>Astragalus phoenix</i> (I)	.	.	.	.	.	.	.	.	.	x
<i>Astragalus</i> sp. (?)	x	.	.	.	.	.	.	.	.	.
<i>Atriplex confertifolia</i> (WNA)	x	x	x	x	x	.	.	x	.	.
<i>Atriplex parryi</i> (M)	x	x	.	.	x	.	.	.	.	x
<i>Atriplex patula</i> (CN)	x	.	.	.	.	.	.	.	.	.
<i>Atriplex torreyi</i> (M)	x	x	x	.	.	.	.	x	.	x
<i>Azolla</i> sp. (?)	.	.	.	.	.	x	.	.	.	.
<i>Baccharis emoryi</i> (WNA)	.	.	.	.	.	.	.	.	.	x
<i>Berula erecta</i> (CN)	x	.	x	.	.	.	.	.	.	x
<i>Bidens cernua</i> (CN)	.	.	x	.	.	.	.	.	.	.
<i>Bidens frondosa</i> (CE)	x	.	.	.	.	.	.	.	.	.
<i>Brickellia microphylla</i> (WNA)	x	.	x	.	.	.	.	.	.	x
<i>Calochortus excavatus</i> (I)	x	.	.	.	.	.	.	.	.	.
<i>Calochortus striatus</i> (M)	.	.	.	.	.	.	.	.	.	x
<i>Carex douglasii</i> (WNA)	x	.	.	.	.	.	.	.	.	.
<i>Carex lanuginosa</i> (NA)	x	.	.	.	.	.	x	.	.	.
<i>Carex praegracilis</i> (NA)	x	.	x	.	.	.	.	.	.	.
<i>Carex</i> sp. 1 (?)	x	.	.	.	.	.	.	.	.	.
<i>Carex</i> sp. 2 (?)	.	x	x	.	x	x	x	x	.	.
<i>Castilleja linearifolia</i> (WNA)	x	.	.	.	.	.	.	.	.	.
<i>Castilleja minor</i> (WNA)	x	.	.	.	.	.	.	.	.	.
<i>Gentaurium namophilum</i> (I)	x	x	x	.	.	.	.	.	.	.

(continued)

TABLE 1 (continued)

