Assessing Spawning Behavior at the Northern Extreme of Pacific Halibut

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Fisheries Management

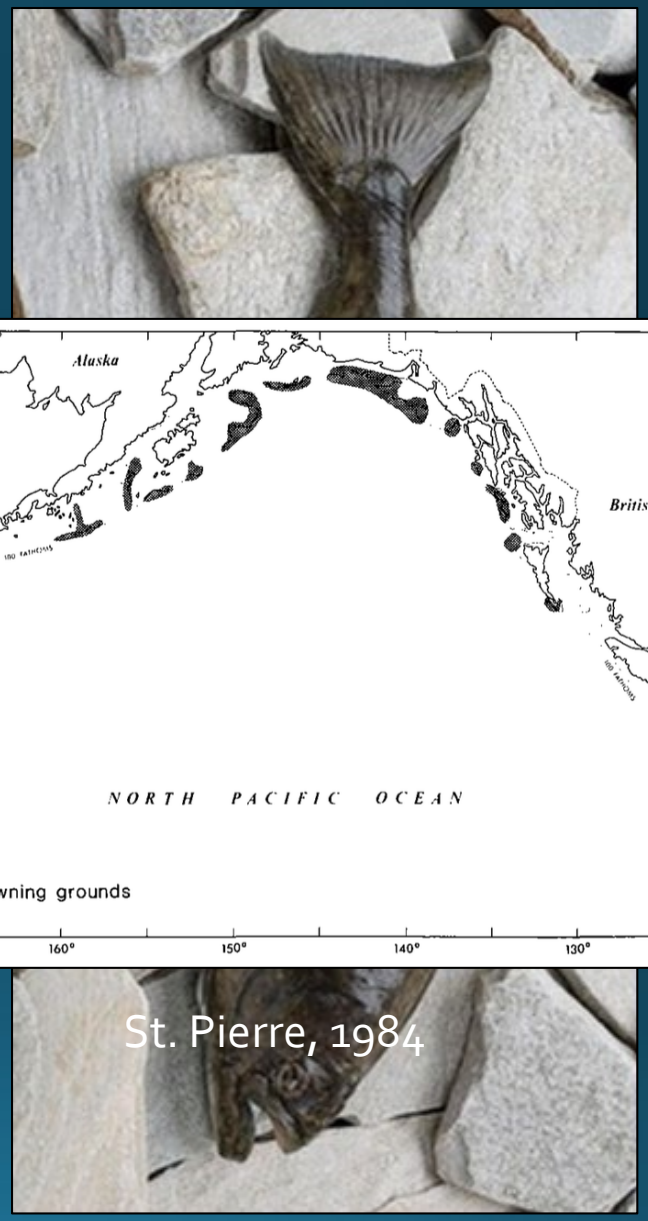
- Informed management is essential for maximizing the productivity of fish stocks
- Relies on stock assessment to estimate fish abundance
- Requires life history information to estimate recruitment
  - Fecundity
  - Maturity
  - Spawning frequency

Spawning Variation

- Spawning metrics are often treated as constant across a fish's range
- Recent studies indicate these can vary latitudinally
- Particularly at northern extremes
  - Reduced spawning frequency
  - Reduced fecundity
  - Reduced spawning season
  - Larger age and size at maturity

Pacific Halibut

- Widely distributed demersal flatfish
  - Range from California to the Northern Bering Sea (NBS)
- Spawn in deep waters off the continental shelf
  - From December to February
- Widespread spawning grounds
  - Not assessed in the NBS



St. Pierre, 1984

Current Management

- Management recommendations made by the IPHC
- Despite a large latitudinal range, managed as a singular coastwide stock
- Fixed metrics in stock assessment
  - Annual spawning
  - Single maturity curve
  - Single recruitment curve

