

Project No: F0522

Title: Reproductive ecology of Atka mackerel, *Pleurogrammus monopterygius*, in Alaska

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**Project Summary:** Atka mackerel support a multi-million dollar commercial fishery and play a key role in the marine ecosystem of the Aleutian Islands. This study represents an ongoing research effort examining aspects of Atka mackerel reproductive ecology which will be directly applicable to estimates of spawning biomass, recruitment, stock dynamics, and distribution patterns. In 2004, spatio-temporal patterns in distribution were examined with respect to spawning condition and habitat use for nesting sites. Additionally, Atka mackerel embryos were incubated at different temperatures at the Alaska SeaLife Center to allow the construction of developmental series. This information is essential since egg development at low temperatures in deeper waters could extend the spawning season dramatically and influence distribution patterns. Variability in female maturity schedule was examined and it is proposed to estimate variability of realized fecundity that also directly affects reproductive output and estimation of female spawning biomass. Male spawning biomass might influence reproductive success as much as female spawning biomass due to nest guarding. Egg cannibalism as a mating strategy could maximize individual reproductive success and minimize the energetic costs associated with nest tending in males.

**Specific objectives of this study are to:** 1) analyze additional years of spatio-temporal distributions by reproductive stage, 2) expand embryonic developmental series over finer sampling scales and broader temperature range; 3) determine parentage of egg batches 4) evaluate egg cannibalism using genetic techniques; 5) investigate spatio-temporal variation in reproductive output (maturity schedule, realized fecundity); 6) determine fecundity and egg caloric content of successive batches spawned in captivity

**Progress summary:** Following is summary of progress made for the specific objectives  
1) *Analyze additional years of spatio-temporal distributions by reproductive stage.* Male Atka mackerel gonad samples were collected in March, May, and June 2005 to complete

the description of the male reproductive cycle using histological methodology. The 671 gonads collected in October 2004 have been histologically processed. Maturity stage of the females has been determined.

In September 2005, 408 gonad samples were collected at Amchitka Island, Tanaga Pass and Petrel Bank. Collections were made during the spawning season, when fish collected in 2002 at Seguam Pass showed the greatest segregation by size and maturity stage.

*2) Expand embryonic developmental series over finer sampling scales and broader temperature range.*

Spawning of eight (3.5.0) captive Atka mackerel began 7/13/05 at the Alaska Sealife Center. Nine fertilized egg batches were used for incubation experiments. Incubation regimes were set at temperatures of 10, 7, and 4°C. Each egg mass was sub sampled every 3 hours until hatching. Duration from spawning to first hatching was a function of incubation temperature, with first hatching occurring at 40.9 days (~10°C), 63.7 days (~7°C), and 96.6 days (~4°C) after fertilization for the 2005 season. More extensive analysis of the 2005 results combined with results from 2004 is planned. Morphological descriptions and staging of each egg mass is pending.

*3) Determine parentage of egg batches.*

#### Spawning event summer 2004

Two adult males and four females produced thirteen eggmasses at the Alaska SeaLife Center in 2004 and have been examined using genetic techniques. The first two clutches examined were “2” and “C”, from which we extracted DNA from 96 eggs/larvae. We determined that typically a single pair of parents was responsible for each clutch, and thus analyzed 24 eggs/larvae from the remaining clutches. Our assumption of a single mating pair producing each egg mass was true in 12/13 of the egg masses overall. The exception was an egg mass that was primarily fertilized by Male 1, but had a small proportion (~10%) of eggs fertilized by Male 2. This event probably does not represent sneaking by Male 2, because that male fertilized all the rest of the egg masses. There was also some variation in the realized fecundity of the females; one female (B) produced 6 of the 13 egg masses, Females D produced 3, Female A produced 2, and Female C produced only one egg mass (which was fertilized by the subdominant male 1).

