

# VERTEBRATE NATURAL HISTORY LABORATORY AND FIELD SYLLABUS

## INTEGRATIVE BIOLOGY 104LF

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# FIELD BIOLOGY OF THE VERTEBRATES

## Integrative Biology 104L

### Introduction

The primary objective of the laboratory and field work in this course is to aid the student in making personal, first-hand observations on the biology of living vertebrate animals in their natural environments. Semi-wild and wild lands in local Regional Parks (e.g., Briones, Coyote Hills, Sunol, Pt. Pinole, and Tilden) and Pt. Reyes National Seashore serve as our chief outdoor areas of study. Containing a variety of habitats and ecological formations such as coniferous forest, oak-bay woodland, chaparral, grassland, fresh-water marsh, lakes and stream banks, these areas support a rich variety of vertebrate species and are easily accessible. Species referred to as "local" are to be found in these Bay Area locations and adjacent areas.

We will emphasize the behavior, adaptations, and way of life of local species in an effort to understand their natural history, their interactions, and the ecosystem of which they are a part. Attention will be given to techniques of field study, species identification, ecologic niches, foraging behavior, food habits, predator-prey relationships, habitat selection, competition within and among species, geographic distribution, and interactions between humans and vertebrate animals as they relate to conservation and human welfare. Although different, perhaps ecologically equivalent, species may be present in other areas, it should be realized that the techniques and principles of vertebrate natural history learned by the study of local animals will have broad geographic application.

Students sometimes question the value of detailed study for purposes of identification of the minor differences that exist between closely similar species. Such study emphasizes, however, the great care the biologist must exercise in determining the identity of the organism being examined. Although two species may appear superficially similar, careful study typically reveals profound physiological, behavioral and ecological differences. Through convergence, similar species may even have come from different evolutionary backgrounds. The validity of some older literature is questionable because the species used

were not identified with certainty. This underscores the importance of correct species identification, a point that will receive constant emphasis during this course.

Because study of distribution often provides valuable information on factors critical to the existence of a species and important clues to its evolutionary history, you may be asked occasionally to give attention to distributional matters. To aid in this, study maps of Californian topography, vegetation, and life zones are included (Figs. 1–9).

The laboratory exercises are designed to support the fieldwork and to illustrate and enlarge upon points presented in the lectures. The vertebrate groups studied — amphibians, reptiles, birds and mammals — and the timing of certain special topics investigated are ordered as to sequence by local seasonal and climatic factors. This results in some unavoidable discontinuity in the presentation of subject matter.

Although taxonomy per se is not the primary focus of this course, detailed knowledge of ordinal and familial classification provides an indispensable framework for understanding the relationships of local species. Moreover, familiarity with the names of common species present in the outdoor areas under study is essential for all descriptive and analytical work.

Please read the laboratory instructions before coming to class and make any recommended preparation in advance.

# Materials

## For the laboratory

- Notebook for notes and drawings (optional). Drawing pencils (colored) (optional).
- Millimeter tape or small plastic rule approximately 300 mm long (required).
- Hand lens (optional).

## For the field

- Loose-leaf three-ring binder notebook, with non-flexible cover and lined paper approximately 6" x 9" (required).
- Drawing pen with black, waterproof ink or high-quality black ball-point pen (required).
- Small plastic ruler (required).
- Binoculars (required).

# Instructions for Use of Laboratory Specimens

Specimens used in the laboratory work are extremely fragile and difficult to obtain and prepare. It is the responsibility of each student to observe some simple rules with regard to handling them so that they will be usable for future classes. Because many students may become curators of school teaching collections, attention is given to the methods used in preparing, cataloguing, and storing specimens.

**Birds** — Bird study skins (unmounted scientific preparations) are made by removing the body and replacing it with cotton and a stick for support. No wire is used in the wings or feet; the latter are thus held on only by fragile dry skin. Do not try to spread the wings or move the feet or legs. Grasp the specimen firmly by the sides of the body when examining plumage and the bill, feet, and legs. Do not pick up the specimen by the head, bill (beak), feet, legs or tail. (See pp. 50-53). Never point with a pencil to any area of a bird specimen.

**Mammals** — Mammal skins are prepared in essentially the same manner as bird skins except that small wires are placed in the legs and tail. When handling a skin grasp it by the body or by both hind legs and tail. Do not attempt to bend the tail or ears. Skulls and lower jaws should always be kept together and replaced in the proper receptacle (check the specimen number against the number on the box or vial). Keep in mind that the small skulls of shrews and bats are particularly fragile and difficult to replace. Never use pencils on skulls. Never move specimens from one tray to another. Please always put your tray in good order before leaving the lab.

**Amphibians and reptiles** — The herpetological specimens are preserved in 70% alcohol. Care must be taken to keep specimens moist at all times with damp paper towels, as drying is extremely harmful to them. Labels on alcoholic specimens are easily torn, as are the legs and tails, when the specimens are removed from the storage jars. Therefore, remove specimens with the utmost care. Please see that they are returned to their proper containers.

# Maps



Fig. 1 TOPOGRAPHY OF CALIFORNIA

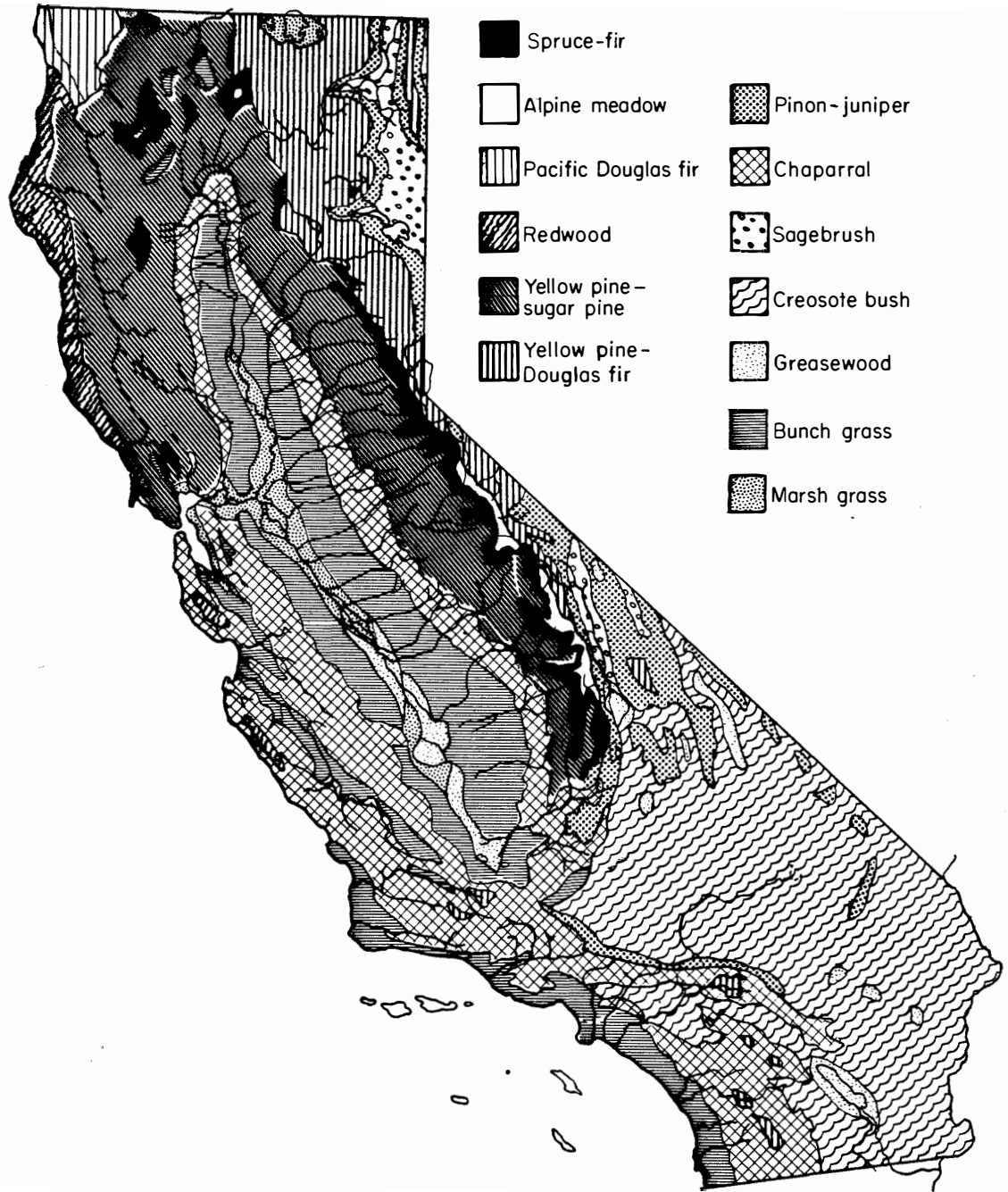
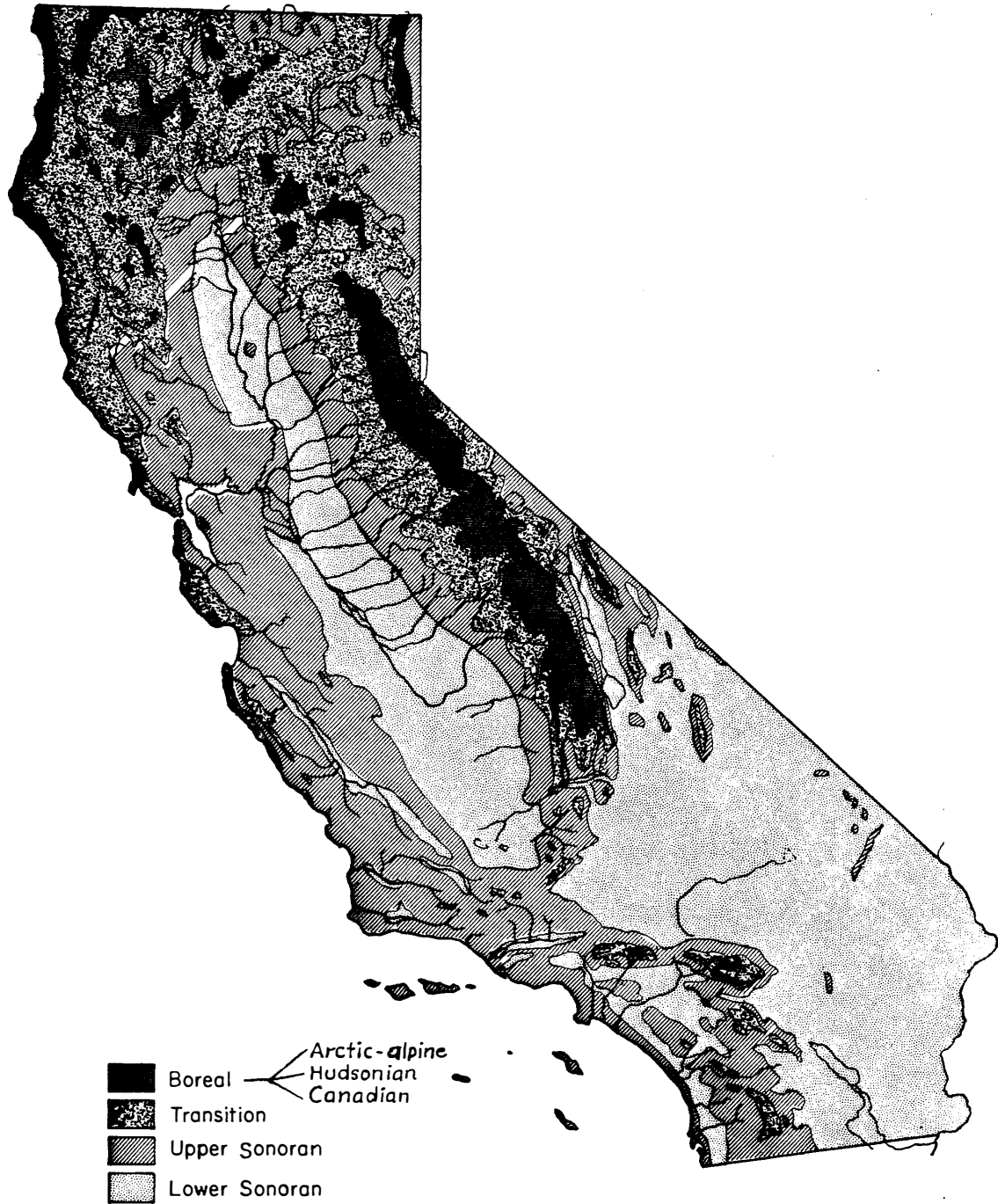


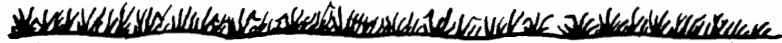
Fig. 2 VEGETATION OF CALIFORNIA





**Fig. 3 LIFE ZONES OF CALIFORNIA**

Grassland



Scrub

Scattered low bushes; few or no trees.



Chaparral

Dense growth, usually under 12-15' height. Intricate system of branches and twigs.



Savannah

Grassland with widely spaced trees.



Woodland

Many trees but canopy discontinuous.



Forest

Close growth of trees; canopy continuous.

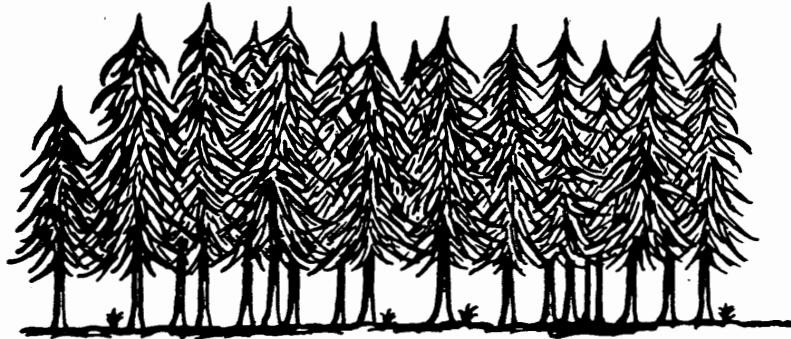
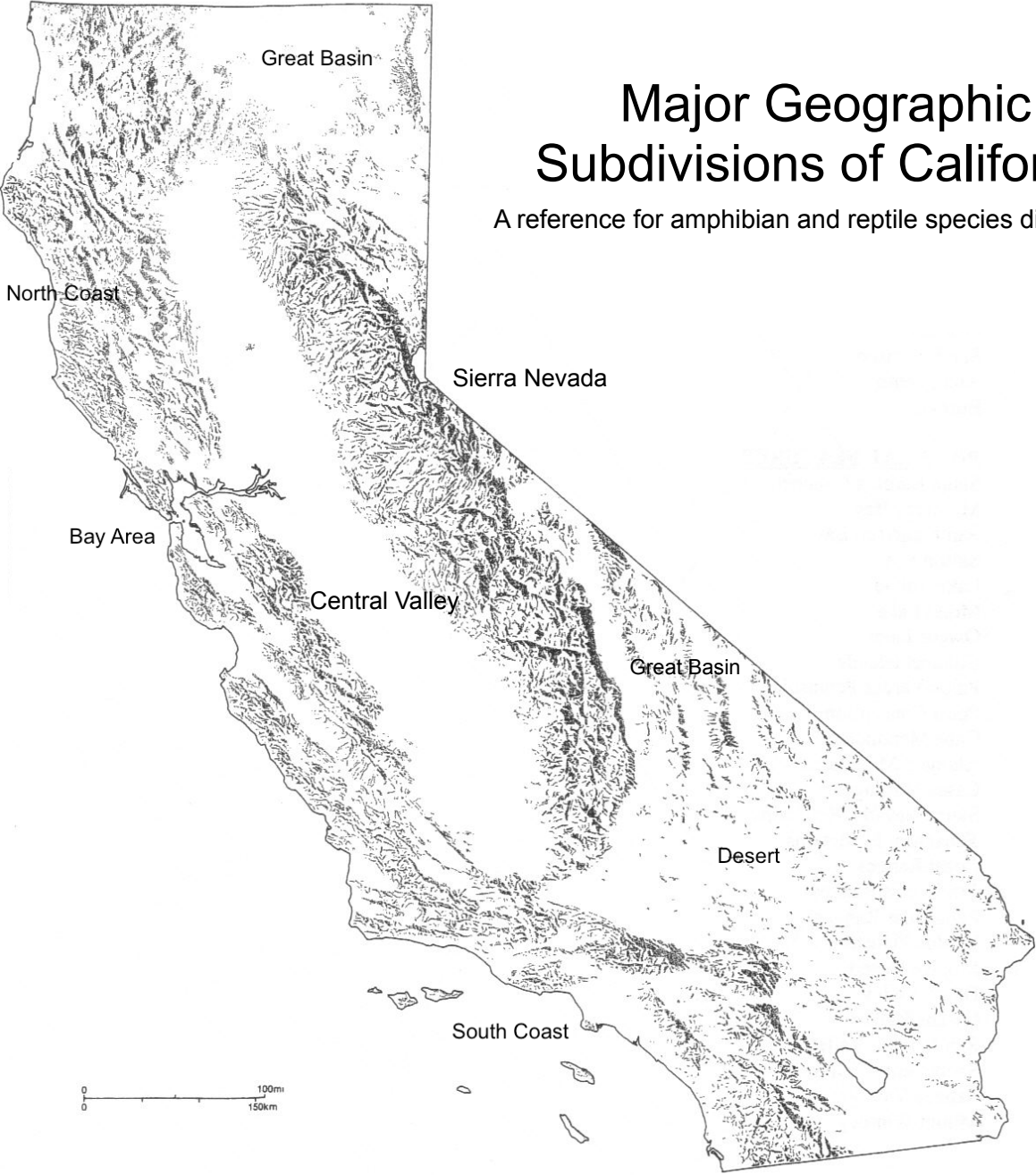


Fig. 4 Vegetation life forms

(Vertical lines on right = 6 ft.)

# Major Geographic Subdivisions of California

A reference for amphibian and reptile species distributions



# Laboratory Exercises on Birds

## Laboratories I to IV (4 weeks)

You will be introduced to approximately 110 species of common local birds, most of which you will have a good chance of seeing in the field. These species are grouped according to their habitats and seasonal status. From examination of study specimens, note the color, pattern, and texture of the plumage, and the detailed structure of bills and feet. As you study each species, compare your findings with the illustrations and descriptions offered in your field guide. Verify the field marks emphasized in the guide by examination of the specimens and look for differences within species that may be due to sex and/or age. Although no drawings are required for the bird laboratories, you are advised to take notes and make sketches of material examined so that personal impressions of each species are recorded in your own words. For precision in your descriptions use the terms given in Fig. 5.

Learn the general food habits of those species presented and add to your knowledge of diet and foraging behavior through personal observation of the birds in the field. Correlate the food taken with the structure of the bill and feet. Attempt to discern probable adaptations, that is, correlations of structure and function. As you become better acquainted with each species in the field you should be able to see where and how the bird actually gathers the food listed. Furthermore, field experience with each kind of bird will reveal that adaptations to the environment are to be seen not only in the structures related to style and place of foraging, but also in many other aspects of appearance and behavior, coloration, voice, shape and size of body, wings, and tail, etc... Become familiar with the characteristics of the order and family to which each species belongs.

The species you will study are presented according to their general habitat preferences and seasonal occurrence. Look for broad correlations between the species of birds present at a given time of the year, the kinds of food eaten, and the seasonal availability of food. Where do our summer resident species spend the winter? Why is the Bay Area unsuitable for them? Where do our migrant species spend the winter; where do they nest? Where do our winter resident birds go to breed? Note the general geographic ranges for each species as presented in the guide.

It is regrettable that our laboratory study of birds must depend upon the use of preserved material. However, since most of the birds you will see are common local species, we hope that the dislike some of you may feel in working with lifeless specimens will be offset by the contribution that the study of these skins will make to your understanding of birds in the field. Remember most of the field guides that you use, relied heavily on museum specimens to produce the accurate drawings and develop the associated text.

On the laboratory examinations, you will be responsible for:

- (1) Identification of all species presented
- (2) knowledge of their structural adaptations, sex and age differences in appearance, food habits, style of foraging, general behavior, general habitat preference, and seasonal status
- (3) the characteristics of the families of birds
- (4) any information presented in the laboratory demonstrations.

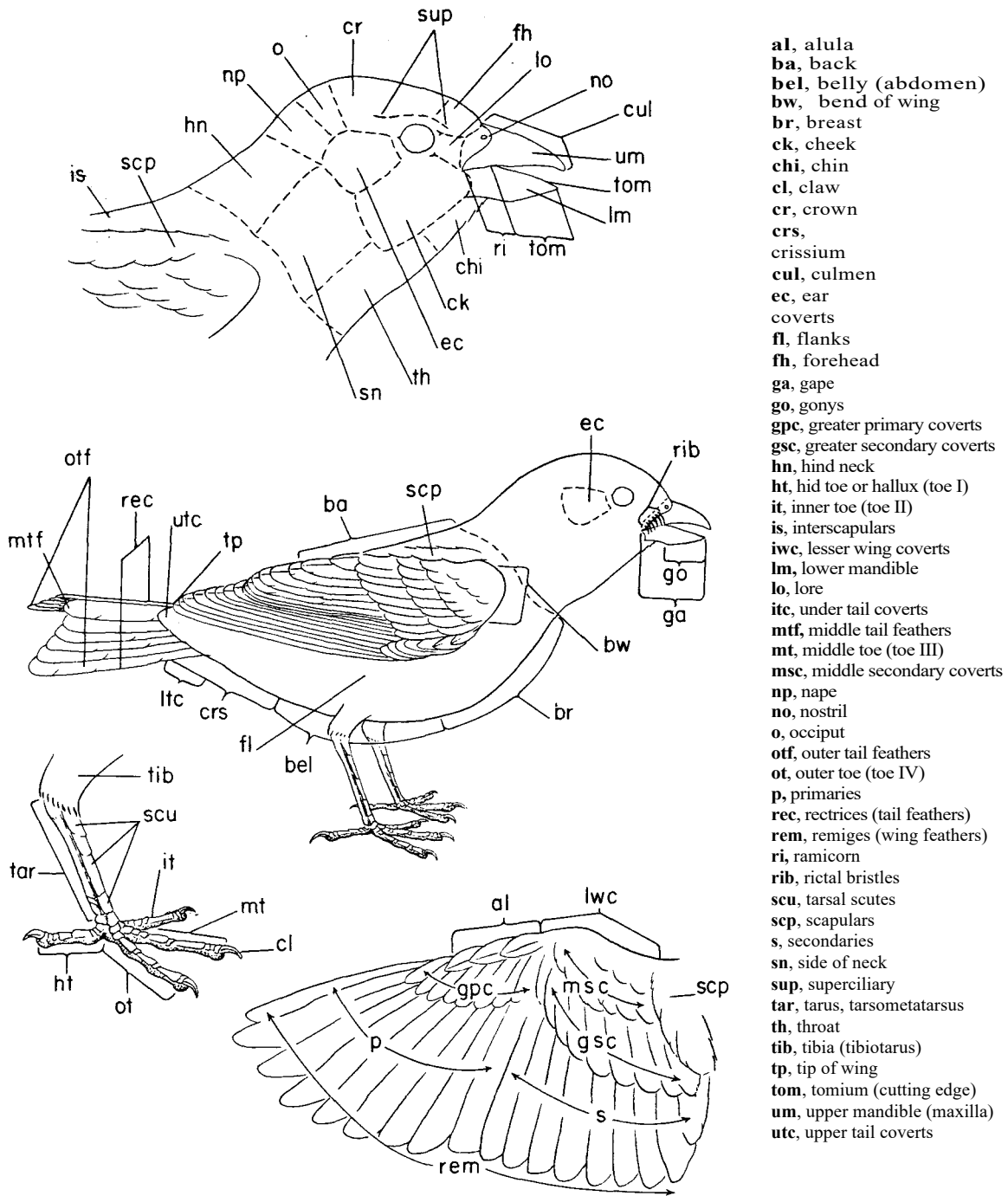


Figure 5. Topography of a passerine bird

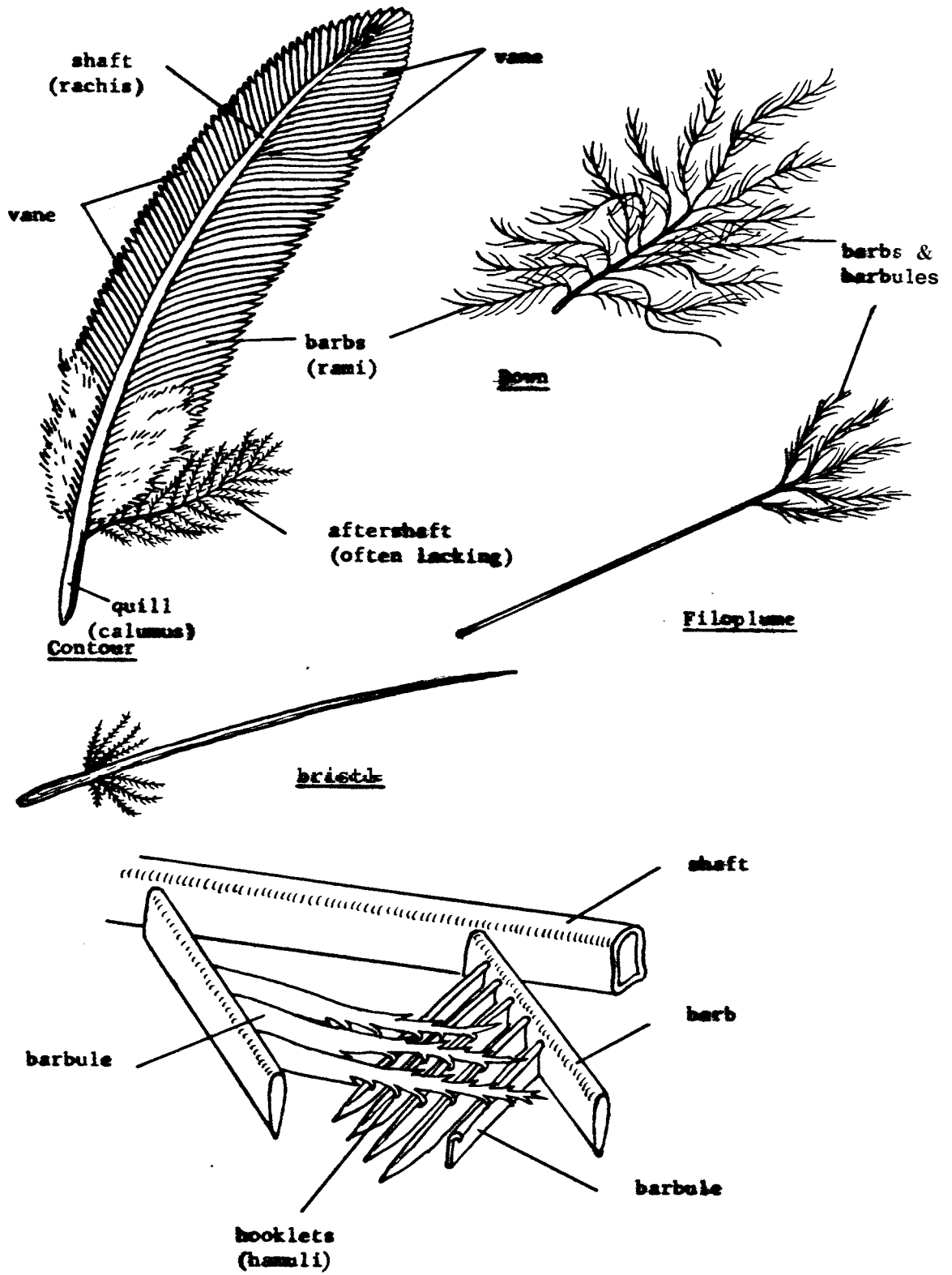
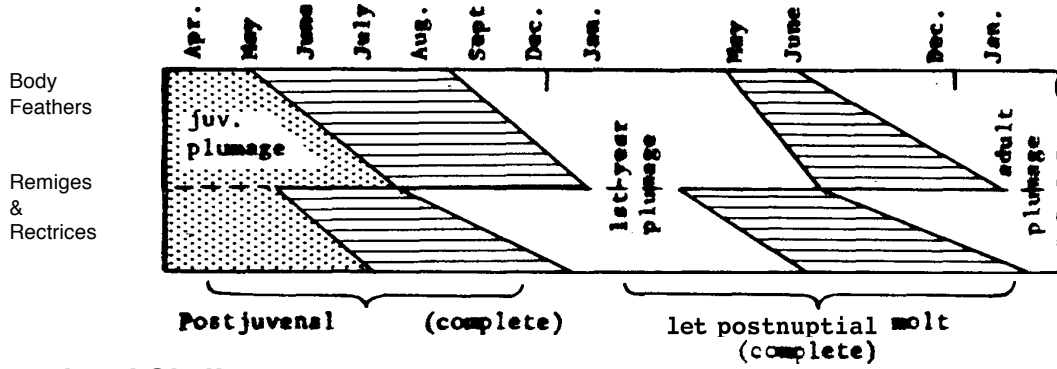


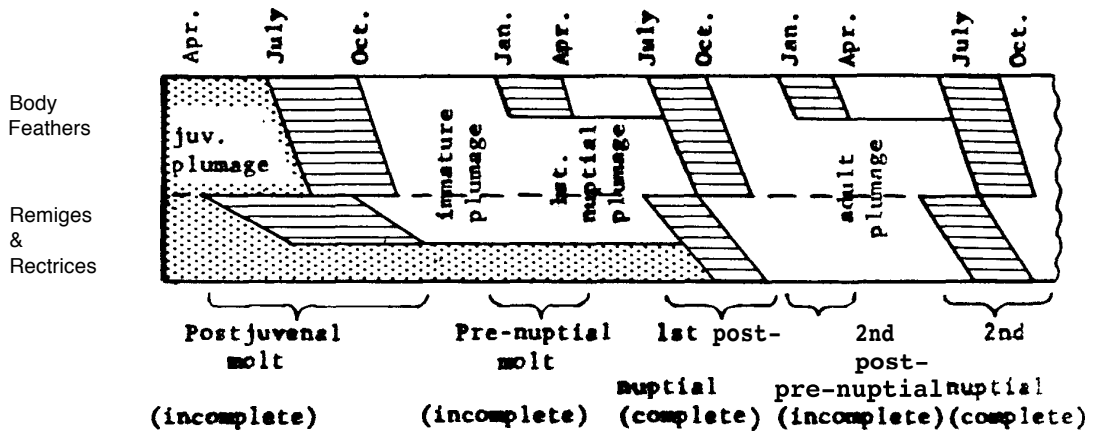
Figure 6. The structure of feathers

# Bird Molt

## Anna's Hummingbird



## Loggerhead Shrike



## Steller's Jay

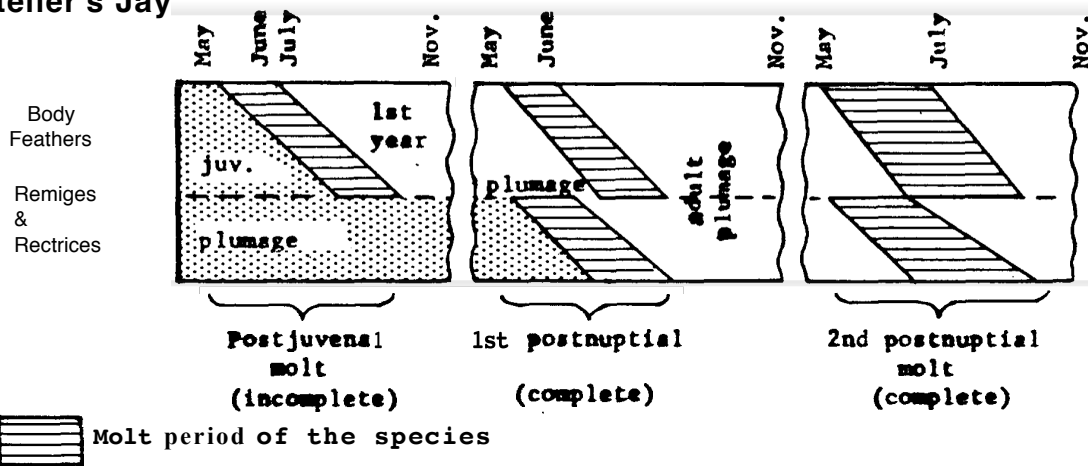


Figure 7. Variation in molt among three local bird species.





# Habitat and Migration

Familiarize yourself with the topography of a passerine bird (Figure 5). Study carefully the illustrations of feather types, structure and distribution (Figure 6) and of examples of stages in molting (Figure 7).

## Example – Species of Shoreline and Aquatic Habitats

### PERMANENT RESIDENTS

Double-crested Cormorant	Western Gull
Great Blue Heron	Forster's Tern
American Coot	Belted Kingfisher
American Avocet	

### SUMMER, FALL & WINTER VISITANT

Brown Pelican

### WINTER RESIDENTS & VISITANTS

Common Loon	Ring-billed Gull
Clark's Loon	Glaucous-winged Gull
Bufflehead	

### MIGRANTS &/OR WINTER VISITANTS

Black-bellied Plover	Sanderling
Whimbrel	Western Sandpiper
Marled Godwit	Least Sandpiper
Short-billed Dowitcher	Dunlin

## Example – Permanent Resident Species of Widespread Habitat Occurrence

Turkey Vulture	Great Horned Owl
Red-tailed Hawk	White-throated Swift
American Kestrel	American Robin
Killdeer	European Starling
Rock Dove	Red-winged Blackbird
Mourning Dove	Brewer's Blackbird
Western Barn-Owl	House Finch
Western Screech-Owl	House Sparrow

## Example – Permanent Resident Species of Woodland and Chaparral

Cooper's Hawk	Hutton's Vireo
California Quail	California Scrub-Jay
Common Poorwill	Chestnut-backed Chickadee
Anna's Hummingbird	Oak Titmouse
Nuttall's Woodpecker	Bushtit
Acorn Woodpecker	Bewick's Wren
Northern Flicker	Wrentit
Black Phoebe	California Thrasher

California Towhee  
Spotted Towhee  
Dark-eyed Junco

White-crowned Sparrow  
Song Sparrow  
American Goldfinch

**Example – Winter Resident Species of Woodland and Chaparral**

Sharp-shinned Hawk  
Ruby-crowned Kinglet  
Red-breasted Sapsucker  
Cedar Waxwing  
Northern Mockingbird

Yellow-rumped Warbler  
Varied Thrush  
Golden-crowned Sparrow  
Hermit Thrush  
Fox Sparrow

**Example – Migrant Species of Woodland and Chaparral**

Allen's Hummingbird  
Violet-green Swallow

Western Tanager

**Example – Permanent Resident Species of Coniferous Forest and Grassland**

SPECIES OF CONIFEROUS FOREST  
(Redwood and introduced pines and firs)

Band-tailed Pigeon  
Steller's Jay  
Red-breasted Nuthatch

Brown Creeper  
Purple Finch  
Pine Siskin

SPECIES OF GRASSLAND AND OAK SAVANNAH

Loggerhead Shrike  
Horned Lark  
American pipit (winter visitant,  
transient)

Savannah Sparrow  
Western Meadowlark

**Example – Permanent Resident Species of Marshland**

American Bittern  
Northern Harrier  
Ridgway's Rail (salt-water)

Marsh Wren (fresh-water)  
Common Yellowthroat

**Example – Summer Resident Species of Woodland and Chaparral**

Allen's Hummingbird  
Pacific-slope Flycatcher  
Western Wood-Pewee  
Warbling Vireo  
Cliff Swallow  
House Wren  
Swainson's Thrush

Orange-crowned Warbler  
Wilson's Warbler  
Black-headed Grosbeak  
Lazuli Bunting  
Bullock's Oriole  
Brown-headed Cowbird

**IB104 TOTAL SPECIES LIST FOR BIRD LABS (112 species)**
**No. spp. in Bay Area**

<b>ORDER</b>		
<b>ORDER</b>	<b>GAVIIFORMES</b> (Loons)	3
<b>FAMILY</b>	<b>GAVIIDAE</b> (Loons) Common Loon	3
<b>ORDER</b>	<b>PODICIPEDIFORMES</b> (Grebes)	6
<b>FAMILY</b>	<b>PODICIPEDIDAE</b> (Grebes) Clark's Grebe	6
<b>ORDER</b>	<b>SULIFORMES</b> (Cormorants, boobies)	4
<b>FAMILY</b>	<b>PHALACROCORACIDAE</b> (Cormorants) Double-crested Cormorant	4
<b>ORDER</b>	<b>PELECANIFORMES</b> (Pelicans, herons, egrets, ibis)	10
<b>FAMILY</b>	<b>ARDEIDAE</b> (Egrets, herons) Great Blue Heron Black-crowned Night-Heron	7
<b>FAMILY</b>	<b>PELECANIDAE</b> (Pelicans) Brown Pelican	2
<b>ORDER</b>	<b>ANSERIFORMES</b> (Swans, geese, ducks)	33
<b>FAMILY</b>	<b>ANATIDAE</b> (Swans, geese, ducks) Northern Shoveler Green-winged Teal Surf Scoter Bufflehead Ruddy Duck	33
<b>ORDER</b>	<b>ACCIPITRIFORMES</b> (Eagles, hawks, kites, vultures)	15
<b>FAMILY</b>	<b>CATHARTIDAE</b> (New World vultures, condors) Turkey Vulture	2
<b>FAMILY</b>	<b>ACCIPITRIDAE</b> (Hawks, eagles, harriers, kites) Red-tailed Hawk Cooper's Hawk Sharp-shinned Hawk Northern Harrier Red-shouldered Hawk*	13
<b>ORDER</b>	<b>FALCONIFORMES</b> (Falcons)	4
<b>FAMILY</b>	<b>FALCONIDAE</b> (Falcons) American Kestrel Peregrine Falcon	4

**IB104 TOTAL SPECIES LIST FOR BIRD LABS (112 species)****No. spp. in Bay Area**

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<b>ORDER</b>	<b>GALLIFORMES</b> (Chickens, pheasant, grouse, quail, turkeys)	4 (3 non-native)
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<b>FAMILY</b>	<b>ODONTOPHORIDAE</b> (New World quail) California Quail	1
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<b>ORDER</b>	<b>GRUIFORMES</b> (Rails, cranes)	8
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<b>FAMILY</b>	<b>RALLIDAE</b> (Rails) American Coot Ridgway's Rail	7
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<b>ORDER</b>	<b>CHARADRIIFORMES</b> (Plovers, sandpipers, gulls, jaegers, terns, auks)	70
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<b>FAMILY</b>	<b>CHARADRIIDAE</b> (Plovers) Black-bellied Plover Killdeer	7
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<b>FAMILY</b>	<b>RECURVIROSTRIDAE</b> (Avocets, stilts) Black-necked Stilt American Avocet	2
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<b>FAMILY</b>	<b>SCOLOPACIDAE</b> (Sandpipers) Willet Whimbrel Marbled Godwit Western Sandpiper Least Sandpiper Dunlin Short-billed Dowitcher	29
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<b>FAMILY</b>	<b>LARIDAE</b> (Gulls, terns) Ring-billed Gull Western Gull Glaucous-winged Gull Forster's Tern	19
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<b>FAMILY</b>	<b>ALCIDAE</b> (Auks, puffins) Common Murre	8
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<b>ORDER</b>	<b>COLUMBIFORMES</b> (Pigeons, doves)	4 (2 non-native)
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<b>FAMILY</b>	<b>COLUMBIDAE</b> (Pigeons, doves) Rock Pigeon Band-tailed Pigeon Mourning Dove	4 (2 non-native)
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**IB104 TOTAL SPECIES LIST FOR BIRD LABS (112 species)**
**No. spp. in Bay Area**

