Can an AUV glider be used to track crab movements?

Crab Plan Team

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May – June 2022 Pilot Project

Marmot Bay, Kodiak Island, Alaska

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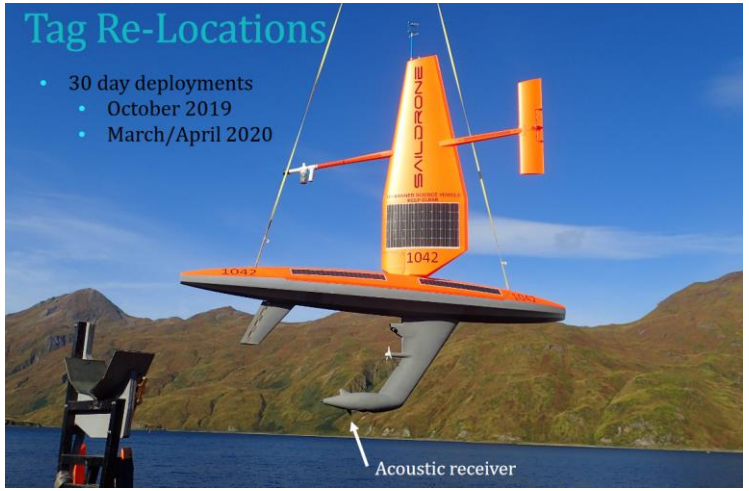
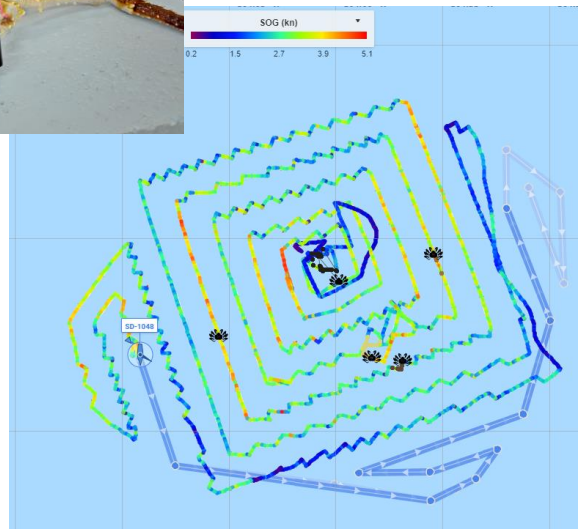
Background

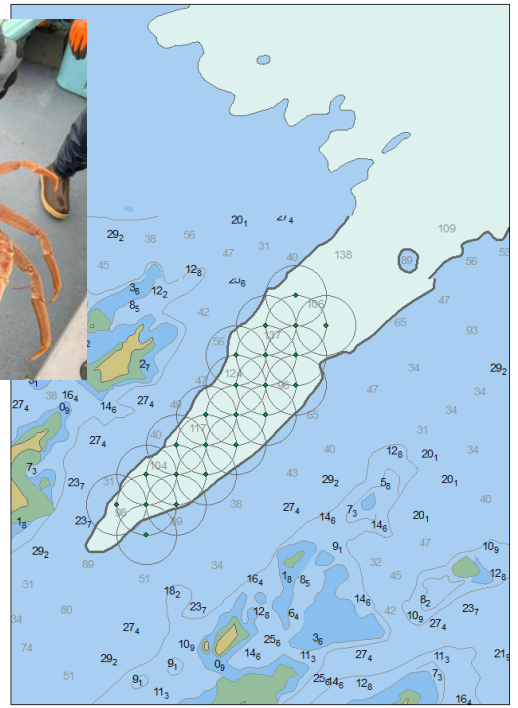
- Acoustic tags have been used in Alaska to assess crab movement
  - Long et al. – Kodiak RKC ghost fishing
    - active divers
  - Zacher et al. – Bristol Bay RKC tracking
    - active saildrone
  - Nault et al. – Kodiak Tanner double tag
    - passive moorings

BBRKC Saildrone





Kodiak Fixed Receivers



Background

- Autonomous underwater vehicles (gliders) increasingly used and efficient
  - UAF-CFOS ART Lab Fleet
    - Oceanographic monitoring
    - AOOS funding / data support
    - 2-4 month deployments
  - New externally mounted acoustic receivers
    - Cypher et al. in press – Prince William Sound Herring Project
    - Opportunistic marine mammal and salmon studies

