What is a Raptor?

Lecture 1: CAU Raptors 2026



What do you think of when you hear the word “raptor”?

What do you think of when you hear the word “raptor”?



What do you think of when you hear the word "raptor"?





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What do you think of when you hear the word "raptor"?















DEFINITIONS AND TERMINOLOGY

- **Raptorial** – describes morphology or feeding behavior associated with capturing vertebrate prey (usually with feet / beak)
- **Bird of Prey** – bird that preys on other living animals
- **Raptor** – Broad term for animals adapted for predation or scavenging; commonly used for predatory birds and some extinct theropod dinosaurs (e.g., Velociraptor)

Term	Working definition	Unexpected inclusions/exclusions
Bird of prey	Any bird that hunts other living things	Includes Kingfishers, robins, gulls, warblers, etc.
Raptorial	Specialized for capturing vertebrate prey	Includes shrikes and skuas that few people call “raptors”
Raptor (modern use)	Predatory land bird with hooked beak and talons	Usually excludes seabirds; vultures complicate the definition
Raptor (evolutionary use)	Birds descended from a common predatory ancestor	Includes extinct theropod dinosaurs. Birds considered raptors (e.g., falcons, hawks, and owls) are not all closely related

WHAT MOST RAPTORS SHARE

- Hooked beak
- Strong grasping feet/talons
- Excellent vision
- Vertebrate prey

But exceptions exist for almost every trait!

Photos: USFWS









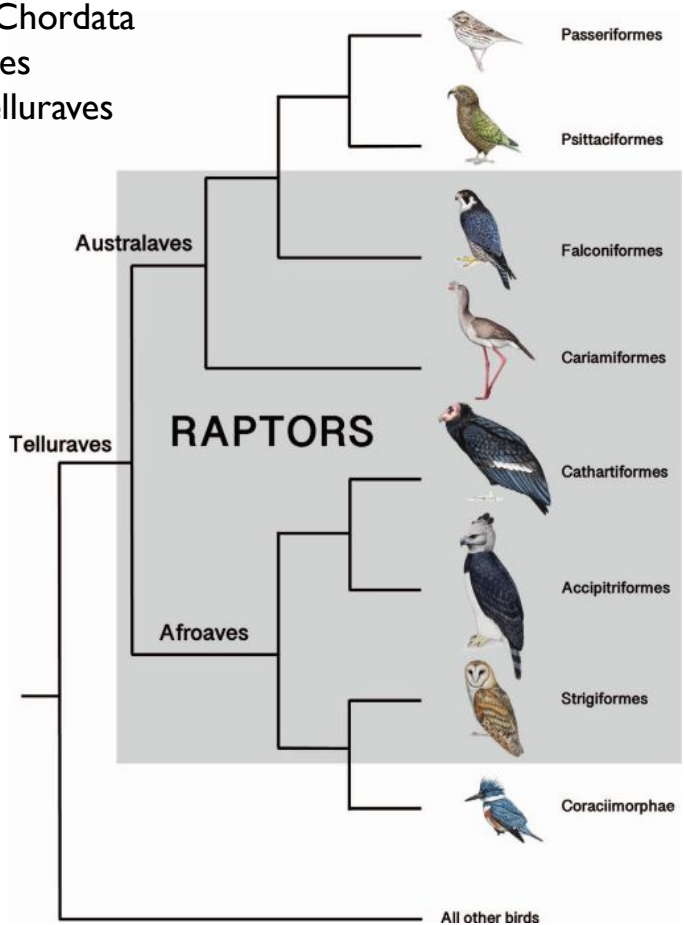
		Characteristic						
Group	Order	Keen Eyes	Raptorial Talons	Hooked Beak	Predatory	Diurnal	Ecological Equivalency	Raptor
Hawks and Eagles	Accipitriformes	X	X	X	X	X	X	X
Falcons	Falconiformes	X	X	X	X	X	X	X
Caracaras	Falconiformes	X	X	X		X	X	X
Owls	Strigiformes	X	X	X	X		X	X
Old World Vultures	Accipitriformes	X		X		X	X	X
New World Vultures	Cathartiformes	X		X		X	X	X
Seriemas	Cariamiformes	X	X	X	X	X	X	X
Shrikes	Passeriformes	X		X	X	X	X	
Ravens	Passeriformes	X			X	X	X	
Cormorants	Suliformes	X		X	X	X		
Warblers	Passeriformes	X			X	X		

CHALLENGES OF CLASSIFICATION RELATED TO MORPHOLOGY AND ECOLOGY

J. of Raptor Research, 53(4):419-430 (2019). https://doi.org/10.3356/0892-1016-53.4.419

Proposed criteria to define raptors combining phylogeny including morphology and ecology.

Kingdom: Animalia
Phylum: Chordata
Class: Aves
Clade: Telluraves



TAXONOMY & PHYLOGENY of RAPTORS

- Taxonomy - The science of naming, describing, and classifying organisms into groups based on shared characteristics and evolutionary relationships.
- Phylogeny - The evolutionary history and relationships among organisms.

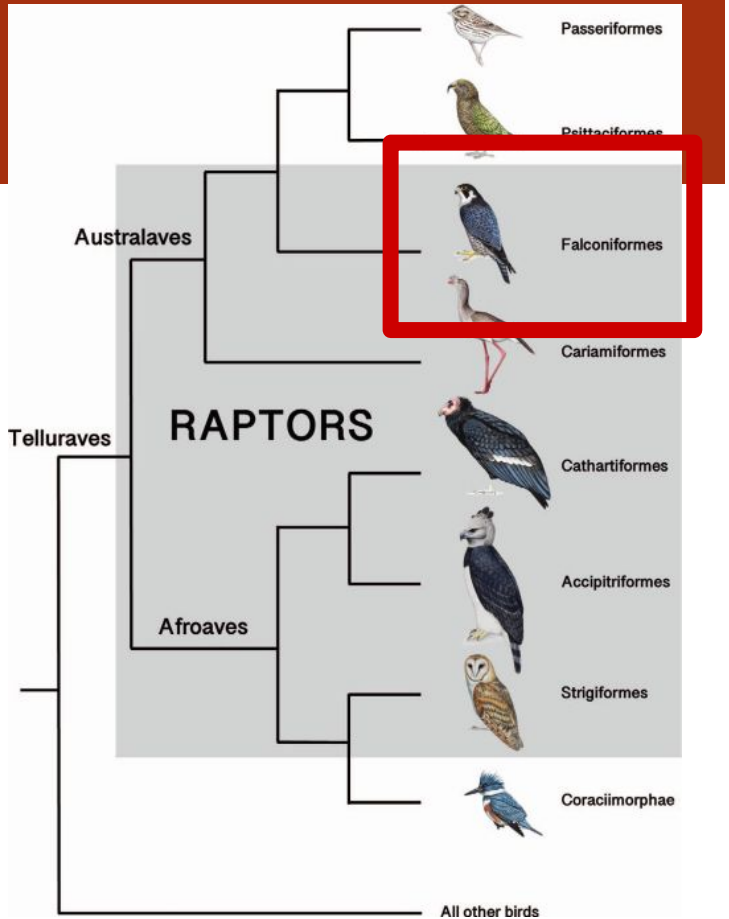
Commentary: Defining Raptors and Birds of Prey; McClure et al.
J. of Raptor Research, 53(4):419-430 (2019).
https://doi.org/10.3356/0892-1016-53.4.419

Major Raptor Groups

FALCONS

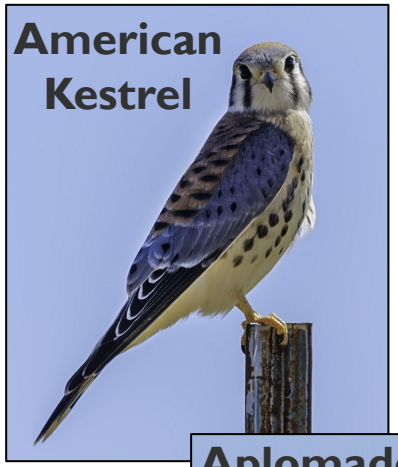
- Small to large in size
- Long, narrow, tapered wings; adapted for high-speed flight
- Streamlined body shape
- Long tail assists with steering and maneuverability
- Short hooked beak with a specialized "tomial tooth" for dispatching prey



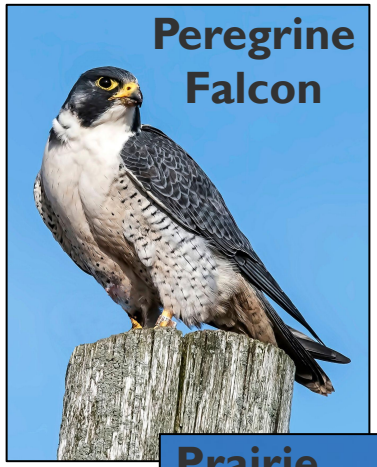


FALCONS

Photos: Cornell Lab of O - All About Birds, USFWS, Pixabay













UNIQUE FALCON FEATURES

- Dark brown/black eyes
- Round head
- Tapered wings
- Long toes
- Malar stripe
- Nostril cone, “baffles”
- Tomial tooth



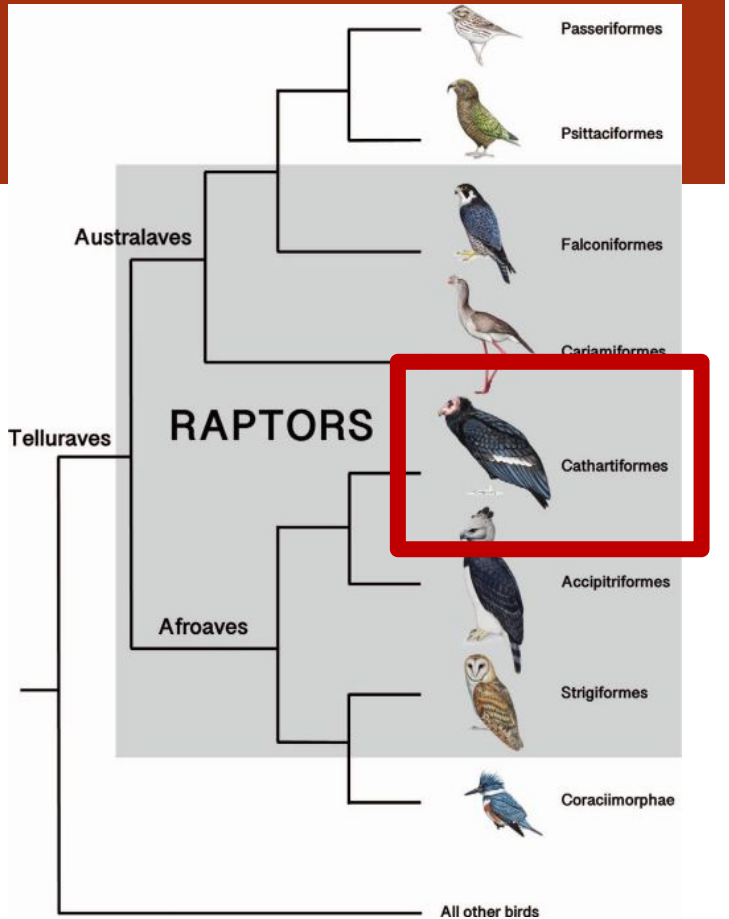




VULTURES

- Large to very large in size
- Large broad wings; adapted for soaring
- Slotted primaries ("fingers") reduce drag and maximize lift
- Bare or sparsely feathered heads
- Flat, relatively weak feet; adapted for walking and scavenging
- Strong hooked beaks specialized for tearing
- Gregarious, some have a well-developed sense of smell and large nares





