A Preliminary Analysis of the Reproductive Biology of Pacific Ocean Perch, *Sebastes alutus*, in the Gulf of Alaska

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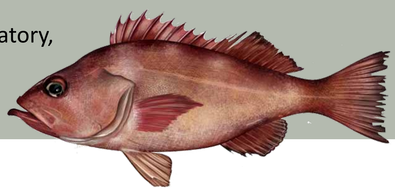


Introduction

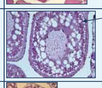
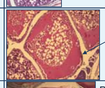
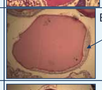
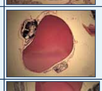
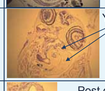
Pacific ocean perch occur from Japan to Cape Navarin in the Bering Sea, along the Aleutian Islands, throughout the Gulf of Alaska and along the North American west coast as far south as southern California (Allen and Smith 1988). Adult members of this species are predominantly found offshore on outer continental shelf and upper continental slope in depths 200-300 m (Chikuni 1975). Pacific ocean perch are the most abundant rockfish in the Gulf of Alaska and are the most commercially important rockfish in this region. The stock assessment of this species in the Gulf of Alaska utilizes a separable age-structured model as the primary assessment tool. This model incorporates maturity estimates which directly influence the estimation of stock biomass and a very small change in this parameter can have a significant impact on the determination of total allowable catch (Hanselman et al. 2009). Therefore it is critical to have accurate and up to date data on the reproductive parameters of this rockfish species. The values for age and length at maturity of this species currently utilized in the stock assessment are derived from a study predominantly employing visual techniques to assess maturity status and oocyte development. Previous studies have revealed a greater potential for incorrect identification of maturity stages during macroscopic (visual) staging when compared to histological evaluations which may bias maturity estimates (Hunter et al. 1992; Zimmerman 1997). The objective of this study is to utilize histological techniques to examine the reproductive seasonality of this species and to update and refine length at maturity estimates of this species within the Gulf of Alaska.

Pacific ocean perch captured on a AFSC biological survey.

Methods

Pacific ocean perch samples were collected throughout the year during National Marine Fisheries Service and Alaska Department of Fish and Game scientific surveys, from the North Pacific Groundfish Observer program, and from scientific charters. Each fish was measured for fork length (FL) and the ovary was removed and preserved in 10% neutral buffered formalin. A cross section taken from the middle of one ovary from each sample was embedded in paraffin and sectioned at 6 µm. These sections were stained with hematoxylin and eosin utilizing standard histological techniques. Maturity stages were defined utilizing the terminology of Bowers (1992), but modified specifically for Pacific ocean perch (Table 1). One ovarian histological section was chosen for each ovary and scanned for the most advanced oocyte stage utilizing a compound microscope. The most advanced oocyte stage within each section was identified and utilized to classify the maturity stage of the fish. Seasonality was examined by plotting the frequency of all stage 2 and higher samples during each month of the year. Samples classified as maturity stage 3 or higher were considered to be mature. Samples classified as stage 2 or maturing were not considered to be immature as studies have shown rockfish within this stage are functionally immature and unlikely to spawn within the year (Nichol and Pikitch 1994). Length at 50% maturity (L_{50}) was estimated by fitting data to the logistic equation: $P = 1/(1+e-(a+bX))$, where P = proportion mature, a and b are parameters of the model and X is the length of the fish.

Table 1. Maturity stages of Pacific ocean perch.

