Migratory behavior and distribution of Pacific halibut

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PURPOSE

To provide the RAB with a description of the studies designed to improve our knowledge on distribution and migration of Pacific halibut in the northeast Pacific Ocean and eastern Bering Sea.

BACKGROUND

The IPHC is currently investigating Pacific halibut distribution and migration that encompasses all life stages via three different research projects.

U32 wire tagging

Of specific interest to the IPHC is the movement of juvenile Pacific halibut both within ocean basins (i.e. Gulf of Alaska and Bering Sea) and between them. The timing and distance traveled between nursery grounds to the adult feeding grounds varies over time and was last studied in the 1980s. Sampling platforms already being utilized for other investigations, the fishery-independent setline survey (FISS) and the NOAA-Fisheries (NMFS) trawl survey, are ideal vehicles for tagging and releasing U32 Pacific halibut during the summer months throughout their geographic range, and are currently the platform for a spatially large-scale wire tagging effort.

Larval dispersal and connectivity

Unlike juvenile Pacific halibut which are demersal, larvae are pelagic for approximately the first six months of life and are distributed largely based on where they originated (i.e. where they were spawned) and where the currents carry them during their pelagic life stage. Of interest to the IPHC is the connectivity of larvae to nursery areas, particularly between larvae spawned in the Gulf of Alaska but that settle in the Bering Sea, and the environmental drivers that may affect the magnitude of this connectivity. Also of interest are the geographic differences in larval dispersal and distribution of settled Pacific halibut related to environmental conditions. Note that it has been established that the counter clockwise Alaska Coastal Current in the Gulf of Alaska flows into the Bering Sea via Aleutian Island passes. The IPHC does not conduct larval surveys, but National Oceanic and Atmospheric Administration (NOAA) icthyoplankton (larval) surveys are conducted annually and IPHC has teamed with NOAA to examine these data spanning from 1972-2015.

PAT tagging

The IPHC has conducted a series of pop-up archival transmitting (PAT) tag studies in the Bering Sea and Aleutian Islands (BSAI) region in order to identify winter spawning locations, determine the timing of seasonal movements, and investigate mixing within the BSAI and between the Bering Sea and Gulf of Alaska of adult Pacific halibut. Until 2017, no tagging had been conducted on Bowers Ridge (located in IPHC Regulatory Area 4B) because this region had not been

previously surveyed by the IPHC. In 2017, we took advantage of the FISS expansion onto Bowers Ridge in order to generate data for this region.

Coastwide deployment of fishery-recovery archival tags on U32 Pacific halibut

In 2018 the IPHC began a program in which electronic archival tags capable of recorded temperature, depth, and light levels for periods in excess of five years were deployed coastwide on U32 Pacific halibut. The data obtained from these tags will be used to relate rearing temperatures to growth rate and examine dispersal-at-age and -sex in Pacific halibut as they grow and recruit into the directed longline fishery.

DISCUSSION

U32 wire tagging

Each summer, IPHC deploys sea samplers on board the NMFS trawl surveys conducted in the Gulf of Alaska, Bering Sea, and Aleutian Islands. Pacific halibut from 20-100 cm fork length are readily captured and sampled. In 2015, a pilot project was initiated on the trawl surveys to test the practicality of tagging and releasing a subsample of captured Pacific halibut with minimal impact to the regular sampling. The pilot project was considered a success and the program was fully implemented in 2016 going forward. Of the Pacific halibut captured, half are randomly selected as possible candidates for tagging. Within that subsample, a fish is tagged if it is U32 and viability is not assessed as “dead” using observer criteria.

In 2016, the IPHC investigated the practicality of adding U32 tagging to the FISS by conducting a pilot project in one Regulatory Area (Area 4D). The pilot project was successful and in 2017, the effort to tag and release U32 Pacific halibut was extended to the FISS in all areas where sampling rates for otoliths were less than 100 percent (i.e. Areas 2B, 2C, 3A, 3B, 4A, and 4B). U32 wire tagging will be continued on the FISS for the next several years. Area-specific tagging rates are set for all areas not sampled at 100% for otoliths, and a subsample of U32 fish not selected for otolith sampling are assessed using observer viability criteria and are subsequently tagged and released if not considered “dead”. Additional information can be found in paper IPHC-2017-RARA27-R Chapters 2.5.1 and 2.5.4.

Table 1. Release and recovery information of Pacific halibut tagged and released on board the NMFS trawl and IPHC fishery-independent setline surveys.