VULTURES

Photos: USFWS & Pixabay



Turkey Vulture



Black Vulture

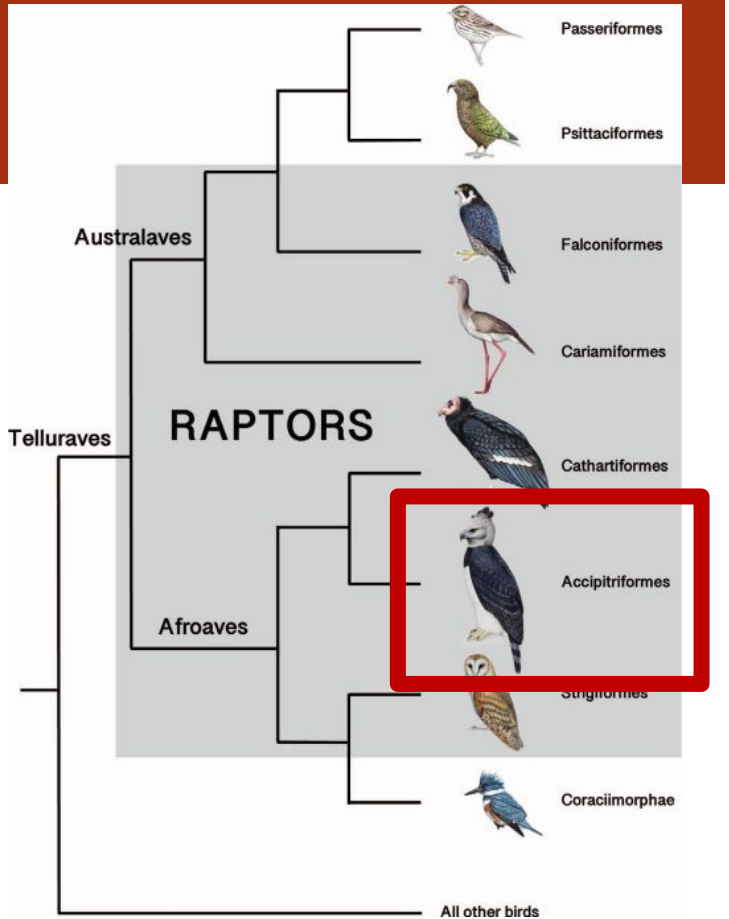


California Condor

EAGLES

- Particularly large in size (up to 15lbs)
- Large broad wings; adapted for soaring (wingspan up to 7ft)
- Slotted primaries ("fingers") reduce drag and maximize lift
- Large robust beaks, massive talons
- Strong muscular legs and feet for carrying large prey





EAGLES

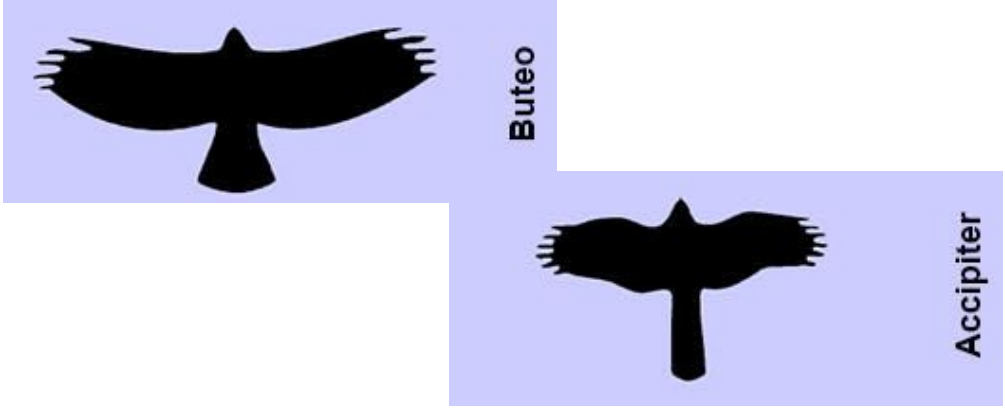
Photos: USFWS

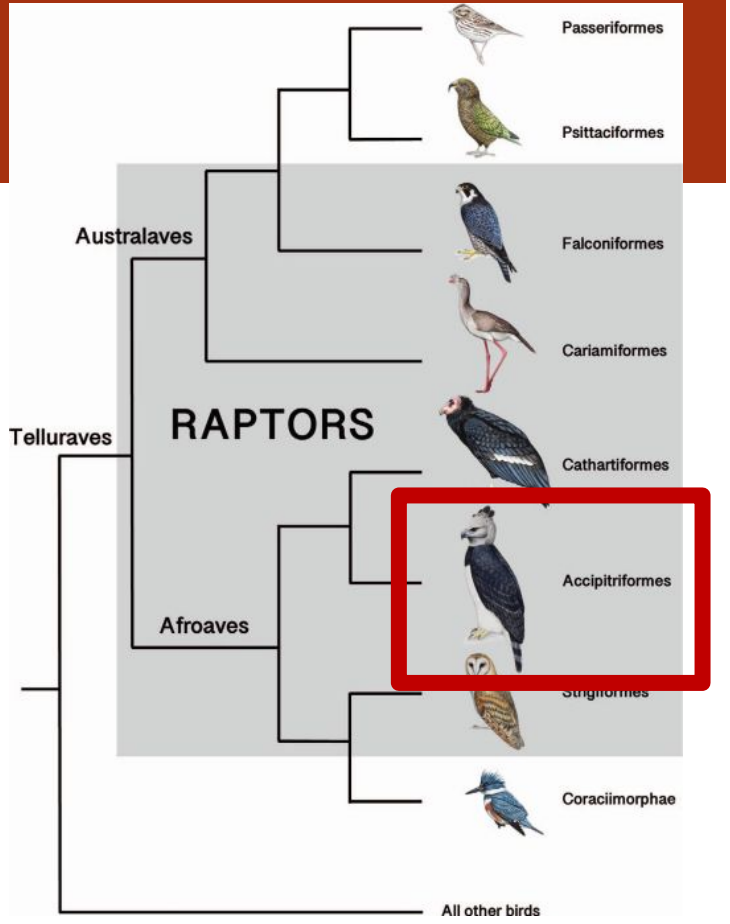




HAWKS

- Small to large in size
- Two major groups of hawks in US
  - Soaring hawks (Buteos)
  - Forest hawks (Accipitrine)

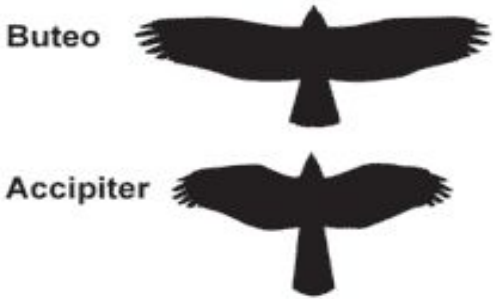




HAWKS

Buteos

- Soaring Hawks
- Long, broad wings
- Relatively short tails
- Fan-shaped tail
- Highly variable diets
- "Sit and wait" style of hunting



Accipitrine

- Forest Hawks, "true" hawks
- Shorter, rounded wings
- Relatively long tails
- Adapted for agile flight in wooded habitats
- Birds comprise much of the diet
- "Dash and grab" style of hunting

HAWKS

Photos: Cornell Lab of O - All About Birds



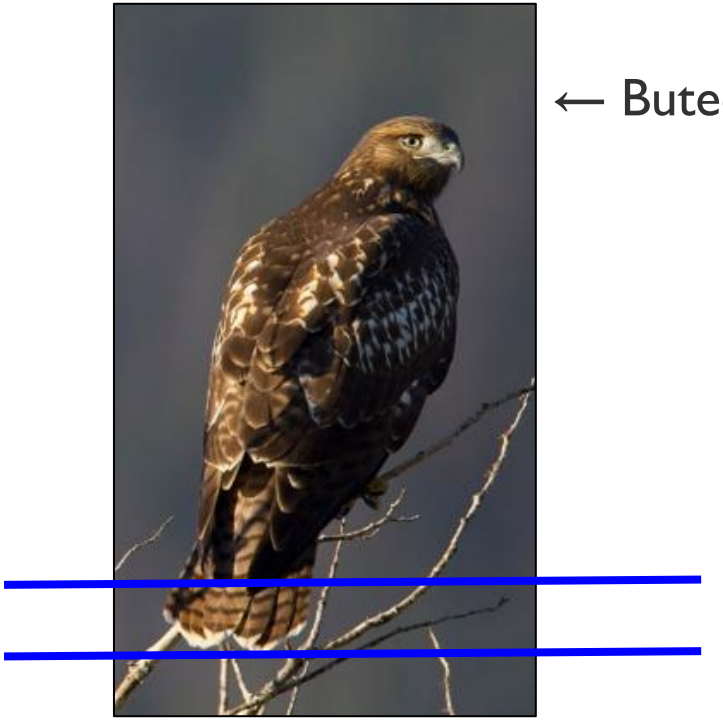
← Buteo

Accipitrine →



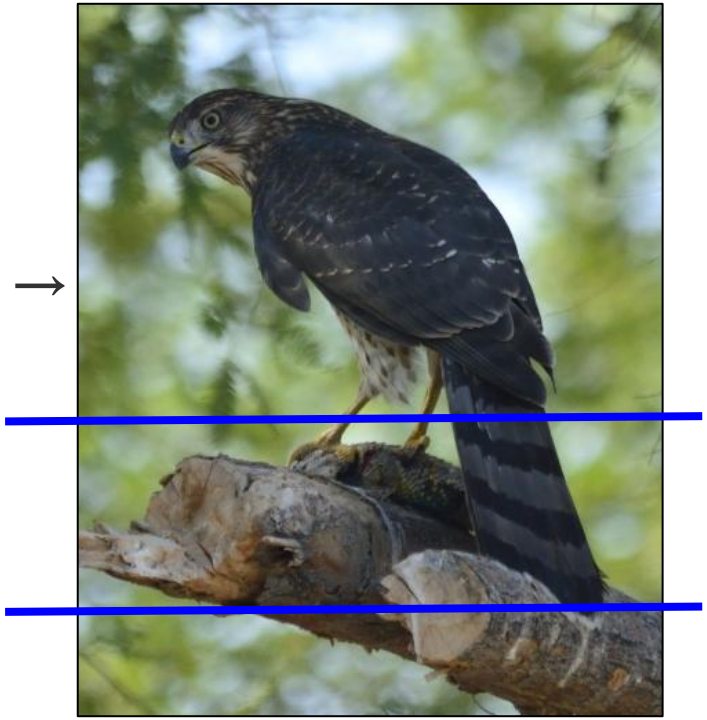
HAWKS

Photos: USFWS



← Buteo

Accipitrine →



HAWKS: BUTEOS

Photos: Cornell Lab of O - All About Birds



Rough-legged Hawk



Red-tailed Hawk



Red-shouldered Hawk



Broad-winged Hawk

HAWKS: BUTEOS (and Parabuteo)

