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CONTENTS

ERRATUM

Gotshall, D. W., G. H. Allen and R. A. Barnhart. 1980. An annotated checklist of fishes from Humboldt Bay, California. Calif. Fish Game, 66(4):220–232. Page 223, Appendix 1. The Bay maximum size of *Notorynchus maculatus* should read 149Kg ** and not 14.9Kg **.

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SEASONAL FOODS OF BLACK BEARS IN TAHOE NATIONAL FOREST, CALIFORNIA[1]

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Black bear, *Ursus americanus,* food habits were determined by analyzing 395 fecal samples collected from 1978 through 1980. Colonial insects were eaten consistently throughout the year, while other animal food items were used sporadically. Consumption of plant material varied with phenology. Grasses and forbs were utilized in the spring, manzanita berries in the summer, and acorns eaten in the fall.

INTRODUCTION

This report is a three-year summary of food habits work conducted in the Tahoe National Forest between 1978 and 1980. Knowledge of food habits is becoming increasingly important to land managers concerned with wildlife values and management plans. This research will be used to validate or update information currently being used by the USDA Forest Service (USFS) and the California Department of Fish and Game (CDFG) in their Wildlife/Habitat Relationships Programs.

Black bear, *Ursus americanus,* food habits in California have been studied by several researchers. Studies have been conducted in the San Bernardino National Forest (Boyer 1976), Sequoia National Park (Goldsmith *et al.* 1981), Yosemite National Park (Graber and White 1978, Graber 1982), and the Shasta-Trinity National Forest (Piekielek and Burton 1975, Kelleyhouse 1975). Studies in other western states have been conducted in Alaska (Hatler 1972), Washington (Poelker and Hartwell 1973) and Montana (Tisch 1961).

STUDY AREA

The study area, approximately 287km^2, is located on the west slope of the Sierra Nevada range about 11 km west of Lake Tahoe in Placer County, California (Figure 1). Ownership of the land is partitioned, checkerboard fashion, between private holdings and the USFS. The majority of the public land is administered by the Tahoe National Forest, Foresthill Ranger District. A small portion along the southern boundary of the study area is in the Georgetown Ranger District, El Dorado National Forest. Elevations range between 1100 m in Royal Gorge to 2560 m at Mt. Mildred. A state game refuge occupies about 50% of the study area. The entire area consists of sharp ridges that are divided by steep canyons and gorges. The North and Middle forks of the American River and the Rubicon River drain the study area to the west. The Middle Fork of the American and the Rubicon are dammed at the western edge of the study area and form French Meadows and Hell Hole reservoirs, respectively.

Average annual precipitation ranges from 150 to 180 cm, 80% of which occurs between November and May, mostly in the form of snow. Intense summer thunderstorms are common. Precipitation during the winter of 1977–78 was

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130% of normal, 90% of normal in 1978–79, and 100% of normal in 1979–80 (H. Baer, Placer Co. Water Agency, pers. commun.).

Habitat types found within the study area are mountain meadow, black oak woodland, chaparral, riparian deciduous, mixed conifer, lodgepole pine, and red fir (Verner and Boss 1980).

The most abundant mast-producing plants are black oak, *Quercus kelloggii;* canyon live oak, *Q. chrysolepsis;* whiteleaf manzanita, *Arctostaphylos viscida;* green-leaf manzanita, *A. patula;* pinemat manzanita, *A. nevadensis;* bitter cherry, *Prunus emarginata;* and Sierra gooseberry, *Ribes roezlii.* Oaks are most commonly found in canyons below 1500 m. Bitter cherry occurs above 1200 m on slopes and along streams. Manzanita is found throughout the study area in association with open stands of oak and conifers, but also occurs in, and often dominates, chaparral ecosystems. Sierra gooseberry is most abundant in areas disturbed by logging activity, such as skid trails, roadsides, and clearcuts.

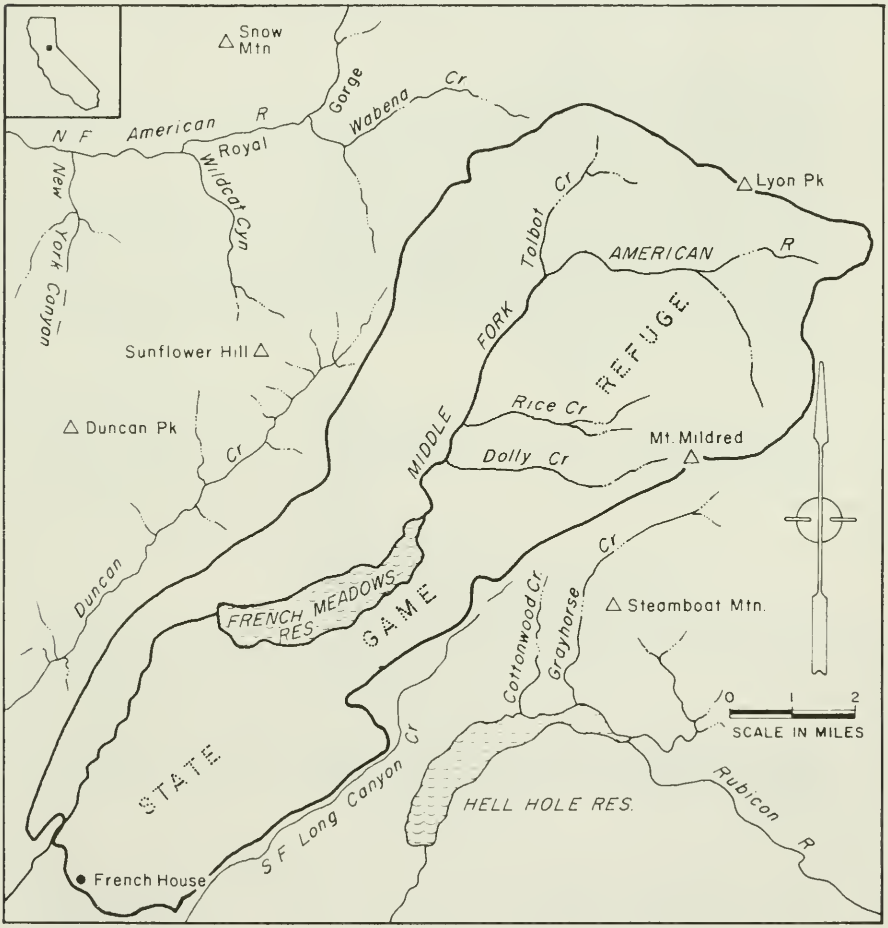

FIGURE 1. Black bear study area, Tahoe National Forest, California.

Herbaceous cover typical of the study area includes grasses, Poaceae; bracken fern, *Pteridium aquilinum;* clover, *Trifolium* spp.; lotus, *Lotus* spp.; larkspur, *Delphinium* spp.; corn lily, *Veratrum californicum;* lupine, *Lupinus* spp.; lovage, *Ligusticum grayi;* and mule ears, *Wyethia mollis.* Most herbaceous growth is found in meadows, riparian areas, along roadsides, on skid trails, and in clearcuts and open conifer woodlands.

Approximately 75% of the study area is composed of commercial conifers, most of which have been selectively harvested since 1970. Clearcutting has occured as well. Parcels collectively less than two sections were harvested during the early 1960s. Logging activity was low in 1979 and high in 1980. Less than 400 ha of commercial conifer are virgin. The remaining portion of the study area includes steep, rocky slopes with mountain chaparral and/or oaks and barren areas.

Annually, about 250 head of beef cattle are grazed throughout the study area between 1 July and 15 October. Sheep are grazed in upper Picayune Valley along the eastern periphery of the study area for a 2-wk period in August.

METHODS

Between June 1978 and October 1980, 395 black bear scats were collected. Scats were preserved in 10% formalin, labeled, and forwarded to the California Department of Fish and Game, Wildlife Investigations Laboratory, Sacramento, California.

During 1979, species area curves (Brower and Zar 1977) for food items were constructed for each month. The number of "new" food items found in each successive scat was plotted against the number of scats analyzed. In all cases, the curves leveled off before reaching 20 scats. For this reason, an attempt was made to analyze between 20 and 25 scats each month to insure a representative sample of food items was obtained.

Each scat was rinsed thoroughly in a sieve (6 sq/cm) to remove small unidentifiable particles, placed in a white enamel tray and examined under a dissecting microscope. All food items were recorded on a food habits analysis card together with an ocular estimate of the percent volume. Any food item constituting less than an estimated 1% of the volume was considered a "trace". Data were analyzed by percent frequency of occurrence and percent volume.

RESULTS AND DISCUSSION

Hatler (1972) concluded that scat analysis is a reliable method for determining plant and animal frequency of occurrence in the diet because most bear foods contain some hard materials, such as seeds, cellulose, exoskeleton, and hair that are resistant to digestion. Volumetric determinations from scats are a valid index for most plant material, but less reliable for animal food items and forbs. Foods which undergo a more thorough digestive process are likely to be underestimated in volume, particularly items such as flesh, insect larvae, and succulent forbs.

A single criterion is usually inadequate to provide meaningful results from food habits analysis. Therefore, percent relative frequency of occurrence and percent volume were averaged to calculate an "importance value". Importance values for each major food type (herbaceous plants, soft mast, insects, etc.) were graphed by month for the years 1978–1980 (Figures 2, 3, and 4) with the intention of providing a more useful estimation of the black bear diet. The 1979 and 1980 data (Figures 3 and 4) are probably more significant because of adequate sample size. The category "other herbaceous plants" (Tables 1, 2, and 3) is a generic term used for stems and leaves other than graminoids, as well as lichen, fungi, and cambium.

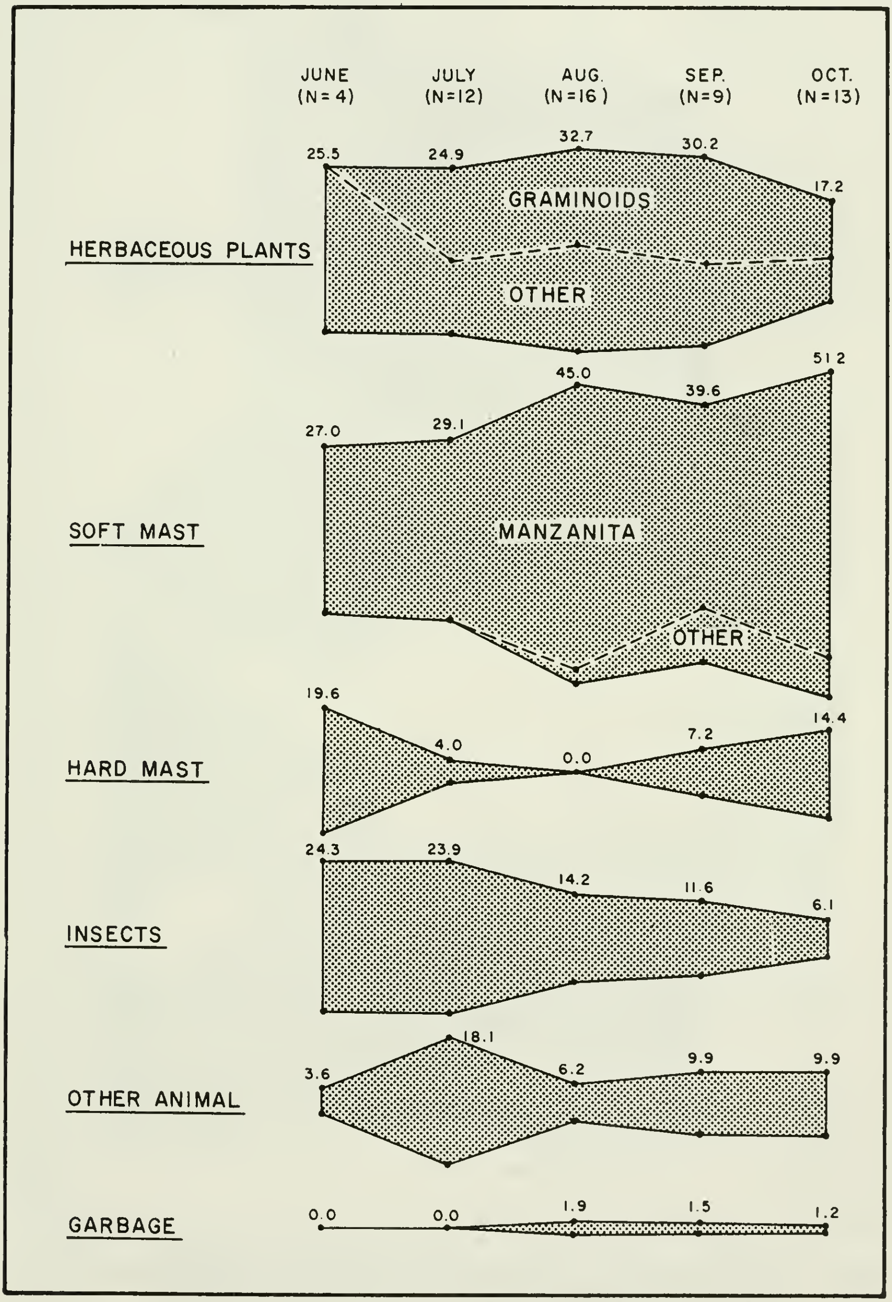

FIGURE 2. Seasonal use and relative importance values of major food types determined from 54 black bear scats collected from Tahoe National Forest in 1978.

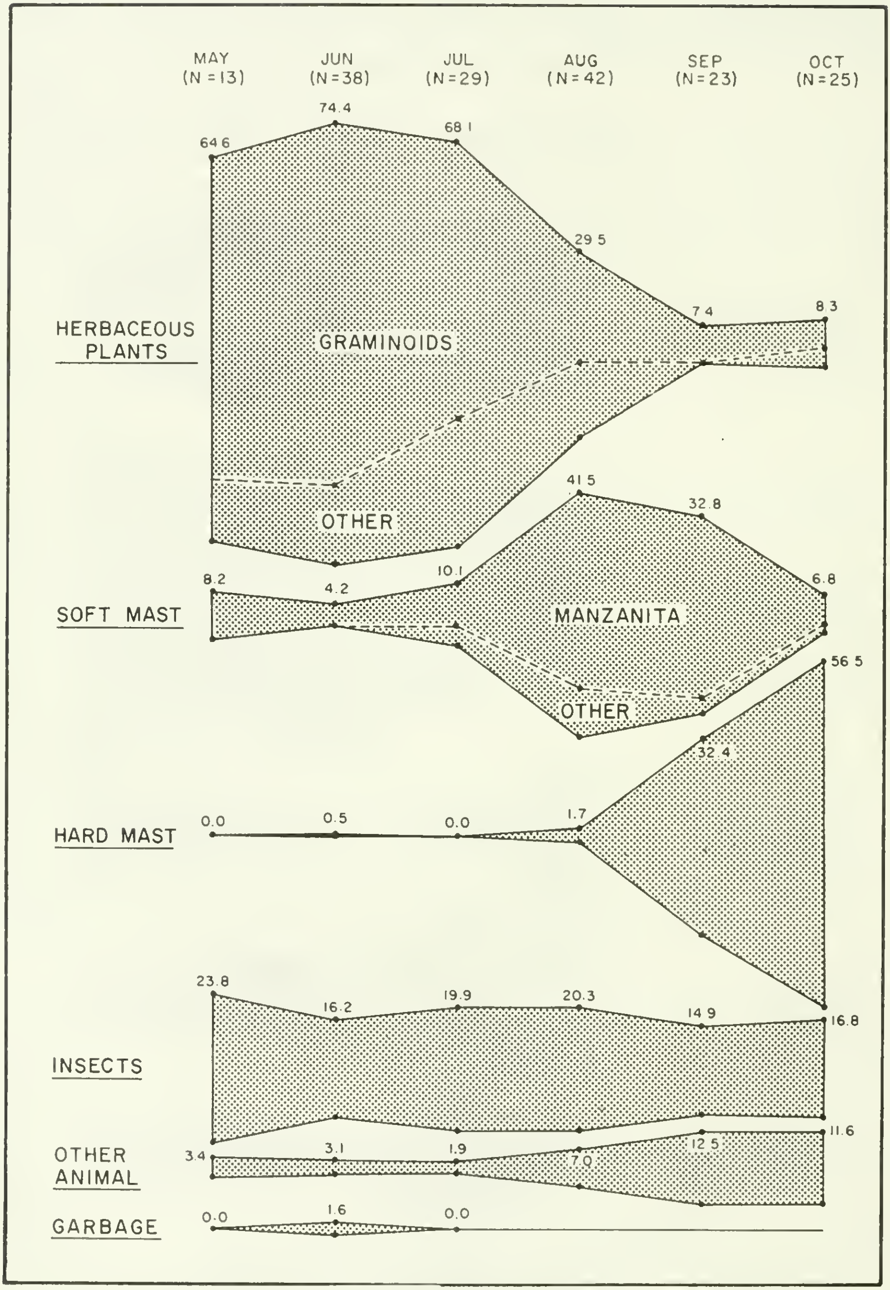

FIGURE 3. Seasonal use and relative importance values of major food types determined from 170 black bear scats collected from Tahoe National Forest in 1979.

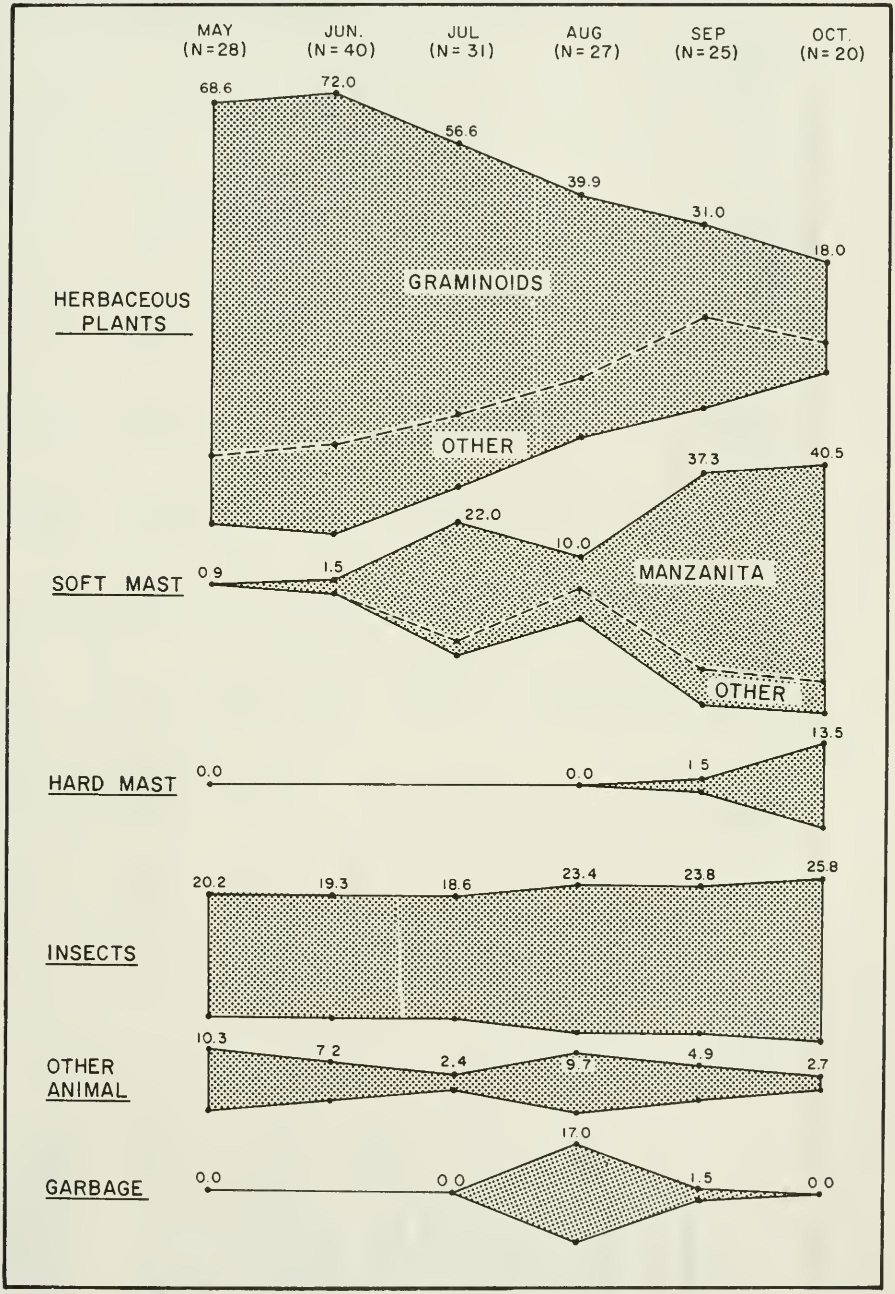

FIGURE 4. Seasonal use and relative importance values of major food types determined from 171 black bear scats collected from Tahoe National Forest in 1980.

