Waterfowl Nutrition

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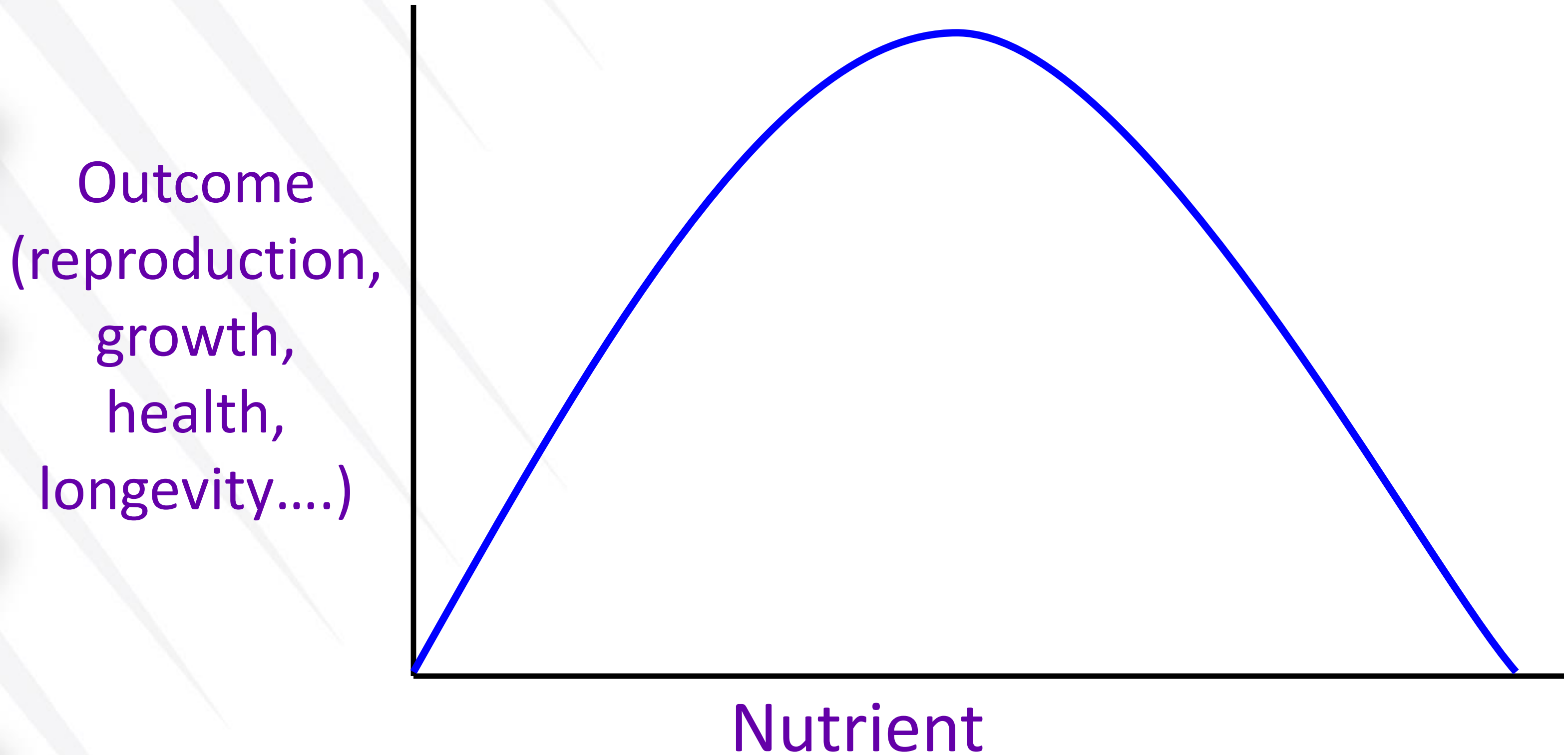
GENERAL NUTRITION PRINCIPLE



ESSENTIAL NUTRIENTS

OXYGEN

WATER

SUBSTRATES TO MAKE ENERGY

AMINO ACIDS/NITROGEN

FATTY ACIDS

VITAMINS

MINERALS

ENERGY

56-90% of time in wild is foraging & feeding

Energy requirements are much higher in wild

Thus, in captivity, energy intake can be excessive

Management scenario	ME requirement (kcal/d)
Indoor aviary	176.6 x $(\text{BW in kg})^{0.73}$
Outdoor aviary in warm/hot environment	203.9 x $(\text{BW in kg})^{0.73}$
Outdoor aviary in cold environment	226.1 x $(\text{BW in kg})^{0.73}$
Free ranging	229.2 x $(\text{BW in kg})^{0.73}$

ENERGY	VITS	MINS

ENERGY	VITS	MINS

ENERGETICS OF INCUBATION

Species/Group	Energy cost (x BMR)	% of energy from body reserves	Body weight loss during incubation
Geese	1.9	20-60%	10-30%
Dabbling Ducks	1.8	20-30%	10-20%
Diving Ducks	3.3	10-30% (80% in common eiders)	10-30%

Many diving ducks have a longer interval between arrival at breeding site and nesting vs dabbling ducks

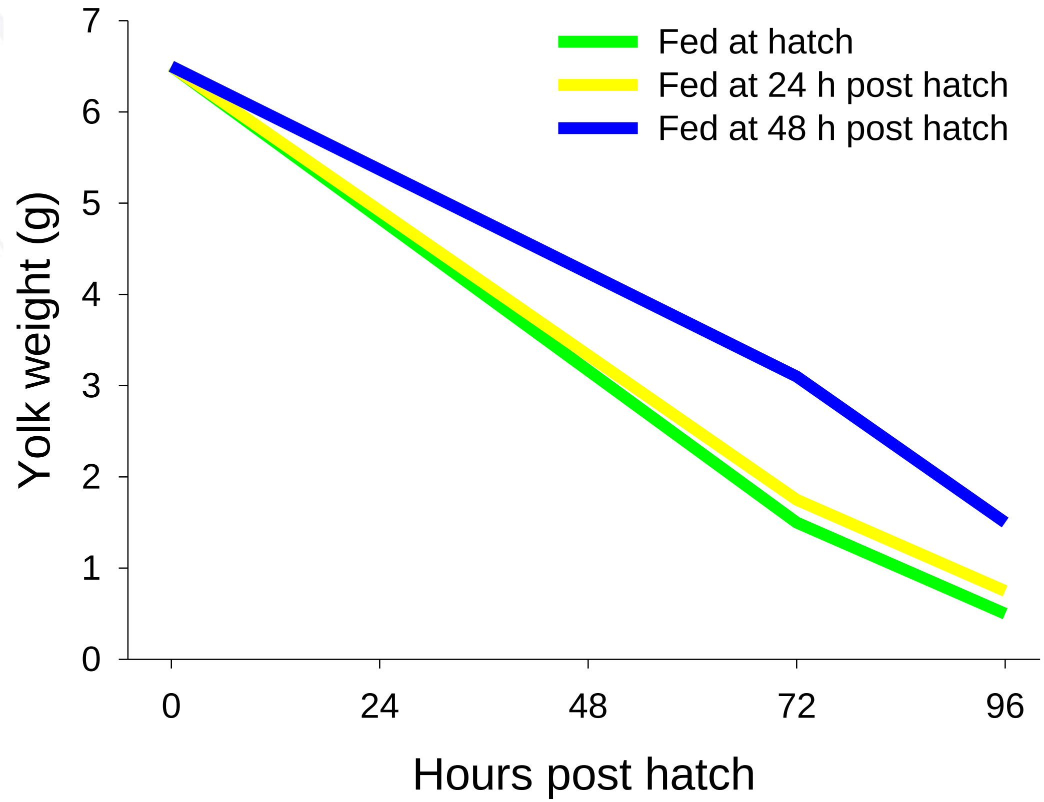
Levels of nutrient reserves may drive breeding - Fat reserves (Shovelers) and protein reserves (Gadwalls) ∞ follicle development