	FS	FLV	DSV	KL	OL	LV	B	LL	SV	AM
<i>Centaureum exaltatum</i> (WNA)	.	.	.	.	X	.	.	.	.	.
<i>Chrysothamnus albidus</i> (GB)	X	X	.	X	.	.	.	X	.	X
<i>Chrysothamnus nauseosus</i> (WNA)	X	X	X	X	X	X	X	X	.	X
<i>Cicuta douglasii</i> (WNA)	X	.	X	.	.	.	.	.	.	.
<i>Cirsium drummondii</i> (WNA)	.	.	.	.	.	X	X	.	.	.
<i>Cirsium mohavense</i> (M)	X	X	.	X	.	.	.	.	.	X
<i>Cladium californicum</i> (WNA)	.	.	.	.	.	.	.	.	.	X
<i>Cleomella brevipes</i> (M)	X	.	.	.	.	.	.	.	.	X
<i>Cleomella obtusifolia</i> (M)	X	.	.	.	.	.	.	.	.	X
<i>Cleomella parviflora</i> (GB)	X	.	.	.	.	.	X	.	.	.
<i>Cleomella placasperma</i> (M)	X	.	.	.	.	.	.	.	.	.
<i>Conzya canadensis</i> (CN)	X	.	.	.	.	.	.	.	.	X
<i>Cordylanthus maritimus</i> (WNA)	X	X	.	X	X	.	.	.	.	.
<i>Cordylanthus ramosus</i> (I)	X	X	.	.	.	.	.	.	.	.
<i>Cordylanthus tecopensis</i> (I)	.	.	.	.	.	.	.	.	.	X
<i>Crepis runcinata</i> (I)	X	.	.	X	.	.	.	.	.	X
<i>Cressa truxillensis</i> (WNA)	.	.	.	.	.	.	.	.	.	X
<i>Cuscuta indecora</i> (CN)	X	.	.	.	.	.	.	.	.	.
<i>Cuscuta nevadensis</i> (M)	.	.	.	.	.	.	.	.	.	X
<i>Cyperus laevigatus</i> (CN)	.	.	.	.	.	.	.	X	.	.
<i>Distichlis spicata</i> (WNA)	X	X	X	X	X	X	X	X	X	X
<i>Dodecatheon pulchellum</i> (WNA)	X	X	.	.	.	.	.	.	.	X
<i>Eleocharis palustris</i> (CN)	X	.	.	.	X	.	.	.	.	.
<i>Eleocharis parishii</i> (WNA)	.	X	.	.	.	.	.	.	.	X
<i>Eleocharis parvula</i> (CN)	X	.	.	.	.	.	.	.	.	.
<i>Eleocharis rostellata</i> (CN)	X	.	X	.	X	X	.	.	X	X
<i>Elodea canadensis</i> (NA)	.	.	.	.	.	X	X	.	.	.
<i>Elymus cinereus</i> (WNA)	X	.	X	.	.	X	X	.	.	X
<i>Elymus salinus</i> (WNA)	X	.	.	.	.	.	.	.	.	.
<i>Elymus triticoides</i> (WNA)	X	X	X	X	.	.	.	X	.	.
<i>Epilobium ciliatum</i> (WNA)	X	.	.	.	.	.	X	.	.	.
<i>Epipactis gigantea</i> (WNA)	X	.	X	.	.	.	.	.	X	.
<i>Equisetum laevigatum</i> (NA)	X	.	.	.	.	.	.	.	.	.
<i>Erigeron lonchophyllus</i> (NA)	X	.	.	.	.	.	.	.	.	.
<i>Eriogonum inflatum</i> (M)	X	.	X	.	.	.	.	.	.	X
<i>Eriogonum heermannii</i> (I)	.	.	X	.	.	.	.	.	.	X
<i>Eriogonum nummulare</i> (GB)	X	.	.	.	.	.	.	.	.	.
<i>Euthamia occidentalis</i> (WNA)	X	.	.	.	.	.	.	.	.	.
<i>Fimbristylis spadiacea</i> (CN)	X	.	.	.	.	.	.	.	.	X

Localities (columns):

FS=Fish Slough,
 FLV=Fish Lake Valley,
 DSV=Deep Springs
 Valley, KL=Klondike
 Lake, OL=Owens Lake,
 LV=Long Valley,
 B=Bridgeport-Travertine
 Springs Area, LL=Little
 Lake, SV=Saline Valley,
 and AM=Ash Meadows.
 Geographic affinities
 (following species
 names): I=Inyo region,
 M=Mojave Desert,
 GB=Great Basin,
 WNA=Western North
 America, NA=North
 America, CN=Cosmopolitan
 native, and CE=Cosmo-
 politan exotic.

(continued)

4.9—A PHYTOGEOGRAPHIC COMPARISON OF FISH SLOUGH AND NEIGHBORING DESERT FLORAS

TABLE 1 (continued)