TABLE 1. Food Items Identified in Black Bear Fecal Samples Collected During 1978, Tahoe National Forest, California

FOOD ITEM	June (N = 4) F%	June (N = 4) V%	July (N = 12) F%	July (N = 12) V%	August (N = 16) F%	August (N = 16) V%	September (N = 9) F%	September (N = 9) V%	October (N = 13) F%	October (N = 13) V%	Total (N = 54) F%	Total (N = 54) V%
Grass types, Graminoids												
Unidentified grasses		—	58	12	65	10	67	17	46	4	56	9
Other herbaceous plants												
Trail plant, *Adenocaulon bicolor*					18	6					6	2
Vetch, *Vicia* sp.					18	Tr					6	Tr
Wild pea, *Lathyrus* sp.							11	Tr			2	Tr
Lupine, *Lupinus* sp.							11	Tr			2	Tr
Ceanothus, *Ceanothus* sp.									23	Tr	6	Tr
Smartweed, *Polygonum* sp.									7	Tr	2	Tr
Bedstraw, *Galium* sp.	25	Tr	50	Tr	18	Tr	33	5	15	Tr	28	1
Club moss, *Lycopodium* sp.					6	2	11	1			4	1
Spike moss, *Selaginella* sp.					18	5	22	Tr			9	2
Manzanita flowers, *Arctostaphylos* sp.	25	Tr	8	Tr							4	Tr
Clover Tribe, Trifolieae					6	Tr			15	Tr	6	Tr
Amaryllis Family, Amaryllidaceae									7	Tr	2	Tr
Crustose lichen, Lecideaceae									7	Tr	2	Tr
Pink Family, Caryophyllaceae	25	Tr	50	Tr	18	Tr			7	Tr	20	Tr
Parsley Family, Apiaceae			8	2	6	3	22	Tr	7	Tr	11	1
Green algae, Chlorophyta							22	3	7	Tr	9	1
Tree cambium									7	Tr	2	Tr
Unidentified	75	2	50	3	25	Tr	22	1	23	1	33	1
Subtotal		2		5		16		10		1		9
Soft mast												
Bitter cherry, *Prunus emarginata*							22	5	23	2	9	1
Gooseberry, *Ribes roezleii*							22	9	30	3	11	2
Dogwood, *Cornus sesslis*									7	8	2	2
Manzanita, *Arctostaphylos* sp.	75	53	75	36	88	62	89	39	100	58	87	51

Snow berry, *Symphoricarpos* sp.									7	Tr	2	Tr
Blueberry, *Vaccinium* sp.					6	Tr	11	1			4	Tr
Subtotal		53		36		62		54		71		56
Hard mast												
Acorns, *Quercus* sp.	50	25	25	1			11	11	23	13	19	7
Pine seeds, *Pinus jeffreyi*									38	4	9	1
Subtotal		25		1		—		11		17		8
Insects												
Termite, *Zootermopsis* sp.	25	Tr	25	8							7	2
Carpenter ant, *Coamponotus* sp.	100	20	83	12	53	10	22	Tr	7	Tr	48	7
Yellow jacket, *Vespula* sp.					6	Tr	44	Tr			9	Tr
Bee, Apidae							11	1			2	Tr
Beetle, Coleoptera	25	Tr	17	Tr							6	Tr
Butterfly/moth larvae, Lepidoptera									7	Tr	2	Tr
Grasshopper, Orthoptera									7	Tr	2	Tr
Unidentified larvae	25	Tr	41	Tr					30	Tr	19	Tr
Unidentified					18	Tr	22	Tr			9	Tr
Subtotal		20		20		10		1		Tr		9
Other animals												
Mule deer, *Odocoileus hemionus*			25	18	11	Tr	11	6	30	7	19	7
Crayfish, *Pacifasticus* sp.					6	Tr					2	Tr
Bird, Aves	25	Tr					11	Tr			4	Tr
Unidentified (flesh, bone, hair)			8	8	18	1	33	1	7	Tr	15	2
Subtotal		Tr		26		1		7		7		9
Garbage					6	1	11	Tr	7	Tr	6	Tr
Total		100		100		100		100		100		100

N = Sample size
F% = Percentage of scats in which food item occurred.
V% = Aggregate percent volume.
Tr = Trace (less than 1%)

TABLE 2. Food Items Identified in Black Bear Fecal Samples Collected During 1979, Tahoe National Forest, California

FOOD ITEM	May (N=13) F%	May (N=13) V%	June (N=38) F%	June (N=38) V%	July (N=29) F%	July (N=29) V%	August (N=42) F%	August (N=42) V%	September (N=23) F%	September (N=23) V%	October (N=25) F%	October (N=25) V%	Total (N=170) F%	Total (N=170) V%
Grass types, Graminoids														
Sedge, *Carex* sp.					3	Tr							1	Tr
Rush, Juncaceae	8	Tr											1	Tr
Unidentified grasses	100	71	97	83	97	60	45	14	26	1	20	2	64	38
Subtotal		71		83		60		14		1		2		38
Other herbaceous plants														
Gooseberry, *Ribes roezlii*			5	Tr									1	Tr
Mule ears, *Wyethia mollis*			3	Tr	3	Tr							1	Tr
Mountain maple, *Acer glabrum*			3	Tr									1	Tr
Lovage, *Ligusticum grayi*					14	2	12	5			4	1	6	2
Kelloggia, *Kelloggia galiodes*					7	1	2	Tr					2	Tr
Corn lily, *Veratrum californicum*					3	3							1	1
Club moss, *Lycopodium* sp.	15	Tr			3	Tr							2	Tr
Spike moss, *Selaginella* sp.					3	Tr					4	Tr	1	Tr
Wild pea, *Lathyrus* sp.	8	1			17	2	14	1					7	1
Bedstraw, *Galium* sp.	15	4	26	1	3	Tr	2	Tr					9	1
Dandelion, *Agoseris* sp.			11	1									2	Tr
Larkspur, *Delphinium* sp.			3	Tr	21	2							4	Tr
Five finger, *Potentilla* sp.			3	1	3	Tr							1	Tr
Lupine, *Lupinus* sp.			3	1									1	Tr
Stickseed, *Hackelia* sp.					3	1							1	Tr
Buckwheat, *Eriogonum* sp.					3	Tr							1	Tr
Vetch, *Vicia* sp.					3	Tr	5	3					2	1
Buttercup, *Ranunculus* sp.					3	Tr							1	Tr
Oak flowers, *Quercus* sp.					3	1							1	Tr
Clover tribe, Trifolieae			8	Tr			2	Tr					2	Tr

Crustose lichen, Lecideaceae											4	Tr	1	Tr
Sunflower Family, Asteracea	3	Tr											1	Tr
Crowfoot Family, Ranunculaceae	8	Tr	3	Tr	3	Tr							2	Tr
Green algae, Chlorophyta			3	Tr									1	Tr
Tree cambium							2	Tr					1	Tr
Unidentified					24	3	10	Tr			4	Tr	8	1
Subtotal		5		4		15		9				1		7
Soft Mast														
Bitter cherry, *Prunus emarginata*							2	1	4	1			1	Tr
Sierra plum, *P. subcordata*									4	Tr			1	Tr
Choke cherry, *P. virginiana*											4	1	1	Tr
Coffee berry, *Rhamnus californica*									4	5			1	1
American dogwood, *Cornus stolonifera*											4	Tr	1	Tr
Gooseberry, *Ribes roezlii*							29	14			4	Tr	8	4
Manzanita, *Arctostaphylos* sp.	31	5	13	3	31	4	60	37	39	36	28	2	35	15
Willow catkins, *Salix* sp.					3	3							1	1
Subtotal		5		3		7		52		42		3		21
Hard Mast														
Pine seeds, *Pinus* sp.			3	Tr									1	Tr
Pine seeds, *P. jeffreyi*											4	2	1	Tr
Acorns, *Quercus* sp.							5	1	52	38			8	5
Acorns, *Q. chrysolepis*											92	76	14	11
Subtotal				Tr				1		38		78		16
Insects														
Termite, *Zootermopsis* sp.	77	14	45	5	21	2	10	Tr	4	Tr	8	Tr	24	2
Carpenter ant, *Camponotus* sp.	16	1	29	3	48	15	50	16			16	5	33	8
Yellow jacket, *Vespula* sp.					10	Tr	26	1	35	11	28	6	17	3
Bee, Apidae							2	Tr					1	Tr
Beetle, Coleoptera	8	Tr	8	Tr			2	Tr			8	Tr	4	Tr
Unidentified larvae			3	Tr									1	Tr
Subtotal		15		8		17		17		11		11		13

TABLE 2. Food Items Identified in Black Bear Fecal Samples Collected During 1979, Tahoe National Forest, California—Continued

FOOD ITEM	*May (N=13)*		*June (N=38)*		*July (N=29)*		*August (N=42)*		*September (N=23)*		*October (N=25)*		*Total (N=170)*	
	F%	*V%*	*F%*	*V%*	*F%*	*V%*	*F%*	*V%*	*F%*	*V%*	*F%*	*V%*	*F%*	*V%*
Other Animals														
Mule deer, *Odocoileus hemionus*	8	4	8	1	7	1	5	2	4	Tr	44	4	12	2
Beechey ground squirrel, *Spermophilus beechyi*									9	Tr			1	Tr
Golden-mantled ground squirrel, *Spermophilus lateralis*											4	Tr	1	Tr
Douglas squirrel, *Tamiasciurus douglasii*							2	2					1	1
Striped skunk, *Mephitis mephitis*							2	1					1	Tr
Shrew, *Sorex* sp.									4	Tr	4	1	1	Tr
Vole, *Microtus* sp.			3	1									1	Tr
Mole, *Scapanus* sp.							2	1					1	Tr
Squirrel Family, Sciuridae			3	Tr									1	Tr
Dog Family, Canidae									4	Tr			1	Tr
Mole/Shrew, Insectivora									4	Tr			1	Tr
Bird, Aves							5	1	4	4			1	1
Tissue (carrion)									4	4			1	1
Subtotal		4		2		1		7		8		5		5
Garbage			8	Tr									2	Tr
Total		100		100		100		100		100		100		100

N = Sample size
F% = Percentage of scats in which item occurred
V% = Aggregate percent volume
Tr = Trace (less than 1%)

TABLE 3. Food Items Identified in Black Bear Fecal Samples Collected During 1980, Tahoe National Forest, California

FOOD ITEM	*May (N=28)*		*June (N=40)*		*July (N=31)*		*August (N=27)*		*September (N=25)*		*October (N=20)*		*Total (N=17)*	
	F%	*V%*	*F%*	*V%*	*F%*	*V%*	*F%*	*V%*	*F%*	*V%*	*F%*	*V%*	*F%*	*V%*
Grass types, Graminoids														
Bluegrass, *Poa* sp.	4	Tr											1	Tr
Sedge, *Carex* sp.	4	Tr	5	Tr									1	Tr
Brome Grass, *Bromus* sp.							4	Tr					1	Tr
Rush, *Juncus* sp.									4	Tr	5	Tr	1	Tr
Unidentified grasses	89	70	98	68	74	54	70	35	48	13	45	11	74	47
Subtotal		70		68		54		35		13		11		47
Other herbaceous plants														
Strawberry, *Frageria californica*	4	Tr											1	Tr
Kelloggia, *Kelloggia galiodes*	7	Tr	5	Tr	3	Tr	7	1	16	Tr	5	Tr	7	Tr
Lovage, *Ligusticum grayi*					3	Tr	22	1	24	1			8	Tr
Mule ears, *Wyethia mollis*									4	Tr			1	Tr
Licorice fern, *Polypodium vulgare*							7	1					1	Tr
Spike moss, *Selaginella* sp.	4	Tr			3	Tr							1	Tr
Manzanita flowers, *Arctostaphylos* sp.	14	8											2	1
Lupine, *Lupinus* sp.	11	3	5	Tr							5	Tr	4	Tr
Clover, *Trifolium* sp.			15	6	6	2			4	Tr			5	2
Lotus, *Lotus* sp.			8	6									2	1
Wild pea, *Laythrus* sp.			5	Tr							10	1	2	1
Pepper-grass, *Lepidium* sp.			3	Tr		3	1						1	Tr
Checker, *Sidalcea* sp.			5	3									1	1
Five finger, *Potentilla* sp.			3	Tr									1	Tr
Dandelion, *Agoseris* sp.					3	Tr			12	1			2	1
Buttercup, *Ranunculus* sp.					3	1							1	Tr

TABLE 3. Food Items Identified in Black Bear Fecal Samples Collected During 1980, Tahoe National Forest, California—Continued

FOOD ITEM	*May (N=28)*		*June (N=40)*		*July (N=31)*		*August (N=27)*		*September (N=25)*		*October (N=20)*		*Total (N=17)*	
	F%	*V%*	*F%*	*V%*	*F%*	*V%*	*F%*	*V%*	*F%*	*V%*	*F%*	*V%*	*F%*	*V%*
Dock, *Rumex* sp.									4	Tr			1	Tr
Club moss, *Lycopodium* sp.			3	Tr					4	Tr			1	Tr
Mint Family, Lamieceae			3	Tr	3	2							1	Tr
Geranium Family, Geraniaceae					3	Tr							1	Tr
Crowfoot Family, Ranunculaceae									12	8			2	1
Fern, Pteridophyta									4	Tr			1	Tr
Unidentified	7	1	10	1	10	Tr	37	3	28	2	10	Tr	16	1
Subtotal		12		16		6		6		12		1		9
Soft Mast														
Gooseberry, *Ribes roezlii*							19	4	4	3	30	10	7	2
Bitter cherry, *Prunus emarginata*					3	Tr			4	4	15	3	3	1
Dwarf Chamaesaracha, *Leucophysalis nana*									4	3	10	2	2	1
Coffee berry, *Rhamnus californica*											10	4	1	Tr
Manzanita, *Arctostaphylas* sp.	4	Tr	5	1	45	20	19	5	68	37	50	31	29	14
Snow berry, *Symphoricarpos* sp.											10	2	1	Tr
Subtotal		Tr		1		20		9		47		52		18
Hard Mast														
Acorns, *Quercus* sp.									8	Tr	40	13	6	2
Cone bracts, *Pinus jeffreyi*					3	Tr							1	Tr
Subtotal						Tr						13		2
Insects														
Termite, *Zootermopsis* sp.	39	6	45	5	26	7	22	6			10	Tr	26	4
Carpenter ant, *Camponotus* sp.	57	3	38	2	36	9	56	5	40	16	40	5	44	6
Yellow jacket, *Vespula* sp.			3	Tr	3	1	30	8	24	10	60	15	16	5
Bee, *Apidae*	4	1											1	Tr
Scarab, *Scarabaeidae*							4	Tr					1	Tr
Long-horned beetle, *Cerambycidae*							4	Tr					1	Tr
Beetle, *Coleoptera*	7	Tr					4	Tr			5	Tr	2	Tr
Unidentified larvae/pupae			3	Tr							5	Tr	1	Tr
Subtotal		10		7		17		19		26		20		15

Other Animals														
Mule deer, *Odocoileus hemionus*	14	6	10	8	3	3	22	9	16	2	5	2	12	5
Harvest mouse, *Reithrodontomys megalotis*	4	Tr											1	Tr
Vole, *Microtus* sp.			3	Tr									1	Tr
Shrew, *Sorex* sp.									4	Tr			1	Tr
Bird, *Aves*	4	Tr					4	Tr			5	1	2	Tr
Unidentified (tissue, bone, hair)	11	2	13	Tr			15	Tr	4	Tr			6	Tr
Subtotal		8		8		3		9		2		3		5
Garbage							33	22	8	Tr			6	4
Total		100		100		100		100		100		100		100

N = Sample size
F% = Percentage of scats in which item occurred
V% = Aggregate percent volume
Tr = Trace (less than 1%)

Black bear food items were dependent on plant phenology (Tables 1, 2, and 3). Bears utilized at least 69 different kinds of plants, 6 orders of insects, and 9 genera of mammals. No attempt was made to identify birds from feather fragments.

Three major dietary shifts occurred during the black bear activity period. Herbaceous plants, mostly grasses, were the most important (importance value) component of the bear diet from May to July (Figures 2, 3, and 4). Later, manzanita and lesser amounts of other berries replaced green plants in the diet. Berry consumption reached a peak between August and October. As the acorn crop matured, it was included in the diet. Consumption of insects and other animal food types was evenly distributed throughout the year; use of garbage was minimal.

Herbaceous Plants

The 1979–80 spring and early summer data indicate that black bears chose green plants, especially grasses, more than any other food type. However, grasses generally were the only major food source available.

Importance values of forbs compared to grasses and grass-like plants (graminoids) must be interpreted with caution. When graminoid frequency was regressed against graminoid volume an r value of .97 was obtained, while a similar analysis for forbs produced an r value of .54. This suggests a bias, probably associated with the higher cellulose content of graminoids resulting in more residual undigested material in scats. Many species of delicate forbs are probably underestimated in the diet because of low amounts of residual plant skeletal material occuring in bear scats.

Precipitation during the winter of 1977–78 was 130% of normal and should have resulted in more green plants for bear food, but the data (Figure 2 and Table 1) do not agree, probably because of low sample size (N=54).

Forbs noted most often in the analysis were bedstraw, *Galium* sp.; Kelloggia, *Kelloggia galiodes;* lovage, and clover (Tables 1, 2, and 3). Since these same forbs were commonly seen in the study area, a subjective judgment regarding selective or random feeding could not be made. However, bears apparently selected against lupine, bracken fern, corn lily, and mule ears. These plants were also common in the study area, but seldom were found in analysis. Lupine, bracken fern, and corn lily are poisonous to livestock.

Black bears lack a cecum and have a simple stomach too acidic to support microorganisms capable of digesting cellulose (Rogers 1976), and therefore have a limited ability to digest vegetation. The black bear digestive system, which is intermediate in length between a herbivore and carnivore, probably has evolved to allow better digestion and absorption of plant material (Herrero 1978). Graminoids and forbs are about 43% digestible compared to 73–81% for animal food stuffs (Mealy 1975). When plant protein is a major part of the diet, its low digestibility must be compensated by a large intake. In the Tahoe Forest study area, scats containing herbaceous material were abundant in spring and more easily located than any other time of year.

This period of predominantly herbaceous food consumption has been described as the "negative foraging period" (Jonkel 1962) because bears continue to draw on any remaining winter fat reserves in combination with a subsistence level diet of herbaceous plants. Many other researchers have reported that weight loss also occurs during this time (Jonkel and Cowan 1971, Poelker and Hartwell 1973, Kelleyhouse 1975). However, current research in Colorado indicates that some female bears show a weight gain on a diet of green plants and aspen buds (T. Beck, Colorado Dept. of Wildlife, pers. commun.).

