Integrated Inventories: 
*The Avian Perspective*

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Overview

• Avian inventory methods and the role of museum collecting in inventory work.

• How should we allocate limited resources for collecting and curating specimens?

• Event-based versus object-based collections?
Avian inventory methods
Overview: Preparing a Bufflehead

Photos: Cindy Ramotnik
“I like Mason’s idea of linking ancillary data to a voucher,” (Anonymous)

This has always been the model in museum ornithology. Only the language and the methods have changed over the centuries.... and we’re still trying to figure out the best way to do it!
### DATA FOR BIRD SPECIMENS

#### CONTEXT
- Locality
- Date
- Habitat
- Collection method
- Collector

#### PHYSIOLOGY DATA
- Body mass
- Heart mass
- Hematocrit
- Total Hemoglobin
- RBC concentration
- Time of capture to blood draw
- Metabolic rate
- Hypoxia resistance

#### PHYSICAL DATA
- Gonad condition
- Bursa dimensions
- Skull ossification
- Molt
- Fat
- Stomach contents
- Soft part colors
- Flight muscle mass
- Wing area and span

#### PRESERVATION
- Specimen
  - Skin
  - Skeleton
  - Formalin-preserved
- Tissues
  - Frozen Liver
  - Frozen Heart
  - Frozen muscle
  - Frozen pancreas
  - Frozen eyeballs
  - Frozen lungs
  - Frozen spun blood
- Ancillary items
  - Head and body photos
  - Wing photos
  - Blood serum photo
  - Ectoparasites
  - Stomach Contents
  - Blood smears
- Condition
  - Time from death to flash-freezing in LN2

#### Ancillary items
- Frozen Liver
- Frozen Heart
- Frozen muscle
- Frozen pancreas
- Frozen eyeballs
- Frozen lungs
- Frozen spun blood
- Head and body photos
- Wing photos
- Blood serum photo
- Ectoparasites
- Stomach Contents
- Blood smears
- Time from death to flash-freezing in LN2
**CONTEXT**

| Locality: Peru: Lima: 12°0.5'S, 76°55.4'W; 352 m elevation |
| Date: 18 October 2008 |
| Habitat: *Lantana* shrubs along riparian corridor in urban area |
| Collection method: netted |
| Collector: Emil Bautista O. |

**PHYSIOLOGY DATA**

| Body mass: 15.6g |
| Heart mass: 0.357g |
| Hematocrit: 53.4% |
| Total Hemoglobin: 16.2 g/dl |
| RBC concentration: $3.78 \times 10^6/\mu l$ |
| Time of capture to blood draw: 15 min. |

**PHYSIOLOGY DATA**

| Preparation type: skin & partial skeleton |
| Tissues saved: Frozen Liver, Heart, *Pectoralis major*, pancreas, eyeballs, lungs, spun blood |
| Additional materials saved: Head and body photos, blood serum photo, ectoparasites, stomach, blood smears |
| Time from death to flash-freezing: 20 min. |

**PRESERVATION**

| Preparation type: skin & partial skeleton |
| Tissues saved: Frozen Liver, Heart, *Pectoralis major*, pancreas, eyeballs, lungs, spun blood |
| Additional materials saved: Head and body photos, blood serum photo, ectoparasites, stomach, blood smears |
| Time from death to flash-freezing: 20 min. |

**PHYSICAL DATA**

| Gonad condition: left testis 2x1mm |
| Bursa dimensions: 2x3mm |
| Skull ossification: 90% |
| Molt: light molt on body, neck and head, no wing or tail molt |
| Fat: none |
| Stomach contents: Insect parts: Diptera, Hymenoptera, Lepidoptera (saved) |
| Soft part colors: Irides brown; tarsi, toes dark gray, orbital skin yellowish-brown; gape pale yellow; bill dark gray, tomia & prox. 1/3 mandible whitish (photographed) |

**Collector:** Emil Bautista O.
### Online database

http://arctos.database.museum/SpecimenSearch.cfm

### CATALOG NUMBERS:

- Tissue #
- Preparator #
- Museum Catalog #

### PHYSICAL DATA

- ** Gonad condition:** left testis 2x1mm
- ** Bone dimensions:** 3x2mm
- ** Skull ossification:** 90%
- ** Matt:** light cast on body, neck and head, no wing or tail molt
- ** Fat:** none
- ** Stomach contents:** intestinal contents: Dictera, Hymenoptera, Lepidoptera (silked)
- ** Soft part colors:** indigo brown; tail, toes dark gray; orbital skin yellowish brown; gape pale yellow, bill dark gray; irida & preh. 1/3_meridius white (photographed)

### PHYSIOLOGY DATA

- ** Body mass:** 15.6g
- ** Heart mass:** 0.357g
- ** Hematocrit:** 53.6%
- ** Total Hemoglobin:** 16.2 g/dl
- ** RBC concentration:** 3.7810^6/µl
- ** Time of capture to blood draw:** 15 min.