Photos: Cornell Lab of O - All About Birds

Ferruginous Hawk



***Parabuteo* Harris's Hawk**



Swainson's Hawk



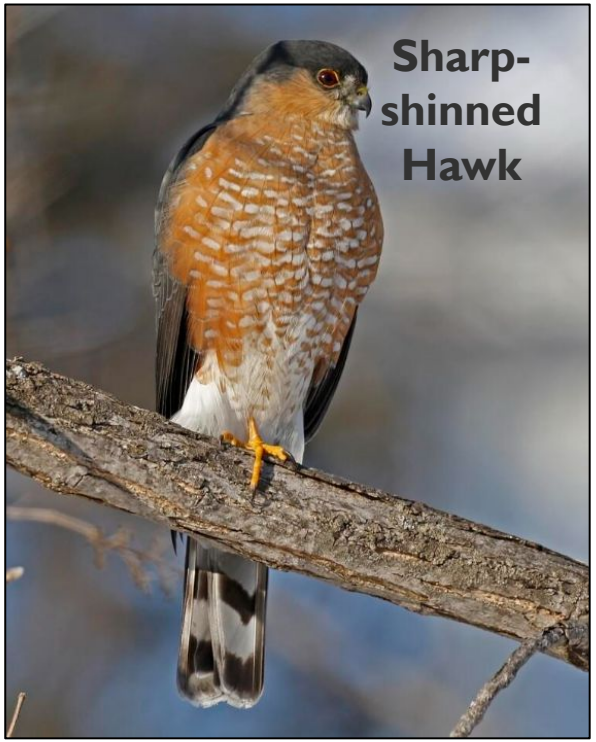
Other spp. not pictured = Common Black Hawk, Gray Hawk, Short-tailed hawk, Zone-tailed hawk

HAWKS: ACCIPITRINE

Photos: Cornell Lab of O - All About Birds







HAWKS VS FALCONS

Feet



Falcon



Wings

Hawks have broader, rounded wings, whereas falcons have more pointed wings.

Hawks have shorter, thicker toes; falcons have longer, slender toes (especially the middle toe).



Hawk



HAWKS VS FALCONS

Beaks, Nares, & Eyes



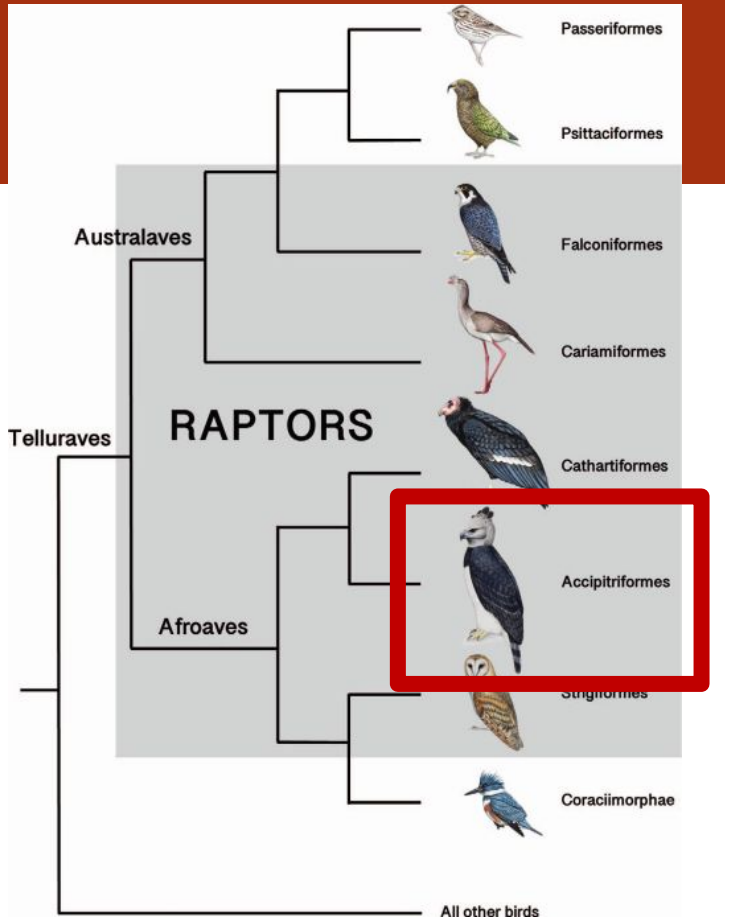


Falcons have a tomial tooth and baffles; hawks do not. Falcons eyes are dark brown to black while hawk eyes are yellow, red, or light to dark brown

OSPREY

- Medium to large in size
- Long narrow wings for sustained soaring
- Streamlined body and angled wings aid diving into water
- Specialized foot arrangement allow grasping fish with two toes forward and two backward
- Large curved talons with spiny foot pads help grip slippery fish
- Dense oily plumage provides water resistance





OSPREY

Photos: USFWS



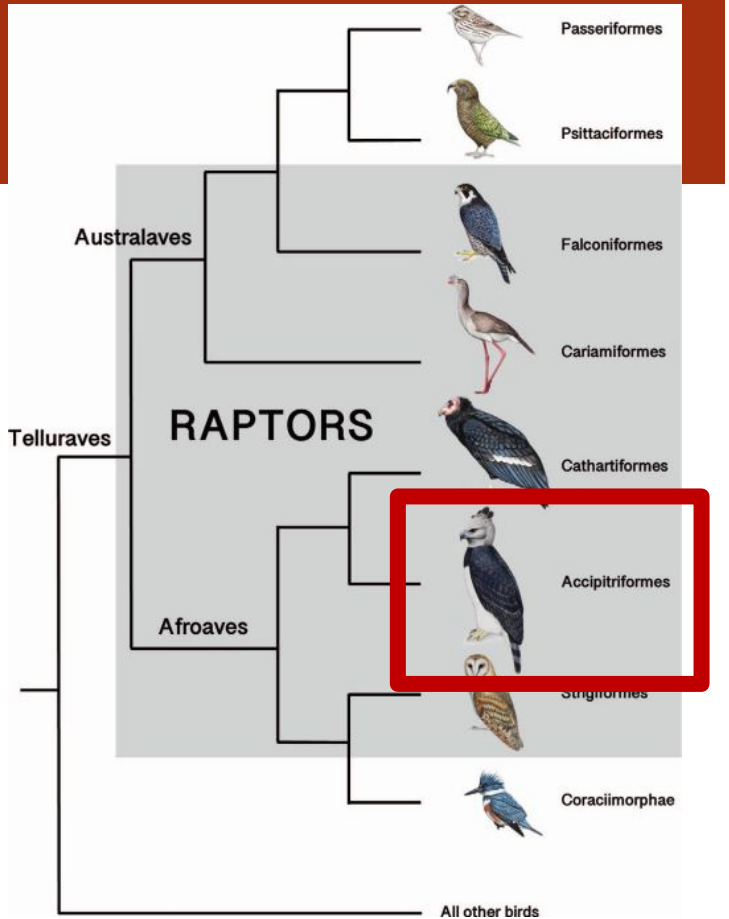
OSPREY



HARRIERS

- Medium-sized, slim-bodied
- Long broad wings adapted for low gliding flight
- Long tails aid balance and maneuverability
- Distinctive owl-like facial disk helps detect prey by sound
- Fly low over fields and marshes while hunting





HARRIERS

Photos: Cornell Lab of O - All About Birds, USFWS

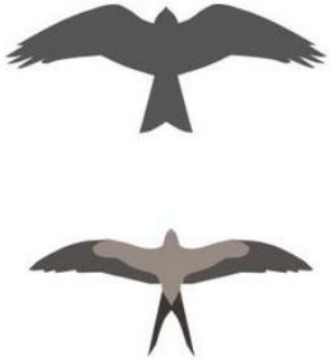


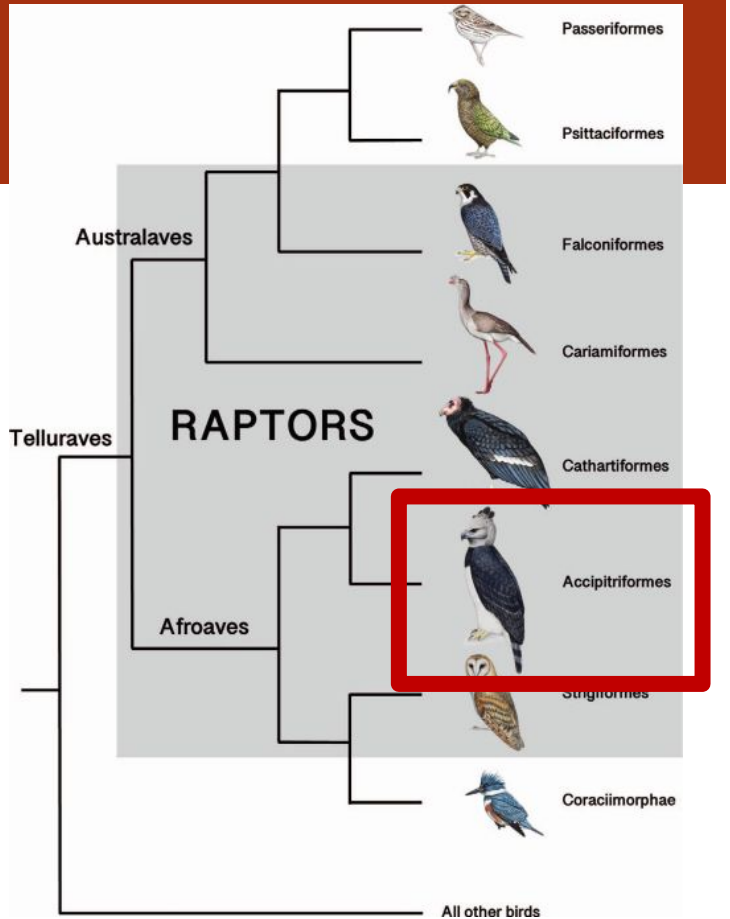
Northern Harrier



KITES

- Light, slender raptors with long, narrow wings
- Deeply forked or slightly notched tails
- Graceful, buoyant flight