ORDER		No. spp. in Bay Area
<b>ORDER</b>	<b>CUCULIFORMES</b> (Cuckoos)	1
<b>FAMILY</b>	<b>CUCULIDAE</b> (Cuckoos) Greater Roadrunner	1
<b>ORDER</b>	<b>STRIGIFORMES</b> (Owls)	10
<b>FAMILY</b>	<b>TYTONIDAE</b> (Barn owl) Western Barn Owl	1
<b>FAMILY</b>	<b>STRIGIDAE</b> (Typical owls) Great Horned Owl Burrowing Owl	9
<b>ORDER</b>	<b>CAPRIMULGIFORMES</b> (Goatsuckers, nightjars, swifts, hummingbirds)	9
<b>FAMILY</b>	<b>CAPRIMULGIDAE</b> (Goatsuckers or nightjars) Common Poorwill	2
<b>FAMILY</b>	<b>APODIDAE</b> (Swifts) White-throated Swift	3
<b>FAMILY</b>	<b>TROCHILIDAE</b> (Hummingbirds) Anna's Hummingbird* Allen's Hummingbird	4
<b>ORDER</b>	<b>CORACIIFORMES</b> (Kingfishers)	1
<b>FAMILY</b>	<b>ALCEDINIDAE</b> (Kingfishers) Belted Kingfisher	1
<b>ORDER</b>	<b>PICIFORMES</b> (Woodpeckers)	8
<b>FAMILY</b>	<b>PICIDAE</b> (Woodpeckers) Acorn Woodpecker Nuttall's Woodpecker* Downy Woodpecker Northern Flicker* Red-breasted Sapsucker	8
<b>ORDER</b>	<b>PASSERIFORMES</b> (Songbirds)	104
<b>FAMILY</b>	<b>TYRANNIDAE</b> (Flycatchers, phoebes, kingbirds) Western Wood-pewee Pacific-slope Flycatcher* Black Phoebe*	7
<b>FAMILY</b>	<b>LANIIDAE</b> (Shrikes) Loggerhead Shrike	1

**IB104 TOTAL SPECIES LIST FOR BIRD LABS (112 species)****No. spp. in Bay Area**

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<b>FAMILY</b>	<b>VIREONIDAE</b> (Vireos) Hutton's Vireo* Warbling Vireo	3
<b>FAMILY</b>	<b>CORVIDAE</b> (Jays, crows, magpies, ravens) Steller's Jay California Scrub-Jay American Crow Common Raven	5
<b>FAMILY</b>	<b>ALAUDIDAE</b> (Larks) Horned Lark	1
<b>FAMILY</b>	<b>HIRUNDINIDAE</b> (Swallows) Violet-green Swallow Cliff Swallow	6
<b>FAMILY</b>	<b>PARIDAE</b> (Chickadees, titmice) Chestnut-backed Chickadee Oak Titmouse	2
<b>FAMILY</b>	<b>AEGITHALIDAE</b> (Penduline tits) Bushtit	1
<b>FAMILY</b>	<b>SITTIDAE</b> (Nuthatches) Red-breasted Nuthatch	3
<b>FAMILY</b>	<b>CERTHIIDAE</b> (Creepers) Brown Creeper*	1
<b>FAMILY</b>	<b>TROGLODYTIDAE</b> (Wrens) Bewick's Wren Marsh Wren* House Wren	6
<b>FAMILY</b>	<b>REGULIDAE</b> (Kinglets) Ruby-crowned Kinglet Golden-crowned Kinglet	2
<b>FAMILY</b>	<b>TURDIDAE</b> (Thrushes) American Robin* Varied Thrush Hermit Thrush* Western Bluebird	6

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<b>FAMILY</b>	<b>SYLVIIDAE</b> (Sylviid babblers) Wrentit*	1
<b>FAMILY</b>	<b>MIMIDAE</b> (Mimic thrushes - mockingbirds, thrashers, catbirds) Northern Mockingbird California Thrasher	2
<b>FAMILY</b>	<b>STURNIDAE</b> (Starlings, mynahs) European Starling	1
<b>FAMILY</b>	<b>MOTACILLIDAE</b> (Pipits) American Pipit	1
<b>FAMILY</b>	<b>BOMBYCILLIDAE</b> (Waxwings) Cedar Waxwing	1
<b>FAMILY</b>	<b>PARULIDAE</b> (Wood warblers) Yellow-rumped Warbler Townsend's Warbler Orange-crowned Warbler Wilson's Warbler* Common Yellowthroat	11
<b>FAMILY</b>	<b>PASSERELLIDAE</b> (North American sparrows) Spotted Towhee* California Towhee* Savannah Sparrow Song Sparrow* Fox Sparrow White-crowned Sparrow Golden-crowned Sparrow Dark-eyed Junco*	19
<b>FAMILY</b>	<b>CARDINALIDAE</b> (Cardinals, grosbeaks, North American buntings, temperate tanagers) Black-headed Grosbeak	4
<b>FAMILY</b>	<b>ICTERIDAE</b> (Blackbirds, orioles, meadowlarks, cowbirds) Red-winged Blackbird* Brewer's Blackbird Brown-headed Cowbird Bullock's Oriole Western Meadowlark*	9



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**IB104 TOTAL SPECIES LIST FOR BIRD LABS (112 species)****No. spp. in Bay Area**

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<b>FAMILY</b>	<b>FRINGILLIDAE (Finches)</b>	<b>8</b>
	Lesser Goldfinch	
	American Goldfinch	
	House Finch*	
	Purple Finch	
	Pine Siskin	
<b>FAMILY</b>	<b>PASSERIDAE (Old-world Sparrows)</b>	<b>1</b>
	House Sparrow	

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**\*20 species for which you must know vocalizations.**

**Note: You do *not* have to know the number of species in the Bay Area. This is provided to give you an idea of the local diversity of these groups.**

## What you must know for the bird labs

1. **Taxonomy** – You must know the common name (English name) of every species, and the Latin name of the class, order, and family to which each belongs.
2. **Seasonal status** of all species according to the following categories (you can use the abbreviations): **Resident (R)**; present all year, breeds in Bay Area); **Winter (W)**; does not breed in Bay Area); **Spring & summer (S)**; breeds in Bay Area); **Migrant (M)**; passes through Bay Area in spring or fall as a migrant, but does not breed).
3. **Habitat of all species.** For most, you can categorize the habitat according to the following categories (see Fig. 4 in your lab manual for a description of the habitats): **Aquatic, Wetland, Grassland, Chaparral, Woodland, Forest, Urban, Widespread.** Although it is given in the species information below, you do not need to know the relative abundance of species (i.e., uncommon, common, etc.).
4. **Diet** – know the main components of the diets of all species, especially dietary specialists.
5. **Non-native species** – Rock Pigeon, European Starling, & House Sparrow are all native to Eurasia.
6. **Bird topography & morphology** – you must know the meaning of the following terms and be able to point them out on a bird: crown, culmen, auriculars (ear coverts), gape, hallux (hind toe), lower mandible, lores, under tail coverts, nape, primaries, rectrices (tail feathers), remiges (wing feathers), rictal bristles, secondaries, supercilium, tarsus, upper mandible, and upper tail coverts. We will use these terms when we describe the appearance of birds. See Figure 5.
7. You must also know the following **foot forms** and the groups that exhibit them: anisodactyl (three toes forward and one back), zygodactyl (two toes forward and two back), syndactyl (two or more digits fused), pamprodactyl (all four toes point forward), totipalmate (all four toes webbed).
8. **Vocalizations** – you must be able to identify the following 20 species from the recordings provided: Red-shouldered Hawk, Anna's Hummingbird, Nuttall's Woodpecker, Northern Flicker, Pacific-slope Flycatcher, Black Phoebe, Hutton's Vireo, Brown Creeper, Marsh Wren, American Robin, Hermit Thrush, Wrentit, Wilson's Warbler, Spotted Towhee, California Towhee, Song Sparrow, Dark-eyed Junco, Red-winged Blackbird, Western Meadowlark, and House Finch. (See section on recordings for more information).

9. **Plumages** – you must be able to differentiate between male & female, adult & immature, breeding & non-breeding plumages for select species, as noted in the species accounts.
10. **Interesting natural history information** (if mentioned in class or in the species accounts) – e.g., nesting behavior, displays, etc.
11. **California near endemics** – we will learn four species that are nearly endemic to California (i.e., their geographic ranges are almost entirely within California): Allen’s Hummingbird, Nuttall’s Woodpecker, Oak Titmouse, & California Thrasher.
12. **Spelling** – all names and terms must be spelled correctly.

\*Note: This guide (along with any additional information given in lab) contains the information that you need to know for the bird labs. If there is a discrepancy in the information given in your lab book and in this guide, defer to this guide.

# Birds of the San Francisco Bay Area: Natural History Notes

The following natural history notes summarize what you need to know for each of these species and groups (although additional information could be given in the labs). The descriptions are given to help you differentiate between these groups. You don't need to know the descriptions per se – i.e., you don't have to tell us how you identified a bird. But you could be asked to name a bird that is zygodactyl or asked the color of the remiges of a bird in front of you.

## **ORDER GAVIIFORMES** (Loons)

**FAMILY GAVIIDAE** (Loons). Diving birds with straight, pointed bills and webbed feet placed far back on body. Compressed tarsi. Larger and stockier than grebes. Primarily piscivorous. Three species regularly occur in the winter in the Bay Area, mainly in coastal (saltwater) aquatic habitats.

### **Common Loon**

## **ORDER PODICIPEDIFORMES** (Grebes)

**FAMILY PODICIPEDIDAE** (Grebes). Straight, usually sharp bill. Relatively long necks in most. Compressed tarsi. Lobed toes. Six species regularly occur in the Bay Area in various aquatic habitats. All except the Pied-billed Grebe occur only in winter. Diet is primarily small fish, but also includes small crustaceans and insects. Sexes are alike. Build nests of floating vegetation and have elaborate courtship displays.

### **Clark's Grebe**

## **ORDER SULIFORMES** (Cormorants, gannets)

**FAMILY PHALACROCORACIDAE** (Cormorants). Diving birds with hooked bills, long necks, long stiff tails, totipalmate feet and small gular pouches. Most are predominantly black in color. Three species occur as residents in the Bay Area. Two species occur only near the coast, but the Double-crested Cormorant occurs widely in a variety of aquatic habitats. Primarily piscivorous.

**Double-crested Cormorant** – Double crests on side of head occur only in breeding plumage in the spring. Bright yellow gular pouch. Often seen with wings extended. You must be able to differentiate between breeding and nonbreeding plumages for this species.

## **ORDER PELECANIFORMES** (Pelicans, herons, egrets).

**FAMILY PELECANIDAE** (Pelicans). Large diving birds with totipalmate (all four toes webbed) feet and unfeathered, distensible gular pouches. The two species that occur in the Bay Area exhibit very different foraging strategies (freshwater American White Pelicans corral fish while swimming in a group, while saltwater Brown Pelicans plunge dive for fish).

**Brown Pelican** – Present year-round in coastal aquatic habitats in the Bay Area (although it does not breed here). Primarily piscivorous.

**FAMILY ARDEIDAE** (Hérons, egrets). Straight, pointed bills. Long legs and necks. Lax plumage. Claw on middle toe is pectinate (comb-like), and aids in preening. Seven species regularly occur in the Bay Area.

**Great Blue Heron** – Common resident in the Bay Area, mainly in aquatic and wetland habitats. Diet consists mainly of small fish, but will eat virtually any small vertebrate. Nests colonially in trees.

**Black-crowned Night-Heron** – Common resident in the Bay Area, in aquatic and wetland habitats. Diet consists mainly of small fish, but eats a variety of small vertebrate and invertebrate prey, and eggs of nesting birds. You must be able to differentiate between adult and immature plumages for this species. Black, gray, and white adult plumage is distinct from streaked brown immature plumage.

**ORDER ANSERIFORMES** (Swans, geese, ducks).

**FAMILY ANATIDAE** (Swans, geese, ducks). Bill broad and flattened and lamellate (sieve-billed) in most. Front toes are webbed and hallux is elevated. Over 30 species occur regularly in the Bay Area, most only in winter. All occur in aquatic habitats; some are ‘dabbling’ ducks (i.e., feed below the surface of the water by upending) and some are ‘diving’ ducks (feed by diving for vertebrate and invertebrate prey). Males have distinctive breeding plumages. You must be able to differentiate between male and female plumages for all duck species.

**Northern Shoveler** – Dabbling duck. Present in winter only.

**Green-winged Teal** – Dabbling duck. Present in winter only.

**Bufflehead** – Diving duck. Present in winter only. Feeds mainly on small aquatic invertebrates. Nest in holes in trees.

**Surf Scoter** – Diving duck. Present in winter only. Feeds mainly on mussels in winter.

**Ruddy Duck** – Small diving ducks with stiff, cocked tails. Resident in the Bay Area. You must be able to differentiate between male and female & breeding and nonbreeding plumages for this species. Males have a distinctive ruddy breeding plumage with a bright blue bill.

**ORDER ACCIPITRIFORMES** (Vultures, eagles, hawks, kites, harriers, osprey). Diurnal birds of prey. Fifteen species regularly occur in the Bay Area; more than half are resident.

**FAMILY CATHARTIDAE** (New World vultures, condors). Unfeathered heads. Moderately hooked bills with large oval perforate nostrils. Weakly raptorial feet are not equipped for grasping prey.

**Turkey Vulture** – Common resident in the Bay Area. Distinctive soaring flight, tilting side to side with wings in a shallow ‘V’. Feeds on carrion. Well-developed sense of smell aids in finding carrion. Uses projectile vomit to defend itself. Cools itself in the summer by urohydrolysis.

**FAMILY ACCIPITRIDAE** (Eagles, hawks, kites, harriers). Strongly hooked bills and raptorial feet. Females are larger than males in most species.

**Cooper's Hawk** – Medium-sized hawk with short, rounded wings and long tail that allows it to maneuver through woods. Fairly common resident in the Bay Area, mainly in woodland and urban park habitats. Prey is mainly birds, although it preys on other small vertebrates as well. Rectrices (tail feathers) are graduated, giving a fan-like appearance to the spread tail. Female is larger than male. You must be able to differentiate between adult and immature plumages for this species. Immature has brown upper parts with a brown *streaked* breast. Adult has slate gray upper parts with a rufous *barred* breast. Compare to Sharp-shinned Hawk.

**Sharp-shinned Hawk** – Like a smaller version of the Cooper's Hawk. Mainly winters in the Bay Area in woodland habitats. Prey is mainly small birds. Rectrices are of uniform length, giving it a squared-off appearance. Female is larger than male, and approaches the size of a male Cooper's Hawk. You must be able to differentiate between adult and immature plumages for this species. Immature has brown upper parts with a brown *streaked* breast. Adult has slate gray upper parts with a rufous *barred* breast. Compare to Cooper's Hawk.

**Red-shouldered Hawk** – A common hawk in the Bay Area, present in urban, woodland, and (especially) riparian habitats. Probably the most vocal of all local raptors. Note the light crescent at the base of the primaries on the spread wing, and black and white (or black and brown for immature) coloration on the remiges. Diet consists of a variety of small vertebrates. Common on the Berkeley campus. You must know the vocalizations of this species. Compare to Red-tailed Hawk and Cooper's Hawk.

**Red-tailed Hawk** – Most common hawk in the Bay Area, present in a wide variety of habitats (mainly open) throughout the year. Plumage is highly variable, but in flight, the dark patagial mark (on the leading edge of the bottom side of the wing) is diagnostic. Prey is mainly small mammals (ground squirrels, mice, young cottontails, gophers), but also preys on birds and snakes. Female is larger than male. Utters a distinctive scream that is used generically as the vocalization of virtually any large soaring bird in movies. You must be able to differentiate between adult and immature plumages for this species. Immature plumage lacks the rufous tail. Compare to Red-shouldered Hawk.

**Northern Harrier** – Fairly common resident in grassland and wetland habitats in the Bay Area, where it hunts a variety of small vertebrate prey (rodents, frogs, snakes, birds). Often seen flying close to the ground with wings in a distinctive 'V'. White upper tail coverts are distinctive. Sexually dimorphic in plumage. Immature has distinct plumage that is similar to the female. Harriers have facial discs that give their faces an 'owl-like' appearance and aid in hearing prey. Nests on the ground in high grass. You must be able to differentiate between male and female plumages for this species.

**ORDER FALCONIFORMES** (Falcons, caracaras, forest falcons, falconets).

**FAMILY FALCONIDAE** (Falcons). Strongly hooked bills with tomial tooth (distinct 'step' in upper mandible). Nostrils circular with bony tubercles. Long pointed wings. Raptorial feet. Four species present in the Bay Area.

**American Kestrel** – Small, colorful falcon. Common resident in Bay Area in a wide variety of open habitats – open woodland, grassland, and wetland. Preys mainly on large insects (grasshoppers, dragonflies, Jerusalem crickets) and voles, but takes a few small birds and reptiles. Often seen hovering. Nests in old woodpecker holes and other tree cavities. You must be able to differentiate between male and female plumages for this species. Male is smaller than female and has a more colorful plumage pattern (more blue on the wings).

### **Peregrine Falcon**

**ORDER GALLIFORMES** (Chickens, pheasants, partridges, quail, grouse, turkeys).

**FAMILY ODONTOPHORIDAE** (New World quail). Bills stout and arched in profile. Elevated hallux.

**California Quail** – Common resident in the Bay Area in chaparral and open woodland with a brushy understory. Feeds on seeds, foliage, fruit, and a few insects. You must be able to differentiate between male and female plumages for this species. Male is more colorful than female and head plume is more developed.

**ORDER GRUIFORMES** (Cranes and rails). Mainly aquatic or marsh-dwelling birds that lack webbed feet.

**FAMILY RALLIDAE** (Rails). Chicken-like birds with laterally compressed bodies ('skinny as a rail'). Bills of variable lengths and shapes. Nostrils perforate. Short, rounded wings. All of the species occur in aquatic or wetland habitats, and six of the seven regularly occurring species in the Bay Area are resident.

**American Coot** – Short, stout, chicken-like bill and lobed toes. Common resident in the Bay Area in aquatic habitats. Omnivorous – feeds on aquatic and terrestrial vegetation, small fishes, tadpoles, snails, insects.

**Ridgway's Rail** – Uncommon, secretive resident of Bay Area salt-marsh (wetland) habitats. Feeds on salt-marsh invertebrates. Compare to shorebirds (Scolopacidae).

**ORDER CHARADRIIFORMES** (Plovers, sandpipers, gulls, terns, skimmers, skuas, auks). Diverse group of birds, most occurring near aquatic or wetland habitats.

**FAMILY CHARADRIIDAE** (Plovers). Usually 3 toes (no hallux). Bill of moderate length, constricted in the middle and swollen at the tip ('pigeon-like'). Often found in more upland habitats away from water compared to other shorebirds.

**Killdeer** – Common resident in the Bay Area in a variety of open habitats – wetlands, mudflats, farm fields, golf courses, dirt parking lots, etc. Eats small invertebrates. Sometimes nests on the gravel roofs of buildings. Very vocal. Performs distraction display in which it feigns injury to lead potential predators away from concealed nest.

**Black-bellied Plover** – The only locally occurring plover with four toes (although hallux is reduced). Occurs in the Bay Area in winter, mainly in wetland habitats. Diet consists of small aquatic invertebrates.

**FAMILY RECURVIROSTRIDAE** (Avocets, stilts). Long, slender shorebirds with long necks and long, thin bills. Both are common residents of the Bay Area in wetland habitats. Diets consist of small aquatic invertebrates such as brine shrimp and other small crustaceans.

**Black-necked Stilt** – Extremely long, red legs that trail behind the bird in flight. Thin straight bill is shorter than that of the American Avocet.

**American Avocet** – Sexually dimorphic: bill of female is more recurved than male. Winter (non-breeding) plumage is less colorful than breeding plumage. You must be able to differentiate between male and female & breeding and nonbreeding plumages for this species.

**FAMILY SCOLOPACIDAE** (Sandpipers). Soft (in life) slender bill of variable length with flexible tip. Four toes in most. Most occur only in winter in the Bay Area in wetland or aquatic habitats. Diet consists primarily of aquatic invertebrates (crabs, mollusks, marine worms, insects, amphipods, etc.). Many have distinct breeding and non-breeding plumages. In this group, you will not be asked whether a particular specimen is in breeding or non-breeding plumage, but you may have to identify *species* in the different plumages.

**Willet** – Occurs in the Bay Area in winter, mainly in wetland habitats.

**Whimbrel** – Occurs in the Bay Area in winter, mainly in wetland habitats. Decurved bill. Compare to Marbled Godwit.

**Marbled Godwit** – Occurs in the Bay Area in winter, mainly in wetland habitats. Recurved bill. Compare to Whimbrel.

**Western Sandpiper** – Distinct breeding and non-breeding plumages. Compare with Least Sandpiper. Occurs in the Bay Area in winter, mainly in wetland habitats. Compare to Least Sandpiper and Dunlin. Western Sandpiper has a paler breast and dark legs.

**Least Sandpiper** – Distinct breeding and non-breeding plumages. Occurs in the Bay Area in winter, mainly in wetland habitats. Compare to Western Sandpiper and Dunlin. Least Sandpiper has a browner breast and yellow legs.

**Dunlin** – Distinct breeding and non-breeding plumages. Occurs in the Bay Area in winter, mainly in wetland habitats. Compare to Western Sandpiper and Least Sandpiper. Dunlin has a longer slightly decurved bill.

**Short-billed Dowitcher** – Distinct breeding and non-breeding plumages. Occurs in the Bay Area in winter, mainly in wetland habitats.

**FAMILY LARIDAE** (Gulls, terns). Gulls present some of the most difficult identification challenges in birds. Male and female plumages are alike, but adults and immatures can be very different. Immatures are grayish-brown, and go through a series of distinct plumages over two to four years before reaching the gray, black, and white pattern typical of most adult gulls. We will greatly simplify gull identification in this course, but you will have to be able to identify three species in either immature or adult plumage. Approximately 12 species of gull regularly occur in aquatic, wetland, and urban habitats in the Bay Area, but only two species breed here. All of the species we will learn are omnivorous scavengers, eating a wide variety of animal food (fish, invertebrates, birds' eggs) and supplementing



this with garbage. Five species of tern occur regularly in the Bay Area. Terns frequently hover and dive for fish.

**Ring-billed Gull** – Common in the Bay Area in winter in aquatic, wetland, and urban habitats.

**Western Gull** – The most common gull in the Bay Area, resident in aquatic and urban habitats, never very far from the coast. Hybridizes with Glaucous-winged Gull in the Pacific Northwest, and hybrids and various intergrades between the two are common here in winter.

**Glaucous-winged Gull** – Common in the Bay Area in winter in aquatic and urban habitats.

**Forster's Tern** – Fairly common resident of the Bay Area in aquatic habitats. Diet consists of fish and insects.

**FAMILY ALCIDAE** (Auks, puffins). Pelagic (ocean-going) birds that occupy a similar niche in the Northern Hemisphere as that occupied by penguins in the Southern Hemisphere (although they are not closely related). Eight species regularly occur in the Bay Area, but most are offshore and go unnoticed by most observers. Four species (including Tufted Puffins) nest on the Farallon Islands, 20 miles offshore from Point Reyes. Like penguins, alcids propel themselves underwater using their stiff wings in pursuit of fish or marine invertebrates, like krill. Unlike penguins, alcids are not flightless, although they are not strong fliers. Pigeon Guillemots and Common Murres are common on the coast in spring and summer.

**Common Murre** – Resident in the Bay Area in coastal waters, but much more common in the spring and summer. Piscivorous. Can easily be seen nesting on rocks offshore in Marin Co. (e.g., below the Pt. Reyes lighthouse).

#### **ORDER COLUMBIFORMES** (Pigeons, doves).

**FAMILY COLUMBIDAE** (Pigeons, doves). Small, slender bill with a soft base and a horny, decurved tip. The middle of the bill is constricted with slit-like nostrils, which are overhung by an operculum. Four species are resident in the Bay Area; two are non-native.

**Rock Pigeon** – Native to Eurasia and North Africa. Natural populations nest on ledges on cliffs. Feral populations have adapted well to ledges on buildings in towns and cities. A wide variety of plumages are encountered as a result of domestication. Birds with wild-type plumage are encountered commonly as well. Very common resident in the Bay Area, mainly in urban settings or at least near human dwellings. Diet consists of grain, seeds, fruit, donuts, French fries, pizza, potato chips, bread crumbs, chocolate sundaes, cheeseburgers, fried chicken, etc.

**Band-tailed Pigeon** – Fairly common resident in forest and woodland in the Bay Area. Diet consists of acorns, grain, fruits, seeds, terminal buds of live oaks. Crush whole acorns with their gizzards.

**Mourning Dove** – Common resident in open habitats (open woodland, grassland) in the Bay Area. Diet consists of grains and seeds.

#### **ORDER CUCULIFORMES** (Cuckoos).

**FAMILY CUCULIDAE** (Cuckoos). Bill curved, either slender or stout. Skin near eyes often bare and colored. Medium or long wings and tail. Feet zygodactyl. One species regularly occurs in the Bay Area.

**Greater Roadrunner** – Uncommon resident in open woodland and chaparral in the eastern and southern extremes of the Bay Area. Diet consists of a wide range of small animal food – large terrestrial invertebrates and small terrestrial vertebrates, such as lizards, snakes, and birds.

**ORDER STRIGIFORMES** (Owls). Nocturnal birds of prey with hooked bills, raptorial feet, and circular facial discs that help to gather sound. Ten species regularly occur in the Bay Area. Serrated edges to primary feathers allow silent flight.

**FAMILY TYTONIDAE** (Barn owls). Triangular, or heart-shaped facial discs. Nail of the middle toe is pectinate.

**Barn Owl** – Common resident in the Bay Area in open habitats (e.g., grasslands). Diet consists mainly of rodents, like mice and gophers. Strongly nocturnal. Often nest and roost in barns or other human structures.

**FAMILY STRIGIDAE** (Typical owls). Circular facial discs. Most are nocturnal, but a few are partially nocturnal or diurnal. Plumage tufts ('ears') are often present on head.

**Great-horned Owl** – large owl with prominent tufts on head. Common resident in Bay Area in a wide range of habitats – wetland, grassland, woodland, urban, etc. Preys on a wide variety of animals: mice, squirrels, rabbits, hares, skunks, birds (including grouse, hawks, other owls), reptiles, amphibians, and insects. Nests in old hawk or crow nests or on cliffs. Hunts at night and at crepuscular hours. Male and female often heard calling back and forth (female hoot is higher pitched).

**Burrowing Owl** – Medium-sized diurnal owl that lives in burrows made by other animals (mainly *Otospermophilus* in the Bay Area). Uncommon resident in the Bay Area in grassland habitats (and becoming more uncommon due to development). Diet consists of a variety of small animal prey: insects, scorpions, small mammals, birds, and reptiles.

**ORDER CAPRIMULGIFORMES** (Nightjars, goatsuckers, swifts, hummingbirds).

**FAMILY CAPRIMULGIDAE** (Nightjars, goatsuckers). Primarily nocturnal or crepuscular birds that hunt on the wing for aerial insects, such as beetles or moths. Soft, cryptically colored plumage. Small, weak, depressed, slightly hooked bill with a very wide gape. Long wings and small, weak feet. Nail of middle toe pectinate. Rictal bristles usually prominent. Two species regularly occur in the Bay Area.

**Common Poorwill** – Uncommon to rare resident in the Bay Area in woodland and chaparral. One of the few birds known to go into torpor

**FAMILY APODIDAE** (Swifts). Fast-flying aerial predators. Plumage of most is black, white, and gray. Long, sickle-shaped wings with very short secondaries. Pamprodactyl, with small weak feet. Spend most of day in flight. Three species regularly occur in the Bay Area.

**White-throated Swift** – Common resident in the Bay Area (although more common in spring and summer). Diet consists of small flying insects caught on the wing. One of the fastest flying birds in the world; can reach speeds close to 200 mph in dives.

**FAMILY TROCHILIDAE** (Hummingbirds). Small, nectar-feeding birds with slender, straight bills of variable lengths. Long, flat, pointed wings with very short secondaries. Small weak feet. Brilliant iridescent colors in both sexes, but males usually brightest. The two species we will learn have elaborate dive displays. Four species regularly occur in the Bay Area.

**Anna's Hummingbird** – Common resident in the Bay Area in woodland and chaparral and in towns and suburbs. Diet consists of flower nectar and tiny insects. Male performs dive display that culminates in a loud 'chirp' made by the male's outer tail feathers. You must be able to differentiate between male and female plumages for this species. Sexually dimorphic – male has bright purplish-pink crown. You must know the vocalizations of this species.

**Allen's Hummingbird** – Fairly common spring breeder in the Bay Area. Perhaps the earliest spring migrant in the Bay Area; males arrive to the breeding grounds in January and depart in May. A near-endemic to California – its range barely reaches southern Oregon. Occurs in woodland and chaparral habitats. Diet consists of flower nectar and tiny insects. Male performs dive display with trilling sounds produced by wings. You must be able to differentiate between male and female plumages for this species. Male plumage has much more iridescent orange (female is greener).

#### **ORDER CORACIIFORMES** (Kingfishers).

**FAMILY ALCEDINIDAE** (Kingfishers). Long, straight, sharp bill. Moderately long and slightly rounded tail. Moderately long, pointed wings. Small, weak feet are syndactyl (second and third digits are joined). Very short tarsi. Head frequently crested.

**Belted Kingfisher** – Fairly common resident in the Bay Area in various aquatic habitats. Nest in burrows that it excavates in the soft earth in stream banks, roadcuts, etc. Plunge-dives to catch fish, its primary prey. This species exhibits reverse sexual dimorphism: female has bright rufous belly band. You must be able to differentiate between male and female plumages for this species.

#### **ORDER PICIFORMES** (Woodpeckers).

**FAMILY PICIDAE** (Woodpeckers). Strong, straight chisel-like bills and reinforced skulls allow woodpeckers to forage for wood-boring insects and their larvae. Strong zygodactyl feet with strong, decurved nails, and stiff, pointed retrices allow them to grasp and brace themselves on vertical surfaces. Woodpeckers play important ecological roles in their communities by providing nesting sites for a variety of animals that cannot drill their own nest cavities. Ducks (e.g., buffleheads), falcons (e.g., kestrels), small owls, passerines (e.g., *Myiarchus* flycatchers, swallows, chickadees, bluebirds, and starlings), and flying squirrels all utilize abandoned woodpecker holes.

**Acorn Woodpecker** – Common resident in the Bay Area in oak woodland. Diet consists of acorns and insects. Maintain large granaries of acorns in small cavities drilled into trees or wooden structures. Live in large groups and breed cooperatively.

**Red-breasted Sapsucker** – Uncommon in winter in the Bay Area in woodland and forest (often in fruit trees). Drill small, orderly sets of holes in tree trunks, then return later to harvest the sap and the insects attracted to the sap. Also feed on cambium of trees.

**Nuttall's Woodpecker** – Fairly common resident in oak woodland in Bay Area. Diet consists mainly of insects and arthropods (not acorns). A near-endemic to California – its range extends into Baja California. Probably the most common species of woodpecker on the Berkeley campus. You must be able to differentiate between male and female plumages for this species. Male has a red nape. You must know the vocalizations of this species. Compare to Downy Woodpecker.

**Downy Woodpecker** – Uncommon resident in the Bay Area, mainly in deciduous woodland. Diet consists mainly of the larvae of wood-boring insects. You must be able to differentiate between male and female plumages for this species. Male has a red nape. Compare to Nuttall's Woodpecker.

**Northern Flicker** – Salmon color of undersides of wings and tail are distinctive. Common resident in the Bay Area in woodland habitats (including parks). Diet consists mainly of ants and beetles that it digs for on the ground. You must be able to differentiate between male and female plumages for this species. You must know the vocalizations of this species.

**ORDER PASSERIFORMES** (Songbirds, perching birds, passerines). The most numerous and diverse order of birds (more than half of all species). Many have elaborate songs. Anisodactyl feet with well-developed hind claw close automatically on perch.

**FAMILY TYRANNIDAE** (Flycatchers). Relatively broad-based, flat bills. Plumage among species within the different genera is often very similar. Often voice is the best way to distinguish between species. Songs are innate (not learned) and are relatively simple. Many exhibit 'flycatching' behavior – sallying forth from a perch to catch flying insects. Almost all are Neotropical migrants that spend only the spring and summer in the Bay Area (when flying insects are most abundant). Plumages of sexes are alike. Some species (genus *Myiarchus*) nest in cavities (in old woodpecker holes or nest boxes)

**Western Wood-pewee** – Present in the Bay Area in spring and summer in woodland and forest habitats. Diet consists of flying insects. Compare to Pacific-slope Flycatcher.

**Pacific-slope Flycatcher** – Common spring and summer breeder in the Bay Area in cool woodland and forest habitats, often near creeks or streams. Present each year on the Berkeley campus (one nesting on the Free Speech Café a few years ago). Diet consists of insects, caught on the wing and gleaned from foliage. You must know the vocalizations of this species. Compare to Western Wood-pewee, Hutton's Vireo, and Ruby-crowned Kinglet. You must know the vocalizations of this species.

**Black Phoebe** – Common resident in the Bay Area in open habitats – open woodland, wetlands, lawns – usually near water. Common on the Berkeley campus. Often seen flycatching outside of VLSB. Diet consists of insects, caught on the wing or on the ground. You must know the vocalizations of this species

**FAMILY LANIIDAE** (Shrikes). Predatory songbirds with strong, hooked bills. Lack raptorial feet. One species is resident in the Bay Area and another occurs rarely in winter. Both occur in open habitats – grassland and wetlands. Diet consists of large insects and small vertebrates such as mice, birds, and

lizards. Shrikes impale prey on thorns, twigs, or barbed wire fences. This allows the bird to tear its prey apart (since it lacks raptorial feet) and may also function as a territory marker. Plumages of sexes are alike.

**Loggerhead Shrike** – Uncommon (and probably declining) resident of Bay Area grasslands and wetlands. Often seen perched on power lines or fences in open country. Compare to Northern Mockingbird.

**FAMILY VIREONIDAE** (Vireos). Small insectivorous birds that occur in woodlands and forests in the Bay Area. Vireos are superficially similar to wood-warblers, but have thicker, hooked bills and are more deliberate in their movements. Most species are Neotropical migrants (not Hutton's). Vireos have the interesting habit of singing while sitting on the nest. Plumages of sexes are alike.

**Hutton's Vireo** – Common resident of Bay Area woodland (especially oak woodland), but is more often heard than seen. Several different song syllable types exist, but singing birds typically repeat a single syllable type in a monotonous series, before eventually switching to another syllable type. You must know the vocalizations of this species. Compare to Ruby-crowned Kinglet and Warbling Vireo.

**Warbling Vireo** – Fairly common in spring and summer in Bay Area woodland and forest. Also tends to sing incessantly, but song is more complex than Hutton's Vireo.

**FAMILY CORVIDAE** (Ravens, crows, jays, magpies). Long, strong bill, which is decurved near the tip. Rounded or graduated tail. Large strong feet and tarsi. Nostrils covered with dense, stiff feathers. Five species are resident in the Bay Area. Corvids are omnivorous; diet consists of nuts, fruits, and a wide range of small animals such as insects, lizards, and mice. They are major predators of bird eggs and nestlings. Also commonly scavenge in garbage dumps and picnic grounds. Plumages of sexes are alike. Corvids are some of the most intelligent birds. Vocalizations can be highly variable. Ravens are the largest 'songbirds' in North America

**Steller's Jay** – Common resident of Bay Area woodland and forest – often near people. Will imitate the vocalizations of red-tailed and red-shouldered hawks.

**California Scrub-jay** – Common resident of Bay Area woodland and chaparral.

**American Crow** – Widespread common resident of the Bay Area, often in open habitats. Commonly found on the Berkeley campus.

**Common Raven** – Widespread common resident of the Bay Area, present in a wider variety of habitats than crows. Often in more extreme environments (e.g., desert, alpine). Capable of a wide range of sounds.

**FAMILY ALAUDIDAE** (Larks). Ground dwelling birds that occur in more barren environments. Very long claw on hallux.

**Horned Lark** – The single North American representative of a large family of birds. Uncommon resident in the Bay Area in grassland and wetland habitats (also occurs in California deserts, and, in summer, above treeline in the Sierra Nevada). Diet consists of seeds, grains, and insects. Female has duller plumage and 'horns' are less pronounced.

**FAMILY HIRUNDINIDAE** (Swallows). Aerial insectivores, superficially similar to swifts, but flight is different and wings are broader based. Plumage is much more colorful than swifts. Long, pointed wings with short secondaries, often a forked tail, and small, weak feet and tarsi. Short, broad-based bill. Six species regularly occur in the Bay Area in open habitats such as wetlands and grasslands. Most are present in spring and summer only.

**Violet-green Swallow** – Common widespread resident in the Bay Area. Female plumage is duller than male. Very similar to Tree Swallow. Nests in cavities (e.g., old woodpecker holes or nest boxes).

**Cliff Swallow** – Common widespread spring and summer breeder in the Bay Area. Nest in colonies (some on Berkeley campus). Attach mud nests to cliffs, buildings, bridges, etc.

**FAMILY PARIDAE** (Chickadees, titmice). Straight, stout, relatively conical bill. Strong tarsi and grasping feet. Nests in cavities. Will excavate its own cavity if the wood is soft or rotten. Otherwise uses old woodpecker holes or nest boxes. Plumage of sexes alike.

**Chestnut-backed Chickadee** – Common resident in the Bay Area in woodland and forest. Common on the Berkeley campus. Diet consists of small insects, fruits, and seeds. Often joins mixed species foraging flocks of insectivorous birds in the winter.

**Oak Titmouse** – Common resident in the Bay Area in oak woodland. Rarer on the immediate coast. A near-endemic to California – its range barely extends into southern Oregon. Diet consists of acorns, fruits, and small insects. Crest is distinctive, but not obvious in specimens. Compare to Warbling Vireo, Bushtit, and female House Sparrow.

**FAMILY AEGITHALIDAE** (Penduline tits). Small, straight, compressed bill. Long tail and rounded wings. One species present in North America.