Objectives

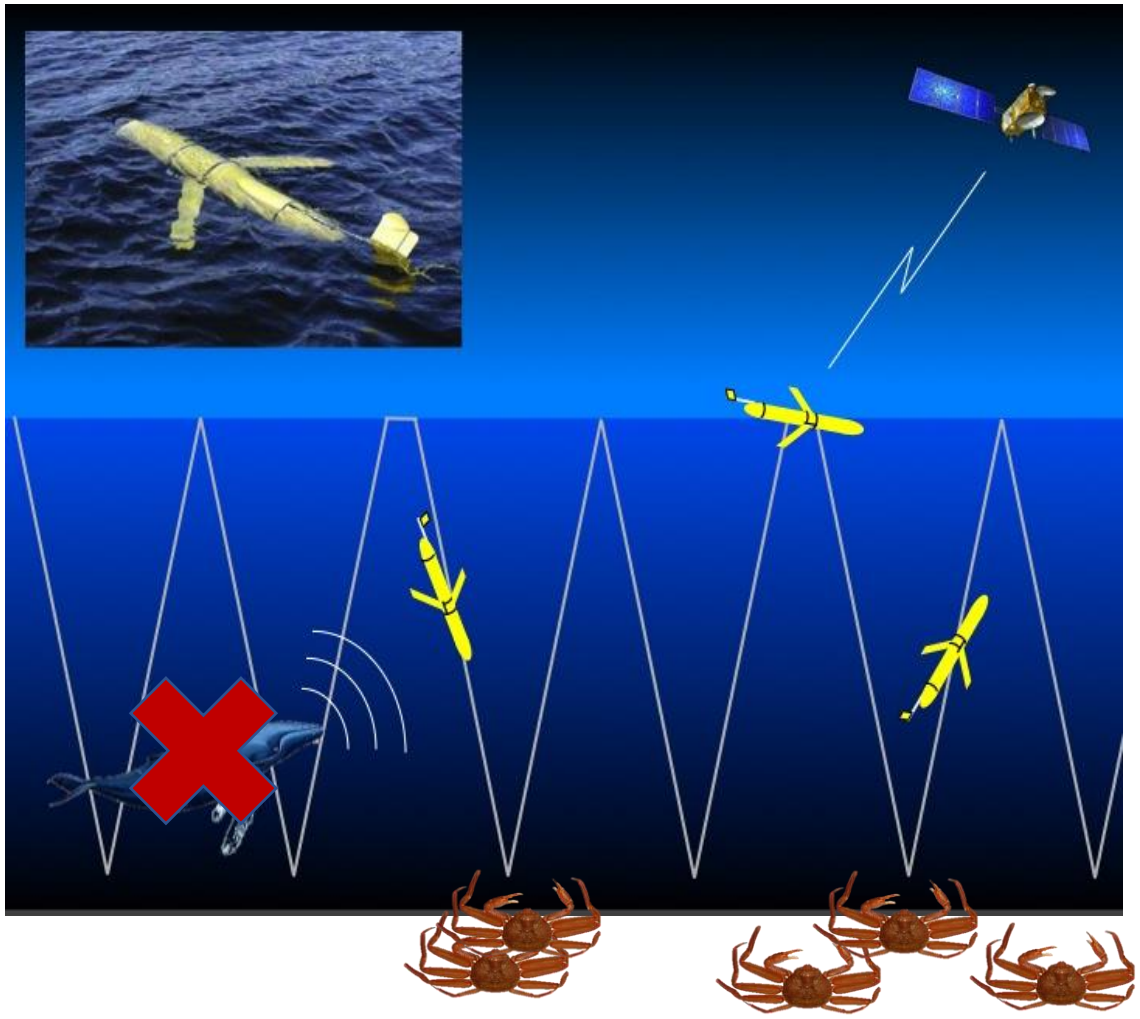
1) Provide proof of concept

2) Conduct signal range tests

3) Assess potential signal interference

4) Determine crab position and movements

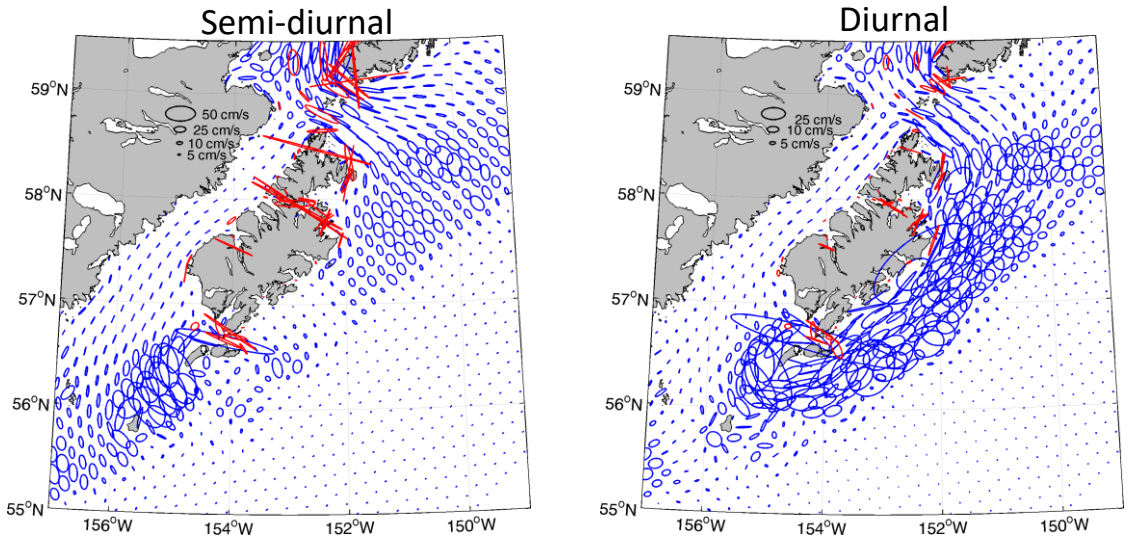
5) Develop a collaborative team



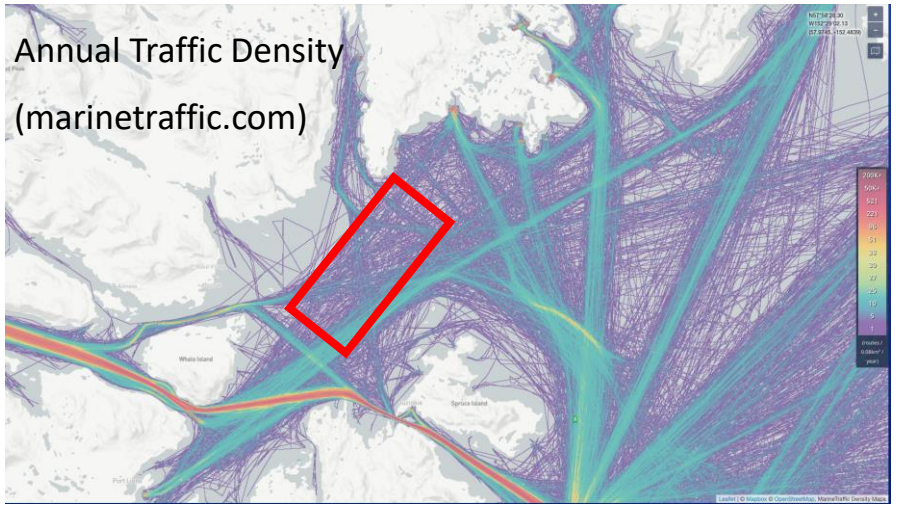
Methods

- DFG-funded 20-day deployment
- Study site – Marmot Bay
  - Extensive preplanning
  - Protected, relatively low traffic deep fjord
- Slocum G3 Glider – ‘Shackleton’
  - Buoyancy-driven propulsion w/ GPS, internal oceanographic bay, and external Vemco VR2C acoustic receiver
  - Remotely operated by ART-Lab Pilots
  - Speed ~ 15 cm/sec (< 0.5 knot)
  - Surface communications and data uplink every 2 hrs.

