


Ecología de la alimentación de las aves acuáticas y otras aves

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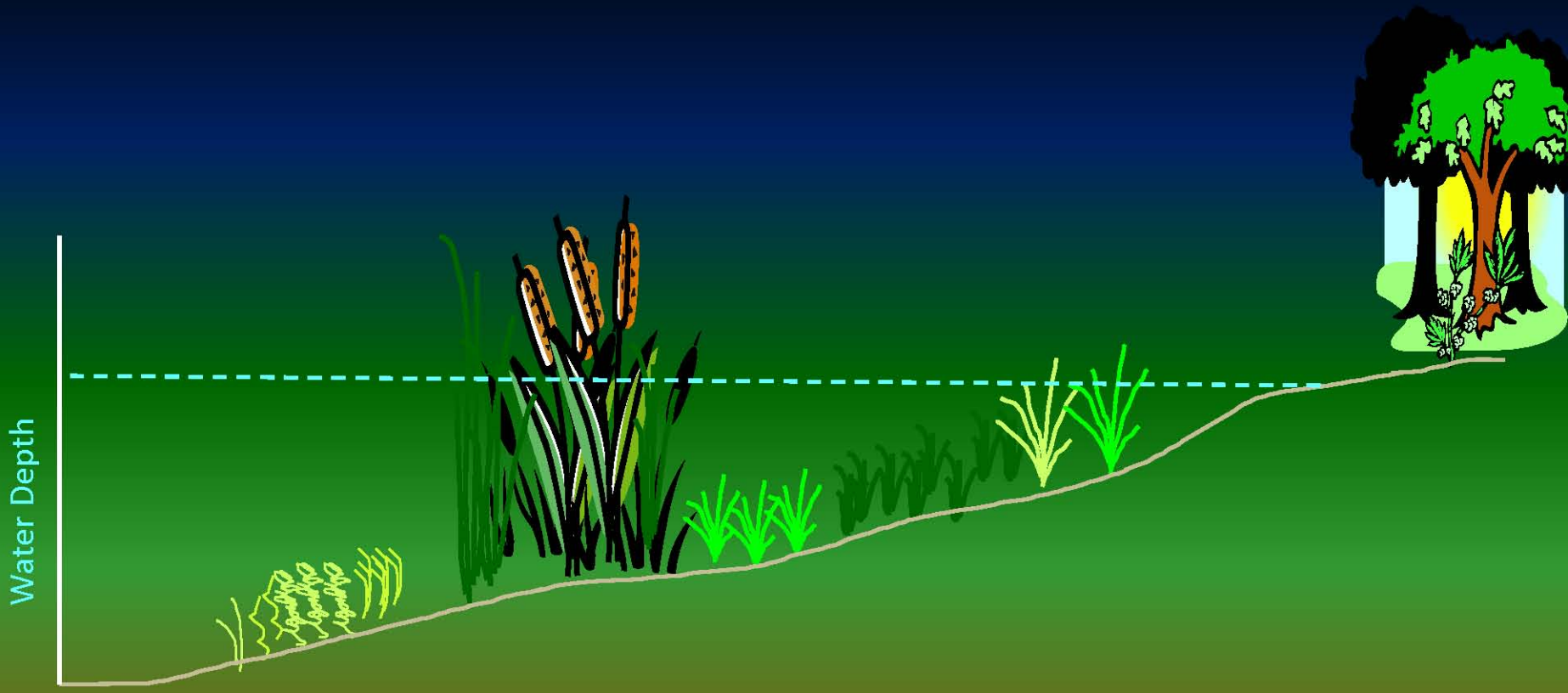
Manejo de humedales para técnicos en México
3-7 March 2014
Laguna Mexicanos




