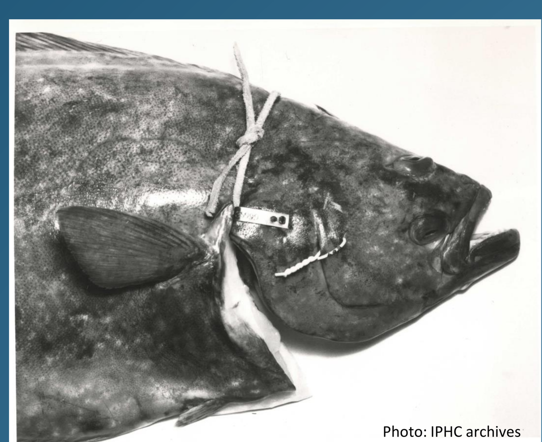
INTERNATIONAL PACIFIC HALIBUT COMMISSION

Biological and Ecosystem Science Program

Pacific halibut migration research at IPHC

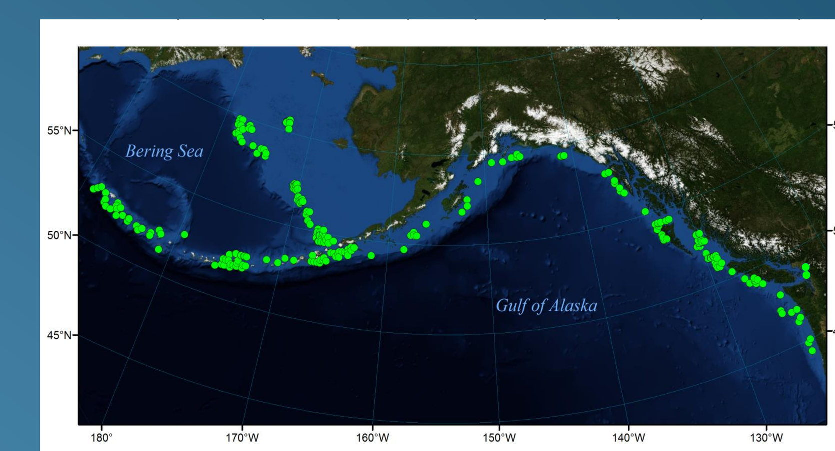
Historical projects



Wire and strap tagging: 1925-2011 – the main objectives included stock distribution, recruitment, migration, bycatch rates and survival. More than 350,000 tags were released through 2011.

Larval surveys: 1930s – the main objective was to collect data on Pacific halibut larvae including determining distribution in the Gulf of Alaska.

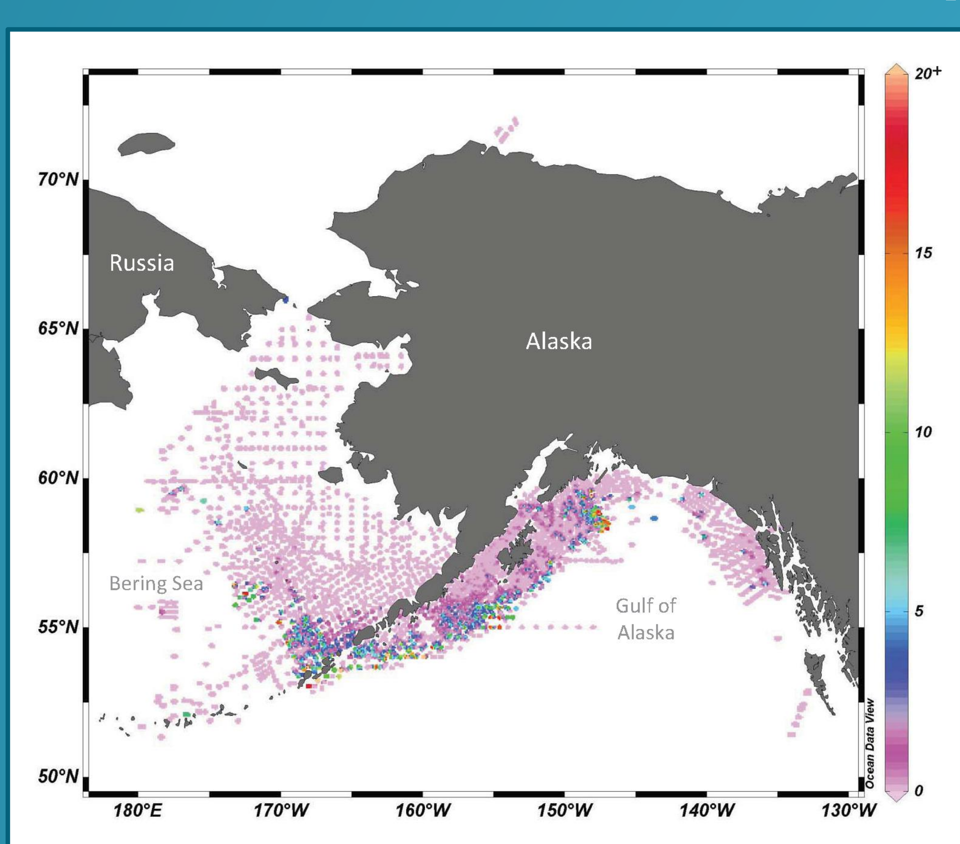
PIT tagging: 2003-2009 – the main objectives were to obtain mortality and migration rates. More than 67,000 Pacific halibut were tagged and released over a two-year period. Over 3,400 of those tags were eventually recovered between 2003-2009 through scanning.