EARLY ACCESS TO FOOD

Yolk sac lasts 12-48 h

transition from lipids to CHO and/or protein

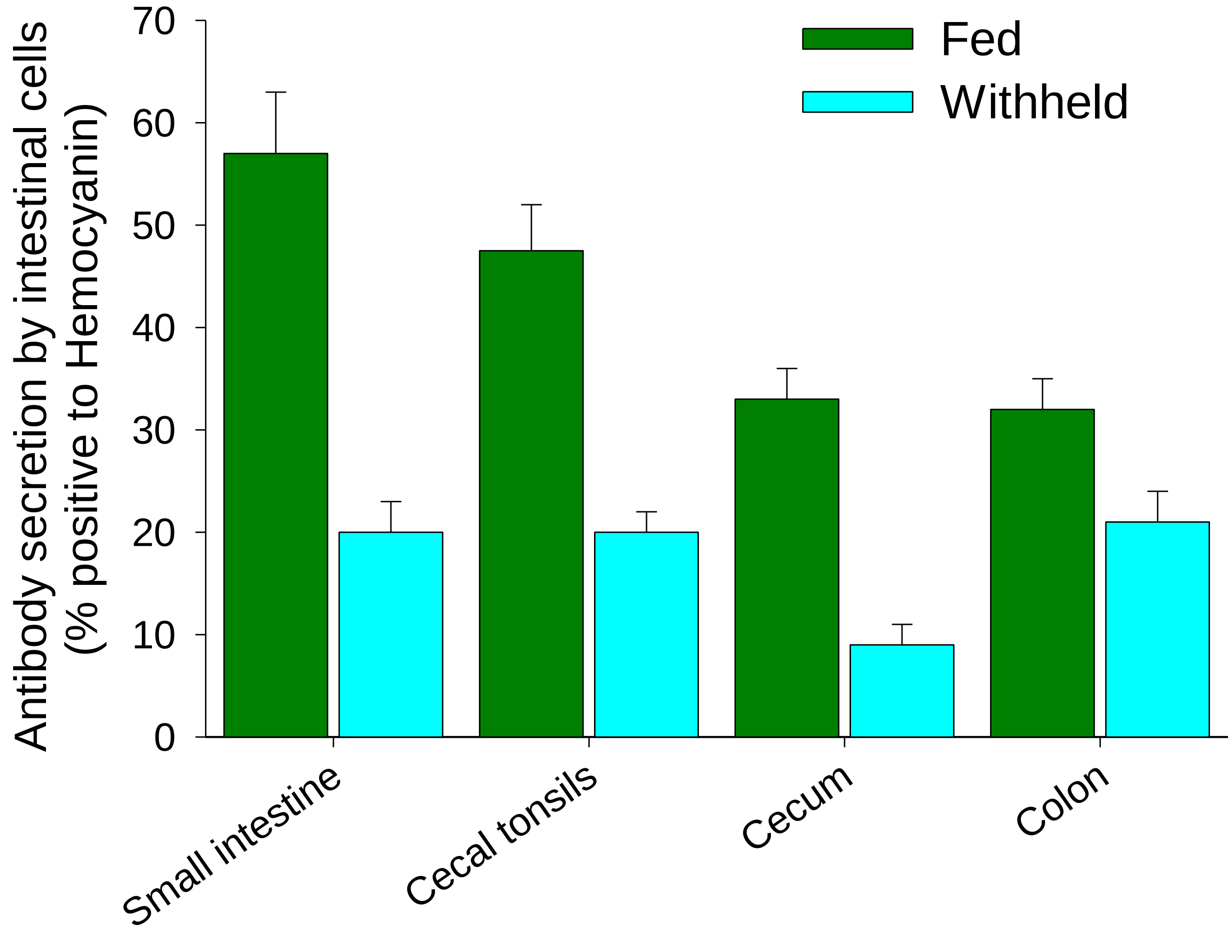
Food access drives yolk sac uptake



Data adapted from Panda and Reddy, 2007.