Current and Tides

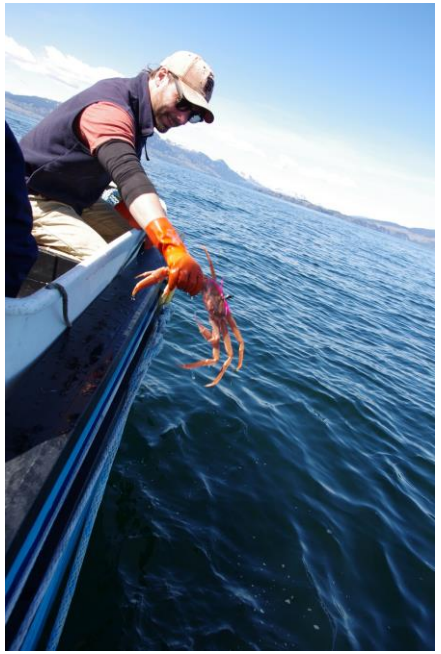


Marine Traffic



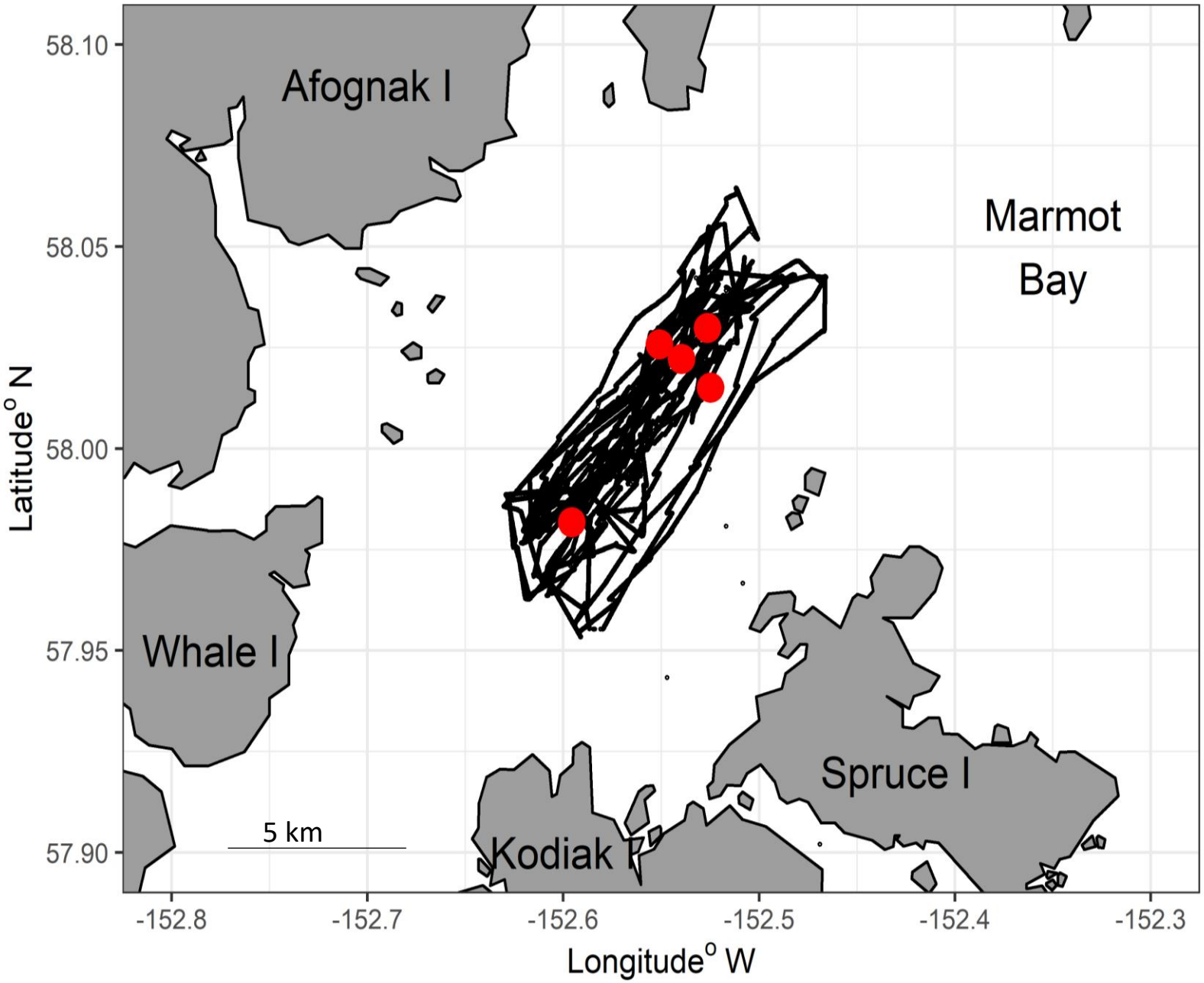
Methods

- Objective 2 – Range test
  - Fixed benthic moorings
    - N = 5 w/ 2 tag types each
  - Repeated sampling
- Objective 3 – Signal interference?
  - Vemco Acoustic Tags
    - 2 types (V9s & V13s)
    - 3 signal delays
      - Ave. ‘ping’ rate: 90s, 140s, 280s
- Objective 4 – Track Tanner crab
  - Tanner crab (N = 35 w/ V9 tags)
    - Adult males
    - Released near 3 mooring sites



