Temperature Tolerance of the Isopod *Saduria entomon*

28th Lowell Wakefield Fisheries Symposium: Responses of Arctic Marine Ecosystems to Climate Change
March 26-29, 2013

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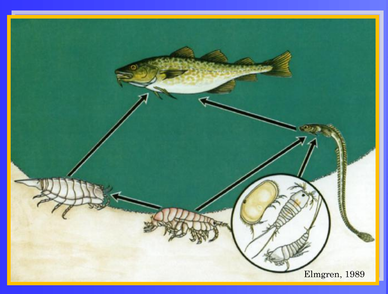
Abstract

The pan-Arctic benthic isopod *Saduria (Mesidotea) entomon* is a euryhaline species that in lives in cold water oceans, bays, estuaries, and lower creeks. In Arctic and sub-Arctic regions, *S. entomon* is an important species in coastal food webs as an opportunistic predator as well as detritus and carrion shredder. In southwest Alaska, the sub-Arctic Nushagak Bay Estuary is home to a large population of *S. entomon* , which has been observed eating the immense number of spawned out salmon and is also found in abundance in waters influenced by salmon processing effluent. Because one of its roles is a carrion shredder, *S. entomon* serves an important function in the Nushagak Estuarine food web. As water temperatures continue to increase in southwest Alaska, can *S. entomon* survive in warmer water? To investigate temperature tolerances of *S. entomon* individuals were collected from Squaw Creek, a small tributary that drains into Nusahgak Estuary. To equilibrate specimens to lab conditions, isopods were placed in a refrigerator at 10°C for over 10 days and kept in water taken from Squaw Creek. Tolerance studies were then conducted for three hour periods using a 2 meter trough with a 0 to 20°C temperature gradient allowing isopods to choose their preferred temperature. Results indicated that the isopods were positively correlated to temperatures between 0 and 10°C and negatively correlated to temperatures above 15°C. Tidbit temperature loggers were placed at isopod collection sites in Squaw Creek to collect temperature data throughout the summer of 2007 and 2008. It was found that ambient water temperatures in Squaw Creek fluctuated from 5°C (May) to 15°C (August). Thus, higher water temperatures may limit the distribution of *S. entomon*, considering that it prefers cooler water. More work needs to be done to investigate the temperature ranges of the creeks and estuaries such as the Nushagak. If 15°C is the upper temperature limit, than *S. entomon* could be used as an indicator of summer watershed temperatures. Future work should help to answer these questions as this project continues to investigate the relationship between water temperature and isopod thermal sensitivity in Nushagak Bay.

Saduria (Mesidotea) entomon

Common isopod in the Arctic and subarctic

Important species in Estuarine Food Web



Alaskan Habitat:

- Important part of benthic nearshore assemblages
- In Bering Sea and estuaries as well as large lakes (e.g. Iliamna and Becharof lakes)
- Euryhaline –fresh water to marine
- Intertidal to 100+ meters
- Varying bottom sediments (gravels to muds)

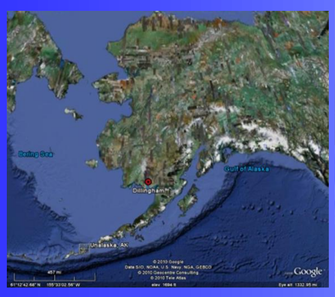
Lifecycle (Narver 1968, Leonardsson 1986):

- 2-4 years
- Juveniles released from May - June from female marsupium
- Second summer, sexual dimorphism occurs - males larger
- Third summer and fall, females develop ova and larvae mature in winter
- Some evidence of 4 size classes

Opportunistic feeding:

- Fish carrion
- Predator (amphipods, mussels, mysides, sculpin, cod and cannibalistic)
- Benthic - also reported to prey on pelagic species (Narver 1968, Leonardsson 1986)

Nushagak Bay Faunal Zones



Estuaries form where rivers meet the sea and contain an assortment of different types of habitats including freshwater and salt marshes, sandy to gravelly beaches, mud flats and sand bars. The Nushagak estuary is among the most productive in Bristol Bay serving as a nursery for fish and invertebrates and for smolting salmon and their migration to and from the sea. In Nushagak Bay four large rivers, the Nushagak, Wood, Snake, and Igushik shape this ecologically and commercially important estuary. Cliffs of glaciofluvial materials are found up to 200 feet high which often characterize the shoreline.