Project Background

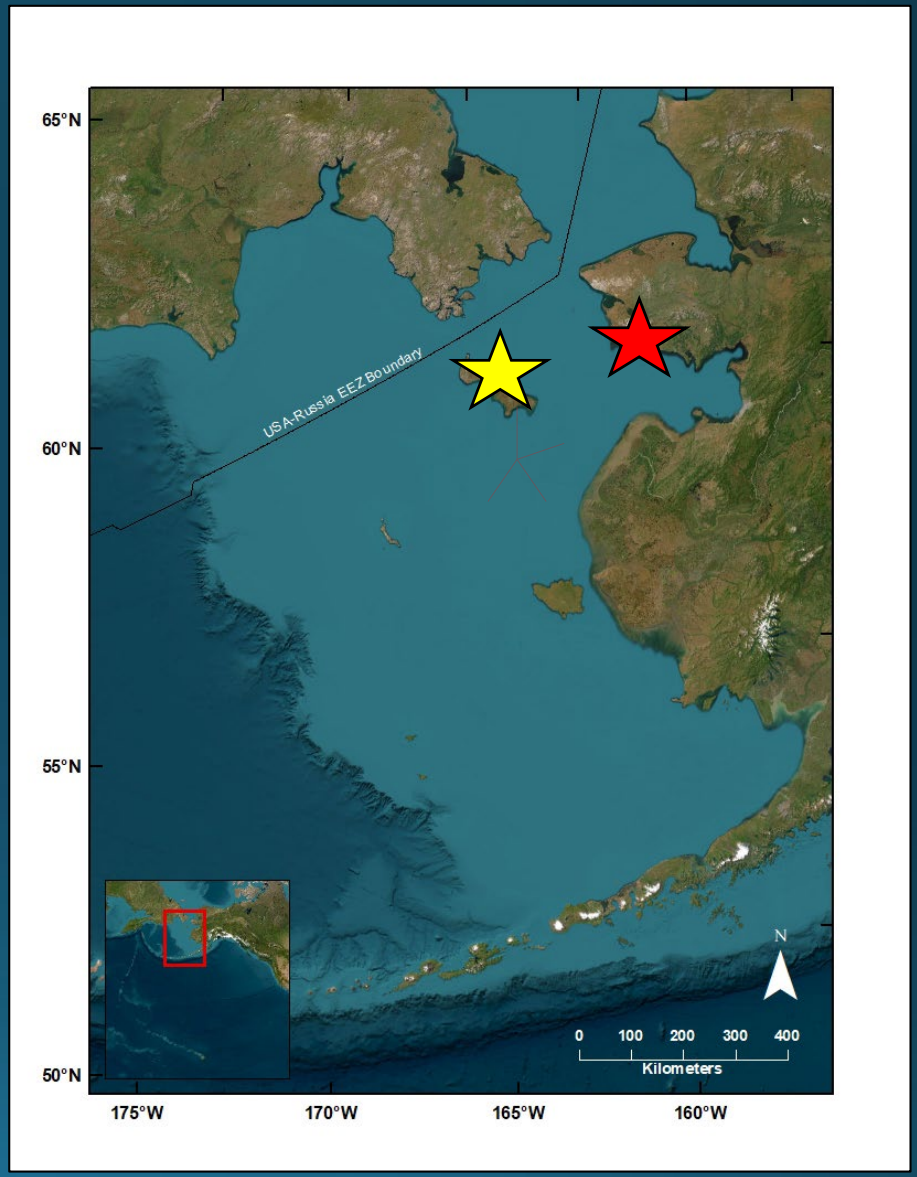
- Pacific halibut spawning metrics may vary latitudinally
  - Violating stock assessment assumptions
- Pacific halibut spawning behavior has not been assessed at the northern extreme of its range
- Deployed satellite tags to assess spawning characteristics in the NBS

Objectives

- Identify spawning and skipped spawning rates of NBS Pacific halibut
- Characterize occupied habitat of spawning and skipped spawning Pacific halibut, as well as the timing of their spawning activity
- Locate spawning habitat of Pacific halibut in the NBS

Study Site

- All individuals were captured and tagged in two NBS locations
  - Nome, located on the north western shore of Norton Sound
  - Savoonga, located on the northern shore of Saint Lawrence Island