**Bushtit** – Common resident in the Bay Area in woodland and chaparral, and in urban and suburban settings with trees. Diet is mainly small insects and spiders. Outside of the breeding season, often move in large flocks of 20 or more birds. Common on the Berkeley campus. Plumage of sexes alike. Builds pensile nest (of lichen, spider webs, etc.) that resembles an old sock. Nests often predated by scrub-jays.

**FAMILY SITTIDAE** (Nuthatches). Straight, slender, chisel-like bill. Short, square tail. Strong feet and tarsi. Strongly curved nails. Adapted for moving in all directions on tree trunks and limbs. Three species are all resident in the Bay Area in woodland and forest habitats. Plumages of sexes alike. Nests in cavities; excavates its own nest hole.

**Red-breasted Nuthatch** – Diet consists of conifer seeds, and small insects, insect eggs and larva. Common on the Berkeley campus.

**FAMILY CERTHIIDAE** (Creepers). Slender, decurved bill. Rounded tail with stiff, pointed retrices. Strong feet and tarsi with long, curved nails on toes. One species resident in the Bay Area.

**Brown Creeper** – Common resident in the Bay Area in woodland and forest. Forages for invertebrates by climbing on the trunks of trees and probing bark. Often seen moving up the trunk of a tree in a spiral, then flying to the base of another tree and starting over. Plumages of sexes

alike. Builds nests behind loose sections of bark. Nests on the Berkeley campus. Inconspicuous, but high-pitched, thin call notes and song commonly heard. You must know the vocalizations of this species. Compare to wrens.

**FAMILY TROGLODYTIDAE** (Wrens). Slender, decurved, compressed bill. Moderately long tarsi. Rectrices and remiges are often barred. Often with short tails that are held cocked up. Six species are resident in the Bay Area. Primarily insectivorous. Plumages of sexes alike. Many species have loud, complex songs.

**Bewick's Wren** – Common resident in chaparral and woodland with a brushy understory. White eye-stripe. Compare to House Wren.

**Marsh Wren** – Common in wetland areas with thick patches of reeds or cattails. Can be secretive and difficult to see as it skulks among the reeds, but its loud spastic song is hard to miss. Males in the central California have on average a repertoire of over 150 song types. Males build a number of domed nests (sometimes more than 20) woven from cattails, sedge, or grass, which are accepted or rejected by inspecting females. Marsh wrens sometimes destroy the eggs or nestlings of conspecifics or other marsh-dwelling birds (e.g., blackbirds). You must know the vocalizations of this species.

**House Wren** – Common in woodland with a brushy understory. Numbers increase in spring and summer. Will often nest in cavities or nest boxes. Faded tan eyebrow. Compare to Bewick's Wren.

**FAMILY REGULIDAE** (Kinglets). Very small olive-green insectivorous birds with distinctive crown markings. Found mainly in coniferous forest. Two species occur in the Bay Area. Males have more colorful crown markings.

**Ruby-crowned Kinglet** – Common winter visitor in the Bay Area in woodland and forest habitats. Red crown patch is usually concealed. Common on the Berkeley campus. Often joins mixed species foraging flocks of insectivorous birds in the winter. 'Ji-dit' call is frequently heard in winter. Compare to Hutton's Vireo. You must be able to differentiate between male and female plumages for this species.

**Golden-crowned Kinglet** – Uncommon resident in the Bay Area in forest habitats, especially in conifers. Tends to stay high in the canopy. Its high-pitched, sibilant calls are heard more than it is seen. You must be able to differentiate between male and female plumages for this species.

**FAMILY TURDIDAE** (Thrushes). Straight, slender, compressed bills. Strong feet and tarsi. Six species occur in the Bay Area. Diet consists of insects and small arthropods and fruit. Tend to forage on or near the ground. Often have loud musical songs.

**American Robin** – Common resident in a wide variety of habitats in the Bay Area. Common on the Berkeley campus. Often the first species to sing in the dawn chorus. You must be able to differentiate between male and female plumages for this species. Female plumage is duller than males. Compare to Varied Thrush. You must know the vocalizations of this species.

**Varied Thrush** – Similar in appearance to a robin, but short-tailed with a dark breast band, and an orange supercilium and wing bars. Common (though inconspicuous) in the Bay Area in winter, in

cool woodland and forest habitats. Often in oaks. You must be able to differentiate between male and female plumages for this species. Female is duller than male. Compare to American Robin.

**Hermit Thrush** – Common in the Bay Area in winter, in chaparral and woodland habitats. Often runs on the ground. Hermit Thrushes leave the Bay Area in late April as Swainson's Thrushes are arriving. Flutelike song sometimes heard in spring before it departs. Compare to Swainson's Thrush, American Pipit, and Fox Sparrow. You must know the vocalizations of this species.

**Western Bluebird** – Common resident in the Bay Area in open oak woodlands. Diet in summer consists mainly of insects. In winter, eats mainly berries (including mistletoe and poison oak), supplemented by insects. Nests in cavities (e.g., old woodpecker holes or nest boxes). You must be able to differentiate between male and female plumages for this species. Female plumage is duller than male.

#### **FAMILY SYLVIIDAE** (Sylviid Babblers).

**Wrentit** – The wrentit is the only New World representative of a large Old World family of songbirds (the sylviid babblers). Short, rounded wings and long tail. Strong feet and moderately long tarsi. Soft, lax plumage. Common resident in the Bay Area in chaparral and in woodland with a brushy understory. Wrentits are weak, reluctant fliers and tend to skulk in dense brush. Diet is comprised of insects and fruits, including poison oak berries. Plumage of sexes is the same. You must know the vocalizations of this species.

**FAMILY MIMIDAE** (Mimic thrushes). Slender, decurved bill. Long rounded, or graduated tail. Short rounded wings. Strong feet and long, strong tarsi. Two species resident in the Bay Area. Plumages of sexes alike. All perform vocal mimicry to some extent.

**Northern Mockingbird** – Common in open habitats with shrubs, including suburbs, parks, etc. Diet consists of fruit and various insects. An extraordinary vocal mimic; mimics other birds, machines, etc. Mockingbirds are very territorial and will defend patches of berry bushes. Compare to Loggerhead Shrike.

**California Thrasher** – Uncommon skulker in chaparral. More often heard than seen. Diet consists of soil invertebrates, insects, fruit, and seeds. A near-endemic to California – its range extends into Baja California.

**FAMILY STURNIDAE** (Mynahs and starlings). One species resident in the Bay Area. Long, straight pointed bill. Feathers of forehead partially divided by culmen. Short, square tail. Long, pointed wings (giving it a 'caped' appearance when flying). Strong feet.

**European Starling** – Iridescent breeding plumage achieved through feather wear rather than molt. Very common resident in the Bay Area, mainly in open and urban habitats. Omnivorous; diet consists of insects, berries, seeds, and garbage. Non-native; introduced from Europe. Nests in cavities, and can have a detrimental effect on native cavity-nesting birds by evicting or excluding them from potential nesting sites.

**FAMILY MOTACILLIDAE** (Pipits). Ground dwelling birds that occur in more barren environments. Very long, straight claw on hallux. Short, slender, pointed bill. Moderately long tail. Pipits walk or run rather than hop.



**American Pipit** – Fairly common in the Bay Area in winter in wetlands and ploughed fields. Diet consists mainly of insects. Plumages of male and female are the same. Thin, twittering ‘pi-pit’ calls give it its name. Compare to Swainson’s Thrush and Hermit Thrush.

**FAMILY BOMBYCILLIDAE** (Waxwings). Short, stout, straight bill with slightly hooked upper mandible; moderately wide gape. Moderately short, square tail. Soft, dense plumage. Red, waxlike tips to secondaries give them their name.

**Cedar Waxwing** – Flocks are common though erratic in the Bay Area in winter in open woodland (including towns, parks, etc.). Diet consists of fruit and insects. Flocks often seen feeding in late winter on berry bushes on the Berkeley campus. Often detected by their high-pitched lisping calls. Plumages of sexes the same.

**FAMILY PARULIDAE** (Wood-warblers). Bill variable in shape and length, but usually short, slender, straight, and pointed. Most brightly colored, often with yellow plumage. Males usually more colorful than females. Eleven species occur regularly in the Bay Area; nearly all are migratory. Diet consists mainly of insects and their larva.

**Yellow-rumped Warbler** – Plumage is highly variable (with male and female plumages, and adult and immature versions of both), but yellow rump is always present. You do not have to identify the different plumage types as such, but you must be able to identify any plumage type to species. Very common in winter in the Bay Area in a wide variety of habitats. Supplements diet with fruit. This, along with large size (for a warbler), allows it to remain farther north in winter than other warblers. Common on the Berkeley campus. Often joins mixed species foraging flocks of insectivorous birds in the winter. Two distinct subspecies occur in the Bay Area: the more common ‘Audubon’s Warbler’ and the ‘Myrtle Warbler’. Both are distinguishable by plumage and by vocalizations. Compare brownish plumages to American Pipit.

**Townsend’s Warbler** – Common in winter in the Bay Area in woodland and forest habitats. Common on the Berkeley campus. Often joins mixed species foraging flocks of insectivorous birds in the winter.

**Orange-crowned Warbler** – Fairly common resident of the Bay Area in chaparral and in woodland with a brushy understory. Numbers increase when migrants arrive to breed in spring and summer. Orange crown is usually concealed. You must be able to differentiate between male and female plumages for this species. Compare to female Common Yellowthroat.

**Wilson’s Warbler** – Common in spring and summer in the Bay Area in riparian woodland. You must be able to differentiate between male and female plumages for this species. You must know the vocalizations of this species.

**Common Yellowthroat** – Common resident in the Bay Area in wetlands (marshes, fens, etc.). Male and female plumages are distinct. Male is brighter with a distinct mask. You must be able to differentiate between male and female plumages for this species. Compare to Orange-crowned Warbler.

**FAMILY PASSERELLIDAE** (North American sparrows). Short, conical bill with culmen straight or slightly decurved – adapted for feeding on seeds. Strong feet and tarsi. Nineteen species regularly occur in the Bay Area. Diet consists mainly of seeds and insects.

**Spotted Towhee** – Common resident in the Bay Area in chaparral and in woodland with a brushy understory. You must be able to differentiate between male and female plumages for this species. Plumage of female duller than male. You must know the vocalizations of this species. Compare to Black-headed Grosbeak.

**California Towhee** – Common resident in the Bay Area in chaparral and other brushy habitats. Often in parks and gardens. Common on the Berkeley campus. Plumage of sexes alike. You must know the vocalizations of this species.

**Savannah Sparrow** – Common resident in the Bay Area in grassland. Plumage of sexes alike. Compare to Song Sparrow and American Pipit.

**Song Sparrow** – Common resident in the Bay Area in wetlands and in brushy habitats near water. Plumage of sexes alike. You must know the vocalizations of this species. Compare to Savannah Sparrow and Fox Sparrow.

**Fox Sparrow** – Common in winter in the Bay Area in chaparral and in woodland with a brushy understory. Plumage of sexes alike. Compare to Hermit Thrush, Swainson's Thrush, Savannah Sparrow, and Song Sparrow.

**White-crowned Sparrow** – Common resident in the Bay Area in chaparral and other brushy habitats. Often in parks and gardens. Plumage of sexes alike. White-crowned Sparrows are well known for their many regional song dialects, and have been a model organism for the study of song learning in birds. Often in mixed flocks in winter with Golden-crowned Sparrows. You must be able to differentiate between adult and immature plumages for this species. Compare to Golden-crowned Sparrow and female House Sparrow.

**Golden-crowned Sparrow** – Common in winter in the Bay Area in chaparral and in woodland with a brushy understory. Distinct adult and breeding plumages. Compare to White-crowned Sparrow and female House Sparrow.

**Dark-eyed Junco** – Common resident in the Bay Area in open woodland and forest. Common on the Berkeley campus. You must be able to differentiate between male and female plumages for this species. Female plumage is a little duller than male. You must know the vocalizations of this species.

**FAMILY CARDINALIDAE** (Cardinals, New World grosbeaks, temperate tanagers). Short, conical, stout bill, massive to moderate in size and with culmen slightly decurved. Commissure strongly angulated. Strong feet and tarsi. Four species occur in the Bay Area.

**Black-headed Grosbeak** – Common resident of riparian woodland in the Bay Area in spring and summer. Diet is comprised of insects, fruits, and seeds. You must be able to differentiate between male and female plumages for this species. Males are more brightly colored than females (female looks somewhat like a large sparrow, although very large bill is distinctive). Compare to Spotted Towhee.

**FAMILY ICTERIDAE** (Blackbirds, cowbirds, orioles, meadowlarks). Sharply pointed, conical bill with the slightly decurved culmen dividing the feathers of the forehead. Commissure moderately angulated. Moderately short or short, rounded tail. Very strong feet and legs. Omnivorous: diet consists mainly of insects and seeds, but also includes some fruit. Nine species occur in the Bay Area, most resident. Often in more open habitats, and many species frequent farms or feedlots. Female plumage duller in most.

**Red-winged Blackbird** – Very common resident in the Bay Area in wetlands, and in human-modified environments (towns, feedlots). You must be able to differentiate between male and female plumages for this species. Male is much larger than female and plumages are very different; female resembles a sparrow (although note typical pointed blackbird bill). You must know the vocalizations of this species. Compare female to sparrows.

**Brewer's Blackbird** – Very common resident in the Bay Area in open habitats and in urban environments. Often seen walking on the sidewalks in towns and cities. You must be able to differentiate between male and female plumages for this species. Male plumage is iridescent; female plumage is duller. Compare female to female Brown-headed Cowbird.

**Brown-headed Cowbird** – Common resident in the Bay Area, in a wide variety of open habitats, including open woodland. Female plumage is duller than male. Cowbirds are brood parasites – they lay their eggs in the nests of other species. Cowbirds have undergone a huge population increase and range expansion in the last 100 years, and this has had a negative impact on many different species of songbird that they parasitize. You must be able to differentiate between male and female plumages for this species. Compare female to female Brewer's Blackbird.

**Bullock's Oriole** – Fairly common in spring and summer in open woodland. You must be able to differentiate between male and female plumages for this species. Female plumage is duller than males.

**Western Meadowlark** – Common resident of the Bay Area in grassland habitats. Plumage of sexes alike. You must know the vocalizations of this species.

**FAMILY FRINGILLIDAE** (Finches). Short, conical, stout bill with culmen straight or slightly decurved. Bill from small to massive in size. Flight often undulating. Eight species occur regularly in the Bay Area; nearly all are resident. Young often fed only seeds.

**Lesser Goldfinch** – Common resident of the Bay Area in open woodland habitats. Diet consists mainly of weed and flower seeds. Often incorporates mimicry into its songs. You must be able to differentiate between male and female plumages for this species. Male plumage is brighter than female. Compare to American Goldfinch and warblers.

**American Goldfinch** – Common resident of the Bay Area in open woodland and grassland habitats. Diet consists mainly of weed and flower seeds. You must be able to differentiate between male and female plumages for this species. Male plumage is brighter than female. Compare to Lesser Goldfinch and warblers.

**House Finch** – Common resident of the Bay Area in open woodland and urban habitats. Common on the Berkeley campus. Diet consists mainly of seeds of annual grasses and forbs. You must be able to differentiate between male and female plumages for this species. Male plumage is brighter than female. You must know the vocalizations of this species. Compare to Purple Finch and sparrows.

**Purple Finch** – Common resident of the Bay Area in woodland and forest habitats. Diet consists of seeds, flowers, berries, buds, and some insects. You must be able to differentiate between male and female plumages for this species. Male plumage is brighter than female. Compare to House Finch and sparrows.

**Pine Siskin** – Common resident of the Bay Area in woodland and forest habitats. Diet consists of catkins of willows and alders, tree buds, and tender needle tips from coniferous trees. Often move in large flocks. Plumage of sexes alike. Compare to female House Finch and Purple Finch and to sparrows.

**FAMILY PASSERIDAE** (Old-world sparrows). Short, conical bill with slightly curved culmen. One species in the Bay Area.

**House Sparrow** – Very common resident in the Bay Area in urban habitats and farmland. Diet consists of seeds, fruit, some insects, and garbage. House Sparrows are not native to North America. They typically nest in cavities in buildings or in nest boxes. They tend to be aggressive and often evict or exclude native birds from potential nesting sites. You must be able to differentiate between male and female plumages for this species. Male plumage much more patterned than female. Female is very plain. Compare to Passerellidae sparrows.

#### References used for natural history notes.

*IB104L – Vertebrate Natural History Laboratory and Field Syllabus*. 2003. Ned K. Johnson et al.

*Biology 427 Lab Manual – Univ of British Columbia – Terrestrial Vertebrates of British Columbia*. 2005. Richard Cannings & J. Mary Taylor.

*The Birds of North America Online*: <http://bna.birds.cornell.edu/BNA/>. Cornell Laboratory of Ornithology, Ithaca, NY. 2005. A. Poole (ed.).

*National Geographic Complete Birds of North America*. 2005. Jonathan Alderfer.

*The Sibley Guide to Birds*. 2004. David Sibley.

## Bird species that regularly occur on the UC Berkeley campus

Black-crowned Night-Heron  
Cooper's Hawk  
Red-shouldered Hawk  
Peregrine Falcon  
Ring-billed Gull  
California Gull  
Western Gull  
Glaucous-winged Gull  
Rock Pigeon  
White-throated Swift  
Anna's Hummingbird  
Downy Woodpecker  
Nuttall's Woodpecker  
Black Phoebe  
Pacific-slope Flycatcher  
Hutton's Vireo  
American Crow  
Common Raven  
Steller's Jay  
California Scrub-jay  
Cliff Swallow

Chestnut-backed Chickadee  
Oak Titmouse  
Red-breasted Nuthatch  
Bushtit  
Brown Creeper  
Ruby-crowned Kinglet  
American Robin  
European Starling  
Cedar Waxwing  
Yellow-rumped Warbler  
Townsend's Warbler  
Wilson's Warbler  
California Towhee  
Song Sparrow  
Dark-eyed Junco  
Brewer's Blackbird  
Purple Finch  
House Finch  
Lesser Goldfinch  
House Sparrow

# Vertebrate Vocalizations

We are making recordings of over 100 species (nearly all birds) available to you from the field recordings of Andrew Rush. This is a work in progress, so the quality of some recordings is better than others. These are provided to you so that you can begin to learn the sounds of the animals of the Bay Area. Most of the recordings are of species that we learn in lab, but other species that you commonly encounter in the Bay Area are included as well. Some of these species are far more often heard than they are seen (e.g., Hutton's Vireo, Marsh Wren, and Wrentit). Detecting animals by sound is a very useful skill, and will greatly increase your awareness of the animals around you.

We have provided the location information for the recordings in the list below. When choosing the sounds, we prioritized recordings that were made in or near the Bay Area, but it was not possible to use local recordings in every case. For some species this would not make much of a difference, but many passerines have regional subspecies with different song types.

**You are required to learn the vocalizations of the following 20 species:** Red-shouldered Hawk, Anna's Hummingbird, Nuttall's Woodpecker, Northern Flicker, Pacific-slope Flycatcher, Black Phoebe, Hutton's Vireo, Brown Creeper, Marsh Wren, American Robin, Hermit Thrush, Wrentit, Wilson's Warbler, Spotted Towhee, California Towhee, Song Sparrow, Dark-eyed Junco, Red-winged Blackbird, Western Meadowlark, and House Finch.

For the lab exam, you will have to identify a subset of these species from sound recordings. If the species has a song, at least part of what you hear will include the song (songs tend to be more distinctive). The vocalizations of these 20 species are fairly distinct from one another, but if you have problems telling them apart, see one of your GSIs. You can find the recordings (mp3s) on the course download site. *Do not wait until the last minute to begin learning these songs!*

This project benefited greatly from the help of the following former IB104 students: Jennifer Bates, Jillian Capdevielle, Irene Steves, and Joleen Tseng. *All recordings copyright Andrew Rush.*

## Species and locations of recordings

1. **Canada Goose** – Marin Co., California
2. **Greater White-fronted Goose** – Butte Co., California
3. **Mallard** – Butte, Marin & Merced Cos., California; Klamath Co., Oregon
4. **Gadwall** – Siskiyou Co., California
5. **Green-winged Teal** – Marin Co., California
6. **American Wigeon** – Butte & Marin Cos., California
7. **California Quail** – Marin & San Mateo Cos., California
8. **Great Blue Heron** – Humboldt Co., California
9. **Great Egret** – Marin Co., California
10. **Snowy Egret** – Marin Co., California
11. **Black-crowned Night-Heron** – Humboldt Co., California
12. **White-faced Ibis** – Merced Co., California
13. **Osprey** – Mariposa Co., California & Apache Co., Arizona
14. **Northern Harrier** – Marin Co., California; Socorro Co., New Mexico
15. **Red-shouldered Hawk** – Humboldt, Marin & San Mateo Cos., California
16. **Red-tailed Hawk** – San Mateo Co., California; Klamath Co., Oregon
17. **Ridgeway's Rail** – Marin Co., California
18. **Virginia Rail** – Marin & Merced Cos., California
19. **American Coot** – Butte & Merced Cos., California
20. **Black-bellied Plover** – Humboldt, Merced & San Francisco Cos., California
21. **Semipalmated Plover** – Humboldt Co., California
22. **Killdeer** – Humboldt & Merced Cos., California
23. **Black-necked Stilt** – Merced Co., California
24. **Willet** – Humboldt Co., California; Elko Co., Nevada
25. **Greater Yellowlegs** – Humboldt & Marin Cos., California
26. **Whimbrel** – Humboldt Co., California
27. **Long-billed Curlew** – Marin Co., California
28. **Marbled Godwit** – Humboldt Co., California
29. **Least Sandpiper** – Merced & Humboldt Cos., California
30. **Long-billed Dowitcher** – Merced & Humboldt Cos., California
31. **Short-billed Dowitcher** – Del Norte & Humboldt Cos., California
32. **Red-necked Phalarope** – Humboldt Co., California
33. **Ring-billed Gull** – Siskiyou Co., California
34. **California Gull** – Humboldt Co., California
35. **Western Gull** – Humboldt Co., California
36. **Elegant Tern** – Del Norte, California
37. **Caspian Tern** – Marin Co., California
38. **Forster's Tern** – Siskiyou Co., California
39. **Band-tailed Pigeon** – San Mateo Co., California
40. **Mourning Dove** – Mariposa & Merced Cos., California; Grant Co., New Mexico
41. **Great-horned Owl** – Marin & San Mateo Cos., California; Klamath Co., Oregon
42. **Common Poorwill** – Okanagan, British Columbia
43. **White-throated Swift** – Bighorn Co., Montana
44. **Anna's Hummingbird** – Marin & San Mateo Cos., California
45. **Allen's Hummingbird** – Marin Co., California
46. **Rufous Hummingbird** – Marin Co., California
47. **Belted Kingfisher** – Alameda, Merced & Stanislaus Cos., California
48. **Lewis's Woodpecker** – Santa Clara Co., California
49. **Acorn Woodpecker** – Alameda, Mariposa, & San Mateo Cos., California
50. **Red-breasted Sapsucker** – San Mateo Co., California
51. **Nuttall's Woodpecker** – Marin & Merced Cos., California
52. **Hairy Woodpecker** – Alameda, Marin, Mendocino, San Mateo Cos., CA; Crook Co., OR
53. **Downy Woodpecker** – Apache Co., Arizona & Merced & San Mateo Cos., California
54. **Northern Flicker** – Marin, Merced, & San Mateo Cos., California

55. **Olive-sided Flycatcher** – Marin & Siskiyou Cos., California
56. **Western Wood-pewee** – Del Norte, Mariposa, Modoc & Siskiyou Cos., California; Klamath Co., OR; Mohave Co., AZ
57. **Pacific-slope Flycatcher** – Marin & San Mateo Cos., California; Christina Lake, British Columbia
58. **Black Phoebe** – Humboldt & Marin Cos., California
59. **Say's Phoebe** – Socorro Co., New Mexico
60. **Ash-throated Flycatcher** – Mohave Co., Arizona
61. **Hutton's Vireo** – Alameda, Marin & San Mateo Cos., California
62. **Warbling Vireo** – Marin & Siskiyou Cos., California; Coconino Co., Arizona
63. **Loggerhead Shrike** – Merced Co., California
64. **Steller's Jay** – Marin & San Mateo Cos., California
65. **California Scrub-jay** – Marin Co., California
66. **American Crow** – Alameda and Del Norte Cos., California; Williams Lake, British Columbia
67. **Common Raven** – Marin Co., California
68. **Tree Swallow** – Merced & Marin Cos., California
69. **Violet-green Swallow** – Coconino Co., Arizona
70. **Barn Swallow** – Del Norte & San Mateo Cos., California
71. **Cliff Swallow** – Merced Co., California
72. **Oak Titmouse** – Alameda, Mariposa, & San Benito Cos., California
73. **Chestnut-backed Chickadee** – Marin & San Mateo Cos., California
74. **Bushtit** – Marin & San Mateo Cos., California
75. **Red-breasted Nuthatch** – White Pine Co., Nevada
76. **White-breasted Nuthatch** – Alameda, Mariposa, & Tuolumne Cos., California
77. **Pygmy Nuthatch** – Marin & San Mateo Cos., California; Mohave Co., Arizona
78. **Brown Creeper** – Marin & San Mateo Cos., California
79. **House Wren** – San Benito Co., California; Elko Co., Nevada; Klamath Co., Oregon
80. **Pacific Wren** – Humboldt & San Mateo Cos., California
81. **Bewick's Wren** – Marin Co., California
82. **Marsh Wren** – Marin & Merced Cos., California
83. **Golden-crowned Kinglet** – San Mateo & Tuolumne Cos., California
84. **Ruby-crowned Kinglet** – Humboldt, Marin, & San Mateo Cos., CA; Gunnison Co., CO
85. **Wrentit** – Marin, Mariposa, & San Mateo Cos., California
86. **Western Bluebird** – Alameda Co., California; Mohave Co., Arizona
87. **Hermit Thrush** – Marin & San Mateo Cos., California; Coconino Co., Arizona
88. **Swainson's Thrush** – Humboldt Co., California
89. **American Robin** – Merced, Nevada, & San Mateo Cos., CA; Klamath Co., OR; Christina Lake, BC
90. **Varied Thrush** – Humboldt Co., California
91. **Northern Mockingbird** – Merced Co., California
92. **California Thrasher** – Alameda & Mariposa Cos., California
93. **Phainopepla** – Alameda & Stanislaus Cos., California
94. **European Starling** – Marin, Merced, & San Benito Cos., California
95. **American Pipit** – Marin & Merced Cos., California
96. **Cedar Waxwing** – Del Norte & Marin Cos., California
97. **Orange-crowned Warbler** – Humboldt, Marin, & Shasta Cos., California
98. **Yellow-rumped Warbler** – Marin Co., California; Custer Co., Colorado
99. **Townsend's Warbler** – Marin Co., California
100. **Black-throated Gray Warbler** – Marin Co., California
101. **Common Yellowthroat** – Humboldt & Marin Cos., California
102. **Wilson's Warbler** – Marin & San Mateo Cos., California
103. **Spotted Towhee** – Marin & San Mateo Cos., California
104. **California Towhee** – Marin Co., California
105. **Lark Sparrow** – Fresno Co., California; Goshen Co., Wyoming
106. **Savannah Sparrow** – Humboldt & Siskiyou Cos., California; Elko Co., Nevada
107. **Lincoln's Sparrow** – Marin & Humboldt Cos., California; White Pine Co., Nevada
108. **Song Sparrow** – Humboldt, Marin, & San Mateo Cos., California



109. **Grasshopper Sparrow** – San Mateo Co., California
110. **Fox Sparrow** – Marin Co., California; Elko Co., Nevada
111. **White-crowned Sparrow** – Del Norte & Marin Cos., California
112. **Golden-crowned Sparrow** – San Mateo Co., California
113. **Dark-eyed Junco** – Alameda, Marin, San Mateo, & Tuolumne Cos., California
114. **Western Tanager** – Tuolumne Co., California
115. **Black-headed Grosbeak** – Marin, Monterey & Shasta Cos., California
116. **Lazuli Bunting** – Del Norte Co., California
117. **Western Meadowlark** – Merced Co., California
118. **Red-winged Blackbird** – Marin & Merced Cos., California
119. **Brewer's Blackbird** – Merced & San Mateo Cos., California
120. **Brown-headed Cowbird** – Klamath Co., Oregon
121. **Bullock's Oriole** – San Benito Co., California; Klamath Co., Oregon; Okanogan Co., Washington
122. **Purple Finch** – Del Norte, Marin & San Mateo Cos., California
123. **House Finch** – Marin Co., California
124. **American Goldfinch** – Marin & San Mateo Cos., California
125. **Lesser Goldfinch** – San Benito & San Mateo Cos., California
126. **Pine Siskin** – Marin & San Mateo Cos., California; White Pine Co., Nevada
127. **House Sparrow** – Merced & San Mateo Cos., California
128. ***Hyliola regilla* (formerly *Pseudacris regilla*)** – Humboldt, Marin, & Modoc Cos., California
129. ***Canis latrans*** – San Mateo Co., California
130. ***Sciurus griseus*** – Marin Co., California
131. ***Otospermophilus beechyi*** – Mariposa Co., California

# Glossary

**Angulate** – Having angles, angled

**Anisodactyl** – three toes forward and one back

**Commissure** – Line of closure of the mandibles

**Compressed** – Laterally flattened, or higher than wide

**Decurved** – Curved downward

**Depressed** – Dorsoventrally flattened; wider than high

**Emarginate** – Of the tail, when slightly notched or forked; the rectrices successively increasing in length from the central pair to the outermost pair

**Gape** – Opening of the mouth.

**Graduated** – Of the tail, when the rectrices are successively shorter, by large intervals, from the central pair to the outermost pair.

**Gular sac** –The gular (throat) region, capable of distension into a sac.

**Hallux** – The hind toe

**Incumbent** – Of hallux when placed at the level of the other toes; not elevated.

**Lamellate** –Possessing thin plates or lamellae

**Lax** – Of plumage, when fluffy and loosely-textured

**Operculum** – soft basal portion of upper mandible which arches over the nostrils.

**Pamprodactyl** – all four toes point forward

**Perforate** – Pierced; nostrils communicate when the nasal septum is incomplete or absent

**Recurved** – Curved upward

**Rounded** – Of the tail, when the rectrices are successively shorter, by small intervals, from the central pair to the outermost pair

**Serrate** – Possessing teeth like a saw

**Syndactyl** – Two or more toes are fused for part of their length

**Totipalmate** – all four toes webbed

**Tubercle** – Small knoblike prominence or nodule

**Zygodactyl** – Yoke-toed; two toes in front and two behind

## Preparation of a Bird Study Skin

It is difficult to obtain birds for study skins and much labor and technical skill is involved in their preparation. Perhaps an awareness of this will result in the better treatment of our laboratory specimens. Refer to Figure 9 below.

- a. After weighing the specimen to the nearest one-tenth of a gram on a platform balance or Pesola spring balance, use a razor blade to make a midline incision through the skin from the center of the breast to a point a few millimeters anterior to the vent.
- b. Using blunt-tipped forceps, separate the skin on one side, exposing the knee. Dotted line indicates the cut made through the knee region to free the leg, enabling the removal of muscle from the "drum stick."
- c. "Drum stick" exposed. Inset sketch shows bone (the tibiotarsus) which is left in place after removal of muscle; it will help anchor the leg to the skin.
- d. Both "drum sticks" have been cleaned and drawn back into skin of legs. Note cut knee joint surfaces. With scissors, carefully cut first through the lower belly and digestive tract and then, somewhat anteriorly, make a second cut through the spinal column. This will disconnect the base of the tail at the position of the dotted line.
- e. With the tail and legs freed from the body, work the skin forward by peeling with the fingers held where the skin attaches to the body. Note fleshy base of tail on right.
- f. Break the humerus of each wing near the body. Cut through musculature around humerus (note dotted lines), severing the wings from the body.
- g. Continue skinning with the skin being carried forward, inside-out, over the head. In the upper sketch the ear skin is still attached to the ear opening in the skull. In the middle sketch the skin around the ear has been pulled free and skinning has continued over the eye region to the base of the bill. Dotted line shows the cuts made to remove the back of the skull and tongue. The bottom sketch shows the tongue remaining attached to the throat and neck when the latter is pulled away from the skull.
- h. Remove the brain by cuts made on each side of the cranium from the roof of the eye socket to the rear of skull (upper left sketch). These cuts are connected by a cut across the skull between the eye sockets (the roof of the skull is left intact; upper right). Cuts from eye sockets to rear of cranium are connected with a cut across the rear of the skull above the exposed rear portion of the brain (lower left). The floor of the cranium with the brain attached is removed as a single block; the dotted line shows the area involved (lower right).
- i. To clean the wing bones, strip the muscle attached to the humerus and cut it off at the joint with the radius-ulna. Do not strip the secondary flight feathers away from the ulna. Instead, work the skin free over the attachment of the radius and humerus. Cut through the radius and associated muscles near the junction with the humerus.
- j. Lift this tissue away from the ulna and sever the radius and muscles close to their distal attachments. The base of the tail is exposed and the uropygial gland is scraped away to prevent soiling of plumage by secretions from the gland.
- k. The skin is turned completely inside out, the eyes are removed, and the sockets are filled with cotton. (Traditionally, at this point the inside of the skin is dusted with arsenic to protect against insect pests. Because

arsenic is dangerous and often unavailable, however, modern preparators avoid damage to specimens by storing them in insect-proof cabinets containing various fumigants. Moth crystals obtained at drugstores are effective for this purpose). The skin is now turned right side out.

l. The skin is ready for stuffing. A slender stick, embedded in the base of the upper mandible and extending to the base of the tail inside the body cavity, is inserted to stiffen the skin. (A useful variant technique by which to embed the stick in the head is to roll a brain-sized cotton ball around the end of the stick which is twirled and tightened, and thereby anchored, inside the cranium.) The dotted lines indicate the position of the stubs of the humeri which are tied together with thread. The distance between the humeri should approximate the width of the body (which should thus be saved as a reference).

m. Prepare a cotton body which approximates the size of the actual body. Insert the body into the bird either with forceps or by wrapping it as a cone around the end of a slender stick which can be inserted. The body stick lies to the left in the diagram (not shown), against the inside skin of the back. The tip of the cotton cone is thrust part way into the mouth. After the wings and feathers are arranged, the tip of the cone is grasped and the stuffing stick is removed.

n. The base of the cotton cone is now covered with the skin and the incision is sewed together.

o. A label is carefully prepared. At a minimum the label should give the sex of the bird (determined now by opening the carcass), the name and catalogue number of the preparator, the locality where the specimen originated, the date the specimen was collected, and the body weight. Additional information typically given: stomach contents, amount of fat under the skin, the degree of development of reproductive organs, any molt noted, and the degree of skull pneumatization. Samples of tissue (heart, kidney, breast muscle, liver) can now be removed, placed in suitable plastic vials, and deep frozen for later biochemical-genetic analyses.)

p. Cross the legs of the specimen and securely tie on the label. The tibiotarsi (see c.) are now pushed forward beneath the belly skin to firmly anchor the legs.

q. The specimen is wrapped in a thin sheet of cotton, or placed in a paper cylinder, and pinned to a board for drying.

Bird study skin preparation techniques vary widely, with each preparator practicing minor variations on the major theme just described. A skilled preparator can complete a specimen of small to medium size in 40 min less.

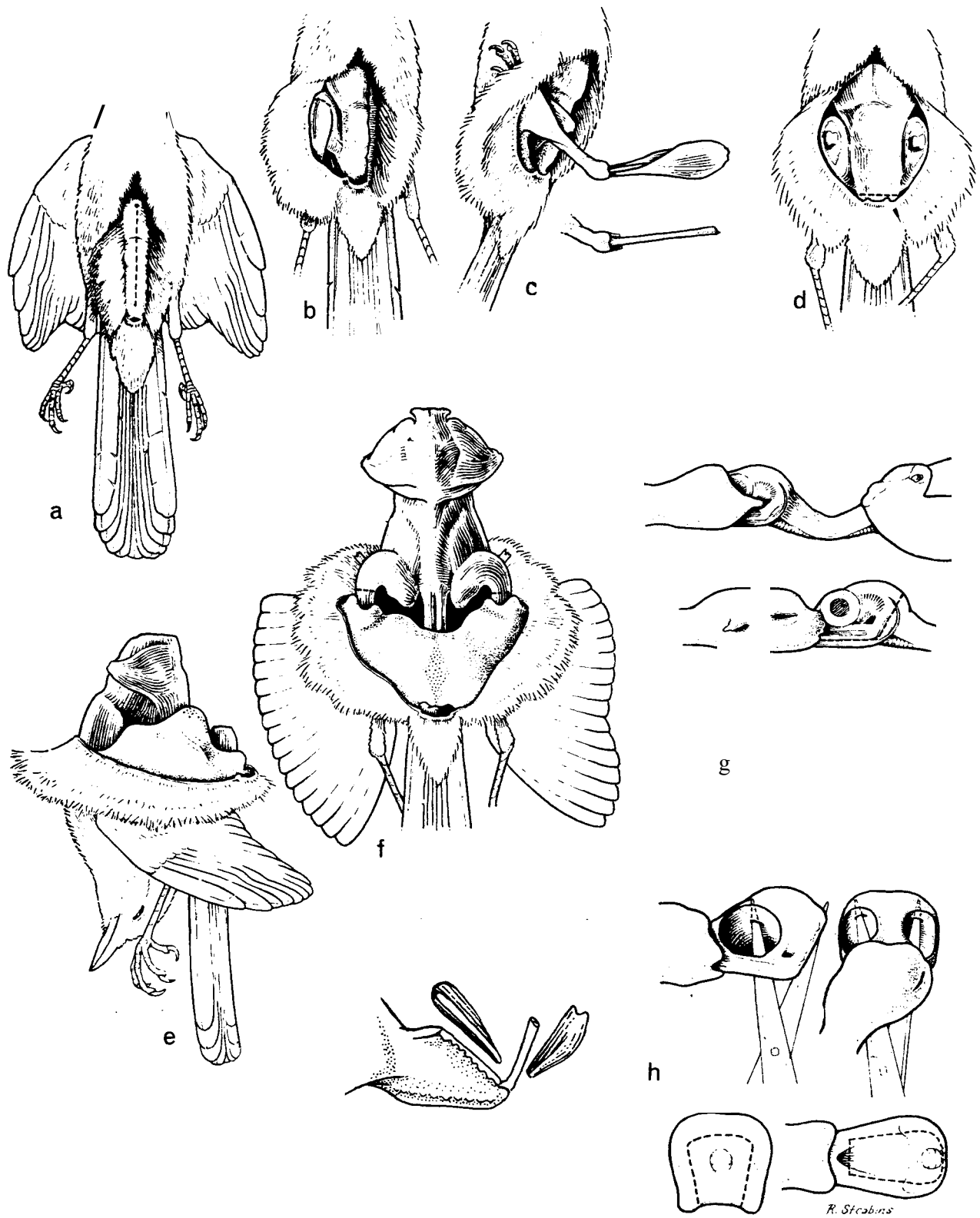


Figure 9. Preparation of a bird study skin.