Electronic tagging (satellite and archival): **2002-2015** – the main objectives included movement within and between ocean basins, connectivity of summer feeding and winter spawning grounds. A total of 535 electronic tags were deployed through 2015.

Current projects

Larval dispersal and connectivity between the Bering Sea and Gulf of Alaska



Project Goals

- Identify the factors contributing to annual differences in larval distribution/dispersal and the resulting settled year classes.
- Model the contribution of spawning grounds to settlement grounds.
- Assess connectivity of the Gulf of Alaska and Bering Sea populations via larval dispersal through Unimak Pass, Alaska.

Figure 1 (left): Standardized catch per 10 m^2 of Pacific halibut larvae caught during the NOAA ichthyoplankton surveys 1972-2015. Note that light pink indicates sampling took place, but no Pacific halibut were found.

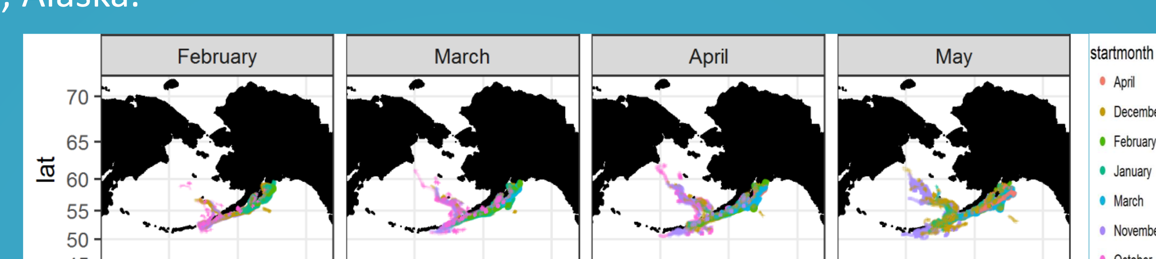


Figure 2 (above): Model output of predicted dispersal over time of larvae spawned in the western Gulf of Alaska. These plots represent a sample of the output from a combination larval recruitment and physical oceanography model developed by NOAA. Colors indicate the month in which the larval particles were released (estimated spawning time) shown in the key on the right.