FORAGING TACTICS AND FOOD RESOURCES



FORAGING TACTICS AND FOOD RESOURCES

Terns
Flight feeders
Shallow divers

Kingfishers
Perch &
Plunge-diver

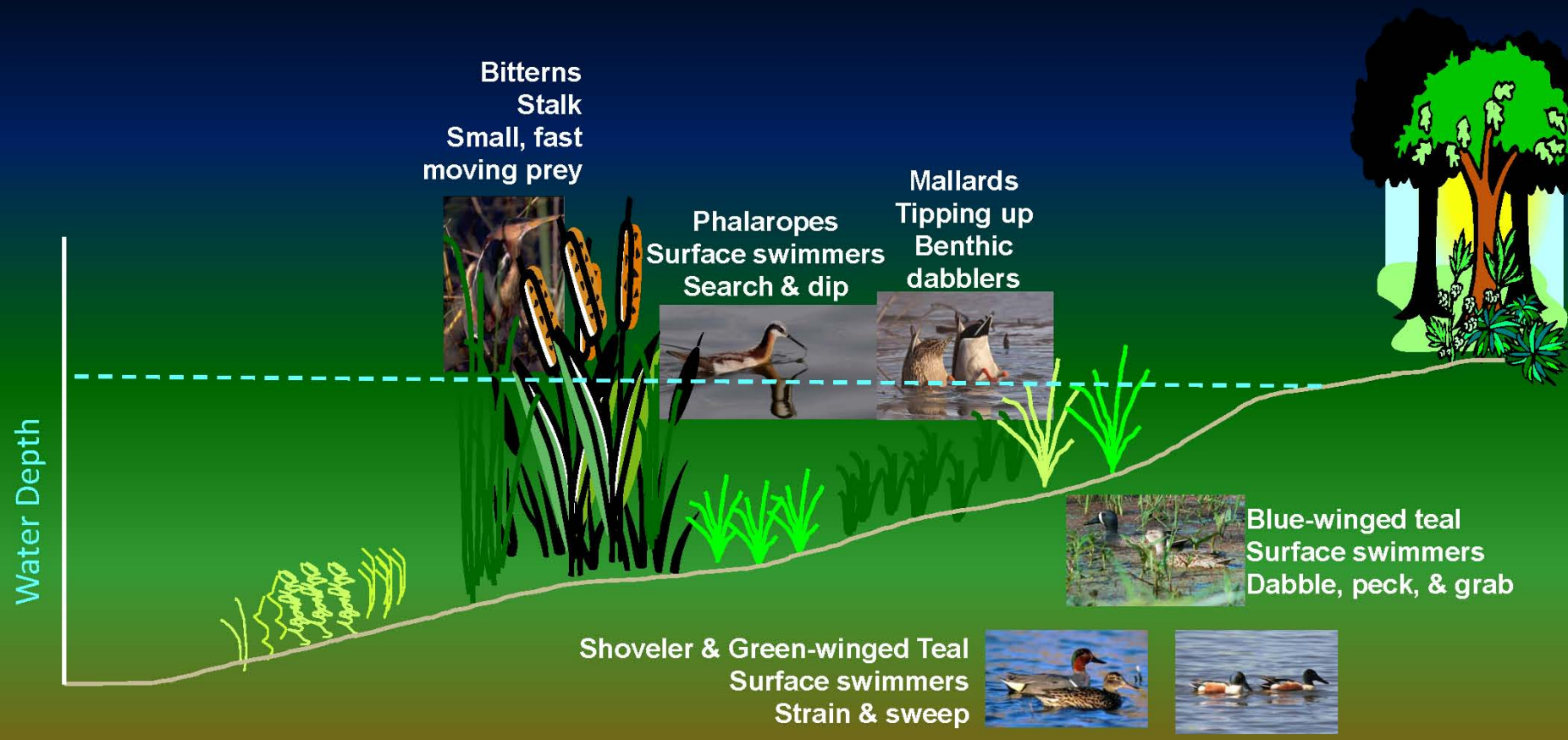
Canvasbacks
Divers for
Tubers

Grebes
Water column
divers
Visual search
& grab

Water Depth

Ruddy Ducks & Scaup
Benthic strainers

FORAGING TACTICS AND FOOD RESOURCES



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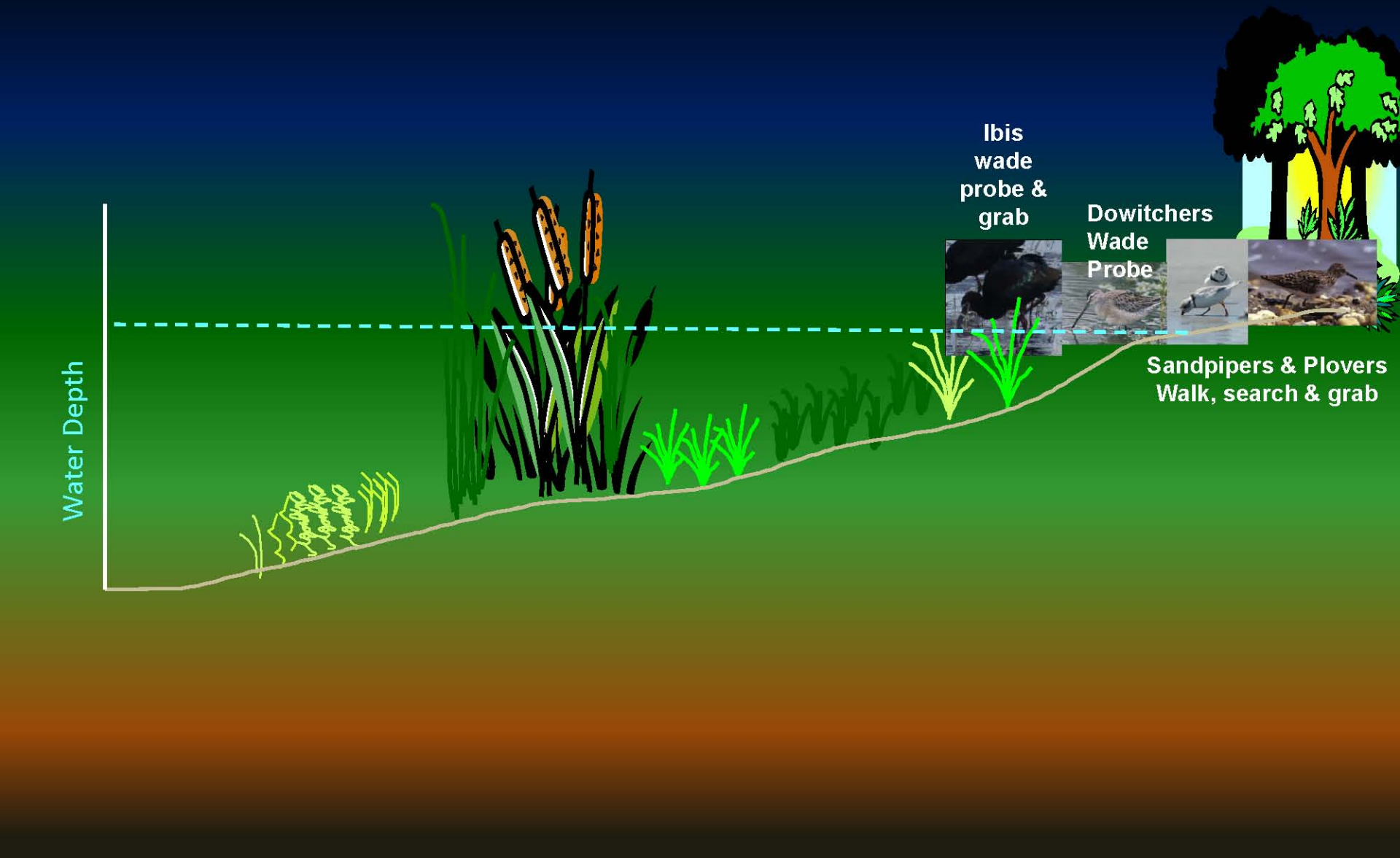


FORAGING TACTICS AND FOOD RESOURCES

Terns
Flight feeders
Shallow divers

Bitterns
Stalk
Small, fast moving prey

Kingfishers
Perch &
Plunge-diver

Canvasbacks
Divers for
Tubers

Phalaropes
Surface swimmers
Search & dip

Mallards
Tipping up
Benthic
dabblers

Ibis
wade
probe &
grab

Dowitchers
Wade
Probe

Grebes
Water column
divers
Visual search
& grab

Water Depth

Sandpipers & Plovers
Walk, search & grab

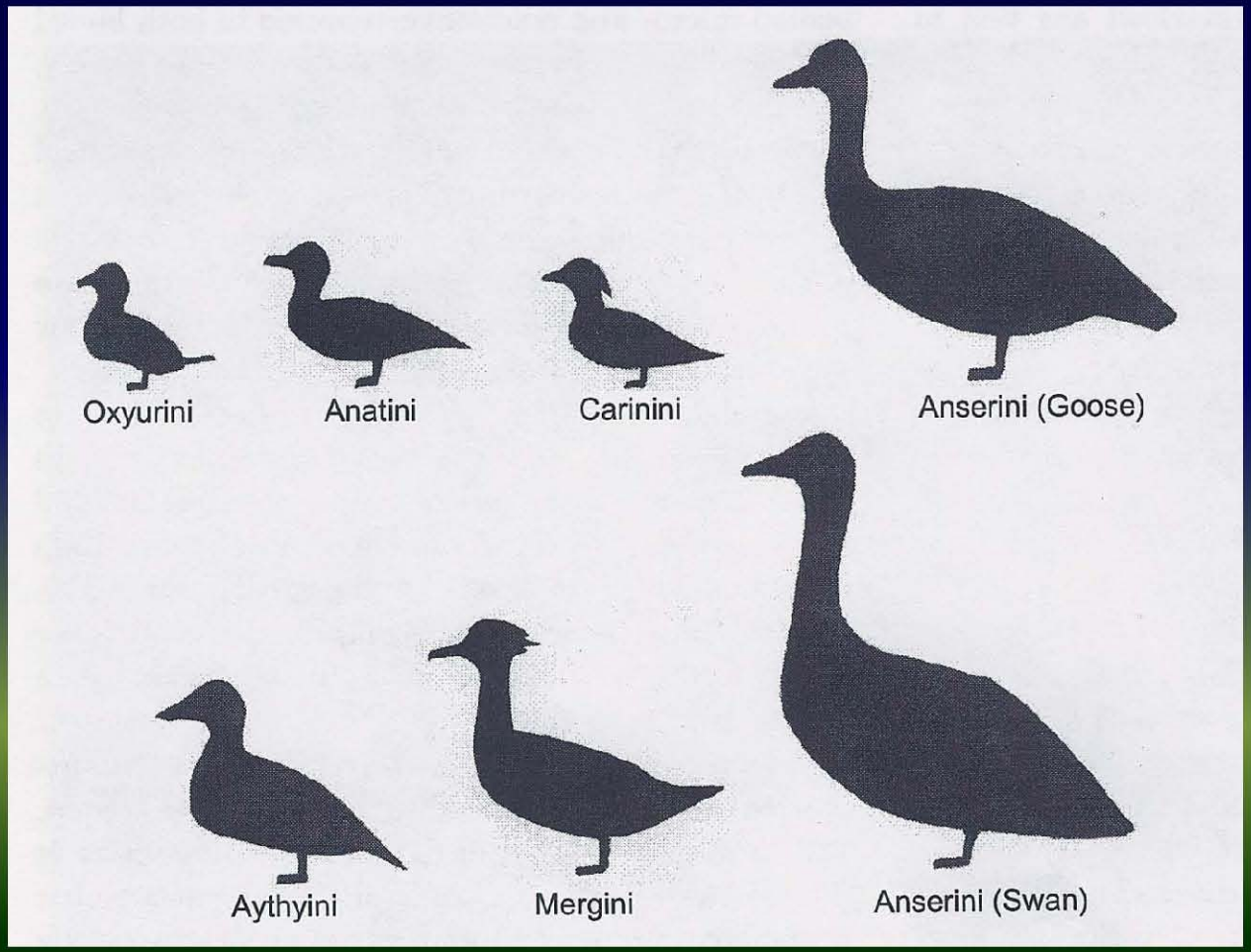
Blue-winged teal
Surface swimmers
Dabble, peck, & grab