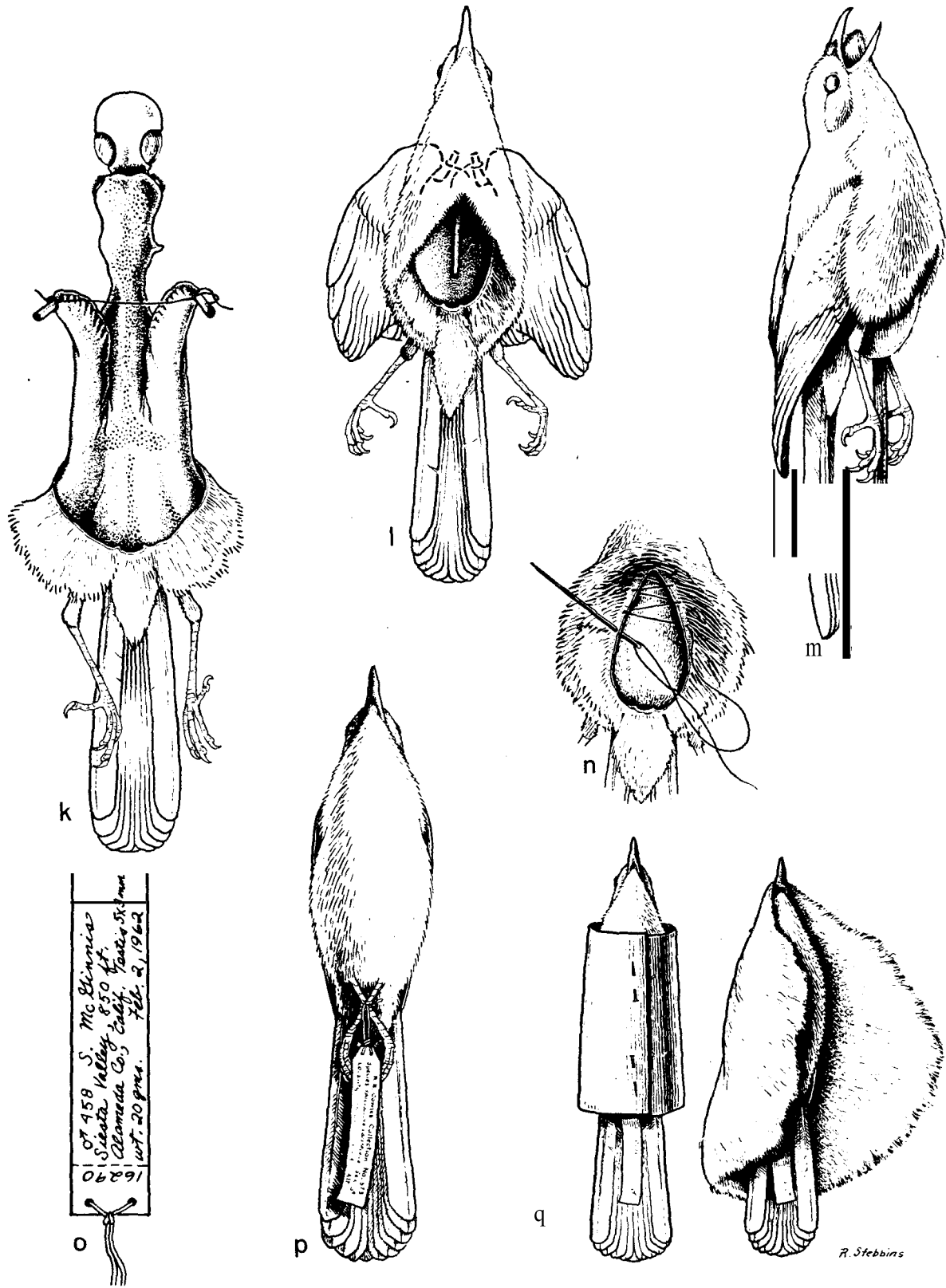


Figure 9. Preparation of a bird study skin (continued)

# Laboratory Exercises on Amphibians

## Laboratories I and II (2 weeks)

In the study of amphibians, emphasis will be on the structure and habits of species that occur in the East Bay hills (Laboratory I) and on the ways in which amphibians, although dependent on a moist environment and intolerant of high temperatures, have adapted to life on land (Laboratory II).

Amphibians typically are not highly specialized in food habits. Except for the larvae of some species, most amphibians feed almost entirely on moving prey, apparently eating almost any small animal encountered that can be swallowed whole. Prey is seldom dismembered. Ecological segregation thus seems more often to be based on differences in habitat and in the timing of activity than on differences in food, although the size of prey and method of capture may be important.

Read the instructions on the care and handling of preserved specimens of amphibians and reptiles (pg. 10) before beginning the laboratory work. For the animals listed in Lab I, you should be able to identify all of them from preserved specimens in terms of Class, Order, Family, Genus and species. You do not have to know the common names, but you will be required to know the Latin name and be able to spell it correctly. It is good to get into the habit of underlining the Latin name: this will be required in order to receive full credit on lab exams and in your field journal. You are responsible for knowing the distribution of each species (refer to the range key and map of California's major geographic subdivisions), their habitat preferences, and other natural history information to the extent described in the lab and in your field guide where referenced.

Examples of habitat and natural history information include:

- Stream (lotic) vs. pond (lentic) adapted larvae, e.g. long laterally compressed fin on tail continuing all the way up onto the back & large gills = lentic
- If there are no lungs and no gills, they must breathe through their skin.
- Species that reproduce in terrestrial vs. aquatic habitats
- Life cycles (e.g. metamorphosis vs. direct development).
- General habitat features discussed in lab manual (e.g., desert habitats of *Scaphiopus couchii* and *Pseudacris cadaverina*; lotic habitat of *Rhyacotriton*)

References: <http://amphibiaweb.org>

# Amphibians Laboratory I

## Identification and Habits of California Amphibians

The object of this week's lab is to familiarize yourself with the characteristics and habits of all amphibian species in the East Bay hills and selected species from elsewhere in the state. As background for Laboratory I, a few ecological differences among local amphibians may be pointed out. The newts (*Taricha*) lay their eggs in water, whereas the several species of lungless salamanders are completely terrestrial and oviposit on land. Although the lungless species coexist in some areas, *Aneides lugubris* is a climber, ascending trees and rock surfaces, whereas *Ensatina* and *Batrachoseps* are ground dwellers and differ greatly in size. *Batrachoseps* enters earthworm and termite burrows, and other small openings that usually cannot be penetrated by *Ensatina*. *Hyla regilla* uses a great variety of breeding sites and may breed in small bodies of water unsuited to frogs in the genus *Rana*. *Rana draytonii* breeds early (January to March) and frequents quiet water of lakes, ponds, and streams, whereas *Rana boylei* is a stream dweller that prefers moving water. *Anaxyrus boreas*, although entering water to breed, is chiefly terrestrial.



# Amphibians of California: Natural History Notes

Range Key: NC=North Coast, SC=South Coast, BA=Bay Area, CV=Central Valley, GB=Great Basin, SN=Sierra Nevada, D=Desert

[-] = Not obvious in specimen

\*Bay Area taxa we are likely to see on field trips

## CLASS AMPHIBIA

### ORDER CAUDATA (Salamanders)

**FAMILY AMBYSTOMATIDAE** (Mole Salamanders). Sister clade to Dicamptodontidae. Teeth in transverse row on roof of mouth (often interrupted), costal grooves usually distinct.

***Ambystoma californiense*** (California Tiger Salamander). Large-bodied, eyes small, dorsal pattern of conspicuous yellow or cream-colored spots on black background. Endemic to California, inhabits grassland and woodland; breeds in permanent or temporary lakes, slow streams or ponds. Endangered by habitat loss and hybridization with introduced *A. mavortium*. -- CV, BA

***Ambystoma mavortium*** (Tiger Salamander). Similar to *A. californiense*, but the light-colored dorsal pattern resembles barring more than large well-defined spots. Found in grassland, woodland; breeds in permanent or temporary lakes, slow streams or ponds. Introduced to CA, refer to the Field Guide for range and distribution information.

***Ambystoma macrodactylum*** (Long-toed Salamander). Smaller than *A. californiense* and *A. gracile*. Long fingers. Very bright dorsal patterning: may be a yellow broken dorsal stripe or orange to yellow dorsal stripes or bars (these will fade in preservation). May have cannibal-morph larvae. Compare with *Rhyacotriton* female. -- GB, SC

***Ambystoma gracile*** (Northwestern Salamander). Smaller than *A. californiense*. Brown to black dorsum, prominent parotoid glands and glandular thickening along dorsal ridge of the tail. No foot tubercles. Inhabits grassland, woodland, forest; breeds in permanent or long-lasting seasonal ponds, lakes, and quiet streams. Facultatively neotenic. -- NC

**FAMILY DICAMPTODONTIDAE** (Giant Salamanders). Sister clade to Ambystomatidae. Teeth in transverse row on roof of mouth (often interrupted), costal grooves usually distinct.

***Dicamptodon ensatus*** (California Giant Salamander). Heaviest terrestrial salamander. Upper parts dark brown with irregular marbling. Eyes large, no constriction of tail. Distinct body segments demarcated by costal grooves (which fall between the ribs). Inhabits coniferous or mixed coniferous and deciduous forests; breeds in streams, occasionally lakes. Facultatively neotenic. -- NC, SC, BA

**FAMILY RHYACOTRITONIDAE** (Torrent or Seep Salamanders). Small body size, large eyes, costal grooves usually distinct

***Rhyacotriton variegatus*** (Southern Torrent Salamander). Small-bodied stream dweller. Large eyes, short blunt snout [-]. Male has squared-off glands at the vent, female does not. Salt-and-pepper patterning all over (including the venter). Relatively short and laterally compressed tail. Very reduced lungs, much oxygen uptake occurs through the skin. Endemic to the Pacific Northwest. Compare to *Hydromantes*: similar size and tail-to-body proportions, but eyes are more pronounced in *R. variegatus*. -- NC

**FAMILY SALAMANDRIDAE** (Newts). Newts are unusual in that they have distinct terrestrial and aquatic phases as adults. Males metamorphose each year and remain in the water throughout the breeding season. Females metamorphose but only enter the water to reproduce. Salamandrids have lungs, palatine teeth in divergent longitudinal rows on the roof of their mouth, and indistinct costal grooves.

\*Important note: The neurotoxin of *Taricha*, tetrodotoxin (TTX), is the same as that of pufferfishes. Certain populations are extremely toxic. They are safe to handle (alive or dead) but never put one anywhere near your mouth. Not even as a joke.

***Taricha granulosa*** (Rough-skinned Newt). Eyes relatively small, usually not intersecting the outline of head when viewed from above, teeth in V-shaped pattern. Brown pigmentation is generally extensive between the lip and the eye. Found in woodland and coniferous forests; breeds in ponds, lakes, and streams. Eggs are laid singly – NC, BA\*

***Taricha torosa*** (Coast Range Newt). Eyes relatively large, usually intersecting the outline of head when viewed from above, teeth in Y-shaped pattern. More yellow visible between the eye and lip than in *T. granulosa*. Found in woodland and mixed coniferous-broad-leaved forests; breeds in ponds and streams. Eggs are laid in spherical masses. -- NC, SC, SN, BA\*

***Taricha rivularis*** (Red-bellied Newt). Eyes completely dark, broad dark band across vent. Brown to black dorsum, red or dark orange ventrally. Dark pigmentation extends along limbs to ventral surfaces of the elbow (not seen in the other *Taricha spp.*) Dark band across the vent especially prominent in males. Light coloration under eye. Found in woodland and coniferous forests; breeds in streams. -- NC

**FAMILY PLETHODONTIDAE** (Lungless Salamanders). The nasolabial groove is diagnostic for this family (it has a chemosensory function). Plethodontids do not have lungs and rely solely on cutaneous respiration. All of our California plethodontids are direct developers and terrestrial breeders.

***Aneides lugubris*** (Arboreal Salamander). Projecting upper jaw teeth, large, triangular head, and pronounced jaw muscles (intraspecific aggression). Toes are squared off at tips [-]. Brownish skin with pale spots. They are climbers and have a prehensile tail. Inhabits woodland chiefly of coast and interior live oak. -- NC, SC, SC, BA\*

***Aneides flavipunctatus*** (Black Salamander). Smaller jaw musculature than *A. lugubris*. Black body. Can be white- or yellow-flecked. Squared off toes [-], 14 -16 costal grooves. Can climb trees, but not to the extent of *A. lugubris* [-]. Prehensile tail. Found in grassland, oak and conifer woodland. Favors talus slopes in the southern part of their range. Eggs are often suspended on ceilings of wet rock rubble, caves or mine shafts with permanent streams or springs. The disjunct "Bay Area" population is restricted to the Santa Cruz area, creating a conspicuous gap in the species' distribution. -- NC, BA

***Aneides vagrans*** (Wandering Salamander). Smaller jaw musculature than *A. lugubris*. "Cloudier" dorsal pattern than *A. flavipunctatus*, appears more blotched than flecked. Squared toes [-], 16 - 17 costal grooves. No tail constriction (compare to *Ensatina spp.*) Tail prehensile. Found in cedar, alder and redwood forests, often at the edges of clearings, especially in decaying logs -- NC

***Batrachoseps attenuatus*** (California Slender Salamander). Worm-like with reduced limbs. Four toes on both front and hind feet (all other western salamanders have four on the front, five on the back). Brown to gray color, sometimes with longitudinal dorsal striping. Found in woodland, coniferous

forests, sparingly in grassland humus layer. Uses worm burrows and root tunnels. Tail grows continuously by adding vertebrae. These salamanders have very low vagility. -- NC, BA\*

***Ensatina eschscholtzii*** (Ensatina). Marked constriction at the base of the tail. Slim fingers (not tapered). They inhabit woodland and coniferous forests. Dramatic geographic variation in color: the local sub-species (*E. e. xanthoptica*) mimics *Taricha* (brown on the back, yellowish on the belly, upper half of iris yellow). Males can be identified by a pronounced nasal forking and their swollen, overhanging upper lip. Their tails are also slimmer and longer than those of females. *Ensatina* is one of the best-studied examples of a ring-species and incipient speciation (see Field Guide and information in Lab II) -- SN, NC, SC, BA\*

***Hydromantes* spp.** (Web-toed Salamanders). Toes webbed, no gland under tail. Eyes more recessed than *Rhyacotriton*. Compare the feet with *Rhyacotriton* and the limbs with *Batrachoseps*. These are rock, crevice, and cave specialists; they also have ballistic tongue projection. You will only need to identify them to genus, but one of the three species that occurs in CA, *H. platycephalus*, boasts the proud title of California's Flattest Salamander. -- SN

## ORDER ANURA (Frogs and Toads)

### FAMILY ASCAPHIDAE (Tailed Frogs)

***Ascaphus truei*** (Coastal Tailed Frog). Small with rough skin. Brown to gray in color and minimal dorsal patterning. The tympanum is not visible externally, and feet not extensively webbed, but note the broadened outer hind toe (compare to toe-pads on *Pseudacris*). Males have a tail-like copulatory organ. It is an extension of the cloaca used for internal fertilization. These frogs inhabit coniferous forests and deciduous woodlands. They prefer cold, fast-moving streams. Larvae have a large disc-shaped mouth that aids in adhering to substrates in fast-moving water. -- NC

**Family Scaphiopodidae** (Spadefoots). Single black spade on hind foot, no parotoid glands, pupils vertical.

***Scaphiopus couchii*** (Couch's Spadefoot). Dorsal markings often form a network; sickle-shaped spade on hind foot. Vertical pupil, no parotoid gland. Found in shortgrass plains, mesquite savannah, creosote bush desert; breeds in short-lived ponds. Larvae occasionally display high rates of cannibalism (see Field Guide). -- D

***Spea hammondi*** (Western Spadefoot). Hourglass-like markings on dorsum, wedge-shaped spade on hind foot. Grayish. Dorsal stripes arranged longitudinally. The spade can be squared (vaguely shaped like a loaf of bread). Vertical pupil, no parotoid gland. Found in grassland, open woodland, washes, and flood plains. Breeds in intermittent streams. -- CV, SN, SC

**FAMILY BUFONIDAE** (True Toads). Bufonids usually have stout bodies, short limbs, pronounced skin tubercles ("warts") and parotoid (poison) glands.

***Anaxyrus boreas*** (Western Toad). Diagnostic white stripe down the back, no cranial crests. Tarsal fold is well-developed. Male is usually less blotched with smoother skin than the female. Parotoid glands are separated by about twice width of the gland (compare to *A. canorus*). With a wide-spread distribution in CA and as a habitat generalist, *A. boreas* can be found in grassland, mountain meadows, farmland, open areas in woodland and coniferous forests; it breeds in ponds, lakes, and at borders of slow streams -- NC, GB, SN, CV, SC, BA\*

***Anaxyrus canorus*** (Yosemite Toad). Large, flat parotoids, less than width of a gland apart. They have marked dichromatic sexual dimorphism: females have a striking coloring and pattern compared to males. Compare their morphology to *A. boreas* (white stripe absent in *A. canorus*), and *A. punctatus* has a pronounced parotoid gland compared to *A. canorus*. -- SN

***Anaxyrus punctatus*** (Red-spotted Toad). Flattened head and body, with rough, round parotoids that are about same size as upper eyelids (vs. large and flat in *A. canorus*). Bony crest on the skull unsubstantial. Skin tubercles are red-tipped [-], small, and evenly distributed. Inhabits desert oases, grassland, rocky canyons and arroyos. -- D

**Family Hylidae** (Chorus Frogs). Hylids are generally small, slim-waisted, and long-legged. They have expanded toe pads used in climbing.

***Hyla regilla*** (Pacific Chorus Frog). Small, some webbing on hind feet, expanded toe pads, and smooth skin. Their diagnostic character is the presence of a black eye-stripe from nostril to shoulder [-]. In males, throat may be gray and wrinkled (this is the vocal sac). Highly variable in color and pattern except the eye-stripe is always present [-]. They can be found in brackish marshes; valley grassland to mountain meadows; breeds in meadow pools, streams, ponds, and lakes. More often heard than seen, this habitat generalist occurs in every geographic region and is probably the best-known native California amphibian. Listed in field guide as *Pseudacris regilla*. -- NC, GB, SN, CV, SC, BA\*

***Pseudacris cadaverina*** (California Chorus Frog). Skin has fine granite-like patterning, appears rougher in texture than *Hyla regilla* [-]. No eye-stripe. Toe tips slightly broader in *P. cadaverina* (more obvious on front feet) [-]. Webbing more extensive than in *H. regilla*. [-]. Coloration gray/light brown [-]. Extremely difficult to distinguish from *H. regilla* post-preservation -- SC

**Family Ranidae** (True Frogs). Ranids are long-legged with powerful hind-limbs. Their hind feet are webbed and have pointed toe-tips.

***Rana draytonii*** (California Red-legged Frog). Relatively large. Webbing doesn't extend to tip of 4th toe. Well-developed dorsolateral folds (appearing as dark stripes), barring that resembles tiger stripes on upper hind-legs. It inhabits woodland and coniferous forests and breeds in quiet stretches of streams, ponds, and lakes; prefers still water. Refer to the Field Guide's "Conservation Note" for information about the steps being taken to preserve threatened populations of *R. draytonii* and lessen the negative impacts of the invasive *L. catesbeiana* -- NC, SC, SN, CV, BA\*

***Rana boylei*** (Foothill Yellow-legged Frog). Smaller than *R. draytonii*, with inconspicuous dorsolateral folds. Tympanum is rough, sometimes a very faint pale triangle on head [-], toe tips are more pale in *R. boylei*, and darker in *R. muscosa*. Inhabits woodland and mixed deciduous and coniferous forest; breeds in streams and rivers -- NC, SC, SN, BA\*

***Rana muscosa*** (Southern Mountain Yellow-legged Frog). Inconspicuous dorsolateral fold, tympanum smooth. Dark toe-tips [-], mottled or marbled dorsal patterning and no pale triangle on head. Complete webbing on hind feet. Found at high elevations in meadows, it breeds in slow streams, ponds and lakes. *Rana muscosa* experienced dramatic population declines during the 20<sup>th</sup> century, most severely in the southern portion of its range. A recent taxonomic split between the Sierra Nevada clade in the north (now *R. sierrae*, the Sierra Nevada Yellow-legged Frog), and southern clade (still *R. muscosa*), resulted in *R. muscosa* being listing as an endangered species

under the Federal Endangered Species Act. -- SN

***Lithobates catesbeiana*** (American Bullfrog). The largest frog in North America. No dorsolateral folds. Sexually dimorphic; the eye-tympanum ratio is roughly equal in females, but the tympanum diameter can exceed the diameter of the eye in males. A prominent fold of skin starting at the eye, extending around the upper edge of the tympanum then descending toward the base of the forearm is also diagnostic. Introduced in CA and widespread.\*

# Amphibians Laboratory II

## Natural History and Systematics

Identification of California Amphibians. All of the preserved material from last week's lab is available for further study. Be sure to compare specimens with descriptions in the Field Guide. Make sure that you can identify diagnostic structures on the specimens. Also, note apparent differences between our preserved study specimens and the descriptions and color plates of living animals (for example, actual colors in life fade in alcohol). Remember your field observations and check to see if they are in accord with Stebbins' comments.

1. Geographic variation and hybridization in *Ensatina*. The genus *Ensatina* provides a classic example of a so-called 'ring species'. Its geographic distribution forms roughly a circle of populations that are differentiated to varying degrees. In some areas, two adjacent 'subspecies' interbreed freely (intergradation); in some areas they do so only rarely or only along a narrow contact zone (hybridization); and in some areas two forms come into contact with virtually no evidence of genetic interchange (they behave as separate species). The 'species' *Ensatina eschscholtzii* is now one of the best-studied North American vertebrates in terms of geographic variation and yet with new techniques we continue to gain insights into a highly complex system.

Read the Field Guide account of variation in *Ensatina* and note the distributional map and color plates for the subspecies. Depending on yearly availability, live specimens of one or more subspecies will be on exhibit. A poster and two publications reporting recent studies are available in the lab for further information.

2. Respiration. The dependence of amphibians on skin respiration has limited their distribution on land. Although most species have lungs, none have been able to rely upon lung respiration alone. In terrestrial species, dermal respiration requires that the skin be highly vascular and kept continuously moist. This is done with glands that secrete a fluid high in water content (mucous), often aided by contact of the skin with moisture in the environment. Body water lost through the skin is replaced chiefly by absorption of water through the skin from moist surroundings, thus it has been impossible for these animals to develop an impervious skin and live in areas lacking moisture (a few species of uricotelic [uric acid excreting] frogs approach the reptiles in their tolerance of dry environments). A further limitation lies in the thermal tolerances of amphibians, which are usually considerably lower than most reptiles, birds, and mammals.

Study the demonstrations to observe the gross differences among gills of larval salamanders, lungs in adult frogs and salamanders (for example, *Taricha*), and the lack of either in lungless salamanders. How do embryos and adult salamanders of the family Plethodontidae respire? During metamorphosis, larval amphibians lose their gills as they switch over to using lungs. Note the transition in external structures of the three *Dicamptodon* on display. Study Figures 10 through 14.

3. Locomotion. Observe the gross differences in body form between frogs and salamanders; larval and adult salamanders (note the tail structures of larval and adult *Dicamptodon*); and frogs and toads. How do the differences between larvae and adults, and between larval frogs and salamanders, relate to differences in their life styles? Be sure to identify 'minor' structures associated with locomotion, such as the 'spades' of Scaphiopodidae (*Scaphiopus* and *Spea*), and the expanded toe tips of *Pseudacris* and *Aneides*. Based on your observations so far in the laboratory and field, and on comments in the Field Guide, what are the roles of such structural differences in the lives of the animals?

4. Feeding. In most amphibians the jaws and roof of the mouth bear small, usually slender, peg-like teeth. They function chiefly in holding and crushing prey and are usually little used in mastication. During vertebrate evolution, a fleshy, muscular tongue first appears in amphibians, and probably originated as an adaptation to life on land. In amphibian larvae and completely aquatic transformed species it is poorly developed or absent. In many terrestrial species it is protrusible and sticky, and used to capture moving prey. The capacity for protrusion is especially well developed in many anurans and in plethodontid salamanders.

Note the gross differences in tongue structure among a frog or toad, a salamander with a simple tongue (for example, *Taricha*), and a salamander with a highly projectile tongue (some plethodontids, for example *Hydromantes*). See Fig. 15 for drawings of amphibian tongues. Don't be dismayed by the complexity, we will discuss these detailed differences and their biological roles in class lectures.

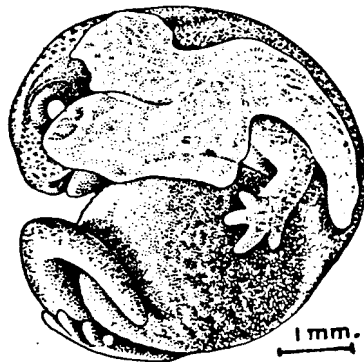
5. Eggs and Larvae. Observe the demonstrations of amphibian eggs and larvae. Note the differences between 'pond type' and 'stream type' larvae in terms of overall body form (see illustrations in your Field Guide), and between the larvae of frogs and salamanders in locomotor and feeding structures. Note the bizarre morphology of the tadpole of *Ascaphus*. How do you think that might relate to its unusual lifestyle?

## Drawing of a late embryo of *Ensatina*

*Ensatina* are plethodontid salamanders that lack an aquatic larval stage of development; the young emerge from the egg as miniature replicas of the adult. Note the broad, fleshy, trilobite gills used in respiration and possibly waste excretion while still in the egg. The gills are reduced to nubbins at hatching and disappear completely within a few days. Direct development is a specialization related to occupation of terrestrial environments. Among salamanders, it occurs only in some Plethodontidae. Direct development has arisen independently many times among families of tropical frogs.

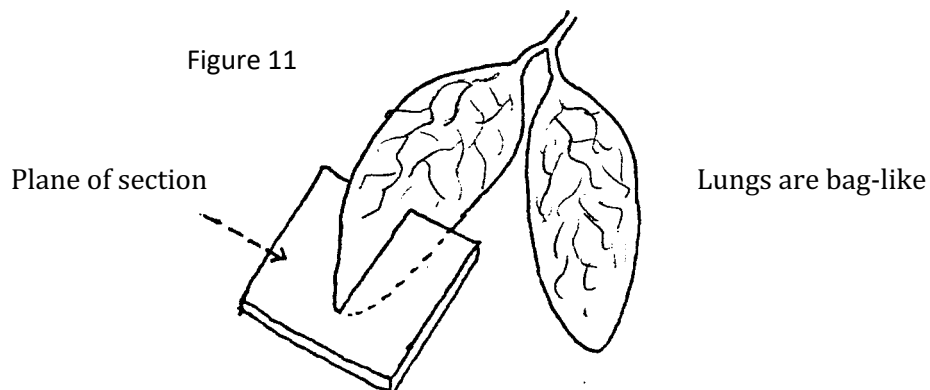
All plethodontid salamanders in the western US develop in this way (see Fig. 10).

(Fig. 10)



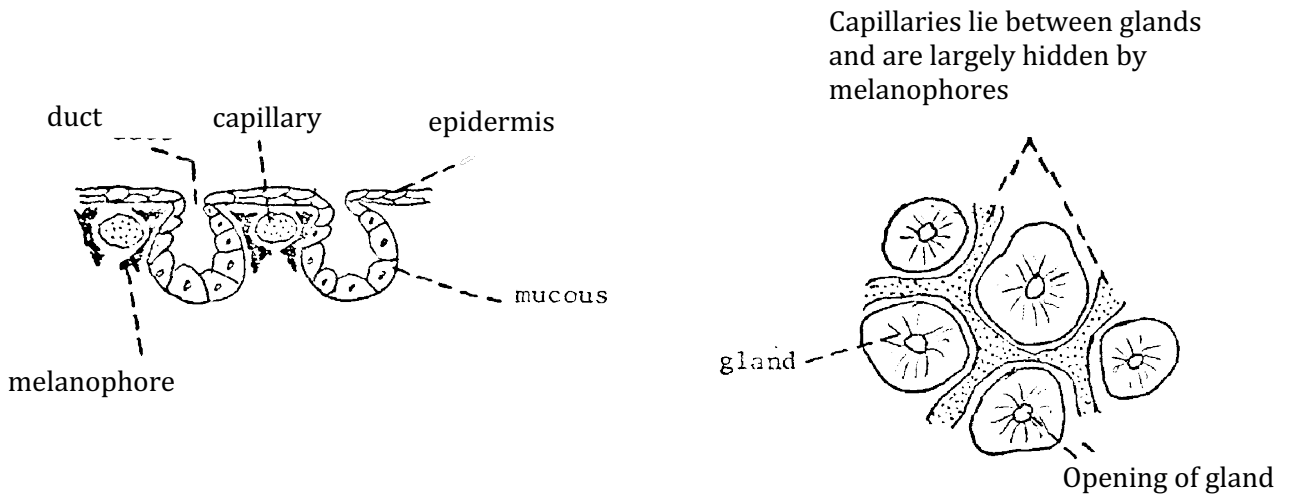
## Lungs of anurans

Toads (*Anaxyrus*) have more partitioning in the walls of their lungs than do other frogs such as *Rana*. They are generally more terrestrial and often operate at higher body temperatures. They tend to have thicker skin than other frogs, and the skin may therefore perform less efficiently as a respiratory organ (Fig. 11).



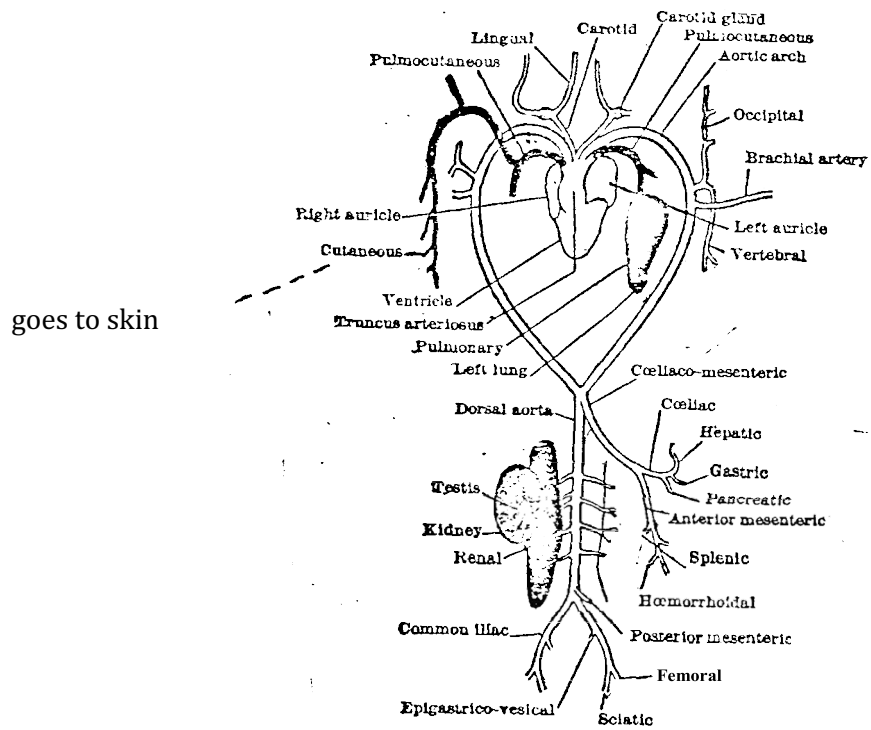


**Salamander skin – Dorsal surface (Fig. 12)**

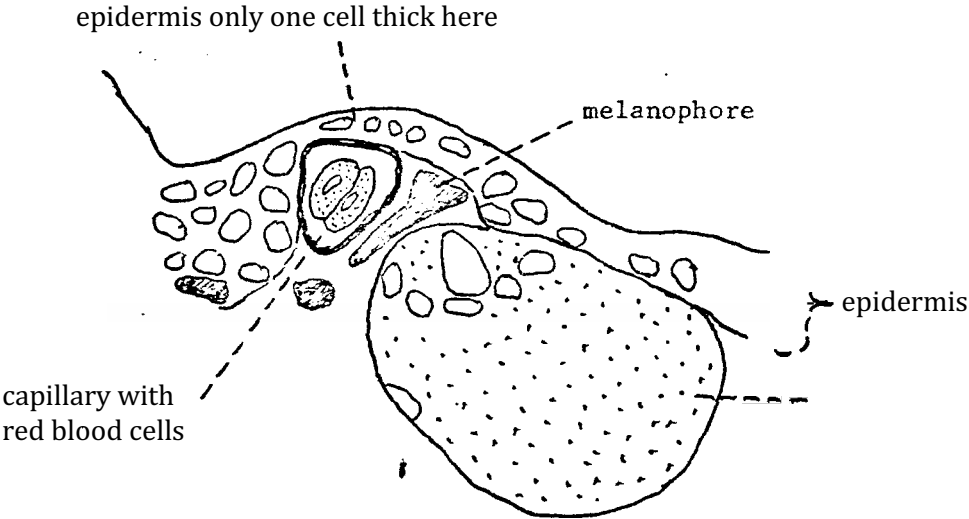


**Arterial system of a frog (from Holmes, 1927, *Biology of the Frog*)**

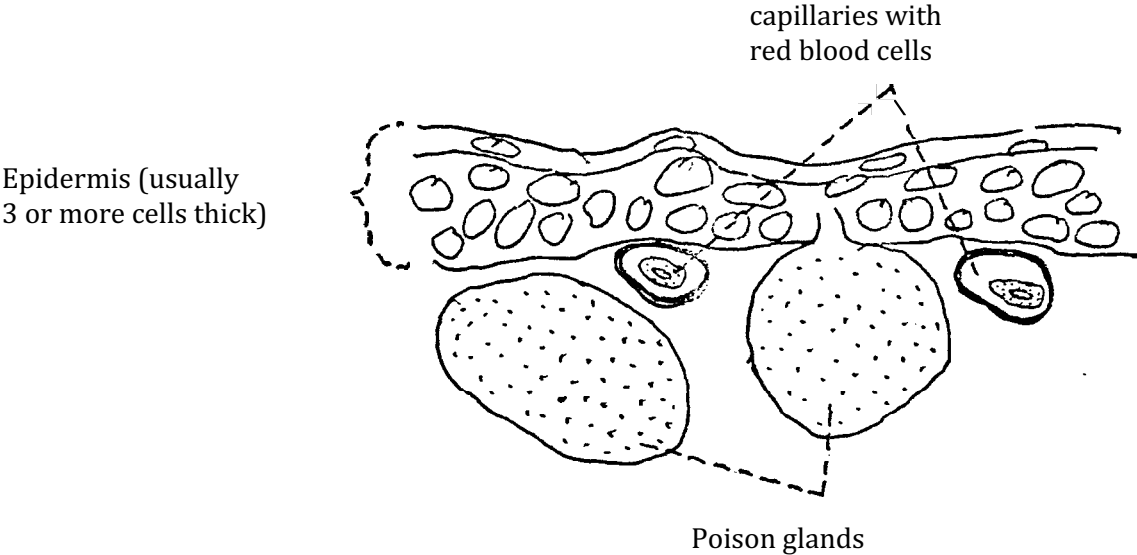
Note the cutaneous blood vessels to the skin, which serves as an important respiratory organ (Fig. 13).



Thinning of epidermis in lungless salamanders (Fig. 14).



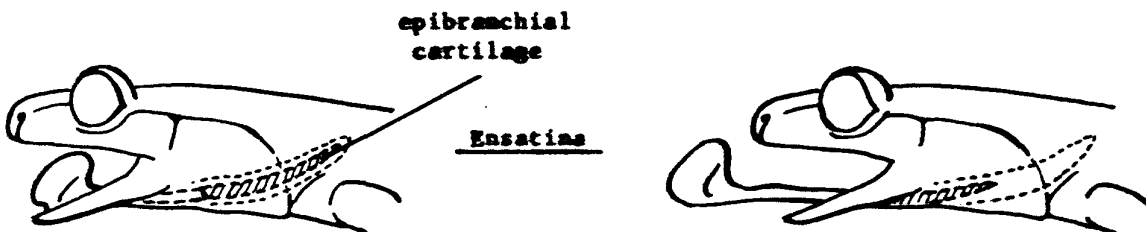
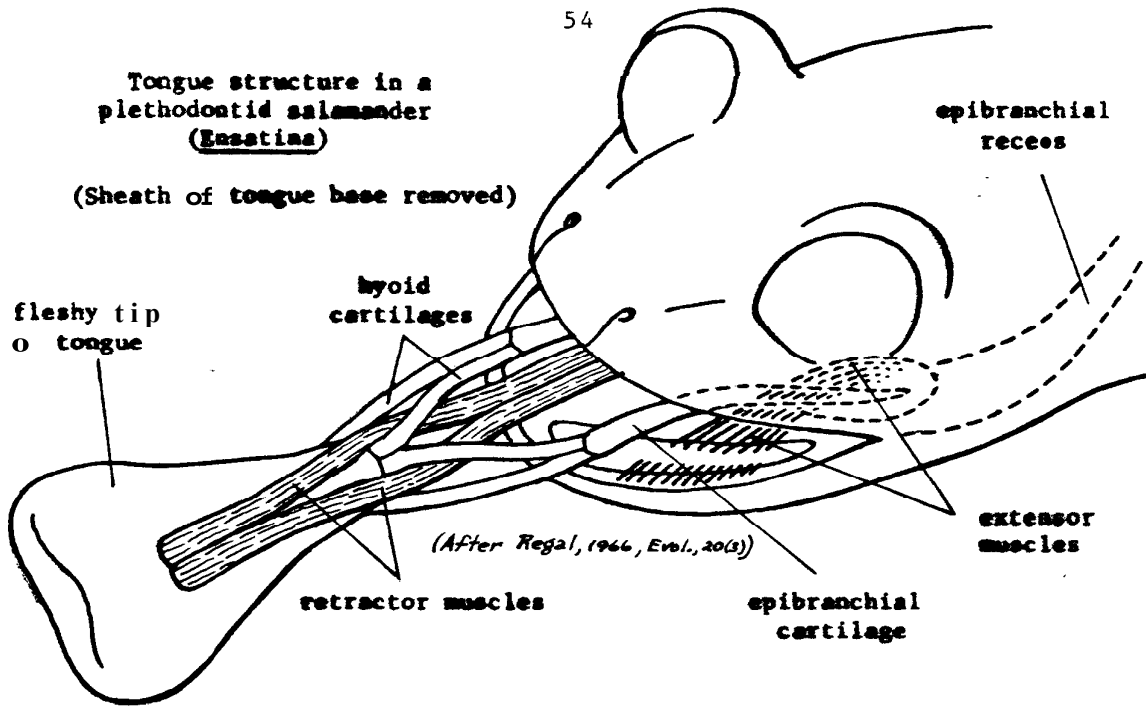
Arboreal Salamander



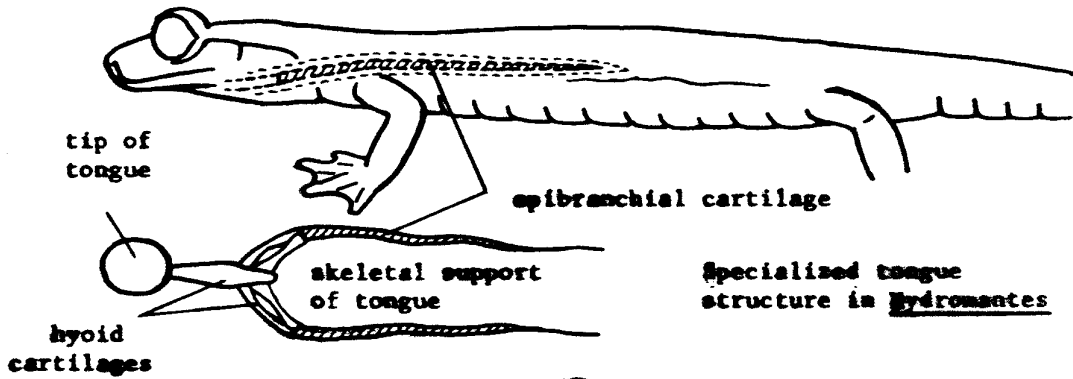
Tiger Salamander  
(less terrestrial than Arboreal Salamander)

Tongue structure in a plethodontid salamander (Ensatina)

(Sheath of tongue base removed)



Movement of epibranchial cartilage in tongue protrusion



Specialized tongue structure in Hydromantes



Tongue action in a toad (Bufo)

Fig.15 Tongue structure in amphibians

# Key to Amphibians

See Stebbins Field Guide for explanation of terms. Numbers in parentheses indicate the preceding choice in the key.