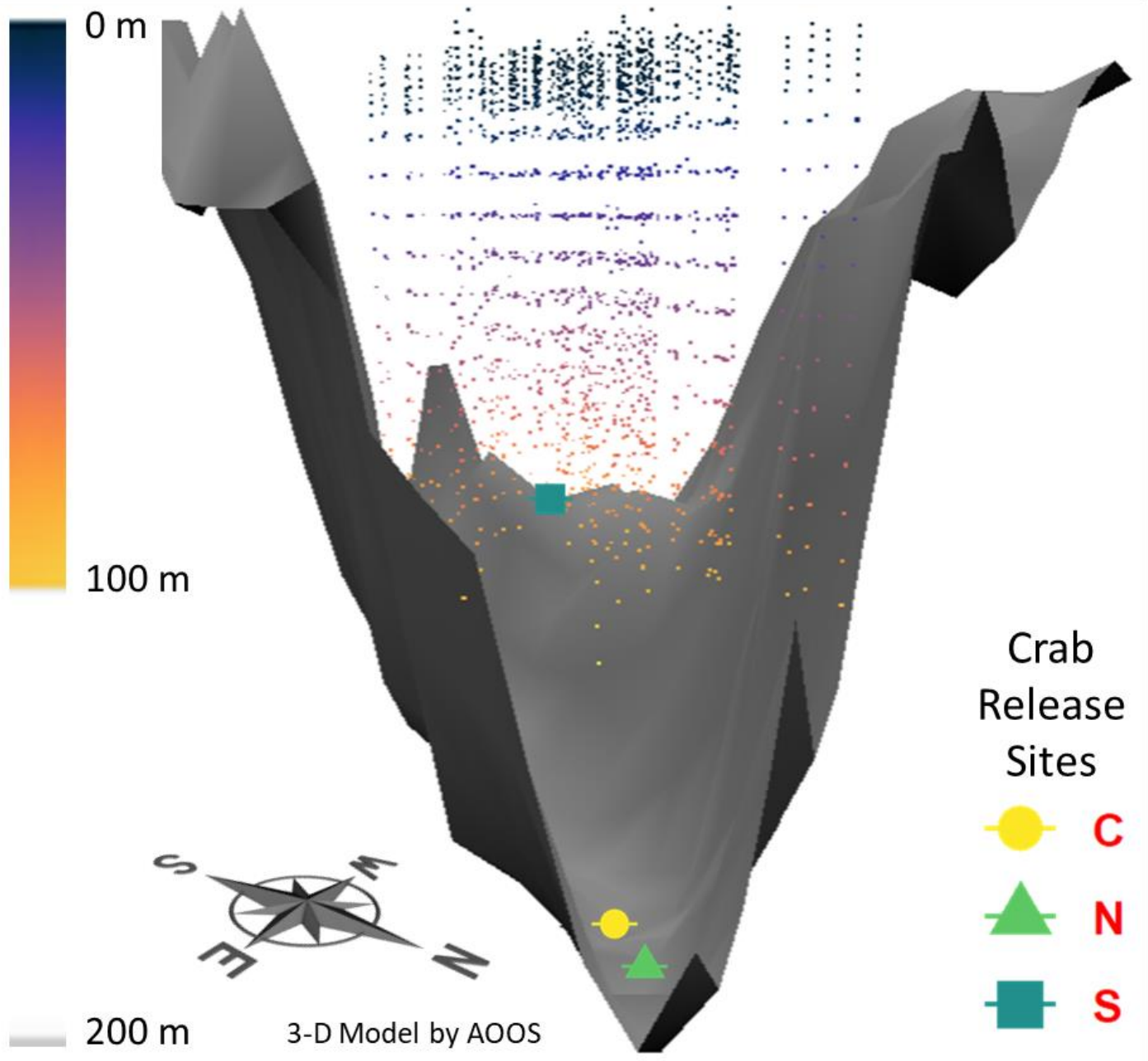
Methods

- 20+ traversing transects
  - ~ 10km per 12 hrs.
- Weekly Plan
  - Mooring flights
  - Expanded area
  - Edges and crabs
- All 40 tags recaptured
  - Pings per tag = 84 to 406