In the Great Smoky Mountains National Park, the black bears' spring diet consisted of 90% grasses plus other herbaceous stems and leaves (Beeman and Pelton 1977). Graminoids and forbs bulked 67% of the spring black bear food in Yosemite National Park (Goldsmith *et al.* 1980). Black bears in the San Bernardino Mountains of southern California averaged 53% herbaceous plants consumed during the spring seasons of 1975 and 1976 (Boyer 1976). Herbage was the principal food of Yosemite bears during spring and early summer (Graber 1982). The results of this study parallel the above findings, as well as many others (Tisch 1961, Hatler 1972, Poelker and Hartwell 1973, Kellyhouse 1975, Landers *et al.* 1979).

Graminoid flowers were seldom found in food habit analyses. Protein content of pre-flowering graminoids is higher than that of post-flowering plants and the highest protein digestibility also is associated with the pre-flowering phase (Mealy 1975). Hence, there is an indication that bears were using grass-type foods when the protein content was greatest.

Soft Mast

The most abundant berry crop in the study area is manzanita. As the nutritional quality of herbaceous plants declined, black bears shifted to this food resource. Bears utilized manzanita in all stages: flowers and unripe, ripe, and dried fruit. Where manzanita occurs at lower elevations and/or on south-facing slopes, flowers and unripe fruit were eaten as early as May. Dried berries from the previous year were noted in a few scats collected in early spring. Use of soft mast continued throughout the year, with peak consumption occurring in late summer and fall. Manzanita berries, like herbaceous plants, are low in digestible energy (Goldsmith *et al.* 1981); consequently, large quantities of this food must be eaten.

Hard Mast

Another dietary shift occurred as the acorn crop matured, but was not as pronounced as in other California studies. Importance values for acorns increased in September (Figures 2, 3, and 4), but there were indications that acorn use by bears is greater than these data show. In the fall, scats were difficult to find because of deciduous leaf cover and general inaccessibility of oak habitats. Most oak woodlands in the study area are found on steep canyon slopes far from roads. Helicopter transport to one such area (Royal Gorge) in January 1981 enabled a ground search that revealed, in just a few hours, over 40 bear scats consisting of manzanita berries and acorns.

The nutritional value of acorns nearly approximates that of corn (Barrett 1971), and acorns become available when other foods have lost much of their nutritional quality (Menke and Fry 1979). Barrett (1971) reports that another omnivorous, monogastric animal, the wild pig, *Sus scrofa,* will abandon a diet of manzanita berries in favor of an adequate acorn supply. In this study area, bears appear to behave similarly.

During 1979, a failure of the black oak acorn crop occurred, but acorns from canyon live oak were abundant. When both acorn crops fail, an increase in bear depredation and nutrition-related mortality can be expected, followed by poor reproductive success the following winter. Similar occurrences resulting from mast shortages have been noted in other studies (Jonkel and Cowan 1971, Rogers 1976). Even though breeding occurs in summer, the blastocyst does not implant until November or December, but then only if the female is in good condition. A variety of mature oak species is necessary for optimum black bear habitat in California.

In 1980 bears did not utilize well-formed, abundant black oak acorns in one area, but did utilize those from other oak locations. Examination of the unutilized area revealed that 85% of those acorns had sustained insect damage. Reports of similar damage to acorns (as high as 80%) have cited the larvae of the filbert worm, *Melissopus latiferreanus,* and filbert weevil, *Curculio occidentis,* as the responsible insects (Brown 1979). Larvae tunnel throughout the acorn, destroy the embryo, and deplete its nutritional value.

Bears have been observed climbing oak trees in order to feed on acorns before they drop (Beeman and Pelton 1977). Arboreal feeding behavior was not observed in this study.

Insects

Carpenter ants, *Camponotus* spp.; termites *Zootermopsis* spp.; and yellow jackets, *Vespula* sp., were consistently represented seasonally during each year of the study (Figures 2, 3, and 4). Black bears were observed "raking" logs on occasion, and further evidence of this behavior was often noted throughout the study area during all seasons. Carpenter ants appeared in the diet all through the year (Tables 1, 2, and 3). Termites mainly occurred from early spring to mid-summer. Yellow jackets were noted in the diet from August to October. Insects were second in importance to herbaceous plants in the spring, to berries in the summer and to acorns in the fall (Figures 2, 3, and 4). Apparently, black bears actively seek out social insects for food which may be their only consistent source of high quality animal protein (Beeman and Pelton 1977). Therefore, the density, size, and age of dead and down woody material may be critical to maintaining optimum black bear habitat.

Other Animal Food

Mule deer, *Odocoileus hemionus,* as determined by the presence of deer hair and one fawn hoof in bear scats, predominated the "other animal food" category. One black bear scat was collected on 1 August 1979 close to where a coyote had killed a doe. On 31 October 1979 several scats containing deer hair and acorns were located near a deer carcass. A local cattleman (B. Dobbas, pers. commun.) claims that black bears feed on deer gut piles during the deer hunting season, which commences in mid-September and terminates in early November. The study area is part of the summer range of the Blue Canyon deer herd. Fawn drop begins in early June, peaks in mid-July, and tapers off in August. In 1978 and 1980 the highest occurrence of deer hair in bear scats was associated with the fawn drop. In 1979 deer hair in scats were most abundant during deer hunting season; unretrieved or crippled deer surely provide a food source during this time of year.

Animal foods other than deer occurred sporadically (Tables 1, 2, and 3) and included Douglas squirrel, *Tamiasciurus douglasii;* vole, *Microtus* sp.; shrew, *Sorex* sp.; mole, *Scapanus* sp.; harvest mouse, *Reithrodontomys* sp.; and two species of ground squirrel, *Spermophilus* spp. In analysis, carrion was so designated only when animal tissue was associated with substantial amounts of maggots (Diptera larvae). Most researchers (Beeman and Pelton 1977, Goldsmith *et al.* 1981) have concluded that mammal and bird food items are probably taken opportunistically.

Mammalian or avian tissue may be undetected in bear scats unless bone, hair, or feathers are present, so it is likely that this food source is under-represented in our data. This would be particularly true with a large animal such as deer with high body volume (flesh) compared to low body surface (hair).

Garbage

Garbage had the lowest importance value of any major food type and was notable only during the summer of 1980 (Figure 4). During that time, bear disturbances in campgrounds were frequent in spite of the abundance of natural foods. However, garbage, like forbs and flesh, leaves little evidence in bear scats and may be underestimated. Black bears should be expected to seek out these "high quality" human foods, especially if they are available during periods when natural foods are in short supply (Hatler 1972, Rogers 1976, Goldsmith *et al.* 1981, Graber 1982).

SUMMARY

Black bear feeding patterns in California approximate those cited by other researchers. In early spring black bears feed primarily on herbaceous plants and to a lesser extent on over-winter berries and acorns. If, or when, berry crops become available in summer and fall, a shift to that food source occurs. Bear foraging strategy again changes when acorns mature in early fall. Social insects and other animal foods are consumed throughout the year. Artificial food sources (garbage, camp supplies, orchard crops) are taken locally when opportunity permits. This information should aid in the prediction of bear food habits in unstudied areas in California.

This research and other studies demonstrate the omnivorous feeding habits of black bears (Poelker and Hartwell 1973, Boyer 1976, Beeman and Pelton 1977, Graber 1982). The results emphasize the importance of vegetation in the bear diet and illustrate cyclic feeding patterns consistent with plant phenology.

MANAGEMENT IMPLICATIONS

The quantity and quality of known bear foods might well be used to determine relative potential population density. Reproductive failure and/or depredation should be anticipated if bear foods are eliminated or key mast crop failures occur. Seasons and bag limits could be adjusted geographically in accordance with fluctuations in important bear foods. Sufficient quantity and variety of mast-producing trees and shrubs, particularly oaks, are essential to maintaining optimum habitat for black bears as well as many other species of wildlife in California. Timber harvest plans should be designed to provide for the maintenance of mature mast-producing trees and shrubs, dead and down timber, and grasses and forbs.

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AN ANNOTATED CHECK LIST OF THE AMPHIBIANS AND REPTILES OF CALIFORNIA [1]

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This represents a comprehensive check list of the present status of all known marine, freshwater, and terrestrial amphibians and reptiles that have been reliably reported as part of the California fauna. Included is a main list of native and established exotic species and four supplementary lists: (i) native species extinct in California, (ii) distributionally or taxonomically invalid species, (iii) established exotic species, and (iv) exotic species unsuccessfully introduced or of questionable status. The main list is composed of 129 full species, comprising 124 native freshwater and terrestrial species, 5 native marine species, and 5 introduced species. The 129 species comprise 29 families and 66 genera.

INTRODUCTION

Previous listings of the herpetofauna of California include: Cooper (1870), Van Denburgh (1897, 1922), Grinnell and Camp (1917), Storer (1925), Slevin (1928, 1934), Smith (1946), and Wright and Wright (1952), with regional lists by numerous authors. Stebbins (1972) provided the most recent check list of amphibians and reptiles from the State along with their distributions. Since then, however, there have been changes in the herpetofauna, its nomenclature, and the status of many species and subspecies. Also, a current comprehensive check list of all known amphibians and reptiles (to the subspecies level) in California has been lacking. This paper is an attempt to enumerate in a single document the present status of all marine, freshwater, and terrestrial species that have been reliably reported as part of the California fauna.

PURPOSE

Like other check lists of the various natural faunas of California, the purpose of this list is to establish the basis for compilation of a detailed handbook of these animals, and to promote stability and uniformity in both common and scientific names. Since Stebbins (1951, 1954, 1966, 1972) has largely achieved these two goals, this list is mainly an update based on new information. It is hoped that the list will become the basis for future editions as major revisions become necessary. This list also complements the comprehensive check lists of other vertebrate groups found in the State (most recently: Hubbs, Follett, and Dempster 1979; Shapovalov, Cordone, and Dill 1981).

SCOPE

The main list covers both native and established exotic species. The supplementary lists include: (i) native species believed to be extinct in California, (ii) distributionally or taxonomically invalid species, (iii) established exotic species, and (iv) exotic species unsuccessfully introduced or of questionable status.

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An attempt has been made to include all native forms whose occurrence has been reported and not disproved in the literature. The existence of most of these species and subspecies will not be questioned as they are known to have breeding populations in the State; however, there are a few exceptions. None of the marine reptiles reproduce in California, but since they occasionally enter state waters, they must be included in the main list. Such criteria allow the inclusion of the sea snake, *Pelamis platurus,* which has been reported several times in southern California waters (Kropach 1975).

There is the distinct possibility that some native species are no longer part of the California fauna. One such native form that now appears to be extinct is the Sonoran mud turtle, *Kinosternon sonoriense.* Since it is virtually impossible to prove or disprove its absence, however, this turtle is still included in the main list. On the other hand, only those exotic species which are known to have successfully reproducing populations in the State are included.

For the purposes of this paper, the definition of the State includes the entire Colorado River where it forms the California boundary, and the Pacific Ocean within 805 km of any point of land in the State between the seaward projections of its northern and southern boundaries. The westward limit coincides roughly with the outer edge of the California Current (Hubbs *et al.* 1979).

The status of endangered, threatened, and rare species, along with species of special concern, is based on information presented by Stewart (1971), Bury (1972), Ashton (1976), the California Administrative Code (1980), Mallette and Nicola (1980), the Federal Register, and the Department of Fish and Games files. The status of exotic species is determined by information presented by Stebbins (1966, 1972), Bury and Luckenbach (1976), Smith and Kohler (1977), personal communications with various authorities, and other papers cited in the text.

Hybrids have been omitted. Intraspecific, interspecific, and intergeneric hybrids of a number of subspecies listed have been recorded from California. The most striking examples are salamanders of the genus *Ensatina* (Brown 1974).

NAMES

Uniformity in the usage of scientific and common names continues to be a never-to-be attained goal (Shapovalov *et al.* 1981). This is due, in part, to our ever increasing knowledge of the relationships of amphibians and reptiles at the family, generic, species, and subspecies levels. New techniques and discoveries, along with painstaking research, have contributed to the problems of nomenclatural confusion. This is especially true with such variable groups as *Batrachoseps, Crotaphytus, Gambelia,* and *Thamnophis,* which seem to defy taxonomic classification at times.

In preparing this list, care has been taken to follow a standard set of rules and not add to the nomenclatural confusion. Classification schemes follow those employed by Goin, Goin, and Zug (1978) with few exceptions. Scientific names used conform to the provisions of the International Code of Zoological Nomenclature, 1964, and the amendments adopted by the Monaco (1972) Congress. Common names, however, have proven to be a never ending source of controversy. The previous authorative list of common names for amphibians and reptiles (Conant *et al.* 1956) was an outgrowth of Schmidt's (1953) check list. Accepted by most herpetologists, this list served as the basis for the common names utilized by Conant (1958, 1975) and Stebbins (1966, in prep.) in their field guides. Unfortunately the list remained unrevised over the years except for a quick update by Dowling (1974) who did not include subspecies. Collins *et al.* (1978) was the first group to revise this list in depth, but their disregard of the criteria they proposed in adopting common and scientific names, along with many other inconsistencies in taxonomy and spellings, has resulted in this list being unacceptable as the definitive work for North American amphibian and reptile nomenclature. Because of these problems, I decided to utilize the criteria adopted by Collins *et al.* (1978) and not the list itself. Thus, common names are based on Conant *et al.* (1956) and Stebbins (1966), except for those species and subspecies that were established after these publications were compiled or that are of uncertain status. In these cases, the original published descriptions (or revisions) or the accounts contained in the Catalogue of American Amphibians and Reptiles (American Society of Ichthyologists and Herpetologists 1963–1970; Society for the Study of Amphibians and Reptiles 1970–present) are utilized as the final authority. These exceptions are mentioned in the text.

In regard to the spelling of scientific patronyms emended to represent a man's name (such as *Ensatina eschscholtzii, Rana boylii, Gopherus agassizii, Phrynosoma douglassii, Thamnophis couchii,* etc.), I chose to follow the lead of Schmidt (1953), Stebbins (1954, 1966, 1972), Conant *et al.* (1956), Wright and Wright (1957), Conant (1958, 1975), Leviton (1972), Cochran and Goin (1978), Collins *et al.* (1978), Smith (1978), and Behler and King (1979), and use single *-i* endings for the sake of clarity. This approach is also taken by ichthyologists (Robins *et al.* 1980). This nomenclatural enigma and its surrounding controversy is amply treated by Jennings (1982).

CHECK LIST

Native Species and Established Exotic Species

This list consists of 129 full species, which may be subdivided as follows: 124 native species (5 marine) and 5 established introduced species.

Species which have been introduced into California are denoted by an asterisk (*), marine reptiles by an (O), and extinct species by a dagger (†). The following symbols are used to denote current status:

- SE: State-listed endangered species.
- SR: State-listed rare species.
- SP: State-listed protected species.
- FE: Federally listed endangered species.
- FT: Federally listed threatened species.
- FP: Species protected by other federal laws (principally those relating to national parks and monuments).
- C: Species common in the State.
- S: Species of special concern in the State. (Those species which may become listed as rare, threatened, endangered, or protected in the near future due to habitat modification or destruction, excessive collecting, disease, or impact of exotic species.)
- r: Species of very limited distribution only in California. Common in adjoining states or Mexico.

Native and Established Exotic Species
Order Caudata—Salamanders.
Family AMBYSTOMATIDAE—Mole Salamanders and Relatives[1]

[1] Edwards (1976) places *Dicamptodon* and *Rhyacotriton* in a separate family—DICAMPTODONTIDAE.

1. *Ambystoma gracile* (Baird). northwestern salamander.
   1a. *Ambystoma gracile gracile* (Baird). brown salamander C
2. *Ambystoma macrodactylum* (Baird). long-toed salamander.
   2a. *Ambystoma macrodactylum croceum* Russell and Anderson. Santa Cruz long-toed salamander .... SE, FE
   2b. *Ambystoma macrodactylum sigillatum* Ferguson. southern long-toed salamander C
3. *Ambystoma tigrinum* (Green). tiger salamander[2]
   3a. *Ambystoma tigrinum californiense* (Gray). California tiger salamander[3] .... S
4. *Dicamptodon ensatus* (Eschscholtz). Pacific giant salamander C
5. *Rhyacotriton olympicus* (Gaige). Olympic salamander.
   5a. *Rhyacotriton olympicus variegatus* Stebbins and Lowe. southern Olympic salamander C

Family SALAMANDRIDAE—Newts.

6. *Taricha granulosa* (Skilton). rough-skinned newt.
   6a. *Taricha granulosa granulosa* (Skilton). northern rough-skinned newt C
7. *Taricha rivularis* (Twitty). red-bellied newt C
8. *Taricha torosa* (Rathke). California newt.
   8a. *Taricha torosa torosa* (Rathke). Coast Range newt C
   8b. *Taricha torosa sierrae* (Twitty). Sierra newt C

Family PLETHODONTIDAE—Lungless Salamanders.

9. *Aneides ferreus* Cope. clouded salamander C
10. *Aneides flavipunctatus* (Strauch). black salamander[4] C
11. *Aneides lugubris* (Hallowell). arboreal salamander C
12. *Batrachoseps aridus* Brame. desert slender salamander .... SE, FE
13. *Batrachoseps attenuatus* (Eschscholtz). California slender salamander C
14. *Batrachoseps campi* Marlow, Brode, and Wake. Inyo Mountains salamander[5] .... S
15. *Batrachoseps nigriventris* Cope. black-bellied slender salamander C
16. *Batrachoseps pacificus* (Cope). Pacific slender salamander[6].
    16a. *Batrachoseps pacificus pacificus* (Cope). Channel Islands slender salamander .... S, FP
    16b. *Batrachoseps pacificus major* Camp. garden slender salamander C
    16c. *Batrachoseps pacificus relictus* Brame and Murray. relictual slender salamander .... S
17. *Batrachoseps simatus* Brame and Murray. Kern Canyon slender salamander .... SR
18. *Batrachoseps stebbinsi* Brame and Murray. Tehachapi slender salamander .... SR
19. *Ensatina eschscholtzi* Gray. ensatina.
    19a. *Ensatina eschscholtzi eschscholtzi* Gray. Monterey salamander C
    19b. *Ensatina eschscholtzi croceator* (Cope). yellow-blotched salamander .... S, SP
    19c. *Ensatina eschscholtzi klauberi* Dunn. large-blotched salamander .... S, SP
    19d. *Ensatina eschscholtzi oregonensis* (Girard). Oregon salamander C
    19e. *Ensatina eschscholtzi picta* Wood. painted salamander C
    19f. *Ensatina eschscholtzi platensis* (Espada). Sierra Nevada salamander C
    19g. *Ensatina eschscholtzi xanthoptica* Stebbins, yellow-eyed salamander C
20. *Hydromantes brunus* Gorman. limestone salamander .... SR
21. *Hydromantes platycephalus* (Camp). Mount Lyell salamander .... S, SP
22. *Hydromantes shastae* Gorman and Camp. Shasta salamander .... SR
23. *Plethodon dunni* Bishop. Dunn's salamander .... S, r[7]
24. *Plethodon elongatus* Van Denburgh. Del Norte salamander C

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[2] Collins, Mitton, and Pierce (1980) suggest a thorough reexamination of the taxonomy of this species. The undesecribed subspecies of *A. tigrinum* from Grass Lake, Siskiyou County, may represent a relect population of tiger salamanders (Mullen and Stebbins 1978). Further study is needed to clarify their taxonomic position.

[3] Taxonomy after Gehlbach (1967). Considered a distinct species by some authors (Storer 1925; Bishop 1943), and listed as such by Collins et al. (1978).

[4] No subspecies of *A. flavipunctatus* are currently recognized (Lynch 1981).

[5] Taxonomy after Marlow, Brode, and Wake (1979).

[6] Taxonomy after Yanev (1980), who also reports two additional undescribed subspecies of *B. pacificus* in California.

[7] Known only in California from three localities in Del Norte County (Bury, Fellers, and Ruth 1969; Storm and Brodie 1970; Stebbins 1972). Common in Oregon and Washington.

