Effects of a rapidly warming climate on the (western) Kenai Peninsula

John Morton
Kenai National Wildlife Refuge
Alaska is warming at 2X Lower 48 rate

Climate warming effects are not masked by other human-caused drivers of change

Kenai Peninsula may be best studied locale in AK outside of high arctic
The western Kenai has warmed and dried in last 50 years.
Forecasted growing season length (days > 0°C)*

- **2010–2019**: 196-219 days
- **2090–2099**: 220-243 days

*as 10-year averages assuming mid-range emissions (A1B) from the 5-model average at 2km resolution*
Dramatic ecological responses to rapidly warming climate

- decreasing available water (60% loss since 1968)
- drying wetlands (6 – 11% per decade)
- receding glaciers (-11% surface area, -21m elevation, +55% thinning rate)
- rising treeline (1m/yr) and shrubline (2.8m/yr)
- unprecedented SB beetle outbreak (triggered by 2 consecutive warm summers)

Official fire season is now April 1 instead of May 1.
Woody shrubs encroach into 8,000 year old Sphagnum peatlands

Dwarf Birch Shrub Age

<table>
<thead>
<tr>
<th>Number of Stems</th>
<th>Apparent Age of Shrubs (Years)</th>
</tr>
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<tbody>
<tr>
<td>20</td>
<td>0</td>
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<tr>
<td>15</td>
<td>10</td>
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<tr>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>30</td>
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</tbody>
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Average stem age is 14 years
Oldest stems are 32 years

Berg et al. 2009
Salmon in 47 of 48 non-glacial streams experience thermal stress in July

Maximum temperatures not to be exceeded:
- egg & fry incubation = 13°C
- spawning areas = 13°C
- migration routes = 15°C
- rearing areas = 15°C
- and may not exceed 20°C at any time

Mauger 2011, Mauger et al. 2017
Changing migration window in last decade

- Earlier arrival records for 33 species
- Later departure records for 38 species
- 27 new species since 2007

Eurasian-collared dove*
Redwing*
Jack snipe*
Skylark*
Long-billed murrelet*
Black-tailed godwit*
Northern mockingbird
Spotted towhee
Turkey vulture
Western kingbird
Western meadowlark
Willow flycatcher
Northern wheatear
Western tanager
Yellow-bellied sapsucker
Warbling vireo
Swamp sparrow
Tennessee warbler
Cape May warbler
Nashville warbler
Wilson’s phalarope
Great egret
Willet
Red-footed booby
Black guillemot
Heerman’s gull
Lesser black-backed gull
American marten colonized Kenai Lowlands ~2002

Alpine rest sites

Lowland rest sites

Baltensperger, Morton & Huettmann 2009
Conversion of white/Lutz spruce forests to Calamagrostis savannah

Boucher and Mead 2006
Spruce Bark Beetle Mortality (1989-2010)
Wildfires (1994–2007)

1994 Windy Point
1996 Crooked Creek
2005 Glacier Creek
2005 Fox Creek
2005 Tracy Avenue
2007 Caribou Hills
40,000-acre contiguous grassland polygon in 2015

2002 imagery
- Forest 55%
- Other 40%
- Herbaceous 5%
Highest fire probability aligned with herbaceous and black spruce cover

Sitka, Lutz and White Spruce
Staudinger et al. (2012). Impacts of Climate Change on Biodiversity, Ecosystems, and Ecosystem Services: Technical Input to the 2013 National Climate Assessment
Questions????

WHAT MOVES HAVE YOU MADE IN RESPONSE TO CLIMATE CHANGE?
— PETER

ABOUT 5 METERS INLAND.