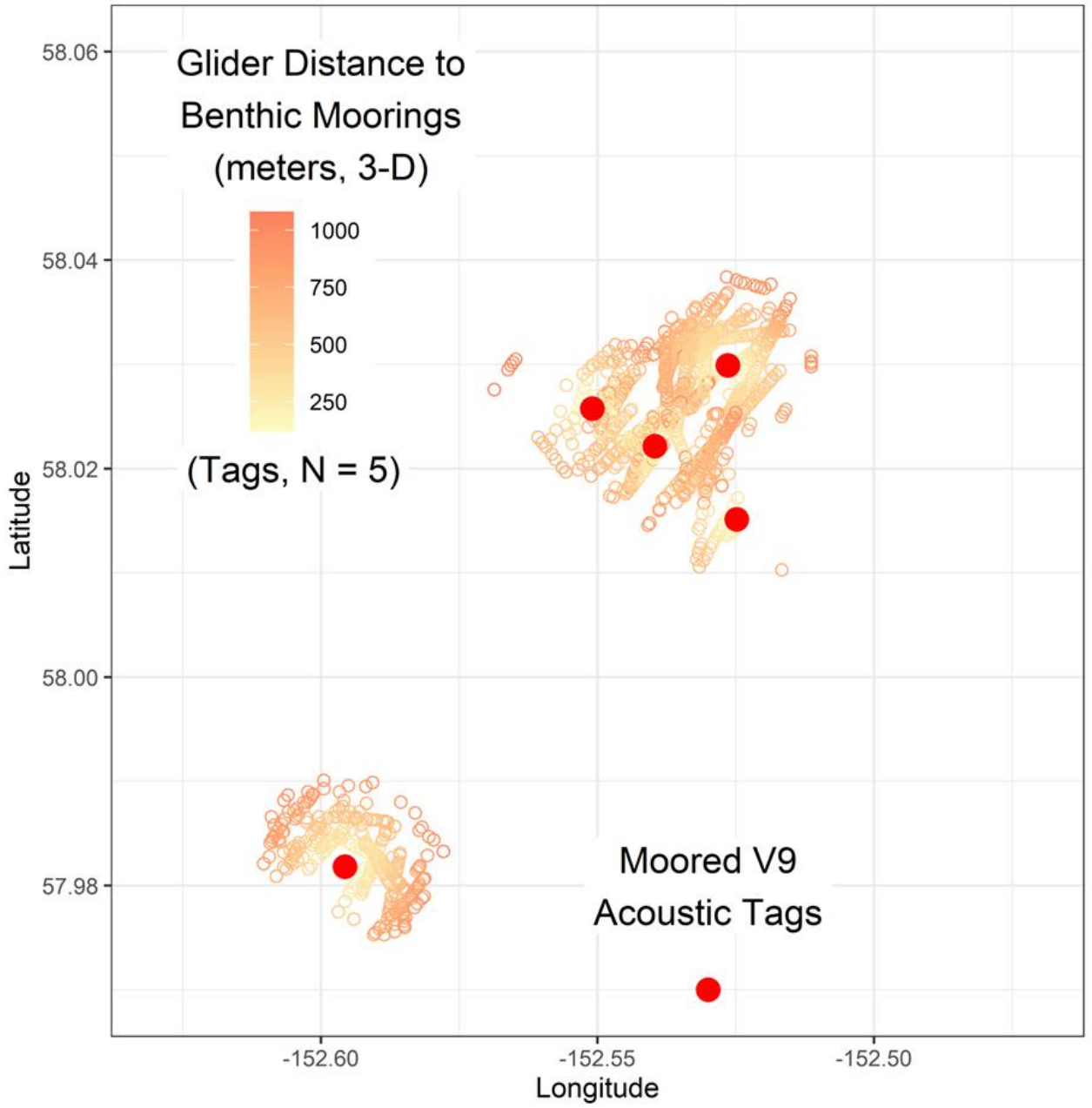
Methods

- Flight Control
  - UAF
    - Active piloting
    - Real-time mapping
  - ADFG
    - Piloting planning
    - Emergency response
  - AOOS
