

<b>Project Title: Developing maturity schedules to improve stock assessments for Greenland turbot in the Bering Sea and Aleutian Islands.</b>	<b>\$12.1K</b>
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**Industry Partners:** Alaska Seafood Cooperative (contact: Jason Anderson, jasonanderson@seanet.com).

**Overview:** This proposed project is considered a “High Priority” by the North Pacific Fishery Management Council (NPFMC) – acquiring basic life history information for data-poor stocks. The goal of this project is to update estimates of length and age at maturity for the commercially important Greenland turbot in the Bering Sea. Our current knowledge of Greenland turbot maturity is based on analyses by Cooper et al. (2007) and D’Yakov (1982). Estimates of maturity at length were higher from the 2007 study than the 1982 study, and suffered from a lack of smaller fish in the sample. For the present stock assessment, a logistic maturity-at-size relationship was used with 50% of the female population mature at 60 cm; 2% and 98% of the females are assumed to be mature at about 50 and 70 cm respectively. This estimate of maturity is based on an approximation from D’yakov’s (1982) study and could greatly benefit from an ovary collection that included a full range of lengths to better estimate the maturation schedule.

The proposed maturity project will be a cooperative effort with the Alaska Seafood Cooperative. It was borne out of annual Marine Stewardship Council meetings where one of the conditions for re-certification was to enhance and update maturity estimates for most of the Bering Sea-Aleutian Islands (BSAI) and GOA flatfish stocks. For Greenland turbot, the industry has agreed to assist with the specimen collection part of the project (under our sampling guidance, technical expertise on the reproductive biology of the stocks, and provision of supplies) by providing a berth on one of their vessels for one to two weeks to facilitate the ovary collection. The AFSC role will be to collect otolith and ovary samples at sea, complete the sample processing, histology, age determination work required and maturity analysis. We are currently seeking funds to complete our part of the agreement.

**Research Description:** Maturity ogives (the proportion of a population mature by age or length) are an important metric of fish populations, and play a critical role in the estimation of female spawning biomass and biological reference points for the annual harvest specifications. Published maturity estimates for commercial species in Alaska have often come from a single year of observations or multiple years with conflicting results. Temporal changes in maturity estimates have implications to fisheries management; therefore, updating maturity estimates is critical. Limited or lack of recent data results in less than ideal values in their respective stock assessment models, especially since annual and/or decadal variation in length or age at maturity estimates have been observed in some fish stocks.

The biology of fish populations (maturity and other vital rates) is time variant, but is also sensitive to other factors such as changes in the ecosystem and climate, and fisheries exploitation. In an effort to provide current maturity data for Greenland turbot and substantially improve the age-structured stock assessment model, this study will provide critical information for the formulation of reference fishing mortality rates and catch levels (ABCs and OFLs) for Greenland turbot species.

Observations on reproductive biology (i.e. maturity) over multiple years provide information on the variability of reproductive processes, which is important in management systems, such as the U.S. Magnuson-Stevens Fishery Management and Conservation and Management Act, where the estimation of fishing reference points is affected by estimation uncertainty. Therefore, maturity schedules from a single-year or a single study need to be periodically updated in future years. It is expected that parameters such as natural mortality, growth, and maturity are not time invariant. Since the biology of a species is sensitive to changes in climate, ecosystems and fisheries exploitation, providing updated information on

critical life history parameters is important given the evidence of non-stationarity of life histories in fish populations. Biological systems are complex but have the ability to adapt with their changing environment. Periodically updating life history information, such as maturity and other parameters are necessary.

For this study, otoliths and ovaries will be collected from each female specimen within a specified size range. Our target is to collect about 300 samples. Each ovary will be placed inside a separate cloth specimen bag with a separate label and submerged in 5-gallon buckets half-filled with 10% formalin to be processed and analyzed later by AFSC personnel. Otoliths are to be stored dry in vials and placed in styrofoam boxes and shipped to AFSC with the ovary samples for subsequent ageing. The formalin will be stored on deck in 5 gallon buckets in an area separate from any fishery products.

After processing, samples will be shipped to an outside histology services laboratory for final slide processing where ovarian cross sections will be embedded in paraffin, thin-sectioned to 4  $\mu\text{m}$ , mounted on slides, and stained with hematoxylin and eosin. Individuals exhibiting yolk deposition (vitellogenesis) will be defined as mature. Spawning individuals will be defined by those with ovaries containing either hydrated oocytes or postovulatory follicles. Reproductive characteristics (notably atresia) and seasonality of ovary condition will be recorded. Data will be fitted to a logistic equation to estimate length and age at 50% maturity using generalized linear modeling based on binomial data. The break-and-burn method will be used in this study for ageing otoliths. Standard quality control methods will be used to age specimens.

This project is being proposed as a single year study. The main cost of this project is to obtain and process the collected samples (ageing), use histological methods to determine maturity and perform data analysis of the results. For this project, funds are requested to pay travel and overtime for a member of the AFSC's FMA division (selected by the Director) to sample at sea on a vessel of opportunity provided by the Alaska Seafood Cooperative. We will provide overtime money for age determination at the AFSC's Age and Growth group to complete age reading of the samples. A contract for a laboratory is also necessary for histological slide preparation prior to analysis.

**Performance Indicators:**

Fulfillment of our agreement with industry to complete updated maturity schedules for BSAI flatfish.

**Deliverables:**

Results will be a maturity collection of Greenland turbot ready for histological analysis by an AFSC researcher by late 2015/early 2016. The updated maturity schedule will eventually be incorporated into the BSAI Greenland turbot stock assessment.

**Budget:**

At-sea sampling: Travel to Dutch Harbor, Alaska, overtime on vessel, lodging for 2 nights (in case of cancelled flights)	\$6,500
Funds needed for overtime in AFSC's Age and Growth lab	\$3,000
Contract # 1 Histological laboratory contract	\$2,100
General supplies and shipping	\$500
<b>Total funds requested</b>	<b>\$12,100</b>

**References:**

Cooper, D.W., K.P. Maslenikov, and D.R. Gunderson. 2007. Natural mortality rate, annual fecundity, and maturity at length for Greenland halibut (*Reinhardtius hippoglossoides*) from the northeastern Pacific Ocean. *Fishery Bulletin*, 105(2): 296-304.

D'yakov, Yu. P. 1982. The fecundity of the Greenland turbot, *Reinhardtius hippoglossoides*, (Pleuronectidae), from the Bering Sea. *J. Ichthyol.* [Engl. Transl. *Vopr. Ikhtiologii*] 22(5):59- 64.