Project in partnership with NOAA/EcoFOCI

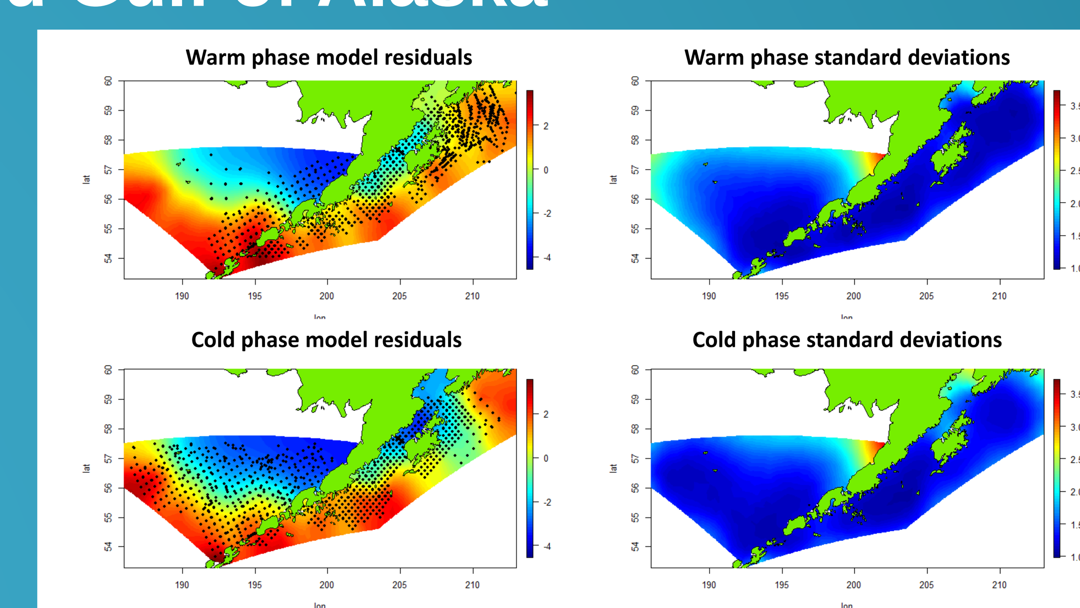


Figure 3 (above): Model residuals (larval density on the log scale standardized to have mean of zero, left panel) and associated uncertainty (right panel) of larvae during warm (2001-2005) and cold (2007-2013) stanzas in the Bering Sea in late spring. These plots are a result of a spatial statistical model developed by IPHC. Points in the left panels show sampling locations.

Using electronic tags to study population structure, seasonal dynamics, and juvenile dispersal

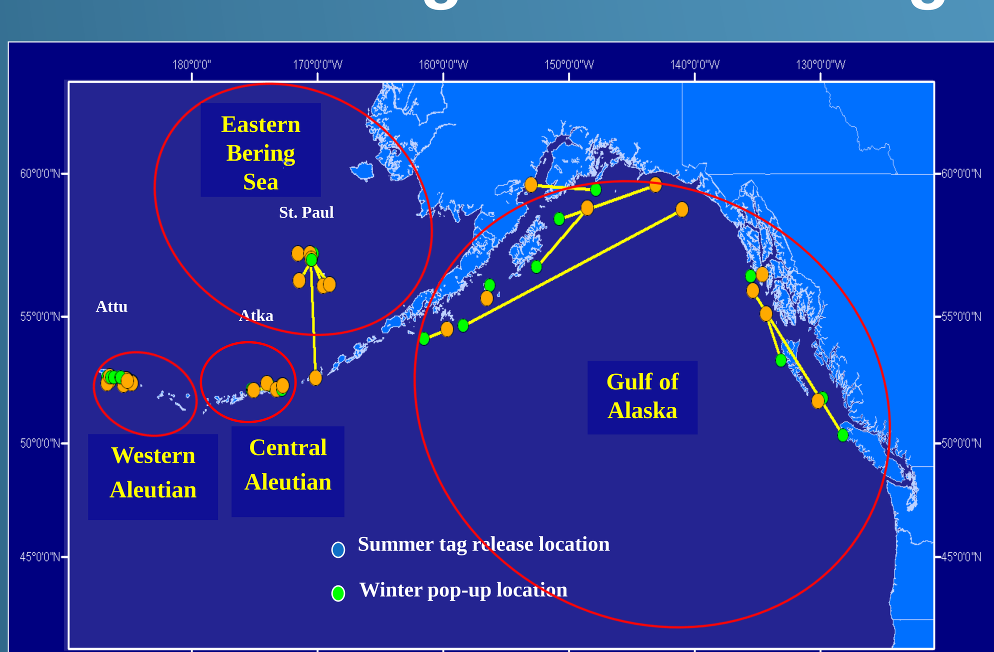


Figure 4 (above): Pop-up satellite tags deployed in the summer and programmed to report fish locations during the winter spawning season suggest that the eastern Pacific halibut population may be segregated into four spawning stock components that correspond to ocean basin and breaks (deep passes) in the Aleutian Chain.

Project Goals

- Identify spawning stock structure as it relates to the concept of "biological regions".
- Examine the redistribution of exploitable and spawning biomass seasonally, to evaluate how stock distribution may differ between the summer survey season and winter; and how movements vary regionally and may be affected by climate variability.
- Quantify dispersal of juvenile Pacific halibut from nursery habitats to adult feeding grounds, to better understand downstream effects of both fishing and natural mortality.