	FS	FLV	DSV	KL	OL	LV	B	LL	SV	AM
<i>Fraxinus velutina</i> (WNA)	.	.	.	.	.	.	.	.	.	X
<i>Galium trifidum</i> (NA)	X	.	.	.	.	.	.	.	.	.
<i>Glaux maritima</i> (CN)	X	.	.	.	.	X	.	.	.	.
<i>Glycyrrhiza lepidota</i> (NA)	X	.	.	X	.	.	.	.	.	X
<i>Gnaphalium palustre</i> (WNA)	X	.	.	.	.	.	.	.	.	.
<i>Grindelia fraxino-pratensis</i> (I)	.	.	.	.	.	.	.	.	.	X
<i>Haplopappus acradenius</i> (M)	.	.	.	.	.	.	.	.	.	X
<i>Haplopappus lanceolatus</i> (WNA)	X	.	.	X	X	.	.	X	.	.
<i>Haplopappus racemosus</i> (GB)	X	X	X	.	.	X	X	.	.	X
<i>Helianthus nuttallii</i> (GB)	X	.	.	X	.	.	.	.	.	.
<i>Heliotropum curassavicum</i> (WNA)	.	.	.	X	X	.	.	X	.	X
<i>Hordeum jubatum</i> (CN)	X	.	X	X	.	.	.	.	.	.
<i>Hordeum brachyantherum</i> (NA)	X	.	.	X	.	.	.	.	.	.
<i>Hutchinsia procumbens</i> (CN)	.	.	.	.	.	.	.	.	.	X
<i>Hydrocotyle verticellata</i> (CN)	.	.	.	.	.	.	.	.	.	X
<i>Iris missouriensis</i> (WNA)	X	.	.	.	.	X	X	.	.	.
<i>Iva acerosa</i> (WNA)	.	.	.	.	.	.	.	.	.	X
<i>Iva axillaris</i> (WNA)	X	X	X	.	.	.	.	.	.	.
<i>Ivesia eremica</i> (M)	.	.	.	.	.	.	.	.	.	X
<i>Ivesia kingii</i> (I)	X	X	.	.	.	X	.	.	.	.
<i>Juncus bufonius</i> (CN)	X	.	.	.	.	.	.	.	.	.
<i>Juncus balticus</i> (CN)	X	.	X	X	X	X	X	X	.	X
<i>Juncus cooperi</i> (M)	.	.	.	.	.	.	.	.	.	X
<i>Juncus longistylus</i> (WNA)	X	.	.	.	.	.	.	.	.	.
<i>Juncus nodosus</i> (NA)	.	.	.	.	.	.	.	.	.	X
<i>Juncus torreyi</i> (NA)	X	.	.	.	.	.	.	.	.	.
<i>Laphamia megaloccephala</i> (I)	.	.	X	.	.	.	.	.	.	.
<i>Lemna minima</i> (WNA)	X	.	X	.	.	.	.	.	.	.
<i>Lemna minor</i> (CN)	X	.	.	.	.	.	.	.	.	.
<i>Lemna trinervis</i> (WNA)	X	.	.	.	.	.	.	.	.	.
<i>Lepidium flavum</i> (M)	X	.	.	.	.	.	.	.	.	X
<i>Lepidium fremontii</i> (M)	X	.	.	.	.	.	.	.	.	X
<i>Leptochloa uninervia</i> (CN)	.	.	.	.	.	.	.	.	.	X
<i>Lycopus asper</i> (NA)	X	.	.	.	.	.	.	.	.	.
<i>Lythrum californicum</i> (WNA)	X	.	.	.	.	.	.	.	X	X
<i>Mentha arvensis</i> (CN)	X	.	X	.	.	.	.	.	.	.
<i>Mentzelia leucophylla</i> (I)	.	.	.	.	.	.	.	.	.	X
<i>Mimulus guttatus</i> (CN)	X	.	X	.	.	.	.	.	.	X
<i>Muhlenbergia asperifolia</i> (CN)	X	X	X	.	.	X	X	X	.	.

(continued)

TABLE 1 (continued)