### PRESERVATION

- ** Preparation type:** skin & partial skeleton
- ** Tissues saved:** Frozen Liver, Heart, Pancreas, Eyeballs, Lungs, Spun Blood
- ** Additional materials saved:** Head and body photos, blood serum photo, ectoparasites, stomach, blood smears
- ** Time from death to flash freezing:** 20 min.
Specimen-based Projects that MSB Bird Division collects for right now

• Evolution of physical characteristics of blood across elevational gradients
• Phylogeny, phylogeography, population genetics of birds in Peru and NM
• Heart and lung size and structure across elevational gradients
• Flight muscle, wing and body size across elevational gradients
• Blood parasites: host relationships, prevalence, and diversity
• Genome size in birds
• Hypoxia resistance in hummingbirds
• Metabolic rate of hovering hummingbirds
• Tracheal morphology and vocal formant spacing
• Pancreas variation in conjunction with diet and trophic level
• Retinal protein variation in birds
• Hemoglobin isomeric composition and O2 affinity
• Chewing louse taxonomy and phylogeny
• West Nile Virus: host relationships, prevalence, and diversity
Ancillary data: Example I

House Wren heart cross sections

Sea level
- RV = 23%

4300m elev.
- RV = 29%

RV = 22%

RV = 30%
Ancillary data: Example 2

Videos of flight performance in Hypoxia
AVIFAUNAL SURVEY OF THE RÍO CHIPAOTA VALLEY IN THE CORDILLERA AZUL REGION, SAN MARTÍN, PERU

Christopher L. Merkord¹, Todd Mark², Dora Susanibar³, Andrew Johnson⁴, & Christopher C. Witt⁴

355 species of birds
97 spp.: specimen
142 spp.: recording/photo
116 spp: seen/heard only

Effort documented in article
• 4003.5 net hours
• judicious collecting by shotgun

Effort NOT documented:
• 550 specimens collected
• Proportion of netted birds that were collected (99%)
• Number of hours spent hunting
• Use of playback
Lognormal rank abundance distribution: long tail of rare species

Species rank
Satellite imagery reveals new critical habitat for three endangered bird species in the high Andes of Peru

Phred M. Benham¹, Elizabeth J. Beckman¹, Shane G. DuBay¹, L. Mónica Flores M.², Andrew B. Johnson¹, Michael J. Lelevier¹, C. Jonathan Schmitt¹, Natalie A. Wright¹, and Christopher C. Witt¹.

- Collected 40 of 52 species found at this super-high elevation site
- Figure shows position of mistnets
Specimen-based Inventories: Problems

• Lots more work per ‘observation’ than other methods

• Very difficult to sample uncommon species thoroughly

• Species are sampled very unevenly due to:
  Collector motivation bias
  Mist-net capture bias
  Variation in difficulty of collecting

• Events not traditionally tracked in museum databases
Do Inventories warrant a fundamental shift in the way we collect birds?

Current collecting activities are project driven.

• Randomized sampling designs are rare, and there’s no way to randomly sample anyway: e.g. mistnet and mesh size biases.

• Sampling is always directed towards one or more immediate research purpose.

• This generates presence data, but not absence data.

• If we do a good survey as part of our work, we publish it, with description of effort in the publication linked to specimen.
Do Inventories warrant a fundamental shift in the way we collect birds?

Quantification of effort?
We quantify net-hours opportunistically, but don’t record them in specimen database

How can you quantify motivation? An avifauna of 50-500 species may be completely prioritized in the minds of a collector for ongoing projects, colleagues’ projects, potential projects… resulting in biased sampling of species
What do specimens add to an inventory?

• Detailed taxonomic study & challenging identifications

• **Genetic characteristics** of populations collected: diversity, uniqueness, relationships, allele and genotype frequencies at any locus.

• Parasite and pathogen studies

• Isotope ratios in any tissue type

• Detailed, repeatable study of any physiological and structural characteristic

• Unanticipated future work involving physical specimens

• None of these studies would require a measure of effort
Is the goal to sample every population at every generation?

NO. Comprehensive collecting in space and time is impossible
USES OF THE BISON

Shown here are some of the many ways the Plains peoples made use of the bison.

MEAT AND SOME INTERNAL ORGANS—FOOD

HIDE—TIPI COVERS, BLANKETS, BEDS, ROBES, SHIELDS, CLOTHING

STOMACH—COOKING POT

BONES—AWLS, SCRAPERS, SLEDS

SKULL—PART OF CEREMONIAL ALTAR

DUNG—FUEL

HORNS—SPOONS

TENDONS—THREAD

TONGUE—FOOD

HAIR—ROPE, STUFFING
How should we make the allocate our limited time?

(1) making more value from each buffalo

(2) collecting more buffalos (the herd is huge)

(3) worrying about how we cull the buffalo so that we sample them in an robotic, unbiased way in order that computer-based peoples of the future can model buffalo distributions with one fewer bad assumption
• Only “presence” data was derived from historical museum specimens… geo-referenced specimens were used for niche-modeling
Why are specimens important to science?

- Same reasons they are a key component in inventory work
EVOLUTIONARY PROCESSES AND SYSTEMATICS
- Taxonomy
- Biogeography
- Phylogenetics
- Evolution

ORGANISM-ENVIRONMENT INTERACTIONS
- Comparative Physiology
- Ecology
- Migration
- Global Change
- Niche modeling

APPLIED SCIENCES
- Epidemiology
- Conservation
- Ecotoxicology

UNANTICIPATED FUTURE USES
- Whole genome sequences?

EDUCATION
- Teaching future scientists