Long-term fluctuations of chum salmon and Pacific herring populations in Hokkaido during 1870-2000

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TOPICS

Long-term population dynamics of chum salmon and Pacific herring in Hokkaido relating to:

✓ Inter-specific interaction
✓ Impacts of climate trends
Inter-specific interaction
Growth curves of chum salmon and Pacific herring juveniles in the Ishikari Bay.


\[ FL = 30.575e^{0.0131t} \]
\[ R^2 = 0.7337 \]

\[ TL = 19.203e^{0.0148t} \]
\[ R^2 = 0.8445 \]
Interspecific Competition for Food? No!

**Food niche width** (Shannon-Weaver function)
- Pacific herring: $H' = 1.802$
- Chum salmon: $H' = 1.105$

**Overlap of food niche** (Simplified Morishita’s index)
- $C_H = 0.322$

Stomach contents of chum salmon and Pacific herring juveniles in the Ishikari Bay. (Data from Seki et al. 1981 in chum salmon juvenile; Sasaki & Ishida 2002 in Pacific herring)
Relationship of catch between chum salmon (S) and Pacific herring (H) in Hokkaido from 1883 to 2004. Curves show non linear competitive interaction between 2 species by Ayala et al. (1973)

Lotka-Volterra competition equation:

\[ K_H > K_s a_H \quad \& \quad K_s > K_H a_S \]

\[ H = 127.69 S^{-1.4484} \quad R^2 = 0.5893 \]
\[ S = 15.071 H^{0.4069} \quad R^2 = 0.5893 \]

Both species have less competitive effect on the other species than they have on themselves (Begon et al. 1990)
Impacts of climate trends
Chum salmon

Correlation map between 1° gridded sea surface temperature in July-September and growth anomaly of Ishikari River chum salmon.

Annual changes in the sea surface temperature (SST) during summer and fall, and anomaly of growth at the Okhotsk Sea (Lo) of the age-4 chum salmon returning to the Ishikari River.

\[ r = 0.592, \ n = 32, \ F = 16.257, \ P < 0.001 \]
Increase in Hokkaido chum salmon population size since the 1980s will be caused by the increments in body size at seaward migration and the growth at the first ocean life in the coastal water of Hokkaido and the Okhotsk Sea.
Decrease in Hokkaido Pacific herring population size may be caused by the increase in the winter SST in the northern Japan Sea and the Okhotsk Sea?
Conclusion

Factors affecting the dynamics of chum salmon and Pacific herring in Hokkaido:

- Climate trend and ocean environment > Inter-specific interaction
- Especially, the SST in the Okhotsk Sea (for salmon and herring) and the northern Japan Sea (for herring)