How many Brown Bears are on the Kenai Peninsula?
Why we estimated the Kenai brown bear population in 2010…. 

- Designated *Population of Special Concern* by State of Alaska in 1998 – 2010
- Genetically less diverse than (and distinct from) adjacent mainland Alaskan brown bears
- Only estimate of 250-300 brown bears based on multiplying the area of suitable habitat by mean bear density from other AK studies
- Population trend unknown ($\lambda = 0.9364 – 1.0588$)
- Low yearling survivorship and small proportion of subadult females suggested low recruitment
- Annual DLPs increased from <1 in 1960s to 5 in 1990s to >20 in 2000s
DNA-based mark-recapture model to estimate population
Simple Lincoln-Petersen Estimator

\[ N = MC/R \]

- \( N \) = Estimate of total population size
- \( M \) = Total number of animals captured and marked on the first visit
- \( C \) = Total number of animals captured on the second visit
- \( R \) = Number of animals captured on the first visit that were then recaptured on the second visit
How many double-crested cormorants in the Skilak Lake colony?
“Mark” 16 birds with red leg-bands
“Re-capture” 5 birds, of which 3 have red leg-bands
27 cormorants

\[ \frac{N}{16} = \frac{5}{3} \]
Simple Lincoln-Petersen Estimator

\[ N = \frac{MC}{R} \]

- \( N \) = Estimate of total population size
- \( M \) = Total number of animals captured and marked on the first visit
- \( C \) = Total number of animals captured on the second visit
- \( R \) = Number of animals captured on the first visit that were then recaptured on the second visit

...estimate is not based on the number of individuals marked (i.e., genotypes) but on their recapture rates
Assumptions of Mark-Recapture Model

- No individuals die, are born, move into the study area (immigrate) or move out of the study area (emigrate) between visits

- No marks fall off animals between visits, and that the researcher correctly records all marks

- Equal capture probability of individuals
145 primary hair stations subjectively placed within 81-km² cells systematically distributed over 11,700 km² study area

29 stations sampled daily over five 5-day trap sessions using rotating panel design
Selection criteria for hair stations

✓ adequate space for helicopter access

✓ > 400m from trails, cabins, roads

✓ riparian/wetland corridors

✓ other travel corridors (ridges, shoulders, chutes)

✓ OTBE, ensure good spatial separation among sites within a cell
Four sets of 2-person field crews operated out of Moose Pass and Soldotna for 31 consecutive days.
11,175 hair samples (grid) + 91 hair samples (rub tree) = 11,266 hair samples

11,266 hair samples → 2,671 DNA samples

2,671 DNA samples → 1,034 brown bear samples

1,034 brown bear samples → 211 unique genotypes

211 unique genotypes → 104 males + 99 females (n = 203)
Distribution of 211 brown bear captures at 145 primary + 7 secondary hair stations
Brown bear population estimate (all ages) on 11,700 km² sample frame

**GRID + telemetry data + rub trees**

<table>
<thead>
<tr>
<th>Sex</th>
<th>Estimate</th>
<th>SE</th>
<th>$M(t +1)$</th>
<th>95% Lognormal CI</th>
<th>LCI</th>
<th>UCI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>214.6</td>
<td>33.7</td>
<td>99</td>
<td>165.0</td>
<td>165.0</td>
<td>301.3</td>
</tr>
<tr>
<td>Males</td>
<td>213.1</td>
<td>30.9</td>
<td>104</td>
<td>167.2</td>
<td>167.2</td>
<td>292.2</td>
</tr>
<tr>
<td>Combined</td>
<td>427.6</td>
<td>46.7</td>
<td>203</td>
<td>353.2</td>
<td>353.2</td>
<td>539.1</td>
</tr>
</tbody>
</table>
ALASKA BROWN BEAR DENSITIES (PER 1000 KM$^2$)
(after Miller et al. 1997)

42 bears per 1000 km$^2$
How many brown bears on the Kenai Peninsula?

428 (353-539) brown bears estimated (all ages) on 11,700 km$^2$ sample frame of which 10,200 km$^2$ is available habitat

$\approx 42$ bears per 1,000 km$^2$

$\approx 582$ bears on the KP (469-719)

$\approx 188$ independent females

$\approx 206$ dependent young

(Morton et al. 2015)
What are the management implications for Kenai brown bears?

✓ Represents 1st empirically-based estimate of the Kenai brown bear population

✓ Puts human-caused mortality (legal harvest, illegal take, vehicle collisions, agency kills and DLPs) into better demographic context

✓ Helps determine sustainable harvest
Human-caused mortality of Kenai brown bears in past 4 years 3 times more than 1995-2011 annual average

<table>
<thead>
<tr>
<th>Year</th>
<th>Total HCM</th>
<th>Adult females</th>
<th>% on KENWR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>44</td>
<td>13</td>
<td>30%</td>
</tr>
<tr>
<td>2013</td>
<td>71</td>
<td>23</td>
<td>35%</td>
</tr>
<tr>
<td>2014</td>
<td>69</td>
<td>6</td>
<td>3%</td>
</tr>
<tr>
<td>2015</td>
<td>29</td>
<td>6</td>
<td>21%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>213</td>
<td>48</td>
<td>22%</td>
</tr>
</tbody>
</table>

- Human-caused mortality of adult female bears averaged 4 per year during 1995-2011 but increased to 14 per year in 2012-14

- Total brown bears killed by humans averaged 20 annually during 1995-2011 but increased to 61 bears annually during 2012-14
Population demographics used in VORTEX

- Based on data 1995-2014
- Polygynous system with 100% of adult males breeding
- Reproductive age = 6 years
- Maximum breeding age = 26 years
- 50% males, 50% females
- Adult females breeding = 34%
- Initial population of 582
- Assumes telemetered population of adult females is representative of peninsula-wide population
- Assumes stable age distribution, no density-dependent mortality

Based on Farley 2013, Morton et al. 2014, ADF&G harvest data 2012-14 (revised with teeth ages)

\[ N_t = N_0 e^{rt} \]
Kenai brown bear population would have grown to 643 by 2014 if harvest had not been liberalized in 2012-14
2012-14 harvest (n = 184) depressed the Kenai brown bear population by 18% (478 bears) from 2010 to 2014.
Questions???

582 brown bears in 2010
478 brown bears in 2014