EARLY ACCESS TO FOOD

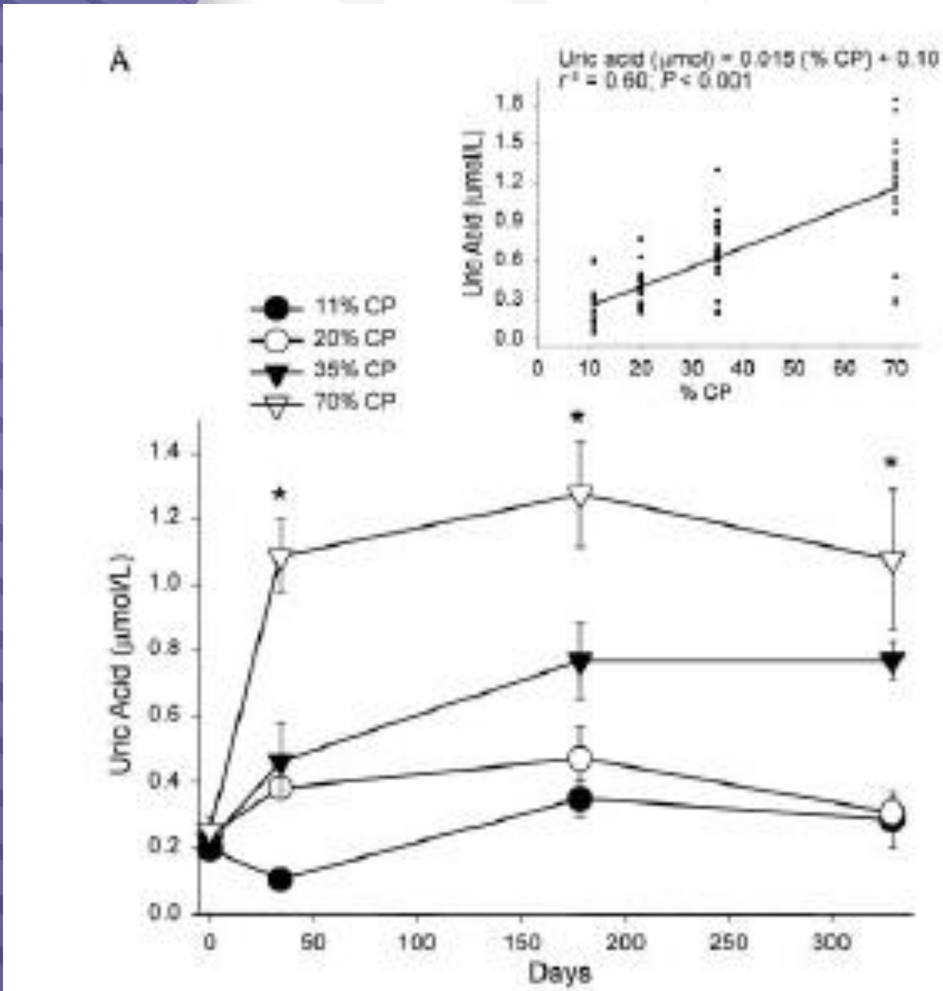
Food access drives immune system development



Effect of withholding feed on intestinal antibody responses in broiler chicks. Data adapted from Shira et al., 2005.

PROTEIN & AMINO ACIDS

Amino acids and N required in the right balance



Birds can adapt to different protein levels

Adaptation period takes ~ 2 weeks

Koutsos et al., 2001. J. Nutr.

PROTEIN & AMINO ACIDS

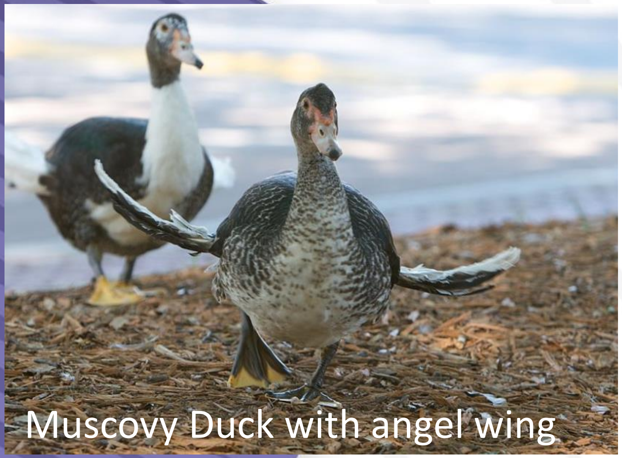
Mallards require 19.6% protein for egg production and hatchability. Levels < 17% reduced success.

May be difficult to achieve w/ plant based diets.

		0-2 weeks	2-7 weeks	Breeding
PROTEIN	%	22	16	15
ARGININE	%	1.1	1	
GLYCINE	%			
HISTIDINE	%			
ISOLEUCINE	%	0.63	0.46	0.38
LEUCINE	%	1.26	0.91	0.76
LYSINE	%	0.9	0.65	0.6
METHIONINE	%	0.4	0.3	0.27
MET + CYS	%	0.7	0.55	0.5
PHE	%			
SERINE	%			
THREONINE	%			
TRP	%	0.23	0.17	0.14
TYROSINE	%			
VALINE	%	0.78	0.56	0.47

Nutrient reqt's of Pekin Ducks (NRC 1994)

SLIPPED WING/ANGEL WING


Muscovy Duck with angel wing

- Tends to occur in slower growing species (temperate/tropical species)

- Nutritional implications
  - excess energy (diet energy or total intake)
  - excess protein

New Zealand Grey ducklings "If their wings start dropping they are put on a diet of alfalfa pellets (instead of Chick Growena) until the condition clears up." Fleig (1970)

Palatability of lower energy/protein diets?

LIPIDS & FATTY ACIDS

LINOLEIC (OMEGA-6) ESSENTIAL

LINOLENIC (OMEGA-3) ESSENTIAL

LONG CHAIN OMEGA-3 LIKELY ESSENTIAL FOR MARINE BIRDS

FATTY ACID SOURCES

Animal protein
saturated and omega-6 FA
Fish
omega-3 FA

Seeds, grains, nuts
Domesticated- saturated & omega-6
Wild- saturated & omega-3

Commercial feeds
Tend to be higher in omega-6

Table 4.1.5 | Fatty Acid Composition of Seeds of Wild Food Plants of the Orange-bellied Parrot (*Neophema chrysogaster*)[44]

	Linoleic Acid C18:2n-6	α-linolenic Acid C18:3n-3	AA C20: 4n-6	EPA C20: 5n-3	DHA C22: 6n-3
Introduced Mainland					
Atriplex prostrata	0.04	0.13	0.27	0	0.30
Cakile maritima	0.06	23.8	0	0	1.23
Chenopodium glaucum	0.06	5.28	0.14	0.02	0.06
Indigenous Mainland					
Halosarcia pergranulata	0	1.6	0	0	0
Samolus repens	0	1.53	0	0	0
Sarcocornia quinqueflora	0	2.0	0	0	0
Suaeda australis	0.23	2.39	0	0	0.04
Indigenous Tasmania					
Baumea tetragona	0	4.48	0	0	0
Gahnia grandis	0	0.37	0	0	0
Restio complanatus	0	3.55	0	0	0
Commercial	0	1.42	0	0	0.08

VITAMINS

- Chemical compounds required in low amounts

- Fat soluble – A, D, E & K
    - Stored with fat, primarily in the liver
    - Harder to excrete excess, so toxicity concern
    - may use less toxic sources
        - e.g., beta-carotene vs retinol for vit A

- Water soluble –
    - B vitamins
    - vitamin C
    - excess can be excreted

		0-2 weeks of age	2-7 weeks of age	Breeding
BIOTIN	ppm			
CHOLINE	100PPM			
FOLATE	ppm			
NIACIN	ppm	55	55	55
PANTOTHENATE	ppm	11	11	11
PYRIDOXINE	ppm	2.5	2.5	3
RIBOFLAVIN	ppm	4	4	4
THIAMIN	ppm			
VITAMIN A	IU/KG	2500	2500	4000
VITAMIN D3	IU/KG	400	400	900
VITAMIN E	IU/kg	10	10	10
VITAMIN B12	UG/KG			
VITAMIN K	ppm	0.5	0.5	0.5