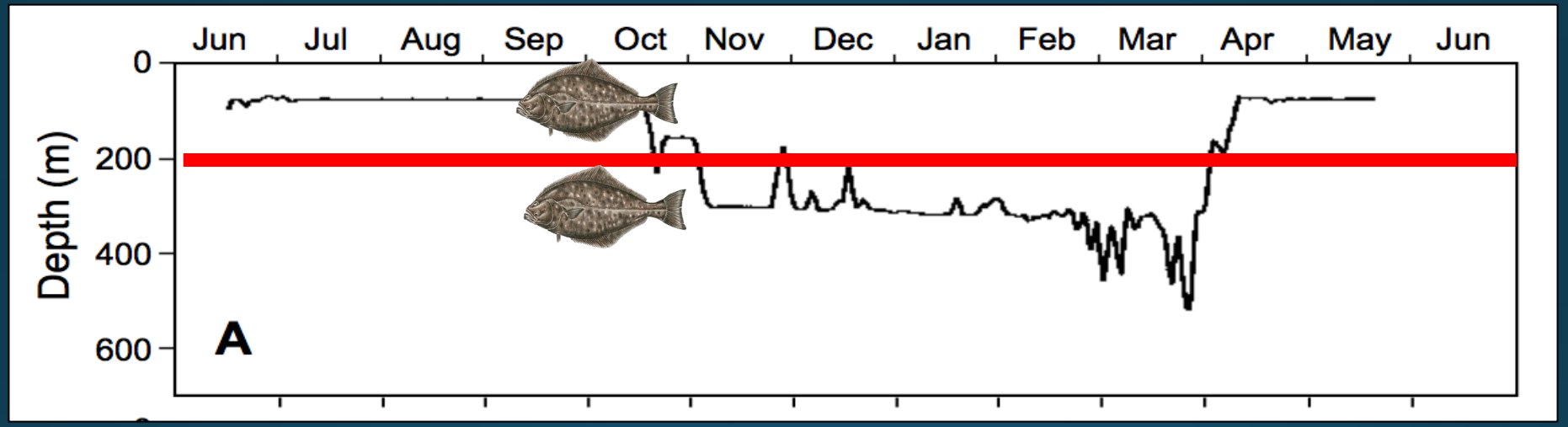
Fish Capture

- Fishing efforts spanned late July to early September
  - Commercial longlining vessels
- Selected fish larger than 100 cm FL for tagging
  - Designates 95% maturity for female Pacific halibut

Tagging Procedure

- Fish tagged using Wildlife Computers miniPATs
  - Recorded depth, temperature, light intensity, and pop off location
- Halibut were released
  - Winter and Summer pop-off dates

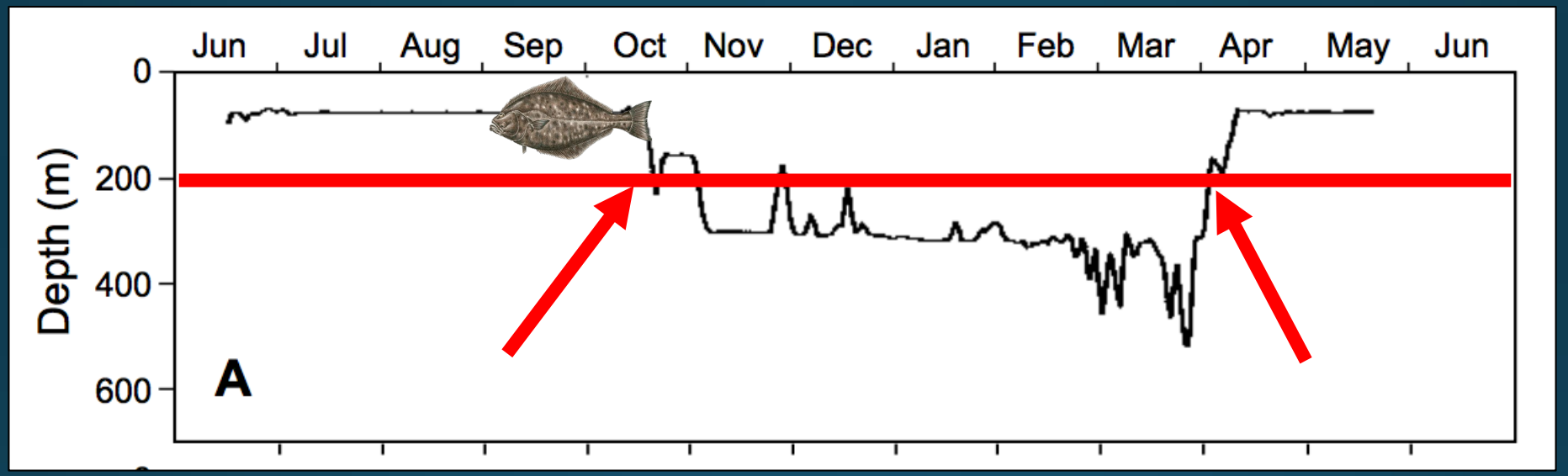
Analysis: Spawning



Loher and Seitz, 2008

- The depth record evaluated for all tags that transmitted data
  - Spawning depths occur below 200m (Loher and Seitz, 2008)
- Fish that failed to descend below 200 m characterized as skipped spawners
  - All others assumed to be spawning individuals
  - Skipped spawning rate ($Skipped/Total$) and Spawning rate ($1 - Skipped\ rate$)

