Assessing the effects of coastal engineering on non-breeding shorebirds in estuaries and inlets

Casey Lott - American Bird Conservancy
Most of the ideas in this presentation come from…

Peer-reviewed literature, online resources

Bird monitoring methods

Wetland bird survey, UK… BTO, RSPB, WWT

http://www.bto.org/survey/webs/index.htm

The Shorebird Model

Centre for Coastal Ecology and Hydrology, UK

http://www.ceh.ac.uk/birds/Default.asp

Photos

Previous workshops: Walker Golder, Brian Harrington, Sidney Maddock

If you haven’t been acknowledged, please forgive me
Inlets and estuaries are very important for birds
Inlet-o-philic species

Highly imperiled

High concern

American Oystercatcher
Mean of counts with standard error

N=254
N=107

Piping Plover

Wilson's Plover

Red Knot

Short-billed Dowitcher
Non-breeding shorebirds alternate between roosting at high tide and foraging at lower tides.
Individual birds use habitats in predictable way

Forage in most profitable habitat for species
Unless excluded by dominant individual
Then... move to next best habitat patch
If no habitat available, roost
Bird monitoring protocols for inlets or estuaries

Identify major foraging and roosting areas
Count birds at roosts at high tide for population size
Divide areas into count sectors if necessary
Count birds at low tide to document foraging areas
Frequency and scheduling of counts
Repeat counts once a month to track seasonal changes
Schedule counts 1hr from high (or low) tide - plus/minus
Schedule counts on same date at adjacent sites

Regional high tide count dates
- September 18
- October 16
- November 6
- December 4
- January 15
- February 12
- March 12

Sunday closest to spring or neap tides (high/low counts)
What do numbers tell us?

Site counts can be compared with global, hemispheric, or regional population estimates for species

Sites with >1% of population considered “important”

Sites with >20,000 individuals considered “important”

Low tide counts: track changes in habitat use over time

High tide counts: site-based population trends

How do we interpret changes in numbers over time?

- May be related to quality of site
- May be related to changes in breeding populations
- May be related to use of other wintering sites

Counts are not unambiguous indicators of site quality
How can monitoring help to meet conservation goals?
Use monitoring data to inform management that will…
Maintain quality sites to improve conservation status
Ultimate objective is to increase population size
Do this by improving over-winter survival rates
Evaluate effects of actions and site-based management on survival, not just numbers
How do we monitor over-winter survival?

Long-term, intensive banding-resighting studies

Expensive, many years to produce results

Alternative- model survival probabilities

Individual-based, behavior-based models

Centre for Coastal Ecology and Hydrology, UK

http://www.ceh.ac.uk/birds/Default.asp
The Shorebird Model

Ridiculously complex, many papers

Solid theory, empirical data, validated and tested

 Requires minimal field data collection

Intertidal food supply (2-3 weeks, one time event)

Bird abundance, habitat mapping, human disturbance
data collected by 2-3 person field crew (Sep.- Mar.)

Time-frame of environmental assessment (modeling)

Can be used to predict effects of actions on survival

Loss of habitat from dredging

Effectiveness of potential mitigation projects

Different scenarios of disturbance management
How does the model work?

Most over-winter mortality is due to starvation

Individuals must eat enough to meet energy demands

Individuals forage in patches that will maximize intake

Individuals vary in foraging efficiency and dominance

Foraging patches vary in quality and competitor density

Model simulates foraging locations, intake rates, body condition, and ultimate fate of each individual for each day of winter across each tidal cycle

If individual meets daily energy demands, it stores fat

If not, it uses energy reserves until these $= 0$ and it dies
Effects of port expansion and proposed mitigation

Foraging areas = F

Dunlin
Curlew
Oystercatcher
Invertebrate diet varied by bird species

**Polychaete**
- *Hediste*
  - 0-4.99
  - 5-9.99
  - 10-14.99
  - 15-19.99
  - 20-24.99
  - 25-29.99
  - 30-34.99
  - 35-39.99
  - 40-44.99
  - 45-49.99
  - 50-54.99
  - 55-59.99
  - 60-64.99
  - 65-69.99
  - 70-74.00
  - 75+