Maturity stage	Description	Photo
1. Immature	Oogonia, early perinucleus and late perinucleus stages present	Oogonial mass; Late perinucleus
2. Maturing	Earliest signs of yolk accumulation, small spherical globules of yolk in the periphery of the oocyte	 Yolk
3. Advanced yolk	Oocytes dominated by yolk droplets, nucleus well defined	
4. Migratory nucleus	Nucleus migrates to the periphery of the oocyte, nuclear membrane becomes more irregular, nucleoli disappear	Nucleus
5. Ovulation/fertilization	Yolk material merges to form a single united mass	 Fused yolk
6a. Early embryo	Blastodermal cap present with a large yolk mass	 Blastoderm
6b. Embryo body	Embryo body appears, blastoderm cap of cells develops into recognizable tissue	
6c. Eyed embryo	Retinal pigmentation becomes apparent	Embryonic eyes
6d. Embryo reduced yolk	Yolk attached to the embryo is reduced in size and may only be present as separate droplets	 Yolk droplets
7. Post ovulatory/resting	Presence of post-ovulatory follicles and cell degeneration	Post ovulatory follicles

Preliminary Results

Pacific ocean perch were sampled throughout the year but only two fish were sampled in the month of July. Pacific ocean perch ovaries began to ripen during the months of August and September with yolk increasing until February. Embryos appeared within the ovaries during February and March and embryos continued to grow and develop until April and May when parturition occurred (Figure 1).

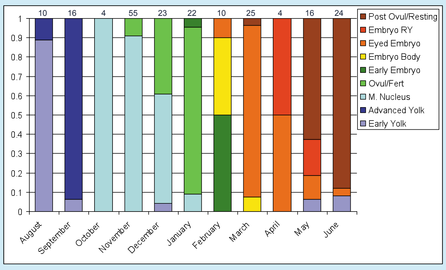


Figure 1. Seasonal changes in the maturity stage of female Pacific ocean perch. The proportion of fish in each stage during each month is presented. July was omitted due to small sample size. The number of samples is listed at the top of each column.

Due to the difficulty of distinguishing maturing and resting stage fish during the late summer months, fish collected during July and August were not included in the length at maturity calculation. The smallest mature fish was 31 cm FL and the largest immature fish was 42 cm FL with most fish mature by 37 cm FL. Length at 50% maturity was calculated to be 34.1 cm FL (Figure 2).

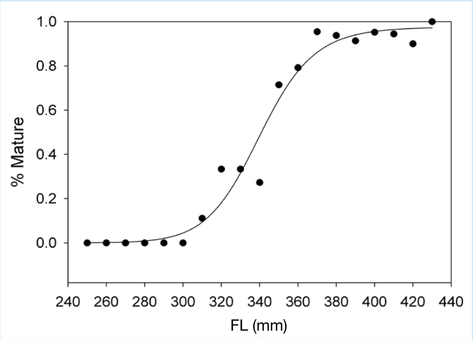


Figure 2. Maturity ogive for female Pacific ocean perch in the Gulf of Alaska.

Discussion

Seasonality of the reproductive biology of Pacific ocean perch is similar to that reported for this species in the Gulf of Alaska by Lunsford (1999). Parturition appears to occur predominately within the month of May. Pacific ocean perch appear to spawn later in higher latitudes with parturition occurring in March off British Columbia and April in the south eastern Gulf of Alaska (Westrheim 1975). This study found the period between fertilization and parturition to be three to four months with embryonic development occurring between February and May. This is longer than previously reported for this species (Westrheim 1975; Gunderson 1976) in other regions and may relate to the later time period of parturition in the Gulf of Alaska.

The management of Pacific ocean perch in the Gulf of Alaska is dependent upon accurate estimation of life history parameters including length and age at 50% maturity. This study found a length at maturity estimate of 34.1 cm FL which is similar to but slightly smaller than value of 35.7 cm FL currently utilized in stock assessment models (Lunsford 1999; Hanselman et al. 2009). Both of these estimates are significantly larger than the previously reported value of 28.5 cm (Chikuni 1975) for Pacific ocean perch in this region. Our estimate for length at maturity is also similar to values reported for Pacific ocean perch off of Washington State and British Columbia (Gunderson 1976). Additional samples are still being obtained and processed for the months of January through May and will be utilized to refine our preliminary estimate of L50. Additionally otoliths from this study will be aged in the upcoming year to allow the determination of age at 50% maturity (A50).

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The findings and conclusions in the paper are those of the authors and do not necessarily represent the views of the National Marine Fisheries Service, NOAA.