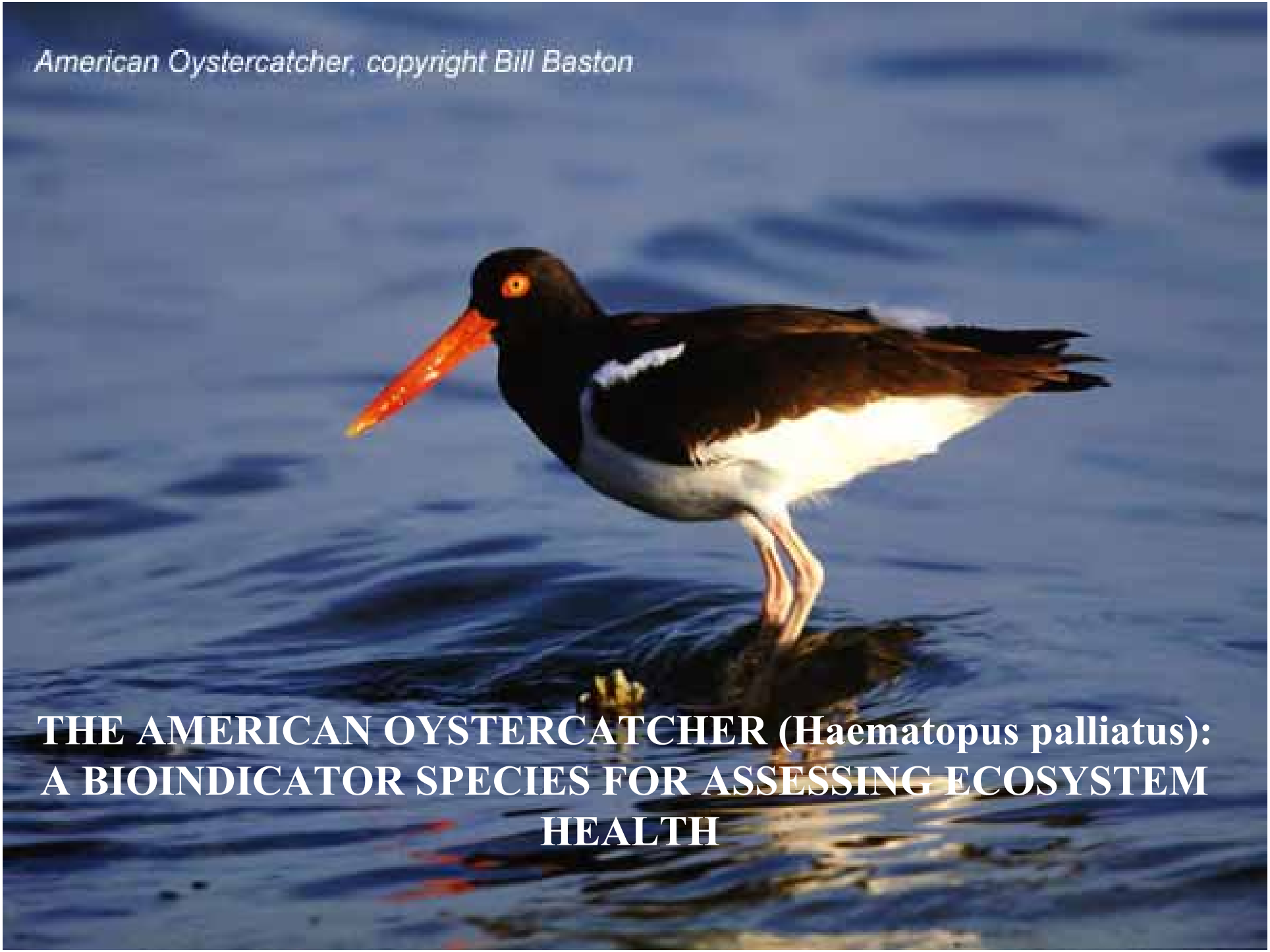

THE AMERICAN OYSTERCATCHER (Haematopus palliatus): A BIOINDICATOR SPECIES FOR ASSESSING ECOSYSTEM HEALTH

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Photo by Brad Winn

Native Wildlife Health Program in Coastal Georgia

- Assist conservation and wildlife management groups on various aspects of wildlife health and disease (research, management, rehabilitation, education)
- Wildlife Management and health related work on SCI, Jekyll Island, other parts of the coast and inland
- International training programs