	FS	FLV	DSV	KL	OL	LV	B	LL	SV	AM
<i>Muhlenbergia richardsonis</i> (NA)	.	.	.	X	.	.	X	.	.	.
<i>Muhlenbergia utilis</i> (WNA)	.	.	.	.	.	.	.	.	.	X
<i>Najas marina</i> (CN)	.	.	.	.	.	.	.	.	.	X
<i>Nitrophila mohavensis</i> (I)	.	.	.	.	.	.	.	.	.	X
<i>Nitrophila occidentalis</i> (WNA)	X	X	X	X	.	X	.	X	.	.
<i>Oenothera hookeri</i> (WNA)	X	.	X	.	.	.	.	.	.	X
<i>Oxystylis lutea</i> (M)	.	.	.	.	.	.	.	.	.	X
<i>Panicum capillare</i> (NA)	X	.	.	.	.	.	.	.	.	X
<i>Paspalum distichum</i> (NA)	X	.	.	.	.	.	.	.	.	.
<i>Persicaria amphibia</i> (CN)	X	.	.	.	.	.	.	.	.	.
<i>Persicaria lapathifolia</i> (CN)	X	.	.	.	.	.	.	.	.	.
<i>Persicaria maculata</i> (CE)	X	.	.	.	.	.	.	.	.	.
<i>Phragmites australis</i> (CN)	X	X	X	.	.	.	.	X	X	X
<i>Plagiobothrys stipitatus</i> (WNA)	.	.	.	.	.	.	.	.	.	X
<i>Pluchea purpurascens</i> (NA)	.	.	.	.	.	.	.	.	.	X
<i>Pluchea sericea</i> (WNA)	.	.	.	.	.	.	.	.	X	.
<i>Poa nevadensis</i> (WNA)	X	X	X	X	X	X	X	.	.	.
<i>Populus fremontii</i> (WNA)	X	X	.	.	.	.	.	.	.	X
<i>Potamogeton foliosus</i> (CN)	X	.	.	X	.	.	.	.	.	.
<i>Potamogeton illinoensis</i> (NA)	X	.	.	.	.	.	.	.	.	.
<i>Potamogeton latifolius</i> (CN)	X	.	.	.	.	X	.	.	.	.
<i>Potamogeton pectinatus</i> (CN)	X	.	.	.	.	X	.	.	.	.
<i>Potentilla pectinisecta</i> (M)	X	.	.	.	.	.	.	.	.	.
<i>Potentilla</i> sp.	.	.	X	.	.	.	.	.	.	.
<i>Prosopis pubescens</i> (WNA)	.	.	.	.	.	.	.	.	.	X
<i>Puccinellia lemmonii</i> (GB)	X	X	.	.	.	.	X	.	.	.
<i>Ranunculus cymbalaria</i> (WNA)	.	X	X	.	.	X	.	.	.	.
<i>Rorippa palustris</i> (WNA)	X	X	X	.	.	X	X	.	.	.
<i>Rosa woodsii</i> (GB)	X	X	.	.	.	.	.	.	.	.
<i>Rumex maritimus</i> (CN)	X	.	X	.	.	.	.	.	.	.
<i>Ruppia maritima</i> (CN)	X	.	.	.	X	X	X	.	.	X
<i>Salix exigua</i> (WNA)	X	X	X	.	.	.	.	.	.	X
<i>Salix gooddingii</i> (WNA)	.	.	X	.	X	.	.	.	.	.
<i>Salix laevigata</i> (WNA)	.	.	X	.	.	.	.	.	.	.
<i>Salix lasiolepis</i> (WNA)	X	.	.	.	.	.	.	.	.	.
<i>Samolus parviflorus</i> (CN)	.	.	.	.	.	.	.	.	.	X
<i>Sarcobatus vermiculatus</i> (WNA)	X	X	X	X	X	.	X	.	.	X
<i>Scirpus acutus</i> (NA)	X	.	X	X	.	.	.	.	X	.

Localities (columns):

FS=Fish Slough,**FLV**=Fish Lake Valley,**DSV**=Deep SpringsValley, **KL**= KlondikeLake, **OL**=Owens Lake,**LV**=Long Valley,**B**=Bridgeport-TravertineSprings Area, **LL**=LittleLake, **SV**=Saline Valley,and **AM**=Ash Meadows.

Geographic affinities

(following species

names): **I**=Inyo region,**M**=Mojave Desert,**GB**=Great Basin,**WNA**=Western NorthAmerica, **NA**=NorthAmerica, **CN**=Cosmopolitannative, and **CE**=Cosmo-

politan exotic.

(continued)

4.9—A PHYTOGEOGRAPHIC COMPARISON OF FISH SLOUGH AND NEIGHBORING DESERT FLORAS

TABLE 1 (continued)