KITES

Photos: Cornell Lab of O - All About Birds, USFWS



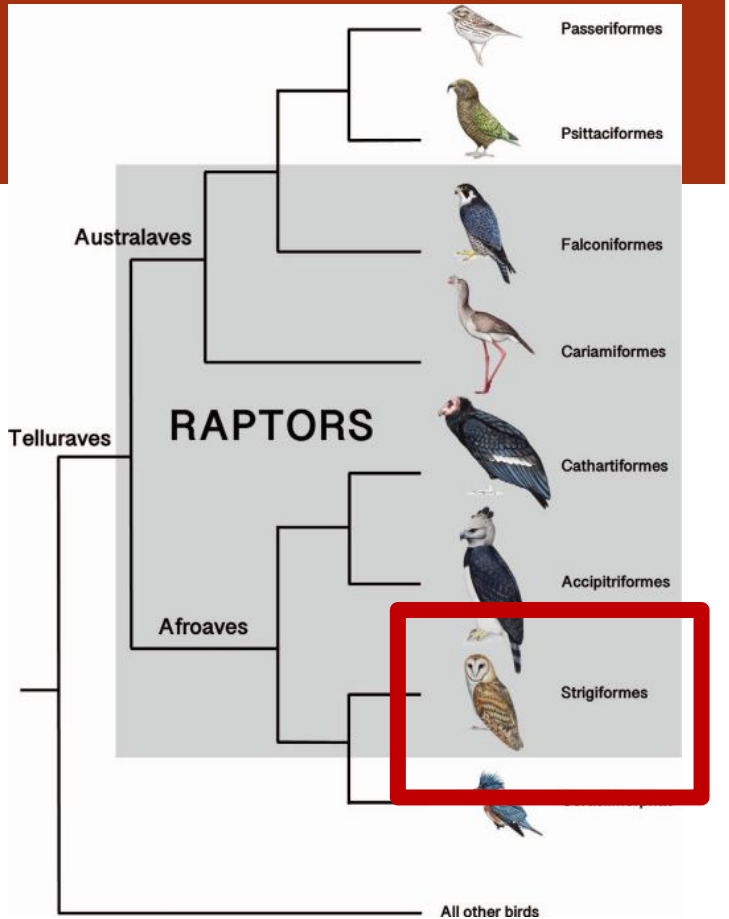




OWLS

- Small to large in size
- Large forward-facing eyes
- Prominent facial disk
- Compact body with relatively short tail
- Broad, rounded wings adapted for slow, silent flight
- Cryptic (camouflaged) plumage
- Many species nocturnal or crepuscular





OWLS

Photos: Cornell Lab of O - All About Birds, USFWS



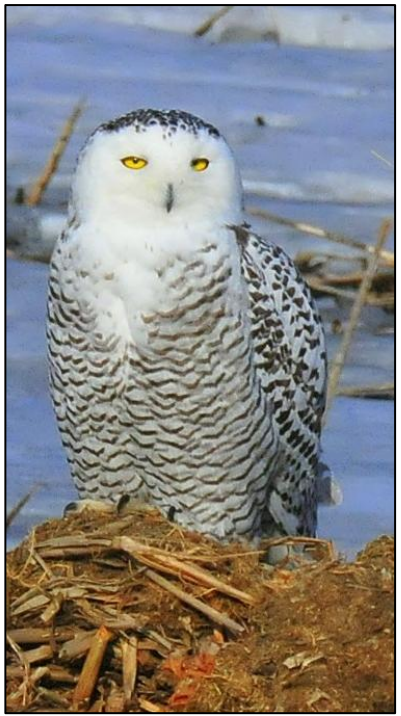
Great Grey Owl



Great-horned Owl



Barred Owl



Snowy Owl

OWLS

Photos: Cornell Lab of O - All About Birds, USFWS



Long-eared Owl



Short-eared Owl



Barn Owl

OWLS

Photos: Cornell Lab of O - All About Birds, USFWS, Pixabay



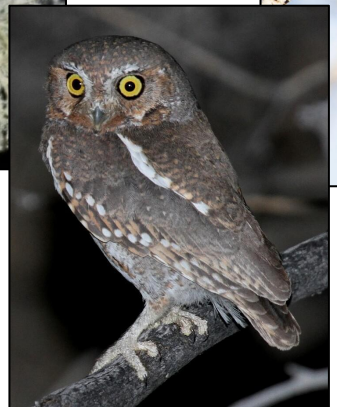
↑ Eastern Screech Owl

Burrowing Owl ↓





↑ Northern Saw-whet Owl

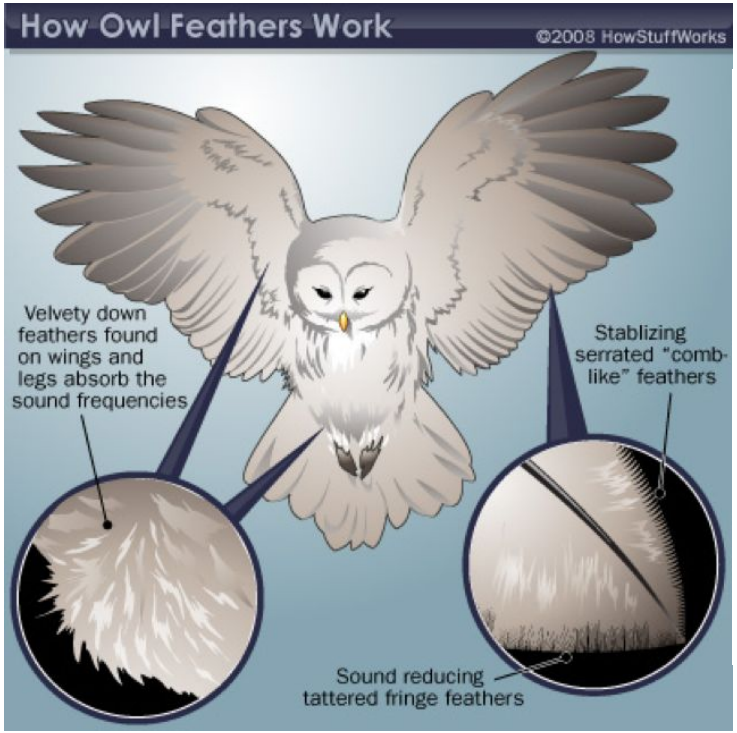


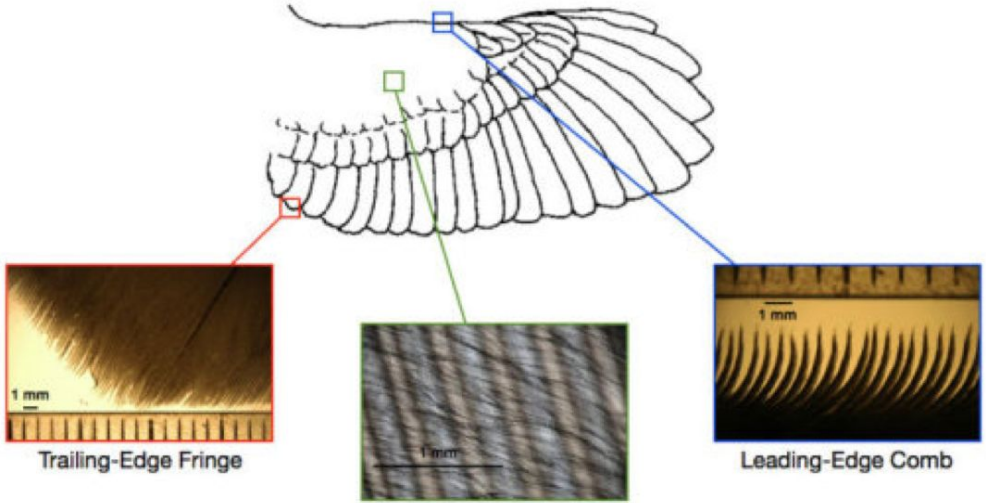
← Elf Owl



↑ Northern Hawk Owl

OWL ADAPTATIONS - SILENT FLIGHT





phys.org

OWL ADAPTATIONS - VISION

"Owls don't have eye*balls*"

- Rod-shaped eyes are fixed in their sockets and cannot move
- Extra neck vertebrae allow owls to rotate their heads to compensate
- Forward-facing eyes provide excellent binocular (depth) vision
- Bony **sclerotic rings** hold the eyes rigidly in place
- **Tapetum lucidum** reflects light back through the retina, enhancing low-light/night vision

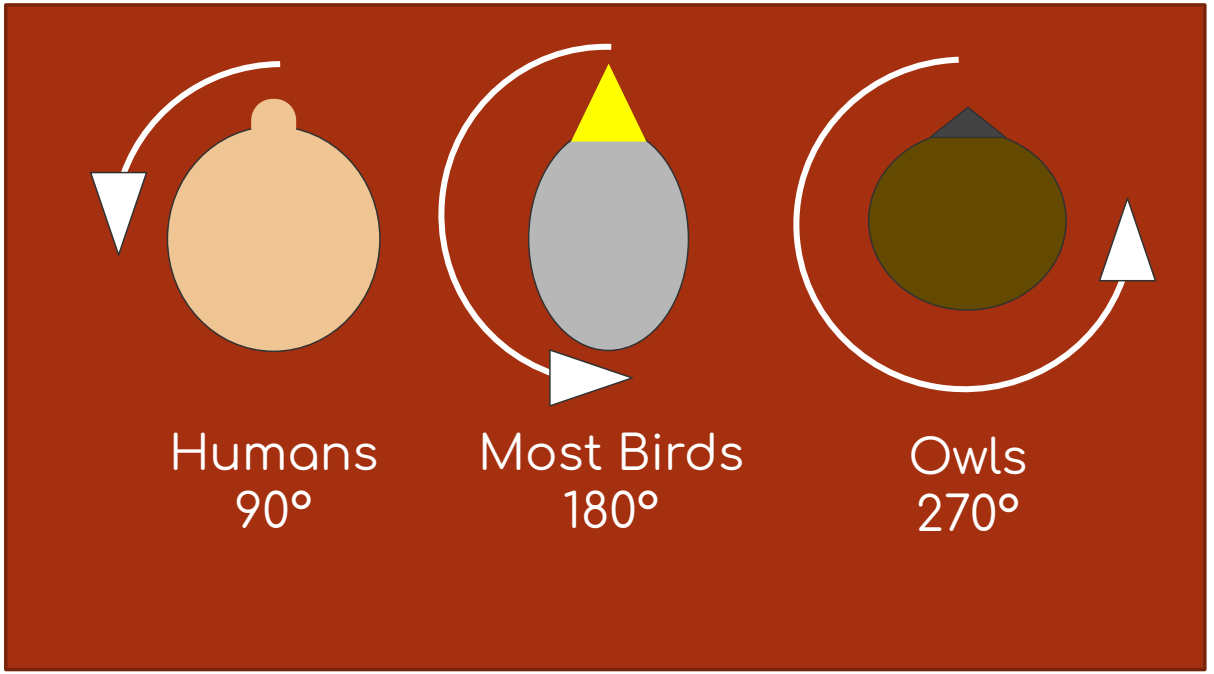




OWL ADAPTATIONS - HEAD ROTATION

How far can owls turn their heads?