25. *Plethodon stormi* Highton and Brame. Siskiyou Mountains salamander .... SR

Order Anura—Toads and Frogs.
Family PIPIDAE—Tongueless Frogs.

26. *Xenopus laevis* Daudin. African clawed frog* C

Family ASCAPHIDAE—Tailed Frogs.

27. *Ascaphus truei* Stejneger. tailed frog C

Family PELOBATIDAE—Spadefoot Toads.

28. *Scaphiopus couchi* Baird. Couch's spadefoot .... r
29. *Scaphiopus hammondi* Baird. western spadefoot .... S
30. *Scaphiopus intermontanus* Cope. Great Basin spadefoot C
31. *Bufo alvarius* Girard, *in* Baird. Colorado River toad .... S, r[8]
32. *Bufo boreas* Baird and Girard. western toad.
    32a. *Bufo boreas boreas* Baird and Girard. boreal toad C
    32b. *Bufo boreas halophilus* Baird and Girard. California toad C
33. *Bufo canorus* Camp. Yosemite toad .... S
34. *Bufo cognatus* Say. Great Plains toad .... r
35. *Bufo exsul* Myers. black toad .... SR
36. *Bufo microscaphus* Cope. southwestern Toad.
    36a. *Bufo microscaphus microscaphus* Cope. Arizona toad .... S, SP, r
    36b. *Bufo microscaphus californicus* Camp. arroyo toad .... S, SP
37. *Bufo punctatus* Baird and Girard. red-spotted toad C
38. *Bufo woodhousi* Girard. Woodhouse's toad.
    38a. *Bufo woodhousi woodhousi* Girard. Woodhouse's toad .... r

Family HYLIDAE—Treefrogs and Their Allies.

39. *Hyla cadaverina* Cope. California treefrog .... S
40. *Hyla regilla* Baird and Girard. Pacific treefrog C

Family RANIDAE—True Frogs.

41. *Rana aurora* Baird and Girard. red-legged frog.
    41a. *Rana aurora aurora* Baird and Girard. northern red-legged frog .... S
    41b. *Rana aurora draytoni* Baird and Girard. California red-legged frog .... S, SP
42. *Rana boyli* Baird. foothill yellow-legged frog .... S
43. *Rana cascadae* Slater. Cascades frog .... r
44. *Rana catesbeiana* Shaw. bullfrog * C
45. *Rana muscosa* Camp. mountain yellow-legged frog C
46. *Rana pipiens* Schreber. northern leopard frog[9] C
47. *Rana pretiosa* Baird and Girard. spotted frog .... S, r[10]

Order Testudines—Turtles.
Family CHELYDRIDAE—Snapping Turtles.

48. *Chelydra serpentina* (Linnaeus). snapping turtle *.
    48a. *Chelydra serpentina serpentina* (Linnaeus). common snapping turtle * C

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[8] Once fairly common in lowlands and fields bordering Colorado River in Imperial County. Fouquette (1970) cites Grinnell and Camp (1917), Storer (1925), and Slevin (1928) for original records. Probably extirpated over most of its native range in California due to habitat destruction and heavy use of pesticides. Last known specimens taken 6 miles north of Winterhaven, Imperial County, on July 31, 1955 (Los Angeles County Museum of Natural History; LACM 87044). *Bufo alvarius* has only been recorded from the Arizona side of Colorado River in recent years (W. Loudermilk, Fisheries Biologist, Calif. Dept. Fish and Game, pers. commun.).

[9] Reportedly native east of the Sierra Nevada Mountains and in the Colorado River Basin (Bury and Luckenbach 1976). Introduced elsewhere in California (see the list of Established Exotic Species).

[10] Known in California only from two specimens taken in Modoc County (Turner and Dumas 1972). Common in northwestern states.

Family KINOSTERNIDAE—Musk and Mud Turtles.

49. *Kinosternon sonoriense* (Le Conte). Sonoran mud turtle. †
 49a. *Kinosternon sonoriense sonoriense* (Le Conte). Sonoran mud turtle. † .... SP

Family EMYDIDAE—Box and Water Turtles.

50. *Chrysemys scripta* (Schoepff). slider *.
 50a. *Chrysemys scripta elegans* (Wied). red-eared slider * C
51. *Clemmys marmorata* (Baird and Girard). western pond turtle.
 51a. *Clemmys marmorata marmorata* (Baird and Girard). northwestern pond turtle........ C
 51b. *Clemmys marmorata pallida* Seeliger. southwestern pond turtle ....S

Family TESTUDINIDAE—True Land Tortoises.

52. *Gopherus agassizi* (Cooper). desert tortoise .... S, SP

Family CHELONIDAE—Sea Turtles.

53. *Caretta caretta* (Linnaeus). loggerhead O.
 53a. *Caretta caretta gigas* Deraniyagala. Pacific loggerhead O........FT, r [11]
54. *Chelonia mydas* (Linnaeus). green turtle O.
 54a. *Chelonia mydas agassizi* Bocourt. Pacific green turtle O ....FT, r [11]
55. *Lepidochelys olivacea* (Eschscholtz). Pacific ridley O........FT, r [11]

Family DERMOCHELYIDAE—Leatherback Turtles.

56. *Dermochelys coriacea* (Linnaeus). leatherback O.
 56a. *Dermochelys coriacea schlegeli* (Garman). Pacific leatherback O........FE, r [11]

Family TRIONYCHIDAE—Softshell Turtles.

57. *Trionyx spiniferus* Le Sueur. spiny softshell *.
 57a. *Trionyx spiniferus emoryi* (Agassiz). Texas spiny softshall * C

Order Squamata—Lizards and Snakes.
Family GEKKONIDAE—Geckos.

58. *Anarbylus switaki* Murphy. Switak's barefoot gecko [12] .... SR
59. *Coleonyx variegatus* (Baird). banded gecko.
 59a. *Coleonyx variegatus variegatus* (Baird). desert banded gecko C
 59b. *Coleonyx variegatus abbotti* Klauber. San Diego banded gecko C
60. *Phyllodactylus xanti* Cope. leaf-toed gecko.
 60a. *Phyllodactylus xanti nocticolus* Dixon. leaf-toed gecko ....S, r

Family IGUANIDAE—Iguanid Lizards.

61. *Callisaurus draconoides* Blainville. zebra-tailed lizard.
 61a. *Callisaurus draconoides myurus* Richardson. Nevada zebra-tailed lizard ....r
 61b. *Callisaurus draconoides rhodostictus* Cope. Mojave zebra-tailed lizard........ C
 61c. *Callisaurus draconoides ventralis* (Hallowell). Arizona zebra-tailed lizard C
62. *Crotaphytus bicinctores* Smith and Tanner. western collared lizard [13] C
63. *Crotaphytus insularis* Van Denburgh and Slevin. Baja collared lizard.
 63a. *Crotaphytus insularis vestigium* Smith and Tanner. Baja collared lizard ....r
64. *Dipsosaurus dorsalis* (Baird and Girard). desert iguana.
 64a. *Dipsosaurus dorsalis dorsalis* (Baird and Girard). desert iguana C
65. *Gambelia silus* (Stejneger). bluntnose leopard lizard .... SE, FE
66. *Gambelia wislizeni* (Baird and Girard). common leopard lizard.

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[11] Occasional along the California coast (Stebbins 1972). More abundant in tropical marine waters further south.

[12] Common name as proposed by Murphy (1974). Listed as "Magic Gecko" by the California Administrative Code (1980).

[13] The taxonomy of this species remains disputed. Smith and Tanner (1972, 1974) placed it as a subspecies of *Crotaphytus collaris*, while Axtell (1972) and Montanucci, Axtell and, Dessauer (1975) preferred to group it under *C. insularis*. For the purposes of this paper, the phylogeny of Sanborn and Loomis (1979) is utilized. They recognize *C. bicinctores* as a full species.

66a. *Gambelia wislizeni wislizeni* (Baird and Girard). common leopard lizard.................... C
66b. *Gambelia wislizeni copei* (Yarrow). Cope's leopard lizard ....r
66c. *Gambelia wislizeni maculosus* (Tanner and Banta). Lahontan Basin leopard lizard........r
67. *Petrosaurus mearnsi* (Stejneger). banded rock lizard...r
68. *Phrynosoma coronatum* (Blainville). coast horned lizard.
68a. *Phrynosoma coronatum blainvilli* Gray. San Diego horned lizard ....S [14]
68b. *Phrynosoma coronatum frontale* Van Denburgh. California horned lizard..................... C
69. *Phrynosoma douglassi* (Bell). short-horned lizard.
69a. *Phrynosoma douglassi douglassi* (Bell). pigmy short-horned lizard ....r
70. *Phrynosoma mcalli* (Hallowell). flat-tailed horned lizard .... S, SP
71. *Phrynosoma platyrhinos* Girard. desert horned lizard.
71a. *Phrynosoma platyrhinos platyrhinos* Girard. northern desert horned lizard.................... C
71b. *Phrynosoma platyrhinos calidiarum* (Cope). southern desert horned lizard C
72. *Sauromalus obesus* Baird. chuckwalla.
72a. *Sauromalus obesus obesus* Baird. western chuckwalla ....S
73. *Sceloporus graciosus* Baird and Girard. sagebrush lizard.
73a. *Sceloporus graciosus graciosus* Baird and Girard. northern sagebrush lizard............... C
73b. *Sceloporus graciosus vandenburghianus* Cope. southern sagebrush lizard...................... C
74. *Sceloporus magister* Hallowell. desert spiny lizard.
74a. Sceloporus magister transversus Phelan and Brattstrom. barred spiny lizard C
74b. Sceloporus magister uniformis Phelan and Brattstrom. yellow-backed spiny lizard C
75. *Sceloporus occidentalis* Baird and Girard. western fence lizard.
75a. *Sceloporus occidentalis occidentalis* Baird and Girard. northwestern fence lizard C
75b. *Sceloporus occidentalis becki* Van Denburgh. island fence lizard..............................S,FP
75c. *Sceloporus occidentalis biseriatus* Hallowell. San Joaquin fence lizard.......................... C
75d. *Sceloporus occidentalis bocourti* Bell. Coast Range fence lizard.................................... C
75e. *Sceloporus occidentalis longipes* Bell. Great Basin fence lizard.. C
75f. *Sceloporus occidentalis taylori* Camp. Sierra fence lizard C
76. *Sceloporus orcutti* Stejneger. granite spiny lizard .... S,r
77. *Uma inornata* Cope. Coachella Valley fringe-toed lizard [15]..SE,FT
78. *Uma notata* Baird. Colorado Desert fringe-toed lizard.
78a. *Uma notata notata* Baird. Colorado Desert fringe-toed lizard..S
79. *Uma scoparia* Cope. Mojave fringe-toed lizard [16] C
80. *Urosaurus graciosus* Hallowell. long-tailed brush lizard.
80a. *Urosaurus graciosus graciosus* Hallowell. western brush lizard C
81. *Urosaurus microscutatus* (Van Denburgh). small-scaled lizard ....r
82. *Urosaurus ornatus* (Baird and Girard). tree lizard.
82a. *Urosaurus ornatus symmetricus* (Baird). Colorado River tree lizard...................................r
83. *Uta stansburiana* Baird and Girard. side-blotched lizard.
83a. *Uta stansburiana stansburiana* Baird and Girard. northern side-blotched lizard C
83b. *Uta stansburiana elegans* Yarrow. California side-blotched lizard C
83c. *Uta stansburiana nevadensis* Ruthven. Nevada side-blotched lizard....................................r
83d. *Uta stansburiana stejnegeri* Schmidt. desert side-blotched lizard C

Family XANTUSIIDAE—Night Lizards.

84. *Xantusia henshawi* Stejneger. granite night lizard.
84a. *Xantusia henshawi henshawi* Stejneger. granite night lizard .... S,r
85. *Xantusia riversiana* Cope. island night lizard ....SP,FT
86. *Xantusia vigilis* Baird. desert night lizard.
86a. *Xantusia vigilis vigilis* Baird. desert night lizard... C
86b. *Xantusia vigilis sierrae* Bezy. Sierra night lizard ....r

Family SCINCIDAE—Skinks.

87. *Eumeces gilberti* Van Denburgh. Gilbert's skink.
87a. *Eumeces gilberti gilberti* Van Denburgh. greater brown skink C

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[14] Bury (1972) considered this subspecies to be depleted, while Ashton (1976) considered it threatened.
[15] Taxonomy after Pough (1973). England and Nelson (1977) discuss present status.
[16] Taxonomy after Pough (1974).

87b. *Eumeces gilberti cancellosus* Rodgers and Fitch. variegated skink C
87c. *Eumeces gilberti placerensis* Rodgers. northern brown skink C
87d. *Eumeces gilberti rubricaudatus* Taylor. western red-tailed skink C
88. *Eumeces skiltonianus* (Baird and Girard). western skink.
88a. *Eumeces skiltonianus skiltonianus* (Baird and Girard). western skink C
88b. *Eumeces skiltonianus interparietalis* Tanner. Coronado Island skink .... r

Family TEIIDAE—Whiptail Lizards.

89. *Cnemidophorus hyperythrus* Cope. orange-throated whiptail.
89a. *Cnemidophorus hyperythrus beldingi* Stejneger. orange-throated whiptail .... S [17],r
90. *Cnemidophorus tigris* Baird and Girard. western whiptail.
90a. *Cnemidophorus tigris tigris* Baird and Girard. Great Basin whiptail C
90b. *Cnemidophorus tigris multiscutatus* Cope. coastal whiptail C
90c. *Cnemidophorus tigris mundus* Cope. California whiptail C

Family ANGUIDAE—Alligator Lizards.

91. *Gerrhonotus coeruleus* Wiegmann. northern alligator lizard.
91a. *Gerrhonotus coeruleus coeruleus* Wiegmann. San Francisco alligator lizard C
91b. *Gerrhonotus coeruleus palmeri* Stejneger. Sierra alligator lizard C
91c. *Gerrhonotus coeruleus principis* (Baird and Girard). northern alligator lizard .... r
91d. *Gerrhonotus coeruleus shastensis* Fitch. Shasta alligator lizard C
92. *Gerrhonotus multicarinatus* (Blainville). Southern alligator lizard.
92a. *Gerrhonotus multicarinatus multicarinatus* (Blainville). California alligator lizard C
92b. *Gerrhonotus multicarinatus scincicauda* (Skilton). Oregon alligator lizard C
92c. *Gerrhonotus multicarinatus webbi* Baird. San Diego alligator lizard C
93. *Gerrhonotus panamintinus* Stebbins. Panamint alligator lizard .... S,SP

Family ANNEILLIDAE—California Legless Lizards.

94. *Aniella pulchra* Gray. California legless lizard.
94a. *Aniella pulchra pulchra* Gray. silvery legless lizard C
94b. *Aniella pulchra nigra* Fischer. black legless lizard .... S

Family HELODERMATIDAE—Venomous Lizards.

95. *Heloderma suspectum* Cope. Gila monster.
95a. *Heloderma suspectum cinctum* Bogert and Martín del Campo.
banded Gila monster .... S,SP,r [18]

Family LEPTOTYPHLOPIDAE—Slender Blind Snakes.

96. *Leptotyphlops humilis* (Baird and Girard). western blind snake.
96a. *Leptotyphlops humilis humilis* (Baird and Girard). southwestern blind snake C
96b. *Leptotyphlops humilis cahuilae* Klauber. desert blind snake C

Family BOIDAE—Boas.

97. *Charina bottae* (Blainville). rubber boa [19]
97a. *Charina bottae bottae* (Blainville). northern rubber boa C
97b. *Charina bottae umbratica* Klauber. southern rubber boa .... SR
98. *Lichanura trivirgata* Cope. rosy boa.
98a. *Lichanura trivirgata gracia* Klauber. desert rosy boa .... S
98b. *Lichanura trivirgata roseofusca* Cope. coastal rosy boa .... S,r

Family COLUBRIDAE—Colubrids.

99. *Arizona elegans* Kennicott. glossy snake.

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[17] Considered threatened by Ashton (1976).

[18] Only recorded a few times in California from Imperial, Inyo, and San Bernardino counties (Bradley and Deacon 1966, Funk 1966, Ford 1981). Specimens reported by Klauber (1931) from Jacumbra Mountain, San Diego County, and Bury and Luckenbach (1976) from the residential areas of Walnut Creek, Contra Costa County, are all escaped pets.

[19] Taxonomy after Stewart (1977).

99a. *Arizona elegans candida* Klauber. Mojave glossy snake C
99b. *Arizona elegans eburnata* Klauber. desert glossy snake.......... C
99c. *Arizona elegans occidentalis* Blanchard. California glossy snake C
100. *Chionactis occipitalis* (Hallowell). western shovel-nosed snake.
100a. *Chionactis occipitalis occipitalis* (Hallowell). Mojave shovel-nosed snake C
100b. *Chionactis occipitalis annulata* (Baird). Colorado desert shovel-nosed snake.......... r
100c. *Chionactis occipitalis talpina* Klauber. Nevada shovel-nosed snake .... r
101. *Coluber constrictor* Linnaeus. racer.
101a. *Coluber constrictor mormon* Baird and Girard. western yellow-bellied racer [20] C
102. *Contia tenuis* (Baird and Girard). sharp-tailed snake .... S
103. *Diadophis punctatus* (Linnaeus). ringneck snake.
103a. *Diadophis punctatus amabilis* Baird and Girard. Pacific ringneck snake.......... C
103b. *Diadophis punctatus modestus* Bocourt. San Bernardino ringneck snake.......... C
103c. *Diadophis punctatus occidentalis* Blanchard. northwestern ringneck snake.......... C
103d. *Diadophis punctatus pulchellus* Baird and Girard. coral-bellied ringneck snake C
103e. *Diadophis punctatus regalis* Baird and Girard. regal ringneck snake.......... r
103f. *Diadophis punctatus similis* Blanchard. San Diego ringneck snake.......... C
103g. *Diadophis punctatus vandenburgi* Blanchard. Monterey ringneck snake C
104. *Hypsiglena torquata* (Günther). night snake.
104a. *Hypsiglena torquata deserticola* Tanner. desert night snake C
104b. *Hypsiglena torquata klauberi* Tanner. San Diego night snake.......... C
104c. *Hypsiglena torquata nuchalata* Tanner. California night snake C
105. *Lampropeltis getulus* (Linnaeus). common kingsnake [21]
105a. *Lampropeltis getulus californiae* (Blainville). California kingsnake.......... C
105b. *Lampropeltis getulus nigritus* Zweifel and Norris. black desert kingsnake.......... r
106. *Lampropeltis zonata* (Lockington, *ex.* Blainville). California mountain kingsnake.
106a. *Lampropeltis zonata zonata* (Lockington, *ex.* Blainville). Saint Helena mountain kingsnake .... SP
106b. *Lampropeltis zonata multicincta* (Yarrow). Sierra mountain kingsnake .... SP
106c. *Lampropeltis zonata multifasciata* (Bocourt). coast mountain snake .... SP
106d. *Lampropeltis zonata parvirubra* Zweifel. San Bernardino mountain kingsnake .... S,SP
106e. *Lampropeltis zonata pulchra* Zweifel. San Diego mountain kingsnake .... S,SP
107. *Masticophis flagellum* (Shaw). coachwhip.
107a. *Masticophis flagellum fuliginosus* (Cope). Baja California coachwhip .... r
107b. *Masticophis flagellum piceus* (Cope). red coachwhip C
107c. *Masticophis flagellum ruddocki* Brattstrom and Warren. San Joaquin coachwhip.......... S
108. *Masticophis lateralis* (Hallowell). striped racer.
108a. *Masticophis lateralis lateralis* (Hallowell). California striped racer C
108b. *Masticophis lateralis euryxanthus* Riemer. Alameda striped racer .... SR
109. *Masticophis taeniatus* (Hallowell). striped whipsnake.
109a. *Masticophis taeniatus taeniatus* (Hallowell). desert striped whipsnake C
110. *Phyllorhynchus decurtatus* (Cope). spotted leaf-nosed snake.
110a. *Phyllorhynchus decurtatus perkinsi* Klauber. western leaf-nosed snake C
111. *Pituophis melanoleucus* (Daudin). gopher snake.
111a. *Pituophis melanoleucus affinis* (Hallowell). Sonora gopher snake .... r
111b. *Pituophis melanoleucus annectens* Baird and Girard. San Diego gopher snake C
111c. *Pituophis melanoleucus catenifer* (Blainville). Pacific gopher snake.......... C
111d. *Pituophis melanoleucus deserticola* Stejneger. Great Basin gopher snake C
111e. *Pituophis melanoleucus pumilis* Klauber. Santa Cruz Island gopher snake.......... S,FP
112. *Rhinocheilus lecontei* Baird and Girard. long-nosed snake.
112a. *Rhinocheilus lecontei lecontei* Baird and Girard. western long-nosed snake C
113. *Salvadora hexalepis* (Cope). western patch-nosed snake.
113a. *Salvadora hexalepis hexalepis* (Cope). desert patch-nosed snake.......... r
113b. *Salvadora hexalepis mojavensis* Bogert. Mojave patch-nosed snake.......... C
113c. *Salvadora hexalepis virgultea* Bogert. coast patch-nosed snake C
114. *Sonora semiannulata* Baird and Girard. western ground snake.[22]

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[20] Fitch, Brown, and Parker (1981) consider this snake to be a full species.
[21] Taxonomy after Blaney (1977).
[22] Frost and Van Deventer (1979) prefer to consider *Sonora semiannulata* as a highly variable species with no subspecies.

