Migration

- Migration is annual movement from one location to another and return to the original location

Yates Mill

- Migration has fascinated people for centuries
- Two types:
  - Latitudinal
  - Elevational
- Understanding migration:
  - Is important for conservation
  - Helps unravel evolutionary history

Why migrate?

- The energetic cost of migration is substantial
- Migration is dangerous
  - Only about half of long distance migrants survive each year
Life history trade-offs

<table>
<thead>
<tr>
<th>Trait</th>
<th>Temperate resident</th>
<th>Migrant</th>
<th>Tropical resident</th>
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</thead>
<tbody>
<tr>
<td>Productivity</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
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<tr>
<td>Adult survival</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Juvenile survival</td>
<td>Low</td>
<td>Moderate to high</td>
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- Annual survival rate in tropics = 80-90%
- Annual survival rate for migrants = 50%
- Annual survival rate for temperate residents = 20–60%

Migration patterns vary within species

- Resident and migrant European Robins
  - Genetic polymorphisms affect the timing of molt, premigratory fattening, and migratory restlessness (Zugunruhe).
  - Crosses of resident and migrant individuals showed intermediate migration.

Migration patterns vary with sex and age

- Ketterson and Nolan’s studies of Dark-eyed Juncos
  - Young males stay farther north
  - Adult females migrate farther south
  - Adult males and young females settle at intermediate latitudes

Early arrival matters

  - American Redstarts arriving early at Hubbard Brook were fatter and got best territories
  - Dominant birds in Jamaica and Honduras preferred mangrove over scrub habitats
  - Stable isotope signatures indicate early Hubbard Brook birds were from mangrove (C3) rather than scrub (C4) habitats
  - Wintering habitats may be limiting

- Rubenstein et al. 2002.
  - Expand approach to look at distributions of breeding and wintering populations.
**Amazing migrants**

**Flight ranges of migrants**

- **Fat is the fuel for migration**
  - **Hyperphagia, rapid fattening before migration**
    - Average weight gain is 15 – 25%
    - Hummingbirds and Blackpolls, 100%
  - Fat is stored under the skin, particularly over the flight muscles on the sternum, and the cavity formed by the furcula

**Fat levels explain the stopover ecology of migrants**
Arrival fat levels explain stopover length

Habitat quality explains daily migrant turnover rates

The timing of migration
- Many migrations show precise timing synchronized to day length and temperature

Patterns of migration
- Broad front
  - Species widely distributed on both breeding and wintering grounds usually migrate in broad fronts

Patterns of migration

- Narrow front
  - Characteristic of species with restricted breeding and wintering ranges

Productive wintering grounds and restricted breeding grounds...

Hunters can shoot more tundra-grubbing snow geese

The government announced new permits Friday to shoot thousands of snow geese under a program to stabilize the population. The geese migrate north—often stopping in Canadian tundra—before migrating south to winter grounds. Hunters have complained about reducing yields of snow geese, and the U.S. Fish and Wildlife Service has estimated the population of snow geese at about 1.9 million.

Speed of migrants

- Hawks, swifts, swallows, migrate during the day
  - Use thermals and feed on the wing
- Passerines migrate at night
  - Avoid predators, save water, stay cool, stable air
- Most species fly between 750 – 1000 m
- Shorebirds up to 4000 m

Time of day and altitude
Fall migration
- Largest flights occur with the southward flow of dry polar air immediately following the passage of a cold front

Spring migration
- Major movements occur in warm southerly air flow on the west side of high pressure centers

New technologies advance our understanding of migration
- Radar Ornithology
- Satellite Tracking
- Flight Call Monitoring
- Geolocators
- GPS Loggers
- GPS Telemetry
- Molecular Tools

Radar ornithology
- WSR 57 – analog
  - Timing and a rough estimate of intensity
- Nexrad – digital
  - Timing, elevation, speed, intensity
A large flight takes off from Cuba 3/14/02
7:30 pm – 1:30 am

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Satellite telemetry
• ARGOS system of three satellites dedicated to wildlife radio tracking
• Transmitters now as light as 10 grams allows tracking birds as light as 200 grams

16 Bar-tailed Godwits were satellite-tagged in New Zealand in February 2007. Godwit E7 was tracked over her complete flight after leaving New Zealand in mid-March to her return in early September, an odyssey that covered almost 30,000 kilometers.
http://www.oystercatchertracking.org

Nocturnal flight call monitoring
• Cornell Laboratory of Ornithology
• Identify migrants to species using digital analysis of recorded nocturnal flight calls
• ARU’s record in remote locations for weeks at a time

American Redstart flight calls

Geolocators
• Passive data collection system
  – Uses day length and light intensity to calculate location within 1° of Lat/Lon
    • Time of local noon determines longitude
    • Time of sunrise and sunset (day length) determines latitude
  – Can also record diving depth, temperature, activity
  – Record for up to 10 years
Second generation geolocators

GPS Loggers and Telemetry

- Cellphone technology has revolutionized animal telemetry
  - Miniature GPS receivers
  - Accelerometers
- Loggers vs Transmitters
- ICARUS Project
  - Receiver on international space station
  - Low power transmitters as small as 5 g.
  - Antenna 2/13/18, operational ~2019

Movement visualizations

Molecular Tags
Stable Isotopes
DNA

Neotropical migrants
European Storks