- Flexible neck allows free movement of head given that their eyes are fixed within the socket
- Owls can turn their head 270°
- 14 neck vertebrae (twice that of mammals)



OWL ADAPTATIONS - ACUTE HEARING



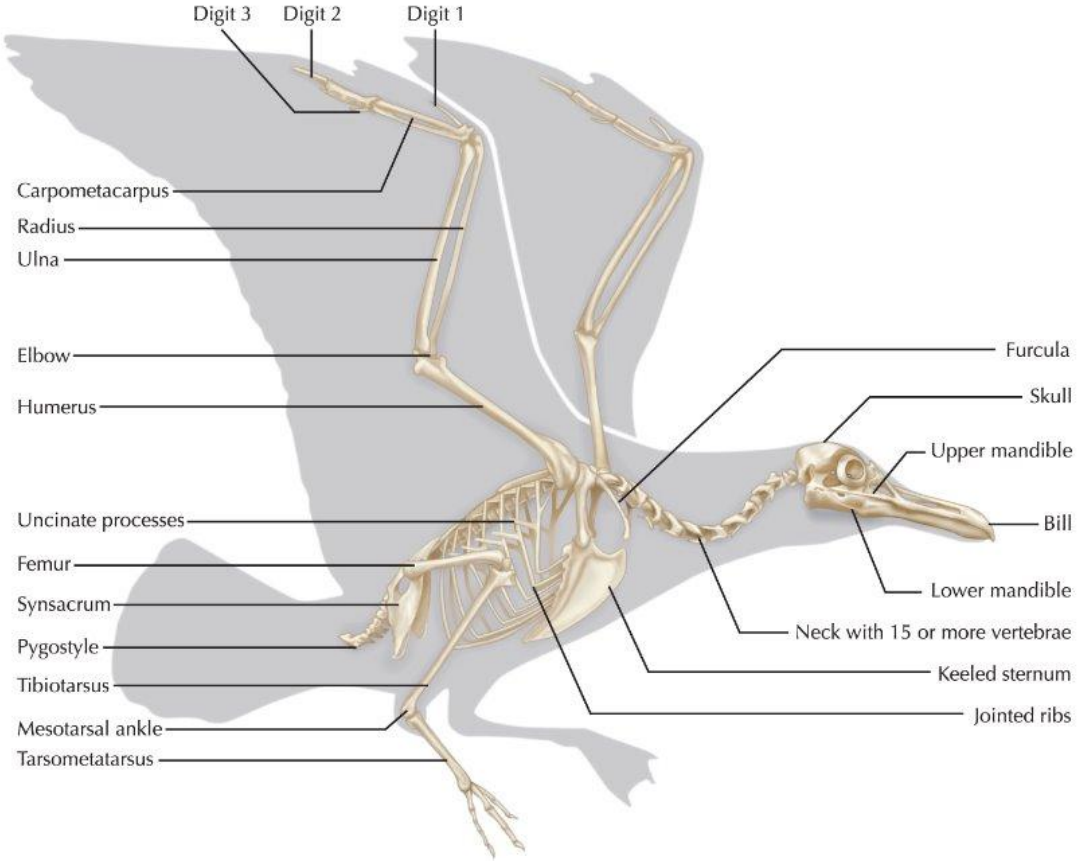


- Exceptional hearing helps owls hunt in darkness
- Can detect tiny differences in sound timing and frequency
- Some species have asymmetrical ears, larger ear drums, and/or more sensory hair cells within the ear helping pinpoint prey location
- Facial discs funnel sound toward the ears like satellite dishes
- Note: Plummicorns (ear tufts) are not ears

Internal Anatomy



AVIAN SKELETON



Gill/Prum, *Ornithology*, 4e, © 2019 W. H. Freeman and Company
DATA FROM PASQUIER 1983

Avian Bones

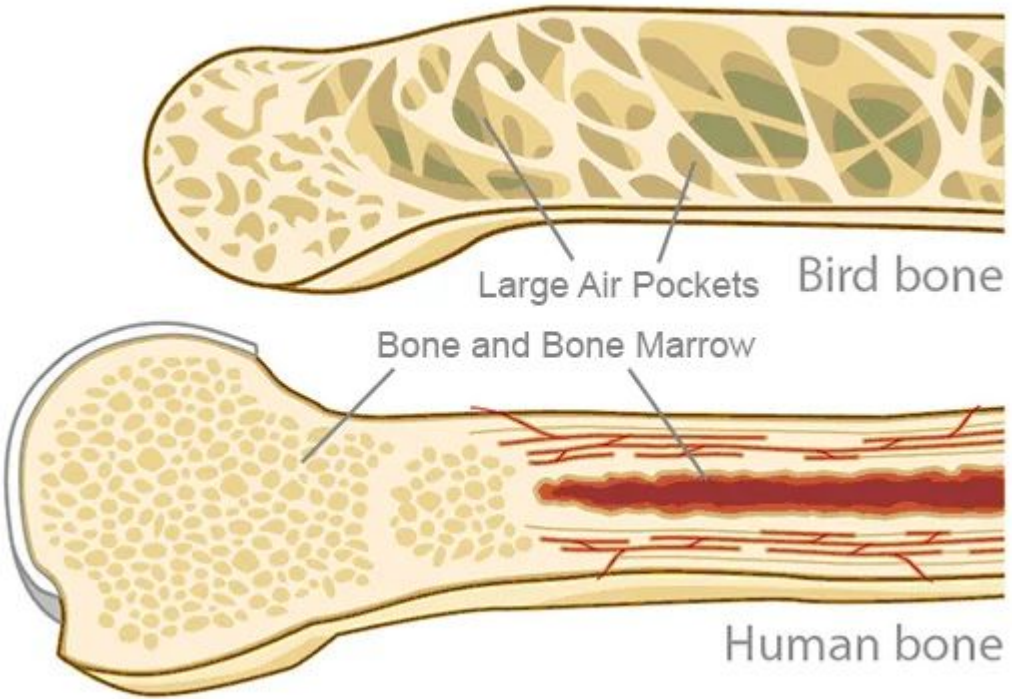
Image source: ornithology.com

Adapted for flight:

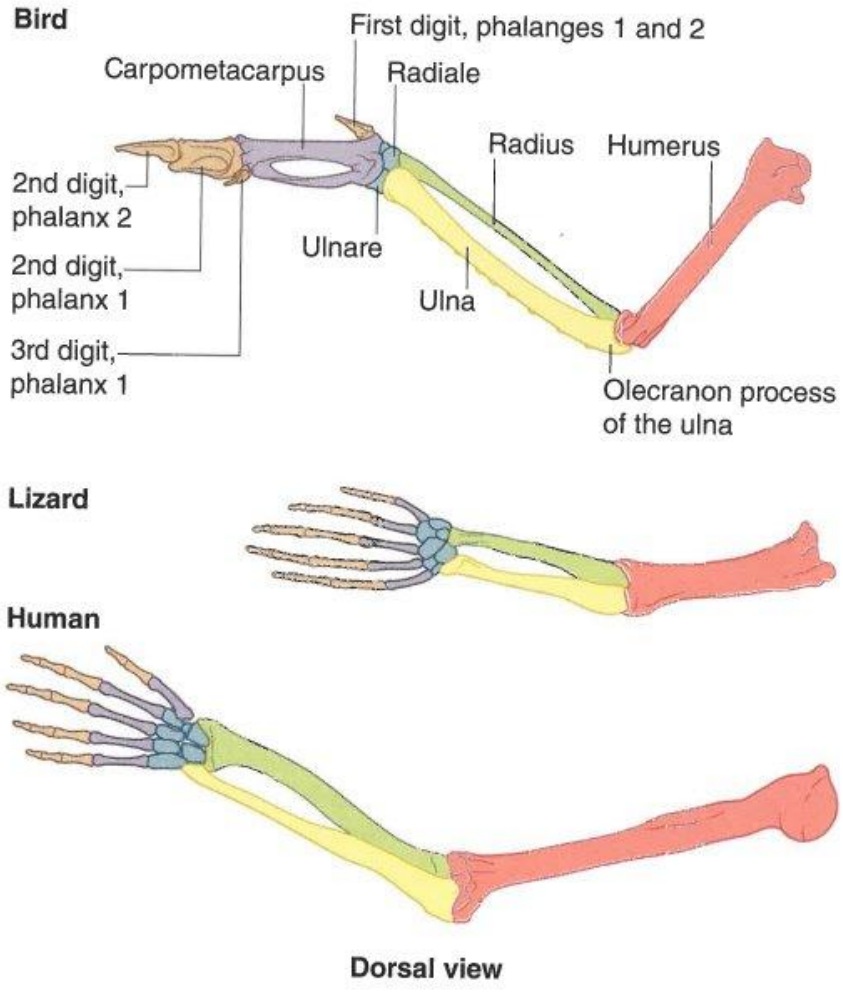
1) Pneumatic Bones
   a) ↓ Weight

2) Loss of bones
   a) ↓ Weight

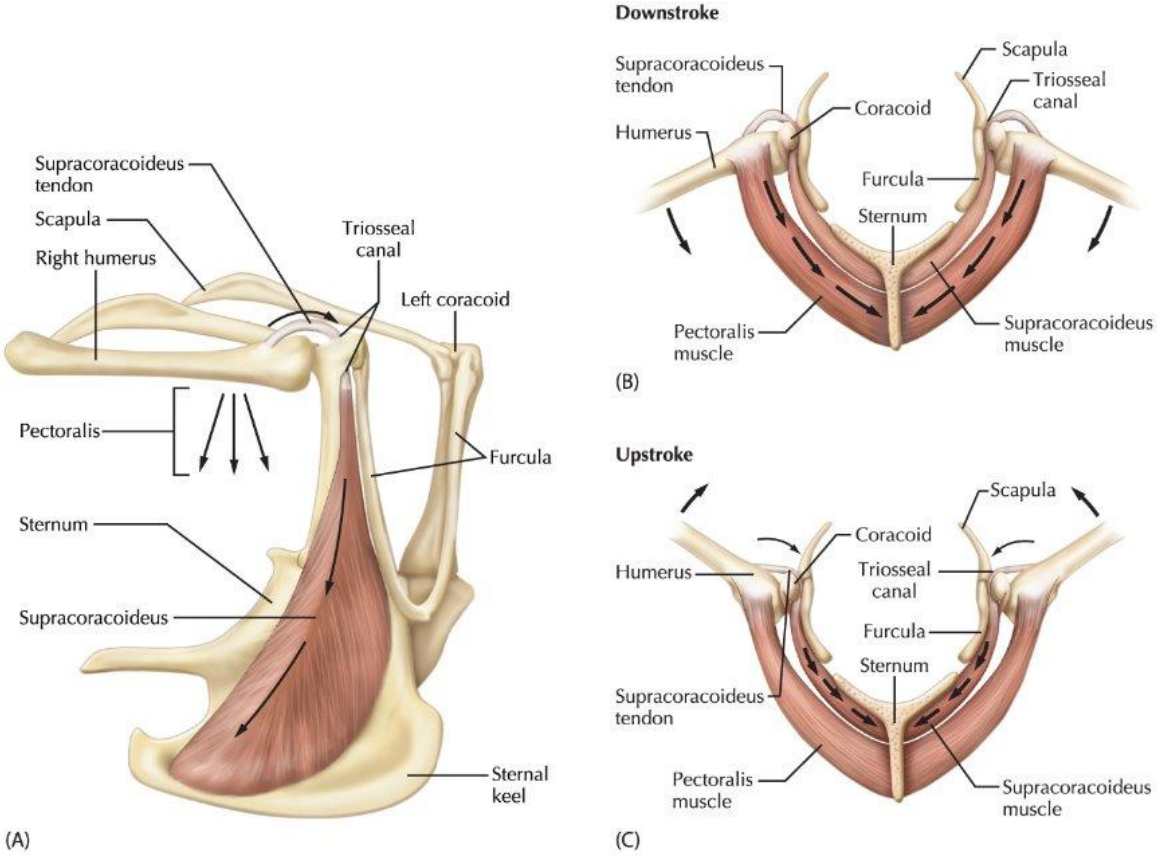
3) Fusion of bones
   a) ↓ Weight
   b) ↑ Strength