1. Tail present, hind legs nearly equal to fore legs in length.  
(Order Caudata - Salamanders) ..... 2
- 1a. Tail absent in adults, hind legs longer and stronger than fore legs  
(Order Anura - Frogs) ..... 14
2. (1) Nasolabial groove extends from nostril to edge of upper lip,  
vomerine and parasphenoid teeth present (Plethodontidae) ..... 3
- 2a. Nasolabial groove absent, only vomerine teeth present ..... 8
3. (2) Toes 4 on both fore and hind feet, limbs greatly reduced  
*Batrachoseps attenuatus* (California Slender Salamander)
- 3a. Toes 4 on fore foot, 5 on hind foot, limbs not reduced ..... 4
4. (3a) Margin of tongue free all around, tongue pedicellate, toes with  
fleshy web at base *Hydromantes* sp. .... 5
- 4a. Tongue attached anteriorly, toes not strongly webbed ..... 7
5. (4) Granite-matching dorsal pattern, (usually 1/2 to 1 1/2 costal  
grooves between tips of toes of adpressed limbs  
*Hydromantes platycephalus* (Mt. Lyell Salamander)
- 5a. Dorsal pattern not granite-matching, tips of toes of adpressed  
limbs usually overlap 1/2 to 1 1/2 costal grooves ..... 6
6. (5a) Dorsum uniformly brown, venter pale with weak development  
of melanophores *Hydromantes brunus* (Limestone Salamander)
- 6a. Dorsum mottled, venter with extensive development of  
melanophores *Hydromantes shastae* (Shasta Salamander)
7. (4a) Tail constricted at base, in cross section tail rounded above  
but narrow, almost keeled, ventrally  
*Ensatina eschscholtzii* (Ensatina)
- 7a. Tail not constricted at base, nearly circular in cross section  
*Aneides lugubris* (Arboreal Salamander)
8. (2a) Costal grooves absent or poorly defined, skin rough or 'warty',  
vomeropalatine teeth in two longitudinal rows diverging posteriorly  
between the orbits (Salamandridae) ..... 9

- 8a. Costal grooves present, skin smooth, vomerine teeth in transverse row ..... 11
9. (8) Eyes dark brown or black, dorsum dark brown or black, dark dorsal coloration extends far onto undersides of limbs in vicinity of elbow and knee *Taricha rivularis* (Red-bellied Newt)
- 9a. Eyes with yellow or silvery color, brown or olive dorsal color which does not extend far onto undersides of limbs ..... 10
10. (9) Eyes relatively large, corneal surface usually extends to contour of jaw when viewed from above, vomeropalatine teeth in two parallel rows anteriorly, diverging abruptly posteriorly forming a Y-shaped pattern *Taricha torosa* (California Newt)
- 10a. Eyes relatively small, corneal surface usually does not extend to contour of lower jaw when viewed from above, vomeropalatine teeth diverging gradually posteriorly forming a V-shaped pattern *Taricha granulosa* (Rough-skinned Newt)
11. (8a) Small body size, eyes large relative to head, short snout, squared glands at vent in males (Rhyacotritonidae) *Rhyacotriton variegatus* (Southern Torrent Salamander)
- 12a. Eyes small relative to head, snout relatively long, large body size..... 13
13. (12a) Distance between upper eyelids no more than 1 1/2 times width of upper lid, dorsum dark with dark marbling (Dicamptodontidae) *Dicamptodon ensatus* (California Giant Salamander)
- 13a. Distance between upper eyelids, 2 times width of upper lid, dorsum dark with scattered light spots (Ambystomatidae) *Ambystoma californiense* (California Tiger Salamander)
14. (1a) Outer (5th) digit of hind foot broadest, male with tail-like process from which vent opens, eye with vertically oval pupil, no ear drum (Ascaphidae) *Ascaphus truei* (Tailed Frog)
- 14a. Outer digit of hind foot not broadened, no tail-like process, eye with horizontally oval pupil (except Pelobatidae) ..... 15
15. (14a) Eye with vertically oval pupil, hind foot with a single metatarsal tubercle consisting of a black, sharp-edged 'spade' on inner margin of foot (Pelobatidae) ..... 16
- 15a. Eye with horizontally oval pupil, two metatarsal tubercles neither notably sharp-edged ..... 17

16. (15)	Spade on hind foot sickle-shaped, width of upper eyelids from above about the same as or less than distance between them, dorsal pattern usually forms a network	<i>Scaphiopus couchii</i> (Couch's Spadefoot)	
16a.	Spade on hind foot wedge-shaped, width of upper eyelids from above usually greater than distance between them, dorsal pattern not a network	<i>Spea hammondi</i> (Western Spadefoot)	
17. (15a)	Body stocky, waist broad, parotoid glands present, body with numerous warts (Bufonidae) .....		18
17a.	Body and waist slender, parotoid glands absent, body not markedly warty .....		21
18. (17)	Parotoid glands round, about same size as upper eyelids, head and body flattened	<i>Anaxyrus punctatus</i> (Red-spotted Toad)	
18a.	Parotoid glands elongate, considerably larger than upper eyelids, head and body not notably flattened .....		19
19. (18a)	Large blotches on dorsum in symmetrical pairs; well developed, divergent cranial crests	<i>Anaxyrus cognatus</i> (Great Plains Toad)	
19a.	Blotches on dorsum not in symmetrical pairs, cranial crests weak or absent .....		20
20. (19a)	White mid-dorsal stripe, fold of skin on tarsus	<i>Anaxyrus boreas</i> (Western Toad)	
20a.	Smooth parotoid gland, marked difference in coloration between males and females	<i>Anaxyrus canorus</i> (Yosemite Toad)	
21. (17a)	Fingers and toes with expanded adhesive disks (Hylidae) .....		22
21a.	Extensive webbing on hind feet, fingers and toes without expanded adhesive disks (Ranidae) .....		23
22. (21)	Dark eye stripe extending to shoulder	<i>Hyla regilla</i> (Pacific Treefrog)	
22a.	No dark eye stripe, skin rough	<i>Pseudacris cadaverina</i> (Calif. Treefrog)	
23. (21a)	Tympanic membrane prominent, as large as eye or, in males, much larger, no dorsolateral folds	<i>Lithobates catesbeiana</i> (American Bullfrog)	
23a.	Tympanic membrane not especially prominent, smaller than eye, dorsolateral folds present or obscure .....		24

24. (23a) Dorsolateral folds prominent, extending posteriorly to sacral hump, red on underparts in life, hind limbs frequently with dark bars or stripes *Rana draytonii* (California Red-legged Frog)
- 24a. d Dorsolateral folds absent or indistinct, not extending to sacral hump, underparts yellow or yellow-orange in life ..... 25
25. (24a) Eardrum rough, usually a light-colored band across head intersecting eyelids, toetips not set off in color from rest of toe *Rana boylei* (Foothill Yellow-legged Frog)
- 25a. Eardrum smooth, no light band on head, coloration on back network-like, toe tips set off in color from rest of toes *Rana muscosa* (Southern Mountain Yellow-legged Frog)

Table 1. Identification Characteristics and Habitats of California Amphibians Habitat description includes Life Zone Range (see Fig. 3).

	Identification	Habitat
Salamandridae	Teeth in divergent longitudinal rows on roof of mouth, costal grooves indistinct	
<i>Taricha torosa</i> (California Newt)	Eyes relatively large, usually intersecting outline of head when viewed from above, teeth in Y-shaped pattern	US-T: Woodland and mixed coniferous-broadleaved forests; ponds and streams
<i>Taricha granulosa</i> (Rough-skinned Newt)	Eyes relatively small, usually not intersecting outline of head when viewed from above, teeth in V-shaped pattern	T-C: Woodland and coniferous forests; ponds, lakes, and streams
<i>Taricha rivularis</i> (Red-bellied Newt)	Eyes completely dark, broad dark band across vent	US-T: Woodland and coniferous forests; streams
Ambystomatidae	Teeth in transverse row on roof of mouth (often interrupted), costal grooves usually distinct	
<i>Ambystoma californiense</i> (California Tiger Salamander)	Eyes small, dorsal pattern of conspicuous yellow or cream-colored spots on black background	LS-C: Grassland; woodland; permanent or temporary lakes, slow streams or ponds
	Identification	Habitat
Dicamptodontidae	Teeth in transverse row on roof of mouth (often interrupted), costal grooves usually distinct	
<i>Dicamptodon ensatus</i> (California Giant Salamander)	Large body size, eyes large, marbled dorsal pattern	US-C: Coniferous or mixed coniferous and deciduous forests; streams, occasionally lakes
Rhyacotritonidae	small body size, eye large, costal grooves usually distinct	
<i>Rhyacotriton variegatus</i> (Southern Torrent Salamander)	males with distinct squared lobes at vent	T: Coniferous or mixed coniferous and deciduous forests; torrents, springs, and seepages
Plethodontidae	Nasolabial groove	
<i>Batrachoseps attenuatus</i> (California Slender Salamander)	Worm-like, 4 toes on front and hind feet, reduced limbs	US-T: Woodland, coniferous forests, sparingly grassland
<i>Hydromantes platycephalus</i> (Mt. Lyell Salamander)	Partially webbed toes, granite-matching dorsal pattern, toes of adpressed limbs do not overlap in adults	T-AA: Granite outcrops, cliff faces, talus in vicinity of snow banks, waterfalls and seepages
<i>Hydromantes brunus</i> (Limestone Salamander)	Partially webbed toes, uniformly brown above, toes of adpressed limbs overlap in adults	US: Limestone talus and caves; seepage areas and vicinity of streams; woodland, mixed deciduous and coniferous forests, and chaparral



	Identification	Habitat
Plethodontidae cont.		
<i>Hydromantes shastae</i> (Shasta Salamander)	Partially webbed toes, mottled pattern, toes of adpressed limbs overlap in adults	US-T: Limestone caves and vicinity; woodland, mixed deciduous and coniferous forest
<i>Ensatina eschscholtzii</i> (Ensatina)	Tail constricted at base	US-T: Woodland and coniferous forests
<i>Aneides lugubris</i> (Arboreal Salamander)	Projecting upper jaw teeth, squarish toe tips	US-T: Woodland chiefly of coast and interior live oak
<hr/>		
Ascaphidae	Outer toe of hind foot broadened	
<i>Ascaphus truei</i> (Tailed Frog)	Male with tail-like copulatory organ, tympanum not visible externally	T-C: Cold streams; coniferous forests and deciduous woodlands
Scaphiopodidae	Single black spade on hind foot, no parotoid glands, pupils vertical	
<i>Scaphiopus couchii</i> (Couch's Spadefoot)	Dorsal markings often form a network; sickle-shaped spade on hind foot	LS-US: Shortgrass plains, mesquite savannah, creosote bush desert
<i>Spea hammondi</i> (Western Spadefoot)	Hourglass-like markings on back, wedge-shaped 'spade' on hind foot	LS-US: Grassland and open woodland, washes, flood plains, intermittent streams

	Identification	Habitat
Bufoinae	Parotoid glands present, pupils horizontally oval, stocky body	
<i>Bufo punctatus</i> (Red-spotted Toad)	Flattened head and body, round parotoids, about same size as upper eyelids	LS-T: Desert oases, grassland, rocky canyons and arroyos
<i>Bufo cognatus</i> (Great Plains Toad)	Dark blotches in symmetrical pairs on back, cranial crests widely divergent posteriorly and united on snout to form a boss	LS-US: Prairies and desert
<i>Bufo boreas</i> (Western Toad)	White stripe down back, tarsal fold, parotoid glands separated by about twice width of gland	LS-C: Grassland, mountain meadows, farmland, open areas in woodland and coniferous forests; ponds, lakes, borders of slow streams
<i>Bufo canorus</i> (Yosemite Toad)	Large, flat parotoids, less than width of gland apart, marked sexual dimorphism	T-H: High mountain meadows; snow melt ponds
Hylidae	Expanded toe pads	
<i>Pseudacris regilla</i> (Pacific Treefrog)	Black eye-stripe to shoulder	US-C: Brackish marshes; valley grassland to mountain meadows; meadow pools, streams, ponds, and lakes
<i>Pseudacris cadaverina</i> (California Treefrog)	Rough skin, no eye stripe	LS-T: Rocky canyons and arroyos; streams with quiet pools and shade

	Identification	Habitat
Ranidae	Webbing on hind feet, no parotoids, pupils horizontally oval	
<i>Rana catesbeiana</i> (American Bullfrog)	No dorsolateral folds, large tympanum (especially in males)	LS-T: Grassland, woodland, marshes, ponds, lakes, and slow streams
<i>Rana draytonii</i> (California Red-legged Frog)	Conspicuous dorsolateral folds, eardrums smooth, no triangle on head, usually bands on legs	US-T: Woodland and coniferous forests; quiet stretches of streams, ponds, and lakes
<i>Rana boylei</i> (Foothill Yellow-legged Frog)	Inconspicuous dorsolateral folds, eardrum rough, pale triangle on head, toe tips pale	US-T: Woodland and mixed deciduous and coniferous forest; streams and rivers
<i>Rana muscosa</i> (Mountain Yellow-legged Frog)	Inconspicuous dorsolateral fold, eardrums smooth, toetips dark, mottled dorsum, no pale triangle on head	T-H: Mountain meadows; slow streams, ponds and lakes

# Laboratory Exercises on Mammals

## IB 104LF, Spring 2021

In the mammal labs, we will focus on the species that are most likely to be encountered in the San Francisco and Monterey Bay Areas, from Point Reyes to Sunol to Big Sur. On a big day in this region, one might observe over 70 mammal species. More than 10% of these species are non-native, having been introduced intentionally, or unintentionally, by humans. We are interested in all of these species, both native and non-native. The primary goal of the mammal lab is for you to learn how to identify the local species based on preserved specimens, and for you to become acquainted with the behavior, ecology, and phylogenetic relationships of each species through the natural history notes and the field guide. You will learn to identify any local mammal species that you may encounter, and you will gain a basic knowledge of mammalian natural history that is applicable anywhere in the world.

The first mammal lab will introduce the bones and teeth of mammals, with a focus on the smaller species (shrews, moles, bats, rodents, lagomorphs, and the opossum). The second lab will cover the large, terrestrial species, including carnivorans and artiodactyls. The third lab will focus on the marine mammals, including the sea otter, pinnipeds (seals and sea lions), and cetaceans (whales, dolphins, and porpoises). Please learn the scientific names for all local species and know the taxonomic hierarchy to which each species belongs. It may be useful to know the common names of the mammal species, but you will not be tested on them.

Please handle all of the skins and skulls with care. The small skulls are particularly fragile, and some are already broken. Please do not point to the skulls with a pen or pencil because this creates marks on the bone. If something breaks, or if a tag is separated from a specimen, please let us know right away so that we can make repairs.

The labels attached to the skins often include a series of standard measurements in the following order: total length (from the tip of the nose to the end of the last tail vertebra), tail length (from the base of the tail at the sacrum to the end of the last tail vertebra), pes length (from the back of the heel on the hind foot to the tip of the longest claw), and pinna length (from the notch at the base of the external ear to the top of the cartilage). Please experiment with taking these measurements on specimens in the lab. Soon we will be measuring live mammals in the field.

For exam purposes, you are responsible for the following:

1. Knowledge of the scientific name of each focal species (the species in **bold** on the list and in the notes), and knowledge of the taxonomic hierarchy to which each of these focal species belongs.
2. Identification of all lab specimens to species level based on a combination of skin and skull.
3. Identification of all large mammal specimens to species level based on skin *or* skull alone, including *Didelphis*, all carnivorans, and artiodactyls.
4. Identification of any isolated skin *or* skull to genus.
5. General knowledge of the natural history of focal mammal species—including range, habitat, diet, and reproductive habits—based on the information given in the “Natural History Notes.”

The species on the local mammal list in the section “Other noteworthy mammals of northern California” are included because they are cool and they may be encountered on hikes in the Sierra Nevada or elsewhere in northern California, but you will not be tested on them. The species under “Mammals extirpated from California” may be gone, but they are not forgotten, and they might even return some day. You will not be tested on these species on the lab exams.

# Major Features of the Mammalian Skull

Please learn to identify the bony elements and structures listed in **bold** below.

## MAJOR BONES

**Dentary**

**Premaxilla**

**Maxilla**

**Nasal**

Lacrimal

**Frontal**

**Parietal**

Interparietal

Supraoccipital

Exoccipital

Basioccipital

Basisphenoid

Presphenoid

Vomer

**Jugal**

**Squamosal**

Alisphenoid

Orbitosphenoid

Pterygoid

Palatine

**Turbinals**

## HOLES IN THE HEAD

**Foramen Magnum**

**External Auditory Meatus**

Foramen Ovale

Foramen Rotundum

Orbital Fissure

Optic Foramen

Incisive Foramen

Infraorbital Foramen

## OTHER FEATURES

**Mandibular Condyle**

**Coronoid Process**

**Angular Process**

**Rostrum**

**Orbit**

**Postorbital Process**

**Sagittal Crest**

Lambdoidal Crest

**Occipital Condyle**

Paroccipital Process

Mastoid Process

**Tympanic Bulla**

**Zygomatic Arch**

## Mammalian Dentition

One of the hallmarks of mammalian development is diphyodonty, where a set of deciduous teeth is replaced by a permanent set of adult teeth. The eruption of the teeth in the jaws—and the fusion of the sutures between the cranial bones—provide an osteological indication of an individual mammal's age. We will study skulls of various ages in the mammal labs, but you will only be tested on adult skulls.

The heterodont dentition of mammals includes incisors, canines, premolars, and molars. The upper incisors are in the premaxillary bones; the upper canines are on, or just distal to, the premaxillary-maxillary suture; the upper premolars and molars are in the maxillary bones; and all of the lower teeth are in the dentary bones.

Within each tooth group, individual teeth are numbered from front to back (mesiodistally). By convention, upper teeth are identified with a capital letter or a superscript (or both), and lower teeth are identified with a lowercase letter or a subscript (or both). Thus,  $I^1$  is the first upper incisor and  $m_3$  is the lower third molar. In carnivoran mammals, the  $P^4$  and  $m_1$  are known as the “carnassial” teeth, and they are very useful in species identification.

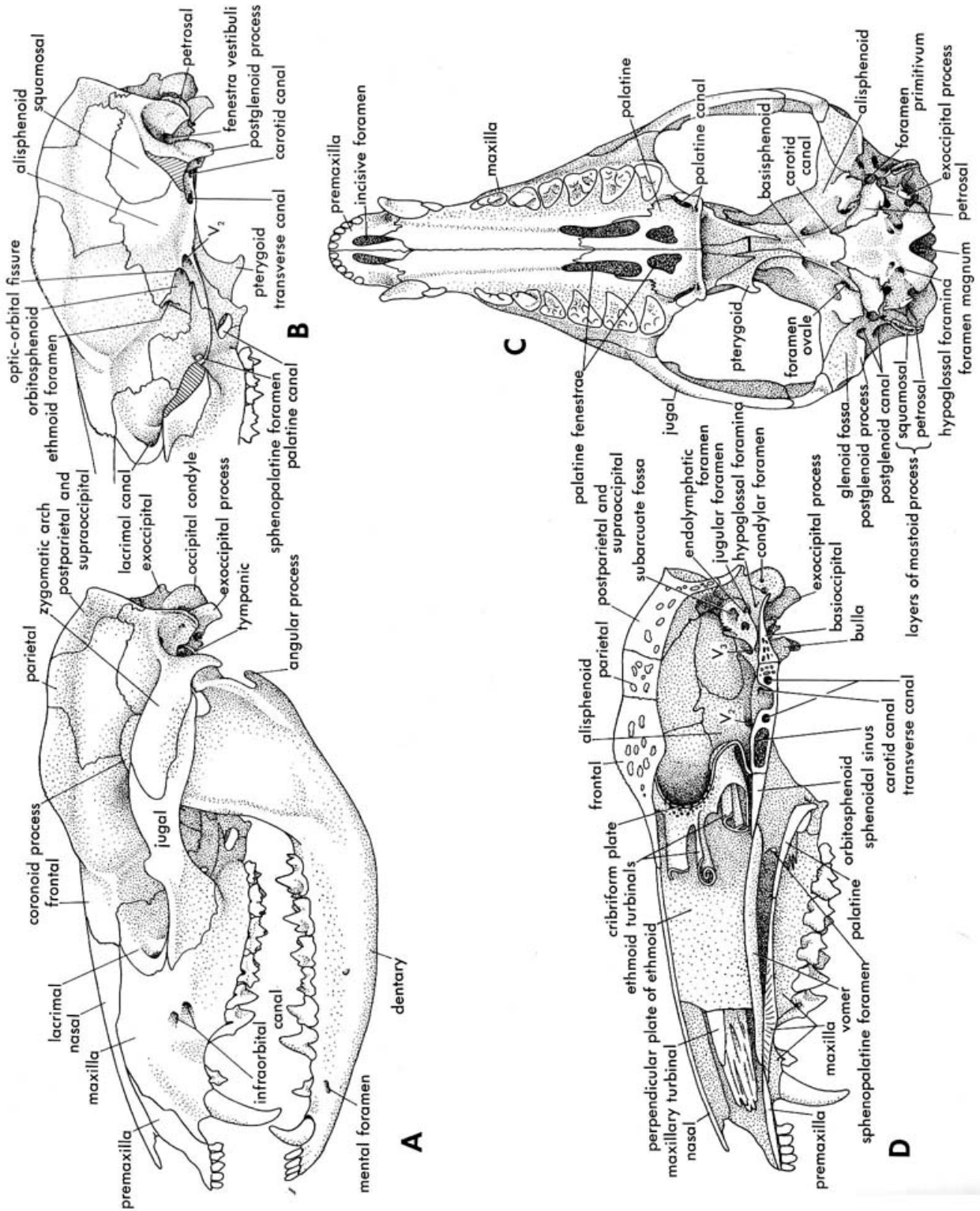
A tooth formula is a shorthand description of the total number of teeth of each type in a skull. The *maximum* number of teeth in the upper and lower jaw quadrants of marsupials (extant metatherians) and placentals (extant eutherians) are as follows:

**5134 / 4134** = 50 total teeth for marsupials

**3143 / 3143** = 44 total teeth for placentals

All local mammals (except the odontocete cetaceans) exhibit the above formulae or some reduction from them. In general, when teeth are lost in evolution, incisors and molars are lost from back to front (distal to mesial), and premolars are lost from front to back (mesiodistally).

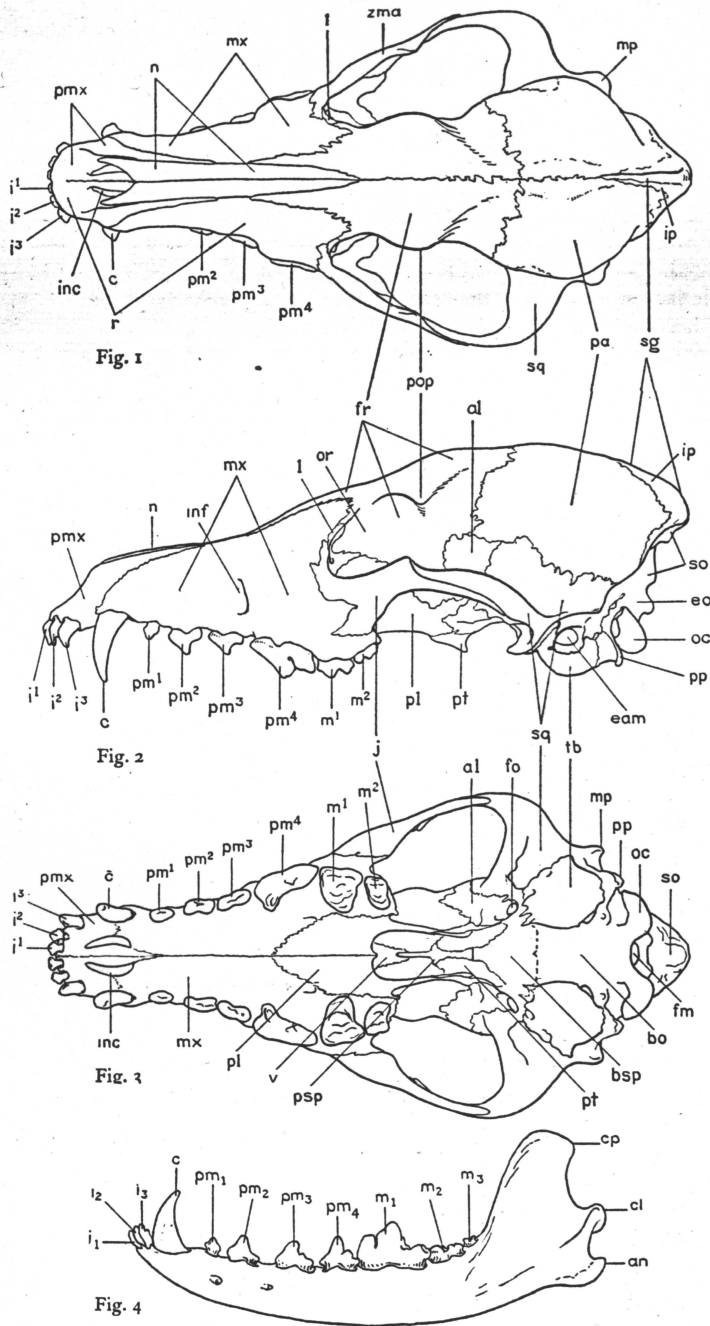
Fig. 16. The skull of an opossum (*Didelphis virginiana*): (A) lateral view, (B) lateral view with zygomatic arch cut away, (C) medial view of right side of cranium, (D) ventral view. From Jollie (1962).





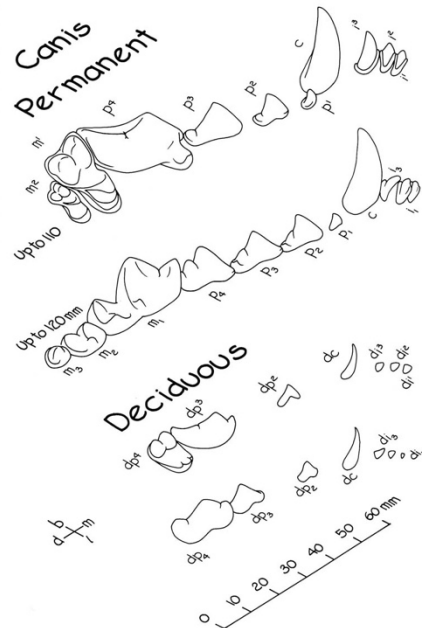


**Fig. 18. The skull of a coyote (*Canis latrans*). Figure adapted from Grinnell & Linsdale (1937), dentition on bottom right from Hillson (2005).**



**Abbreviations**

- al - alisphenoid
- an - angular process
- bo - basioccipital
- bsp - basisphenoid
- c - canine
- cl - mandibular condyle
- cp - coronoid process
- eam - external auditory meatus
- eo - exoccipital
- fm - foramen magnum
- fo - foramen ovale
- inc - incisive foramen
- inf - infraorbital foramen
- ip - interparietal
- j - jugal
- l - lacrimal
- mp - mastoid process
- mx - maxillary
- n - nasal
- oc - occipital condyle
- or - orbit
- pa - parietal
- pl - palatine
- pmx - premaxillary
- pop - postorbital process
- pt - pterygoid
- r - rostrum of skull
- sg - sagittal crest
- so - supraoccipital
- sq - squamosal
- tb - tympanic bulla
- v - vomer
- zma - zygomatic arch



# Mammals of the San Francisco and Monterey Bay Areas

## Marsupialia (Metatheria)

### Didelphimorphia

#### Didelphidae

- 1 *Didelphis virginiana* – Virginia Opossum <sup>1/171</sup> \*

## Placentalia (Eutheria)

### Lipotyphla

#### Soricidae

- 2 *Sorex ornatus* – Ornate Shrew <sup>32/376</sup>  
3 *Sorex trowbridgii* – Trowbridge's Shrew <sup>33/380</sup>  
4 *Sorex vagrans* – Vagrant Shrew <sup>32/375</sup>  
5 *Sorex sonomae* – Fog Shrew <sup>No plate /373</sup>

#### Talpidae

- 6 *Scapanus latimanus* – Broad-footed Mole <sup>34/386</sup>  
7 *Neurotrichus gibbsii* – Shrew-Mole <sup>34/385</sup>

### Chiroptera

#### Molossidae

- 8 *Tadarida brasiliensis* – Brazilian Free-tailed Bat <sup>40/425</sup>

#### Vespertilionidae

- 9 *Myotis californicus* – Californian Myotis <sup>37/400</sup>  
10 *Myotis evotis* – Long-eared Myotis <sup>37/410</sup>  
11 *Myotis lucifugus* – Little Brown Myotis <sup>37/410</sup>  
12 *Myotis thysanodes* – Fringed Myotis <sup>37/410</sup>  
13 *Myotis volans* – Long-legged Myotis <sup>37/407</sup>  
14 *Myotis yumanensis* – Yuma Myotis <sup>37/402</sup>  
15 *Corynorhinus townsendii* – Townsend's Big-eared Bat <sup>39/422</sup>  
16 *Lasiurus cinereus* – Hoary Bat <sup>38/418</sup>  
17 *Lasiurus blossevillii* – Western Red Bat <sup>38/417</sup>  
18 *Antrozous pallidus* – Pallid Bat <sup>39/423</sup>  
19 *Eptesicus fuscus* – Big Brown Bat <sup>36/414</sup>  
20 *Lasionycteris noctivagans* – Silver-haired Bat <sup>38/411</sup>

### Rodentia

#### Aplodontiidae

- 21 *Aplodontia rufa* – Sewellel <sup>3/178</sup>

#### Sciuridae

- 22 *Tamias merriami* – Merriam's Chipmunk <sup>9/216</sup>  
23 *Tamias sonomae* – Sonoma Chipmunk <sup>9/216</sup>  
24 *Sciurus carolinensis* – Eastern Gray Squirrel <sup>11/225</sup> \*  
25 *Sciurus niger* – Eastern Fox Squirrel <sup>11/227</sup> \*  
26 *Sciurus griseus* – Western Gray Squirrel <sup>12/229</sup>  
27 *Otospermophilus beecheyi* – California Ground Squirrel <sup>5/201</sup>

## Castoridae

- 28 *Castor canadensis* – American Beaver <sup>2/179</sup>

## Heteromyidae

- 29 *Chaetodipus californicus* – California Pocket Mouse <sup>15/251</sup>  
30 *Dipodomys heermanni* – Heermann's Kangaroo Rat <sup>18/267</sup>  
31 *Dipodomys venustus* – Narrow-faced Kangaroo Rat <sup>18/265</sup>

## Geomyidae

- 32 *Thomomys bottae* – Botta's Pocket Gopher <sup>14/242</sup>

## Dipodidae

- 33 *Zapus trinotatus* – Pacific Jumping Mouse <sup>22/337</sup>

## Cricetidae

### Arvicolinae

- 34 *Microtus californicus* – California Vole <sup>26/316</sup>  
35 *Ondatra zibethicus* – Common Muskrat <sup>2/326 \*</sup>

### Neotominae

- 36 *Reithrodontomys megalotis* – Western Harvest Mouse <sup>19/289</sup>  
37 *Reithrodontomys raviventris* – Salt-marsh Harvest Mouse <sup>19/290</sup>  
38 *Peromyscus maniculatus* – North American Deermouse <sup>20/277</sup>  
39 *Peromyscus truei* – Piñon Deermouse <sup>21/282</sup>  
40 *Peromyscus boylii* – Brush Deermouse <sup>21/281</sup>  
41 *Peromyscus californicus* – California Deermouse <sup>21/275</sup>  
42 *Neotoma fuscipes* – Dusky-footed Woodrat <sup>23/300</sup>  
43 *Neotoma lepida* – Desert Woodrat <sup>23/297</sup>  
44 *Neotoma macrotis* – Big-eared Woodrat <sup>na</sup>

### Muridae – Old World Rats & Mice

- 45 *Mus musculus* – House Mouse <sup>19/331 \*</sup>  
46 *Rattus norvegicus* – Brown Rat <sup>24/333 \*</sup>  
47 *Rattus rattus* – Roof Rat <sup>24/332 \*</sup>

## Lagomorpha

### Leporidae

- 48 *Sylvilagus bachmani* – Brush Rabbit <sup>28/344</sup>  
49 *Sylvilagus audubonii* – Desert Cottontail <sup>28/351</sup>  
50 *Lepus californicus* – Black-tailed Jackrabbit <sup>31/355</sup>

## Carnivora

### Felidae

- 51 *Lynx rufus* – Bobcat <sup>47/435</sup>  
52 *Puma concolor* – Cougar <sup>48/433</sup>

### Canidae

- 53 *Urocyon cinereoargenteus* – Gray Fox <sup>50/448</sup>  
54 *Vulpes vulpes* – Red Fox <sup>50/447 \*</sup>  
55 *Canis latrans* – Coyote <sup>49/439</sup>

## Procyonidae

- 56 *Bassariscus astutus* – Ringtail <sup>52/454</sup>
- 57 *Procyon lotor* – Raccoon <sup>52/455</sup>

## Mephitidae

- 58 *Spilogale gracilis* – Western Spotted Skunk <sup>53/457</sup>
- 59 *Mephitis mephitis* – Striped Skunk <sup>53/459</sup>

## Mustelidae

- 60 *Mustela frenata* – Long-tailed Weasel <sup>54/466</sup>
- 61 *Mustela vison* – American Mink <sup>55/467</sup>
- 62 *Taxidea taxus* – American Badger <sup>52/470</sup>
- 63 *Lontra canadensis* – North American River Otter <sup>56/471</sup>
- 64 *Enhydra lutris* – Sea Otter <sup>56/472</sup>

## Ursidae

- 65 *Ursus americanus* – American Black Bear <sup>51/450</sup>

## Pinnipedia

### Otariidae

- 66 *Zalophus californianus* – California Sea Lion <sup>57/477</sup>
- 67 *Eumetopias jubatus* – Steller Sea Lion <sup>57/476</sup>

### Phocidae

- 68 *Phoca vitulina* – Harbor Seal <sup>58/478</sup>
- 69 *Mirounga angustirostris* – Northern Elephant Seal <sup>59/485</sup>

## Artiodactyla

### Cervidae

- 70 *Odocoileus hemionus* – Mule Deer <sup>41/496</sup>
- 71 *Cervus elaphus nannodes* – Tule Elk <sup>42/490</sup>

### Suidae

- 72 *Sus scrofa* – Wild Boar <sup>44/487</sup> \*

## Cetacea

### Odontoceti

- 73 *Tursiops truncatus* – Bottlenose Dolphin <sup>61/514</sup>
- 74 *Phocoena phocoena* – Harbor Porpoise <sup>62/527</sup>
- 75 *Phocoenoides dalli* – Dall's porpoise <sup>62/527</sup>

### Mysticeti

- 76 *Eschrichtius robustus* – Gray Whale <sup>66/540</sup>
- 77 *Megaptera novaeangliae* – Humpback Whale <sup>66/546</sup>
- 78 *Balaenoptera musculus* – Blue Whale <sup>65/542</sup>

## Other noteworthy mammals of northern California

- 1 *Erethizon dorsatum* – North American Porcupine <sup>1/338</sup>
- 2 *Marmota flaviventris* – Yellow-bellied Marmot <sup>3/182</sup>
- 3 *Tamiasciurus douglasii* – Douglas Squirrel <sup>13/232</sup>
- 4 *Arborimus pomo* – Sonoma Tree Vole <sup>26/313</sup>
- 5 *Ochotona princeps* – American Pika <sup>28/342</sup>
- 6 *Canis lupus* – Wolf <sup>49/441</sup>
- 7 *Martes americana* – American Marten <sup>55/462</sup>
- 8 *Martes pennanti* – Fisher <sup>55/463</sup>
- 9 *Gulo gulo* – Wolverine <sup>56/469</sup>
- 10 *Antilocapra americana* – Pronghorn <sup>44/500</sup>

## Mammals extirpated from California

- 1 *Ursus arctos* – Brown Bear <sup>51/451</sup>
- 2 *Panthera onca* – Jaguar <sup>48/437</sup>
- 3 *Bison bison* – American Bison <sup>45/502</sup>

The numbers in superscript after the common names refer to the plate and page numbers in the mammal field guide (Reid 2006). An asterisk (\*) indicates an introduced (non-native) species.

# Mammals: Natural History Notes

The following natural history notes for local mammal species were compiled from various sources, including *Fur-bearing mammals of California* (Grinnell et al. 1937), *Game birds and mammals of California: a laboratory syllabus* (Leopold 1951), *Mammals of the Pacific states* (Ingles 1965), *Bats of North America* (Barbour & Davis 1969), *The mammals of North America* (Hall 1981), *Walker's mammals of the world* (Nowak 1999), *Mammals of California* (Jameson & Peters 2004), *A field guide to mammals of North America* (Reid 2006), journal articles, and the web. You are encouraged to consult the published literature for more natural history info.

These notes on mammal species local to the Greater Bay Area—including the San Francisco and Monterey Bay Areas and including the surrounding region north to Point Reyes, east to Mount Diablo, and south to Mount Hamilton and Big Sur—are intended as a supplement to Reid's (2006) field guide to North American mammals. Each species entry begins with a description of the geographic range and ends with a reference to the plate and page number for that species in the field guide (Reid 2006). The remainder of the entry includes basic natural history information related to taxonomy, habitat preference, morphology, diet, predators, locomotion, seasonality, reproduction, and local history. The diversity of mammals in the Bay Area is truly exceptional!