	FS	FLV	DSV	KL	OL	LV	B	LL	SV	AM
<i>Scirpus americanus</i> (CN)	x	x	x	x	x	x	x	x	x	x
<i>Scirpus maritimus</i> (CN)	x	.	.	x	.	.	.	.	.	x
<i>Scirpus nevadensis</i> (CN)	x	x	x	.	x	x	x	.	.	.
<i>Scirpus pungens</i> (CN)	x	x	.	.	x	.	x	x	.	.
<i>Schoenus nigricans</i> (CN)	.	.	.	.	.	.	.	.	.	x
<i>Sida hederacea</i> (WNA)	.	.	.	.	.	.	.	.	.	x
<i>Sisyrinchium demissum</i> (WNA)	.	.	.	.	.	.	.	.	.	x
<i>Sisyrinchium halophilum</i> (GB)	x	.	.	.	.	.	.	.	.	.
<i>Smilacena stellata</i> (NA)	x	.	.	.	.	.	.	.	.	.
<i>Solanum douglasii</i> (WNA)	.	.	.	.	.	.	.	x	.	.
<i>Solidago canadensis</i> (WNA)	.	x	x	.	.	.	.	.	.	.
<i>Solidago spectabilis</i> (WNA)	x	.	.	.	.	.	.	.	.	x
<i>Spartina gracilis</i> (WNA)	x	x	x	.	.	x	.	.	.	x
<i>Spiranthes infernalis</i> (I)	.	.	.	.	.	.	.	.	.	x
<i>Spiranthes porrifolia</i> (WNA)	x	.	.	.	.	.	.	.	.	.
<i>Sporobolus airoides</i> (WNA)	x	x	x	x	.	.	.	x	.	x
<i>Stanleya pinnata</i> (WNA)	.	.	.	.	.	.	.	.	.	x
<i>Suaeda moquinii</i> (WNA)	x	x	x	x	x	.	.	x	x	x
<i>Suaeda occidentalis</i> (WNA)	.	.	.	.	.	.	.	.	.	x
<i>Thelypodium integrifolium</i> (WNA)	x	.	.	x	.	.	.	.	.	x
<i>Triglochin debilis</i> (GB)	x	x	x	.	x	x	x	.	.	.
<i>Typha domingensis</i> (CN)	x	x	x	x	.	.	.	x	x	.
<i>Typha latifolia</i> (CN)	x	.	.	.	.	.	.	.	.	.
<i>Utricularia vulgaris</i> (CN)	x	.	.	.	.	.	.	.	.	.
<i>Veronica americana</i> (CN)	.	.	.	.	.	.	.	.	.	x
<i>Vitis arizonica</i> (WNA)	.	.	.	.	.	.	.	.	.	x
<i>Wislizenia refracta</i> (M)	x	.	.	.	.	.	.	.	.	.
<i>Xanthium strumarium</i> (CN)	x	.	.	.	.	.	.	.	.	.
<i>Zannichellia palustris</i> (CN)	x	.	.	x	.	.	.	x	.	.
TOTAL SPECIES	126	42	52	30	24	27	24	23	11	83
(Wetland)										
Coefficients of similarity for basins:										
		FLV	DSV	KL	OL	LV	B	LL	SV	AM
FS		0.44	0.43	0.37	0.26	0.26	0.26	0.26	0.15	0.38

TABLE 2

	Inyo	Mojave	Great Basin	Western North America	North America	Native Cosmopolitan	Introduced Cosmopolitan	Total
Fish Slough	6	10	12	47	16	31	3	125
Fish Lake Valley	3	3	6	22	0	6	1	41
Deep Springs Valley	3	3	2	26	2	13	1	50
Klondike Lake	1	2	1	16	3	5	0	28
Owens Lake	0	2	1	12	0	7	0	22
Long Valley	1	0	2	10	2	10	0	25
Bridgeport (Warm Spring Flat-Travertine Springs)	0	0	4	9	3	6	0	22
Little Lake	0	2	1	11	0	8	0	22
Saline Valley	0	0	0	6	1	4	0	11
Ash Meadows	8	12	4	35	8	17	—	83

Table 2. Phytogeographic analysis of Fish Slough and neighboring basins: number of species in each phytogeographic category at each site.

TABLE 3

	Inyo (%)	Mojave (%)	Great Basin (%)	Western North America (%)	North America (%)	Native Cosmopolitan (%)	Introduced Cosmopolitan (%)
Fish Slough	5	8	10	37	13	25	2
Fish Lake Valley	7	7	15	54	0	15	2
Deep Springs Valley	6	6	4	52	4	26	2
Klondike Lake	4	7	4	57	11	18	0
Owens Lake	0	9	5	55	5	32	0
Long Valley	4	0	8	40	8	40	0
Bridgeport (Warm Spring Flat-Travertine Springs)	0	0	18	41	14	27	0
Little Lake	0	9	5	50	0	36	0
Saline Valley	0	0	0	55	9	36	0
Ash Meadows	10	14	5	40	10	21	—

Table 3. Phytogeographic analysis of Fish Slough and neighboring basins: percentage of species in each phytogeographic category at each site.