BONES OF THE WING



FLIGHT MUSCLES



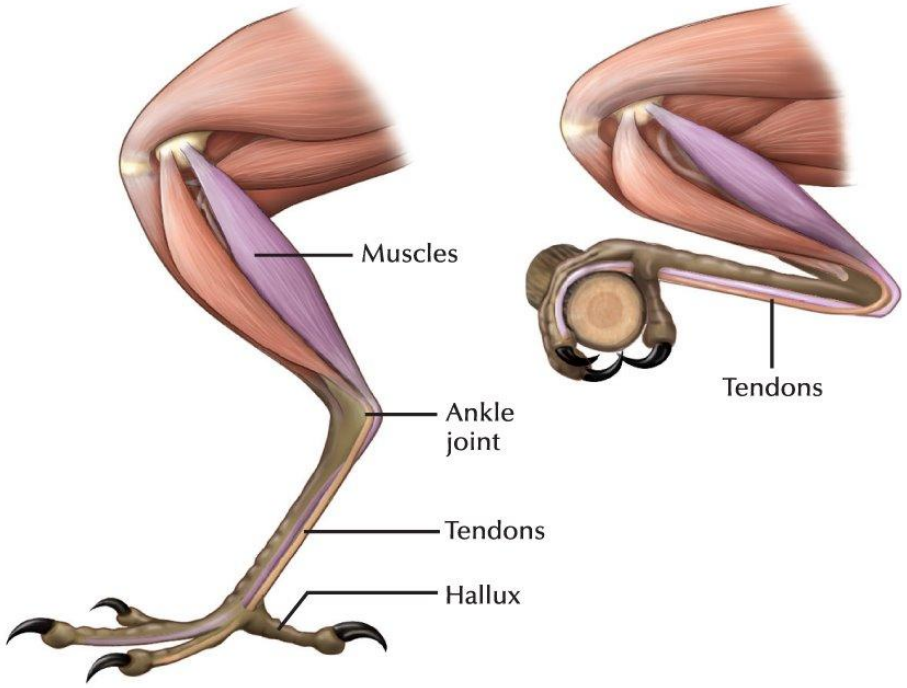
Gill/Prum, *Ornithology*, 4e, © 2019 W. H. Freeman and Company
DATA FROM GEORGE AND BERGER 1966, ABLE 2004

Flight Muscles Video

LEGS

Automatic Perching

"Ratchet mechanism" locks the tendons and digits in place

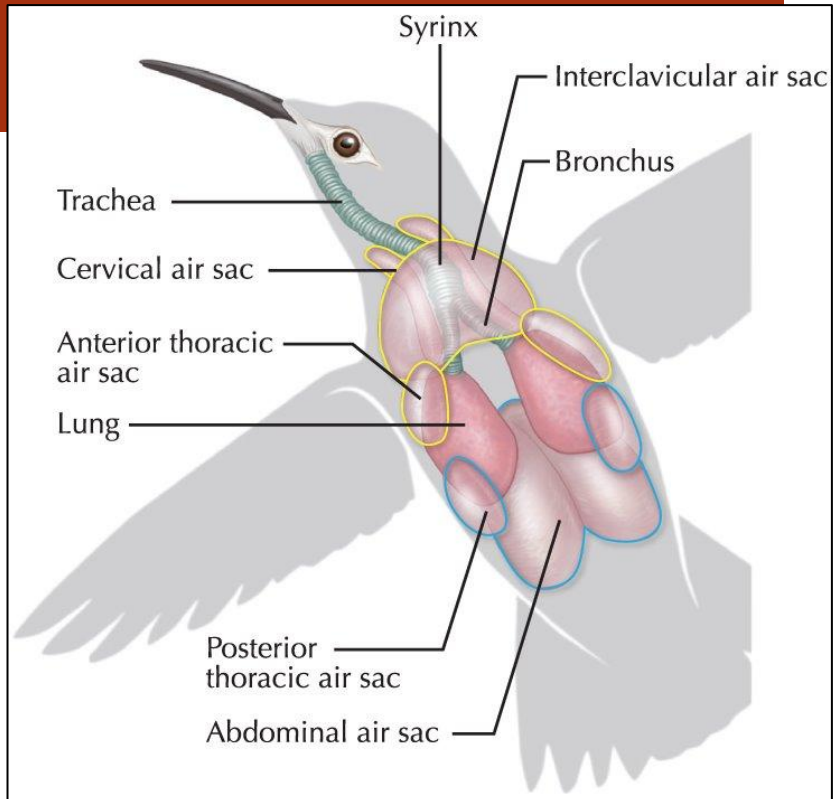


Gill/Prum, *Ornithology,* 4e, © 2019 W. H. Freeman and Company
DATA FROM WILSON 1980

RESPIRATORY SYSTEM

- Highly efficient
- Continuous breathing to maximize oxygen absorption
- Air sacs (9)
  - Help reduce weight
  - Unidirectional air flow for
  - Air sacs also help temperature regulation (birds don't sweat)
  - Important for vocalization (air sacs act as bellows for syrinx)

Avian respiration video

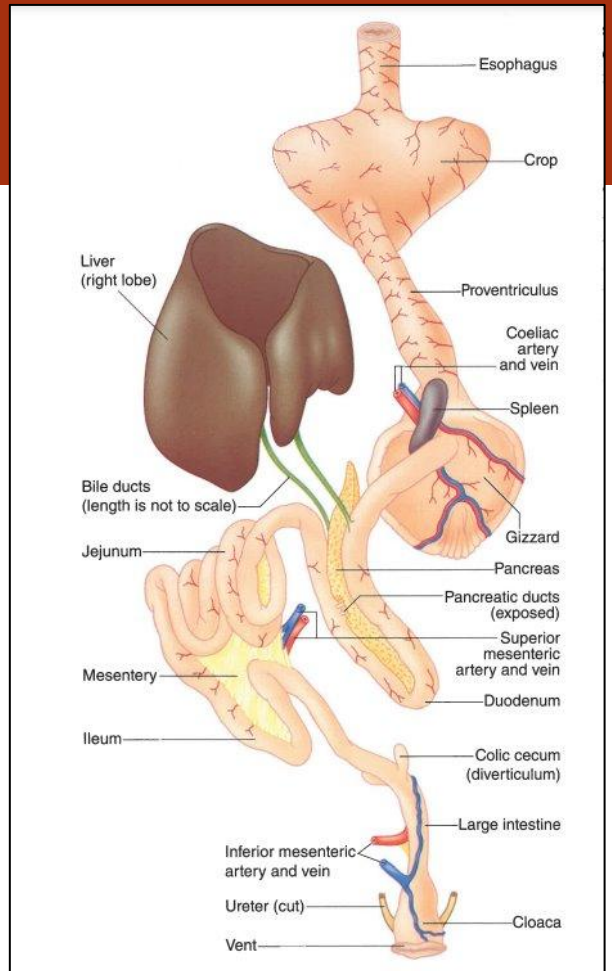


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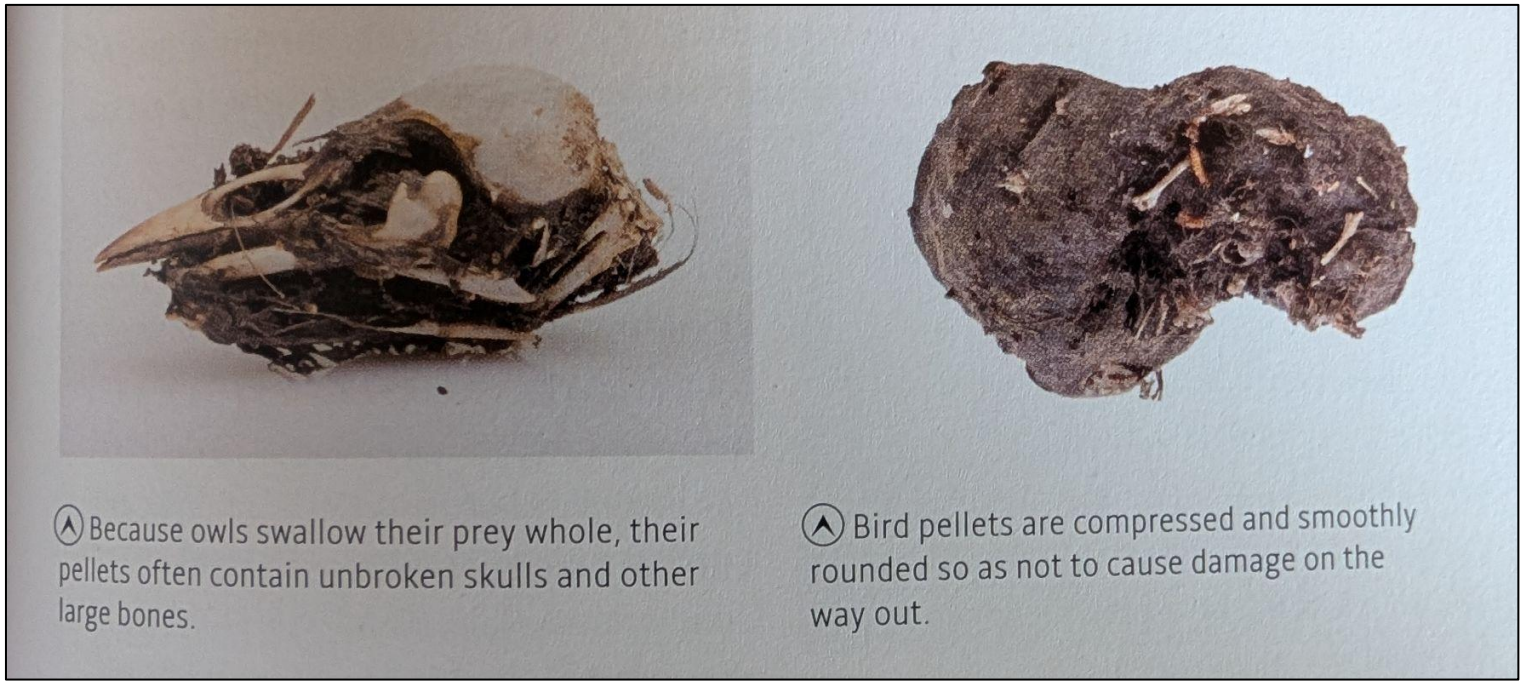
DATA FROM TYRRELL AND TYRRELL 1985

DIGESTIVE SYSTEM

- Crop for temporary food storage
  - Owls do no have a crop
- Strong stomach acids that digest bone, fur, and tissues
- Gizzard that helps process tough material
- Pellet casting — indigestible materials are regurgitated



PELLETS & CASTS



Because owls swallow their prey whole, their pellets often contain unbroken skulls and other large bones.

Bird pellets are compressed and smoothly rounded so as not to cause damage on the way out.