Ruddy Ducks & Scaup
Benthic strainers

Shoveler & Green-winged Teal
Surface swimmers
Strain & sweep

MORPHOLOGICAL ADAPTATAIONS

Body Size and Leg Position



MORPHOLOGICAL ADAPTATIONS

Leg Position & Body Size

Anatini

- Central leg placement
- Light bodied
- Long, pointed wings

Shallow wetlands

Small openings in heavy emergent cover

Aythyini

- Rearward leg placement
- Compact, heavy bodied
- Shorter, broader wings

Large, deeper wetlands

Inverts and plants beyond reach of dabblers

MORPHOLOGICAL ADAPTATIONS

Bill Morphology

Mallard

Northern Shoveler

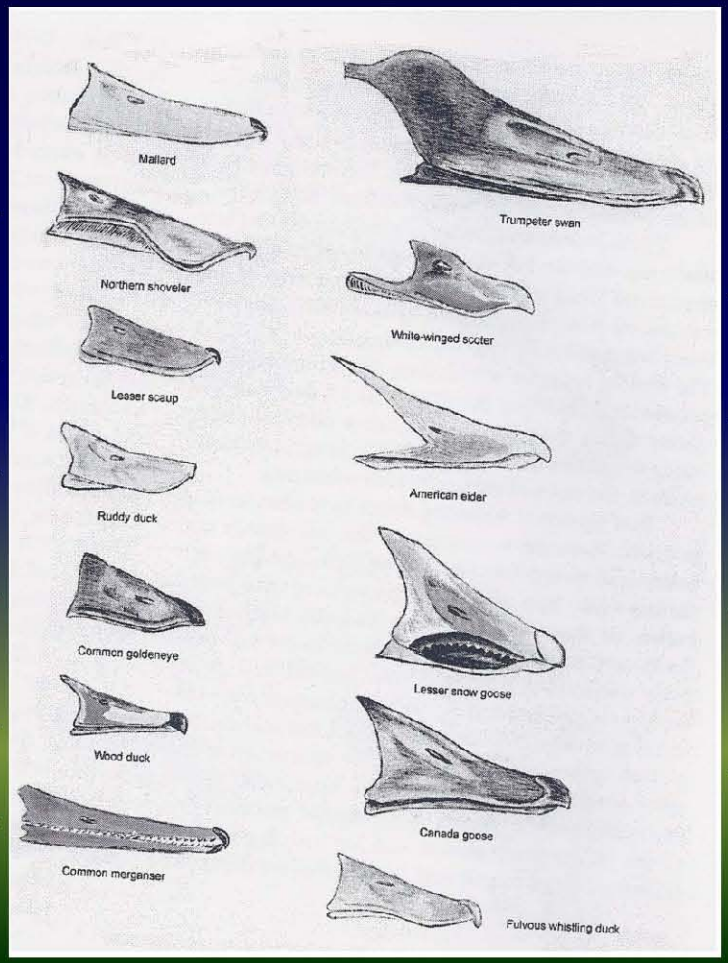
Lesser scaup

Ruddy duck

Goldeneye

Wood duck

Merganser



Trumpeter Swan

Scoter

Amer. Eider

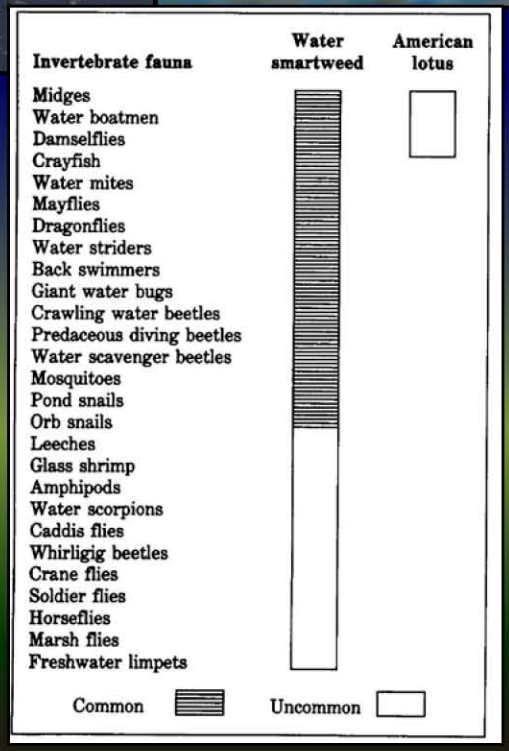
Snow Goose

Canada Goose

Whistling duck

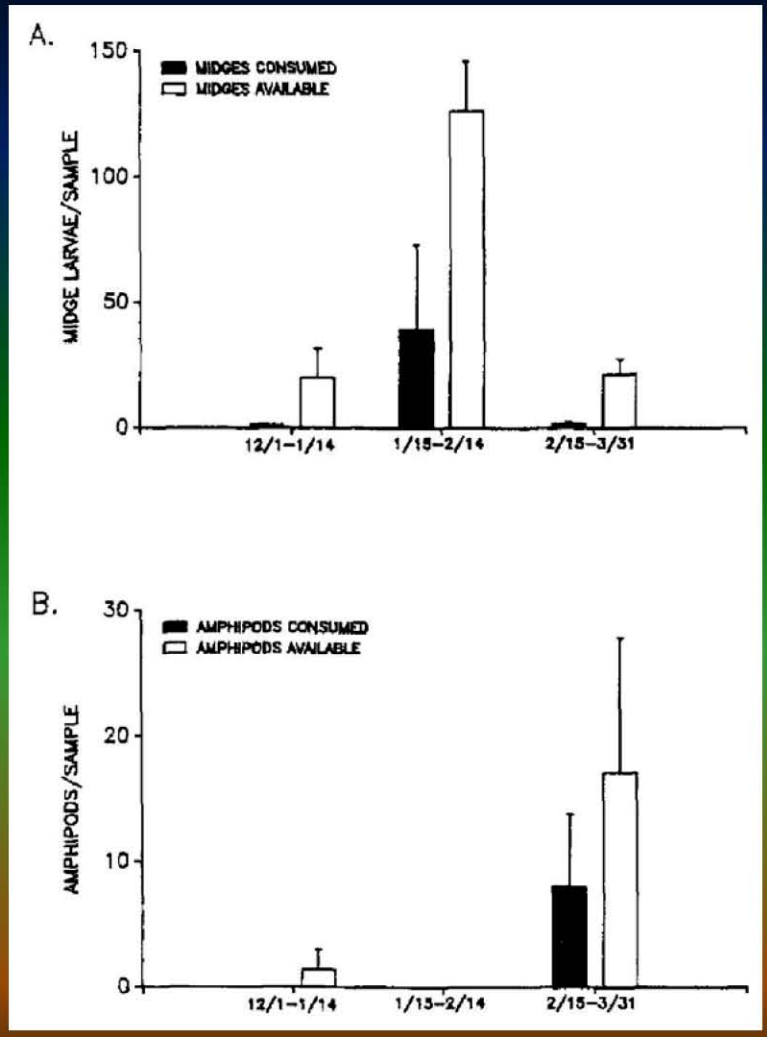
DABBLING DUCKS & SMARTWEED

- Annual smartweeds = abundant seeds
- Seeds remain viable after flooding
- Relatively high energy content
  - 31% of breeding green winged teal diet in Prairie Potholes
  - 8% of green winged teal diet in Maine (May)
  - Important to wintering NOPI
  - 13% of wintering wood duck in SC
- High diversity & abundance of invertebrates due to plant structure



DABBLER FORAGING & INVERTEBRATES

- Sympatric green-winged teal and mallards
  - Teal – surface and water column inverts, smaller bugs than mallards
  - Mallards – benthic inverts
- Temporal shifts
  - Availability and consumption



