The Potential Impact of Loss of Sea Ice on Alaska’s Subarctic and Arctic Large Marine Ecosystems

Presented By

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Sea Ice Impacts **FAT** (LIPID) Available to Fish

**Large Zooplankton**

- Omega 3 benefit to Humans
  - Ease Depression
  - Lower Cholesterol
  - Eliminate Joint Pain
  - Promotes Weight Loss
  - Reduced Risk of Heart Disease
Sea Ice In Arctic and Subarctic Ecosystems

Adapted from Large Marine Ecosystems of the Arctic area, Revision of the Arctic LME map, Protection of the Arctic Marine Environment, Arctic Council, May 15, 2013.
Time of Sea ice Retreat and Zooplankton (Fish Food) Fat Content

- **Early Ice Retreat** leads to **Late Bloom, Warm Water**, resulting in **Mostly SMALL zooplankton** and **Less FAT**.

- **Late Ice Retreat** results in **Early Bloom, Cold Water**, leading to **Mostly LARGE zooplankton** and **More FAT**.

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Example: Spring Ice Extent

Early Ice Retreat
2002 to 2005

Late Ice Retreat
2007 to 2012

May 2002

May 2012

Alaska

Alaska
Sea Ice Extent and Walleye Pollock Fishery

- Commercial value = $497.0 million (2012 McDowell Group)
- 40% drop in available pollock catch from 2004 to 2008
Late Ice Retreat = Higher **FAT** Content in Zooplankton

Zooplankton Type

- Larval Fish
- Small Euphausiid
- Other

Small Copepod
- Medium Copepod

Large Copepod
- Large Euphausiid

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Shifts in Walleye Pollock Diet

You are what you eat!

Condition of young Pollock

**Early Ice Retreat**

**Late Ice Retreat**

Fish store more FAT during years with Late Ice Retreat

Amount of **FAT** stored before winter = Higher Survival

![Graph showing survival to age 3](image)

Timing of Sea Ice Retreat = Fish Food Quality = Walleye pollock survival

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In the Arctic, It’s Survival of the Fattest

- Food Web
  - Zooplankton
  - Arctic cod
  - Ice seals

- Polar Bear
Summer Distribution and Abundance of Young Arctic and Saffron Cod

Arctic cod
(2.6\times10^{11} fish)

Saffron cod
(6.5\times10^{9} fish)

Prefer colder water

Prefer warmer water

Sea Surface Temperatures

Abundance (Fish nmi^{-2})

Data are from the Arctic Ecosystem Integrated Survey - see https://web.sfos.uaf.edu/wordpress/arcticeis/ for more information
Predators must consume 2.7x the Saffron Cod to get the same lipid as 1 Arctic Cod

Heintz & Vollenweider Unpublished data
Growth Response in Relation to Temperature

- Arctic cod
- Saffron cod
- Pacific cod
- Walleye pollock

- Arctic cod
  - $T_{max} = 7.3^\circ C$

- Saffron cod
  - $T_{max} = 14.8^\circ C$

- Pacific cod
  - $T_{max} = 11.5^\circ C$

- Walleye pollock
  - $T_{max} = 13.0^\circ C$

Ben Laurel, In Review
Water will be too warm for Arctic Cod?

Courtesy of Muyin Wang, Pacific Marine Environmental Laboratory, Seattle, WA
Conclusion

Reduced sea ice extent and duration in Alaska’s Arctic and Subarctic ecosystems will limit the available *HIGH FAT* prey that Fish and Mammals require for good health and survival.

This has the potential of affecting some of the most important commercial fisheries in Alaska and could impact marine mammal populations in the Arctic that Alaskan’s depend on for food.