Georgia Wildlife Health Program












Importance of health assessment of wild populations

- Standardized approach to health assessment, disease investigation and mortality events is important in free-ranging wildlife
- Disease and health often overlooked in management plans for wildlife
- Baseline data is needed to establish "normal" health parameters
- Long-term health monitoring of wildlife populations essential tool especially for threatened and endangered species
- Wildlife as bioindicators

Collaborations between biologists, scientists from various disciplines (nutrition, toxicology, parasitology), veterinarians

- Take advantage of having animal in hand by collecting various biomedical samples such as blood, feces, feathers, necropsy

Threats to shorebird and AMOY Populations

- Threatened by human disturbance
- Habitat loss
- Predation/invasive spp
- Inundation
- Contaminants?
- Natural toxins?
- Infectious disease?
- Often multiple factors

AMOY as potential important indicator of ecosystem health

- Depend on quality coastal breeding habitat and prey on bivalves
- Detection of contaminants in the population may reflect the source of bivalve contamination, such as environmental pollution from industry, agriculture, recreation and non point source runoff
- Bivalves food source of AMOY and humans-pathogen and contaminant detection could have public health implications

Objectives of this project

- Establish baseline values in clinical pathology, toxicology, reproductive parameters, microbiology, parasitology, morphometric measurements, and gender confirmation with DNA technology
- Evaluate seasonal and age related differences in baseline health, contaminant, and reproductive parameters

Objectives continued

- Establish normal nutritional parameters in the plasma of AMOY (pl vitamins A, D, and E)
- Perform nutritional and contaminant analysis on commonly consum items at different locations in GA and SC
- Perform contaminant analysis on AMOY eggs (yolk) collected at dif locations in GA and SC
- Data comparison between GA and SC (Cape Romain)

Methods
Field Captures

- **Cannon netting during non-breeding season (Sept thru Feb)**
- **Box trapping during breeding season**
- **Decoy method**

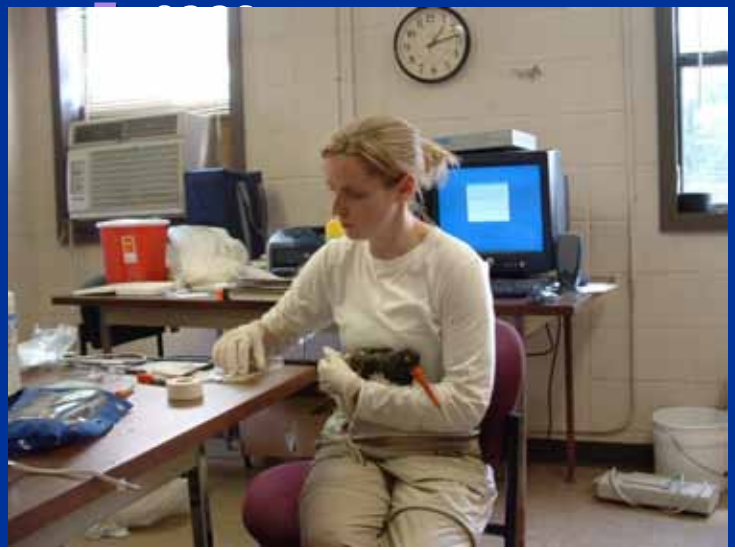
Numbers captured

- Total of 171 birds captured in Georgia and South Carolina from 2001-2006
- 91 birds in GA: LSSI, CI, Sapelo and Wolfe
- 81 birds in SC: Cape Romain National Wildlife Refuge
- More captures in 2007 and 2008

Methods

Sample Collection and Processing

- Physical examination
- Morphometric measurements
- Biological samples
  - Blood
  - Feathers
  - Cloacal swabs
  - Feces
  - Prey items



- Complete blood count
- Serum biochemistries
- Estradiol and testosterone
- heavy metals
- organochlorines
- PCBs
- Feather mercury and arsenic
- DNA sexing
- Disease exposure
  - *Aspergillus*
  - *Chlamydophila psittaci*
  - West Nile Virus
  - Avian Influenza Virus