DIVING DUCKS

Bill Morphology

Hooded merganser

- Narrow bill
- Strongly serrated

Catching fish

Larger crustaceans

Eiders

- Stout bills
- Powerful

Crush relatively large mollusks

Common Goldeneye

- Stout, powerful bills
- Smaller than eiders

Smaller mollusks and crustaceans

DIVING DUCKS

Bill Morphology

Ruddy Ducks

- Wide, flat bill
- Fine lamellae

Filter sediments for

Chironomids

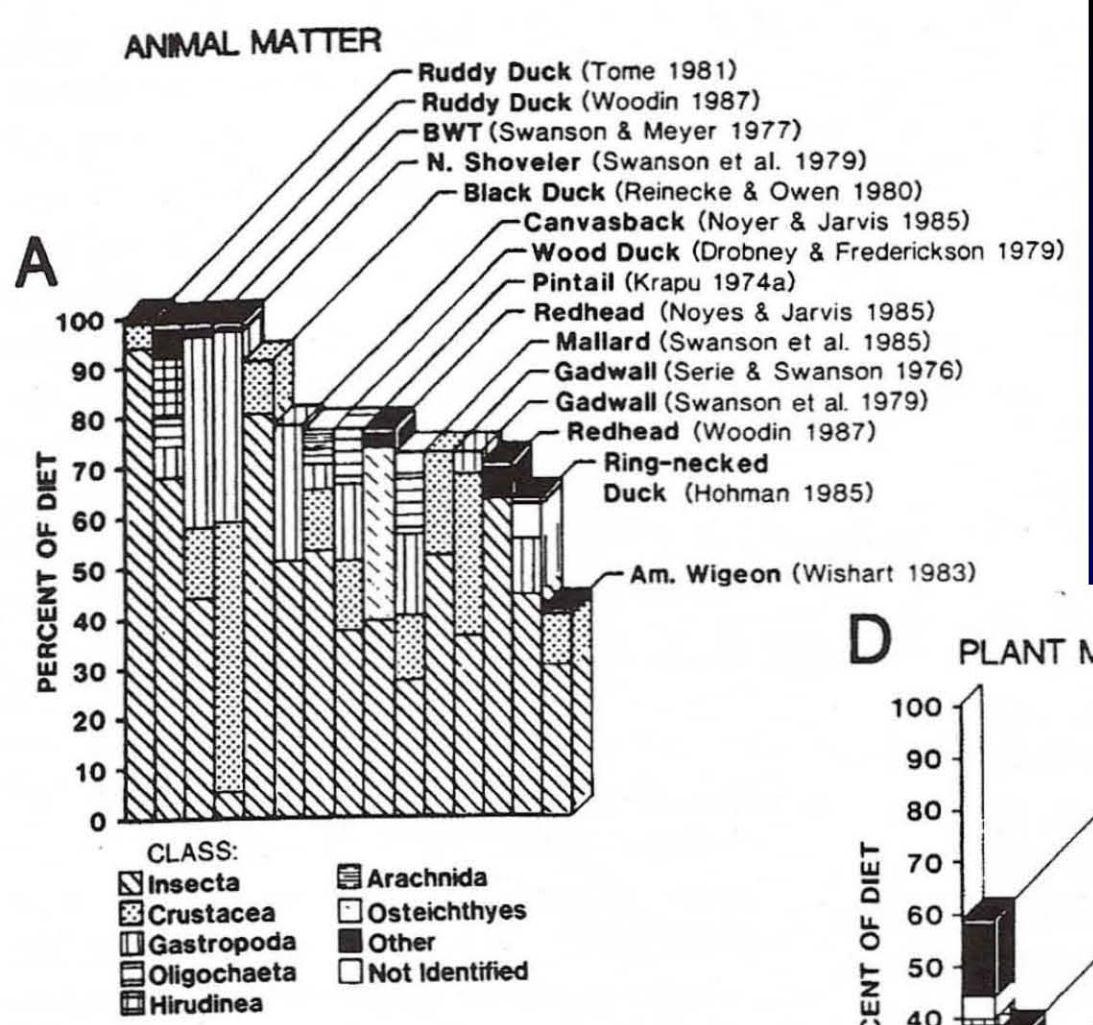
Canvasback

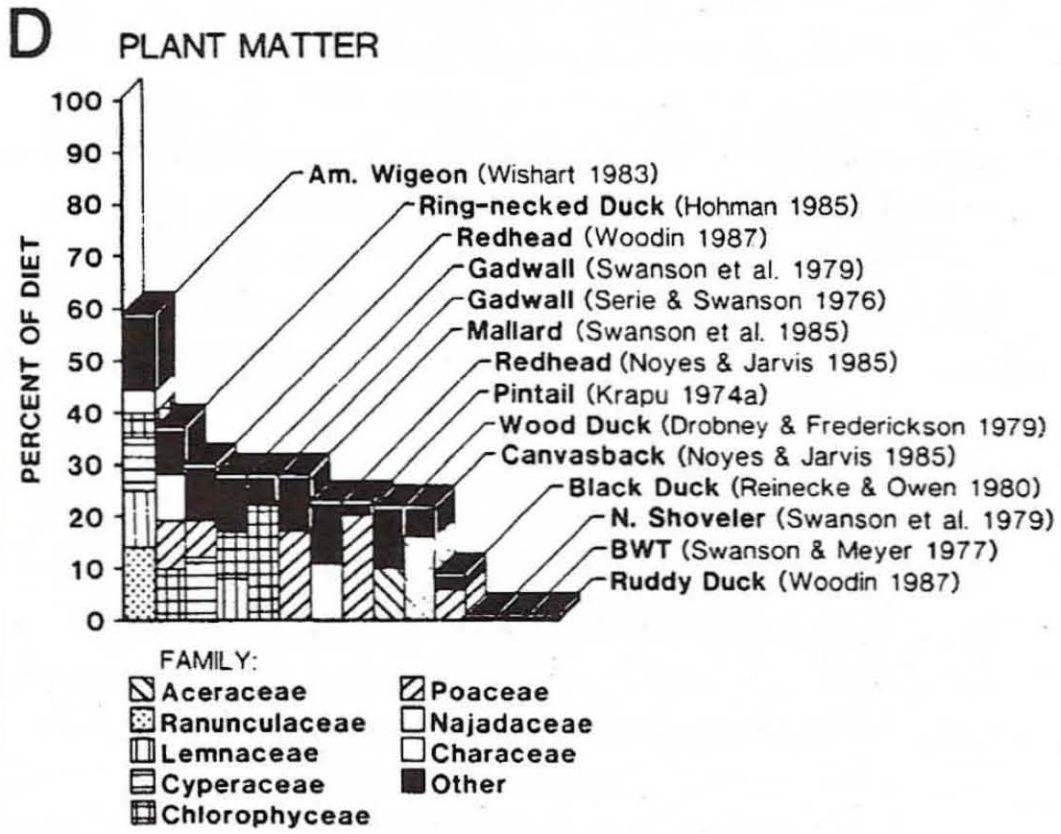
- Long, sloping bill
- Length=turion depth
- Coarse lamellae

Wild celery

Amphipods

EGG-LAYING HEN FOODS





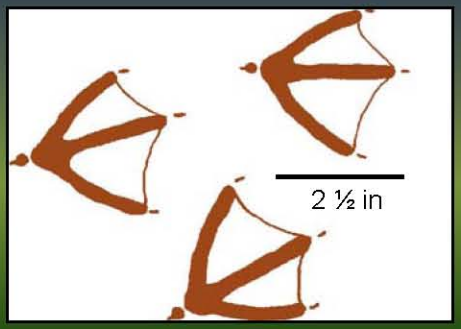
SUBMERGED AQUATIC VEGETATION AND FORAGING ECOLOGY

WILD CELERY

- Submerged perennial herb
- Long ribbon-like leaves from basal rosette
- Water up to 20 ft
- Gravel to clay substrates, but seems to grow best in silty sand or other coarse soils
- Spreads by rhizomes w/ turions (winter buds)
- Tolerant of some turbidity, but turions VERY sensitive to sedimentation
  - Buried 15 cm deep = nearly 100% emergence
  - Buried 20 cm deep = 25% emergence
  - Buried > 25 cm deep = NO EMERGENCE

FEEDING ECOLOGY & WILD CELERY

- Canvasback
  - Long sloping bill to forage in bottom sediments
  - Depth of turions = length of canvasback bill
  - Coarse lamellae
  - Large webbed feet located toward rear of body → AGILE UNDERWATER SWIMMERS
  - Can dive up to 30 ft (the entire depth range of wild celery)



IMPORTANCE OF WILD CELERY

- Dominant diet of canvasbacks during winter and migration
  - Tubers have high carbohydrate content
  - Decline in CANV population linked to decline in SAV in Chesapeake Bay & Mississippi R.
  - Migration routes and wintering areas have changed over the past 40 years in response to SAV decline
  - Winter buds = 43% of fall migrating CANV diet at Lake Onalaska in upper Mississippi R.
  - Winter buds and root stalks = 55% of migrating CANV diet in upstate NY
- Other diving ducks
  - Made up 20% of plant material in ruddy duck diet at Lake Onalaska during fall migration

SAGO PONDWEED

- Submerged aquatic perennial herb
- Pioneering species that is more prolific after dry period
- Early spring growth
- Grows in up to 5 ft water; rarely deeper
- Tolerates wide range of environmental conditions
- Roots proportionately small suggesting it obtains more nutrients from the water column than substrate
- Spreads mainly by rhizomes and turions; drupelets (seeds) important for dispersal
  - Turion production > drupelet production
- Drupelet germination may be enhanced after passing through digestive systems of waterfowl

FEEDING ECOLOGY & SAGO PONDWEED

- Trumpeter swans
  - Long necks to reach turions
  - Heavy powerful bills to grub for turions
  - Adults will "paddle" and pull up vegetation cygnets

- All waterfowl
  - Early growth of sago = ↑ availability during breeding season
  - High abundance of aquatic invertebrates
  - Senescence in fall → readily available floating mats of vegetation
  - Rhizome fragments accumulate along water edge as a result of waterfowl foraging

IMPORTANCE OF SAGO PONDWEED

- Turions VERY important for trumpeter swans
  - High in carbohydrates
  - High digestive efficiency
  - 15% crude protein
  - Pre-breeding, breeding, winter
  - 24% of diet of wintering TRUS

IMPORTANCE OF SAGO PONDWEED

(and other narrow-leaved pondweeds)

- Dabbing ducks
  - 11% of summer wood duck diet in SC
  - 46% of breeding GWTE diet in Prairie Potholes
  - 15% of post-breeding, molting male NOPI in Saskatchewan
  - 27% of migrating NOPI diet in Utah
  - 37% of GADW duckling diet in Alberta (slender pondweed)
  - 46% of plant material in AMWI ducklings (20 days)
- Diving ducks
  - 74–98% of breeding CANV diet in Manitoba
  - 91% of plant food (92% of total diet) in prelaying ♀ CANV diet at Ruby Lake, NV
  - One of 2 most abundant plants in breeding REDH
  - Primary plant in migrating RUDU diet in upper Miss. R.

IMPORTANCE OF SAGO PONDWEED

(and other narrow-leaved pondweeds)

- Important invert habitat → protein source for broods
  - Diptera, tricoptera, odonata, chironomidae, & crustaceae
- Fish
  - Substrate for invertebrates (major food source for fish)
  - Escape cover
- Muskrats
  - Forage
  - Material for houses

MUSKGRASS (*Chara* sp., *Nitella* sp.)

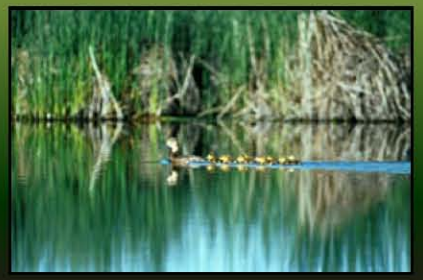
- Macroscopic alga
- Cylindrical, whorled branches
- Up to 18% crude protein; 48% NFE
- Usually found in mineral-rich waters
- Water depths 4 cm - 20 m
- Fresh to brackish water
- Skunk-like or garlic order when crushed
- Stabilizes bottom sediment
- Filters nutrients
- **NEEDS LOW TURBIDITY AND HIGH LIGHT INTENSITY**

DESPITE IMPORTANCE, VERY LITTLE KNOWN ABOUT MUSKGRASSES IN THE U.S.