## ORDER DIDELPHIMORPHIA (American Marsupials)

### FAMILY DIDELPHIDAE (American Opossums)

*Didelphis virginiana* (Virginia Opossum). The native range included southeastern Canada and the eastern United States south through Mexico and Central America. Apparently introduced to California at San Jose in the early 20<sup>th</sup> century, *Didelphis virginiana* expanded rapidly across the state. Opossums are nocturnal, and they flourish in human modified ecosystems, including cultivated lands and suburbs. The tail is prehensile and they are skilled climbers. The skull houses 50 teeth, including 10 upper incisors (no other mammal in North America has more than 6 upper incisors). The braincase is small and the ectocranial crests are prominent. The diet is varied and includes eggs, fruit, vegetables, invertebrates, and young birds and mammals. Builds nests of leaves and grass. Matures at 6 months and may have 2 litters per year. Gestation is 12–13 days, litter size is 8–18, and the young complete their development in the marsupium (the pouch). Feigns death when threatened, causing some predators to ignore it. **1/171.**

## ORDER LIPOTYPHILA (Insectivores)

### FAMILY SORICIDAE (Shrews)

*Sorex ornatus* (Ornate Shrew). Ranges along California from just north of San Francisco and the Sierran foothills to northern Baja California; a small, disjunct population occurs on the southern tip of Baja. Found primarily in marshes, along streams, and in upland areas with dense vegetation. Eats invertebrates, including insect larvae and pupae. Breeding occurs in late February and peaks in April/May, with a second smaller breeding peak in late summer/early fall when young from the previous spring enter reproductive age. **32/376.**

***Sorex trowbridgii*** (Trowbridge's Shrew). Ranges along the Pacific Coast from southern British Columbia to southern California, and along the Sierra Nevada. Like most shrews, it relies primarily on invertebrates, including insects and their larvae, but this species also takes a considerable amount of plant material as well as fungi. Because of its taste for conifer seeds this species may be a problem for reforestation projects. Occurs in moist and mature forests as well as dry areas with abundant vegetation. Avoids the wet soils favored by *S. ornatus*. The litter size is usually 4, and it may breed 2–4 times in a season, but it rarely lives more than 18 months. **33/380**.

***Sorex vagrans*** (Vagrant Shrew). A small, ecologically versatile shrew that occurs from the San Francisco Bay Area and the northern Sierra Nevada to southern Canada and across the northwestern US to Montana. An isolated population of this species occurs in central Mexico. *Sorex vagrans* is a small shrew (the size of *S. ornatus*) that feeds primarily on invertebrates, but also plant matter and fungi. **32/375**.

***Sorex sonomae*** (Fog Shrew). This is a large shrew that prefers marshes, wet thickets, and damp forests where it feeds on invertebrates and amphibians. Occurs from Point Reyes to western Oregon. **No plate/375**.

#### **FAMILY TALPIDAE (Moles)**

***Scapanus latimanus*** (Broad-footed Mole). The range is primarily California excluding the arid regions. Prefers rich and moist soils. A fossorial mammal, *Scapanus latimanus* coexists with pocket gophers (*Thomomys*) but exploits different foods. The diet consists primarily of annelid worms (especially earthworms) as well as insects and other small invertebrates. The eyes are vestigial and prey is located by touch. Birth occurs in March or April and the litter size is 4 (range 2–5). The young disperse above ground and may fall prey to hawks and other predators. The soft hairs can lie flat in any direction, facilitating forward and backward progress in the burrow. May be active by day or night. The skeleton and appendages are modified for digging. **34/386**.

***Neurotrichus gibbsii*** (Shrew-Mole). Range is western North American from California to British Columbia, from the coast to the interior mountain ranges. Prefers wet temperate forests with soft soils that allow for easy digging; favored microhabitats provide leaf litter or short, brushy vegetation with adequate cover. Builds shallow tunnels through the litter, and somewhat deeper tunnels to a depth of 30 cm. Manus modestly widened. Pinnae absent, eyes rudimentary, nose relatively long and flat, tail is short and thick with bristly hairs. No sexual dimorphism. Smallest talpid in the New World. Mass ranges from 8–14 g, length from 92–132 mm. Breeds from Feb–Aug. Gestation unknown but at least 4 weeks; nests above ground with average 3 offspring per litter. Active night and day. May travel in groups with over 10 individuals. Tunnels and burrows have open entrances, frequently hunts above ground. High metabolism necessitates high food intake, eats up to 1.4 times body weight per day. Diet includes earthworms, insect larvae, gastropods, centipedes, fungus, and seeds. **34/385**.

#### **ORDER CHIROPTERA (Bats)**

##### **FAMILY MOLOSSIDAE (Free-tailed Bats)**

***Tadarida brasiliensis*** (Brazilian Free-tailed Bat). Ranges across the southern USA to South America; found throughout California. The local subspecies (*T. b. mexicanus*) is often called the “Mexican free-tailed bat.” Notable for congregating in vast numbers in caves in summer (> 20 million individuals), it also utilizes rock shelters, bridges, and buildings. A fast, long distance flyer, it eats small moths caught on the wing. *Tadarida* hunts at heights of 5–10 meters, often above water. They may travel 40 or more

miles to reach their hunting grounds. One pup is produced in early summer. The local subspecies winters in central to southern Mexico. In the northern part of the species range, some populations hibernate. Various avian predators are attracted to their colonies, including Great-horned Owls, Barn Owls, Red-tailed Hawks, Cooper's Hawks, Kestrels, and Peregrine Falcons. Raccoons, striped skunks, and snakes may range throughout their colonies, feeding particularly on juvenile bats that have fallen from their perches. **40/425.**

#### **FAMILY VESPERTILIONIDAE (Vesper Bats)**

***Myotis californicus*** (Californian Myotis). The range is North America west of the Rockies, and it occurs throughout California. Prefers oak-bay woodlands and open coniferous forests. Man-made structures are used as night roosts. Feeds 1–3 meters off the ground with slow, erratic flight. May be active on warm winter days but hibernates otherwise. Litter size is 1, born between late May and mid-June. **37/400.**

*Myotis evotis* (Long-eared Myotis). Ranges across the western United States and throughout California, except in desert environments. Prefers open coniferous forests or heavy chaparral. Roosts in cabins and sheds rather than caves. The litter size is 1, probably born in early summer. Forages in wooded areas and is listed as a beetle specialist. **37/410.**

*Myotis lucifugus* (Little Brown Myotis). Found across North America except southernmost regions. This is a common house bat and is typical of developed areas. Tends to forage near aquatic environments on emerging insects, sometimes also forages over trees. May consume its body weight in insects in one night. Young are left at the roost in large maternity colonies while the mother forages. **36/403.**

*Myotis thysanodes* (Fringed Myotis).. Ranges across the western United States into southern Canada and northern Mexico. Slow flier in heavily vegetated environments. Gleans beetles and moths from vegetation or catches prey in flight. Forms large maternity colonies with young born in early summer. **37/411.**

*Myotis volans* (Long-legged Myotis). Ranges across the western USA and throughout California except in deserts. Prefers pine-oak woodlands or heavy chaparral. A migratory species, the winter range is unknown. Roosts in trees and crevices. Emerges early in the evening to forage 3–5 meters above water or in open woods, catching moths and other insects. Forms large nursery colonies and gives birth to single young early in summer. **37/407.**

*Myotis yumanensis* (Yuma Myotis). Ranges across western North America and occurs throughout California. Prefers heavy coniferous forest, and it is closely associated with water. Roosts in caves, mines, buildings, and under bridges. The litter size is 1 and the young are born in the late spring. Migratory, the winter range is not known. Forages over water, catching flying aquatic insects. **37/402.**

*Corynorhinus townsendii* (Townsend's Big-eared Bat). Ranges across the western USA and Mexico; found throughout California. A cave-dweller, this bat also roosts in buildings and mine shafts. Hibernates throughout the range. The litter size is 1. Breeding occurs in winter roosts, the sperm is stored, and the young are born in late May and early June. **39/422.**

***Lasiurus cinereus*** (Hoary Bat). Ranges from Central Canada south to Argentina; found throughout California. As in *L. blossevillii*, individuals of *L. cinereus* are solitary and roost in tree foliage during summer. It is a swift and direct flyer that emerges late in the evening to forage for moths around the



crowns of trees or in open forest. Migratory, this species winters in warm climates. The litter size is 2. **38/418.**

*Lasiurus blossevillii* (Western Red Bat). Ranges across the southern USA from Texas to California and south through South America. Mainly forages in deciduous, riparian communities. Roosts in the foliage of trees. It is a solitary species in summer months when individual feeding areas may exist. It forms roosting colonies in winter. Takes crickets, beetles, cicadas, and other insects. Begins flying early in the evening, usually hunting along watercourses or about trees, and it is also attracted to insects around artificial lights. Breeds in August, the sperm is stored, and 2–5 young are born in late May or early June. Migratory. Falls prey to *Didelphis*, Roadrunners, Sharp-shinned Hawks, Kestrels, Great-horned Owls, and jays, perhaps related to their habit of roosting in foliage, sometimes close to ground level. **38/417.**

*Antrozous pallidus* (Pallid Bat). Ranges across the southwestern USA and throughout California. A bat of arid lands, *Antrozous* roosts in rock crevices, caves, and buildings, and it is primarily a bat of arid environments. Probably hibernates throughout most of the range. Emerges late in the evening, stays close to the ground, and catches most of its prey on the ground itself, alighting to capture beetles, crickets, scorpions, and even small vertebrates. One or two young are born in the first half of June. **39/423.**

*Eptesicus fuscus* (Big Brown Bat). Ranges across North America except the Gulf Coast states; found throughout California. Roosts in caves, rock crevices, tree holes, and buildings. A large bat that flies in a relatively straight course, 6–10 meters above ground level. Eats beetles, crane flies, and other insects that are caught over fields and above streams in riparian and forested areas. Hibernates rather than migrates, and the sperm is stored. Two young per litter in the eastern USA, but only 1 in the west. Young are born in May–June. This is a well-studied species. **36/414.**

*Lasionycteris noctivagans* (Silver-haired Bat). Northern North America, including California north of Monterey Bay. Roosts in trees and forages along forest edges, but the diet is little known. Hibernates in trees and rock crevices. A slow flyer with good maneuverability, this species also forages over ponds, usually about 6 meters above the surface. A litter includes 2 young, born in early summer. **38/411.**

## ORDER RODENTIA (Rodents)

### FAMILY APLODONTIIDAE (Sewellels)

*Aplodontia rufa* (Sewellel). Sewellels are not well known to the general public nor to science. The most common local name is mountain beaver, but they are not closely related to beavers and they occur in coastal forests and thickets as well as along streams and in moist thickets in the mountains. Sewellels are stocky or plump and weigh about 2 lbs (1 kg). They superficially resemble muskrats, but the tail is short and furry. The vegetarian diet includes plant species that are rarely consumed by other mammals, including ferns, stinging nettle, and rhododendron, and they feed on a wide variety of plants. Sewellels construct extensive burrow systems and may be active at any time of day but they are primarily nocturnal. *Aplodontia* is often called the most primitive living rodent and a living fossil because it exhibits anatomical features of ancestral forms, including a protrogomorphous masticatory musculature and a simple kidney that cannot produce concentrated urine. Sewellels must drink relatively large quantities of water each day, and in order to maximize nutrient intake from their relatively low-quality diet, sewellels consume their soft fecal pellets for a second passage through their digestive tract. Females have one litter with up to six young each year in early spring. **3/178.**

### FAMILY SCIURIDAE – Squirrels

*Tamias merriami* (Merriam's Chipmunk). A relatively large chipmunk from the San Francisco Bay Area south to the Mexican border, occurring in chaparral, woodland, and piñon–juniper forest. The alarm call is a repeated series of chips that give these animals their common name. The diet includes seeds and buds as well as some insects. This species is adept at caching food, and it is known to raid the granaries of acorn woodpeckers. Nests are usually made in tree holes (sometimes those of woodpeckers) and the litter has up to six young, typically 3–5. **9/216**.

*Tamias sonomae* (Sonoma Chipmunk). Endemic to northwestern California, north of San Francisco. Occupies chaparral, open patches in redwood forest, and a range of forest types (ponderosa pine, Douglas fir, oak and bay laurel), as well as riparian thickets. Primarily herbivorous, but diet is not well known. The dark stripes on the dorsum are fuscous or black, whereas these stripes tend to be reddish brown in *Tamias merriami*. Relative to *T. merriami* (which occurs in the southern half of the state), *T. sonomae* is smaller overall but the tail is relatively long and thick. The species may be overlooked as it is shy and may shelter in dense vegetation. The call consists of 3–5, high-pitched notes, or a single note repeated. The distinctive chips of the chipmunk are characteristic sounds of many North American forests. Females breed in the spring, and litters usually consist of 3–5 young (typically 4). **9/216**.

*Sciurus carolinensis* (Eastern Gray Squirrel). Ranges throughout forested areas of eastern North America, north into southern Quebec, Ontario, Manitoba, and Saskatchewan, and south into eastern Texas. Widely introduced in western North America, Europe and South Africa. In the Bay Area, eastern gray squirrels are common on the San Francisco Peninsula, especially in Golden Gate Park, and they occur in the southern part of the East Bay. *Sciurus* is the genus of "tree squirrels," and *S. carolinensis* does well in the trees of urban parks and private gardens. It feeds on a variety of plant foods. Two to six young are born in the early spring after a gestation period of 40–45 days. Usually outcompetes the slightly larger *S. niger* where both species are introduced. **11/225**.

*Sciurus niger* (Eastern Fox Squirrel). Ranges from the eastern USA (excluding the North Atlantic states) to the edge of the Great Plains; introduced throughout California, particularly in metropolitan areas. A tree squirrel that also spends considerable time on the ground, this species builds large nests of sticks and leaves among the branches, but it seems to prefer to raise its young in a trunk cavity. Individuals forage mainly for acorns and nuts, but they also eat seeds, fruit, buds, and young tree shoots, as well as mushrooms, insects, and bird eggs. Predators include raccoons, foxes, bobcats, large hawks, and owls, as well as domestic dogs and cats. Breeding takes place in mid-winter and often again in late spring. The litter size ranges from 1–6, but it is usually 3. The altricial young are born after a gestational period of 45 days. Fox Squirrels first breed at 11 months of age and may live 4–6 years. **11/227**.

*Sciurus griseus* (Western Gray Squirrel). Ranges across the forested areas of the Pacific coastal states from the Mexican border to northern Washington. Feeds primarily on acorns, and most of the range includes oak trees of various species. In the autumn, it spends considerable time gathering and burying acorns to which it returns in winter. Other important foods include tender twigs, shoots, and nuts. Diurnal and active all year, they prefer to build nests high above the ground, enlarging old woodpecker holes or constructing nests of leaves far out among the branches (the nests are called "drays"). A litter of 3–5 young is born in late winter or spring. **12/229**.

*Otospermophilus beecheyi* (California Ground Squirrel). Ranges from southern Washington and Oregon south into Baja California; found throughout California except the eastern deserts. Diurnal and fossorial, it lives in self-dug burrows, among rocks, or in crevices on cliffs (*Otospermophilus* is the genus of "ground squirrels"). It is most numerous in open areas. The diet includes seeds, grains, nuts, acorns, fruit, green vegetation, and sometimes insects and carrion. Because these squirrels require little or no

ground cover, an effective form of population control on rangeland is to prevent overgrazing. A litter of 7 young (range 3–15) is usually born in late spring after one month of gestation. A second litter may be produced later in the year. Almost every predator that is large enough will prey on this species; ground squirrels are the mainstay of the coyotes, badgers, and red-tailed hawks in their range. It may hibernate in cold climates and aestivate in areas with hot, dry summers. Although it can reach high local densities—and the complex of belowground burrows may be interconnected—this species is not considered colonial. A sharp alarm whistle is given. **5/201.**

#### **FAMILY CASTORIDAE (Beavers)**

*Castor canadensis* (American Beaver). The American Beaver was extirpated from most of California by European fur traders. Joseph Grinnell found that beavers were not widespread in California, and Grinnell assumed that they had never occurred in significant numbers along the coast or in the San Francisco Bay Area. As a result, the American Beaver is considered an invasive species in some areas where they have appeared in recent years, and they are trapped and killed as vermin. However, recent reviews of the historical record indicate that *Castor canadensis* occurred throughout California at the time of European immigration, and beavers are increasingly tolerated in rural, suburban, and even urban areas where their dam building may be broadly disruptive. Beavers are large and powerful rodents that are remarkably quick on land. When nervous or threatened, beavers may slap the water with their broad and muscular tail before retreating. Beavers tend to mate in February and produce 3–4 kits in the Spring. **2/179.**

#### **FAMILY HETEROMYIDAE (Pocket Mice & Kangaroo Rats)**

*Chaetodipus californicus* (California Pocket Mouse). South coastal ranges of California and the western slopes of the Sierra Nevada south to Baja, excluding the open and arid conditions. Prefers slopes with chaparral where the understory is sparse and the soil firm. Shares the external, fur-lined cheek pouches with kangaroo rats, but *Chaetodipus* is not saltatorial. Solitary, it stores seeds in caches in the burrow or on the ground surface near the burrow entrance. Preyed upon by owls, badgers, coyotes, and snakes. During periods of cold weather or food shortages, it may become torpid to conserve energy. Obtain moisture from seeds and leafy vegetation rather than drinking free water. The young are born in spring, and the litter size averages four, with one or two litters per year. Gestation is probably 3–4 weeks. **15/251.**

*Dipodomys heermanni* (Heermann's Kangaroo Rat). Endemic to the southern half of California, from Contra Costa County south to Ventura, and from the foothills of the Sierra Nevada to the coast ranges. Inhabits dry, sparsely vegetated grasslands and open chaparral, particularly with sandy to gravelly soil. Generally, a seed-eater but requires some succulent vegetation as a water source and may eat large amounts of green grass and some insect matter in the spring. Solitary, with each individual living in a self-dug burrow system. Females may have up to 3 litters per year, each with an average of 3 young, and the young may reach reproductive maturity in the first year after birth. A subspecies from the Berkeley Hills (*D. h. berkeleyensis*) was first described in 1919 from the "head of Dwight Way," but it is probably now extinct due to loss of habitat and pressure from feral cats. **18/267.**

*Dipodomys venustus* (Narrow-faced Kangaroo Rat). Closely resembles *D. heermanni* but with larger ears and more contrasting dark and light stripes on the tail. Occurs at Hastings. **18/265.**

#### **FAMILY GEOMYIDAE (Pocket Gophers)**

***Thomomys bottae*** (Botta's Pocket Gopher). Ranges across western North America including much of California except the northeastern deserts, from below sea level to above timberline; most abundant in grasslands or agricultural fields. A solitary, fossorial herbivore that lives in extensive, self-dug burrow systems that may cover up to 2,000 square feet. Males and females occupy separate, exclusive-use territories. The teeth as well as the claws are used in excavation. *Thomomys* harvests green vegetation near the burrow entrances, and it may store food in the fur-lined cheek pouches. Preyed upon by owls, hawks, coyotes, foxes, bobcats, badgers, weasels, and snakes. Litter size varies from 3–10, and the gestation period is 19 days. **14/242.**

#### **FAMILY DIPODIDAE (Jumping Mice)**

***Zapus trinotatus*** (Pacific Jumping Mouse). The jumping mice are not closely related to other Californian rodents, sharing an affinity with the jerboas and birch mice of the Old World. *Zapus* occurs at Point Reyes as a subspecies of special concern, *Z. p. orarius*. The Western Jumping Mouse prefers damp meadows and coastal forests from Marin County to southern Canada. The tail is very long and narrow, and the hind feet are massive. *Zapus* hibernates for up to half of the year in underground burrows, and females produce one litter of up to eight young annually. **22/336.**

#### **FAMILY CRICETIDAE, SUBFAMILY ARVICOLINAE (Voles, Muskrats, & Lemmings)**

***Microtus californicus*** (California Vole). Occurs primarily in grasslands, meadows, and marshes of California, with representatives in southwest Oregon and Baja California at the ends of the range. Green vegetation comprises the main winter food, and voles live mainly on seeds in dry summer months. The aboveground runways connect the burrow entrances that lead to their nests. *Microtus californicus* may be active by day or night, depending in part on seasonal stresses related to water and temperature. Like some other arvicolines, California Voles undergo cyclic changes in population density, reaching peaks every three or four years. In peak years they may serve as the sole food item for several carnivores, including hawks, owls, weasels, and feral cats. Females begin breeding at 3 weeks of age, the gestation period is 21 days, and there may be several litters per year of 1–11 young (the average number of young is about 5). **26/316.**

***Ondatra zibethicus*** (Common Muskrat). Broadly distributed across northern North America. Originally restricted in California to the Colorado River Valley and the Great Basin part of Lassen County, *Ondatra* has now been introduced widely throughout the state, mostly in freshwater marshes, where it is a strict herbivore that feeds almost exclusively on green vegetation. The litters are produced two or more times per year and they vary from 3–9 young (with an average of 6–7). The gestation period is 28 days. **2/326.**

#### **FAMILY CRICETIDAE, SUBFAMILY NEOTOMINAE (Deer Mice, Woodrats, & Relatives)**

***Reithrodontomys megalotis*** (Western Harvest Mouse). Widespread from Canada to southern Mexico, and from the Mississippi River to the Pacific coast; found throughout California. Usually associated with stands of short grass, *R. megalotis* constructs globular nests from grass and other fine vegetation. They are easily distinguished from other native mice by the grooved upper incisors. Primarily seed-eaters, they also take insects in spring. Good conservers of water. The average litter includes 4 young and gestation is 23–24 days; it may breed year-round in favorable climates. **19/289.**

*Reithrodontomys raviventris* (Salt-marsh Harvest Mouse). Endemic to salt marshes of the San Francisco Bay Area. This species is listed both federally and by the state of California as an endangered species. It persists only in the remaining fragments of local salt marsh around the Bay. The eastern edge of the range is the east side of the Suisun Marsh complex. At very high tides, *R. raviventris* may retreat to adjacent uplands, where it may overlap with *R. megalotis*. There are two subspecies of *R. raviventris*: *R. r. raviventris* occurs to the south and usually has buffy or orange fur in the ventral pelage, whereas *R. r. halicoetes* occurs to the north and has a white venter. The Salt-marsh Harvest Mouse is closely associated with *Salicornia* (pickleweed), which is also one of the primary foods. Breeds from spring to autumn and the litter size is 1–7. It has a docile temperament compared to *R. megalotis*. The introduced red fox readily forages in salt marshes and may be an important predator. **19/290.**

*Peromyscus maniculatus* (North American Deer mouse). Extremely widespread in North America, excluding the southeastern USA; occurs throughout California in virtually all habitats, including deserts, forests, and grasslands. In the Bay Area, *P. maniculatus* is found primarily in grasslands, open chaparral, and oak woodland. The diet is varied, but seeds and vegetation are most important. Nocturnal, it is preyed upon by nearly all small predators. The home range may exceed 5 acres in extent, and smaller territories are defended within this area. Litter size averages 5 (the range is 1–8), and the gestation period is 21–27 days. The young are able to breed at 6–7 weeks of age, and breeding may occur in any month, but it is less frequent in winter. **20/277.**

*Peromyscus truei* (Piñon Deer mouse). Southwestern USA and central Mexico; occurs throughout California except in the Central Valley and southern deserts. Called the Piñon Deer mouse because it is common in piñon-juniper woodland in the more arid parts of its range. This is a large-eared *Peromyscus* that is characteristic of brushy areas, woodlands, and chaparral. The ears are exceedingly large. The ears are particularly large in the Sierran populations (pinna longer than pes), and they are smaller in coastal population (pinna slightly longer or approximately equal in length to pes). The tail is about the same length as the head and body. A good climber. Breeding is more restricted in *P. truei*, limited to late winter and spring, but a single female may have 3–4 litters a year, with an average of 3–4 young per litter. **21/282.**

*Peromyscus boylii* (Brush Deer mouse). This species is more closely tied to forest than *P. truei*, and *P. boylii* cannot survive in ecosystems where the summer is too hot and dry. The fur of *P. boylii* is shorter and stiffer than that of *P. truei* on which it is long and lax. The external ear is shorter than the hind foot (pinna is shorter than pes). **21/281.**

*Peromyscus californicus* (California Deer mouse). Ranges along the coastal mountains of California and the foothills of the southern Sierra Nevada into Baja. The largest species of *Peromyscus*, it somewhat resembles a small woodrat in both morphology and habits. Found in dense chaparral and sclerophyllous woodland, the nest is an elaborate mass of sticks and twigs with a chamber of fine grass. Often lives in close association with *Neotoma fuscipes*, sharing the nest. In the Bay Area, acorns and *Umbellularia* seeds are primary food items. The usual suspects prey on this species, but the densely vegetated habitat protects it from many aerial predators. There are usually 3–4 litters per year with an average of 2 young per litter (the normal range is 1–3 young per litter). Breeding is less frequent in the winter months. Males and females pair for life (monogamy); this is an unusual mating system for mammals, especially for rodents. **21/275.**

*Neotoma fuscipes* (Dusky-footed Woodrat). Ranges through most of California and southern Oregon except high mountains and desert areas. Prefers heavy chaparral, thickets along streams, and deciduous or mixed woodland. Builds large stick houses in trees, among tree roots, or in dense shrubs, including poison oak thickets. A single house may be occupied by successive generations of wood rats over many

years. Except during the breeding season, there is normally only one rat found in a house at a time. The vegetarian diet includes the leaves, bark, and fruits of various plant species, including poison oak, California bay (*Umbellularia*), live oak, and many others. Owls, foxes, coyotes, and large snakes prey on these rodents. Breeding is in late winter and spring, gestation is 33 days, and the litter is 2 or 3. The phallus is simple, thick, and short. **23/300.**

*Neotoma lepida* (Desert Woodrat). Common in dry scrubland and semi-desert with rocky outcrops and growth of succulents. Builds stick nest under vegetation or among rocks. Difficult to distinguish from other *Neotoma* species, although the morphology of the phallus is distinct. The phallus of *N. lepida*—like that of *N. bryanti*—is long and thin. **23/297.**

*Neotoma macrotis* (Big-eared Woodrat). This is the species that is now recognized to occur at Hastings. The phallus is divided into four distinct lobes. This species does not yet have an entry in your field guide.

#### **FAMILY MURIDAE** (Old World Rats & Mice)

***Mus musculus*** (House Mouse). Originally restricted to Asia, the common House Mouse has been introduced throughout the world. In California, it occurs in association with humans as well as in disturbed habitats such as roadsides and fields. The diet is omnivorous and opportunistic, and the list of potential predators includes feral cats, weasels, foxes, raccoons, skunks, hawks, owls, snakes, and others. *Mus musculus* can breed at 35 days of age, the gestation period is 19 days, there may be up to 12 young in a litter, and they can breed throughout the year. This extraordinary fecundity can lead to population plagues such as occurred in the Central Valley in 1926–27 and 1941–42 when densities were estimated to exceed 82,000 mice per acre. Our familiar white lab mice derive from this species. **19/331.**

***Rattus norvegicus*** (Brown Rat). Also known as the Norway rat or sewer rat. Originally confined to the Old World and now cosmopolitan as a human commensal and pest. Found throughout California around human habitations and locally in cultivated fields. This rat is a good digger and superb gnawer. The diet is omnivorous and this species causes great economic damage and poses a health hazard. Females first breed at 3–4 months old and they produce litters of 6–22 young after a gestation of 22 days. Predators include cats, dogs, owls, hawks, and snakes. The domestic lab rat derives from this species. **24/333.**

***Rattus rattus*** (Roof Rat). Also known as the black rat or tree rat. Another Old World original that has been introduced globally, it is distributed across the coastal United States and Mexico. Common near ports and on ships, in heavy vegetation along stream courses, and in some coastal forests. It resembles *R. norvegicus* in ecology and breeding performance, but *R. rattus* is smaller and less aggressive. *R. norvegicus* tends to outcompete *R. rattus* when the two species overlap in temperate climates. However, *R. rattus* is a more dedicated climber (the tail is proportionately much longer), and *R. rattus* may be found in the upper stories of a building while *R. norvegicus* occupies the basement. **24/332.**

#### **ORDER LAGOMORPHA** (Rabbits, Hares, & Pikas)

##### **FAMILY LEPORIDAE** (Rabbits & Hares)

***Sylvilagus bachmani*** (Brush Rabbit). Ranges along the Pacific coast from Oregon to Baja California. Differs from *S. audubonii* mainly in its preference for thick brush. Feeds on forbs and grasses. Breeding is limited to January–June, the gestation period is 27 days, there are 3–6 altricial young per litter, and 3–4 litters per season. Brush Rabbits create runways in the chaparral and are wary about leaving cover. The average home range of *S. bachmani* males is less than 70 meters in diameter, and the home range of

females is roughly 40 meters. Succulent vegetation seems to be required throughout the year. Compared to *S. audubonii*, *S. bachmani* is small and dark with relatively short ears. **28/344**.

***Sylvilagus audubonii*** (Desert Cottontail). Ranges across the western US and northern Mexico; occurs in the southern two-thirds of California except for the high mountains. Found in thickets, grasslands with scattered brush, and cultivated fields with cover. Eats grasses, leaves, fallen fruit, or, more rarely, tree bark. In a study in Madre County, the predators were the following, listed in order of importance: coyote, rattlesnake, horned owl, gopher snake, gray fox, and red-tailed hawk. This species may use holes in the ground for predator escape, but the young are born in shallow excavations on the surface. The gestation period is 26–30 days, the litter contains 3–5 altricial young, and there are several litters per year. The home range of *S. audubonii* may be less than 300 meters in diameter. **28/351**.

***Lepus californicus*** (Black-tailed Jackrabbit). Ranges across the western USA and northern Mexico; occurs throughout California in suitable habitat. Common in open grasslands and brush lands, but also invades broken chaparral and woodland. More diurnal than most rabbits, but also active at night; some principal foods are forbs, grasses, bark, and twigs of shrubs. Can be an agricultural pest. The main predators are coyotes, foxes, bobcats, hawks, eagles, owls, large snakes, and humans. Breeding may continue year-round, with as many as seven precocial young in a litter. Gestation period is 43 days. Black-tailed Jackrabbits nests among surface vegetation in shallow depressions and do not burrow. **31/355**.

## ORDER CARNIVORA (Carnivorans)

### FAMILY FELIDAE (Cats)

***Lynx rufus*** (Bobcat). The range is the United States south to central Mexico; found throughout California but scarce on farms and in urban areas. Food consists primarily of mice, woodrats, gophers, rabbits, squirrels, and some birds. Dens are commonly in caves or other rock hollows. Solitary and terrestrial, bobcats also swim and climb well. Crepuscular and nocturnal. Mating takes place in late winter and 1–4 young (with an average 2.8) are born after a gestation period of about 60 days. The young are weaned at 2 months and the litter disbands at 6–9 months; females breed once per year. **47/435**.

***Puma concolor*** (Cougar). Ranges across the western hemisphere, with one of the widest native ranges of any terrestrial mammal (from west-central Canada to southern Argentina). There are numerous common names for this species across the range (e.g., mountain lion, catamount, puma). The habitat varies from coniferous forests and temperate woodlands and coastal grasslands to the tropical forests of Amazonia. At present, in western North America, it occurs primarily in regions sparsely populated by humans, although contacts between humans and cougars are increasingly common. The chief food is deer, but smaller mammals—including rabbits, skunks, and porcupines—are also eaten. Dens are made in caves or on rocky cliffs. Both sexes are solitary and meet only for the brief mating period. A female may raise 1 litter of 2–3 young every 2 years; births occur most commonly in spring or early summer. Home ranges vary seasonally, but on an annual basis the home range may encompass more than 400 square kilometers. Males have larger home ranges than females. **48/433**.

### FAMILY CANIDAE (Dogs)

***Urocyon cinereoargenteus*** (Gray Fox). The range includes the United States and Mexico except the northern mountain states; found throughout California, chiefly in chaparral and oak woodland. Locally common in the East Bay. *Urocyon* represents the basal lineage in the extant Canidae. The mixed diet includes gophers, mice, woodrats, birds, and, seasonally, fruits. Mainly nocturnal. The chief predators are eagles, canids, large felids, and humans. *Urocyon* readily climbs trees to forage or escape predation,

and the claws are semi-retractile. Dens are found under large rocks or in cliff crevices. A litter of 2–7 pups, usually 3–4, is born in spring after a gestation period of 63 days. The family unit breaks up in early fall, although the parents may stay together during the year. Densities may reach 4 individuals per square mile in choice habitats. **50/448.**

***Vulpes vulpes*** (Red Fox). This species is cosmopolitan, and the range is generally expanding. Occurs across Canada and the USA except the southwestern deserts. In California, this species was previously restricted to the Sierra Nevada above 1370 meters; recent introductions, apparently from the eastern United States, have established populations in the Sacramento Valley and Bay Area. Whereas the native Sierran red foxes inhabit forested environments, the introduced populations occur in agricultural areas, oak woodland, chaparral, and mixed grassland-brushland habitats. They feed primarily on rodents (especially *Microtus* and *Peromyscus*) and lagomorphs. Females are monestrous and usually breed in winter (December–March). The gestation period is about 52 days and the mean litter size is 5. The male remains with the female until the pups are raised. Males supply food to the females during lactation; when the young are able to survive alone, both sexes hunt for food. The young stay in the den for 4–6 weeks, but the parents may move them from den to den. The young usually leave the den and disperse 4–5 months after birth. Just prior to the dispersal of the young, the male leaves the female, and pair bonding does not occur again until the next breeding season. **50/447.**

***Canis latrans*** (Coyote). Ranges across western North America, from Alaska to Mexico; found throughout California. A characteristic inhabitant of open plains and valley floors, coyotes enter chaparral and forests where broken by clear areas. Usually a solitary animal, this is now our most common large carnivoran. Suspected of predation on livestock, the diet consists mostly of rabbits, rodents, and carrion. Dens are made in caves, natural crevices, or enlarged badger burrows. Coyotes apparently pair for life, but the two mates usually do not see each other frequently except during the breeding season. Breeding usually takes place in January and 5–10 pups are born after a gestation of 60–65 days. **49/439.**

#### **FAMILY PROCYONIDAE (Raccoons & Relatives)**

***Bassariscus astutus*** (Ringtail). The range extends across western North America from southwestern Oregon to southern Mexico and east to Kansas. Individuals occasionally appear far beyond the native range, and this may be attributable to the Ringtail's propensity to board rail cars. Occurs most commonly in oak-conifer woodland, especially in association with rocky outcrops. The diet is predominantly carnivorous and includes *Peromyscus* and *Neotoma*, but the Ringtail also takes birds and berries (e.g. *Manzanita*, *Arbutus*). Ringtails are agile and skilled climbers, and they den in rock crevices, tree cavities, and human-made structures. Called the "miner's cat" because of its use by early settlers as a mouser around homes and mine shafts. Although it tames easily, this species is secretive in the wild and rarely seen. Nocturnal. Litters include 1–4 young, born April–July. **52/454.**

***Procyon lotor*** (Raccoon). Southern Canada and the United States south to Panama; throughout California except in deserts. This species is closely tied to water, but it is flexible and opportunistic in its ecology. The diet is omnivorous, including crayfish, frogs, small mammals, earthworms, fruit, acorns, nuts, human refuse, and so forth. Like other omnivores, raccoons lack the sectorial carnassial teeth. Active at dusk and by night. Raccoons combine a plantigrade pes with dexterous hands. They are excellent climbers and have prominent claws, and they swim well. Food washing behavior ("dousing") is typical but little understood. Females breed at 1 year of age and males at 2 years; gestation is 63 days and the young are born between December and April; the average litter size is 3.5 with a range of 1–6. At present, the adults tend to have few predators other than humans and dogs; however, the young are more vulnerable. **52/455.**



## FAMILY MEPHITIDAE (Skunks & Stink Badgers)

***Spilogale gracilis*** (Western Spotted Skunk). The range is southern British Columbia to northern Mexico; found throughout California. Prefers dry uplands with rocky and brushy habitat as well as broken forests. A nocturnal mammal, this skunk climbs well. The den may be under a tree, in a crevice among rocks, or in an underground burrow. Somewhat more predatory than *Mephitis*, this species feeds on small vertebrates, insects, and vegetal matter. There are probably few natural enemies. Breeding takes place in early spring and 2–6 young are born in early summer. **53/457.**

***Mephitis mephitis*** (Striped Skunk). The range is southern Canada, USA, and northern Mexico; throughout California except in the southeastern deserts. Inhabits a wide range of environments from riparian associations to open woodlands, as well as in human modified ecosystems. Like most mephitids, *Mephitis* has well developed anal scent glands that are used in defense, and they seem to have few predators, although great horned owls, cougars and coyotes are known to take them. The diet is omnivorous, including insects, fruits, small mammals, bird eggs, human refuse, domestic pet food, and so forth. It lives in burrows and under buildings, and it is most active at dusk and by night. Extended periods of inactivity may occur in the northern part of the range. Breeding takes place in late winter with 4–10 young born after gestation period of 63 days; weaning is at 2 months of age. Both sexes breed at 1 year of age. **53/459.**

## FAMILY MUSTELIDAE (Badgers, Weasels, Otters & Relatives)

***Mustela frenata*** (Long-tailed Weasel). Geographically widespread from southern Canada to northern South America; found throughout California except in the southeastern deserts. Hunts by day and night, catching mainly small mammals. The long, slender body navigates well through rodent burrows. Eats 40% of its body weight each day. Mating is in July or August, implantation is delayed until spring, and gestation lasts 205–337 days. The litter size is 6–9. Adult size is reached in 3 months, and males first breed at 1 year of age. **54/466.**

***Mustela vison*** (American Mink). Occurs across the USA except southwestern deserts and some southeastern states; occurs and throughout Canada except the Arctic north. Prized for its fur and under pressure from trappers, the range of the mink contracted dramatically in California. Mink are again active in the Delta (Suisun Marsh), but they are generally limited by habitat disturbance and introduced predators. They are a semi-aquatic species that favors the land–water ecotone, and they are excellent swimmers. They forage for crayfish, frogs, muskrat, and small vertebrates in general. The mink line is nested high within the weasel clade (*Mustela*); some authors prefer *Neovison vison* as the formal name for this species. A skeletally robust mink inhabited coastal New England into the 19<sup>th</sup> century, and this so-called “sea mink” (*Mustela macrodon*) is not uncommon in archaeological deposits in Maine. **55/467.**

***Taxidea taxus*** (American Badger). Ranges throughout western North America, from southern Canada to central Mexico; occurs across California except the extreme northwestern corner. Found in a wide range of habitats but prefers open, unforested country. Under natural conditions, it may be active at any hour, but in the presence of humans it is primarily nocturnal. Usually solitary. These mustelids actively dig rodents out of their burrows producing sign in the form of large elliptical holes. Prey include ground squirrels, chipmunks, kangaroo rats, and pocket gophers, as well as carrion, lizards, and snakes. They are powerful animals and immune from attack by most predators. They breed in August and September, and implantation is delayed until mid-February. The 1–5 young (usually 2) are born after a development period of 6 weeks. **52/470.**

***Lontra canadensis*** (North American River Otter). Formerly ranged across the United States and Canada. Hunting pressure led to extirpation across much of the former range, but present-day reintroduction programs continue apace. This is the only freshwater otter species of the region, and it is often associated with beaver and muskrat. Dense populations of river otters occur in Suisun Marsh on a prey base of introduced crayfish (*Procambarus clarkii*). *Lontra* is regularly observed in Bolinas Lagoon and other Bay Area sites. Tolerant of salt water, it readily enters estuaries and marine systems. The diet consists primarily of fish and crayfish, but it also eats other small vertebrates and invertebrates, as well as a perhaps surprising amount of plant foods in some cases (e.g., the otters in Suisun Marsh are reported to consume asparagus from abandoned farms). Active at any time of day, North American River Otters concentrate the foraging after sunrise and in the late afternoon (crepuscular). Mating takes place after the young are born in the spring, and implantation is delayed. The litter is usually 2–4 young. Previously widespread, primarily freshwater. **56/471.**

***Enhydra lutris*** (Sea Otter). Present range extends across North Pacific rim from Russia to California, formerly from Japan to Mexico. Archaeological middens rich in sea otter bones are known from Emeryville and throughout the Bay Area. Pelage specialized for insulation with thick, waterproof guard hairs and extremely dense underfur. Post-canines notably enlarged and inflated, adapted to a diet of hard-shelled prey. Digits on hands are short; feet are broadly flattened, fully webbed, and flipper-like; tail is relatively short, thick, and muscular. Stone tools are used to dislodge prey from substrate and crack open shells. Adult males 1.2–1.5 m long and 22–45 kg, females 1.0–1.4 m and 14–33 kg. Diet of primarily marine invertebrates includes urchins, molluscs, and crustaceans; slower-moving demersal fish also taken. Adult females and sub-adult males may rest together in single-sex groups called rafts with 10–100 animals. Adult male sea otters defend territories from spring to fall. Litter is usually 1 pup, occasionally 2, with a gestation period of 6–9 months. Young reach sexual maturity in 5 years. Lifespan of males is 10–15 years, females is 15–20 years. **56/472.**

#### **FAMILY URSIDAE (Bears)**

***Ursus americanus*** (American Black Bear). Black bears, like grizzly bears, used to roam across the Golden State. Human activity led to the loss of the Grizz from the state, while the black bear retains a foothold in remote areas and parks. Individual black bears occasionally appear in Marin County, ambling down from the north, but otherwise black bears remain outside of the Bay Area proper. Black bears are great omnivores with a taste for insect larvae and vertebrate flesh and fungi, but with a strong dietary emphasis on plant matter, including tubers, seeds, berries, and fresh green growth. In certain respects, invasive wild boar (*Sus scrofa*) have filled the vacant niche of the large omnivorous bear. Black bears occur in the heavily forested areas around the Central Valley, and they are typically black or brown, but many individuals in the Sierra Nevada, including in the Yosemite area, are known as “cinnamon bears” for the color of their coat. Black bears mate in summer, and the female gives birth to one or two small young during winter, nursing them in the hibernaculum in cold climates. The bears emerge hungry in the spring, and the female usually skips a year of reproduction to recover her body weight before producing again. **51/450.**

#### **FAMILY OTARIIDAE (Sea Lions & Fur Seals)**

***Zalophus californianus*** (California Sea Lion). Ranges from central Mexico north to British Columbia, breeding only in the southern part of the range to the Channel Islands. Males have bulbous foreheads and robust bodies (2.2 m, 315 kg) and females are more slender (2.0 m, 110 kg). Forelimbs are long, broad, and wing-like with cartilaginous extensions from fingertips strengthened by fibrous tissue at the outer edge. Hindlimbs form large flippers with fleshy cartilaginous extensions; middle three digits on hindlimb possess nails used in grooming. External ears visible and hindlimbs can be rotated under the

body to support weight when standing or walking. Diet of squid, anchovies, sardines, rockfish, mackerel, and other fish. Males may form large groups during non-breeding season at suitable haul-out sites. Males aggressively defend breeding territories that can include up to fourteen females (polygamy). Reach sexual maturity at 4–5 years and breed from May–August. Females can mate as soon as three weeks after giving birth. Gestation is 9 months. Life span 20–30 years. **57/477**.