Riverine

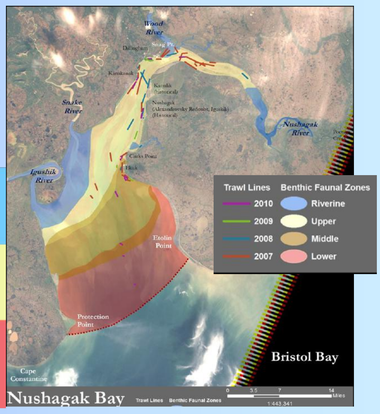
Sediment: Gravel / Cobble, course sand
Turbidity: Low (0-50 NTU)
Diversity: Lowest
- All freshwater
Biomass: Lowest

Upper Estuary

Sediment: Course to fine sand
Turbidity: Highest (200-300 NTU)
Diversity: Medium
- Euryhaline epibenthic to pelagic
Biomass: Medium (shrimp/amphipods)

Lower Estuary

Sediment: Med. sand to silt (bars), course sand (channels)
Turbidity: Variable (50 – 200 NTU)
Diversity: Highest
- Euryhaline epibenthos and marine
Biomass: Highest (echinoderms, fin fish)



In Nushagak Bay *S. entomon* is found in:

- Faunal zones: Riverine, Upper and Lower Estuary.
- Salinities: 0 to 20ppt
- Temperatures: 0 to 12°C
- Associated fauna: grammid amphipods, rainbow smelt, salmon smolt, krevgen shrimp,sculpin

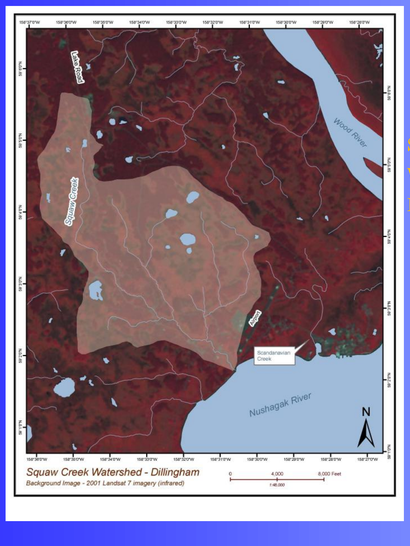
Riverine - Estuary Fauna

Upper Estuary Fauna

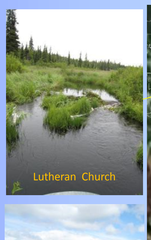
Lower Estuary Fauna

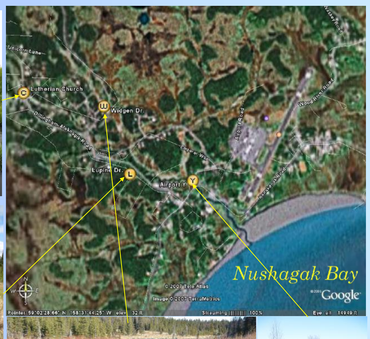
Study Site: Tidally influenced Squaw Creek

S. entomon collected for temperature experiments

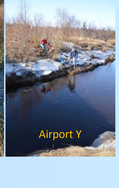


Squaw Creek
Watershed
Dillingham, AK





Squaw Creek
Sampling Stations



Methods

Collection of Isopods

Collected using minnow traps baited with sockeye eggs

Preparing Test Organisms

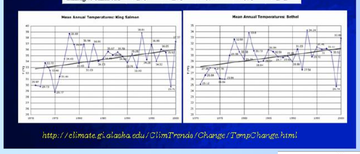
- Keep in 10°C for more than 4 hours
- Greater the 8% oxygen
- Healthy swimming individuals

Alaska Temperatures Changes

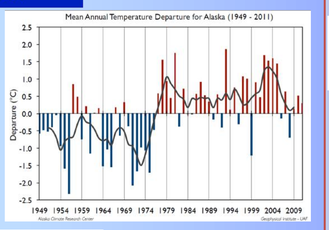
Air Temp Changes

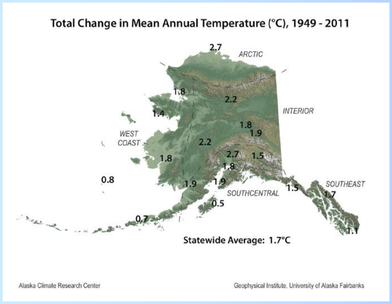
Alaska Climate Research Center (°C)

Place	Annual	Spring	Summer	Fall	Winter
Bethel	+1.8	+2.4	+1.0	-0.1	+3.7
King Salmon	+1.9	+2.3	+0.7	+0.3	+4.4



http://climate.gi.alaska.edu/ClimTrends/Change/TempChange.html





Results

Temperature Experiments

Two Types of experiments were conducted

Temperature Tolerances

Experiment ran for over 8 hours

Temperature Preferences

- Temp gradient

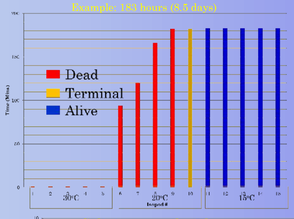
Temperature Tolerances Summary

Temp (°C)	n=	died	Mean hours to death	SD
0.5	50	0	<250	0
15	5	0	<183	0
20	18	94% (17)	89.0	58.1
25	7	100%	97.4	46.6
30	18	100%	2.3	1.6