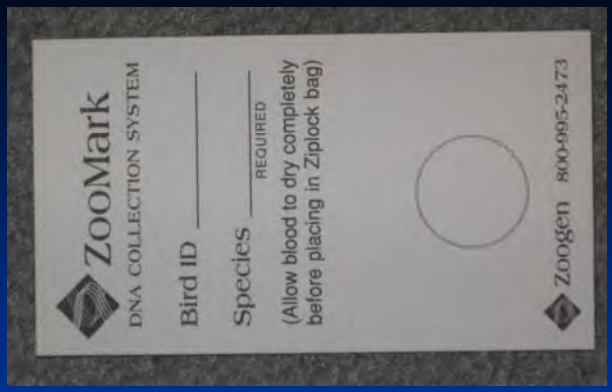
Methods
Statistical Analyses

- Data collected and organized into database
- Compared health parameters with respect to age, sex, and capture state
  - Continuous variables: Shapiro Wilks test and probability plots to assess normality
  - ANOVA
  - Normality rejected: Mann-Whitney U test
- Categorical variables: χ^2 test of independence
  - age, sex, capture state

Sample collection and processing

- Right jugular vein
- Importance of sample processing
  - Collection techniques
  - Blood smears
  - Centrifugation
  - Prompt cooling and freezing
  - Proper submission to lab
  - Sample labeling
- Use of same lab throughout study

DNA sexing and morphometrics



- 85 males, 69 females
- More females in SC 38/70, than in GA 31/84
- More males captured in GA 53/84 than SC 32/70
- Females significantly larger than males by body weight, bill length and wingchord

Sexing continued

- The sex-specific ranges in this study had a large amount of overlap.
- If used alone as a method for determining sex, large males would likely be systematically misclassified as females.

	Adult Male		Adult Female		*P*	Juvenile Male		Juvenile Female		*P*
Parameter	**N**	**Mean ± SD**	**N**	**Mean ± SD**		**N**	**Mean ± SD**	**N**	**Mean ± SD**	
Weight (kg)	52	581.2±53.20 (425-702)	34	630.8±45.62 (540-739)	<0.001	13	541.7±46.54 (430-594)	12	581.2±35.05 (535-635)	0.026
Bill length (cm)	35	80.24±5.12 (70.0-94.3)	21	91.0±7.03 (76.0-101.6)	<0.001	4	80.1* (75.7-87.2)	5	89.7* (86.6-97.0)	0.028
Wingchord (cm)	36	252.8±9.61 (222-273)	18	261.1±12.68 (229-282)	0.011	4	245.5* (242-259)	5	261* (248-264)	0.063
Tarsal length (cm)	36	58.0±4.92 (47.7-70.0)	22	60.4±4.35 (51.0-68.0)	0.062	4	57.8* (47.4-67.4)	5	62.4* (56.9-63.7)	0.623

*Medians and ranges are reported where normality was rejected.

Results Reference Ranges

- No biologically significant differences in CBC or plasma chemistry parameters
- Mean, SD, and range calculated
  - CBC
  - Plasma biochemistry values

Parameter	Mean ± SD	Range	N
Packed Cell Volume (%)	45.2±3.63	38-55	145
Total Solids (g/dL)	3.9±0.60	2.5-5.5	142
White Blood Cell Count (x.10^3/mL)	8.7±4.25	2.3-9.7	62
Heterophils (%)	46.1±14.87	16-77	115
Lymphocytes (%)	36.0±13.65	10-73	115
Monocytes (%)*	1	0-8	115
Eosinophils (%)	13.9±8.52	1-37	115
Basophils (%)*	2	0-8	115
Glucose (mg/dL)	337.2±50.05	247-534	94
Sodium (mmol/L)	150.7±17.34	142-175	85
Potassium (mmol/L)	3.20±0.742	2.0-6.2	84
Carbon dioxide (mmol/L)	23.8±3.85	9-32	83
Creatinine (mg/dL)*	0.1	0-0.3	84
Total protein (g/dL)	4.00±0.664	2.5-5.8	97
Calcium (mg/dL)	9.43±1.140	2.3-12.7	94
Phosphorus (mg/dL)	2.40±2.194	0.1-19.7	91
Uric acid (mg/dL)	7.45±3.585	1.7-15.7	95
Alanine aminotransferase (U/L)	82.9±41.26	31-223	83
Aspartate aminotransferase (U/L)	478.6±227.75	171-1491	95
Lactate dehydrogenase (U/L)	2305.6±1233.23	1032-6258	90
Creatinine phosphokinase (U/L)*	442	42-8535	93
Amylase (U/L)	423.8±167.62	219-1011	90
Lipase (U/L)*	20	5-446	88
Gamma glutamyl transferase (U/L)	11.1±2.91	5-20	87
Cholesterol (mg/dL)	222.8±40.68	147-347	88
Triglycerides (mg/dL)	95.4±21.14	58-192	88
Bile acid (umol/L)*	7.6	0.6-46.5	71
Pre-albumin (g/dL)*	0	0-0.45	95
Albumin (g/dL)	1.777±0.5481	0.68-4.59	95
Alpha 1 globulins (g/dL)	0.440±0.2838	0.08-1.18	95
Alpha 2 globulins (g/dL)	0.590±0.0879	0.38-0.86	95
Beta globulins (g/dL)	0.922±0.2403	0.47-1.68	95
Gamma globulins (g/dL)	0.249+0.1434	0.05-0.81	95
Glucose (mg/dL)	337.2±50.05	247-534	94

* Medians and ranges are reported where normality was rejected.