114a. *Sonora semiannulata isozona* (Cope). Great Basin ground snake C
114b. *Sonora semiannualata linearis* Stickel. vermilion-lined ground snake C
115. *Tantilla hobartsmithi* Taylor [23]. southwestern black-headed snake [24] .... r
116. *Tantilla planiceps* (Blainville) [23]. western black-headed snake C
117. *Thamnophis couchi* (Kennicott). western aquatic garter snake [25]
117a. *Thamnophis couchi couchi* (Kennicott). Sierra garter snake C
117b. *Thamnophis couchi aquaticus* Fox. aquatic garter snake C
117c. *Thamnophis couchi atratus* (Kennicott, *in* Cooper). Santa Cruz garter snake C
117d. *Thamnophis couchi gigas* Fitch. giant garter snake .... SR
117e. *Thamnophis couchi hammondi* (Kennicott). two-striped garter snake .... S
117f. *Thamnophis couchi hydrophilus* [26] Fitch. Oregon garter snake C
118. *Thamnophis elegans* (Baird and Girard). western terrestrial garter snake.
118a. *Thamnophis elegans elegans* (Baird and Girard). mountain garter snake C
118b. *Thamnophis elegans biscutatus* (Cope). Klamath garter snake [27] .... r
118c. *Thamnophis elegans terrestris* Fox. coast garter snake C
118d. *Thamnophis elegans vagrans* (Baird and Girard). wandering garter snake .... r
119. *Thamnophis marcianus* (Baird and Girard). checkered garter snake.
119a. *Thamnophis marcianus marcianus* (Baird and Girard). checkered garter snake. .... r
120. *Thamnophis ordinoides* (Baird and Girard). northwestern garter snake .... r
121. *Thamnophis sirtalis* (Linnaeus). common garter snake.
121a. *Thamnophis sirtalis fitchi* Fox. valley garter snake C
121b. *Thamnophis sirtalis infernalis* (Blainville). California red-sided garter snake C
121c. *Thamnophis sirtalis tetrataenia* (Cope, *in* Yarrow). San Francisco garter snake .. SE,FE
122. *Trimorphodon biscutatus* (Duméril, Bibron, and Duméril). lyre snake.
122a. *Trimorphodon biscutatus lambda* Cope. Sonoran lyre snake C
122b. *Trimorphodon biscutatus vandenberghi* Klauber. California lyre snake .... S

Family HYDROPHIDAE—Sea Snakes [28]

123. *Pelamis platurus* (Linneaus). yellow-bellied sea snake 0 .... r [29]

Family VIPERIDAE—Vipers.

124. *Crotalus atrox* Baird and Girard. western diamondback rattlesnake .... r
125. *Crotalus cerastes* Hallowell. sidewinder.
125a. *Crotalus cerastes cerastes* Hallowell. Mojave Desert sidewinder C
125b. *Crotalus cerastes laterorepens* Klauber. Colorado Desert sidewinder C
126. *Crotalus mitchelli* (Cope). speckled rattlesnake.
126a. *Crotalus mitchelli pyrrhus* (Cope). southwestern speckled rattlesnake C
126b. *Crotalus mitchelli stephensi* Klauber. Panamint rattlesnake C
127. *Crotalus ruber* Cope. red diamond rattlesnake.
127a. *Crotalus ruber ruber* Cope. red diamond rattlesnake .... r
128. *Crotalus scutulatus* (Kennicott). Mojave rattlesnake
128a. *Crotalus scutulatus scutulatus* (Kennicott). Mojave rattlensnake C
129. *Crotalus viridis* Rafinesque. western rattlesnake.
129a. *Crotalus viridis helleri* Meek. southern Pacific rattlesnake C
129b. *Crotalus viridis lutosus* Klauber. Great Basin rattlesnake C
129c. *Crotalus viridis oreganus* Holbrook. northern Pacific rattlesnake C

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[23] Taxonomy after Cole and Hardy (1981).

[24] Common name as proposed to the SSAR Committee on Common and Scientific Names. Taylor (1937) did not state a common name in his original description and *Tantilla hobartsmithi* synonymizes all of *T. utahensis* and part of *T. atriceps.*

[25] The taxonomy of this species is currenty under review (G. Stewart, Professor of Zoology, Calif. St. Univ., Pomona, pers. commun.).

[26] The correct spelling of this subspecies is apparently *T. c. hydrophilus,* not *T. c. hydrophila* (Rossman 1979).

[27] The validity of this subspecies is presently disputed (Rossman 1979, Fitch 1980).

[28] Classification after Pickwell and Culotta (1980).

[29] Strays occasionally are found in California waters (Kropach 1975, Pickwell and Culotta 1980). Such occurrences are probably due to storm enhanced currents which sweep the snakes north of their breeding range off the southern Baja California coast.

SUPPLEMENTARY LISTS
Native Species Extinct in California:
Order Testudines—Turtles.
Family KINOSTERNIDAE—Musk and Mud Turtles.

1. *Kinosternon sonoriense* (Le Conte). Sonoran mud turtle.†.
   1a. *Kinosternon sonoriense sonoriense* (Le Conte). Sonoran mud turtle [30] †.
   Never abundant in the State. Positively known only from old records listed by Van Denburgh (1922) at Palo Verde and Yuma Indian Reservation, Imperial County, along the lower Colorado River (Stebbins 1954, 1966, 1972). Dill (1944) reported seeing *K. sonoriense* in the Colorado River in 1942, but did not obtain any specimens. The species now appears to be extinct in California even though it is protected by State law.

Distributionally or Taxonomically Invalid Species:
Order Testudines—Turtles.
Family KINOSTERNIDAE—Musk and Mud Turtles.

1. *Kinosternon flavescens* (Agassiz). yellow mud turtle.
   1a. *Kinosternon flavescens arizonense* Gilmore. Arizona mud turtle [31].
   Thought by Stebbins (1966, 1972) to be expected in California because of the subspecies' close proximity in Yuma, Arizona. This is no longer considered to be true (Seidel 1978). The species is listed as protected in California (California Fish and Game Code 1980).

Family TRIONYCHIDAE—Softshell Turtles.

2. *Aspidonectes californiana* Rivers. "Sacramento softshell".*
   Described by Rivers (1889) from a specimen obtained by three fishermen from the Sacramento River. Van Denburgh (1917) concluded that this turtle was an escaped specimen from the San Francisco Fish Markets and originated from China. Pope (1935) concurred with Van Denburgh and declared the specimen to be *Trionyx sinensis* Weigmann, a softshell turtle native only to eastern Asia. Webb (1975) has since considered this softshell to be *T. steindachneri* Siebenrock, a species also native to Asia.[32] No other specimens have been recorded from the wild in California. *Aspidonectes californiana* is not a valid taxonomic entity.

Established Exotic Species:
Order Anura—Toads and Frogs.
Family PIPIDAE—Tongueless Frogs.

1. *Xenopus laevis* Daudin. African clawed frog *.
   Several species of the genus *Xenopus* were once widely imported into the state for use in pregnancy tests and also for the pet trade (McCoid and Fritts 1980). Escaped or released individuals have developed large breeding populations in Los Angeles, Orange, Riverside, and San Diego counties (St. Amant, Hoover, and Stewart 1973; McCoid 1976; McCoid and Fritts 1980). The genetic make-up of some of these populations is not known and may be composed of more than one species (J. St. Amant, Fisheries Biologist, Calif. Dept. of Fish and Game, pers. commun.). The population in the Santa Clara River Basin at Vasquez Rocks, Los Angeles County, has been greatly reduced to prevent the spread of the species into adjacent drainages further north (St. Amant 1975, Zacuto 1975, Bell 1978, Branning 1979). To date, there have been no records of any clawed frogs north of Los Angeles County with the exception of the specimen mentioned by McCoid and Fritts (1980) from Yolo County.

Family RANIDAE—True Frogs.

2. *Rana catesbeiana* Shaw. bullfrog *.
   Uncertainty exists over the date of the first introduction of this species into California (Jennings, in prep.). Storer (1922, 1925) states that the bullfrog was introduced several times in California between 1914 and 1920 from stock obtained in Hawaii, Illinois, Louisiana, Missouri, and else-

[30] Taxonomy after Iverson (1981).
[31] Taxonomy after Iverson (1979).
[32] Both of these turtles have been introduced into the Hawaiian Islands and are now established locally in several areas (Ernst and Barbour 1972; McKeown and Webb 1982).

where. It was later spread rapidly throughout the state by well-meaning naturalists and farmers and is now established in most areas except high mountains and deserts (Stebbins 1972, Bury and Luckenbach 1976). An important game animal (Treanor and Nicola 1972, Treanor 1975), it may have contributed to the decline of two native frog species in the Central Valley (Moyle 1973).

3. *Rana pipiens* Schreber. northern leopard frog *.

Some uncertaintly exists over the native range and genetic make-up of *R. pipiens* populations found in California. The frog is reportedly native east of the Sierra Nevada Crest and along Colorado River (Bury and Luckenbach 1976) and was probably introduced into the Lake Tahoe Basin and perhaps Modoc and Inyo counties after the turn of the century (Bryant 1917, Storer 1925, Bury and Luckenbach 1976). It is known to have been introduced into El Dorado, Imperial, Kern, Los Angeles, Orange, San Francisco, Tehama, and Tulare counties (Storer 1925; Banta and Morafka 1966; Stebbins 1966, 1972; Dixon 1967; Moyle 1973; Bury and Luckenbach 1976). The status of these introduced populations is not clear at this time although several appear well established. The leopard frogs found in the Lake Tahoe Basin and northeastern California are definitely *R. pipiens* (Pace 1974), while leopard frogs found elsewhere in the State probably represent a mixture of stocks. Affinities of the Colorado River populations are currently under study (Jennings, in prep.).

Order Testudines—Turtles.

Family CHELYDRIDAE—Snapping Turtles.

4. *Chelydra serpentina* (Linnaeus). snapping turtle *.

4a. *Chelydra serpentina serpentina* (Linnaeus). common snapping turtle *.

Reported as introduced into California (Pritchard 1979) and established in the vicinity of Fresno, Fresno County (Stebbins 1972). Specimens have also been taken in San Diego River, San Diego County (L. Bottroff, Fisheries Biologist, Calif. Dept. Fish and Game, pers. commun.), Long Beach, Los Angeles County (L. Swantz, Orange County Chap. of the Calif. Turtle and Tortoise Soc., pers. commun.), Walnut Creek, Contra Costa County, Corte Madera, Marin County, and Colorado River (Bury and Luckenbach 1976). The origin of these populations is probably escaped juveniles once kept as pets. The importation of snapping turtles into California is now prohibited (California Fish and Game Code 1980).

Family EMYDIDAE—Box and Water Turtles.

5. *Chrysemys scripta* (Schoepff). slider *.

5a. *Chrysemys scripta elegans* (Wied). red-eared slider *.

Young of this turtle were once widely imported by the pet trade. Although their sale has been greatly curtailed, the species has become well established in many areas of San Diego County. Principal locations include: Upper and Lower Otay, Miramar, El Capitan, Sweetwater, and Poway reservoirs and San Diego River (L. Bottroff, pers. commun.). The species is also established in several ponds near Long Beach, Los Angeles County (L. Swantz, pers. commun.) and may be reproducing in the Sacramento-San Joaquin drainage area.

Family TRIONYCHIDAE—Softshell Turtles.

6. *Trionyx spiniferus* Le Sueur. spiny softshell *.

6a. *Trionyx spiniferus emoryi* (Agassiz). Texas spiny softshell *.

Probably introduced into the lower Colorado River Basin from New Mexico around 1900 (Dill 1944, Miller 1946, Stebbins 1972). Now strongly established in Colorado River from the International Boundary upstream to Nevada and westward in Imperial County to Salton Sea. Specimens have also been taken in San Pablo Reservoir, Contra Costa County, and San Gabriel River, Los Angeles County (Bury and Luckenbach 1976). The species has recently become established in Lower Otay Reservoir and San Diego River, San Diego County, from illegally released specimens originating from Colorado River (L. Bottroff, pers. commun.). The turtle is currently classified as a sport animal (California Fish and Game Commission 1981).

Exotic Species Unsuccessfully Introduced Or Of Questionable Status:

Order Caudata—Salamanders.

Family CRYPTOBRANCHIDAE—Giant Salamanders and Hellbenders.

1. *Andrias japonicus* (Temminck). Japanese giant salamander *.

Reported by Croker (1942) "to be found in the wild state in the Sacramento Valley." This statement is apparently based upon a single specimen collected from the Sacramento River. The source of the salamander was a cargo vessel from Japan (W. Houck, Professor of Zoology, Humboldt St. Univ., pers. commun.). Other specimens found include one reported by Myers (1951) and another listed by Bury and Luckenbach (1976). Both appear to be introductions and it is unlikely that the species is established in the State.

Family AMBYSTOMATIDAE—Mole Salamanders and Relatives.

2. *Ambystoma tigrinum* (Green). tiger salamander.
   2a. *Ambystoma tigrinum diaboli* Dunn. gray tiger salamander *.
   2b. *Ambystoma tigrinum mavortium* Baird. barred tiger salamander. *
   2c. *Ambystoma tigrinum melanosticum* (Baird). blotched tiger salamander *.
   2d. *Ambystoma tigrinum nebulosum* Hallowell. Arizona tiger salamander *.

   Larvae of these subspecies have been widely introduced into reservoirs in the Central Valley, southern California, Colorado River Basin, and the Salton Sea from various sources for use as live fish bait. Metamorphosed adults have been observed at China Lake, Kern County, Twenty Nine Palms, San Bernardino County, and Santa Ana River, Orange and Riverside counties (Bury and Luckenbach 1976, B. Brattstrom, Professor of Zoology, Calif. St. Univ., Fullerton, pers. commun.). Reproducing populations are not yet known, but the potential is there. Such activities have increased the distribution of this salamander in Arizona (Stebbins 1966, Collins 1981). The population of salamanders at Grass Lake, Siskiyou County, may represent a native relict population and not an introduction (Mullen and Stebbins 1978).
3. *Notophthalmus viridescens* (Rafinesque). eastern newt *.
   3a. *Notophthalmus viridescens viridescens* (Rafinesque). red-spotted newt *.
   3b. *Notophthalmus viridescens lousianensis* (Wotterstorff). central newt *.

   Adults of these subspecies are commonly sold in pet stores and the larvae have been sold as fish bait in several localities. Many have escaped or have been intentionally released into the wild, but there are no known naturally reproducing populations in the State.

Order Anura—Toads and Frogs.
Family BUFONIDAE—True Toads.

4. *Bufo marinus* (Linnaeus). giant toad *.

   One specimen of this toad was found living in the wild in Ventura County (J. St. Amant, pers. commun.). Intensive searches in the surrounding area revealed no other specimens. The importation of *B. marinus* into California is prohibited (California Administrative Code 1980).

Order Crocodylia—Crocodilians.
Family CROCODYLIDAE—Alligators, Caimans, True Crocodiles, and False Gavials [33].

5. *Alligator mississippiensis* (Daudin). American alligator *.

   Escaped specimens which were illegally imported from the southeastern United States have been reported in the Sacramento-San Joaquin Delta area. Only one authentic case of a 1.5 m specimen of *A. mississippiensis* found living in the wild in the Delta is known. All other sightings have turned out to be *Caiman crocodilus* (see below). Hock (1954) reported a 3 m specimen of *A. mississippiensis* taken in Colorado River that was apparently dumped into the river by a traveling carnival.
6. *Caiman crocodilus* (Linnaeus). spectacled caiman *.

   Several subspecies of this crocodilian are widely sold in pet stores. Escaped or liberated specimens have been found living in the wild in the Sacramento—San Joaquin Delta area and in southern California (Bury and Luckenbach 1976). The crocodilian recently sighted in the Feather River, Sutter County, may be a spectacled caiman (W. DeJesus, Herpetologist, Sacramento City Zoo, pers. commun.). There are no known reproducing populations. At present, because of the uncertainty to which family caimans are classified under, spectacled caimans are considered exempt from the laws that prohibit the importation of crocodilians into California (N.

[33] Classification of the families of the order Crocodylia remains unresolved. Conant (1975) places alligators and caimans in a separate family—ALLIGATORIDAE, while Goin et al. (1978) places them in a subfamily under the family CROCODYLIDAE. For the purposes of this paper, the latter classification is utilized.

Dollahite, Chief, Wildlife Protection Branch, Calif. Dept. Fish and Game, pers. commun.).

Order Testudines—Turtles.
Family CHELYDRIADE—Snapping Turtles.

7. *Macroclemys temmincki* (Troost). alligator snapping turtle *.

Murphey (1969) recorded a specimen of this species from Sacramento County. The turtle was apparently an escaped pet. No other specimens have been found.

Family EMYDIDAE—Box and Water Turtles.

8. *Chrysemys concinna* (Le Conte). river cooter * [34].
   8a. *Chrysemys concinna hieroglyphica* (Holbrook). hieroglyphic river cooter *.
9. *Chrysemys floridana* (Le Conte). cooter *.
   9a. *Chrysemys floridana hoyi* (Agassiz). Missouri cooter *.
10. *Chrysemys scripta* (Schoepff). slider *.
    10a. *Chrysemys scripta scripta* (Schoepff). yellow-bellied slider *.
    10b. *Chrysemys scripta callirostris* (Gray). peacock slider *.
    10c. *Chrysemys scripta elegans* (Wied). red-eared slider *.
11. *Graptemys geographica* (Le Sueur). map turtle *.
12. *Graptemys kohni* (Baur). Mississippi map turtle *.
13. *Graptemys pseudogeographica* (Gray). false map turtle *.
    13a. *Graptemys pseudogeographica ouachitensis* Cagle. Quachita map turtle *.

All of the above turtles were once widely imported as young for the pet trade. Many escaped or were intentionally released into the wild, resulting in sporadic sightings in various areas of the State, principally the Central Valley and southern California. None have established known reproducing populations except for *Chrysemys scripta elegans* (see *C. s. elegans* in the list of Established Exotic Species). Recently, several adult cooters and map turtles were trapped in a pond near Long Beach, Los Angeles County (L. Swantz, pers. commun.) and adult cooters, mainly *C. f. hoyi*, have also been taken in San Diego County (L. Bottroff, pers. commun.). The lack of young individuals at both of these locations, however, tends to support the view that they are not reproducing. Two specimens of *C. s. callirostris,* native to South America, taken in Lower Otay Reservoir, San Diego County, were apparently released pets (L. Bottroff, pers. commun.). The sale of young turtles in California has been effectively curtailed by the Federal Government (U.S. Public Health Service 1972).