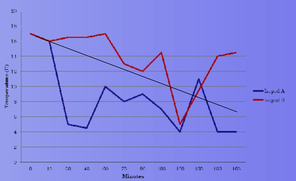
Temperature Preferences Summary

	2008	2009	Totals
# of Exp	3	6	9
n=	6	18	24
Total hours	11.3	17.8	27
Mean	12.8° Hi=20° Lo=3°	15.7° Hi=21° Lo=1°	14.5° Hi=21° Lo=1°
SD	6.2	6.0	6.2

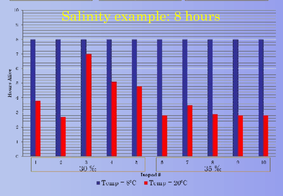
Example: 183 hours (8.5 days)

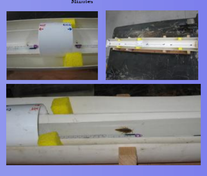


Example: 3 hours



Salinity example: 8 hours

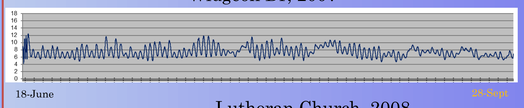




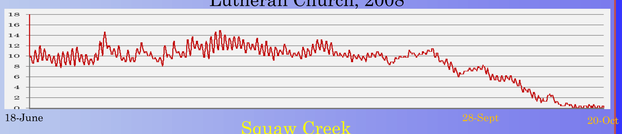
Summer Stream Temperatures

Airport Y, 2007

Widgeon Dr, 2007



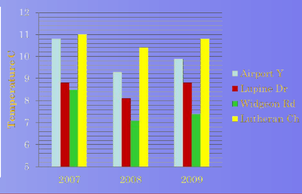
Lutheran Church, 2008



Squaw Creek

Average June– Aug Water Temperature

Location	2007 (n=9)		2008 (n=12)		2009 (n=10)	
	mean	st dev	mean	st dev	mean	st dev
Airport Y	10.8	2.2	9.3	1.8	9.9	1.6
Lupine Dr	8.8	2.0	8.1	1.5	8.8	1.6
Widgeon Rd	8.5	2.8	7.1	1.8	7.4	1.6
Lutheran Church	11.0	2.4	10.4	2.2	10.8	2.1



Conclusions

The Bristol Bay region has climate and fauna that is considered to be sub-Arctic, but it does maintain an ambiguous boundary with the northern Pacific. This close proximity and the interconnectedness of the North Pacific to Bristol Bay suggests that small scale changes to water temperature may have large influences on species composition and density. This is possible because many of its species may believed to be near their warm temperature tolerance. One example of a species thought to be near its warm water limit is *Saduria entomon*. *S. entomon* is cold water species that has an upper temperature tolerance around 15°C (Leonardsson 1986).

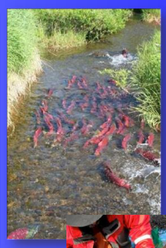
Results of temperate tolerance experiments of *S. entomon* from the groundwater fed Squaw Creek in Dillingham has shown that temperatures of 20°C or more are lethal and at that temperature specimens survive no more than 90 hours. At 15°C however, 100% of the specimens survived for over 8 days in an aquarium. *S. entomon* clearly prefer cooler waters. There was one incident were acclimating isopods were frozen to surface ice in the aquarium, and the specimen survived unharmed.

More work is needed to test if temperatures restrict the range of *S. entomon* from estuaries into connected lakes and streams. In Nushagak Bay, water surface temperatures have been measured as high as 20°C in August. In Squaw Creek, the population of *S. entomon* are found to live close to its upper temperature threshold often measured peaking at 14°C on summer afternoons. The cool shallow groundwater inflows (approximately 10-11°C) help to modulate the stream temperatures.

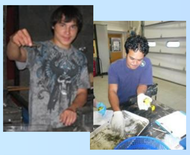
Another significant anthropogenic factor are summer inputs form canneries, which add tons of biomass into Nushagak Bay every day throughout the commercial salmon harvest season.

More information is needed on the temperature tolerances of local estuarine species including their population sizes, migrations, abundance trends, and interactions with invasive species. Conservation efforts in a warming Bering Sea and Bristol Bay are also made more difficult by the limited data available for temperature tolerances of non-commercial estuarine species.

The incomplete physiological knowledge on Arctic/sub-Arctic estuarine species makes it difficult to detect and measure the influence of climate change on local populations. Bristol Bay estuarine fauna is critical to maintain the health of the region. Many vital species will presumably change at alarming levels with the warming temperatures predicted by the IPCC.

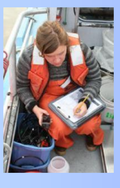


Acknowledgements



Thanks to the BBESL interns:
Angela Chingliak
Jon Blanco
Sidney Nelson

And Staff
Sarah Pederson



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