    - Post-survey
      - Visualizations
      - Data archiving



Results

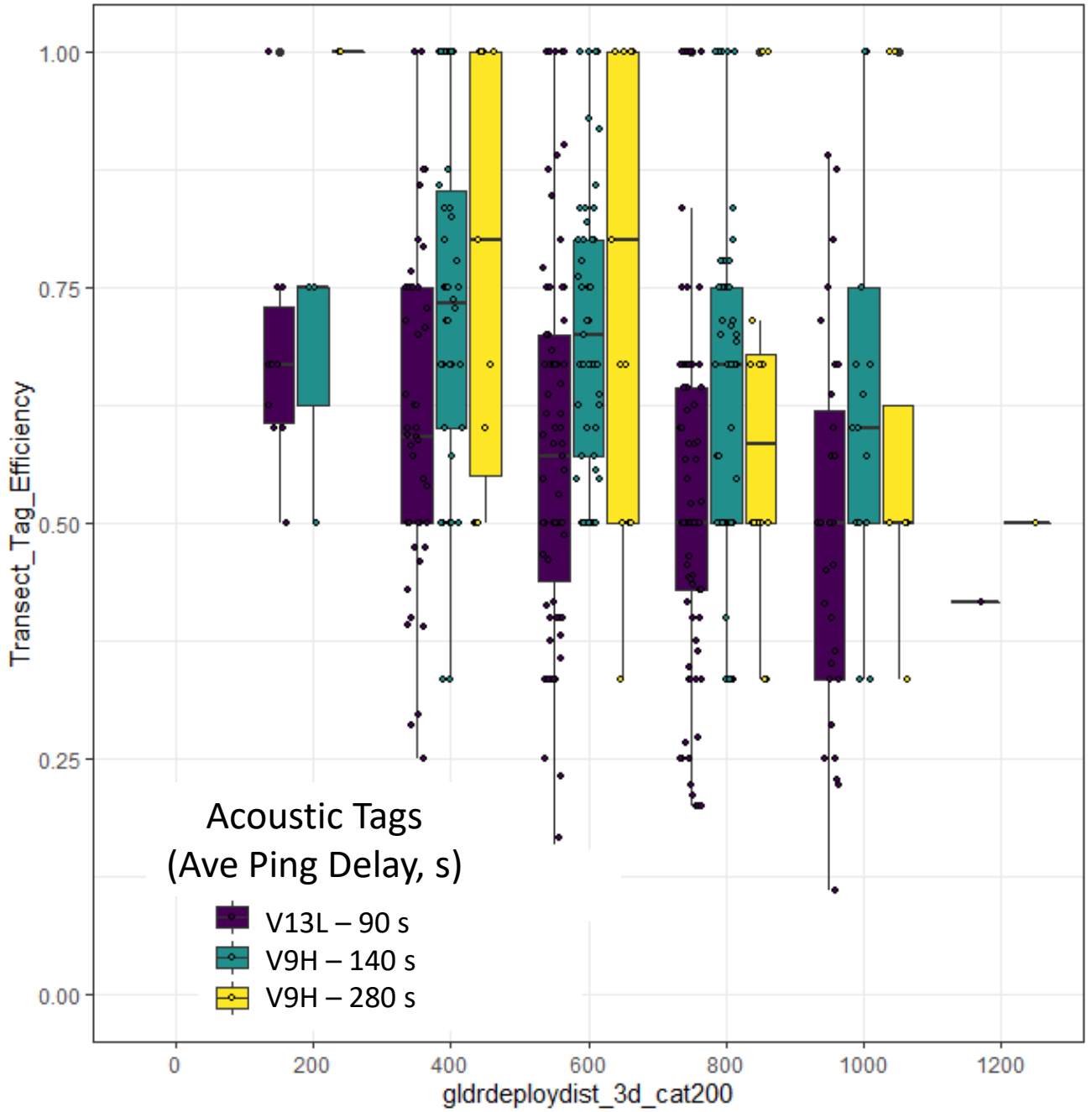
- Objective 2 – Range Test
  - Moorings only
  - Range ~ 1000 m