Analysis: Spawning Conditions

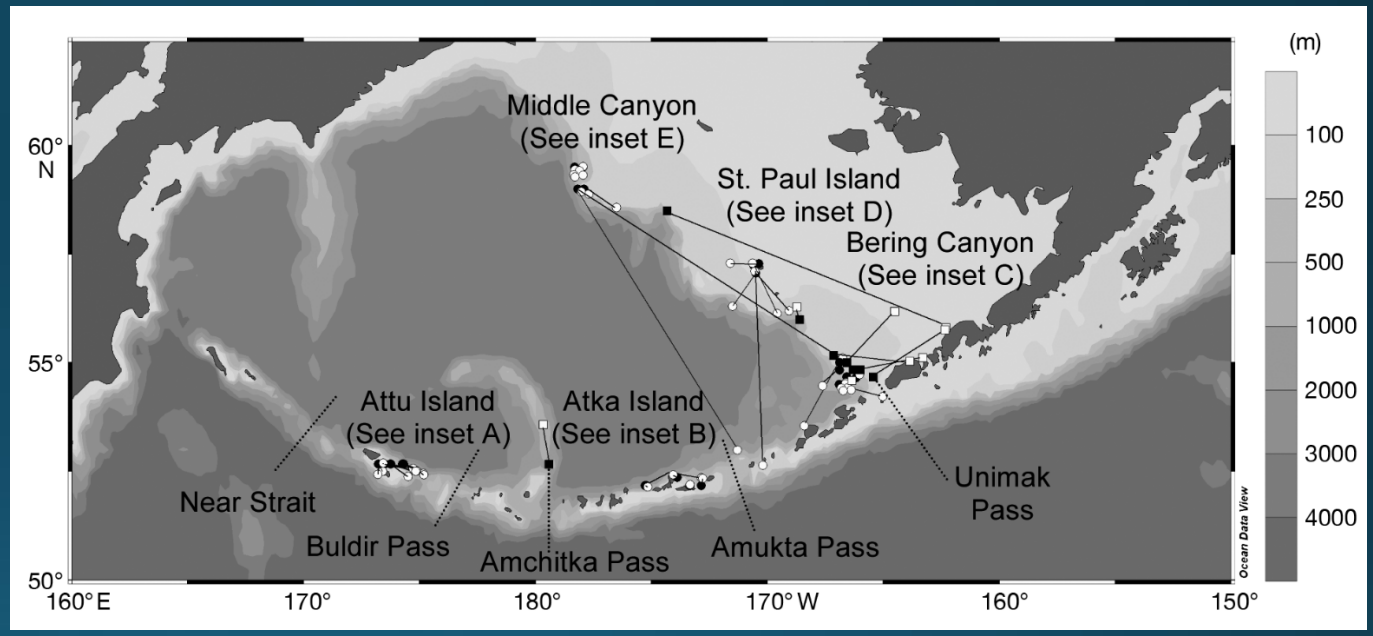


Loher and Seitz, 2008

- Occupied conditions summarized for spawning and skipped spawning fish
  - Aggregated boxplots of depth and temperature
- Timing of spawning activity was also identified from the depth record
  - Time from which fish first descended below and last ascended above 200 m

Analysis: Spawning Location

- Pop-off locations were used to identify where spawning activity occurred
  - Winter pop-offs
- Also used to locate wintering grounds of skipped spawners