Wire tagging project	Years of tagging	Tags released	Tags recovered (as of 1/25/18)
Bering Sea trawl survey	2015, 2016, 2017, 2018	2,432	9
Gulf of Alaska trawl survey	2015, 2017	2,205	27
Aleutian Islands trawl survey	2016, 2018	318	2
IPHC FISS	2016, 2017, 2018	3,844	36
Total		8,799	74

Larval dispersal and connectivity

To date, work in this area has included fully describing the ichthyoplankton survey dataset and parameterizing both a IPHC-developed spatial model and a National Oceanic and Atmospheric Administration (NOAA)-developed combination physical oceanography and larval recruitment model. These models will: 1) aid in the examination of densities and distribution of larvae and the resulting settled fish when detected in the NOAA Fisheries bottom trawl survey two years later, and 2) provide important information about the contribution of spawning grounds to nursery areas and most notably, the contribution of larvae to the Bering Sea from the Gulf of Alaska via Unimak Pass. Variations in distribution, magnitude, and density of animals among years will be compared to help identify differences in dispersal and recruitment correlated with environmental conditions, specifically, between warm and cold stanzas in the Bering Sea. Products from these analyses will include: distribution maps, calculation of catch weighted average size by month, an estimation of larval contribution to nursery areas from the major spawning grounds identified in St-Pierre (1984), and differences in dispersal and settlement related to environmental factors. The first part of this work is expected to be completed in 2019.

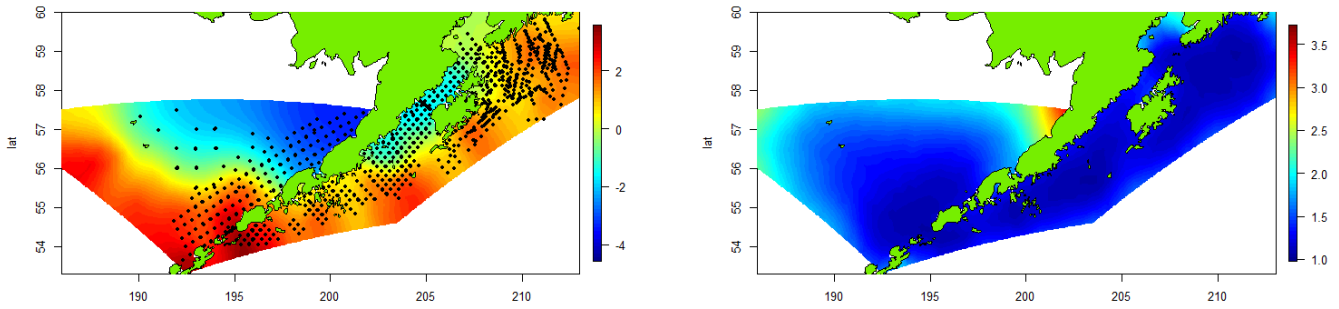

Figure 1. Spatial model residuals (larval density on the log scale standardized to have mean of zero, left panel) and associated uncertainty (right panel) of larvae during a warm stanza (2001-2005) in the Bering Sea.

PAT tagging

A total of 22 Pacific halibut were tagged with miniPAT tags (manufactured by Wildlife Computers, Redmond, Washington) in IPHC Regulatory Area 4B. Tagging occurred on dates ranging from 05-10 July 2017. Sixteen Pacific halibut (four male, 11 female, and one of unknown sex) ranging from 117-170 cm FL were tagged with PAT tags scheduled to detach and report on 15 January 2018. Six Pacific halibut (four male, two female) ranging from 117-144 cm FL were tagged with PAT tags programmed to detach after 365 days, resulting in scheduled reporting dates of 5 and 10 July 2018.

Thirteen of the winter-programmed tags reported locations and data as scheduled; one reported as scheduled but failed to provide locations or data; and two failed to report. As such, eleven tags generated transmissions of sufficient strength to determine their locations and download accumulated environmental data. Ten fish were located very close to where they had been tagged, on Bowers Ridge and northern Petrel Bank; the eleventh fish had migrated to the central 4D Edge when its tag reported in mid-January of 2018. The tags' environmental data (i.e. depth,

temperature, and light-based locations during time at liberty) will be decoded and fully analyzed during 2019.

