Current Knowledge of The Early Life History of Arrowtooth Flounder (*Atheresthes stomias*) In The Eastern Bering Sea: With Comments on Kamchatka Flounder (*A. evermanni*)

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Introduction: Arrowtooth flounder (ATF) are large, predatory flatfish that occur along the west coast of North America from central California to the Bering Sea. They are major predators of commercially important walleye pollock and in recent years abundance of ATF in the eastern Bering Sea (EBS) has been increasing. The cause of this increase is unknown; however, factors influencing growth and survival of the early life stages have been hypothesized. These stages of ATF have been difficult to study in the EBS because the early life stages of its congener, Kamchatka flounder (KF), are morphologically similar. As a result, all specimens collected in the EBS have been identified as *Atheresthes* spp. In this study we collected larval and early juveniles of both species from the EBS (2006-2010), used genetic techniques to conclusively identify them, visually assessed specimens to identify species-specific morphological traits, and then used these identified specimens to study the ecology, distribution, and relative condition of ATF early life stages in the EBS.

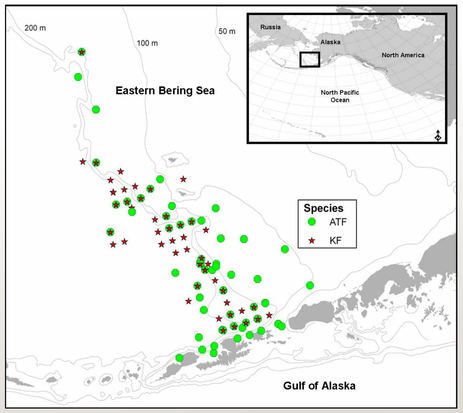
Genetic Identification

Methods: DNA was extracted for each individual using a single eyeball and the mtDNA gene region COI was amplified using PCR. A restriction enzyme digest using *Bmt*1 was used to cut the PCR product at a unique nucleotide sequence present only in ATF. The DNA fragments were visualized using gel electrophoresis. Identification was based on either the presence two fragments for ATF or a single fragment for KF.

Gel image showing ladder, positive ATF result and postive KF result.

Results:

- From individuals ranging from recently hatched larvae to early juveniles we genetically identified:
  151 = ATF
  178 = KF
- Genetic results confirm that both species are collected in the EBS, often in the same hauls.



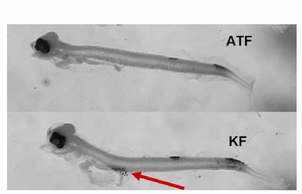
Distribution of genetically identified specimens in the EBS.

Visual Identification

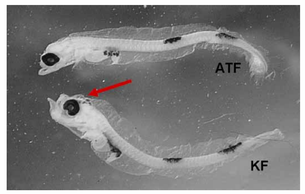
Methods: Individual specimens were examined and compared to one another to conclusively identify morphological and pigmentation characteristics. Individuals were either genetically identified specimens or formalin-preserved *Atheresthes* spp. specimens from previous EBS cruises (2006-2009).

Results:

- Larvae of ATF and KF are very similar morphologically, but there are some size-specific developmental differences.

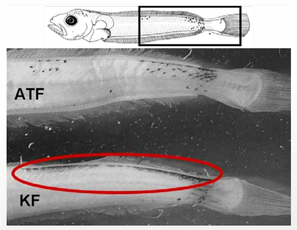


4 – 8 mm:
- Presence of gut pigment on KF



9 – 12 mm:
- Presence of head pigment on KF

13 – 18 mm:
- At this time we remain unable to fully separate ATF from KF as the pigment is highly variable



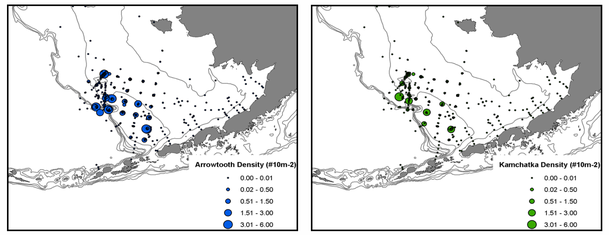
18 – 23 mm:
- Dorsal pigment patches coalesce and are more dense on KF than ATF

Ecology and Distribution

Methods: Genetically identified specimens were used to analyze the spatial and temporal distribution of ATF and KF larvae and early juveniles (4 – 23 mm).

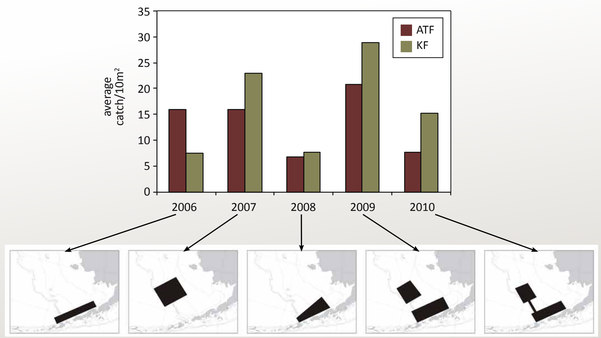
Results:

- There is no clear spatial or temporal separation of small ATF and KF. There is a slight spatial separation in larger (≥18 mm) specimens, with ATF occurring more along the shelf (shallower water) than KF.



Distribution of individuals ≥18 mm

- There is interannual variation in the catch of genetically identified ATF and KF collected during the month of May (2006-2010). While there are differences in sampling area between the years, some years are similar enough (i.e., 2006 and 2008; 2009 and 2010) to suggest factors other than spatial variability.

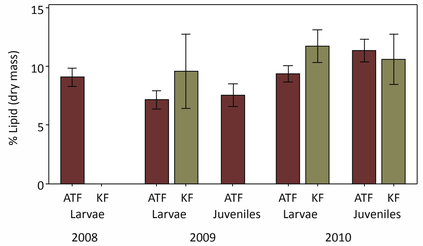


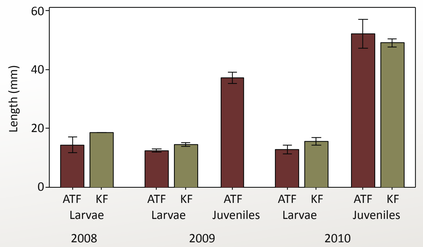
Bioenergetics

Methods: Lipid content was used to compare the relative condition of ATF and KF larvae and juveniles. Each individual specimen was homogenized and aliquots were taken from the homogenate to 1) determine the moisture content using a Leco Thermogravimetric analyzer and 2) gravimetrically determine the lipid content (expressed as a percentage of the individual dry weight).

Results:

- Average lipid content (with 95% CI) of larval and juvenile ATF and KF. In the larval stage, KF appear to have higher lipid content than ATF, however this trend seems to reverse in the juvenile stage.





- Average length (mm; with 95% CI) of ATF and KF specimens used in the lipid analysis. Larvae were collected between June and July, juveniles between mid August and the end of September. In 2008, the larvae were sampled later than those from 2009 and 2010.

Future Work:
Before the ecology and distribution of ATF in the EBS can be better understood, more work is needed to fully separate KF and ATF in the larval stage (13 – 18 mm). Once all size classes can be visually identified by morphological or pigmentation characters, historical specimens (1991 – 2010) that were previously only identified at the generic level (i.e., *Atheresthes* spp.) can then be identified to the species level and used in further ecological analyses.

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