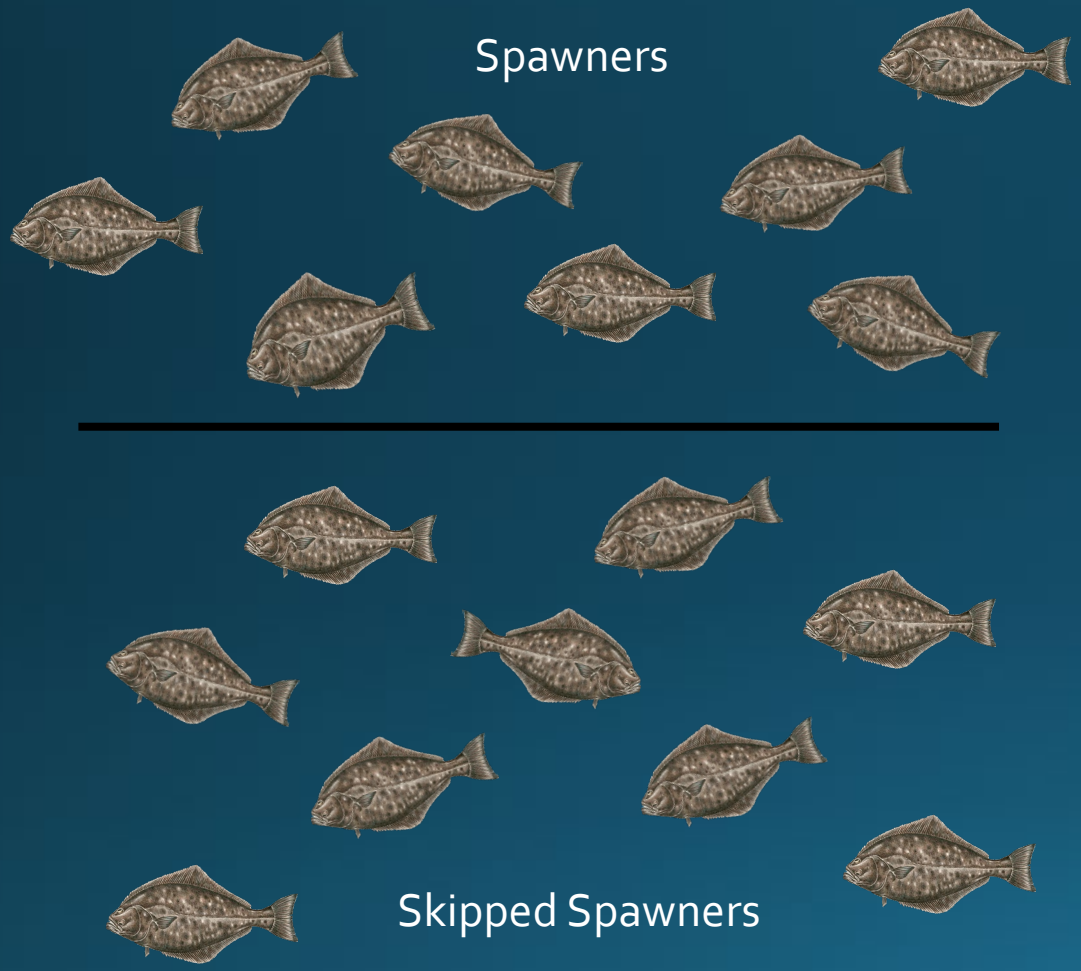


Seitz et al., 2011

Preliminary Results

- A total of 69 satellite tags have been deployed
  - 25 are currently at liberty
- 23 tags reported to satellites, transmitting variable amounts of usable data
  - Time series and locations when release date was reached and adequate data transmitted

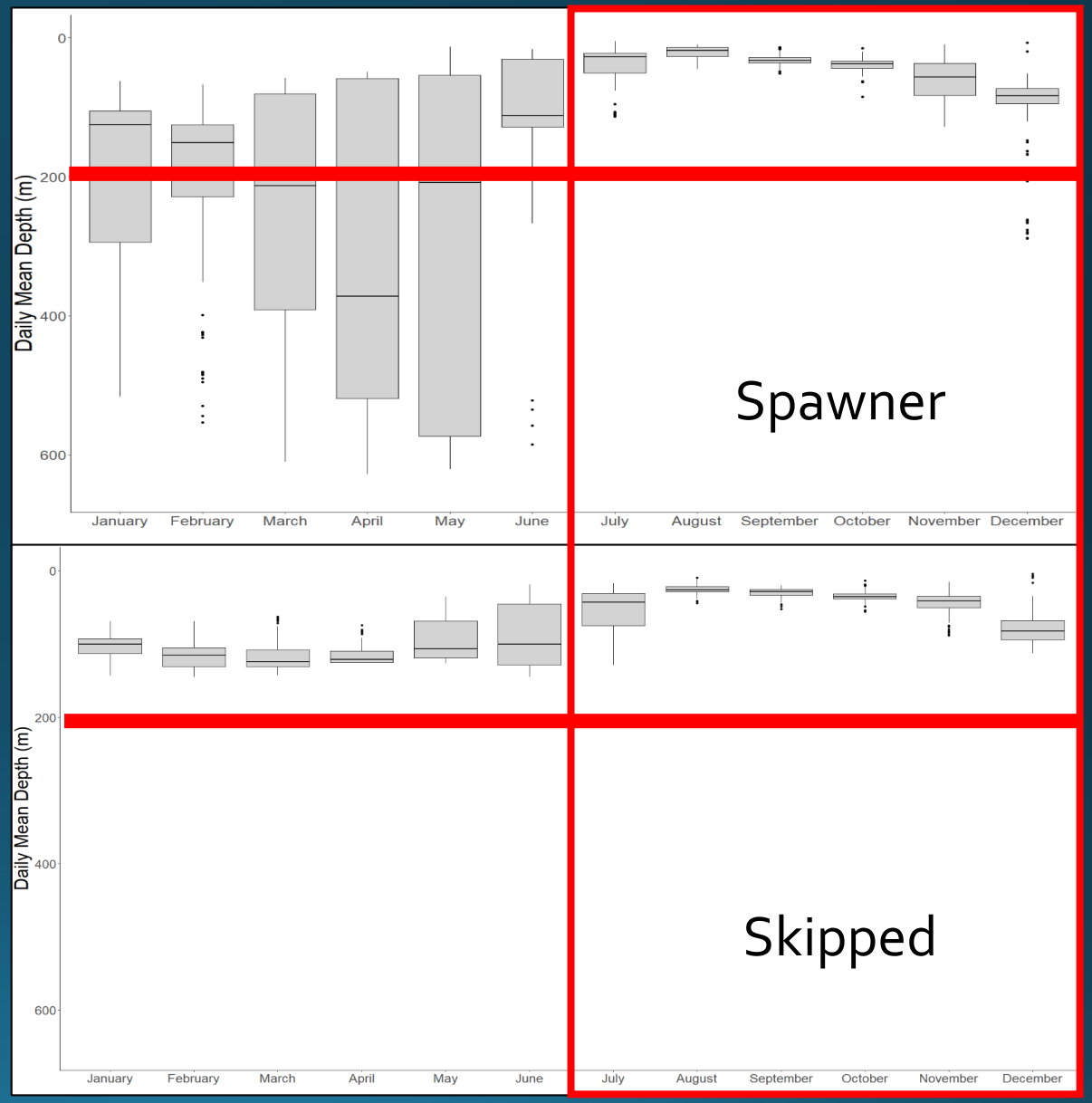
Spawning Rate



- 17 tags with sufficient data to determine spawning vs skipped spawning
- 8 halibut occupied spawning depths
- 9 fish failed to utilize spawning habitat
  - Never reached 200m in depth
- Spawning rate of 47%
  - Skipped rate of 53%