IMPORTANCE OF MUSKGRASS

- Dabbling ducks
  - 96% BWTE diet during late winter in Yucatan Peninsula
  - >99% of wintering NOPI diet in Yucatan
  - 25% of late winter NOSH diet in Mexico
  - 6% of breeding GADW diet in ND
  - 5% of GWTE diet

- Redheads
  - Great Basin wetlands
    - 63% of male diet
    - 59% of pre-laying ♀ diet
    - 99% of brood-rearing ♀ diet
    - 53% plant material in Class I ducklings (muskgrass and bulrush)
    - 98% plant material in Class II ducklings (muskgrass and horned pondweed)
  - SW Manitoba
    - 57% plant material in juvenile diet, of which 18% was muskgrass



FORAGING ECOLOGY OF DUCKLINGS

- Well fed adult population → large and healthy brood
- Providing sufficient forage base for ducklings equally important for healthy population

- Foraging methods:
  - Downy ducklings chase down food along shoreline
  - Dabble…then tip-up as early as 1 week
  - Catch water surface invertebrates emerging or dying
  - Filtering crustaceans, dead or dying insects
  - Nighttime foraging common
  - Some diver ducklings dive as early as 2 days old

FORAGING BY AGE CLASS DABBLER DUCKLINGS

Pintail	
Class	% of Diet as Invertebrates
Ia	98
Ib	96
Ic	91
IIa	82
IIb	39
IIc	91
III	50

Mallard	
Class	% of Diet as Invertebrates
Ia	97
Ib	90
Ic	75
IIa	50
IIb	29
IIc	10
III	<1

American Wigeon	
Class	% of Diet as Invertebrates
Ia	99
Ib	97
Ic	89
IIa	5
IIb	2
IIc	1
III	5

Gadwall	
Class	% of Diet as Invertebrates
Ia	94
Ib	58
Ic	71
IIa	21
IIb	2
IIc	5
III	<1

FORAGING BY AGE CLASS
DIVER DUCKLINGS

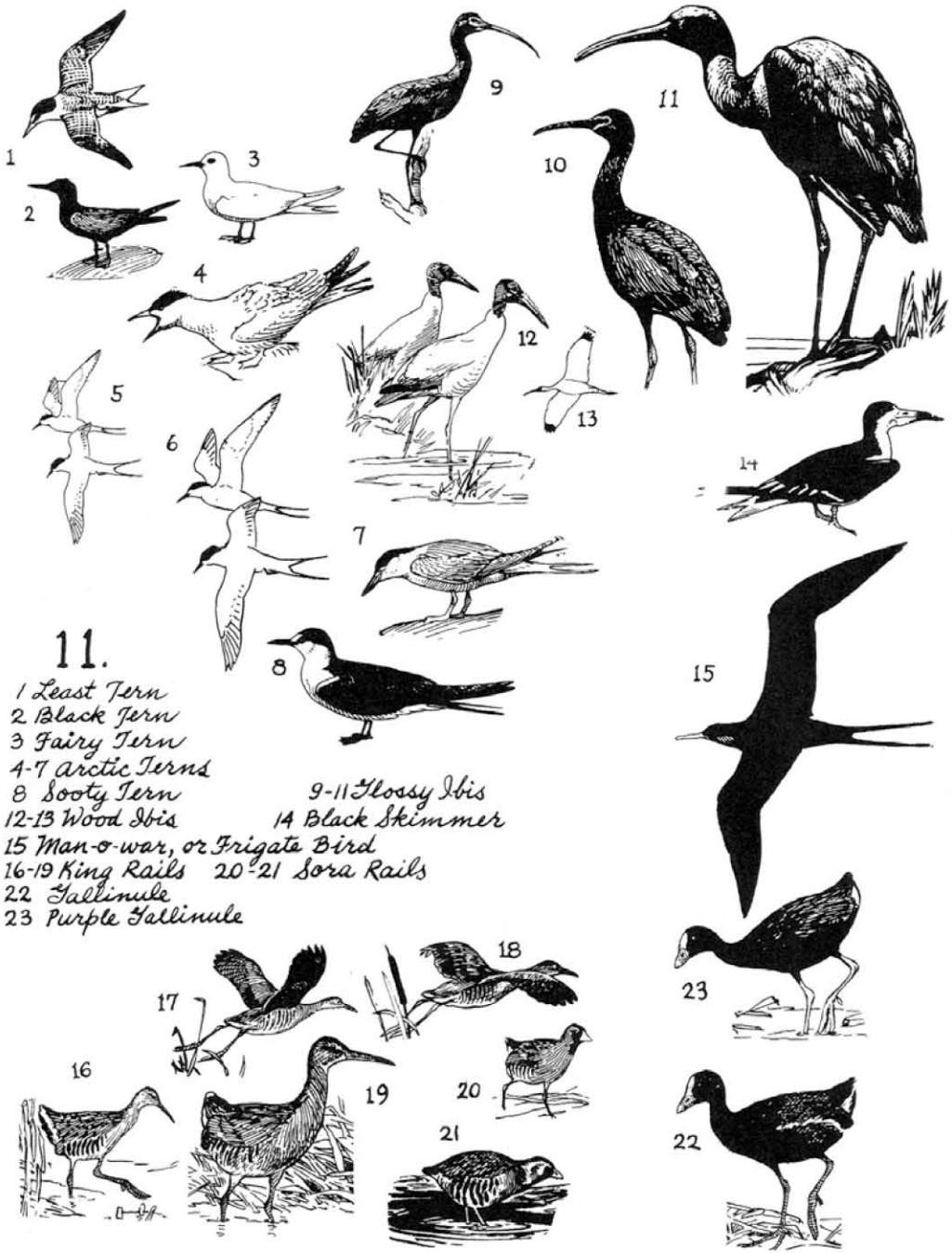
Redhead	
Class	% Inverts
I	47
II	2

19% of total diet = water boatman
13% of total diet = midges

Lesser Scaup	
Class	% Inverts
Ia	99
Ib	99
Ic	98
IIa	99
IIb	92
IIc	98
III	95

Canvasback	
Class	% Inverts
I	85
II	90

92% of inverts are
Snails, caddiflies, & damselflies



MORPHOLOGICAL ADAPTATIONS OF WATERBIRDS

Bill Length & Shape
Leg Length
Body Size

Rails

Line drawing by Bob Hines

RAILS

- Interspersion of vegetation and open water
- Water depths
  - King rails: mud flats – 25 cm
  - Virginia rails: mud flats – 15 cm
    - Probe mud and shallow water
  - Soras: Variable
    - Run across vegetation over deeper water

- Omnivorous
  - King rails: specialize on crustaceans and insects
  - Soras: higher proportion of seeds and vegetation compared to other rails
    - Rake vegetation with feet to search for food