Nutrient reqt's of Pekin Ducks (NRC 1994)

VITAMINS
CONCERNS FOR PISCIVORES

- Thiamin (deficient)
- Vitamin E (deficient)
- Vitamin A (high)

MINERALS

- 1° concern is Calcium –
  - Egg laying = growth > maintenance
  - Can use supplemental calcium source

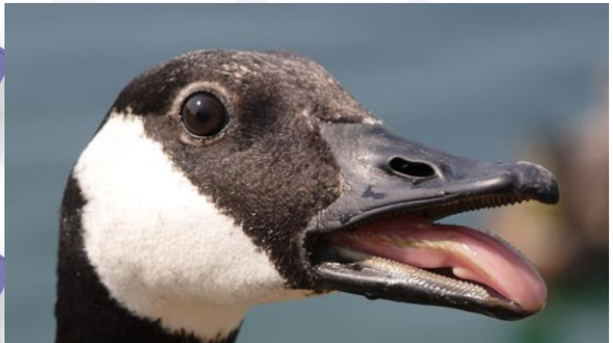
		0-2 weeks	2-7 weeks	Breeding
CALCIUM	%	0.65	0.6	2.75
NON PHYTATE PHOSPHORUS	%	0.4	0.3	
SODIUM	%	0.15	0.15	0.15
MAGNESIUM	%	0.05	0.05	0.05
CHLORIDE	%	0.12	0.12	0.12
COPPER	ppm			
IODINE	ppm			
IRON	ppm			
MANGANESE	ppm	50		
SELENIUM	ppm	0.2		
ZINC	ppm	60		

WATERFOWL FEEDING STRATEGIES

Herbivorous Waterfowl
Dabbling Ducks
Diving Ducks
Sea Ducks

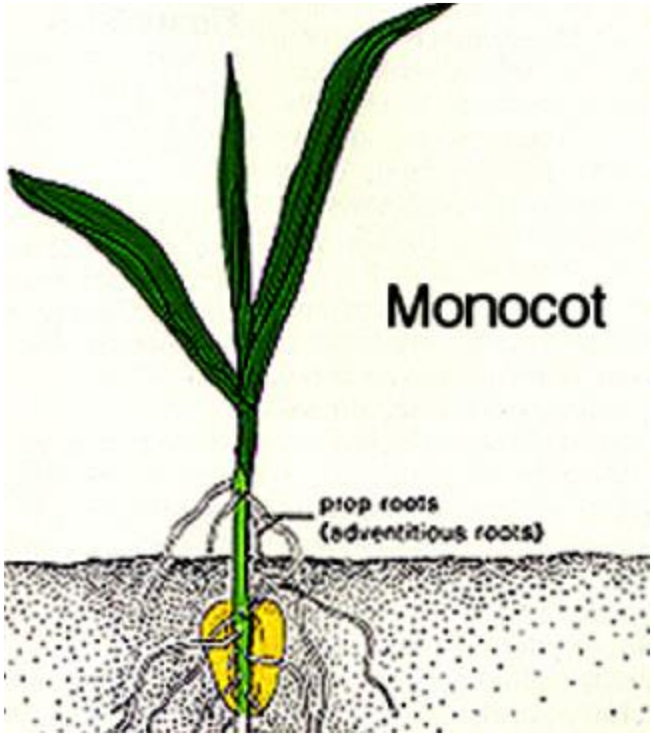
HERBIVOROUS WATERFOWL

Geese, swans, some ducks (anserinae, anatinae)
- leaves, seeds, roots (e.g., *Anser* genus)
- aquatic vegetation (e.g., swans)



Canada goose (*Branta Canadensis*)

Greylag Goose (*Anser anser*)



HERBIVOROUS WATERFOWL

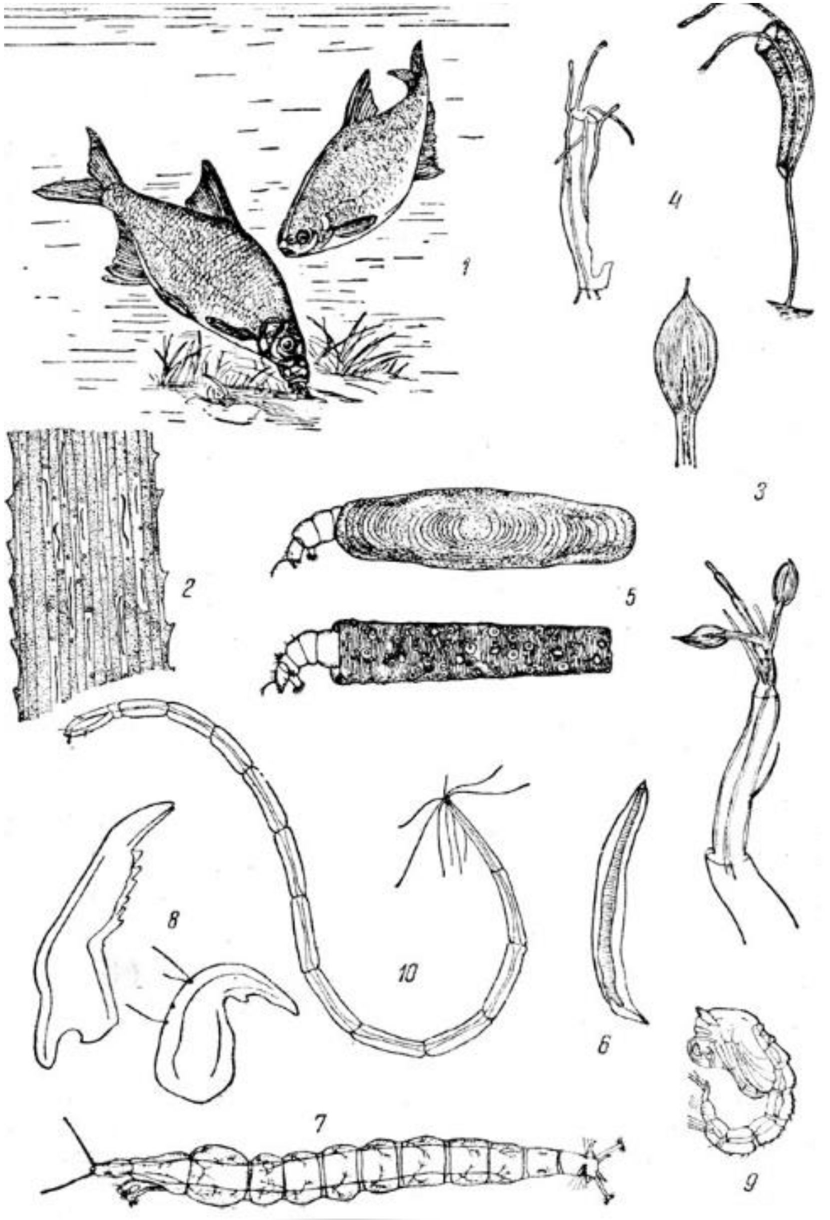
- Some seasonality in food selection
  - Green leaves in summer & spring
  - Seeds, grains, roots in fall & winter
    - Pasture/grass in some small bodied geese