Results

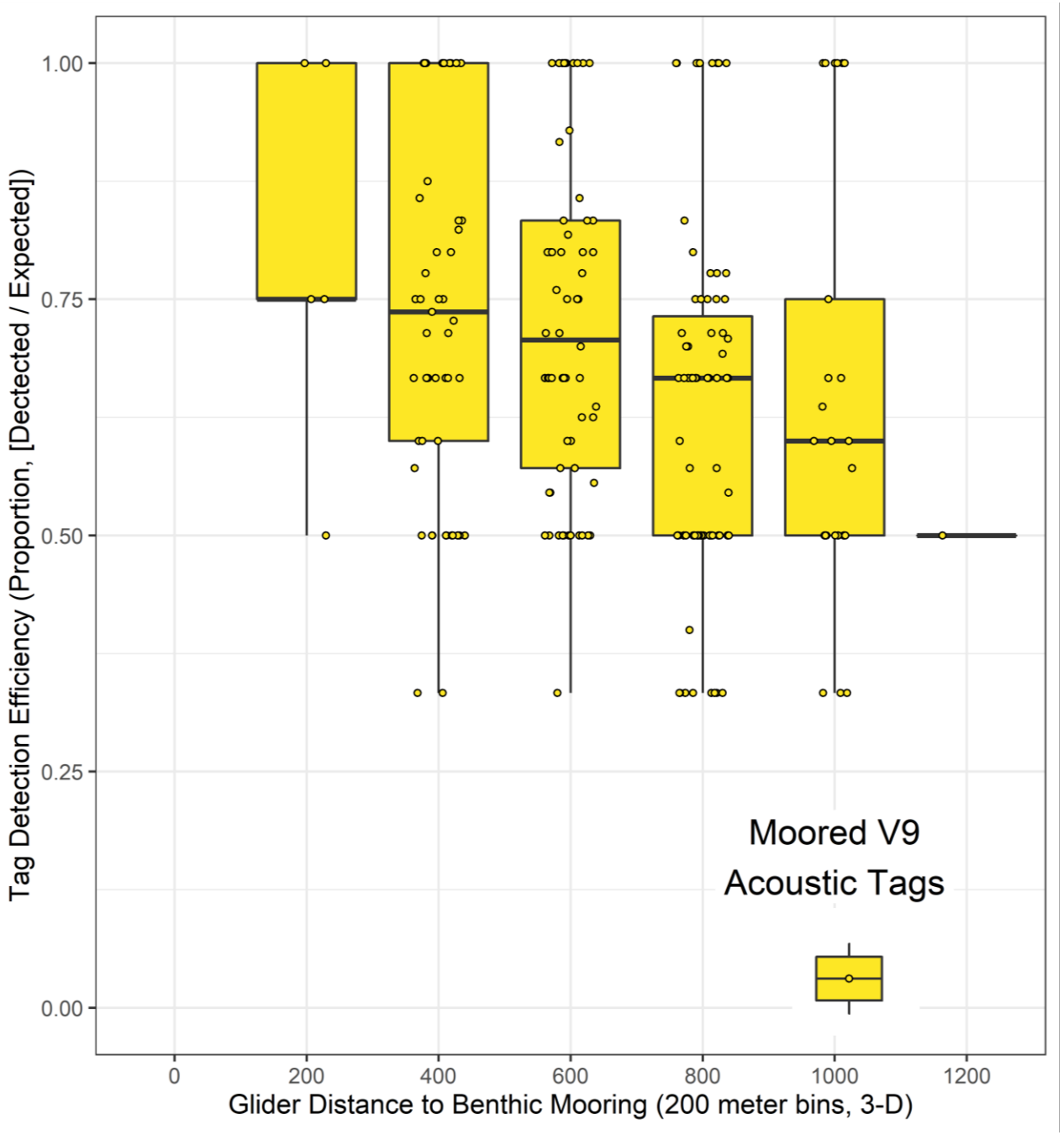
- Objective 2 – Range Test
  - Moorings only
  - Range ~ 1000 m