MORPHOLOGICAL ADAPTATIONS OF SHOREBIRDS

Bill Length & Shape

Leg Length

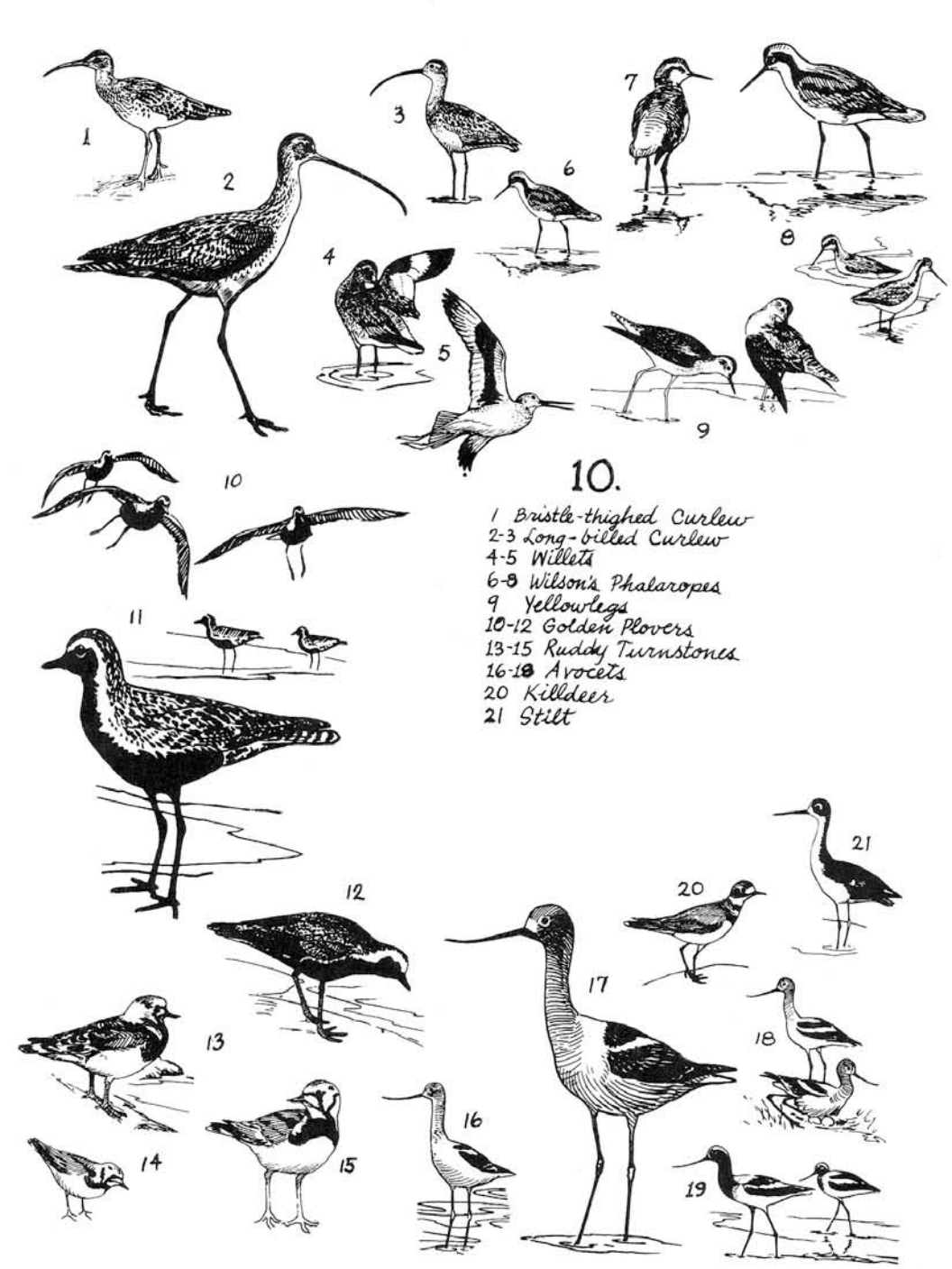
Body Size

Sandpipers

Plovers

Avocets

Ibis

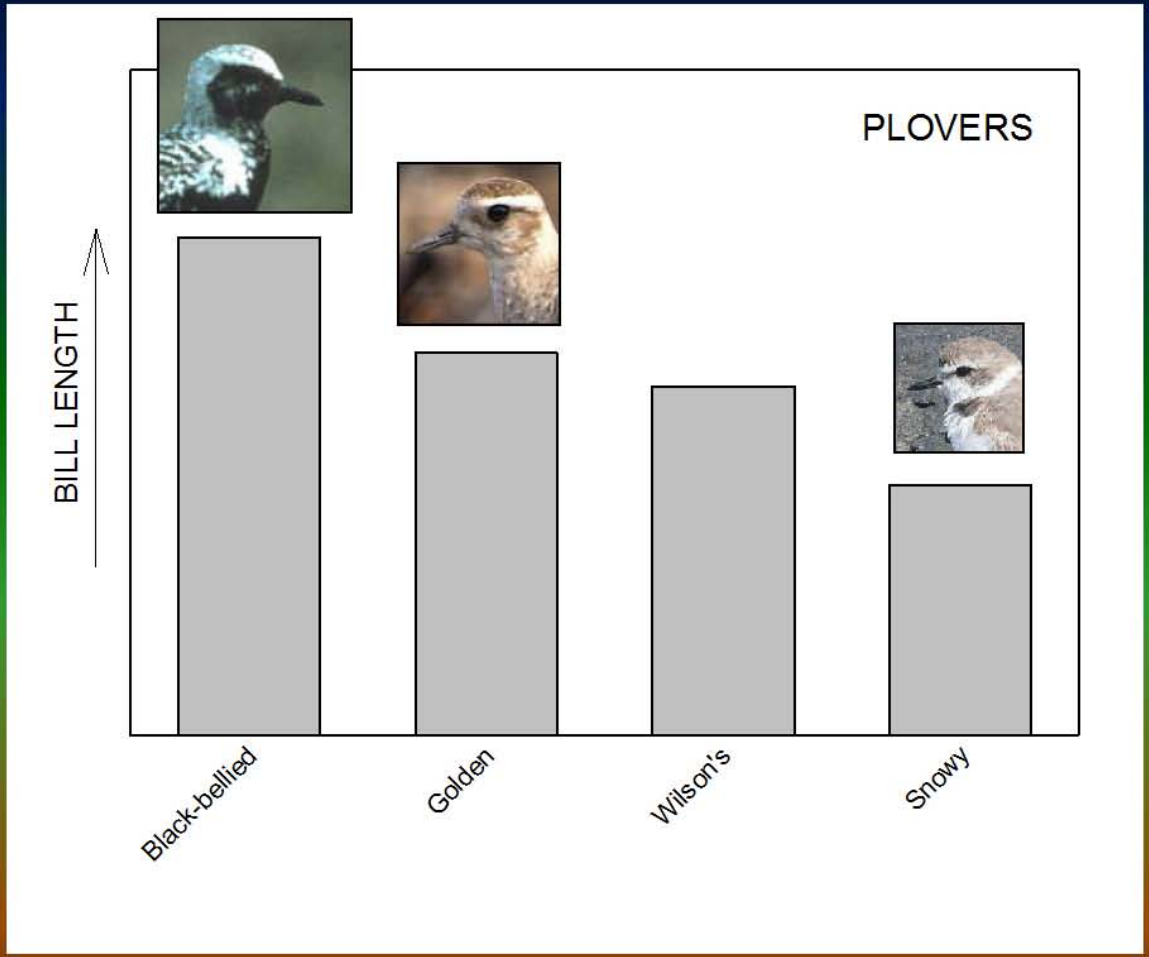


Line drawing by Bob Hines.

PLOVERS

- More terrestrial than sandpipers
  - Drier portions of mud flats
  - Grasslands
  - Burned fields, tilled farmlands, pasture
- Foraging
  - Run, stop abruptly, grab prey