- Higher protein levels during breeding & growth
- Higher energy levels pre-migration

-Animal matter may be important during growth

HERBIVOROUS WATERFOWL

Insects and microscopic inverts associated w/ aquatic plants



HERBIVOROUS WATERFOWL

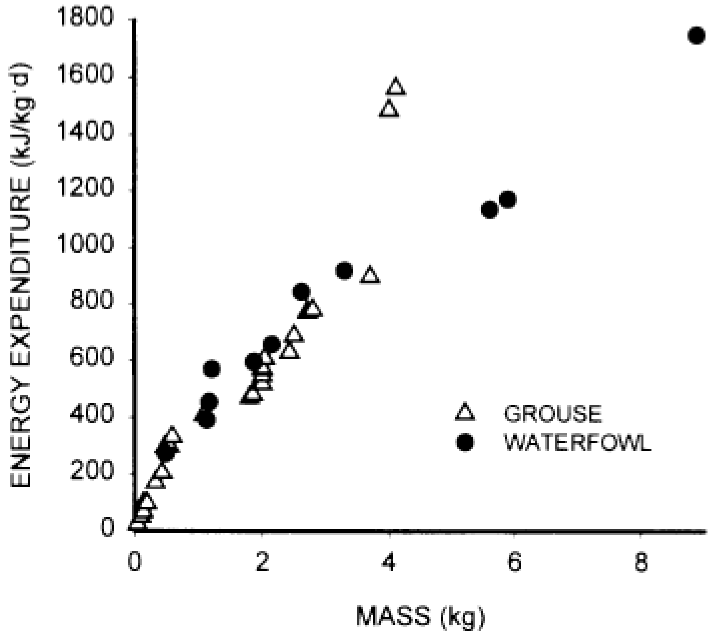


FIGURE 1. Mass-specific daily energy expenditure (standard metabolic rate) of herbivorous grouse and waterfowl. Data from: Lasiewski and Dawson 1967, Zar 1969, West 1972, Rintamäki et al. 1983, Goldstein and Nagy 1985, Bennett and Harvey 1987, Vehrencamp et al. 1989.

- Similar maintenance energy requirement as Galliformes

- Expected to have higher reqt for growth and breeding

  - Faster growth rate (esp. arctic)
  - Larger eggs (% BW)

The Condor 99:314–326

ADAPTATIONS TO AND CONSEQUENCES OF AN HERBIVOROUS DIET IN GROUSE AND WATERFOWL[1]

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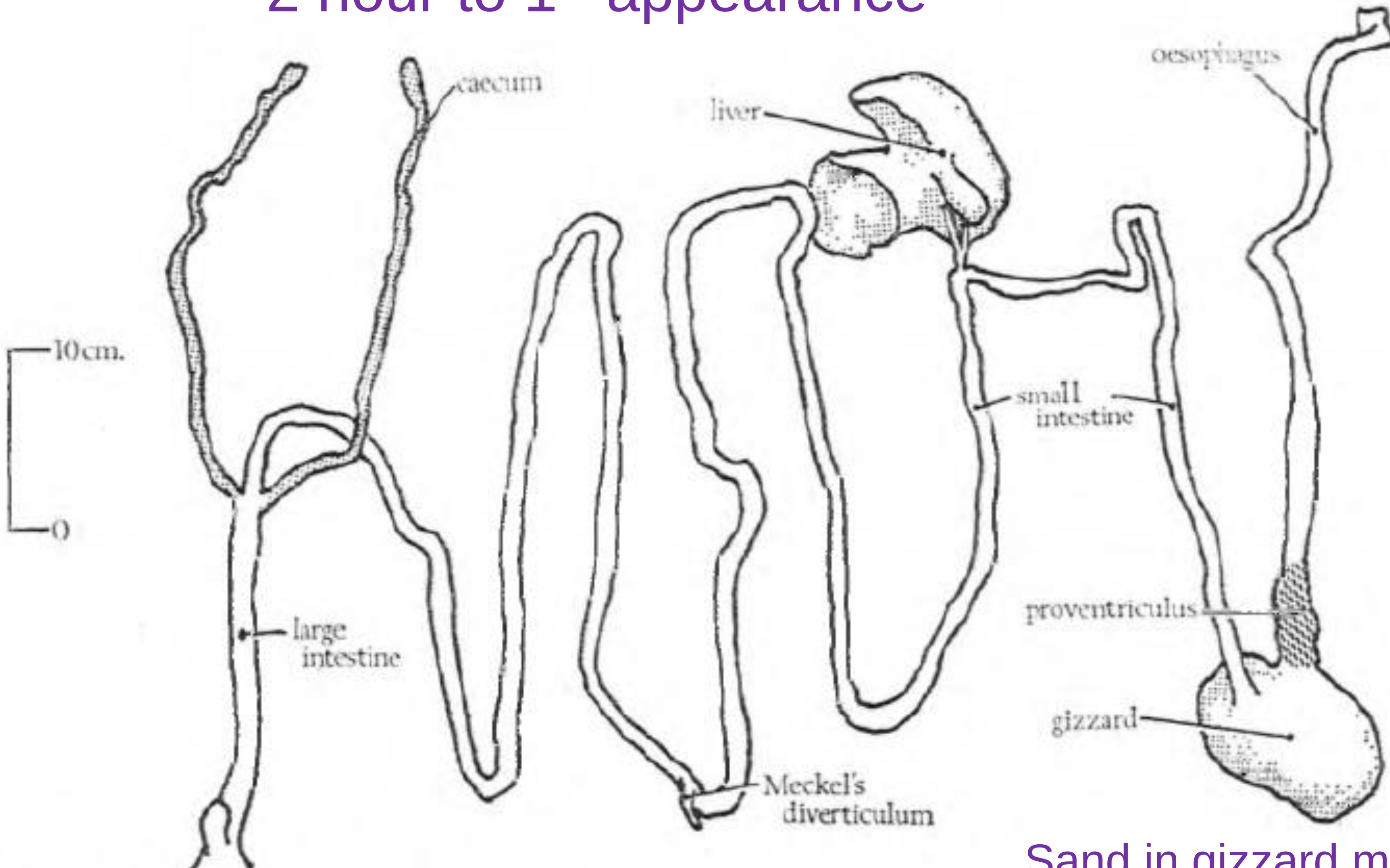
HERBIVOROUS WATERFOWL

2 hour to 1st appearance



Sand in gizzard may "puncture" plant material

Figure 1. Alimentary canal of a domestic goose.