#### Spawning event summer 2005

Twenty (4.1.15) Atka mackerel housed at the Alaska SeaLife Center began nesting and spawning in late July, 2005. This spawning population was left undisturbed until 8/25/05 when all egg masses, nine in total, were removed from the tank. Eggs masses were distributed between two territories. The population resumed undisturbed spawning until 9/6/05 when all egg masses were removed again, one from each of the two previous territories and three from a new third territory. Ten more egg masses were removed from the third territory on 10/14/05. A total of twenty four egg masses were preserved of genetic analysis.

*4) Evaluate egg cannibalism using genetic techniques.* Highly polymorphic DNA markers were used to assess parentage of embryos consumed by five adult Atka mackerel

of each gender. Gut contents contained both single eggs and one or two egg masses. Most of these egg masses consisted of batches of developing full and half-sib embryos produced by multiple (3 - 8) parents. All female cannibals were excluded as the mother of embryos they had eaten, thus indicating heterocannibalism. Similarly, four of five males in spawning coloration were excluded as the sire for cannibalized embryos. One male was determined to be the sire of two half-sib families detected in one egg mass (consisting of egg batches deposited by multiple females), documenting filial cannibalism. However, this male sired only 22 % of the embryos genotyped in the egg mass, which contained a minimum number of eight parental genotypes. It is unknown if he was the attendant male or possibly an adjacent territory holder. These preliminary analyses of partially cannibalized egg clutches indicate a complex polygamous mating system in Atka mackerel, and suggest that sneaked fertilizations and nest raiding by adjacent guardian males may be common behaviors in this species.

*5) Investigate spatio-temporal variation in reproductive output (maturity schedule, realized fecundity).* Maturity was determined for females from Seguam pass in 2004 (Figure 1). These results were added to the results from the previous NPRB project 417, (funded 2004).

Ageing of the 2004 samples have been completed. Currently, sample analysis for the maturity schedule is being completed and the age at maturity schedule will be determined.

*6) Determine fecundity and egg caloric content of successive batches spawned in captivity.* Female gonad samples were collected from the 2005 Gulf of Alaska trawl survey, and from September in 2005 aboard the FV *Seafisher*. Those samples will be used to determine the methodology for estimating egg energetic content.

Researchers at the Alaska SeaLife center collected samples for fecundity and egg caloric analysis and shipped subsamples to Seattle. Spawning of eight (3.5.0) captive Atka mackerel began 7/13/05 at the Alaska Sealife Center and yielded forty separately deposited egg masses. Gravimetric sampling was performed on each egg mass to determine number of eggs per egg mass. Sub samples for each egg mass were preserved for genetic analysis which will be used to determine maternal parentage. Analysis of maternal parentage, number of eggs per egg mass, and time order of egg deposition is planned.

Ovaries were collected for egg caloric content analysis aboard the F/V *Gladiator* in May during the 2005 NMFS Gulf of Alaska trawl survey and aboard the F/T *Seafisher* in September 2005 during commercial fishing operations.

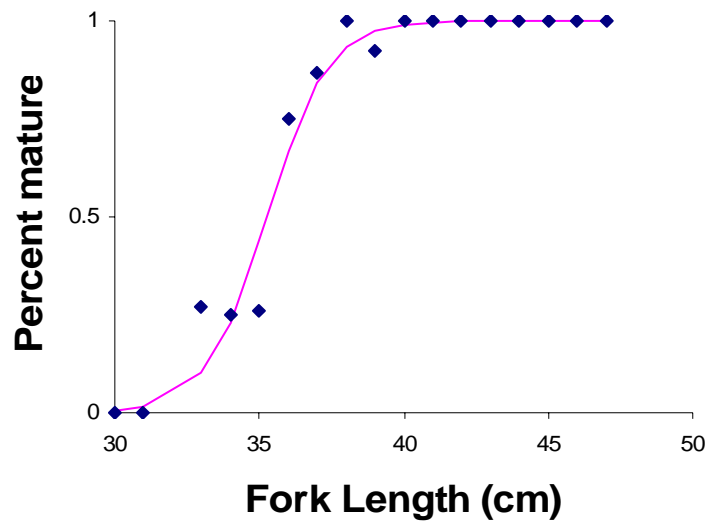


Figure 1. Female maturity at length relationship from Seguam pass in 2004.