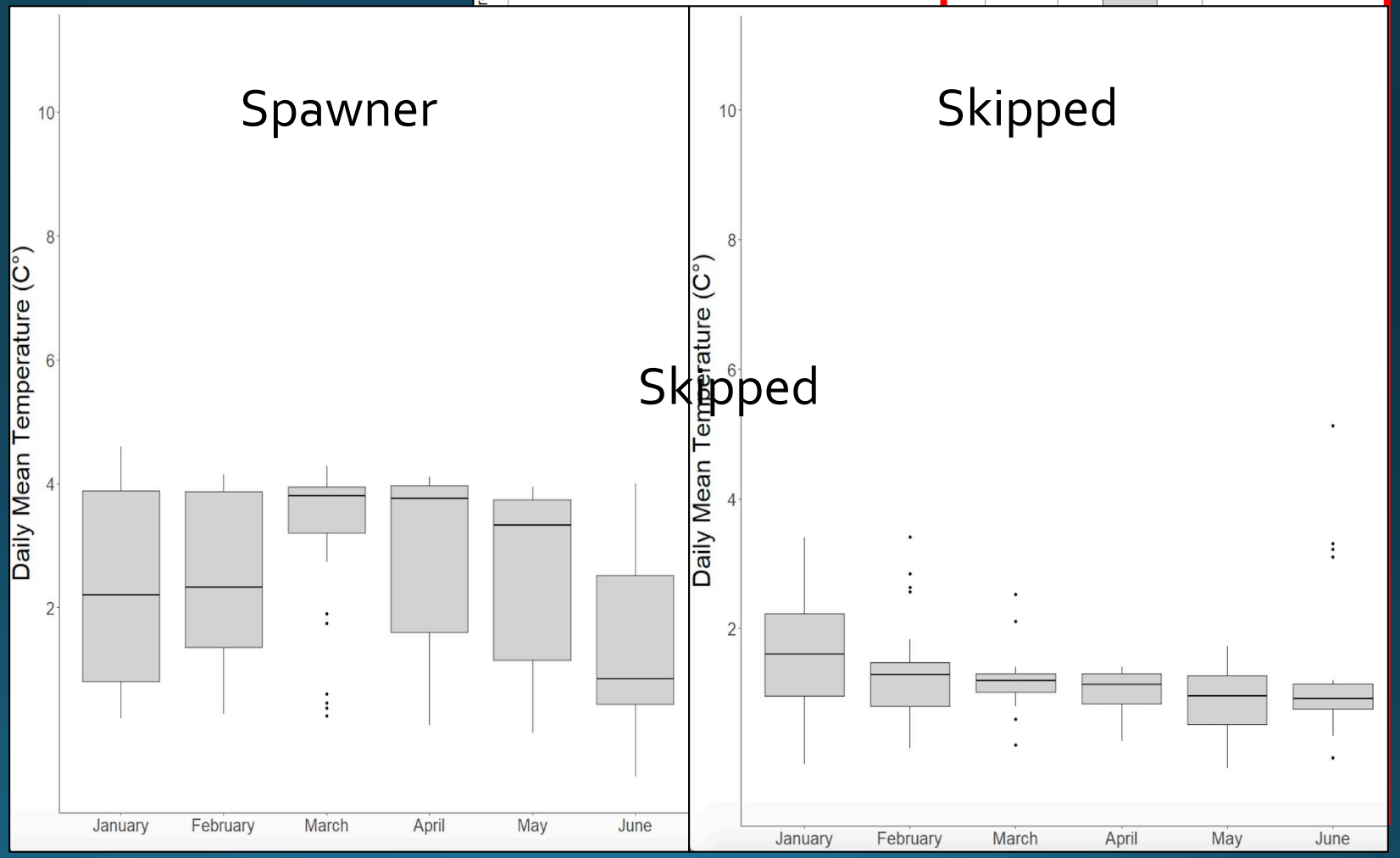
Depth Occupancy

- Aggregated mean daily depth
  - Boxplot by month
- Summer occupation is consistent across groups
  - Highly variable deep water occupation for spawners
  - Skipped spawners consistently inhabit waters around 100 m
- Significantly different (95%, Welch's t-test)
  - 408 ±134m (200–642m)
  - 100.3 ± 25.34m (.5–145.5m)