14. *Chrysemys picta* (Schneider). painted turtle *.
    14a. *Chrysemys picta picta* (Schneider). eastern painted turtle *.
    14b. *Chrysemys picta belli* (Gray). western painted turtle *.
    14c. *Chrysemys picta dorsalis* Agassiz. southern painted turtle *.
    14d. *Chrysemys picta marginata* Agassiz. midland painted turtle *.

Chrysemys picta belli was once thought to be native to California based upon adult specimens observed at the San Francisco Fish Markets. The turtles probably originated from Oregon or Washington (Van Denburgh 1922). Young and adults of various subspecies of *C. picta* reported in recent years from the San Francisco area (Banta and Morafka 1966) and Los Angeles (Bury and Luckenbach 1976) were escaped or intentionally released pets. Observations of a large female *C. picta* and several young at Kaiser Meadow, Siskiyou County, are currently under investigation (R. Stebbins, Emeritus Professor of Zoology, Univ. of Calif., Berkeley, pers. commun.).

15. *Malaclemys terrapin* (Schoepff). diamondback terrapin *.
    15a. *Malaclemys terrapin terrapin* (Schoepff). northern diamondback terrapin *.
    15b. *Malaclemys terrapin centrata* (Latreille). Carolina diamondback terrapin *.

One hundred and twenty of these turtles were imported from the East Coast and planted in San Francisco Bay in 1896 (Vogelsang and Gould 1900). Several other attempts have been made to establish this turtle in San Francisco Bay since then (most notably Taft (1944) with 562 individuals from North Carolina), but all have been unsuccessful (Brown 1971). The species is still occasionally encountered in the pet trade, probably the source of the turtles reported by Banta and Morafka (1966) in Stow Lake, San Francisco County. *Malaclemys terrapin* is still

[34] *Chrysemys concinna* has recently been lumped under *C. floridana* (Pritchard 1967), a move not accepted by all authorities (Ernst and Barbour 1972). The old taxonomy is utilized in this list so as not to obscure temporal data, a concern voiced by Holman (1977).

protected by State law in California (California Administrative Code 1980).

16. *Terrapene carolina* (Linnaeus). eastern box turtle *.
    16a. *Terrapene carolina carolina* (Linnaeus). eastern box turtle *.
    16b. *Terrapene carolina triunguis* (Agassiz). three-toed box turtle *.
17. *Terrapene ornata* (Agassiz). western box turtle *.
    17a. *Terrapene ornata ornata* (Agassiz). ornate box turtle *.
    17b. *Terrapene ornata luteola* Smith and Ramsey. desert box turtle *.

Large numbers of these turtles (mainly adults) have been imported into the State for the pet trade. Escaped or released individuals have been encountered in the wild in Walnut Creek, Contra Costa County (Bury and Luckenbach 1976), the Los Angeles region (Dixon 1967), San Diego County (L. Bottroff, pers. commun.), and the Central Valley. Up to 50 specimens yearly were recovered from fields and residential areas of Walnut Creek (Bury and Luckenbach 1976). In spite of the large numbers of individuals in localized areas, there are no known naturally reproducing populations.

Family TESTUDINIDAE—True Land Tortoises.

18. *Geochelone carbonaria* (Spix). red-legged tortoise *.

Six specimens of this tortoise were found during 1972 in fields and yards near Walnut Creek, Contra Costa County (Bury and Luckenbach 1976). They were escaped or released pets.

19. *Gopherus berlandieri* (Agassiz). Texas tortoise*.

Literally thousands of Texas tortoises have been imported into California in recent years for the pet trade (Brame and Peerson 1969). Escaped or intentionally released specimens have been encountered in the wild in southern California, the Central Valley, and the Mojave Desert. The release of *G. berlandieri* in desert areas threatens the genetic integrity of native *G. agassizi* populations (Stebbins 1972).

Order Squamata—Lizards and Snakes.
Family GEKKONIDAE—Geckos.

20. *Gehyra mutilata* (Wiegmann). stump-toed gecko*.

Shaw (1946) reported a single specimen of *"Peropus mutilatus"* [= *Gehyra mutilata*] on the San Diego Zoo grounds, San Diego County. The lizard was apparently an escapee from the San Diego Zoo Reptile House where four species of Hawaiian geckos were regularly released by Cyrus B. Perkins to feed the lizard-eating snakes (Shaw 1946). No further specimens have been sighted or captured. James E. Berrian (Curatorial Assistant, Dept. of Herpetology, San Diego Nat. Hist. Mus.) reports that there are no *Gehyra* in the Museums' collection and further that Dr. James Bacon (General Curator of Herpetology, San Diego Zoo) informed him that the winters in the area are probably too cold for the species to survive. However, the possibility of geckos still living in buildings should not be ruled as out of the question. A careful search should be made of likely Zoo structures to determine if any geckos are present.

Family AGAMIDAE—Agamid Lizards.

21. *Agama* sp. Daudin. African rock lizard*.
22. *Zonurus* sp. Merrem. African rock lizard*.

Members of these Old World lizard genera are sold in pet stores in the State. Specimens have been found in the wild in the Los Angeles area (Bury and Luckenbach 1976). There are no reproducing populations.

Family IGUANIDAE—Iguanid Lizards.

23. *Anolis carolinensis* (Voigt). green anole*.
    23a. *Anolis carolinensis carolinensis* (Voigt). green anole*.

Ronald Marlow of the Museum of Vertebrate Zoology, Univ. of Calif., Berkeley (now at the Univ. of Chicago), reported in Bury and Luckenbach (1976) that this subspecies had established a breeding population in Ontario, San Bernardino County. The population is apparently now extinct (G. Stewart, pers. commun.). Individuals are still occasionally found in residential areas of San Francisco County (Banta and Morafka 1966), and southern California (LACM 131565). All are escaped or intentionally released pets. The species is widely sold in pet stores and at carnivals throughout the State.

24. *Ctenosaura hemilopha* (Cope). spiny-tailed iguana*.
    24a. *Ctenosaura hemilopha macrolopha* Smith. Long crested spiny-tailed iguana * [35]

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[35] Taxonomy after Smith (1972).

Reported by Stebbins (1972) in Fullerton, Orange County. Lizards were originally brought from Sonora, Mexico, to California State University, Fullerton, for use in an experiment. A fire destroyed the building in which the lizards were housed and many escaped. Intensive collecting by students and school personnel recaptured all but a few individuals. These specimens survived through three or four winters, after which the population disappeared (B. Brattstrom, pers. commun.).

25. *Iguana iguana* (Linnaeus). green iguana*.

This species is imported into the United States in large numbers for the pet trade (Busack 1974). Many have escaped or have been intentionally released into the wild. Specimens have been taken in the San Francisco area (Banta and Morafka 1966) and in southern California. There are no known naturally reproducing populations.

26. *Phrynosoma cornutum* (Harlan). Texas horned lizard*.

Escaped or intentionally released pets have been reported in the wild in southern California and in residential areas of San Francisco (Banta and Morafka 1966). No known naturally reproducing populations. This reptile is widely sold in pet stores throughout the State.

27. *Sceloporus cyanogenys* Cope. blue spiny lizard*.

A single specimen of this species was collected in 1970 at the base of the Palms to Pines Highway, Riverside County, and deposited in the Los Angeles County Museum of Natural History (LACM 65240) (Stebbins 1972, Bury and Luckenbach 1976). The specimen was apparently an escapee or released captive from a scientific project or personal collection. No other specimens have been collected (B. Brattstrom, pers. commun.).

28. *Sceloporus jarrovi* Cope. Yarrow's spiny lizard*.

28a. *Sceloporus jarrovi jarrovi* Cope. Yarrow's spiny lizard*.

A group of these lizards (many of them toe clipped) were released on a vacant lot in Fullerton, Orange County, about a decade ago. This population was extirpated 6 months after the release when a shopping center was built on the site (B. Brattstrom, pers. commun.).

29. *Sceloporus poinsetti* Baird and Girard. crevice spiny lizard*.

29a. *Sceloporus poinsetti poinsetti* Baird and Girard. crevice spiny lizard*.

A single specimen was collected from a residential neighborhood in Northridge, Los Angeles County, and presented to the Los Angeles County Museum of Natural HIstory during 1980 (LACM 131566). It was an escaped or intentionally released pet.

Family SCINCIDAE—Skinks.

30. *Eumeces obsoletus* (Baird and Girard). Great Plains skink*.

Bury and Luckenbach (1976) reported a specimen in the Los Angeles area. It apparently was an escaped pet.

31. *Tiliqua* sp. Gray. blue-tongued skink*.

Reported by Myers (1951) on the outskirts of San Mateo, San Mateo County. The skinks apparently were escaped pets.

Family CORDYLIDAE—Girdle-tailed Lizards.

32. *Cordylus giganteus* Smith. sungazer*.

This South African live-bearer is the largest member of the girdle-tailed lizard group. Because of its ferocious appearance (the whole body except for the belly is covered with large heavy-keeled scales), large size, and ability to thrive in captivity, the species is sometimes seen in pet stores. One such lizard (apparently a released pet) was captured in Arroyo Seco Canyon, Angeles National Forest, Los Angeles County, and brought to the Eaton Canyon Nature Center in the late 1970's (R. Jillson, Whittier Narrows Nature Center, pers. commun.). The specimen was taken to the Los Angeles Zoo where it was identified to species (H. Fisher, Curator of Herpetology, L.A. Zoo, pers. commun.). All attempts to breed this specimen in captivity were unsuccessful and it was returned to the Nature Center where it died in 1981. It has since been preserved and is now on public display (P. Sullivan, Eaton Canyon Nature Center, pers. commun.). No other specimens have been reported.

Family TEIIDAE—Teiid Lizards.

33. *Tupinambis* sp. (Linnaeus). tegu lizard*.

Lizards of this South American genus are widely sold in pet stores throughout the State. Their large size and ability to thrive on chicken eggs, make them a popular pet item. Specimens have been encountered in residential areas of southern California (Bury and Luckenbach 1976) and

San Francisco (Banta and Morafka 1966). All are escaped pets. There are no reproducing populations in the wild.

Family HELODERMATIDAE—Venomous Lizards.

34. *Heloderma horridum* (Wiegmann). Mexican beaded lizard*.
Two escaped pets were discovered in the residential areas of Walnut Creek, Contra Costa County (Bury and Luckenbach 1976). No other specimens of this venemous lizard have been reported.

Family VARANIDAE—Monitor Lizards.

35. *Varanus exanthematicus* (Daudin). savannah monitor lizard*.
Sean Barry of the Department of Zoology, Univ. of Calif., Davis, reported in Bury and Luckenbach (1976) a specimen of this lizard found in Pasadena, Los Angeles County. It was an escaped pet.

Family BOIIDAE—Boas and Pythons.

36. *Boa canina* Linnaeus. emerald tree boa*.
This South American species was occasionally observed in California warehouses in the days before banana shipments were routinely gassed on entry into the U.S. One such specimen was taken in Stockton and deposited in the California Academy of Sciences (CAS 8375) (Bury and Luckenbach 1976). The species has not been seen in the State for many years.
37. *Boa constrictor* Linnaeus. boa constrictor*.
38. *Corallus enydris* (Linnaeus). tree boa*.
39. *Python molurus* Linnaeus. Indian python*.
40. *Python reticulatus* Schneider. reticulated python*.
The above four species of snakes are frequently sold as pets and there are many reports of escaped specimens in and near residential areas (Bury and Luckenbach 1976). There are no known wild reproducing populations. Many of the specimens found in the wild often die during winter because of low temperatures (W. DeJesus, pers. commun.).

Family COLUBRIDAE—Colubrids.

41. *Drymarchon corais* (Daudin). Indigo snake*.
42. *Lampropeltis getulus* (Linnaeus). common kingsnake.
42a. *Lampropeltis getulus floridana* Blanchard. Florida kingsnake*.
43. *Nerodia fasciata* (Linnaeus). southern water snake * [36].
43a. *Nerodia fasciata fasciata* (Linnaeus). banded water snake*.
These three snakes, all native to the eastern United States, were reported by Bury and Luckenbach (1976) in the Los Angeles city area. All were escaped pets. There are no known naturally reproducing populations.
44. *Nerodia sipedon* (Linnaeus). common water snake*.
44a. *Nerodia sipedon sipedon* (Linnaeus). northern water snake*.
One young specimen was collected from El Dorado Park, Los Angeles County, and given to the Los Angeles County Museum of Natural History in 1974 (LACM 109564). The snake is probably the result of a released pregnant female. No other specimens have been found.
45. *Leptodeira annulata* (Linnaeus). cat-eyed snake*.
Repeatedly reported from San Francisco warehouses before the practice of routinely gassing banana shipments (Banta and Morafka 1966). The species has not been seen in California for many years.

Family ELAPIDAE—Cobras and Their Allies

46. *Naja haje* (Linnaeus). Egyptian cobra*.
Reported by Sean Barry as collected in Pasadena, Los Angeles County (Bury and Luckenbach 1976). No other specimens have been recorded. The discovery of this highly venomous snake in a heavily populated residential area points out the problem of the public illegally keeping dangerous exotic reptiles in private collections.

[36] Although the substitution of *Nerodia* for *Natrix* has not been utilized by many workers, its acceptance by the Catalogue of American Amphibians and Reptiles predestines its use in this check list.

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NORTHERN OCCURRENCES OF THE SEA SNAKE, *PELAMIS PLATURUS,* IN THE EASTERN PACIFIC, WITH A RECORD OF PREDATION ON THE SPECIES [1]

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Four specimens of the yellow-bellied sea snake, *Pelamis platurus,* from southern California and the outer coast of Baja California represent the northernmost records of this species in the eastern Pacific. Three of the snakes were probably carried northward by a warm countercurrent (Davidson Current) along the coast of Baja California and southern California during the warm periods of 1972–73 and 1976–77. One of the individuals had been ingested by a puffer *Sphoeroides* cf. *annulatus;* this represents the second reported instance of predation on the species in nature.

INTRODUCTION

The yellow-bellied sea snake, *Pelamis platurus* (Linnaeus), is the most widely distributed species of snake (Pickwell 1972, Pickwell and Culotta 1980). Although breeding populations seem restriced to tropical latitudes (Dunson and Ehlert 1971; Graham, Rubinoff, and Hecht 1971; Hecht, Kropach, and Hecht 1974), the species occurs widely in both the Pacific and Indian oceans, and is the most pelagic of the sea snakes. Individuals have been found as far north as Possiet Bay (lat 42°39'N; Strauch 1873; = Zaliv Pos'yeta, U.S.S.R.) in the western Pacific, but northern records in the eastern Pacific remain poorly known.

We here document the occurrence of a live individual of *P. platurus* on the coast of southern California and three specimens from the outer coast of Baja California, Mexico, one of which appears to represent the second record of predation on the species in nature.

LOCATIONS

San Clemente

On 23 November 1972, a live adult *P. platurus* was discovered stranded on the beach at San Clemente, Orange Co., California (lat 33°25'N). Andrew J. Reich, a lifeguard, took custody of the snake and placed it in a salt water aquarium where it survived for 12 hours. The specimen was frozen shortly after death and borrowed 6 days later by Pickwell for examination and preservation. It was returned to the collector, who ultimately deposited it in the herpetological

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[2] Mr. Fitch passed away on 30 September 1982.

collections of the Natural History Museum of Los Angeles County (LACM 109657). This is the first sea snake collected in the continental United States.

The specimen is a female with a snout-vent length of 660 mm, tail length of 79 mm, tricolor pattern, dark venter, narrow lateral yellow stripe, eggs present in oviduct, substantial fat deposits, and no ectoparasites.

Mean sea surface temperature at San Clemente for 23 November 1972 was 16.1°C, and for the month of November 16.5°C, with a range of daily means of 15.6 to 17.8°C.

Bahia Blanca

Ivan Goyette, a commercial fisherman from the boat *Margot,* presented a dead *P. platurus* to the California Department of Fish and Game at Long Beach on 21 November 1977. The snake was reported to have been regurgitated by a puffer, *Sphoeroides* sp., that was gill-netted in the vicinity of Bahia Blanca, Baja California Norte, Mexico (lat 29°02′N). The 11.5 cm stretch gill net was set at a depth of 46–64 m at 5–8 km offshore, where the fisherman was attempting to catch white seabass, *Atractoscion nobilis.* Unfortunately, the fish was not retained, but from the fisherman's careful description it was either *S. annulatus,* the bullseye puffer or *S. lobatus,* the longnose puffer (Fitch 1973), probably the former.

When the snake was brought in it appeared to be quite fresh, but to have been chewed, and the head and neck were missing. The specimen (LACM 127002) is a male with a body length (minus head and neck) of 470 mm, a tail length of 73 mm and a bicolor pattern. We estimate the total length of the specimen to have been 650–700 mm.

Bahia Magdalena

A specimen of *P. platurus* was collected by Paul Bartsch at Isla Santa Margarita on 19 March 1911. This island, centered at lat 24°26′N forms the southern barrier of Bahia Magdalena, Baja California Sur, Mexico. The snake was collected on the 1911 *Albatross* Expedition to Baja California and the Gulf of California and appears to have been overlooked in the published results of the expedition (Townsend 1916, Schmidt 1922) and most of the herpetological literature for Baja California. The specimen was cited by Smith (1943), but was incorrectly listed as being from the Tres Marias Islands (Nayarit). However, the Bahia Magdalena location was shown on a distribution map of *Pelamis* by Graham *et al.* (1971). The specimen is in the collection of the National Museum of Natural History (USNM 51078).

Another *P. platurus* was collected in the area of Bahia Magdalena on 17 January 1977 by John Kipping. The snake was dead when found on Isla Magdalena, 3 miles south of Boca de Soledad (lat 25°15′N), but appeared to be fresh with no obvious signs of decay (J. Kipping, pers. Commun.). This specimen is deposited at the California Academy of Sciences (CAS 143253).

DISCUSSION

Distribution

The pelagic adaptations of *P. platurus* (such as the ability to feed at the sea surface) permit individuals to survive ocean current transport over great distances (Pickwell 1972), but the thermal tolerances of the species appear to limit breeding populations to between the 18–20°C isotherms (Dunson and Ehlert 1971; Graham *et al.* 1971; Hecht *et al.* 1974).

Along the Pacific coast of North America, the northernmost locality at which a breeding population of *P. platurus* has been found is Bahia Banderas, Jalisco, Mexico (lat 20°38′N; Pickwell pers. observ.). Occasionally the species may be abundant farther north. Zweifel (1960) reported 13 individuals collected on 7 February 1920, about 24 km offshore between San Blas, Nayarit, and Mazatlan, Sinaloa, Mexico.

In the Gulf of California, individuals of *P. platurus* were reported before the turn of the century from Isla Espiritu Santo (Baja Calif. Sur; lat 24°30′N) by Mocquard (1899) and as far north as Guaymas (Sonora; lat 27°54′N) by Cope (1887). Shaw (1961) reported the species from Bahia de los Angeles (Baja Calif. Norte; 29°N), and individuals at least periodically range to near the head of the Gulf at San Felipe (Baja Calif. Norte; 31°N; LACM 104332) where one of us (Fitch) has seen live *P. platurus* on the beach on two separate occasions.

While these records do not seem indicative of a resident reproducing population of *Pelamis* in the Gulf of California, they do suggest that it may be a regular visitor there. Northward-moving surface currents prevail near the mouth of the Gulf from June through November and in some years may be greatly accentuated during the August–September period of strong chubasco winds. In summer and fall the surface temperatures (approximately 30°C) throughout the Gulf approximate those of the eastern tropical Pacific and in winter remain above 18–20°C to a latitude of about 25°N (Hubbs and Roden 1964, Robinson 1973).