*Eumetopias jubatus* (Steller Sea Lion). Ranges today from California around the Pacific Rim to Japan. A very large sea lion, considerably larger than *Zalophus*: males (up to 3.0m and 1000kg), females (2.5m, 300kg). Much lighter in color than *Zalophus*, appearing golden brown or blond when wet. Hauls out in rocky coastal areas, but generally avoids humans. Usually quiet outside of the breeding season whereas *Zalophus* is generally noisy. Feeds on fish, cephalopods, crabs, and clams, and may enter river mouths if not disturbed. Males defend harems on rocky islets and females mate within two weeks after giving birth to a single baby that may suckle for up to 1 year. **57/476**.

#### **FAMILY PHOCIDAE** (Earless Seals)

*Phoca vitulina* (Harbor Seal). Ranges across both coasts of North America from arctic regions south to Mexico in the Pacific and Florida in the Atlantic. Non-migratory but may range across hundreds of kilometers. Individuals haul out on rocky shores, reefs, beaches, and glacial ice for rest, thermoregulation, predator evasion, and to give birth. The face has a dog-like aspect but with large eyes, external pinnae are not visible, forelimbs are relatively short, and hindlimbs are long, flexible flippers. Individuals vary in color, but most commonly are greyish with light and dark mottling. Males are slightly larger than females, weigh up to 110 kg, and are 1.7-1.9 m in length. Diet includes mainly fish, as well as cephalopods and crustaceans. Individuals reach sexual maturity at 6–7 years, and they may live for 25-30 years. Gestation is about 11 months. **58/478**.

*Mirounga angustirostris* (Northern Elephant Seal). Feeding range extends across the northern Pacific Ocean but breeding range is restricted to California and Mexico, with a major breeding colony at Año Nuevo near Santa Cruz. Strong sexual dimorphism. Adult males have an inflated proboscis that hangs over the lower lip and a heavy neck with a roughened skin shield, and generally dark bodies. Females have smaller noses and smoother necks. Males can reach over 4 m and weight up to 2,000 kg, females reach 3 m and 600 kg. The diet consists mainly of squid and fish, but rays and sharks are also taken. Individuals fast for long periods during breeding and molting seasons and may lose up to half their body mass. During the breeding season (December–March), males defend large groups of females against rival males (polygamy). Reach sexual maturity at 7 years. Gestation lasts 11 months. Life span of females 19 years, males only 13 years. **59/485**.

#### **ORDER ARTIODACTYLA** (Even-toed Ungulates and Cetaceans)

##### **FAMILY CERVIDAE** (Deer)

*Odocoileus hemionus* (Mule Deer). The range is western North America from Canada to Mexico, and the species is found throughout California except the Central Valley and some desert areas. The local subspecies (*Odocoileus hemionus columbianus*) is known as the Black-tailed Deer. Characteristic of open woodlands and chaparral, but also found in grasslands and forest. Usually browses in winter (eats the growing tips of woody plants) and takes berries, acorns, and fruit in summer; grasses and forbs are eaten as well. Important forage species include the genera *Quercus*, *Ceanothus*, *Purshia*, and *Garrya*. Mule Deer thrive in secondary successional areas where there is nutritious growth low to the ground, and they tend to be scarce in mature forests. One or two fawns are born per year, productivity being directly related to the quality of the range. Mating occurs in fall, the gestation period is 195–212 days,

and the young are born after mid-winter, usually in spring. Females usually don't breed until they are 18 months old. Annual altitudinal migrations occur where winters are severe. Males form a harem during the rutting season. Predators include cougar, wolf, and brown bear, and coyotes may take young individuals. Much studied for game purposes. **41/496.**

***Cervus elaphus nannodes*** (Tule Elk). Elk (*Cervus elaphus*) are a single widespread species that used to range across the northern hemisphere, from north Africa through Eurasia to North America. Habitat loss and hunting pressure led to a contraction of their former range, and the species was nearly extirpated from California. Elk, known as wapiti or red deer in other parts of the world, have been reintroduced to parts of their former range, including successful reintroductions in California. Large herds of elk now roam at Point Reyes, and smaller herds can be found on Grizzly Island in the Delta. Tule Elk (*Cervus elaphus nannodes*) is the subspecies that formerly occupied the California Central Valley and the more southern coastal areas, where it flourished in wetland conditions (in the tule grass marshes, for example). It is this subspecies that has been reintroduced in the Bay Area. Herds of Roosevelt's Elk (*Cervus elaphus roosevelti*) can be found in the northwestern corner of California. Tule elk are considerably smaller than Roosevelt's elk, but both are much larger than *Odocoileus*. Elk feed on grasses and forbs and require a wide range to roam and feed. This leads to contentious problems in cattle ranching areas where elk are able to jump fences and compete with domesticates for forage. The rutting season for elk is late summer and early fall, and a single calf is born the following spring. **42/490.**

#### **FAMILY SUIDAE** (Swine)

***Sus scrofa*** (Wild Boar). Members of the family Suidae are not native to the New World. The Wild Boar of the United States is an amalgam of at least two major genetic streams: (1) the domestic pigs first introduced by early Europeans (these are the stereotypical barnyard pigs), and (2) the wild European boar species (*Sus scrofa*) that was introduced primarily for sport hunting. The history of the introduction of swine to the New World is incompletely understood, and the genetics is complicated by the fact that European domestic pigs were themselves originally domesticated from *Sus scrofa*. Wild Boar populations are now firmly established in the United States and the range is expanding in many areas. They are particularly characteristic of the southern states from Florida to Texas, and they are successful in California. Commonly seen from a distance but not easily tracked (the sense of smell is superb). The truly omnivorous *Sus scrofa* relies heavily on acorns and vegetal resources, but it also rummages in soil and leaf litter for grubs and earthworms, and it supplements the diet with small vertebrates and some carrion. It is a habitat generalist and may forage across an extensive area in search of food. Active by day or night; variable in behavior and opportunistic. It is a destructive forager and may cause extensive damage to human interests such as golf courses, agricultural lands, and private lawns and gardens. The successful eradication of *Sus scrofa* from ecologically sensitive areas requires expensive and well-coordinated efforts. One to two litters of 1–12 young are born per year. Range in California expanding. **44/487.**

#### **CLADE CETACEA** (Whales, porpoises, and dolphins)

##### **SUBORDER ODONTOCETI** (Toothed whales)

***Tursiops truncatus*** (Bottlenose Dolphin). Familiar and wide-ranging dolphin of tropical to warm temperate oceans. Northern edge of the range includes San Francisco, and individuals visit San Francisco Bay. Pods of up to a dozen individuals may occur in association with other species. Renowned for cognitive capacity, social behavior, playfulness. Homodont dentition includes 23–25 pairs of sharp, sturdy teeth in each jaw. Diet consists of fish, squid, small sharks, and almost anything else it can catch. Swallows most prey whole, may decapitate larger prey. Habitat generalist that forages across a range of

depths in the nearshore environment. Gestation is about 12 months, litter size is usually 1 calf, occasionally twins. Maturity reached at 12-13 years, average lifespan 25 years, maximum age 35 years. Males are notably larger than females. Fusiform body plan reduces drag and individuals swim over 30 km/hr (20 mph). **61/514**.

***Phocoena phocoena*** (Harbor Porpoise). Typical of inshore waters of temperate and ice-free polar regions of northern hemisphere, including brackish systems. Smallest oceanic cetacean at 1.5 m and 60 kg. Recognizable by its size, lack of a beak (short face), low triangular dorsal fin, and countershading (dark upper body with light underneath). Homodont dentition includes about 25 pairs of small, spade-shaped teeth in each jaw. Usually seen in pairs or groups of 5–10, but may aggregate in groups of up to 100 when feeding. Not playful and rarely jumps out of the water. Diet consists primarily of fish and cephalopods. Many prey taken from near the seabed in relatively shallow water down to 200 m. Average dive time about 4 minutes. Sexual maturity reached at 3–4 years, with a gestation period of 11 months. Average lifespan 24 years. **62/527**

#### **SUBORDER MYSTICETI** (Baleen whales)

***Eschrichtius robustus*** (Gray Whale). A previously widespread species, only one population remains today in the eastern Pacific from Mexico to Alaska. Undertakes the longest migration of any mammal, moving between the rich arctic feeding grounds to the warm lagoons off Baja where they reproduce. During the migration, they swim at 4–5 knots for up to 20 hours per day, covering about 100 km. Feeds primarily in the northern waters in the summer and mates and gives birth in the southern waters during winter. Lacks the dorsal fin and exhibits a series of bumps and notches down the lower two-thirds of the back. Dark grey or black in color with a motley collection of scars, spots, patches, and barnacle clusters. Females are larger than males. Maximum length about 12 m with an average length of 11m and average weight 35,000 kg. Diet consists of baitfish such as anchovies, pelagic and benthic amphipods, and krill. The relatively short and coarse baleen is yellowish white with 140–180 plates per side. Gestation is approximately 1 year and individuals return to the same lagoon each winter. Sexual maturity is reached at 8 years, and offspring may be produced every other year. Average lifespan is estimated from 75–80 years. **66/540**

***Megaptera novaeangliae*** (Humpback Whale). Occurs in all major oceans of the world from equator to sub-polar. Multiple populations; most populations exhibit winter migrations to sub-tropical and tropical regions. Usually feed near surface and breed offshore near reefs and islands. Females usually larger than males and may reach 18m and 22,000–36,000 kg. Very large pectoral fins (uniqueness helps in individual identification), countershading, prominent throat grooves, curved and deeply notched fluke, and sensory tubercles on face. Known for elaborate songs, breaching displays, and intricate “bubble net” feeding behaviors. Diet consists mostly of krill, but also plankton and small fish. Known to consume over 1000 kg of food per day. Breeding usually occurs every 2 years, but sometimes twice in a 3-year span. Males are polygamous; gestation is 11 months. Average lifespan 60 years. **66/546**

***Balaenoptera musculus*** (Blue Whale). **65/542**.

# Bibliography

- BARBOUR, Roger W., and Wayne H. DAVIS. 1969. *Bats of America*. University Press of Kentucky: Lexington, KY. (UCB Bioscience fQL737.C5.B35, folio)
- GRINNELL, Joseph, Joseph S. DIXON, and Jean M. LINSDALE. 1937. *Fur-bearing mammals of California: their natural history, systematic status, and relations to man*. Two volumes. University of California Press: Berkeley, CA. (UCB Bioscience QL719.C2.G72)
- HALL, E. Raymond. 1981. *The mammals of North America*. Second edition. Two volumes. Wiley: New York. (UCB Bioscience QL715.H15 1981, reference)
- HILLSON, Simon. 2005. *Teeth*. Second edition. Cambridge University Press: Cambridge.
- INGLES, Lloyd G. 1965. *Mammals of the Pacific States: California, Oregon, and Washington*. Stanford University Press: Stanford, CA. (UCB Bioscience QL719.A15.N6.15)
- JAMESON, E. W., Jr., and Hans J. PEETERS. 2004. *Mammals of California*. The University of California Press: Berkeley.
- JOHNSON, Ned K., Meredith J. MAHONEY, James L. PATTON, and Robert C. STEBBINS. 2003. *Vertebrate Natural History Laboratory and Field Syllabus: Integrative Biology 104L*. University of California, Berkeley.
- JOLLIE, Malcolm. 1962. *Chordate morphology*. Reinhold: New York. (UCB Bioscience QL805.J6)
- LEOPOLD, A. Starker. 1951. *Game birds and mammals of California: a laboratory syllabus*. Unpublished.
- NOWAK, Ronald M. 1999. *Walker's mammals of the world*. Sixth edition. The Johns Hopkins University Press: Baltimore. (UCB Bioscience QL703.W222 1999)
- REID, Fiona A. 2006. *A field guide to mammals of North America*. Peterson Field Guide Series. Fourth edition. Houghton Mifflin Company.
- WILSON, Don E., and DeeAnn M. REEDER (eds). 2005. *Mammal species of the world: a taxonomic and geographic reference*. Third edition. The Johns Hopkins University Press: Baltimore, MD.

## Recommended Books

- ALLEN, Sarah G., Joe MORTENSON, and Sophie WEBB. 2011. *Field Guide to Marine Mammals of the Pacific Coast*. University of California Press: Berkeley, CA.
- ELBROCH, Mark. 2003. *Mammal tracks and sign: a guide to North American species*. Stackpole Books: Mechanicsburg, PA.
- 2006. *Animal skulls: a guide to North American species*. Stackpole Books: Mechanicsburg, PA.
- 2012. *Field guide to animal tracks and scat of California*. The University of California Press: Berkeley.
- VAUGHAN, Terry A, James M. RYAN, and Nicholas J. CZAPLEWSKI. 2015. *Mammalogy*. Sixth edition. Jones & Bartlett Learning: Burlington, MA.

## Internet Resources

- American Society of Mammalogists: <http://www.mammalsociety.org>
- Mammal Species of the World, on-line edition: <http://www.bucknell.edu/msw3/>
- Mammalian Species accounts: [http://www.mammalsociety.org/uploads/Mammalian%20Species\\_Accounts.xlsx](http://www.mammalsociety.org/uploads/Mammalian%20Species_Accounts.xlsx)
- Animal Diversity Web: <http://animaldiversity.ummz.umich.edu/site/accounts/information/Mammalia.html>
- Encyclopedia of Life: <http://eol.org/pages/1642/overview>
- The Hall of Mammals (UCMP): <http://www.ucmp.berkeley.edu/mammal/mammal.html>
- The mammals of Texas, on-line edition: <http://www.nsrl.ttu.edu/tmot1/>
- California roadkill observation system: <http://www.wildlifecrossing.net/california/>

# Laboratory Exercises on Reptiles

## Laboratories I, II, and III (3 Weeks)

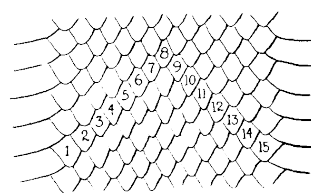
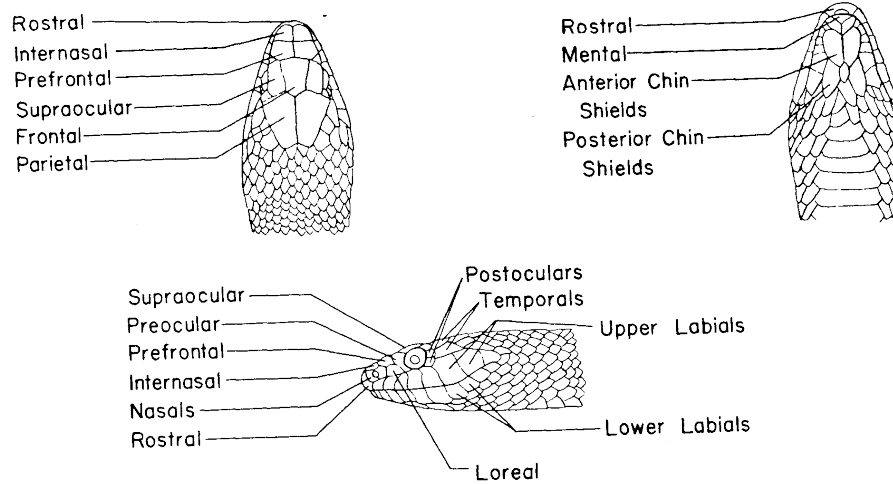
The reptile laboratories will stress external identification characteristics and various aspects of locomotion, feeding, and defense against predators. Since reptiles are often the dominant vertebrates in deserts and California contains one of the world's richest desert reptile faunas, we will range beyond our local ecosystem in these exercises. Reptiles exhibit more diversity in food habits than amphibians, and in areas where a variety of species live in close proximity competition might be reduced by differences in microhabitat and diet.

### Laboratory I

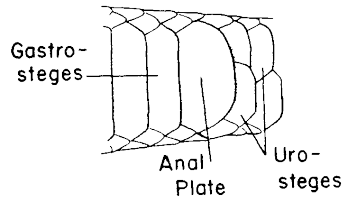
#### **Identification and Habits of East Bay Reptiles**

Refresh your memory on proper handling of preserved specimens (p. 6 of this manual). Learn the Order, Family, Genus and species, identifying characteristics (see the figure below and additional illustrations in your Field Guide), and natural history features, including general distribution, habitat, diet, mode of reproduction (egg laying or live birth) for each of the reptile species listed below. You should know distributional ranges, habitat preferences, and habits to the extent described in the following pages and in your Field Guide. Additional species may be added to those required, depending on yearly availability.

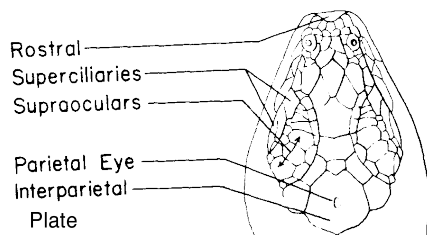
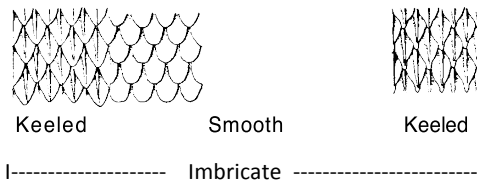
**Figure. External Features of Reptiles**



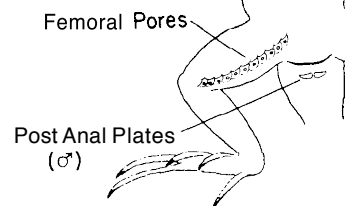
Dorsal scale row (method of counting)



**Snake dorsal scale types**



**LIZARDS**





# Reptiles of the East Bay hills and vicinity

Range Key: NC=North Coast, SC=South Coast, BA=Bay Area, CV=Central Valley, GB=Great Basin, SN=Sierra Nevada, D=Desert

## ORDER TESTUDINES (Turtles)

### FAMILY EMYDIDAE (Pond Turtles)

*Actinemys marmorata* (Western Pond Turtle). Carapace shields marked with network of spots, lines, or dashes of brown or black, which tend to radiate from growth centers of shields. Found in woodland, forest, and grassland in quiet water of ponds, small lakes, and streams. -- NC, BA, SN, CV, SC

*Trachemys scripta* (Pond Slider Turtle). Vertical yellow streaking on costal shields; broad red stripe behind the eye and eye-like spots on the plastron. Introduced in CA. Habitat generalist. Prefers woodland, forest, and grassland; breeds in water of ponds, small lakes, and streams. Often replaces *A. marmorata* in appropriate habitat. -- BA, SC

## ORDER SQUAMATA (Lizards)

### FAMILY PHRYNOSOMATIDAE

*Phrynosoma blainvillii* (Blainville's Horned Lizard). Two rows of projecting fringe scales on side of body; enlarged imbricate, pointed scales on throat; crown of enlarged thorn-like spines at back of head. Found in sandy areas in valley, foothills, and semi-arid parts of mountains. Ant specialist. Mating occurs venter-to-venter. Threatened due to habitat loss. -- BA, CV, SC

*Sceloporus occidentalis* (Western Fence Lizard). Dorsal scales mucronate, blue throat and belly patches. Inhabits grassland, chaparral, woodland, forest, usually in vicinity of rock outcrops or logs. -- NC, BA, CV, SN, GB, SC, D

### FAMILY SCINCIDAE (Skinks)

*Plestiodon skiltonianus* (Western Skink). Cycloid scales on both dorsal and ventral surfaces. Seven upper labial scales and juveniles have bright blue tails. Inhabits woodland forest and grassland, prefers areas with rocks and herbaceous cover. -- NC, CV, BA, SC, GB

*Plestiodon gilberti* (Gilbert's Skink). Thick-bodied, orange tail in adults, tail blue or orange in juveniles. eight upper labials (*P. skiltonianus* usually has seven). Dark side-stripe stops abruptly at the base of tail. Found in grassland, desert, chaparral, woodland, pine forest. Prefers rocky areas near streams and springs. -- CV, BA, SC, SN, D

### FAMILY TEIIDAE (Teiids)

*Aspidoscelis tigris* (Western Whiptail). Pointed head, granular dorsal scalation, ventral scales quadrangular, movable eyelids, very long slender tail. Found in arid and semi-arid regions, sandy or gravelly desert flats, rocky hillsides, desert scrub, grassland, and woodland. Active forager that can run at great speed, sometimes bipedally. This genus is well-known for its tendency to produce

parthenogenic (clonal) lineages via hybridization (although *A. tigris* is not parthenogenetic and reproduces sexually). -- NC, BA, CV, SC, GB, D

**FAMILY ANGUIDAE** (Alligator Lizards and Relatives): Anguids can be identified by well-defined lateral fold on the side of the body

***Elgaria coerulea*** (Northern Alligator Lizard). Longitudinal dark lines between scale rows on belly. Habitat is deciduous and coniferous woodland, sparingly in grassland. Ovoviviparous (live birth). -- NC, SC, BA, SN

***Elgaria multicarinata*** (Southern Alligator Lizard). Longitudinal dark lines down middle of scale rows on belly. Found in woodland, grassland, and chaparral. More crepuscular and nocturnal than *E. coerulea*. Oviparous (lays eggs) -- NC, SC, BA, SN, CV

**FAMILY ANNIELLIDAE** (Legless Lizards)

***Anniella pulchra*** (Northern California Legless Lizard). No limbs, eyes small but with movable lids. Ventral scales similar to dorsal scales in size (not broad). Inhabits woodland, grassland, and chaparral. Ovoviviparous. Several new species of *Anniella* have been described from California in recent years with *A. pulchra* most geographically proximate to the Bay Area. -- BA, SC, CV, D

**ORDER SQUAMATA** (Snakes)

**FAMILY BOIDAE** In our boas, the scales between lower labials are all small, the ventrals are less than three times as long as wide, and you can find spurs at the sides of the vent in males. These are remnants of the pelvic girdle and hind-limbs. Unlike most other snakes, boas have two well-developed lungs (most other snakes only have one).

***Charina bottae*** (Northern Rubber Boa). Thick-bodied, usually lighter underneath. Body has rubbery feel, covered in small scales. Large scales on head arranged symmetrically, end of tail blunt. Inhabits deciduous and coniferous woods. Can live for up to 50 years in the wild. -- NC, SC, BA, SN, GB

**FAMILY COLUBRIDAE**

***Diadophis punctatus*** (Ring-necked Snake). Orange neck ring and dark head; small, slender body. Gray or green to blue dorsally, pale to orange below with the color deepening toward the tail-tip. Found in moist coniferous and deciduous woodland. When threatened, coils its tail and exposes the bright orange ventral surface. -- NC, BA, SC, SN

***Contia tenuis*** (Sharp-tailed Snake). *Contia spp.* are slim-bodied and diminutive; among California's smallest snakes. The ventral surface alternates black and cream-colored cross bands, and the tail bears a distinctive sharp terminal spine. Found in moist woodland, grassland, and forest, usually near streams, they have sharply recurved teeth and a dietary preference for slugs. There is a second, recently described species of *Contia* that occurs in the peripheral Bay Area – *Contia longicaudae*, so named because of its markedly longer tail. *Contia longicaudae* can be found on the south peninsula and north of Point Reyes, but we are unlikely to see it. You should be able to identify *C. tenuis* to species and know where you are likely to encounter it. -- NC, BA, SC, SN

***Coluber constrictor*** (Yellow-bellied Racer). Long, slender-bodied. Adults can be a uniform green to brown dorsally, venter can be white to pale yellow. Juvenile coloring is markedly different with brown saddles on a pale background (pattern superficially resembles *Pituophis catenifer*, but *C. constrictor* is a

more gracile snake). Lower preocular wedged between ends of upper labials, dorsal scales smooth. Found in grassland, meadows, prairies, woodland glades, often near streams. Abundant in CA. Very generalist diet. -- NC, SN, CV, SC, GB, BA

***Masticophis lateralis*** (Striped Racer). The several species in the genus *Masticophis* have bounced back and forth between *Masticophis* and *Coluber* in recent years and we follow *Masticophis* here as this seems to be the recent consensus. Note that your field guide uses *Coluber*. Dorsum blackish with a conspicuous pale yellow or orange stripe on each side, Lower preocular wedged between ends of upper labials. Rocky areas in chaparral, often broken by grassy areas. Threatened locally due to habitat loss. -- NC, SC, BA, SN

***Pituophis catenifer*** (Gopher Snake). Longest snake in CA. Four prefrontals, dorsal scales keeled. Heavy-bodied, dorsal patterning of large black, brown, or reddish brown blotches. Occurs in highly varied habitats: grassland, chaparral, shrubby desert, deciduous and coniferous woodland. -- NC, SC, BA, CV, SN, GB, D

***Lampropeltis californiae*** (California Kingsnake). The species *L. getula* was recently split into several species including *L. californiae*. Note that the field guide employs the outdated name *L. getula* for this species. Pattern of white or cream rings alternating with broad black or dark brown crossbands; these often resemble saddles more than bands as in *L. zonata*. Inhabits varied habitats, grassland, desert, chaparral, and woodland. Kingsnakes are generalists predators and will occasionally consume rattlesnakes (see Field Guide) -- NC, SC, BA, CV, SN, GB, D

***Lampropeltis zonata*** (California Mountain Kingsnake). Shiny smooth scales; tri-colored with rings of red, white, and black; white stripes bounded by black. Snout is usually black. Occurs in most CA mountain ranges in a variety of habitats including sage scrub, chaparral and forests. Is a CA Species of Special Concern due to habitat loss. -- NC, BA, SN, SC

***Tantilla planiceps*** (Western Black-headed Snake). Small snake, black on the head and pale dorsally, even lighter in color beneath. Distinct white neck ring. Inhabits grassland, chaparral, oak woodland, desert edge habitats. Venomous but not dangerous to humans (see Field guide). Specialist predator on centipides. -- BA, SC

## FAMILY NATRICIDAE

***Thamnophis atratus*** (Aquatic Gartersnake). Internasals tends to be greater in length than width and pointed anteriorly, usually 8 upper labials, 6th and 7th usually not higher than wide, dorsal stripe present. Marshes, rivers, and streams from sea level to high in the mountains. Dietary specialist of aquatic vertebrates: fishes, frogs, tadpoles. -- NC, BA, SC

***Thamnophis elegans*** (Western Terrestrial Gartersnake). Dorsal stripe always present, internasals tend to be greater in width than length and not pointed anteriorly, usually 8 upper labials 6th and 7th often higher than wide. Found near marshes, rivers, and streams from sea level to high in the mountains. -- NC, BA, SC, GB, SN

***Thamnophis sirtalis*** (Common Gartersnake). Seven upper labial scales, dorsal and side stripes usually well-defined. Highly varied habitats, grassland, chaparral, desert, deciduous, woodland, found varied aquatic habitat. See Field Guide about the evolutionary arms race with its prey species, *Taricha*. -- NC, BA, SC, SN, GB, CV

**FAMILY VIPERIDAE** (Vipers and Rattlesnakes): Vipers have distinctly triangular heads, keeled scales, large hollow fangs, and loreal pits. PLEASE READ the "Rattlesnake Bites and Treatment" section in your Field Guide to better inform yourself of the danger these animals pose and how to safely conduct yourself during field trips.

***Crotalus oreganus*** (Northern Pacific Rattlesnake). Large dark blotches on back, usually more than 2 internasals. Found in varied habitats; grassland, chaparral, deciduous and coniferous woodland. -- NC, SN, GB, CV, BA, S

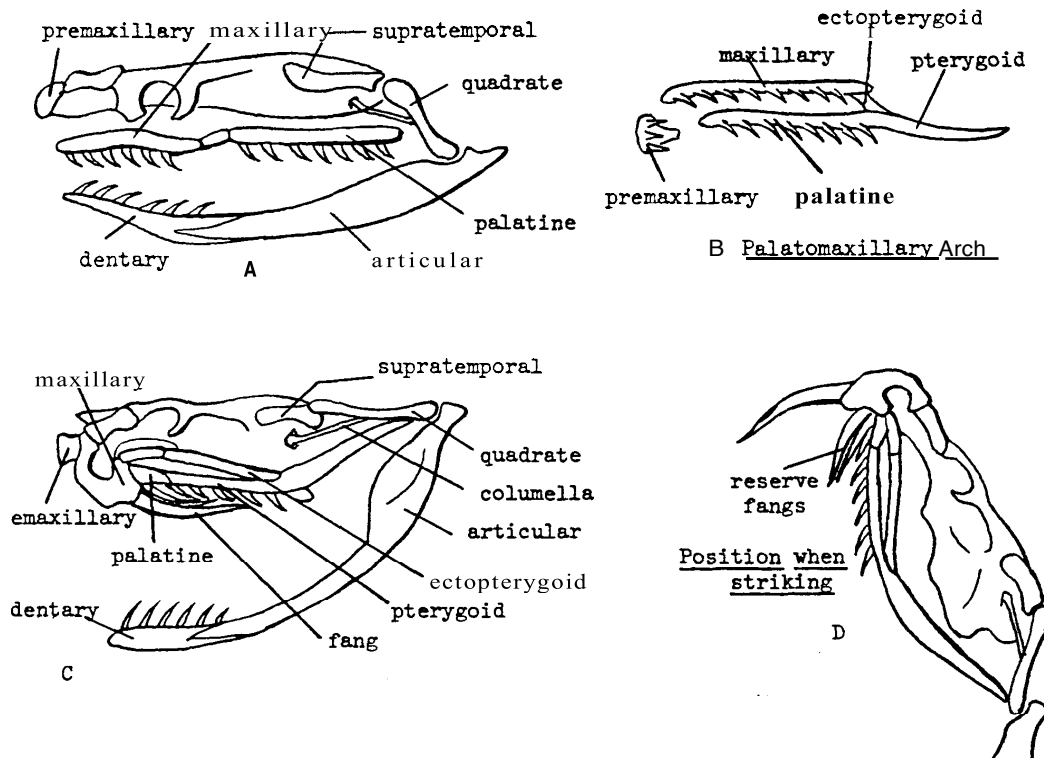


Fig. Skull structure in snakes. A and B, colubrid; C and D, viperid. B, is roof of mouth, left side only. Except for the premaxillary, which forms a single unit, a similar set of bones is present on the right side.

# Laboratory II

## Identification and Habits of Desert Reptiles

Examine the desert reptiles in lab this week and learn the Order, Family, Genus, species, and natural history information (see Reptile Lab I for details) of each species. East Bay Reptiles will also be on display this week.