Goose feeding and cellulose digestion

JOHN G. MATTOCKS

HERBIVOROUS WATERFOWL

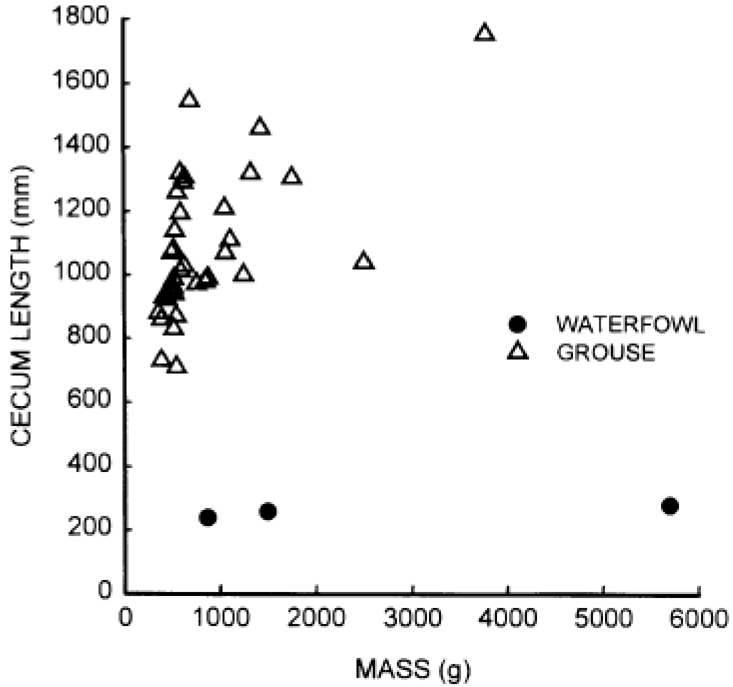


FIGURE 5. Paired ceca lengths (mm) in relation to body mass (g) in herbivorous grouse and waterfowl. References as for Figure 3.

- Relatively constant cecal size
- Insignificant fiber fermentation (<20% fiber digestion from grass)
- Need higher quality plant material

The Condor 99:314–326

ADAPTATIONS TO AND CONSEQUENCES OF AN HERBIVOROUS DIET IN GROUSE AND WATERFOWL[1]

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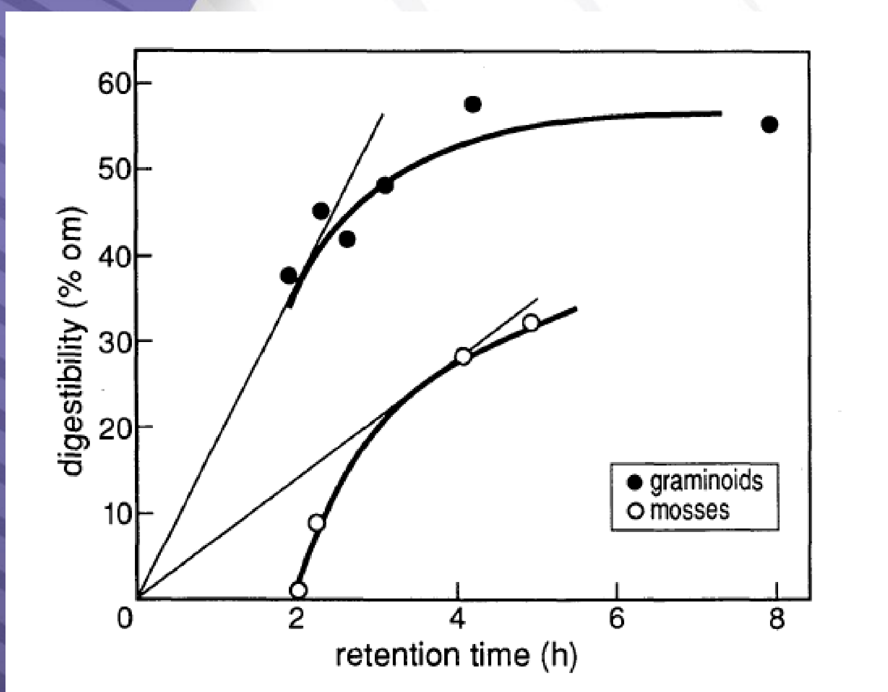
HERBIVOROUS WATERFOWL

- May change retention time to improve digestibility of fibrous material (Prop & Vulink, 1992)
- Requires tradeoff w/ intake (↑ loafing periods)



DABBLING WATERFOWL

Omnivorous- mixture of plant and animal material

Generally consumption of animal material by nesting females

	% of invertebrates in diet (black ducks, Reinecke & Owen 1980)
Males	60
Laying females	75
Post-lay females	55

American black duck

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DABBLING WATERFOWL- Diet composition

Diet item	Moisture (%)	Protein (% DMB)	Fat (% DMB)	Ash (% DMB)	Total CHO (% DMB)	Species/ Reference
Gammarus	76	48	5	33	15	Black ducks Jorde & Owen 1988
Periwinkle	35	9	1	88	2	Black ducks Jorde & Owen 1988
Soft shelled clam	58	6	<1	91	3	Black ducks Jorde & Owen 1988
Blue mussel	64	16	1	80	3	Black ducks Jorde & Owen 1988
Whirligig beetle		46	28	2	25	Black ducks Reinecke & Owen, 1980
Water flea		32	2	51	16	Ruddy Ducks, Northern Shovelers, Northern Pintails Euliss et al., 1997