Most of the outer coast of Baja California, on the other hand, is generally dominated by the cool southward-moving California Current system and by areas of cold-water upwelling. As the California Current moves southward it veers progressively westward and below about 25°N the outer coast of Baja California receives warm northward-moving equatorial water for at least part of the year. Thus, while tropical marine faunas dominate the Gulf of California, they usually extend to only Bahia Magdalena on the outer coast (Hubbs 1960; Walker 1960; Thomson *et al.* 1979).

North of 25°N latitude, the northward-moving current generally submerges to a depth greater than 200m. In certain years, however, it surfaces on the inshore side of the California Current during late fall and winter, particularly if north winds are weak. At times this warm counter-current, called the Davidson Current, may extend at the surface from Cabo San Lucas to Point Conception or beyond (Reid, Roden, and Wyllie 1958). It seems reasonable that individuals of *P. platurus* would be recruited occasionally into this northward-moving current system.

The movement into southern California waters of tropical marine species during the 1957–59 warm period was well documented by Radovich (1961). Similar northward incursions occurred in 1972–73 and 1976–77, the years when the sea snakes were found. A longnose puffer, *Sphoeroides lobatus,* was taken off California for the first time in December 1972 (Fitch 1973). At least five other southern species of fishes not normally found in California waters were taken in 1972–73 and six others in 1977 (Fitch and Schultz 1978, Fitch unpublished data). Unusually large numbers of the pelagic red crab, *Pleuroncodes planipes,* were observed off southern California in early February 1973 (Mais 1973) and great numbers washed ashore onto the beaches. Pelagic red crabs also were seen in southern California waters in large numbers in the 1957–59 warm period (Radovich 1961) but quantities seen in 1973 appeared greater (Mais 1973). Normally *Pleuroncodes* occurs in waters south of central Baja California. These occurrences further suggest an association between the northward incursion of warm southern water and the yellow-bellied sea snake records reported here.

Data from La Jolla (Scripps Pier; lat 32°52′N) indicate that ocean temperatures off southern California were above average during the years and months in which the two specimens of *P. platurus* were recently taken along the outer coast of Baja California. The mean annual surface temperature at La Jolla for 1917–1978 is 16.85°C (±0.07), with a range of annual means of 15.53–18.50°C. For 1976, 1977 and 1978 the means were 17.76, 17.25 and 17.42°C, respectively, each higher than any year since the 1957–59 warm period (Radovich 1961). The recent Bahia Magdalena specimen was taken in January 1977, for which the mean La Jolla temperature was 16.22°C, 2.18°C above the 62 year January mean. The Bahia Blanca specimen was taken in November 1977, with a La Jolla mean of 17.38°C, 1.12°C above average. Although these temperature data are from hundreds of kilometres north of the two Baja California localities, they suggest that stronger than usual Davidson Current conditions prevailed along the outer coast at the time.

The San Clemente specimen (23 November 1972) also was taken in a slightly warmer than average year. At La Jolla (70 km south of San Clemente) the November 1972 average temperature was 0.12°C above the 62-year average while the preceding 2 months were 0.19°C and 0.41°C above their respective means.

It is possible that one or more of these sea snakes could have been transported northward accidentally or intentionally by man (e.g., aboard fishing vessels). However, the timing of the three occurrences and their congruence with available information on temperature and the incursion of tropical species of fishes and invertebrates into southern California waters suggest natural oceanic dispersal.

Predation

Other sea snakes (family Hydrophiidae) are commonly fed upon by large fishes, particuarly sharks, and by sea eagles, but predation on *P. platurus* appears to be extremely rare (Heatwole 1975, Kropach 1975). Examination of the stomach contents of 457 fishes representing 25 species of potential predators from the Gulf of Panama, where *Pelamis* is seasonally abundant, yielded no remains of the sea snake; and birds frequenting slicks with *Pelamis* were not observed to attack or pick up the snakes (Kropach 1975). Two attacks on *Pelamis* by sailfish or small marlins were described by Paulson (1967) but ingestion of the snakes was not observed, Wetmore (1965) reported seeing a frigate bird, *Frigata magnificens,* pick up a *Pelamis,* carry it for a short distance, and then drop it.

An adult male leopard seal, *Hydrunga leptonyx,* collected in poor condition on a beach in New South Wales, Australia, was reported to have regurgitated a partly digested *Pelamis* (Heatwole and Finnie 1980). While the seal was almost certainly a naive or opportunistic predator on the sea snake, this represents the first verified account of predation on *Pelamis* in the wild and the first known instance of predation on any sea snake by a mammal.

In the laboratory, Rubinioff and Kropach (1970) demonstrated that *Pelamis* (alive, dead, skinned or in pieces) was strictly avoided by 10 species of eastern Pacific predatory fishes (even when the fishes were starved). Fishes of nine closely related Atlantic species attacked and occasionally ingested the snakes; three fishes died from resultant snake bites. Van Bruggen (1961) reported that an octopus in an aquarium attacked and ingested a 30-cm *Pelamis.*

The regurgitation of the specimen of *P. platurus* (LACM 127002) by a puffer *Sphoeroides* cf. *annulatus* from Bahia Blanca represents the second reported occurrence to date of predation on this snake in nature. It is possible that the snake was scavenged, but the food habits of puffers and the freshness of the *Pelamis* at the time it was brought in suggest that the snake probably was alive when attacked and eaten. The exceptionally strong crushing plates in the mouths of puffers allow them to feed on a variety of armored organisms that are unavailable to most other fishes (e.g., certain crustaceans, mollusks, sea urchins, brittle stars, polychaete worms, etc.; Hiatt and Strasburg 1960; Hobson, 1974; Shipp 1974). With this crushing mechanism and feeding strategy, it seems reasonable that large puffers might occasionally attack, crush, and swallow sea snakes. Nevertheless, predation on *P. platurus* by *Sphoeroides* is probably a rare occurrence in spite of the widespread distribution of both species in the tropical eastern Pacific. This is due to the largely epipelagic habits of *Pelamis* as opposed to the primarily epibenthic habits of puffers.

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THELOHANIA CONTEJEANI PARASITISM OF THE CRAYFISH, *PACIFASTACUS LENIUSCULUS,* IN CALIFORNIA [1]

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This is the first record of the occurrence of microsporidian parasite, *Thelohania contejeani,* from western North America, and the first report of infection in *Pacifastacus leniusculus.* Clinical symptoms observed in the crayfish are described, and the parasite is described microscopically from slides of the pansporoblasts and spores. The possible impacts of this new sighting of *Thelohania contejeani* are discussed and recommendations for further research are given.

INTRODUCTION

Thelohania contejeani Henneguy is a microsporidian parasite of decapod crustaceans. First described in Europe in 1892, it is known to parasitize *Astacus astacus* in Finland (Sumari and Westman 1969), Lithuania (Mažylis 1978), and the U.S.S.R. (Voronin 1971); *Austropotamobius pallipes* in Great Britain (Cossins and Bowler 1974, Brown and Bowler 1977), France (Vey and Vago 1973), Germany (Schäperclaus 1954), and Ireland (O'Keeffe and Reynolds, In press); *Astacus leptodactylus* in Lithuania (Mažylis 1978) and Poland (Krucinska and Simon 1968); and *Cambarus affinis* in Poland (Krucinska and Simon 1968). In addition, *Thelohania* sp. parasitism has been reported in *Paranephrops zealandicus* and *P. planifrons* from New Zealand (Quilter 1976, Jones 1980) and *Cherax destructor* from Victoria and New South Wales, Australia (Carstairs 1978).

Records of microsporidiosis in North American crayfish are sparse. In the United States, Sprague (1950) described a new species of *Thelohania, T. cambari,* in *Cambarus bartoni,* from streams along the Georgia/North Carolina border; in Louisiana, Sogandares-Bernal (1962) found *Cambarellus puer* infected with *Plistophora* sp. and *C. shufeldti* infected with *Thelohania* sp.; and Horton H. Hobbs Jr. (Senior Zoologist, Dept. of Invert. Zoo., Natl. Mus. Nat. Hist., Washington D.C., pers. commun.) found individuals of *Orconectes virginiensis* and *Cambarus acuminatus* from southeastern Virginia with opaque white abdominal muscles that he assumed were parasitized by *Thelohania* sp. In Canada, *Orconectes virilis* from Ontario are reported to be infected with *Thelohania* sp. (France, In press).

This paper documents, for the first time, *T. contejeani* in *Pacifastacus leniusculus leniusculus* from the Stanislaus River in California.

MATERIALS AND METHODS

Crayfish were collected in the Stanislaus River at Parrots Ferry (Figure 1) on

[1] Accepted for publication August 1982.

24 July 1979 as part of a study on the statewide distribution of crayfish in California. At the time the specimens were collected, this section of the Stanislaus River was about 15 m wide, clear, and fast flowing with many riffles and pools. The bottom composition was about 50% sand and 50% rubble. The surface temperature was 18°C.

FIGURE 1. Map of the Stanislaus River showing collection locality for infected crayfish.

Four crayfish were collected by hand while snorkeling among the rocks in about 1–2 m of water. They were sealed in a plastic bag and stored in an ice chest with ice and water until taken back to the laboratory and frozen. On 31 July 1979 the specimens were taken to the Department of Fish and Game's Fish Disease Laboratory for analysis. Wet mount preparations (coverslip scrapings of thawed abdominal muscle) examined under 10x, 40x, and 90x objectives on a Leitz Dialux phase contrast microscope revealed an apparent microsporidian infection. The specimens were then preserved in 50% isopropanol, and on 2

October 1980 similar preparations of the preserved abdominal muscle were made to obtain biometric data on spore and pansporoblast shape and size. All data were obtained at 900x using preserved material, a calibrated ocular micrometer, and phase contrast equipment.

RESULTS

The four crayfish were identified as *P. l. leniusculus,* following the nomenclature proposed by Hobbs (1972, 1974). When collected, three of the four crayfish had semisoft carapaces, indicating a fairly recent molt. They also appeared stressed and were weak and sluggish. Their abdominal muscles, visible through the sternum, were an opaque, milky white (Figure 2).

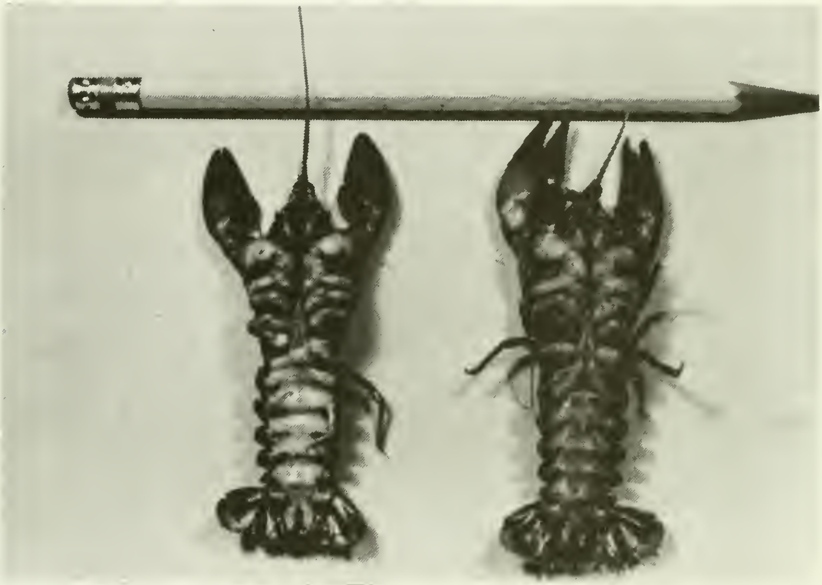

FIGURE 2. *Thelohania contejeani* infected crayfish on the left showing the characteristic white, opaque abdominal muscles. Noninfected crayfish on the right. *Photograph by junior author.*

Microscopic examination of slides of the abdominal muscle revealed a heavy infection with spores and pansporoblasts of a microsporidian parasite. Each pansporoblast contained eight spores. As the number of spores per sporoblast is a generic characteristic (Cossins and Bowler 1974), the parasite was identified as *Thelohania* sp.

The pansporoblasts are generally spherical with a mean diameter of 7.5 μ (range = 6.5 to 8.0 μ) (Figure 3). The oval spores, possessing a vacoule at one end, have a mean length of 3.4 μ (range = 3.0 to 3.8 μ) and a mean width of 2.2 μ (range = 2.0 to 2.4 μ) (Figure 3). The measurements given in the literature for *T. contejeani* pansporoblasts range from 5 to 9 μ; the length of the spore ranges from 2 to 4 μ, and the width ranges from 1.5 to 2.3 μ (Kudo 1924, Cossins 1973, Cossins and Bowler 1974, Quilter 1976, Bulla and Cheng 1977). Because of the close clinical and biometrical similarities between this microsporidian and *contejeani* infecting other crayfish, we identified this microsporidian as *T. contejeani.*

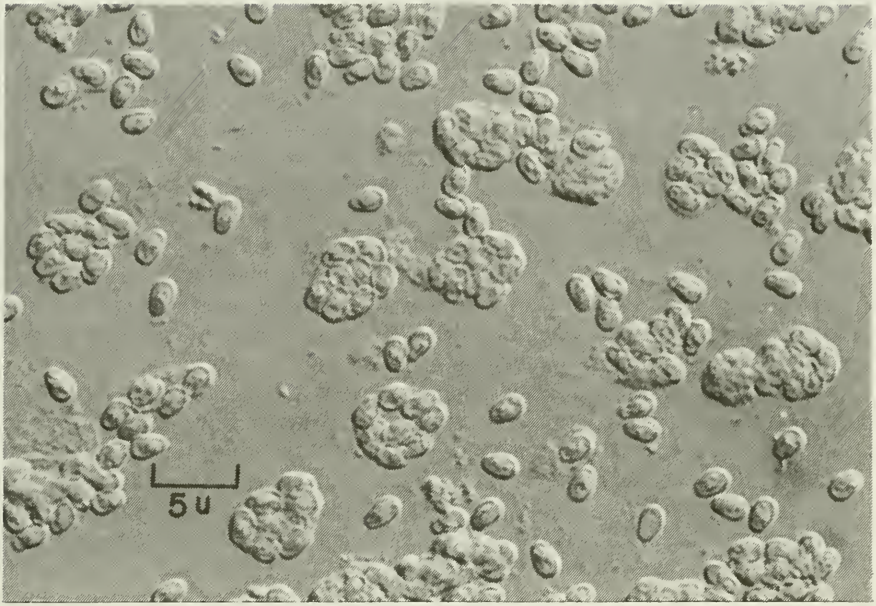

FIGURE 3. Photograph (900x) of phase contrast slide of preserved crayfish abdominal muscle showing the pansporoblasts and spores of a microsporidian parasite identified as *Thelohania contejeani. Photograph by junior author.*

DISCUSSION

Cossins (1973) states that such factors as waterflow, crayfish density, and the extent of cannibalism may affect the spread of *T. contejeani.* With the completion of New Melones Dam, the lotic habitat of the Stanislaus River supporting the *Thelohania* infected population has been transformed into a lentic habitat. The level of the old Melones Reservoir at maximum storage (Figure 1) was 224 m above sea level and the capture site is 247 m above sea level. The maximum storage expected behind the New Melones Dam during 1982 will raise the reservoir level to 283 m, and the minimum expected storage will drop the reservoir level to 257 m (U.S. Dept. of the Interior, Bureau of Reclamation, unpubl. data). Not enough is known about the environmental parameters that affect *Thelohania* to predict how this habitat change will effect the level of infection in the crayfish population or the possible spread of *Thelohania* to other crayfish populations.

This is the first record of the occurrence of *T. contejeani* from western North America and the first report of infection in a member of the genus *Pacifastacus.* If past trends are repeated, *T. contejeani* can be expected to spread downstream to the Delta population of *P. leniusculus* where it may have an adverse impact on the commercial fishery. The capture site is separated from the commercial fishing grounds of the Delta by two dams and about 200 km of river. The disease is apparently not now present in the Delta. Over 30,000 *P. leniusculus* from the commercial catch in the Sacramento-San Joaquin Delta were measured and sexed at processing plants between 1975 and 1980, with no sign of *Thelohania* parasitism.

Locality records of *Thelohania* sp. indicate clustering. Quilter (1976) found *Paranephrops zealandicus* on the South Island of New Zealand infected with *T. contejeani* in 1974 and concluded that the distribution of the parasite was restricted. However, by 1977 *P. planifrons* from the North Island of New Zealand was found to be infected with *Thelohania* sp. (Jones 1980). *T. contejeani* was not known in Finland until 1965, but between 1965 and 1969 it was reported from four different waterways (Sumari and Westman 1969). This clustering of new sightings may simply be an artifact of increased crayfish research and exploitation rather than new introductions of the parasite.

The levels of infection reported in the literature range from 0.3 to 30% (Schäperclaus 1954, Vey and Vago 1973, Cossins and Bowler 1974, Quilter 1976, Carstairs 1978, Mažylis 1978, Jones 1980, France, In press, O'Keeffe and Reynolds, In press). However, O'Keeffe and Reynolds (In press), using microscopic examination, found that 40% of *Austropotamobius pallipes* infected with *Thelohania* in Ireland eluded detection by macroscopic examination. Therefore, the figures given may be underestimates.

All individuals infected with *Thelohania* apparently die. However, the time required for the disease to run its course is unknown, but it may be lengthy. In Lithuania, experimentally infected individuals took 5 to 6 months to exhibit clinical symptoms, and they could feed, molt, and remain vigorous for up to a year in captivity before dying (Mažylis 1978). Detailed and controlled experiments are needed to establish the exact environmental and biological factors that affect the parasite and the susceptibility of crayfish to it.

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Calif. Fish and Game 69(3): 184–192 1983

NOTES

FOOD HABITS OF COYOTES, *CANIS LATRANS,* IN EASTERN TEHAMA COUNTY, CALIFORNIA

An investigation of the food habits of a relatively dense (0.5/km², Barrett unpubl. data) coyote population was carried out on a 13,000-ha study area approximately 20 km southeast of Red Bluff. The area is a Sierra Nevada foothill woodland dominated by blue oak, *Quercus douglasi* (Barrett 1978). The purpose of the study was to determine the degree to which coyotes on the Dye Creek Ranch might be relying on feral pigs, *Sus scrofa,* as prey items.

From June 1967 through September 1969, 1,042 fresh coyote scats were collected primarily along dirt roads and trails. Each scat was dated by season (spring—March through May, summer—June through August, fall—September through November, winter—December through February) and dried for storage. Dried scats were broken apart and the predominant food items recorded (Korschgen 1969)

The majority of scats contained a single food item. The major patterns revealed are: (i) coyote foods in the dry summer and fall seasons were primarily fruits from relatively uncommon shrubs; (ii) carrion of ungulates (including livestock, mule deer, *Odocoileus hemionus,* and pigs) composed roughly half the winter and spring diets, and (iii) rodents composed a relatively constant proportion of the diet throughout the year (Figure 1 and Table 1). Livestock and deer were not available during the dry season, while pig carrion, particularly that of very young piglets, was relatively common at that time. However, pig remains were slightly more common in wet-season than dry-season scats. Most of the ungulate material was probably eaten as carrion, as was evidenced by the presence of mummified hide or maggot remains in the scats. Rabbits are a dominant food item throughout most of the coyote's range (Beckoff 1978), but they are rare at Dye Creek, accounting for their scarcity in this study.