Aging

- Majority of birds were adult (101/130)
- More juveniles captured in GA 25/76 than SC 4/54

Physical Examination

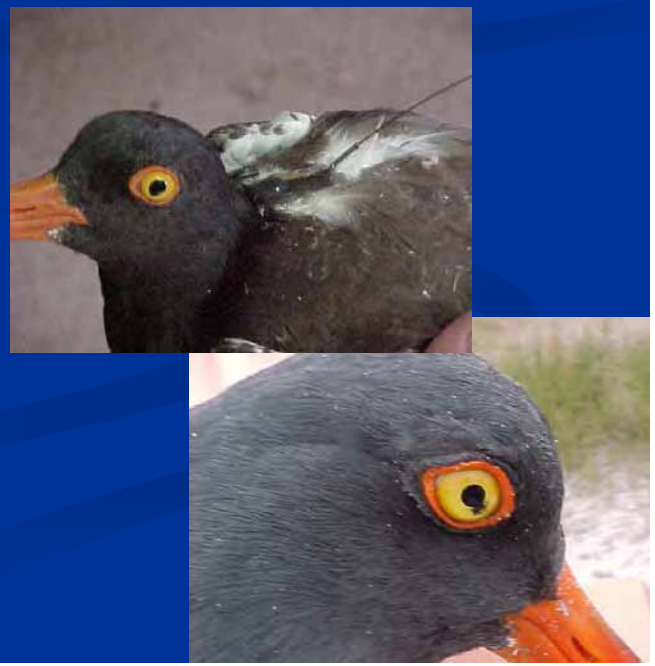
- Systematic approach
  - Eyes, beak, nostrils, oral exam
  - Ausculation
  - Coelomic palpation
  - Body condition scoring
  - Feather evaluation
    - Quality
    - External parasites
    - Molt condition
    - Stress lines
  - skin
  - Vent
  - Preen gland
  - Musculo-skeletal
  - Feet

Body condition score (BCS)

- Palpation of muscle at the keel
- 1 emaciated
- 2 thin
- 3 normal
- 4 overweight
- 5 obese
- Most birds in good body condition 70/96 (2.25-2.75)
- 9 had a BC of 2 and 17 had a BC of 3, no variation by age, sex or location

Iris depigmentation

- Unknown cause or significance
- Not age related
- Classified as mild, moderate or severe
- 90% of AMOY evaluated effected
- Found unilaterally and bilaterally
- Defect more common in females
- Black OC: fairly accurate method of sexing



Lice: *Saemundssonia haematopi*

- Present on all birds examined for lice (101)
- 82 birds had mild lice
- 21 had moderate
- Only 1 had severe
- No variation by sex, age or location

Parasites

- Eimeria sp in feces
- Acathocephalan sp in feces
- No hemoparasites

Results

Disease Exposure

- **Negative for AIV and WNV (n=34)**
- **24% (26/107) positive for *C. psittaci* antibody**
  - **South Carolina (15/47) > Georgia (11/60)**
- **32% (28/88) positive for *Aspergillus* antigen**
  - **South Carolina (17/39)> Georgia (11/49)**
  - **Significantly higher uric acid levels in positive birds**

Contaminant Panel

- **Mercury***
- **Arsenic***
- **Zinc**
- **Lead***
- **Chromium**
- **Copper**
- **Tin**
- **Strontium**
- **vanadium**

- PCBs
- DDT and metabolites*
- DDE*
- Toxaphene*
- Chlordanes
- Benzene hexachloride

Results

Contaminant Levels

- Mercury detected in 73% (32/44) of blood samples
  - Median 0.09 ppm (0-0.23 ppm)
- Mercury levels lower than reports from other shorebird species
- Other contaminants below minimum detection limits
- Low or undetectable levels of contaminants consistent with Mussel Watch reports for the capture locations

Avocets

1.09 ppm Hg

Stilts

0.25 ppm Hg

Loons

Up to 7.8 ppm Hg

Reproductive failure at 0.4 ppm Hg

Heavy metals continued

- Lead (n=52), tin (n=19), vanadium (n=19), chromium (n=14), copper (n=19), and strontium (n=19) were not detected in blood samples.
- Arsenic was detected in 5/10 (50%) of samples tested
- Median zinc concentration in blood (n=19) was 6.1 ppm with a range of 5.5 to 9.5 ppm.
- Mercury, arsenic and zinc levels did not differ significantly by age, sex, or location.