BILL LENGTH OF PLOVERS

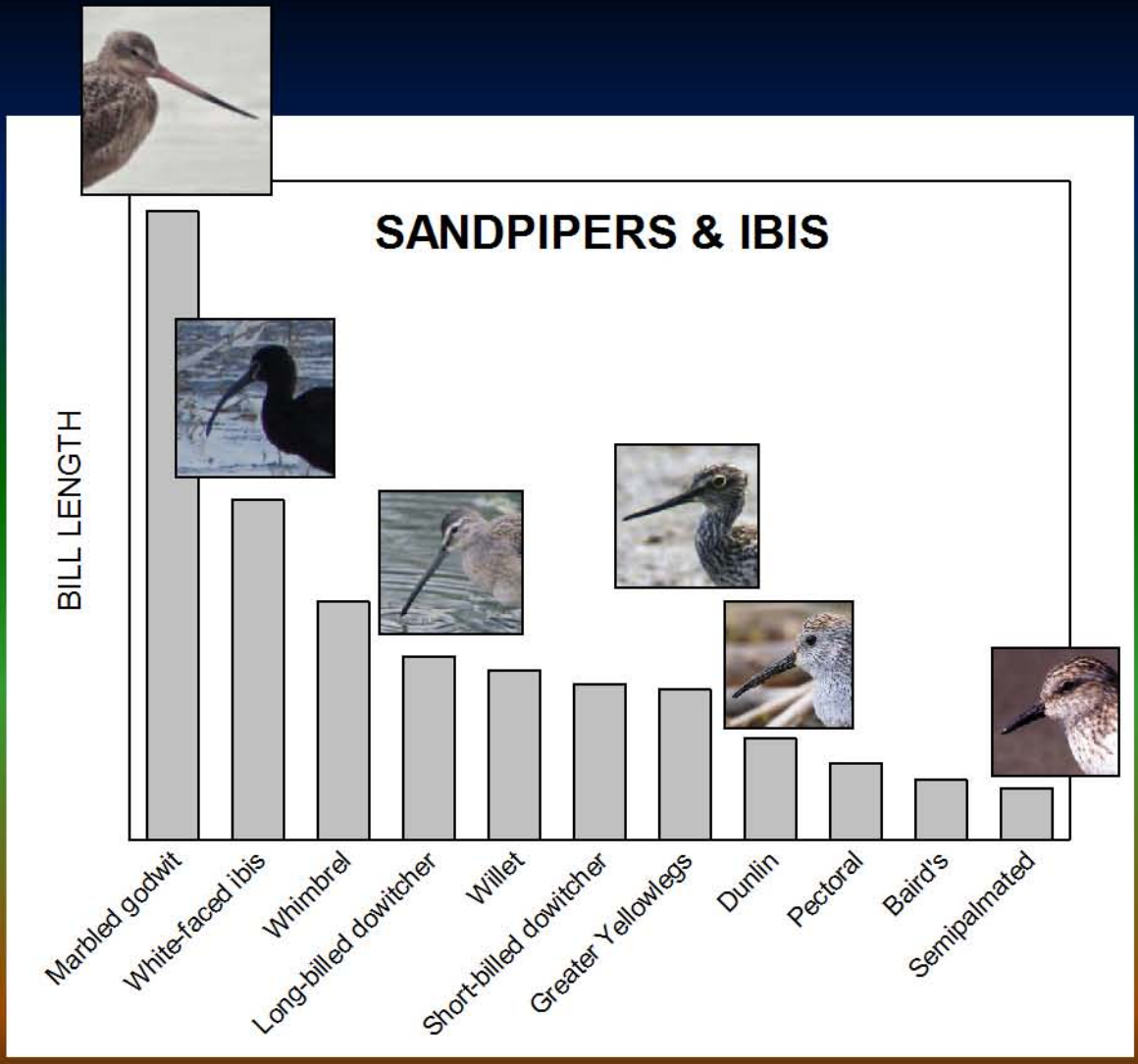


SANDPIPERS

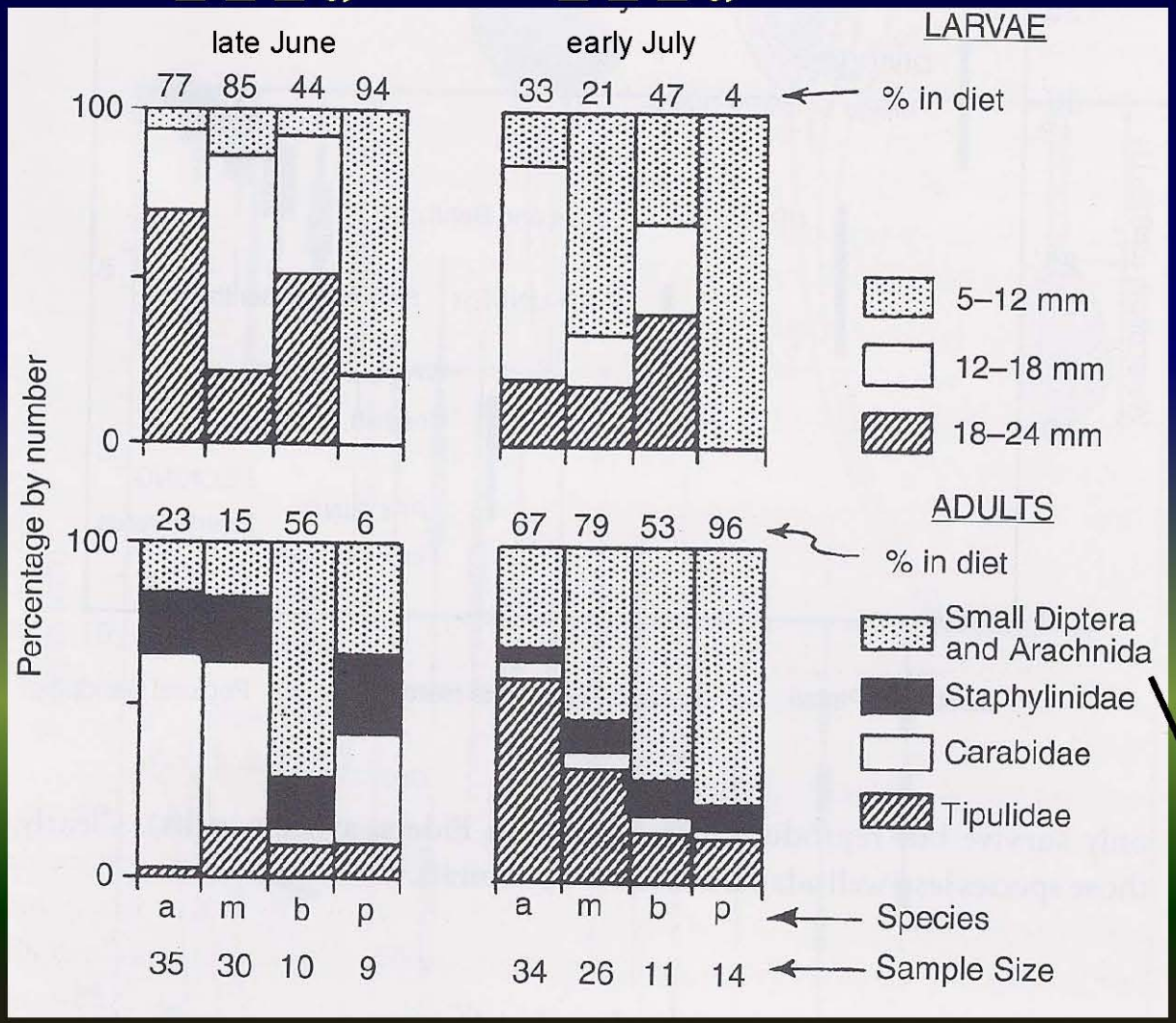
- Diverse group with morphological adaptations for feeding niches, prey size, etc.
  - Leg length
  - Neck length
  - Bill length and shape

- Foraging Habitats
  - Open or sparsely vegetated mudflats
  - Shallow open or short grassy sheetwater areas
  - Sandy shores

BILL LENGTH OF SANDPIPERS

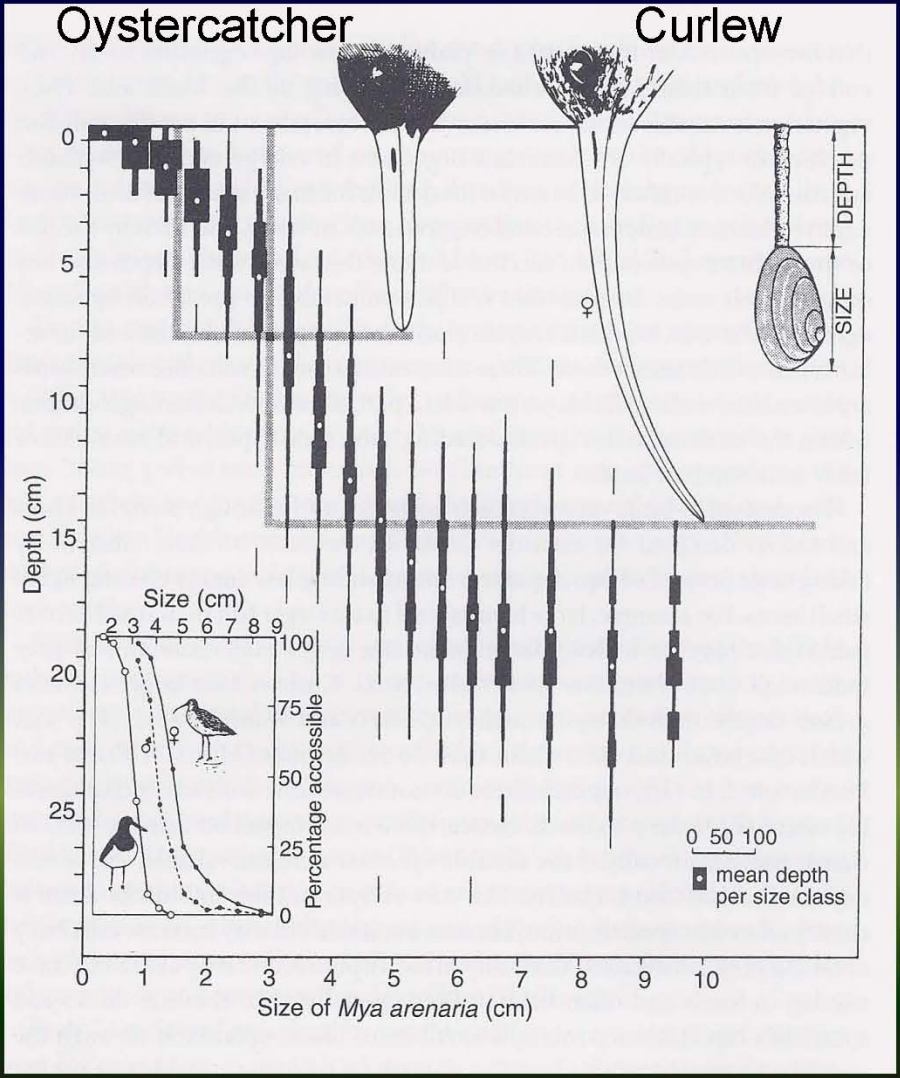


Sandpipers: Bill Size & Prey



(flies, spiders, mites)
(rove beetles)
(ground beetles)
(crane flies)

Bill Size, Clam Size, and Depth



GREATER YELLOWLEGS

Foraging Strategy:
Gleaners

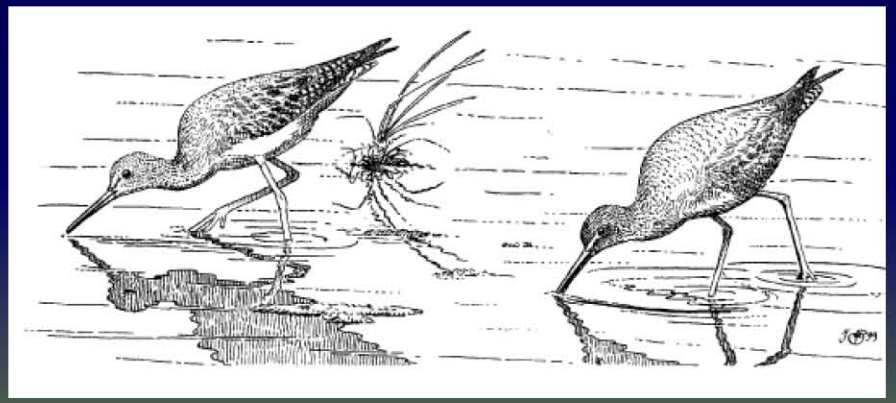
- Takes prey from water column or mud with swift stabs at the surface
- Visual foraging
- Invertebrates, small fish, amphibians
  - Dragonfly larvae
  - Beetles (adults & larvae)
  - Minnows
  - Snails
- Occasionally seeds
- Avg. depth 7 cm

…a fine game bird earlier in the twentieth century, many a yellowlegs was shot "by an angry gunner as a reward for its exasperating loquacity"
(Bent 1937 from Elpich et al. 1998)