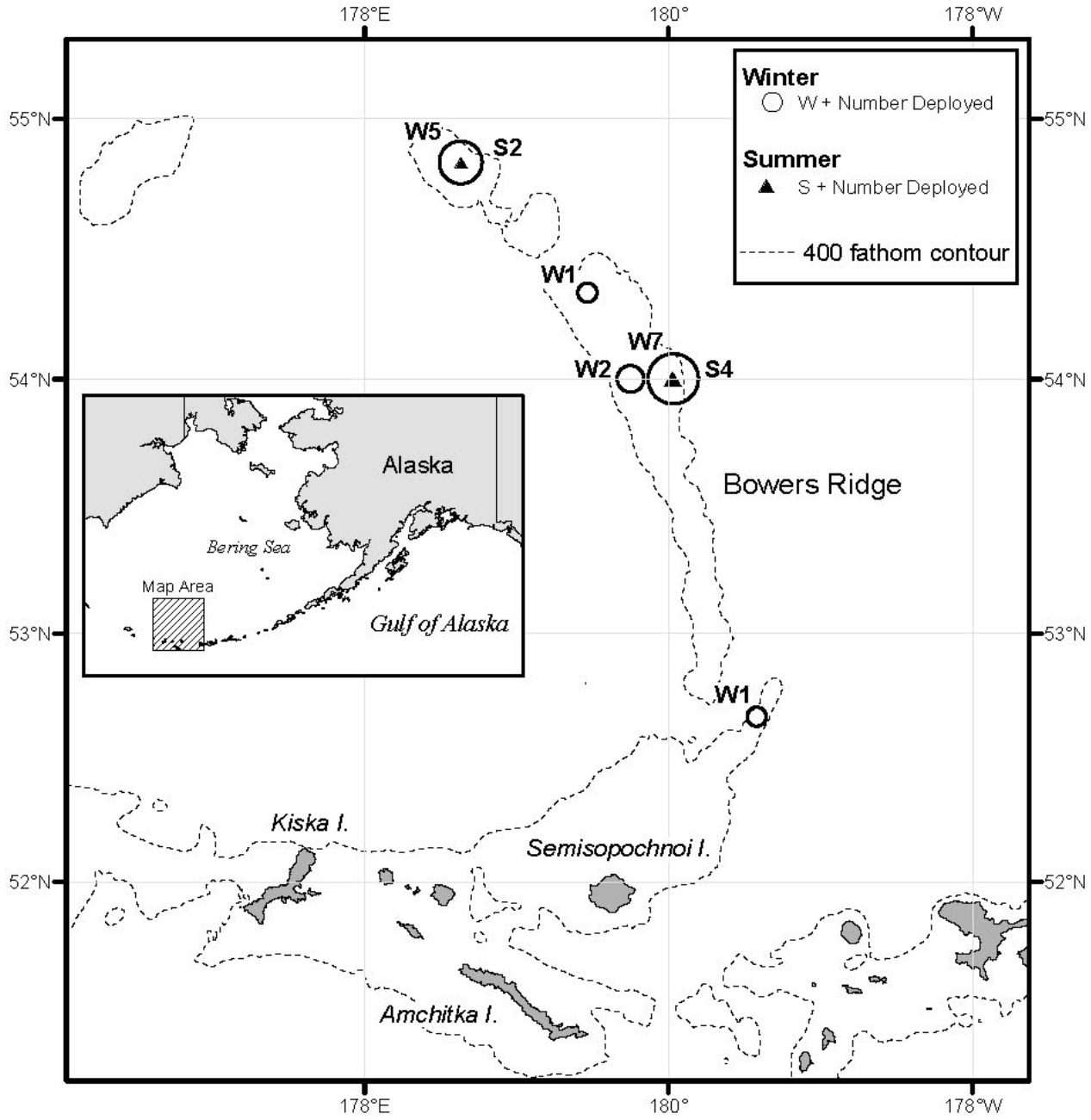

Figure 2. Release locations of Pacific halibut tagged with miniPAT tags in 2017.

Coastwide deployment of fishery-recovery archival tags on U32 Pacific halibut

A total of 255 fish ranging in length from 51-81 cm FL were tagged with long-term (i.e. 5-7 year operating life) electronic archival tags during IPHC's fishery-independent setline survey. Tags were released from coastal Oregon to the Area 4D shelf Edge and westward as far as Adak

Island in the Aleutians. Additionally, due to the expectation that tag-recovery rates are likely to be low in Area 4B, thirteen fish ranging from 58-79 cm FL were tagged with pop-archival transmitting tags between Adak and Attu Islands. These tags were programmed to report after either 365 (10 fish) or 730 days (3 fish). Additional tag deployments will take place during 2019. Tissue samples were collected from all tagged fish in order to determine their sex via genetic analysis. Rewards will be offered for the recovery of these tags, where the reward amount will vary according to the amount of information provided to the IPHC: $300US if only the tag is returned; $400US if the tag is returned along with length and sex information and the fish's otoliths; $500US if the entire fish along with its tag is presented to an IPHC port sampler or equivalent agency biologist (e.g. fisheries observer) for sampling. The data obtained from these tags will be used to relate rearing temperatures to growth rate and examine dispersal-at-age in Pacific halibut as they grow and recruit into the directed longline fishery.

RECOMMENDATION

That the RAB:

1) **NOTE** paper IPHC-2019-RAB020-11 which outlined the research projects describing studies designed to improve our knowledge on Pacific halibut distribution and migration at all life stages.

REFERENCES

St-Pierre, G. 1984. Spawning locations and season for Pacific halibut. Int. Pac. Halibut Comm. Sci. Rep. 70. 46 p.