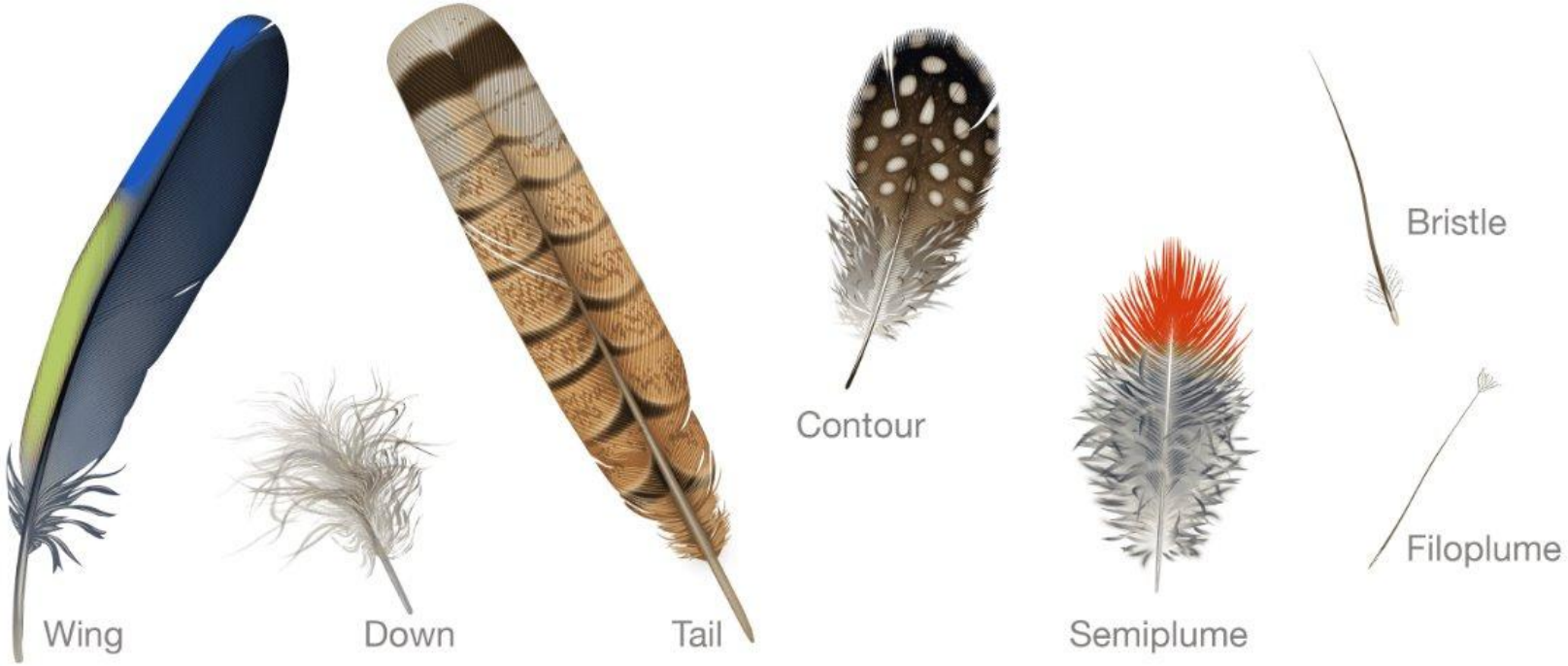
Source: How Birds Work (M. Taylor)

Owl pellets

External Anatomy

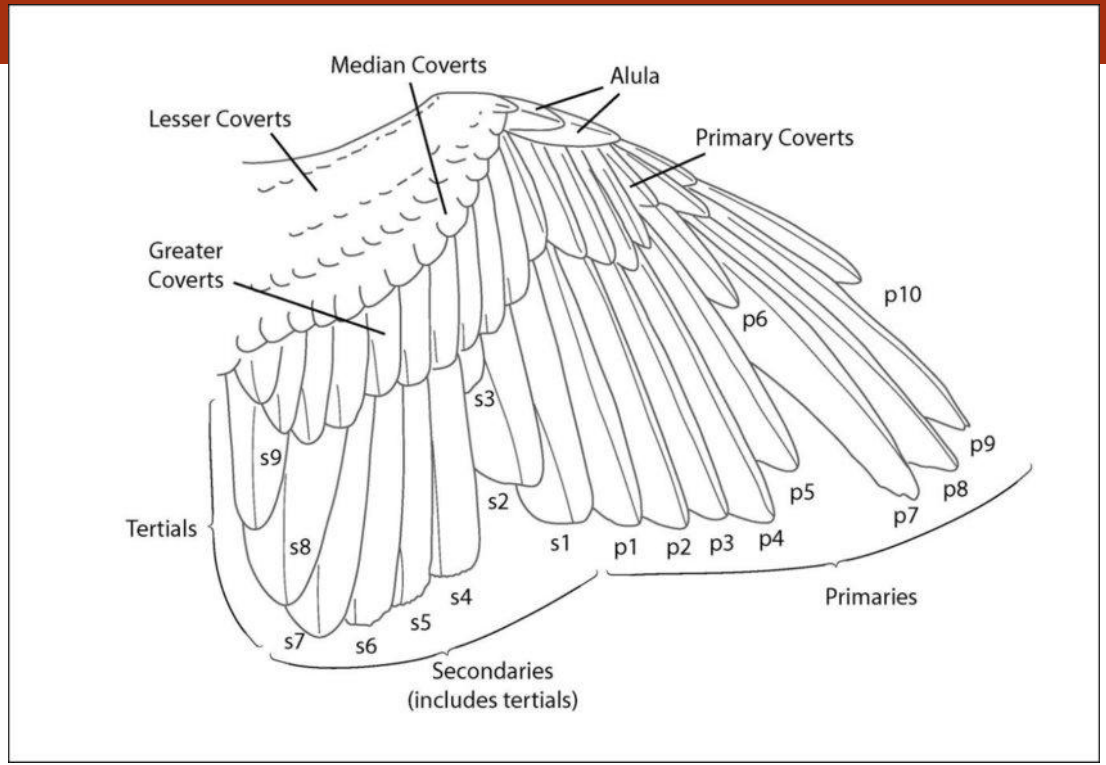


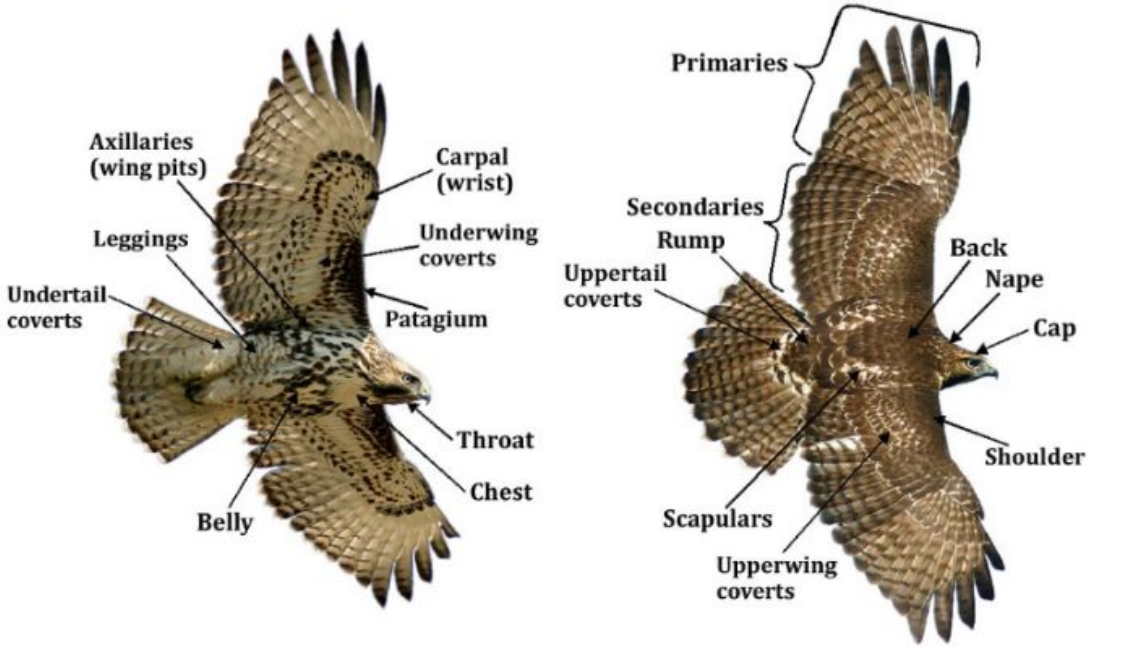
FEATHERS



FEATHERS

- Flight Feathers (remiges)
  - Primary
  - Secondary
  - Tertiary
- Alula
- Contour
  - Coverts
- Tail (retrices)





PC Jerry Liguori

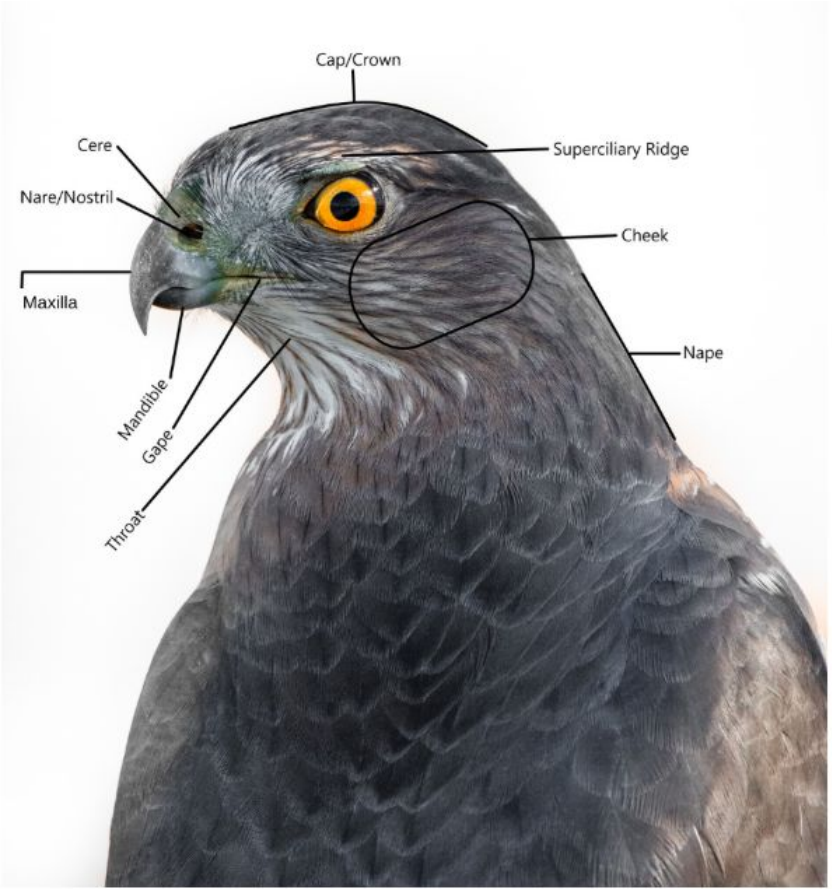
PARTS OF A RAPTOR

Hawkwatch International website has a brief vocabulary list and visuals related to feathers, body, and head

https://hawkwatch.org/raptor-vocab-101-anatomy/

PARTS OF THE HEAD

Hawkwatch International website has a brief vocabulary list and visuals related to feathers, body, and head

