Ecological constraints, migratory pathways, and anthropogenic impacts on red-throated divers in the North Pacific

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Red-throated Divers - Research Foci

1) Ecological constraint
   Food availability, quality, breeding success and variation in oceanographic conditions.

2) Population connections
   Migration movements (telemetry) and genetic differentiation

3) Anthropogenic impacts
   Contaminants exposure
Aerial Surveys of Breeding Waterbirds
Migratory Bird Management
U.S. FWS

Relative Abundance of Red-throated Divers

Tree Line
1300 km
Aerial Surveys of Breeding Waterbirds
Migratory Bird Management
U.S. FWS

Relative Abundance of Red-throated Loons

2002-2003 (Manokinak)

2008-2010 (Pt. Lay)

53% decline in abundance in less than 20 years
**Jeff Ball thesis (Manokinak)**
No 2-chick broods
Both parents frequently away foraging
Low energy density prey

**Dan Rizzolo thesis (Pt. Lay)**
66% of broods w/ 2 chicks
One parent always attending
High energy density prey
Chick Body Mass as a Function of Age and Chick Status

Pt. Lay (NW AK) 2008-2009

Manokinak River, Y-K Delta 2002-2003
The Menu

- Saffron Cod 3.0 kJ g⁻¹ wet mass
- Least Cisco 5.2 kJ g⁻¹ wet mass
- Rainbow Smelt 3.5 kJ g⁻¹ wet mass
- 4-horn Sculpin * kJ g⁻¹ wet mass
- Arctic Flounder 3.1 kJ g⁻¹ wet mass

*Energy values from Ball et al. 2007
The Menu

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*Energy values from Ball et al. 2007*
*G. pacifica* typically feeds young Notostraca (tadpole shrimp)
Low energetic value, but very abundant.

Thus, *G. pacifica* has constantly moderately low productivity.
And, *G. stellata* has years of very high and very low productivity.
Fresh vs. Salt trends in RTLO assuming mean (i.e. 0) levels of segment, year, and segment*year random effects

**Regime Shift (Pacific Decadal Oscillation)**

- Salt trend 1976-1999: 0.947 (0.933 - 0.960)
- Salt trend 2000-2009: 1.079 (1.040 - 1.112)
- Fresh trend 1976-1999: 0.974 (0.955 - 0.989)
- Fresh trend 2000-2009: 1.013 (1.013 - 1.096)
Regime Shift (Pacific Decadal Oscillation)

Is this too little data to be useful; or this implies foraging on freshwater lakes lacks booms and busts.
Survival of Adult Red-Throated Loons (*Gavia stellata*) May be Linked to Marine Conditions

(Waterbirds 2014:118-124)

Table 1. Seven different models of variation in the survival of adult Red-throated Loons marked in Alaska.

<table>
<thead>
<tr>
<th>Model of Survival Variation</th>
<th>Number of Parameters</th>
<th>Analysis with Two Mortalities</th>
<th>Analysis with Four Mortalities</th>
<th>Average of Two Analyses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early vs. late years</td>
<td>2</td>
<td>0.60</td>
<td>0</td>
<td>0.317</td>
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<tr>
<td>Breeding vs. nonbreeding seasons</td>
<td>2</td>
<td>1.48</td>
<td>1.76</td>
<td>0.154</td>
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<tr>
<td>Invariant</td>
<td>1</td>
<td>0.52</td>
<td>1.86</td>
<td>0.188</td>
</tr>
<tr>
<td>Migration vs. non-migration seasons</td>
<td>2</td>
<td>0.52</td>
<td>3.06</td>
<td>0.179</td>
</tr>
<tr>
<td>Breed/molt vs. other seasons</td>
<td>2</td>
<td>0.95</td>
<td>3.76</td>
<td>0.115</td>
</tr>
<tr>
<td>All four seasons differ</td>
<td>4</td>
<td>3.31</td>
<td>4.62</td>
<td>0.047</td>
</tr>
</tbody>
</table>
Satellite Telemetry: Capture and Marking

Mist nests during chick-rearing

Bow nests during nesting

Suspended dive net

Uher-Koch et al. 2016. Ringing and Migration (Nesting or early chick rearing)
Satellite Telemetry: Capture and Marking

Mist nests during chick-rearing

Bow nests during nesting

Suspended dive net

Transmitter
(abdominal implant; ~ 42 g)

Antenna

Uher-Koch et al. 2016.
Ringing and Migration
(Nesting or early chick rearing)

Numbers and Distribution of Satellite Transmitters

N = 80

N = 20

N = 33....plus 9 six-week old chicks
Numbers and Distribution of Satellite Transmitters
Diver Genetics:

**G. adamsii**
Genetic distinctions among populations
Low levels of genetic variability

**G. stellata**
Evaluation of genetic distinctions ongoing
Low levels of genetic variability

**G. pacifica** and **G. immer**
Are both more genetically variable than **G. adamsii** or **G. pacifica**
Arctic Coastal Plain, n = 5

Yukon-Kuskokwim Delta, n = 3

Copper River Delta, n = 7
Adult *Gavia stellata*

- N=14
  - Arctic Coastal Plain (ACP)
- N=6
  - Seward Peninsula (SP)
- N=7
  - Yukon-Kuskokwim Delta (YKD)
- N=6
Seward Peninsula

Mouth of the Kuskokwim River

Copper River and Yakutat Bay
After 2005, we did not obtain any more locations west of Tokyo; suspected signal interference.
Arctic Coastal Plain (n=1)

- Breeding Grounds
- Fall Stopover
- Wintering Grounds
- Spring Stopover
- In Flight
Last location June 26, 2009
(maybe residing in wintering area for first full summer?)
Last location June 26, 2009

(maybe residing in wintering area for first full summer?)

Dispersal may affect genetic distinctions among populations
Red-throated Divers
(All high quality locations for all individuals)
Red-throated Loons

Toxicity of PCBs

![Map showing locations with red dots indicating high quality locations for all individuals.]

![Graph showing TEQs (pg/g ww) for different regions: Arctic Coastal Plain (n=12), Cape Espenberg-Seward Peninsula (n=6), Yukon-Kuskokwim Delta (n=7), Copper River Delta (n=5).]

A
YBLOs farther offshore than RTLOs
Red-throated Divers

(All high quality locations for all individuals)
Recent population declines in northern Alaska:

Changes in marine prey? Coastal erosion? Contaminants?
Thank You! Any Questions ??

Photo by R. Askren