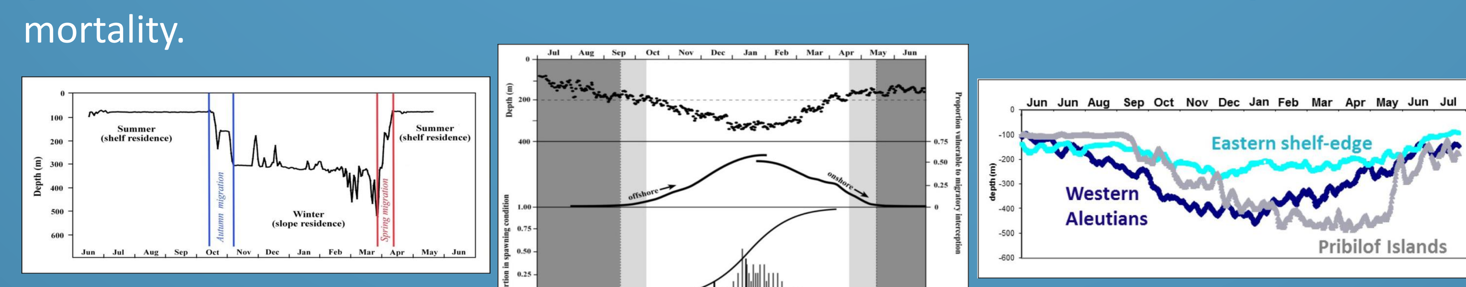


Figure 5 (above): *Left*: Adult Pacific halibut undertake migrations between shallow summer feeding grounds and deeper winter spawning areas. *Center*: These movements can be summarized among individuals to define periods of seasonal migration according to depth, movement state, and relative to peak spawning period(s). *Right*: Analyses conducted within the Bering Sea demonstrate that the timing of seasonal migration varies according to subregion, and may also trend from south-to-north.

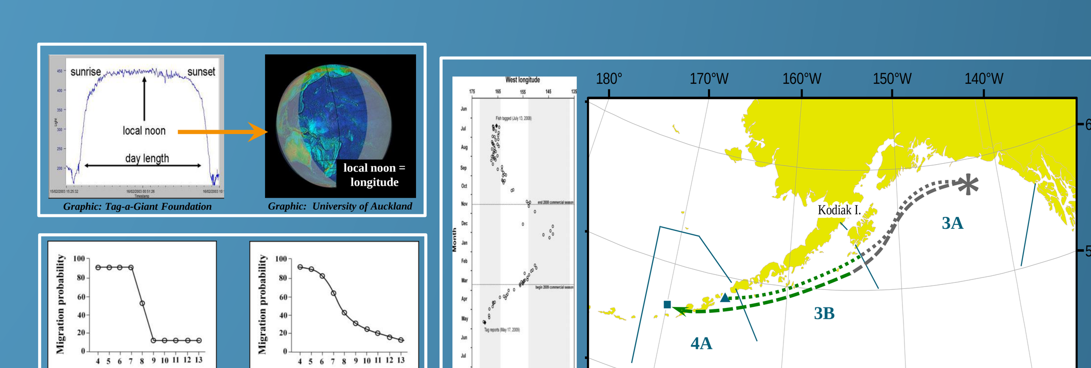


Figure 6 (above): *Upper left*: Light data can be used to determine fish location given that the timing of local noon indicates longitude. *Right*: Daily longitudes derived from light can be used to track migrations. Here, an adult Pacific halibut is tracked as it departs Area 4A feeding grounds to spawn in Area 3A, and returns to 4A the following spring. *Lower left*: For juvenile halibut, we hope to obtain enough data from long-term archival tags – which can store up to seven years of information – to determine whether their "downstream" movements tend to occur rapidly over a short period of time ("stepwise") or more gradually as they age ("smooth"). This information will be useful for building spatially-explicit population models that incorporate migration.