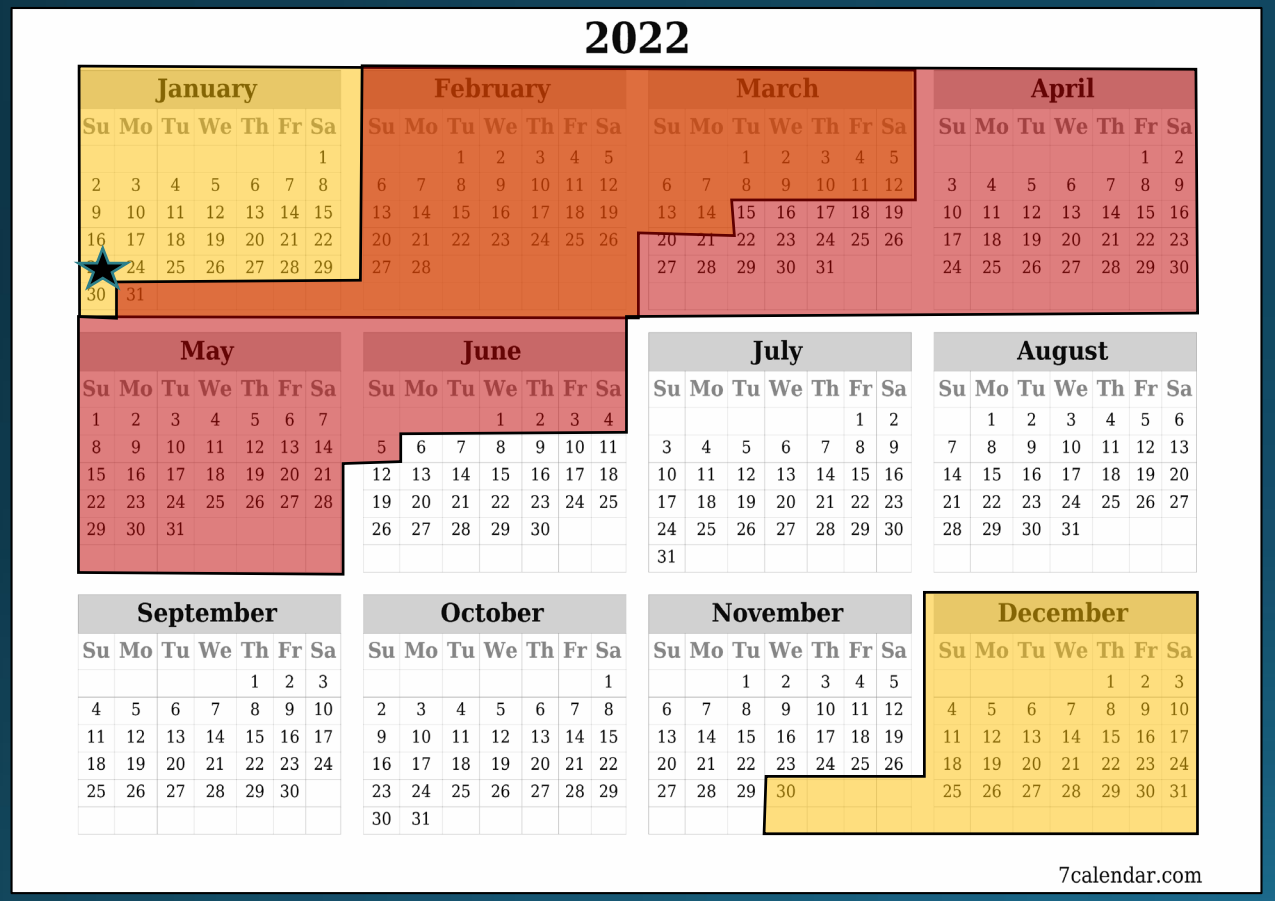


Thermal Occupation

- Aggregated thermal occupation by month
  - Summer occupation is consistent
- Variation during the spawning season
  - Spawners appear to occupy warmer waters
- Significantly different (95%, Welch's t-test)
  - 3.527 ±0.93℃ (0.5–4.6℃)
  - 1.5±0.82℃ (-0.2–4.4℃)