**Mud shrimp**
- *Cerastoderma*
  - 0-4.99
  - 5-9.99
  - 10-14.99
  - 15-19.99
  - 20-24.99
  - 25-29.99
  - 30-34.99
  - 35-39.99
  - 40-44.99
  - 45-49.99
  - 50-54.99

**Clam**
- *Mytilus*
  - 0-4.99
  - 5-9.99
  - 10-14.99
  - 15-19.99
  - 20-24.99
  - 25-29.99
  - 30-34.99
  - 35-39.99
  - 40-44.99
  - 45-49.99
  - 50-54.99

Fig. 2. The size range (mm) of prey taken by each bird species in the model. DUN = dunlin, CUR = curlew, OYC = oystercatcher.
### Sampling to characterize different foraging patches

<table>
<thead>
<tr>
<th>Patch name</th>
<th>Area (ha)</th>
<th>Mean exposure time (h)</th>
<th>Description</th>
<th>Prey species</th>
<th>Disturbance (n d⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vasières 1</td>
<td>206.5</td>
<td>8.09</td>
<td>Mudflat</td>
<td><em>Hediste diversicolor, Corophium volutator</em></td>
<td>0.016 0.125</td>
</tr>
<tr>
<td>Vasières 2</td>
<td>214</td>
<td>6.41</td>
<td>Mudflat</td>
<td><em>Hediste diversicolor, Macoma balthica</em></td>
<td>0.016 0.125</td>
</tr>
<tr>
<td>Vasières 3</td>
<td>21</td>
<td>3.24</td>
<td>Mudflat</td>
<td><em>Hediste diversicolor, Macoma balthica</em></td>
<td>0.016 0.125</td>
</tr>
<tr>
<td>Pennedepie</td>
<td>388</td>
<td>2.99</td>
<td>Cockle bed</td>
<td><em>Cerastoderma edule, Macoma balthica, Nephtys hombergii</em></td>
<td>0.09 0.20</td>
</tr>
<tr>
<td>Villerville</td>
<td>218</td>
<td>2.24</td>
<td>Mussel bed</td>
<td><em>Mytilus edulis</em></td>
<td>0.13 0.64</td>
</tr>
</tbody>
</table>

**Patches varied by size and exposure length**

**Patches varied by invertebrate composition and biomass**

**Patches varied in disturbance rates**

**Patches had different value for different species!!**

**Effects of action spatially explicit and will vary by species**
Partial model validation

White bars = field observations- Grey bars = model predictions

Model accurately predicted use of different foraging patches

Effects of expansion will vary by patch and species
Physical habitat loss (105 ha) of flats due to expansion
Disturbance-related habitat loss due to expansion
Combined effect not shown here
Model used to design mitigation area

Oystercatchers needed 50 ha mitigation area to compensate for habitat lost to port expansion (no buffer)

Dunlins needed 100 ha mitigation area (no buffer)

Effectiveness of mitigation depended on prey densities
Insights from applications of shorebird model

Disturbance can increase mortality just like habitat loss

Keeps some birds from high quality foraging areas

Increases energy expenditures

Increases competitor density in undisturbed areas
Mortality starts to increase well before food is depleted. Due to factors that restrict access to food supplies, competition with other birds, and human disturbance, 4-8 times as much food as birds will eat is needed. The food:bird ratio can be seen as carrying capacity.
Summary: bird monitoring for inlets and estuaries

Do systematic sampling of intertidal invertebrates in early winter (when first birds arrive)

Map and measure the area of foraging patches

Measure or model the exposure time of foraging patches

Identify all areas used for roosting by birds

Count birds at high tide (1x/ mo.) for population size

Do focal observations at low tide in different patches to document disturbance frequency & behavioral response

Develop models to test effects of management alternatives based on bird, food, and disturbance data on over-winter survival for priority species

Repeat periodically to test predictions, track changes