LESSER YELLOWLEGS

Foraging Strategy: Gleaners

- Takes prey from water column or mud with swift stabs/thrusts of bill
- Very active, visual forager
- Aquatic & terrestrial invertebrates
  - 65 families
  - Beetles
  - Flies
- Occasionally small fish & seeds
- Avg. depth 2-3 cm; up to 16 cm



DOWITCHERS

Foraging Strategy: Probers

- Probe in surface layers of sediment; often probe deeper than length of bill
- Described as a “sewing machine” motion
- Tactile receptors at tip of bill
- Aquatic Invertebrates
  - Chironomids (breeding)
  - Insect larvae & seeds (Migr./Winter)
- Water depth 0-8 cm; up to 16 cm

Long-billed Curlew

- Foraging Strategy: Probers
  - Probes deeper than other shorebirds (up to 15 cm)
  - Nonbreeding habitats
    - Firm mud substrate flooded < 1 cm
    - Will also use wet mud habitats flooded < 12 cm
  - Breeding habitats
    - Short grass, mowed alfalfa
    - Pecking foraging strategy
  - Use of microhabitats related to burrow density of prey

- Prey: Carnivorous
  - Non-breeding
    - Crustaceans
    - Mollusks
    - Benthic Inverts
  - Breeding
    - Grasshoppers
    - Beetles
    - Worms

WHITE-FACED IBIS

- Long down-curved bill
  - Non-visual tactile probing (dominant)
  - Sweep in water
  - Surface pecking
- Foraging habitats
  - Mudflats
  - Sheetwater areas from flooding
  - Shallow wetlands (avg. 11 cm) with short vegetation
  - Flooded agriculture fields
  - Travel up to 50 km from roost sites to forage
- Prey
  - Aquatic insects
    - High density and biomass of chironomids
  - Crustaceans
  - Earthworms

Pre-breeding April 2011

AMERICAN AVOCET

Foraging Strategy

Sweeper

- 3 visual and 6 tactile foraging methods described
- Takes prey from water surface, column or mud
- Aquatic invertebrates
  - Water boatmen
  - Beetles
  - Midges
- Also small fish, terrestrial invertebrates, and seeds
  - Sago pondweed
  - Saltgrass
- Foraging depths 0-25 cm

Invertebrate-Waterfowl/Shorebird Associations

Species[a]	Independent Variable	Significance of Variable: Parameter Estimate ± SE	Wald χ^2	P Value	Significance of Model: Model χ^2	DF[b]	P Value
Northern Shoveler	Chironomid Biomass	0.0014 ± 0.0008	2.78	0.10	4.98	1	0.03
American Green-winged Teal	Chironomid Biomass	0.0055 ± 0.0028	3.72	0.05	12.55	2	0.002
	Oligochaete Biomass	0.0047 ± 0.0023	4.24	0.04			
Dowitcher spp.	Water Depth	−0.4646 ± 0.2196	4.48	0.03	9.56	1	0.002
Dunlin	Water Depth	−0.2914 ± 0.1446	4.06	0.04	5.30	1	0.02
Western Sandpiper	Water Depth	−0.4757 ± 0.3813	1.55	0.21	11.75	3	0.008
	Chironomid Density	−0.0005 ± 0.0003	2.40	0.12			
	Oligochaete Density	0.0001 ± 0.0001	1.76	0.18			
Least Sandpiper	Water Depth	−0.7490 ± 0.3533	4.49	0.03	11.30	1	0.0008

[a] No significant models for Gadwall, Northern Pintail, and American Avocet.
[b] Degrees of freedom.

Invertebrate-Shorebird Associations

Invertebrate	Least Sandpiper r^2	Least Sandpiper P	Western Sandpiper r^2	Western Sandpiper P	All shorebirds r^2	All shorebirds P
Corophium spp. Amphipod	0.36	0.0007	0.31	0.0002	0.22	0.0001
Eogammarus sp. Amphipod	—[b]		—		0.04	0.05
Gnorimosphaeroma spp.Isopod	0.05	0.14	—		—	
Marine worms	0.04	0.14	—		—	
Other invertebrates	0.07	0.09	0.10	0.06	—	
F	6.47		8.50		10.02	
Total r^2	0.53	0.0012	0.40	0.0015	0.26	0.0001
df	4, 23		2, 25		3, 85	

[a] Data for Least and Western sandpipers are based on total birds and average invertebrate densities within 25 m² grid sections ($n = 28$), whereas analysis of all shorebirds is derived from total shorebirds within 1 m of invertebrate core samples.
[b] Variable did not meet 0.5 significance level for entry into the model.

All shorebirds include:

Baird's sandpiper
Least sandpiper
Western sandpiper
Semipalmated plover
Ruddy turnstone

HYPOTHETICAL MANAGEMENT SCENARIO

YEAR 1 (&2): DRAWDOWN

Germination of:

Annuals

Sedges

Rushes

Benefits of 2 years of drawdown

1. Likely to get different results due to different precipitation
2. If really wet year 1st year → late summer drawdown
3. Can allow late germinating plants better establishment
4. Can increase interspersion of vegetation

WETLAND DRAWDOWNS AND RESPONSE OF FOOD RESOURCES

SLOW DRAWDOWNS
Managed or Natural
ALL wetland types

- Maximize edge habitat
- Concentrate resources (e.g., invertebrates, seeds)
- Longer period of resource availability
- Keep nutrients in the system
- Time for invertebrates to adjust to changing conditions

	Drawdown Rate	
	Fast[a]	Slow[b]
Plants		
Germination		
Length of ideal conditions	Short	Long
Root development		
Wet year	Good	Excellent
Dry year	Poor	Excellent
Seed production		
Early season drawdown	Good	Excellent
Midseason and late drawdown	Poor	Good
Wet year	Good	Good
Dry year	Poor	Good
Invertebrates		
Availability	Good	Excellent
Early season	Good	Excellent
Midseason and late drawdown	Poor	Good
Length of availability	Short	Long
Potential for nutrient export	High	Low
Potential for reducing soil salinity	Good	Poor

[a] < 7 days.

[b] > 14 days.

HYPOTHETICAL MANAGEMENT SCENARIO

YEAR 3: SHALLOW FLOODING

Smaller zone of annuals

Sedges and rush spread by rhizomes

Benefits

1. Increased seed production by perennial sedges
2. More inverts associated with aquatic veg. and longer hydroperiod
3. Seeds and bugs available to broods

HYPOTHETICAL MANAGEMENT SCENARIO

YEAR 4: DEEPER FLOODING
BUT
NOT STABLE
NOT TOO DEEP

Annuals may disappear

High availability of sedges & rushes

Submerged vegetation will increase

Benefits

1. Increased tuber production by submerged veg.
2. Attract more species of diving ducks
3. Cover and food for molting

HYPOTHETICAL MANAGEMENT SCENARIO

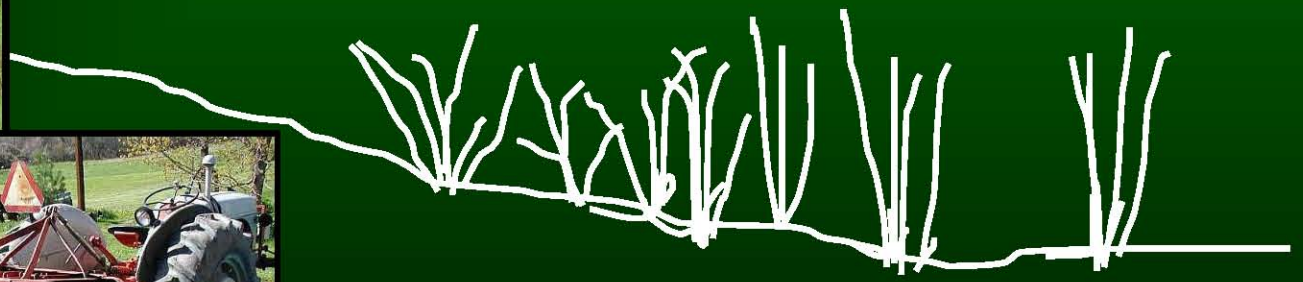
YEAR 5: DRAWDOWN AND/OR OTHER DISTURBANCES

Sedges and rushes too rank

Need to:

Stress below ground biomass and

Break up above ground matter



IN SUMMARY

Diverse morphological adaptations

Timing of use/life history requirements

↓

Diversity of foraging niches

Habitat (vegetation, water depth, etc)

Prey Biomass, Size, & Abundance

↓

Availability

QUESTIONS?

Terns
Flight feeders
Shallow divers

Bitterns
Stalk
Small, fast
moving prey

Kingfishers
Perch &
Plunge-diver

Canvasbacks
Divers for
Tubers

Phalaropes
Surface swimmers
Search & dip

Mallards
Tipping up
Benthic
dabblers

Ibis
wade
probe &
grab

Dowitchers
Wade
Probe

Grebes
Water column
divers
Visual search
& grab

Water Depth

Sandpipers & Plovers
Walk, search & grab

Blue-winged teal
Surface swimmers
Dabble, peck, & grab

Ruddy Ducks & Scaup
Benthic strainers

Shoveler & Green-winged Teal
Surface swimmers
Strain & sweep