## Reptiles of California Deserts

Range Key: NC=North Coast, SC=South Coast, BA=Bay Area, CV=Central Valley, GB=Great Basin, SN=Sierra Nevada, D=Desert

### ORDER TESTUDINES (Turtles)

#### FAMILY TESTUDINIDAE (Land Tortoises)

*Gopherus agassizii* (Desert tortoise). Large size. Limbs elephantoid, blunt nails, no sign of webbing. Desert inhabitant; washes, sandy and gravelly flats. The only native tortoise in CA. The number of rings on carapace shield increase with age, but are not a reliable indicator of years. -- D

### ORDER SQUAMATA (Lizards)

#### FAMILY EUBLEPHARIDAE (Eyelid Geckos)

*Coleonyx variegatus* (Western Banded Gecko). Velvety skin, granular scalation, vertical pupil and movable eyelids. Inhabits rocky or sandy desert, chaparral. Can produce vocalizations in the form of high-pitched squeaks, which is unusual among lizards. Nocturnal. -- D, SC

#### FAMILY IGUANIDAE (Iguanids): Iguanids are usually large-bodied and mostly herbivorous

*Sauromalus ater* (Common Chuckwalla). Large, with small rounded scales. No rostral scale, loose folds of skin on neck and sides. Lives in deserts, mostly associated with rocks. When threatened, will inflate body to wedge itself into rock crevices. Primarily herbivorous, arid-adapted (see Field Guide). -- D

*Dipsosaurus dorsalis* (Desert Iguana). Pale in color with a row of enlarged keeled scales down middle of back. Inhabits shrubby desert, thorn scrub, sandy or gravelly flats. The third largest CA lizard. Can run very fast (18 mph) and maintain record-high body temperatures (see Field Guide). -- D

#### FAMILY CROTAPHYTIDAE (Collared and Leopard Lizards)

*Crotaphytus bicinctores* (Great Basin Collared Lizard). Dorsal scalation granular, two black collar markings. Found in arid and semi-arid regions; desert, woodland, brushland, and grassland always in association with rocks. Males aggressively territorial and may engage in male-male combat involving biting. -- GB, D, SC

*Gambelia wislizenii* (Long-nosed Leopard Lizard). "Leopard" spots, pale crossbars on body and tail. Found in arid and semi-arid plains with sparse grass or bushes. Non-territorial. Sexual dimorphism:

females are larger than males, and males do not have breeding coloration. May hybridize with *G. sila*. -- GB, D, SC

***Gambelia sila*** (Blunt-nosed Leopard Lizard). Short snout, dark spots arranged in rows along midline of body. Favors arid grasslands, flatlands, canyon floors, washes. Territorial. In contrast to *G. wislizenii*, males of this species are larger than females and exhibit breeding coloration. *G. sila* is endangered due to habitat destruction. -- CV

#### **FAMILY PHRYNOSOMATIDAE** (horned lizards, sand lizards, spiny lizards and allies)

***Callisaurus draconoides*** (Zebra-tailed Lizard). Medium-sized, slender lizard, with very long hind limbs and moderately long tail with distinct ventral "zebra stripes". They will raise the tail and move it from side to side to show the stripes as part of their display. Striking breeding coloration on ventral sides of torso in males. Associated sandy and gravelly desert flats and washes. -- D

***Phrynosoma platyrhinos*** (Desert Horned Lizard). Pale and flat-bodied with one row of projecting fringe scales on side of body, throat scales small, blunt profile. Found in desert; sandy and gravelly flats and washes, alluvial fans with scattered rocks. Ant specialist, but occasionally eat plants (see Field Guide). -- D, GB

***Sceloporus magister*** (Desert Spiny Lizard). Large mucronate scales on dorsum, black wedge-shaped mark on shoulder, blue throat and belly patches. Found in arid and semi-arid regions; thorn scrub, brushland, often in rocky areas. -- D

***Uma scoparia*** (Mojave Fringe-toed Lizard). Dorsal scalation granular, projecting fringe scales on toes. You do not need to distinguish the three California species, but know that there are three and that *U. scoparia* is the one you'd be most likely to encounter in the appropriate range and habitat (Mojave Desert). *Uma spp.* are desert inhabitants where they specialize on fine, wind-blown sand habitats, particularly sand dune systems. Because of habitat loss, the two other *Uma* species are of conservation concern. -- D

***Uta stansburiana*** (Common Side-blotched Lizard). Very small lizard with black or dusky spot on side behind arm pit, no band of enlarged scales on back or blue belly patches. Common in arid and semi-arid regions; shrubby desert, grassland, chaparral, woodland; washes, sandy and gravelly flats. They are well known as a study-system for the "rock-paper-scissors" mating system. -- BA, GB, SC, CV, D

***Urosaurus graciosus*** (Long-tailed Brush Lizard). Smaller lizard. Tail over twice as long as snout-vent length; band of enlarged, keeled, imbricate scales down middle of back, blue belly patches in males. Arboreal inhabitants of desert habitats, frequenting grass clumps, bushes, and trees. Often found in gravelly washes where smoke trees and/or creosote bush is abundant. See Field Guide for accounts of a monogamous mating system. -- SC, D

#### **FAMILY XANTUSIIDAE** (Night Lizards)

***Xantusia vigilis*** (Desert Night Lizard). Very small with a singular row of supraocular scales. Granular dorsal scalation, ventral scales quadrangular, eyes covered with transparent non-movable spectacle. Inhabits arid and semi-arid regions, often where yuccas and agaves abound. Nocturnal, viviparous, and CA's smallest lizard. One of few known "social" lizards, and can be found living in family groups. -- D, SC

#### **FAMILY HELODERMATIDAE** (Venomous Lizards)

***Heloderma suspectum*** (Gila Monster). Short, swollen tail, scales suggest bead work, coloration is a marbled mixture of black along with orange, pink, or yellow. Found in desert flats, canyons and arroyos, particularly in rocky areas. Our largest CA lizard. Venomous. – D

## ORDER SQUAMATA (Snakes)

### FAMILY BOIDAE (Please see note on boids in Lab I)

***Lichanura orcutti*** (Rosy Boa). Medium-sized snake, with a dorsal pattern varying between longitudinal stripes and mottling. Small scales on head, tail not rounded as in *C. bottae*. Found in rocky shrub lands and desert, some-times near oases and permanent or intermittent streams. Crepuscular and arid adapted; does not necessarily require a water source nearby. -- D, SC

### FAMILY COLUBRIDAE

***Arizona elegans*** (Glossy Snake). Faded coloration; scales smooth and glossy, slender bodied. Desert habitats, grassland, chaparral, woodland. Prefers open areas. Crepuscular to nocturnal, but often preys on diurnal lizards captured at night (see Field Guide). -- SC, D, (BA)

***Chionactis occipitalis*** (Western Shovel-nosed Snake). Black saddle-shaped marks on dorsum, countersunk lower jaw, flattened snout. Inhabits desert, areas of sparse vegetation, washes, dunes, sandy flats, rocky hillsides. Burrows via “sand swimming.” -- D

***Hypsiglena ochrorhyncus*** (Coast Night Snake). Smaller snake. Pale dorsally with dark blotches on back with smaller ones on the side. Prominent neck marking: two fused dark blotches. Chaparral, sagebrush, desert mountain meadows. Venomous, but poses little threat to humans because of its size. -- NC, SN, SC, D, GB, BA

***Rhinocheilus lecontei*** (Long-nosed Snake). A slender snake with distinct black saddles that do not encircle the body. These alternate with broad bands of red, pink or yellow with white edging. White flecking at the base of the dark saddles is diagnostic. Also has scattered dark blotches along the venter. Found in deserts, annual grassland and shrubland. Crepuscular and nocturnal. A burrower, it preferentially preys on *Aspidocelis* spp. -- CV, SC, D, GB

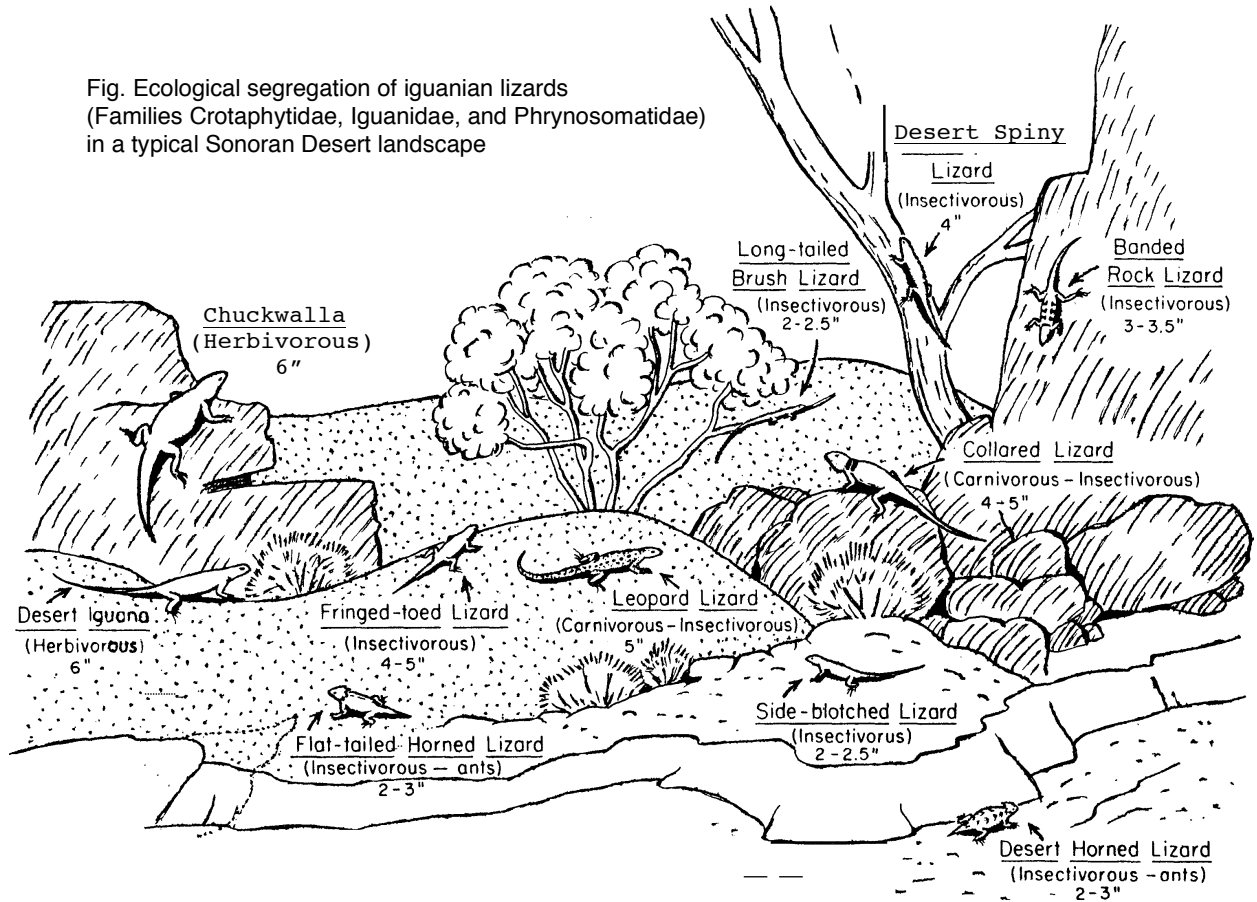
***Masticophis flagellum*** (Coachwhip). Second longest snake in CA and slender-bodied. Dorsal coloration can consist of wide, dark, brown to pink cross-bands on a tan background (subspecies *M. f. piceus*, the Red Racer) or a yellow to red or dark brown body with faint cross-banding on the neck. Prefers open areas where their primary asset, speed, is not hindered: desert, open grassland. Their aggressive hunting behavior and ability to move fast allow them to prey on some of the fastest terrestrial vertebrates (e.g. *Dipsosaurus dorsalis*). Listed in field guide as *Coluber flagellum*. -- SC, GB, D

***Trimorphodon lyrophanes*** (California Lyre Snake). Broad triangular head with a distinct lyre-shaped marking on the head and neck. Hexagonal dorsal patterning. Found in varied habitats; usually in rocky areas of desert grassland, chaparral, oak and coniferous woodland, desert scrub. Often prey on rock-dwelling lizard species and bats. -- SC, D

### FAMILY VIPERIDAE (Vipers and Rattlesnakes). Please refer back to comments on this family found in Lab I

***Crotalus cerastes*** (Sidewinder). Smaller than *C. oreganus*, with supraoculars turned upward and pointed, forming horn-like projections over the eyes. Found in sandy and gravelly desert flats where vegetation is sparse. It is the smallest CA rattlesnake. Noted for its specialized mode of locomotion (sidewinding) on low-friction substrates. – D

Fig. Ecological segregation of iguanian lizards (Families Crotaphytidae, Iguanidae, and Phrynosomatidae) in a typical Sonoran Desert landscape





# Laboratory III

## Natural History, Diversity and Review

1. Identification of California Reptiles. All of the East Bay and Desert Reptiles from labs I and II will be on display for you to review. Be sure to compare specimens with descriptions in the Field Guide. Make sure that you can identify diagnostic structures on the specimens. Also, note apparent differences between our preserved study specimens and the descriptions and color plates of living animals (for example, actual colors in life fade in alcohol). Remember your field observations and check to see if they are in accord with Stebbins and McGinnis' comments. Other things to examine: juvenile and adult coloration; male and female features; habitat specializations (e.g. color or external features); variation among individuals. Make sure you can identify similar looking species that occur in the different habitats.

2. Reptile Diversity. Examples of reptile diversity will be on display. Lizards occur in diverse habitats worldwide and have evolved a range of morphological and ecological specializations. Convergent evolution is the presence of similar attributes in distantly related organisms whose common ancestor lacked those traits. It is often associated with particular habitats and/or habits, and in such cases may be evidence that those characteristics represent common solutions to "problems" posed by the environment. For example, adaptation to arboreal or desert conditions has occurred repeatedly among squamates. Limb reduction and loss has also evolved independently in different lineages.

Figure. Sidewinding locomotion.

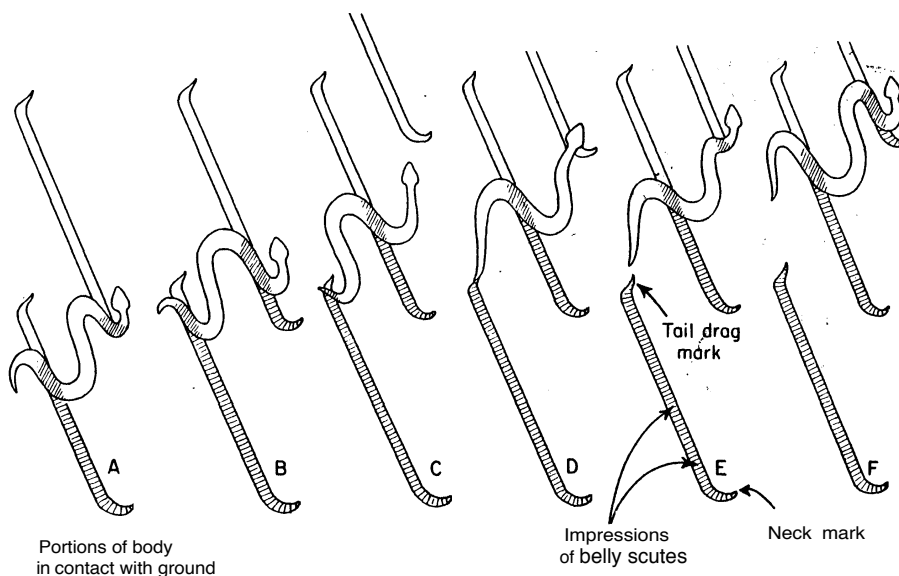


Table. Identification Characteristics and Habitats of some California Reptiles.  
Habitat description includes Life Zone Range (see Fig. 3).

	Identification	Habitat
Testudinidae: <i>Gopherus agassizii</i> (Desert Tortoise)	Limbs elephantoid, blunt nails, no sign of webbing	LS. Desert; washes, sandy and gravelly flats
Emydidae: <i>Actinemys marmorata</i> (Western Pond Turtle)	Carapace shields marked with network of spots, lines, or dashes of brown or black which tend to radiate from growth centers of shields	LS-T. Woodland, forest, and grassland; quiet water of ponds, small lakes, and streams
Anguinae	Well defined lateral fold on side of body	
<i>Elgaria coerulea</i> (Northern Alligator Lizard)	Longitudinal dark lines between scale rows on belly	US-C. Deciduous and coniferous woodland, sparingly in grassland
<i>Elgaria multicarinata</i> (Southern Alligator Lizard)	Longitudinal dark lines down middle of scale rows on belly	LS-T. Woodland, grassland, and chaparral
Anniellidae: <i>Anniella pulchra</i> (California Legless Lizard)	No limbs, eyes small but with movable lids, ventral scales not broad, similar to dorsal scales in size	LS-T. Burrows in leaf litter, alluvium, and sand in woodland, forest, chaparral, and grassland
Crotaphytidae		
<i>Crotaphytus bicinctores</i> (Great Basin Collared Lizard)	Dorsal scalation granular, two black collar markings	LS-US. Arid and semi-arid regions; rocky areas in desert, woodland, brushland, and grassland
<i>Gambelia wislizenii</i> (Long-nosed Leopard Lizard)	"Leopard" spots, pale crossbars on body and tail	LS-US. Arid and semi-arid plains with sparse grass or bushes
Gekkonidae: <i>Coleonyx variegatus</i> (Western Banded Gecko)	Velvety skin, granular scalation, vertical pupil and movable eyelids	LS-US. Rocky or sandy desert, chaparral
Helodermatidae: <i>Heloderma suspectum</i> (Gila Monster)	Short, swollen tail, scales suggest bead work, 4th toe about same length as 3rd	LS-US. Desert flats, canyons and arroyos, particularly in rocky areas

	Identification	Habitat
Iguanidae		
<i>Dipsosaurus dorsalis</i> (Desert Iguana)	Row of enlarged keeled scales down middle of back	LS. Shrubby desert, thorn scrub, sandy or gravelly flats
<i>Sauromalus ater</i> (Common Chuckwalla)	No rostral scale, loose folds of skin on neck and sides	LS. Desert, rocks.
Phrynosomatidae		
<i>Callisaurus draconoides</i> (Zebra-tailed Lizard)	Upper labials separated by oblique sutures, "zebra" markings on tail, very slender limbs	LS. Desert, sandy and gravelly flats
<i>Phrynosoma blainvillii</i> (Coast Horned Lizard)	Two rows of projecting fringe scales on side of body; enlarged imbricate, pointed scales on throat; sloping profile	US-T. Sandy areas in valley, foothills, and semi-arid parts of mountains
<i>Phrynosoma platyrhinos</i> (Desert Horned Lizard)	One row of projecting fringe scales on side of body, throat scales small, blunt profile	LS-US. Desert; sandy and gravelly flats and washes, alluvial fans with scattered rocks
<i>Sceloporus occidentalis</i> (Western Fence Lizard)	Dorsal scales mucronate (smaller than in <i>S. magister</i> ), no prominent black shoulder mark, blue throat and belly patches	LS-C. Grassland, chaparral, woodland, forest, usually in vicinity of rock outcrops
<i>Sceloporus magister</i> (Desert Spiny Lizard)	Large mucronate scales on dorsum, black wedge-shaped mark on shoulder, blue throat and belly patches	LS-US. Arid and semi-arid regions; thorn scrub, brushland, often in rocky areas
<i>Uma</i> sp. (Fringe-toed Lizards)	Dorsal scalation granular, projecting fringe scales on toes	LS. Desert; fine wind-blown sand
<i>Uta stansburiana</i> (Common Side-blotched Lizard)	Black or dusky spot on side behind arm pit, no band of enlarged scales on back, no blue belly patches in male	LS-T. Arid and semi-arid regions; shrubby desert, grassland, chaparral, woodland; washes, sandy and gravelly flats
<i>Urosaurus graciosus</i> (Long-tailed Brush Lizard)	Tail over twice as long as snout-vent length; band of enlarged, keeled, imbricate scales down middle of back, blue belly patches in male	LS. Desert; arboreal, frequents grass clumps, bushes, and trees

Phrynosomatidae cont.	Identification	Habitat
Scincidae: <i>Plestiodon skiltonianus</i> (Western Skink)	Cycloid scales on both dorsal and ventral surfaces, young with blue tail	US-C. Woodland forest and grassland, prefers areas with rocks and considerable herbaceous cover
Teiidae: <i>Aspidoscelis tigris</i> (Western Whiptail)	Granular dorsal scalation, ventral scales quadrangular, movable eyelids, very long slender tail	LS-T. Arid and semi-arid regions, sandy or gravelly desert flats, rocky hillsides, desert scrub, grassland, and woodland
Xantusiidae: <i>Xantusia vigilis</i> (Desert Night Lizard)	Granular dorsal scalation, ventral scales quadrangular, eyes covered with transparent nonmovable spectacle	LS-US. Arid and semi-arid regions, often where yuccas and agaves abound
Boidae	Scales between lower labials all small, ventrals less than three times as long as wide, spur at side of vent in male	
<i>Charina bottae</i> (Rubber Boa)	Large scales on head arranged symmetrically, end of tail blunt	US-T. Deciduous and coniferous woods
<i>Lichanura orcutti</i> (Rosy Boa)	Small scales on head	LS-US. Rocky shrublands and desert, sometimes near oases and permanent or intermittent streams
all non-boid snakes	large chin shields, ventrals 3 or more times longer than wide	
Colubridae		
<i>Chionactis occipitalis</i> (Western Shovel-nosed Snake)	Black saddle-shaped marks on dorsum, countersunk lower jaw, flattened snout	LS. Desert, areas of sparse vegetation, washes, dunes, sandy flats, rocky hillsides
<i>Coluber constrictor</i> (Racer)	Lower preocular wedged between ends of upper labials, dorsal scales smooth	US-T. Grassland, meadows, prairies, woodland glades, often near streams
<i>Contia tenuis</i> (Sharp-tailed Snake)	Ventral surface with pattern of alternating black and cream-colored cross bands, tail with sharp terminal spine	US-T. Moist woodland, grassland, and forest, usually near streams

Colubridae cont.	Identification	Habitat
<i>Diadophis punctatus</i> (Ring-necked Snake)	Orange neck ring	US-T. Moist coniferous and deciduous woodland
<i>Lampropeltis californiae</i> (California Kingsnake)	Pattern of white or cream rings alternating with broad black or dark brown crossbands	LS-T. Varied habitats, grassland, desert, chaparral, and woodland
<i>Masticophis lateralis</i> (Striped Racer)	Dorsum blackish with a conspicuous pale yellow or orange stripe on each side, Lower preocular wedged between ends of upper labials	US-T. Rocky areas in chaparral, often broken by grassy areas
<i>Pituophis catenifer</i> (Gophersnake)	Four prefrontals, dorsal scales keeled	LS-T. Highly varied habitats, grassland, chaparral, shrubby desert, deciduous and coniferous woodland
<i>Thamnophis atratus</i> (Aquatic Gartersnake)	Internasals tends to be greater in length than width and pointed anteriorly, usually 8 upper labials, 6th and 7th usually not higher than wide, dorsal stripe present	LS-C. Marshes, rivers, and streams from sea level to high in the mountains
<i>Thamnophis elegans</i> (Terrestrial Gartersnake)	Dorsal stripe always present, internasals tend to be greater in width than length and not pointed anteriorly, usually 8 upper labials 6th and 7th often higher than wide	US-C. Grassland, brushland, woodland and forest from sea level to high in the mountains
<i>Trimorphodon lyrophanes</i> (Lyresnake)	Distinct lyre-shaped mark on back of head	US-LS. Varied habitats; usually in rocky areas of desert grassland, chaparral, oak and coniferous woodland, desert scrub
Viperidae		
<i>Crotalus cerastes</i> (Sidewinder)	Supraoculars turned upward and pointed, forming horn-like projections	LS. Desert, sandy and gravelly flats where vegetation is sparse
<i>Crotalus oreganus</i> (Western Rattlesnake)	Large dark blotches on back, usually more than 2 internasals	LS-C. Varied habitats; grassland, chaparral, deciduous and coniferous woodland

# Notes on field notes

## Narrative style

One of the common problems that we encounter when looking at students' field notes is the adherence to a strict chronological timeline of observations. This likely stems from our requirement that field notes be written in a 'narrative' style. A narrative style means that we want an account – i.e., complete sentences and paragraphs that describe your visit to a site. The word 'narrative' implies linearity, but you don't have to take this to an extreme. We don't need a chronological play-by-play that adheres to a strict timeline. Often this is not the most effective way to communicate biologically interesting or relevant information. For example, imagine a journal account that describes part of a visit in the following way...

We saw Species 1 feeding in some oaks, then we saw Species 2, then we saw Species 3. Species 3 was singing a song that sounded like church bells. Next, we observed Species 1 preening. We then saw Species 4 and 20 individuals of Species 5. A female Species 4 was apparently building a nest in the chaparral. Next, two individuals of Species 1 were flushed and pursued by a coyote.

It would be better to summarize your observations of Species 1 (at least within specific parts of the route), then go on to mention or discuss other species. This departure from a strict timeline of events and observations makes the journal entry easier to read and is especially helpful to readers who might scan your notes for information on specific species.

Also, a short descriptive phrase or even one adjective can make what is otherwise a somewhat dry list of species convey interesting biological information. Compare 'we saw dunlins' to 'we saw 20 dunlins feeding on the mudflats.' This can be done in your species list as well. For example, after the entry for Lesser Goldfinch, you could add 'approx. 6, all in willows along the creek.' You don't have to do this for every species or every observation, but details add information.

You can also summarize information according to biologically meaningful categories. For example...

- i. **Species** – Summarize observations of a particular species' occurrence and behavior across the entire route or within distinct habitats or zones at a site. For example: 'We observed **White-tailed Kites** at three points along the route, always in open grassland areas with scattered trees. Two observations were of apparently mated pairs (total number = 5).' Notice here that I also put the species name in boldface type. This is not required, but underlining or putting species names in boldface makes the notes easier to read or scan.

- ii. **Habitats or areas** – Summarize occurrences of multiple species as they occur in distinct habitats or areas. For example, as you encounter a new habitat along a route, summarize the (unique) community of vertebrates at that site. For example: ‘Next we walked the boardwalk through the marsh. During ~20 minutes of observations, we noted the only **Marsh Wrens** (~5), **Common Yellowthroats** (3), **Common Moorhen** (1), and **Northern Harriers** (2) of the day. We also spotted what appeared to be a **Neovison** as we exited the marsh and found **Ondatra zibethica** scat at three spots on the boardwalk itself.’
- iii. **Behavior** – Note multiple species that exhibit similar behavior, or contrast differences in behavior among species. For example, you could note similarity or differences in foraging behavior among raptor species, or contrast singing behavior (e.g., choice of perch) among singing birds. For example: ‘Throughout the day, the only species that we observed singing were sparrows (**Song, Savannah, and White-crowned Sparrows**). We further noted that these sparrow species are all non-migratory. Perhaps migratory sparrows do not sing in this area.’

Don’t be too quick to draw conclusions regarding animal behavior if you are not certain. Be conservative. For example: ‘**apparently** mated pairs’ in (i) above, ‘**perhaps** migratory sparrows’ in (iii), or, ‘its stabbing motions in the dry grass, **suggested** that the egret might be hunting for small mammals.’

### **Species accounts**

Your species accounts should be based on observations that you made in the field when you encountered an animal rather than information that you learned about that species elsewhere. If a GSI or professor or colleague points out aspects of the animal’s life history, behavior, physiology, etc. that you think will add interesting information to your account, make sure to *attribute* the information to that person.

### **Characterizing the habitats and topography**

Even if you do not know how to identify the different plants, you should be able to at least describe the vegetation structure – i.e., the relative density of trees and shrubs and the presence of open vs. wooded vs. shrub habitat. Differentiating between coniferous and broadleaf trees also adds useful information. Also, try to note habitat transitions along the route. You can include photos of different habitats. Photos taken from a vantage point on a hill or promontory can capture the lay of the land well.

It is important to note the topography at sites as well. For example, Arrowhead Marsh is basically flat, while Briones has open hills and deep, wooded ravines. How does this affect what we observe at Briones? Which animals are in the more open areas and which are on the wooded slopes or ravines?

### **Diagrams & drawings**

Include diagrams and drawings that are big enough and clear enough to either convey additional information or clarify the text.

### **Anthropomorphic fun**

It is not necessary for your notes to be deadly serious and it is fine (even good) for your notes to be funny at points, but they must convey relevant, interesting, and accurate biological information. Try not to anthropomorphize ('that snake was mad', 'the bird was singing its happy song', 'those mice totally hate that bobcat'). There is some leeway in this. Descriptions of appearance and sound are, by their nature, subjective. Terms like 'plaintive' and 'scolding', and mnemonics like '*Madge, Madge, Madge, come get your tea kettle-ettle-ettle*' are often used to describe bird sounds. Terms like 'a gentle expression' have been used in field guides to describe the appearance of certain gulls. But, if you use these, use them to describe appearance or to characterize sounds, *not to ascribe motives!*

And, last but not least...use past tense and active voice.



## RULES FOR FIELD NOTES

- (1) The field notebook is a hard-backed, loose-leaf notebook. The only acceptable sizes of paper are 6 x 9½ inches or 5½ x 8½ inches. Paper must be lined. Use black, waterproof ink.
- (2) Your field notebook will consist of species accounts and a journal whose form and content are described below. You must follow the form described. The reason is this: If your notebook is to be of value, you must be able to extract with the least amount of effort the information that you had put into it. In extracting information from your notebook, you will often be looking for a particular species, or a particular date or locality. Thus this information must be where it can be easily found, so you don't have to read dozens of pages to find the one you want. You may not be the only person to extract information from your notes, so you should use a form from which other people (such as the T.A.) can also obtain information with the least amount of effort. Remember that your notebook is loose-leaf; basic information such as date, locality, etc. must go on every page so that if pages get scattered, they can be returned to proper order.

### Species Accounts

Form (These rules for the form of your notebook must be adhered to.)

- (3) Put at the top of the page the name of the species to be dealt with on that page. You may use common name (or scientific name, or both, if you prefer). Place name high enough so that there is a space between it and the locality, which goes on the first line.
- (4) In the upper left-hand corner of every page, left of the margin, write your name, and the year below your name.
- (5) On the first line, to the right of the margin, enter the locality in full detail, including county and state. Use correct abbreviations and punctuation. (Go from most detailed item in your locality-heading to the most general, ending with the state.) You may make your locality-heading general enough so that it will apply to all observations made on your morning field trip, but then it is essential to put the details of the locality (e.g. "200 yds. N of Nature Area Gate") in the body of your entry along with the observations made there. Underline the locality heading with a wavy line. (This makes the locality headings stand out, so that you can readily pick them out of the material written in your notebook.) Enter locality heading at top of each page, even if continued from previous page.
- (6) On the line below the locality, to the left of the margin, write the date. (Do not use numerical abbreviations - 3/10/72.) Put the date (month and day) in left margin of every page, even if continued from previous page. Do not put anything else besides the date in the left margin (except your name and the year in the upper left corner). On the second and subsequent pages for a given date, you may put the word "continued" beneath the date if you wish.
- (7) Write on only one side of paper.

- (8) Don't skip lines. Begin next day's journal entry or species account immediately below last entry. Enter new headings for date and locality as necessary when observing on subsequent days or at different places. (You may skip one line above entry of new locality heading in the middle of a page.) Make entries compact; after 20 years of fieldnote-keeping, you'll save a lot of shelf-space. Write small, but legibly; put as much material as possible on each page. When, for any given species, the page becomes filled, head a new page with the species name, keeping the two thenceforth together. (When you have more than one page for any given species, you may number pages consecutively in upper right corner, if you wish.) Make certain that full information as to place, date, and name of observer is entered on new pages.

#### Content of Species Accounts

- (9) Enter facts as observed for that species, at the moment; also any inferences that seem logically to be made from those facts. Put down observations at once, as made. Do not leave any notes on individual species to be written up at the end of the day. Memory is treacherous. Do not copy pages, even if soiled. Original pages should be kept as authentic records of field work.
- (10) Observations will include: nature of immediate environment, "field" characters, mannerisms, behavior, voice, reactions to danger, foraging, mating, and nesting habits; in other words, where each species is found, how it looks and sounds, and what it does. Every sort of fact definitely observed should be recorded; and observations even of the same nature should be repeated again and again, as opportunity recurs, for each kind of animal.
- (11) Make observations as detailed as possible. Note kinds and species of plants, when pertinent. Be as specific as you can; say "conifer" or "broadleaf tree" if you don't know species. Is bird in crown or on trunk of tree? What is the manner of feeding? Does flying bird soar, glide, or flap its wings continuously? Note interactions between individuals and between members of different species.
- (12) Quantify where possible. How high up in tree is bird? How far from cover? How many individuals in flock? How many songs per unit time? How many feeding trips to nest per unit time?
- (13) At first when you are learning to identify birds, you may wish to record detailed descriptions of the birds' plumage in your notebook. Once you have learned to positively identify a species of bird, repeated description of plumage by itself doesn't make a good species account, unless you are relating to how color or pattern might be used or if individual seems unusual. If you wish to repeat bird descriptions in your species accounts for your own benefit, by all means do so. Descriptions of plumage related to comments on crypticity or conspicuousness, sex identification, signaling devices, etc. are desirable. Regarding amphibians and reptiles, it is desirable to describe more fully individuals you find, since members of a species may vary considerably in color, pattern, or size.
- (14) Enter time of day when appropriate in species account. Indicate a.m. and p.m. or use military time (e.g. 08:33; 14:52).

- (15) If you record second-hand information (something you have not observed yourself) give source.
- (16) As a rule, use telegraphic style in recording field observations; select words of explicit meaning. Diagrams or sketches are often helpful.
- (17) At the outset, the species records will be entered in the field notebook in the order in which the species have been met in the field. Soon it will be found convenient to sort the pages in accord with systematic relationship (check-list order) with tabs, or an index, to facilitate quick finding.

#### Journal

- (18) At the close of each period in the field, a journal or general account of observations should be written. The pages used should be headed with the caption "Journal" and with the date and locality designations that will apply for the entry. In the journal give route of travel (see maps 1-6), hours of observation, weather conditions, habitats and topography, lists of species seen (and estimated numbers of each species), and general impressions such as apply to groups of species. Subsequent day's entry of the journal follows immediately beneath last entry, with necessary headings as to date and place. These journal pages should be grouped in the front of the notebook. (Helpful hint: You may wish to make a brief reminder list on the inside cover of your field notebook of the items that should be included each time in your journal write-up.)
- (19) Use the same form for journal pages as described above for species accounts, except put Journal at top of page instead of species name. Write your name and the year as in species accounts.
- (20) If you put extensive notes on a particular species in your journal, put a cross-reference on appropriate species account page to that day's journal entry so that you can find that information again. Likewise, if you place information that belongs in the journal into a species account (and don't want to re-write the material into your journal), put a cross-reference in that day's journal entry to the appropriate species account so you will know where these data are recorded.

The field notebook will grow and gain importance with the experience of the observer. To the student, it will indicate development of his powers of observation and increase of his ability to record accurately and interpret what is seen and heard.

This and the preceding pages may be detached and placed permanently in your notebook for frequent reference.

Stebbins, Robert 1956 ○	<p style="text-align: center;">Black-tailed Rattlesnake          (<i>Crotalus molossus</i>)</p>
	<p style="text-align: center;"><u>Southwestern Research Sta., 5400 ft., Chiricahua</u></p>
	<p style="text-align: center;"><u>Mts., Cochise Co., Ariz.</u></p>
Aug. 11	<p>2:00 p.m. Large adult found by my son and Bill Miller, about 100 yds. south of the laboratory under a piece of tin. Snake was stretched out as though going somewhere. Caught in butterfly net. Rattled some but not vigorously. Again I gain the impression this is a rather docile snake. Capture site in oak-juniper woodland, along dry stream bottom.</p>
	<p style="text-align: center;">○</p>
	<p style="text-align: center;"><u>2 1/2 mi. W. Southwestern Research Sta., 7500 ft.,</u></p>
	<p style="text-align: center;"><u>Chiricahua Mts., Cochise Co., Ariz.</u></p>
Aug. 13	<p>10:00 a.m. Bob Drake saw an adult black-tail in the canyon bottom. The snake rattled briefly, only once, then remained quiet. Mont Cazier got one in same general area but higher - probably around 8000 ft.</p>
	<p style="text-align: center;">○</p>
	<p style="text-align: center;"><u>1/2 mi. E. Bill Miller Ranch, 5000 ft., Post Office</u></p>
	<p style="text-align: center;"><u>Canyon, Peloncillo Mts., Hidalgo Co., New Mex.</u></p>
Aug. 24	<p>Bill Miller showed me where a bobcat had killed and eaten a black-tail. The cat ate from the rear up to the belly region. The head had been chewed off and discarded. Miller said this was characteristic. He remarked</p>

Fig. Sample page from field notebook. Cut out and place in your field notebook.

## INDIVIDUAL FIELD PROJECT IN VERTEBRATE NATURAL HISTORY

Choose a field site that is safe and easily accessible. An area on the lower campus, in Strawberry Canyon in the Berkeley Hills, in one of the local Regional Parks, or in your home neighborhood should suffice. Pick a species or community of species that is easily found so that data can be gathered effectively each time you conduct field work. Plan to visit your field site repeatedly during the semester. Regular field study will be necessary to answer most kinds of questions. Your observations should be entirely original and based on your own watching and interpretation; do not resort to published literature or to other second-hand sources of information. Take field notes according to the method taught in the course; keep these notes permanently in regular field notebook and be prepared to turn them in along with your typewritten field project at the end of the semester. Discuss possible topics for your individual field project with one or more faculty or graduate student instructors in the course. The Research Proposal for your project (see pages ~~124-126~~) will be asked for early in the semester.

Opportunities for field projects dealing with local species of vertebrates are limitless. The following list of sample topics will provide an indication of the kinds of individual projects that have been undertaken in the past: The Density of Fox Squirrels on the Berkeley Campus; Burrowing Behavior of Pocket Gophers; Habitat use by Black-tailed Deer in Strawberry Canyon; Daily Movements of the Slender Salamander; The Influence of Temperature and Sunlight on the Behavior of the Western Fence Lizard; Courtship Behavior of the California Newt; Color Morphs and Habitat in the Pacific Treefrog; The use of Eucalyptus Trees by Birds; Nesting Behavior of the Red-tailed Hawk; Food Habits of the Great Horned Owl; The Density of Clapper Rail Nests; Differential Foraging Sites by Male versus Female Brewer's Blackbirds; Habitat Structure in the Vicinity

of Display Sites in the Anna's Hummingbird; The Influences of Light Intensity and Weather on the Awakening Times of Birds; Foraging Sites of Rufous-sided Towhees; Flocking Behavior in the American Coot; Tidal Influences on Heron Foraging; Age-related Differences in Displays of Male Red-winged Blackbirds.

Your neatly-typed report should include:

- Title
- Introduction (include purpose of study)
- Methods (include synopsis of dates and places of observation)
- Results (organized narrative giving facts ascertained, but not mere repetition of field notes)
- Discussion (interpretation of observations)
- Summary

Organize your report logically and write with attention to good English composition, correct grammar, and proper spelling. Provide the scientific name of the vertebrate species studied at least once at the beginning of the report even if the common name is used throughout the remainder of the report. Papers should be typed double-spaced and not exceed 15 pages. Longer papers will not be accepted; we encourage the concise presentation of facts and interpretations. The project will be judged on both the quality of the fieldwork and on the quality of your data summarization, analysis, and interpretation. This is not to be a term paper researched from library sources. However, if the starting point of your study is based on facts determined by another researcher or on information provided to you by the staff of the course, either in lecture, laboratory, or in informal discussion, then you should mention that source.

The typed report must be able to stand on its own, that is, it must be understandable without reference to anything else, even your field notes. However, field notes and/or data sheets that form the recorded basis for the report must be submitted along with the report when these are turned in at the end of the semester. This will enable the staff to judge the quality of the field data on which your analysis and interpretation rests.

## RESEARCH PROPOSAL FOR PROJECT

To help you organize your field project research, we are requiring a brief outline of the work you are proposing. The form on the next page is to be filled out and turned in to your lab T.A. on or before the due date. The proposal will not be graded, but will be read and, if adequate, approved and returned. Unsatisfactory proposals must be rewritten and resubmitted for approval. You must retain the approved proposal and turn it in again with the finished project.

The following comments explain the form (Numbers refer to questions on the form).

1. (Self-explanatory) What is your subject?
2. We encourage consultation. Although the project is to be your own work, early discussion of it can help you produce a more meaningful project as well as save you from potentially wasted effort.
3. Ask questions of nature and then set out to find answers. This approach helps you focus your efforts, so that you have a goal in mind when carrying out your research.
4. The way to answer such questions is to gather data. Quantify whenever possible; numbers often support a more convincing argument. The mechanics of data-gathering need to be considered. What form will the data take on paper? How will you summarize it later? When and where do you need to take data? How will your activities affect the animals you are studying?....
5. Consider how relevant your data will be to the questions you are asking. Assuming your data collection is successful, will you be able to answer your questions?

6. If we know where you are working, we may be able to minimize potential conflicts between different projects.
7. Killing, collecting, and marking vertebrates, particularly birds, is regulated by law. We encourage studies of wild vertebrates that do not involve these activities.



# Field Project Proposal Guidelines, Spring 2021

**Overview:** This proposal should be 1-2 pages double spaced and be an outline for the project you plan to conduct over the semester in IB104. The more detailed the proposal is, the better we will understand what you are trying to accomplish and the better feedback we can give. Please include your name, lab section, project title, and the names of any GSIs or Instructors that you have discussed this project with.

**Introduction/Background:** This section introduces your study system. Your study system can be your focal organism, community, behavior, habitat, etc. Begin this section broadly with a statement explaining the problem to entice the reader (e.g., "bats are everywhere but not much is known about their overwintering habits"). Follow this with some background information on what is known as well as why you are choosing this study system - did you observe a particular behaviour in the field? have you noticed the particular distribution of an organism? etc. Near the end, include your 1) **Question:** the central question you are seeking to answer for your project 2) **Hypotheses:** the main specific hypothesis that you plan to test as well as at least one alternative hypothesis. (See: *Asking Questions and Formulating Hypotheses from the Handbook of Biological Investigation* if you need guidance).

## Material and methods

Describe how you plan to test your hypothesis and answer your study question. Include the following:

- 1) your study site(s)
- 2) proposed timeline
- 3) materials you will use
- 4) what type of data you will be collecting
- 5) how you plan to analyze those data

Be as specific as possible. Are you using a specific protocol that you have used in another class or that we have employed in this class? Or do you need to develop a protocol for this project? Why do you think this is the best method to answer your question? Carefully considering each of these points will help us understand your thought process and save you time in the future. Feel free to add in any figures that will help convey your methods.

## Anticipated results

Describe the conditions required to confirm or falsify your hypothesis. You could also use this space to draw graphs of your anticipated findings.

## Literature cited

Your report should be based on your own observations, data and analyses and be able to stand by itself without outside sources. However, if you use an outside resource, add the citation here.

Remember, you must hand in an approved proposal with your final project.