Using wire tags to study the movement of juvenile Pacific halibut

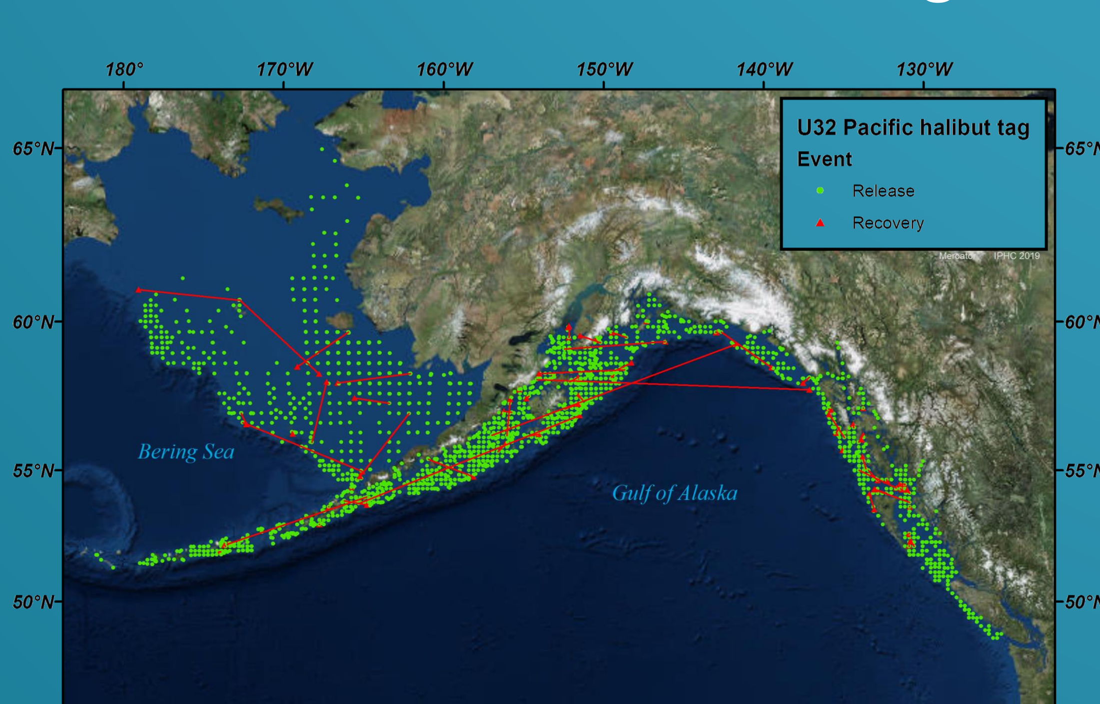


Figure 7 (above): Over 8,600 U32 Pacific halibut have been wire-tagged between 2015 and 2018 and 74 have been recovered.

Project Goals

- Tag young Pacific halibut (<82 cm fork length or "U32") that are still actively migrating from nursery areas to adult feeding grounds.
- Increase our understanding of juvenile Pacific halibut movement and growth.

Figure 8 (above): On IPHC fishery-independent setline survey (FISS), a portion of U32 Pacific halibut not selected for otolith sampling are wire-tagged and released with a goal of 500 tagged fish per Regulatory Area. A total of 3,844 U32 Pacific halibut have been wire-tagged on the FISS since 2016.

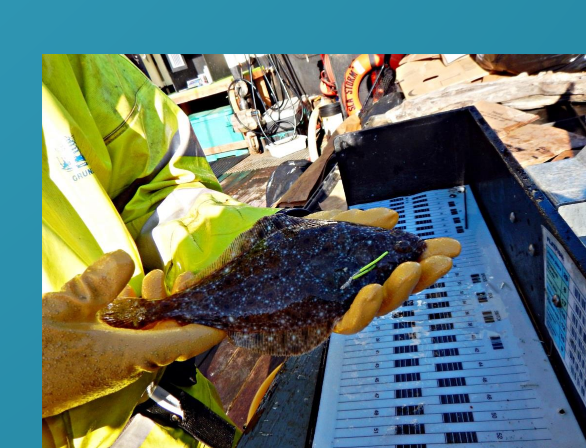


Figure 9 (above): Since 2015, a portion of the Pacific halibut caught during the annual NMFS trawl survey have been wire-tagged. 50% of the Pacific halibut catch is sampled for otoliths, sex, and maturity; the other 50% are potential tagging candidates, and are tagged if alive and U32. Over 4,800 have been tagged through 2018.

Project in coordination with NOAA/NMFS

Future directions

- Connect spawning grounds to nursery areas using modeling and genetics - build on the results from the current projects to identify possible links between spawning and nursery grounds, then validate with genetic studies.
- Expand migration/dispersal knowledge to include un-sampled and lightly sampled areas – this could include, for example, the western Bering Sea through collaborations with Russian scientists, and the coastal inshore areas of the Gulf of Alaska and eastern Bering Sea.