Egg evaluation

- 12 eggs from GA, 11 eggs from SC
- There were no detectable levels of arsenic (n=14), tin (n=4), vanadium (n=4), or chromium (n=4) in eggs tested.
- Mercury was detected in 4 of 18 eggs tested, ranging from 0.07 to 0.09 ppm.
- Zinc was detected in all four eggs tested, with levels ranging from 10 to 73 ppm.
- All egg (n=18) organochlorine and polychlorinated biphenyls levels were below laboratory detection limits.

Feather contaminant analysis

- 3 of the 37 feathers collected from oystercatchers in Georgia had detectable mercury levels
- Feathers with no detectable mercury were all from oystercatchers captured at Wolfe Island, GA in September, 2002.
- Feathers from the eight birds sampled at Cape Romain had mercury levels above detectable limits
- Feather mercury levels were an order of magnitude greater than whole blood levels for 5 birds with both samples analyzed.
- Arsenic was detected in four of eight feather samples from birds captured at Cape Romain
- Feather and blood arsenic levels were approximately equal for one bird in which both samples were analyzed

Prey item contaminants

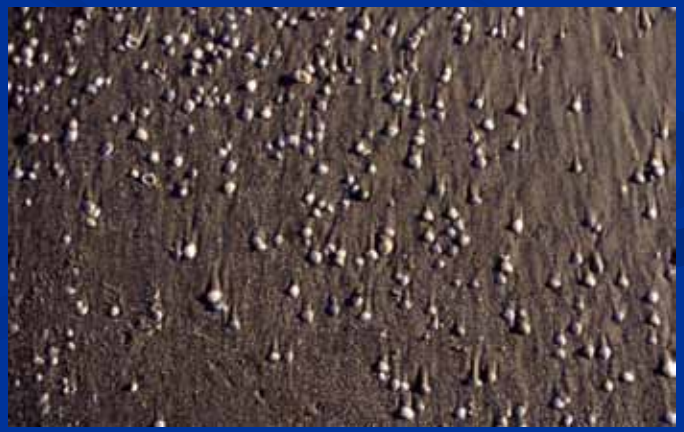
- One sample composed of whelks had a mercury concentration of 0.061 ppm.
- All samples had detectable levels of arsenic
- Organochlorine levels were below detectable limits for all samples.

Nutrition

- Vitamin A/E/D
- Identify and collect prey species that AMOY are eating at various locations
- Analyze nutritional content of prey items as indicator of habitat resources

Prey items observed being fed upon and subsequently analyzed

- Eastern Oyster *(Crassostrea virginica*
- Blood Ark Clam *(Anadara ovalis*)
- False Angel Wing *(Petricola pholadiformis)*
- Crabs and polycheate worms.
- Knob Whelks (*Busycon carica)*
- Ribbed Mussels (*Geukensia demissa*)
- Northern Quahog (*Mercenaria mercenaria*)



Plasma Vitamin A, E, D

- Extremely elevated, especially vitamin A levels
- Near toxic levels for other species

Parameter	Mean+SD	Range	N
Vitamin A (µg/mL)	1.827±0.325	1.06-2.45	37
Vitamin E (µg/mL)	8.970±4.511	2.97-27.21	37
Vitamin D (ng/mL)	0*	0-11	14

Overview of Nutrition Results

- Opportunistic feeders
- Prey items
  - high in water content
  - High in protein
  - low in fat content
- *P. pholadiformis* (false angel wings) has particularly high ash content

- **Minimum Ca:P ratio 1.5:1, but as high as 10:1 (even without shells!!)**

Conclusions

- Oystercatchers are sexual dimorphic by size, but field measurements may not be appropriate for sexing
- First reported reference ranges for health parameters for any species of oystercatcher
- Contaminant levels were low in all biomaterials sampled and correlated well with Mussel Watch reports
- Apparently healthy birds at capture, reflecting a relatively uncontaminated ecosystem