TABLE 4

	FS	FLV	DSV	KL	OL	LV	AV*	B	LL	SV	AM
<i>Astragalus argophyllus</i> var. <i>argophyllus</i>	x										
<i>Astragalus lentiginosus</i> var. <i>piscinensis</i>	x										
<i>Astragalus phoenix</i>											x
<i>Calochortus excavatus</i>	x					x					
<i>Calochortus striatus</i>											x
<i>Centaurium namophyllum</i> var. <i>nevadense</i> **	x	x	x								x
<i>Cordylanthus tecopensis</i>											x
<i>Eriogonum nummulare</i>	x										
<i>Fimbristylis spadicea</i>	x										x
<i>Grindelia fraxino-pratensis</i>											x
<i>Ivesia eremica</i>											x
<i>Ivesia kingii</i>	x	x				x	x				
<i>Mentzelia leucophylla</i>											x
<i>Nitrophila mojavensis</i>											x
<i>Spartina gracilis</i>	x	x	x			x	x				
<i>Spiranthes infernalis</i>											x
TOTAL	8	3	2	0	0	2	3	0	0	0	10

* Adobe Valley, Mono Co., California, east of Mono Lake. Data from P. Novak (pers. comm.).

** Now considered *C. exaltatum* by many authorities (e.g., California Native Plant Society).

Table 4. Species of special concern in wetlands of Fish Slough and neighboring basins.

Acknowledgements. We thank Mark Bagley and Sally Manning for assistance with field work, and White Mountain Research Station for accommodations.

REFERENCES

- Beatley, J. C., Climates and vegetation patterns across the Mojave/Great Basin desert transition of southern Nevada, *Am. Mid. Nat.*, 93, 53-70, 1975.
- Beatley, J. C., *Vascular plants of the Nevada Test Site and Central/Southern Nevada*, Technical Information Center, Office of Technical Information, Energy Research and Development Administration, U.S. Department of Commerce, Springfield, Virginia, 1976.
- Ferren, W. R., Jr., Flora in *Biotic Inventory and Ecosystem Characterization for Fish Slough, Inyo and Mono Counties, California*, edited by W. R. Ferren, Jr. and F. W. Davis, pp. IV-37-IV-50, and Figs. IV-13-IV-20,

- Calif. Dept. Fish and Game Rep.*, Sacramento, California, 1991.
- Forbes, H. C., W. R. Ferren, Jr., and J. R. Haller, The vegetation and flora of Fish Slough and vicinity, Inyo and Mono counties, California, in *Plant Biology of Eastern California*, edited by C. A. Hall, Jr., and V. Doyle-Jones, pp. 99-138, University of California, White Mountain Research Station, *Symp. Vol. 2*, 1988.
- Knight, T. A. and G. H. Clemmer, Status of populations of the endemic plants of Ash Meadows, Nye County, Nevada, *U.S. Fish and Wildlife Serv. Rep.*, Great Basin Complex, Reno, Nevada, 1987.
- McLaughlin, S. P., Floristic analysis of the southwestern United States, *Great Basin Nat.*, 46, 46-65, 1986.
- Nevada Natural Heritage Program, *Sensitive plant species of Ash Meadows*, compiled in cooperation with Nevada Division of Forestry, Department of Conservation and Natural Resources, Carson City, Nevada, 1990.
- Odion, D. C., R. M. Callaway, W. R. Ferren, Jr., and F. W. Davis, Vegetation of Fish Slough, an Owens Valley wetland ecosystem, in *The History of Water: Eastern Sierra Nevada, Owens Valley, White-Inyo Mountains*, edited by C. A. Hall, Jr., V. Doyle-Jones, and B. Widawski, pp. 171-197, University of California, White Mountain Research Station, *Symp. Vol. 4*, 1992.