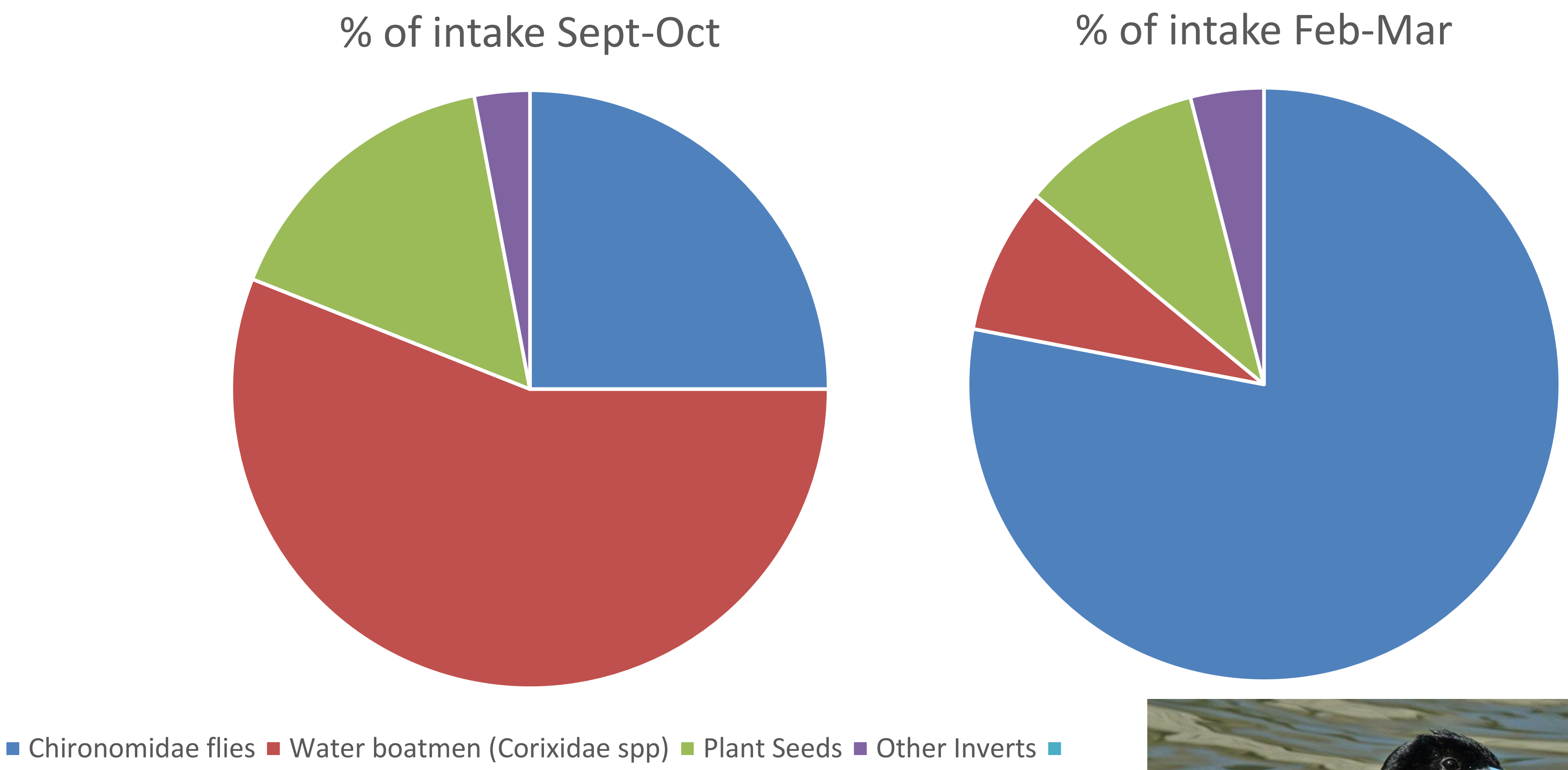
High ash/shell content may contribute grit and calcium

DABBLING WATERFOWL- Diet composition

Diet item	Moisture (%)	Protein (% DMB)	Fat (% DMB)	Ash (% DMB)	Total CHO (% DMB)	Species/ Reference
Duckweed		25	3	11	60	Black ducks Reinecke & Owen, 1980
Arrowhead		19	3	5	73	Black ducks Reinecke & Owen, 1980
Sedge		10	5	4	70	Black ducks Reinecke & Owen, 1980
Pondweed		9	4	2	85	Black ducks Reinecke & Owen, 1980
Barnyardgrass		10-12	1-3	6-26	62-68	Ruddy Ducks, Northern Shovelers, Northern Pintails Euliss et al., 1997
Wheat		15-19	2	4	76	Ruddy Ducks, Northern Shovelers, Northern Pintails Euliss et al., 1997