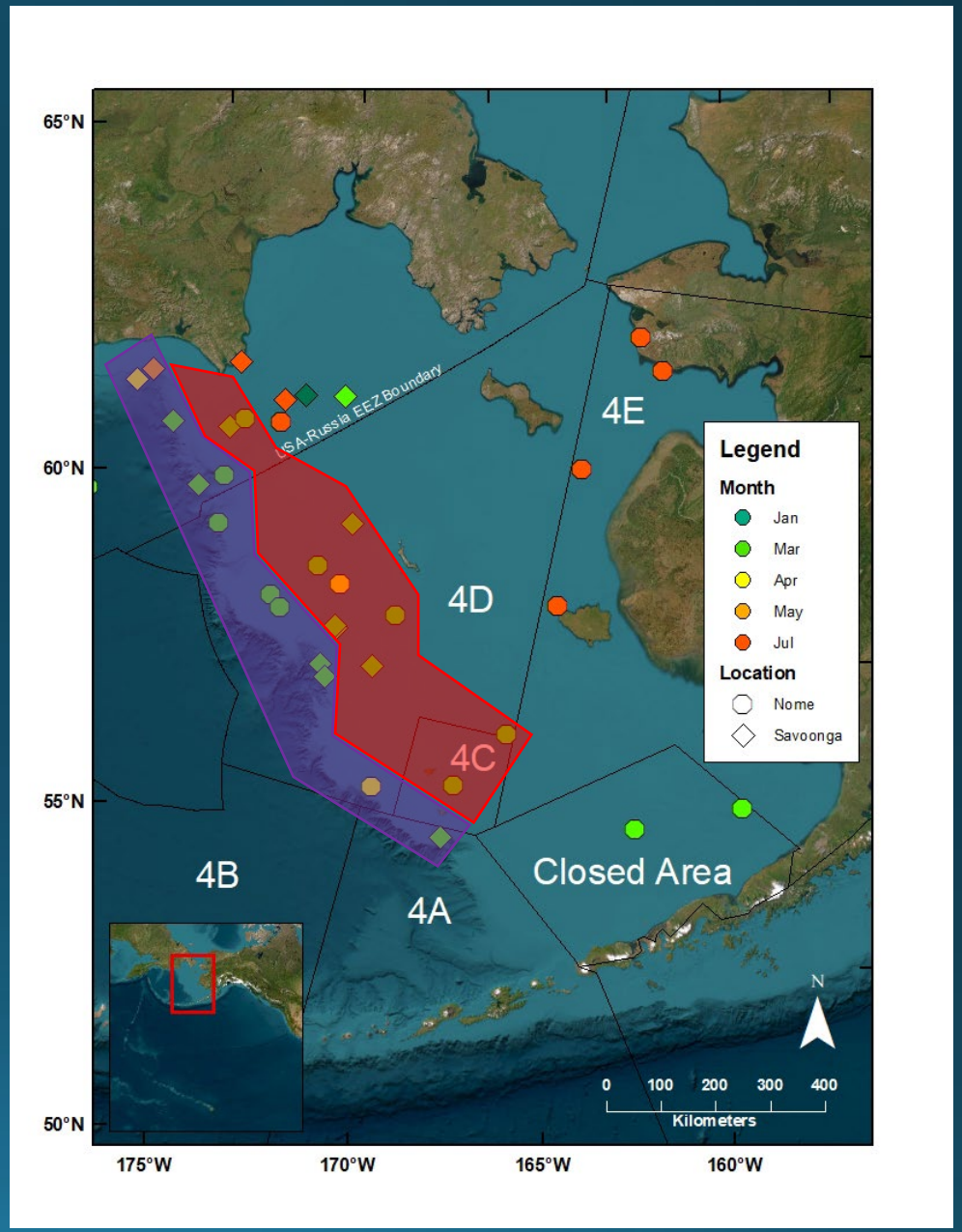
Spawning Timing



- Mean arrival was 1/23 ± 14 days (N=7)
  - Range from 11/30 to 3/14
- Mean departure was April 10 ± 23 days (N=5)
  - Range from 1/31 to 6/5
- Mean duration of spawning habitat occupation of 69 ± 15 days (N=5)
  - Range from 12 to 92 days

Pop-off Location

- A total of 35 locations
  - 19 from Nome and 16 from Savoonga
  - Some unvalidated (need depth data)
- Nome fish mostly in US waters
  - Savoonga fish mostly in Russia
- Spawners distributed along shelf edge
  - Skipped spawners proximate to spawners but on the shelf
- Summer pop-offs indicate return movements to tagging region



Discussion

1. Pacific halibut in the NBS appear to be biennial spawners
2. Spawning season appears to end later than in southerly latitudes
3. Indicated the presence of previously unidentified northern spawning habitat
4. Suggests current management may be over estimating spawning biomass and mis-apportioning recruitment

Future Work

- Analyze additional tags following data transmission
- Assess potential variation between Nome and Savoonga tagged fish
- Communicate results to the IPHC for consideration in future stock assessment practice

Acknowledgments

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- Funding for graduate student support was provided by CMI, the Rasmuson Fisheries Research Center fellowship, North Pacific Research Board Graduate Student Research Award, and UAF CFOS
- I would also like to thank local captains who participated in tagging efforts

Questions?

Recovered Tags

- Two tags indicated skipped spawning behavior
  - No spawning rises and shallow water occupation
- One tag exhibited spawning behavior
  - Deep water occupation and two spawning rises
- Large, rapid ascents into the water column
  - 75 and 150 meters in magnitude, 3 and 7 minutes in duration