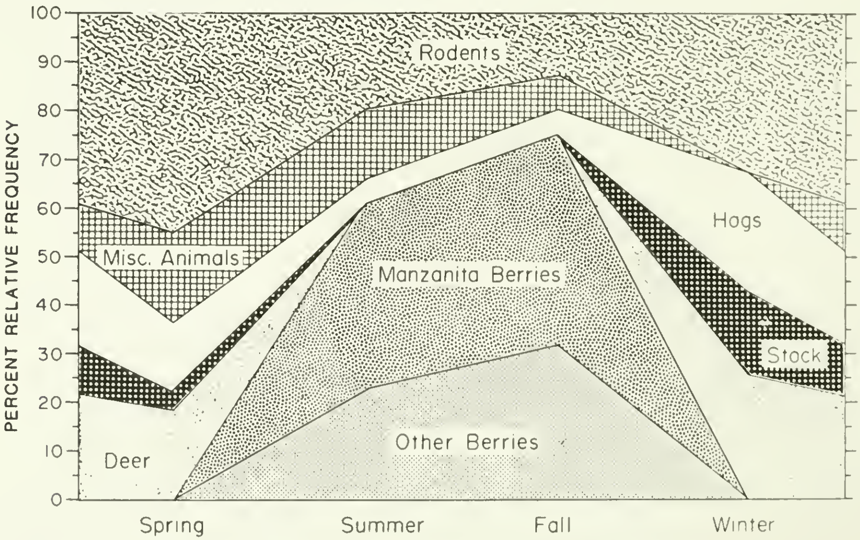

FIGURE 1. Food habits of coyotes in eastern Tehama County, California.

TABLE 1. Seasonal Food Habits of Coyotes in Eastern Tehama County Indicated by the Percent Relative Frequency of Occurrence of Food Items in 1042 Scats.

	Percent relative frequency of occurrence				
Food items	*Spring (76)*[1]	*Summer (487)*[1]	*Fall (476)*[1]	*Winter (12)*[1]	*Annual average*
Rodents	45.5	19.0	13.0	33.3	27.7
Thomomys bottae[2]					
Dipodomys heermani					
Peromyscus maniculatus					
Neotoma fuscipes					
Spermophilus beecheyi					
Erethizon dorsatum					
Rabbits	5.5	4.0	2.0	0.0	2.9
Lepus californicus					
Carnivores	3.0	0.8	0.6	0.0	1.1
Canis latrans					
Canis familiaris					
Urocyon cinereoargenteus					
Lynx rufus					
Procyon lotor					
Mephitis mephitis					
Ungulates					
Sus scrofa	14.5	5.7	5.4	25.0	12.7
Odocoileus hemionus	18.5	0.0	0.2	25.0	10.9
Bos taurus	1.5	0.0	0.0	16.7	4.5
Ovis aires	1.5	0.0	0.0	0.0	0.4
Birds	5.5	2.5	1.7	0.0	2.4
Reptiles	3.0	1.0	0.6	0.0	1.2
Fish	0.0	0.8	0.4	0.0	0.3
Invertebrates	1.5	5.2	0.8	0.0	1.9
Grasshoppers					
Beetles					
Snails					
ANIMAL TOTAL	100.0	39.0	24.7	100.0	66.0
Fruits					
Arctostaphylos manzanita	0.0	37.0	40.6	0.0	19.4
Rhamnus californica	0.0	6.0	18.0	0.0	6.0
Juniperus californica	0.0	17.0	2.0	0.0	4.7
Vitis californica	0.0	0.0	10.5	0.0	2.6
Ceanothus cuneatus	0.0	0.0	1.7	0.0	0.4
Cercis occidentalis	0.0	0.0	0.4	0.0	0.1
Green grass	0.0	1.0	2.1	0.0	0.8
VEGETABLE TOTAL	0.0	61.0	75.3	0.0	34.0

[1] Sample size
[2] Within categories, species are listed in order of decreasing relative frequency of occurrence

Preferred coyote foods were most limited in the summer and fall. This was corroborated by observations of very thin coyotes with a high incidence of mange in these seasons.

Although they sampled no coyotes in Tehama County, Ferrel, Leach, and Tillotson (1953) studied coyote food habits in the "Inland-Sierra Region" and had results similar to mine, but they found a much less pronounced shift to vegetable foods in the dry season. In the Lava Beds National Monument, Bond (1939) also found a high utilization of fruits during the summer.

Wild pigs have increased dramatically in California since the 1953 study

(Barrett 1977). It is likely that they are now utilized by coyotes throughout many parts of the state, although wild pigs were not listed as coyote food by Ferrel *et al.* (1953).

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A STUDY OF THE EFFECTS OF BOLERO 10G ® ON THE MOUNTAIN GARTER SNAKE, *THAMNOPHIS ELEGANS ELEGANS*

The U. S. Environmental Protection Agency granted California an emergency exemption (Section 18 of the Federal Insecticide, Fungicide, and Rodenticide Act) in April 1981. The exemption allowed Bolero 10G ® to be used to control sprangletop and barnyard grass in rice cultivation. The supplemental label included the statement, "Before permits are granted, the Pesticide Investigations Unit of the Department of Fish and Game must be consulted at (916) 445-0154 to determine if any rare or endangered species will be adversely affected." The giant garter snake, *Thamnophis couchi gigas,* is the one rare species which occurs in the rice growing region. No data were available to ascertain whether this animal would be adversely affected by use of the herbicide. The purpose of this study was to determine the effects of Bolero 10G ® on garter snakes in order to fulfill the intent of the label restriction.

MATERIALS AND METHODS

Bolero 10G ® is a granular herbicide. The formulated product contains 10% thiobencarb. Aerial applications occur in spring when rice is in the two-leaf stage and target weeds are susceptible. Garter snakes may be exposed to thiobencarb either directly or through the food chain. The mountain garter snake, which occurs within the range of the giant garter snake, was chosen as the test animal to examine the two possible modes of exposure. It was considered inappropriate to utilize the giant garter snake for the tests because of its scarcity. The metabolism of thiobencarb in the mountain and giant garter snakes is assumed to be similar.

Mountain garter snakes were collected on 28 April 1981 from Rancho Seco Lake, Sacramento County. Snakes were held in terraria at the Department of Fish and Game Field Station. They were fed, *ad libitum,* live golden shiners weighing about 1g each. They were hand-fed thawed frozen squawfish and live golden shiners in preparation for feeding and exposure trials. Bolero 10G ® was administered orally in gelatin capsules implanted in fish to establish an approximate acute toxicity level.

Data indicate accumulations of approximately 100 ppm (100 mg/kg) of thiobencarb are possible in fish (Chevron Chemical Company, unpub data). The exposure to a typical 200-g garter snake would be about 1.5 mg/kg if it ate three small fish containing this level.

LABORATORY STUDIES

Five feeding studies were conducted. One was a control, testing the procedure with an inert ingredient. Snakes were held for 10 to 16 days after feeding trials for observation of short-term effects.

Individual snakes were identified by marking with nail polish.

FIELD STUDIES

Snakes were taken to a field treated with Bolero 10G ®. An aerial application of approximately 45 kg/ha occurred 2 hours before placement of the snakes. The theoretical maximum dissolved water concentration would be in the range of 4.5 to 3 mg/1 thiobencarb when water is 10 to 15 cm in depth. Two live-cars containing one snake each were placed at the edge of a treated field. Two others, also containing a snake each were placed in the field's untreated water supply ditch as a control. The locations of the traps were adjusted as necessary for fluctuating water levels.

The snakes were removed after 5 days exposure and held in the laboratory for an additional 8 days for observation of short-term delayed effects.

RESULTS AND DISCUSSION

No mortalities were observed in either laboratory or field tests. In a field situation, for example, a snake could be exposed to fish which have accumulated up to 100 ppm in their tissue. Since a small fish weights about one gram, and a snake might consume three of these in a day, an exposure would be to 0.3 mg thiobencarb. We conclude the possibility of a direct acute effect is minimal (Table 1) since no mortalities were observed in dosage levels approximately 160 times this expected dose.

TABLE 1. Results of Single-Dose Oral Exposure of Mountain Garter Snakes to Bolero 10G ® (thiobencarb).

Test No.	*Weight of snake (kg)*	*Thiobencarb dose (mg)*	*Rate (mg/kg)*	*Results*
1	.202	0[1]	0	Negative
2	.202	32	158	Negative
3	.055	~20	~364	Negative
4	.108	30	277	Negative
5	.077	48	623	Negative

[1]Inert ingredients only as a control.

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The use of rice fields for field trials was permitted by the Demeter Corporation of Woodland, California.

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SMOKED ALUMINUM TRACK PLOTS FOR DETERMINING FURBEARER DISTRIBUTION AND RELATIVE ABUNDANCE

As part of a long-term effort to develop a wildlife survey system for California, a cooperative project between the University of California, the U. S. Forest Service, the California Department of Fish and Game, and the U. S. Fish and Wildlife Service was carried out during 1979 and 1980 to develop and test techniques for assessing the distribution and relative abundance of furbearers in the Sierra Nevada. The techniques must be applicable to all types of terrain at all seasons of the year. They must be efficient in terms of time and labor and be suitable for sampling a wide range of furbearers, including mustelids, canids, felids, and procyonids.

The most widely used technique for this purpose has involved attracting animals to bait or scent and recording visits by detecting tracks in fine soil or snow surrounding the bait station (Cook 1949; Richards and Hine 1953; Stains 1956; Wood 1959; Pimlott, Shannon, and Kolenosky 1969; Bamford 1970; Linhart and Knowlton 1975; Lindzey, Thompson, and Hodges 1977). Live-trapping methods are relatively expensive, and methods by which observers count tracks while walking transects in snow (Ruff 1939, Priklonski 1970) produce extremely variable results.

During the summer of 1979 the dirt track plot method (Linhart and Knowlton 1975) was tried on a 71-km^2 portion of the Inyo National Forest extending from Owens Valley west to the Sierra Crest. One plot was located within 100 m of the center of each 1000-m cell of the UTM grid (Myers and Shelton 1980:160). Powdered rotten egg capsules, provided by the Fish and Wildlife Service, were randomly allocated to half the plots, and a bait consisting of decomposed fish and cod-liver oil was allocated to the remainder. The latter bait was smeared on a stick placed in the track plot. Coyotes visited only plots with egg scent. No other animals displayed a significant preference for one attractant. The plots were checked five times at 2-day intervals. Despite the generally inaccessible location, two technicians were able to run 16 plots in 14 days, including 2 days for travel to and from the study area.

After 21 plots were established it was clear that the use of fine sand or soil was inappropriate. The local soils were too rocky and transporting in soil was not feasible.

Consequently, the technique of smoking a hard, smooth surface with a kerosene-benzene flame, as used in small mammal studies (Mayer 1957, Justice 1961, Sheppe 1965, Marten 1972, M'Closkey 1975), was adapted by using two 814 × 407 × 0.6 mm aluminum panels for the tracking surface. Normally the aluminum was packed to the plot and smoked on site using an 80-cm aluminum wand with a cotton wick on one end to hold the kerosene-benzene mixture. The mixutre was transported in an aluminum bottle. After a 1-m radius plot was cleared to mineral soil and leveled, the aluminum panels were smoked by placing each on a 200 × 2000 mm strip of aluminum lawn border material which had been bent in a semicircle. The burning wand was passed back and forth under the panel until a solid layer of soot was deposited on it. The panels could be smoked elsewhere and transported to the plots in a box with slots to keep the panels from rubbing against each other. One person can pack materials for up to 10 plots, although normally only 4 to 5 plots were visted per day. Other potential tracking mediums include ink (Lord *et al.* 1970) and liquid talc (Brown 1969). These would eliminate the fire hazard but are more difficult to remove than soot, which can be simply polished off with fine steel wool.

The smoked aluminum plots worked well except in rain. Tracks of even the smallest mammals were readily observed. Most tracks were extremely clear and easily identified. Fifteen species of mammals were recorded, including fisher, *Martes pennanti*; marten, *Martes americana*; striped skunk, *Mephitis mephitis*; long-tailed weasel, *Mustela frenata*; coyote, *Canis latrans*; and bobcat, *Lynx rufus*.

Although suitable for the relatively dry summer season, the large ground plots are inappropriate for winter surveys. A smaller version of the smoked aluminum panel (458 × 165 × 0.6 mm) was used inside a plywood box mounted on the trunk of a tree. This design was intended specifically for a winter survey of marten in a 2500-ha portion of the Sagehen Creek basin within the Tahoe National Forest. The boxes were intended to hold live traps as well as tracking panels. Each of the 53 boxes was located at the center of a 200-m cell of the UTM grid. Sample cells were chosen in a random start, systematic fashion (Myers and Shelton 1980). One technician ran all the plots semimonthly (15 ± 3 days) from January through June 1980. Nine full days were required when deep snow necessitated using snowshoes or skis, while later in the season, when a vehicle could be used, the same work could be accomplished in 4 to 5 days.

Occasionally, heavy snowfall damaged the boxes; however, in general they were very effective for detecting martens in winter when baited with raw fish. A test without bait for two periods resulted in a reduction in estimated relative density (Bamford 1970) of 15% relative to two previous baited periods. Other species detected included flying squirrels, *Glaucomys sabrinus*; Douglas squirrels, *Tamiasciurus douglasii*; deer mice, *Peromyscus maniculatus*; and porcupine, *Erethizon dorsatum*. Coyotes, raccoons, *Procyon lotor*, and bobcats, *Lynx rufus*, were the only other furbearers in the area but they could not be sampled by these relatively small boxes located on tree trunks.

To assess pine marten sampling methods, a comparison was made between the tracking boxes and a hair snare (Department of Fish and Game, Sacramento). The hair snares consisted of 610 × 254 mm cylinders of welded mesh wire containing coils of barbed wire and a bait box of hardware cloth. Snares were attached vertically to tree trunks. Animals reaching for the bait would catch tufts of hair in the barbed wire. The hair was collected and identified microscopically by comparison with a reference collection. Thirty-nine hair snares were interspersed with 42 tracking boxes, all using the same fish bait and checked at the same intervals.

The tracking boxes were considerably more efficient than the hair snares (Table 1). The cumulative percentage of plots visited by martens was 64 for the boxes and 38 for the snares. No doubt many of these visitation records represent repeated visits by the same individual; nevertheless, since the tracking box visitation rate stablized after only four tracking periods at a level nearly twice as great as that for the hair snares, the boxes provide more data per unit of effort. Hair snares might be more appropriate for sampling larger species where plots cannot be checked at intervals of less than a month. For winter surveys of pine marten and similar sized furbearers, the tracking boxes are recommended if the plots can be run at least semimonthly.

TABLE 1. Relative Efficiency of Hair Snares and Tracking Boxes for Assessment of Pine Marten Distribution and Relative Abundance.

	Hair snare	*Tracking box*
Number of plots	39	42
Semimonthly periods sampled	11	11
Cumulative percentage of plots visited by martens	7	34
Relative density estimate (see Bamford 1970)	0.49	1.03

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AVIAN CHOLERA IN AN AMERICAN FLAMINGO, *PHOENICOPTERUS RUBER*: A NEW HOST RECORD

During January-March 1979, an avian cholera epizootic at the south end of the Salton Sea in southern California killed an estimated 3,800 waterfowl, shorebirds, and wading birds. On 12 February, an American Flamingo carcass was found during disease surveillance and control activities by personnel of Salton

Sea National Wildlife Refuge (SSNWR). The bird was probably one of two flamingos periodically observed in the area during the previous year and was suspected to have escaped from a captive flock (L. Dean, SSNWR, pers. commun.).

The carcass was submitted to the National Wildlife Health Laboratory (NWHL), U.S. Fish and Wildlife Service, Madison, Wisconsin, for determination of cause of death. The bird had abundant deposits of subcutaneous, mesenteric, and coronary fat. Petechial hemorrhages were evident on the coronary fat, pancreas, and mucosal surface of the proventriculus and intestine. Intestinal contents were gray and mucoid. The liver appeared swollen and fatty; focal necrosis was not evident.

Pasteurella multocida, the causative organism of avian cholera, was cultured from the liver and spleen. The isolate was identified as serotype I (Heddleston's scheme) by standard agar gel diffusion test at the National Veterinary Services Laboratory, Ames, Iowa. This serotype is found commonly in waterfowl epizootics in the Pacific Flyway (NWHL, unpubl. records).

Tissues stained with hematoxylin and eosin disclosed a mild periportal inflammatory cell infiltration in the liver. Pale basophilic particulate material in tissues surrounding vessels of the liver and spleen was believed to represent bacteria; there was no evidence of an inflammatory reaction to this material. Acute vacuolar degeneration of endothelial cells of blood vessels and surrounding reticuloendothelial cells of the spleen was observed. We speculate that the vascular changes observed represent a peracute toxic response to *P. multocida.* The absence of an inflammatory response to the bacteria within the liver and spleen supports this contention.

This case is the first reported occurrence of avian cholera in a flamingo, and adds to the large number of avian species known to be susceptible to this disease (Rosen 1971, Wilson 1979). In this instance, the specimen was of presumed captive origin and outside the natural range of the species.

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REPRODUCTION OF ARCTIC GRAYLING, *THYMALLUS ARCTICUS*, IN THE LOBDELL LAKE SYSTEM, CALIFORNIA

Arctic grayling were first brought to California and held at Sisson Hatchery (now Mt. Shasta Hatchery) in 1904 (Emig 1969). Several attempts to establish this species in California waters from 1905 to 1933 resulted in success only at Grayling Lake in Yosemite National Park (Emig 1969). The resultant population apparently remained viable until 1934 (Shapovalov, Cordone, and Dill 1981).

From 1969 to 1975, the California Department of Fish and Game stocked 58 high mountain lakes and one stream in an effort to reestablish Arctic grayling (A. Cordone, Senior Fishery Biologist, Calif. Dept. Fish and Game, pers. commun.). Good survival and growth were documented at many of these waters but reproduction had not been confirmed (Shapovalov, Cordone, and Dill 1981). Included among these waters was Lobdell Lake, Mono County, a 19-ha reservoir with a mean depth of 7.5 m (at maximum pool) situated at the 2800 m elevation in the eastern Sierra Nevada. It was stocked with 500 catchable-sized Arctic grayling from Arizona in 1970; no subsequent plants have been made (A. Cordone, pers. commun.).

In May 1980, I collected a total of 12 Arctic grayling by angling from Lobdell Lake and its outlet stream, Desert Creek. This prompted more intensive sampling efforts in September 1980. A seine of 3-mm mesh size was used for sampling in Lobdell Lake, while a Smith-Root Type Seven electrofisher was utilized to sample two 45-m long sections of Desert Creek, beginning at 2 km and 3 km downstream from the Lake, respectively. Standard length was recorded and scales were obtained from each fish prior to release.

Thirty-one fish collected from Desert Creek ranged in length from 76 to 107 mm, with a mean length of 88 mm. The 27 fish from Lobdell Lake ranged from 62 to 310 mm, with a mean of 120 mm. Based on scale analysis, all 31 fish from Desert Creek were age 0+. Seventeen of the Lobdell Lake fish were age 0+, nine were age 1+, and one was age 2+. Age 0+ Lobdell Lake fish ranged from 62 to 94 mm ($\bar{x}$=80 mm), age 1+ fish ranged from 161 to 181 mm ($\bar{x}$=176 mm), and the age 2+ fish was 310 mm long.

D. Wong, Fishery Biologist, Calif. Dept. Fish and Game (pers. commun.) also found evidence of natural reproduction by Arctic grayling in the Lobdell Lake system. In July 1980 at Lobdell Lake he collected seven age 1+ fish ranging from 155 to 170 mm fork length (FL) ($\bar{x}$ = 162 mm), four age 2+ fish of 290 to 301 mm FL ($\bar{x}$ = 297 mm), and a 3+ fish of 373 mm FL.

Consistent with these findings, Arctic grayling were observed spawning in the inlet stream, a channel routing water from Deep Creek to Lobdell Lake (E. Gerstung, Assoc. Fishery Biologist, Calif. Dept. Fish and Game, pers. commun.). Thus, it is apparent that the Lobdell Lake system contains a reproducing Arctic grayling population, the only such population known to exist in California.

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