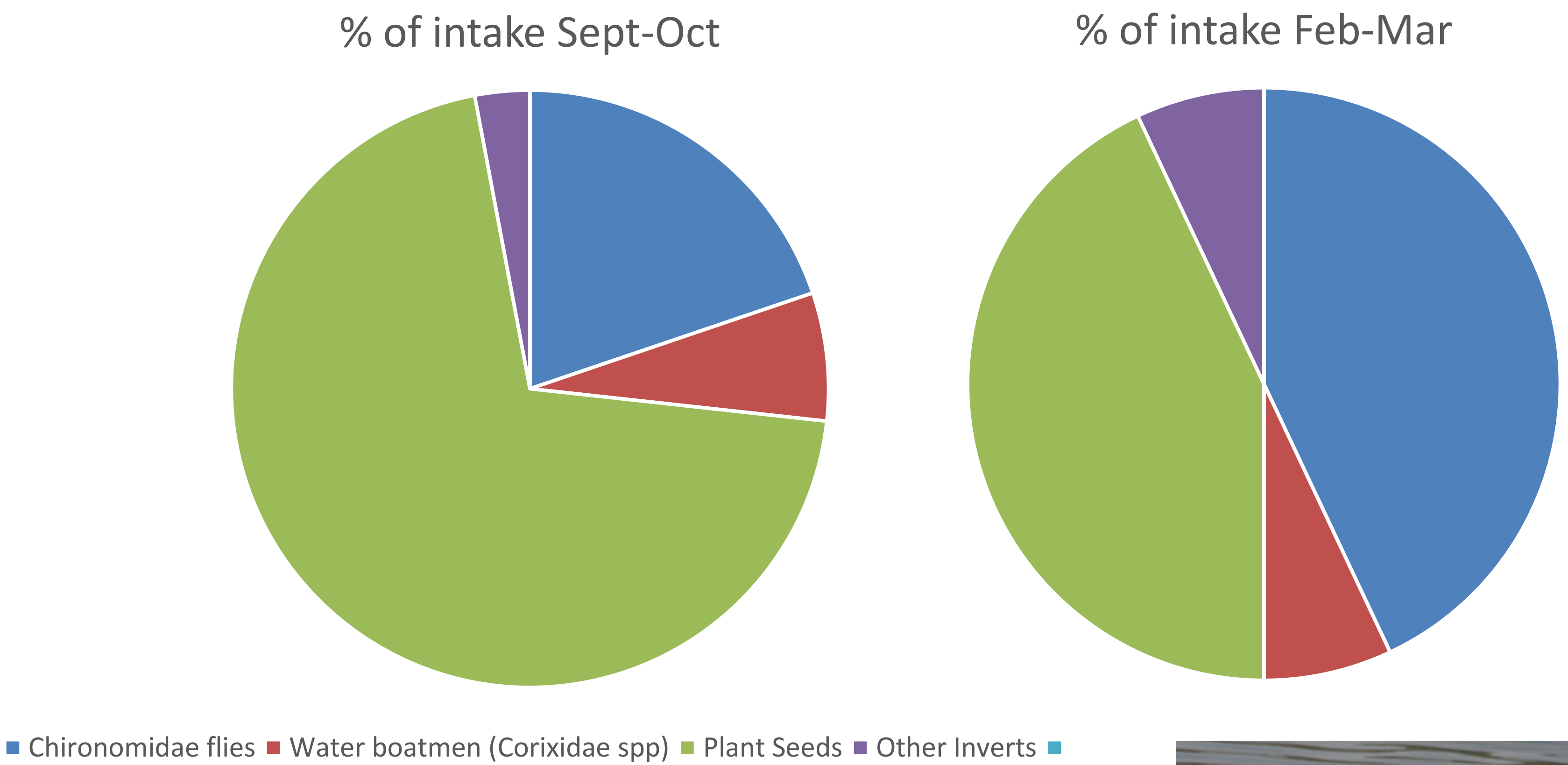
DABBLING WATERFOWL

Overall consumption of Ruddy Ducks (Euliss et al., 1997)



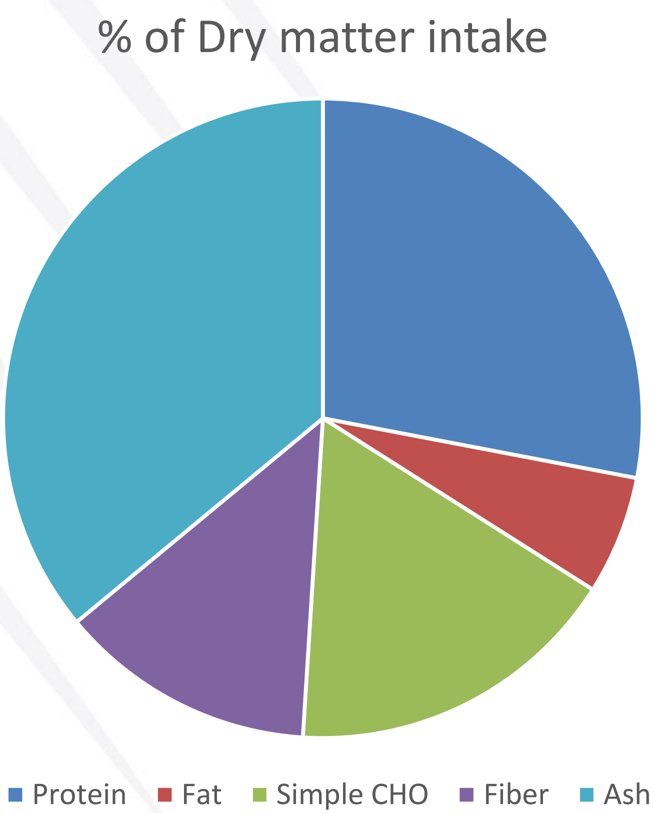
DABBLING WATERFOWL

Overall consumption of Northern Pintails (Euliss et al., 1997)



DABBLING WATERFOWL

Overall consumption of breeding female black ducks
(Reineke & Owen, 1980)



DIVING DUCKS & SEADUCKS

- Diving ducks
  - Different anatomy, esp. legs, optimized for propulsion through water
  - Generally omnivorous with combination of plant and animal material – similar to dabbling ducks

Ring necked duck

DIVING DUCKS & SEADUCKS

- Seaducks
    - More carnivorous, eating aquatic inverts
    - Often have salt glands (emerge in adulthood) to tolerate marine environment
    - Eiders, scoters, mergansers etc.
    - Diet often dominated by crustaceans and bivalves

Hooded merganser

DIVING DUCKS & SEADUCKS

- Seaducks
    - some seaducks do eat fish seasonally

Table 2. Percent occurrence of prey remains in Harlequin Duck feces during four seasons at Hornby Island, British Columbia, 1998–1999. "Spawn" was defined as a three-week period after herring spawn was first deposited in early March.

Prey	Season (number of samples)				
	Molt (25)	Winter (33)	Spawn (61)	Spring (83)	Total (202)
Bryozoan	0.0	3.0	1.6	0.0	1.0
Polychaete	0.0	21.2	0.0	43.4	21.3
Chiton	0.0	72.7	11.5	37.3	30.7
Snail	72.0	97.0	54.1	65.1	67.8
Limpet	68.0	75.8	8.2	28.9	35.1
Mussel	8.0	12.1	11.5	15.7	12.9
Urchin	0.0	12.1	1.6	8.4	5.9
Barnacle	4.0	18.2	31.1	27.7	24.3
Isopod	4.0	0.0	1.6	1.2	1.5
Amphipod	0.0	12.1	6.6	21.7	12.9
Crab	96.0	78.8	13.1	43.4	46.5
Fish	4.0	3.0	0.0	0.0	1.0
Herring eggs	0.0	0.0	31.1	28.9	21.3
Algae	4.0	75.8	98.4	92.8	80.7
Grit	12.0	54.5	73.8	90.4	69.8

J. Field Ornithol. 73(4):363–371, 2002

Use of fecal analysis to determine seasonal changes in the diet of wintering Harlequin Ducks at a herring spawning site

Michael S. Rodway[1] and Fred Cooke

Harlequin duck

DABBLING WATERFOWL- Diet composition

Diet item	Moisture (%)	Protein (% DMB)	Fat (% DMB)	Ash (% DMB)	Total CHO (% DMB)	Species/ Reference
Ischadium spp (mussel)		8-10	1-5	45-50		Surf scoters (Wells-Berlin et al., 2015)
Periwinkle	35	9	1	88	2	Black ducks Jorde & Owen 1988
Soft shelled clam	58	6	<1	91	3	Black ducks Jorde & Owen 1988
Blue mussel	64	16	1	80	3	Black ducks Jorde & Owen 1988

High ash/shell content may contribute grit and calcium but may reduce digestibility of protein & fat

THANK YOU


Courtesy of Sylvan Heights Waterfowl Park
Photo: Patrick Doerr