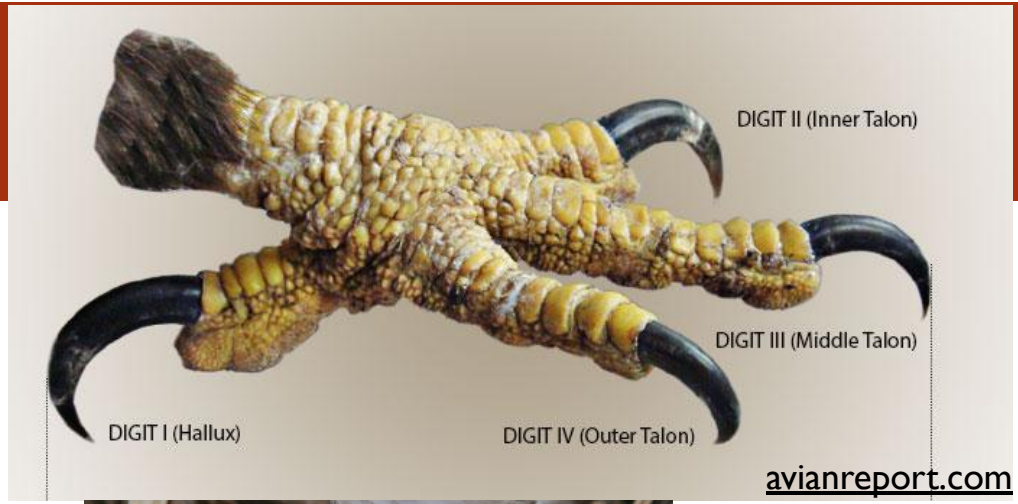


PC Kyler Noe

https://hawkwatch.org/raptor-vocab-101-anatomy/

FEET

- Four toes on each foot
- Anisodactyl toe arrangement
  - 3 in front, 1 in back (hallux)
  - Most raptors
- Zygodactyl toe arrangement
  - 4th digit can rotate back to provide better grip
  - 2 in front 2 in back
  - Owls and Osprey



avianreport.com



↑ Anisodaty

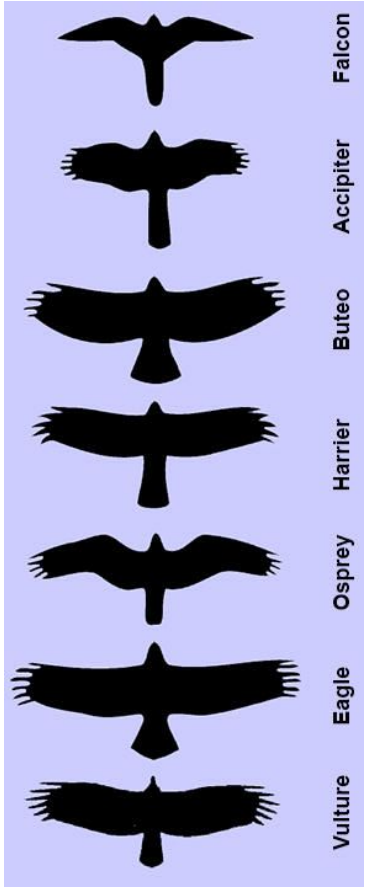
← Zygodactyl

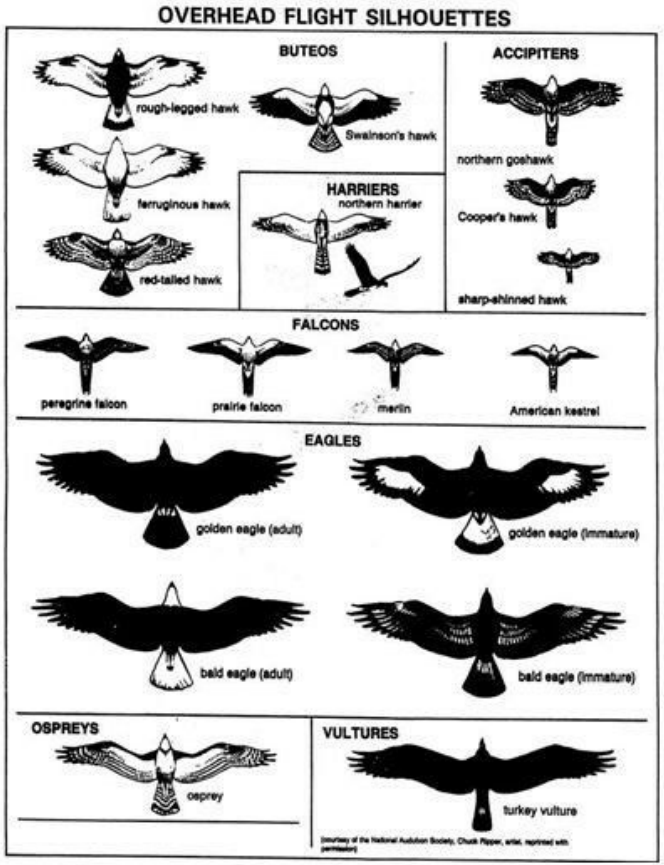
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Resources for Specimen Exploration



SILHOUETTES OF RAPTORS





WING SHAPES

(A) Long, narrow wings, such as those of an albatross, are best for high-speed gliding in high winds.

(B) The short, rounded wings of grouse permit fast takeoffs and rapid maneuvers.

(C) The slim, unslotted wings of falcons permit fast, efficient flight and good maneuverability in open habitat.

(D) Slots between the primaries of Buteo hawks decrease induced drag during thermal soaring.



Gill/Prum, *Ornithology,* 4e, © 2019 W. H. Freeman and Company

BEAKS ADAPTED FOR HUNTING AND EATING PREY

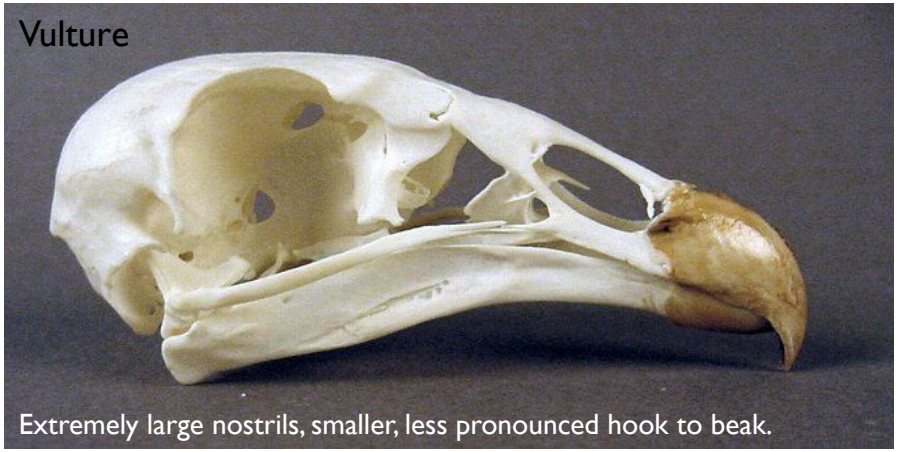
https://skullsite.com/
https://boneclones.com/











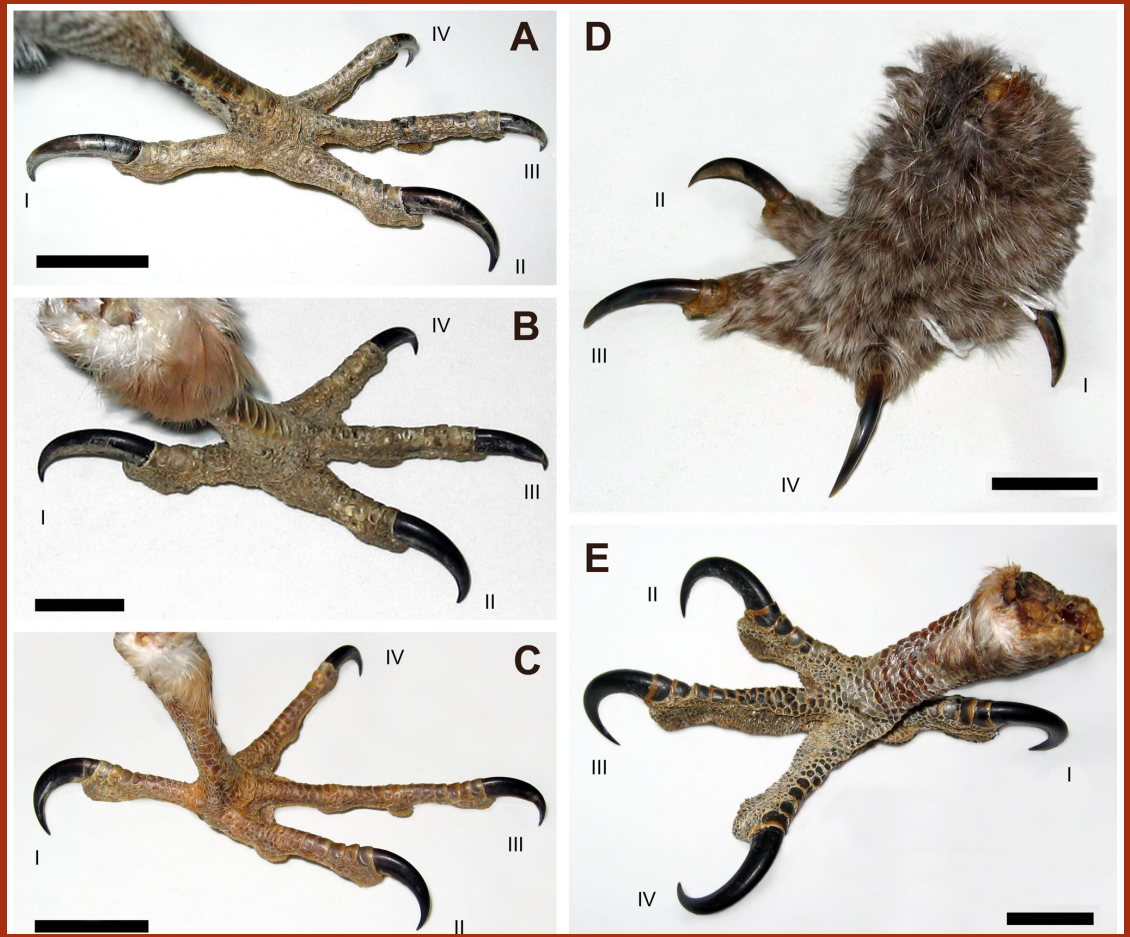
Differentiating skull characteristics:

- Beak shape and unique features (e.g. tomial tooth – falcon); color may differentiate between specific species
- Eye socket - Scleral ring bone **shape and depth**, which dictates the overall shape of the eye (owl vs other raptors)
- Length of skull/beak
- Skull shape – owls and falcons have a more rounded skull, hawks may have a broad but flatter skull, eagle and vulture skulls are particularly large/long

FOOT AND TALON VARIATION ARE RELATED TO PREY IMMOBILIZATION AND RESTRAINT

A. Accipitrine (goshawk)
B. Buteo (red-tailed hawk)
C. Falcon (peregrine)
D. Owl (great grey owl)
E. Osprey

Distinguishing characteristics
- Digit length and thickness
- Talon curvature
- Feathering



Fowler et al. PLOS, 2009
https://doi.org/10.1371/journal.pone.0007999.g001