- Tag Detection Efficiency
  - Distance - line of sight
  - 200m distance bins
  - V13L < V9Hs
    - ANOVA, p<0.001
  - V9H-140 = V9H-280
    - ANOVA, p=0.46



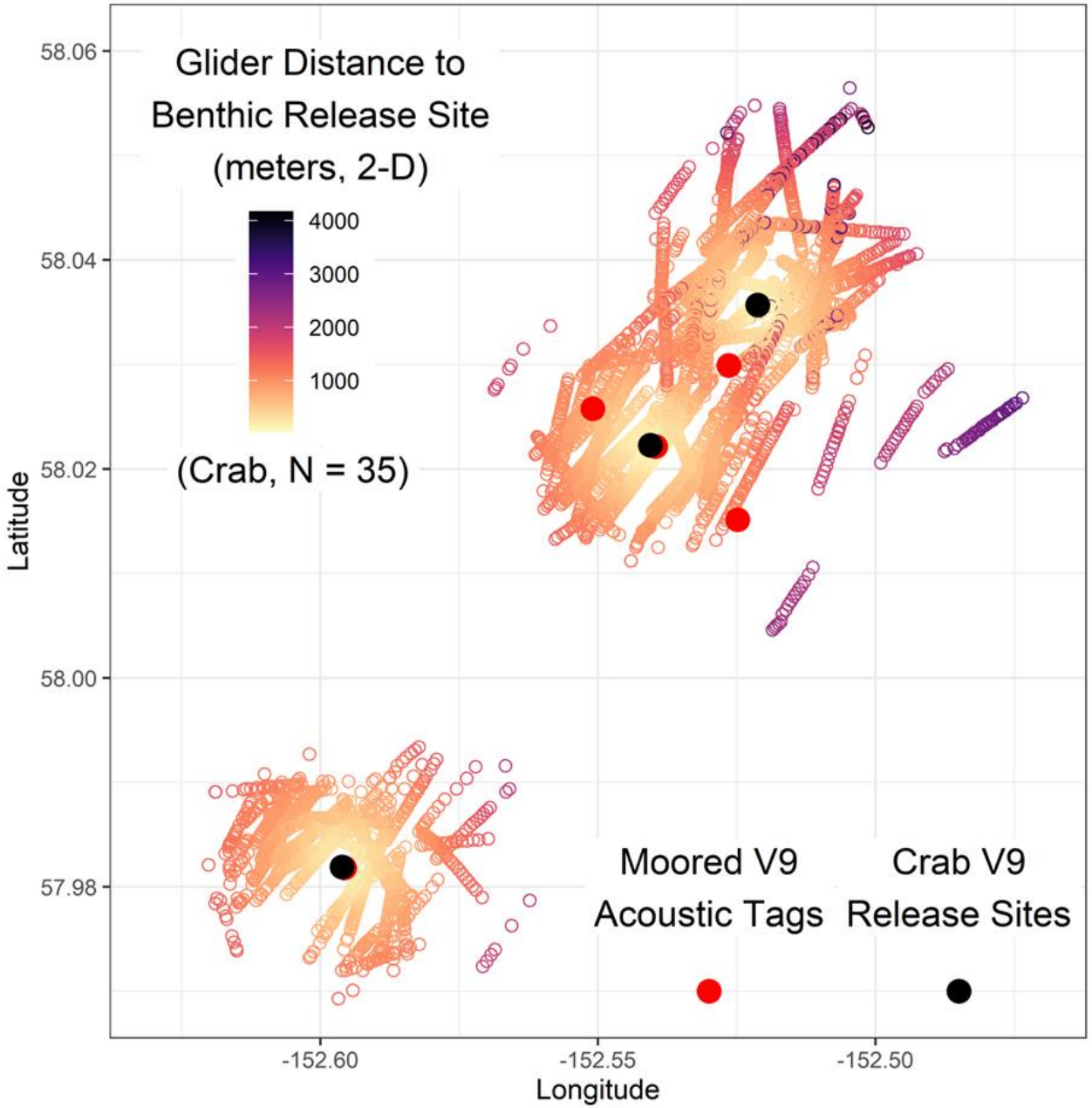
Results

- Objective 2 – Range Test
  - Moorings only
  - Range ~ 1000 m
- Tag Detection Efficiency
  - Combined V9H tags
  - > 60 % out to 1000 m
- Objective 3 – Interference
  - Unknown, but appears to be limited impact



Results

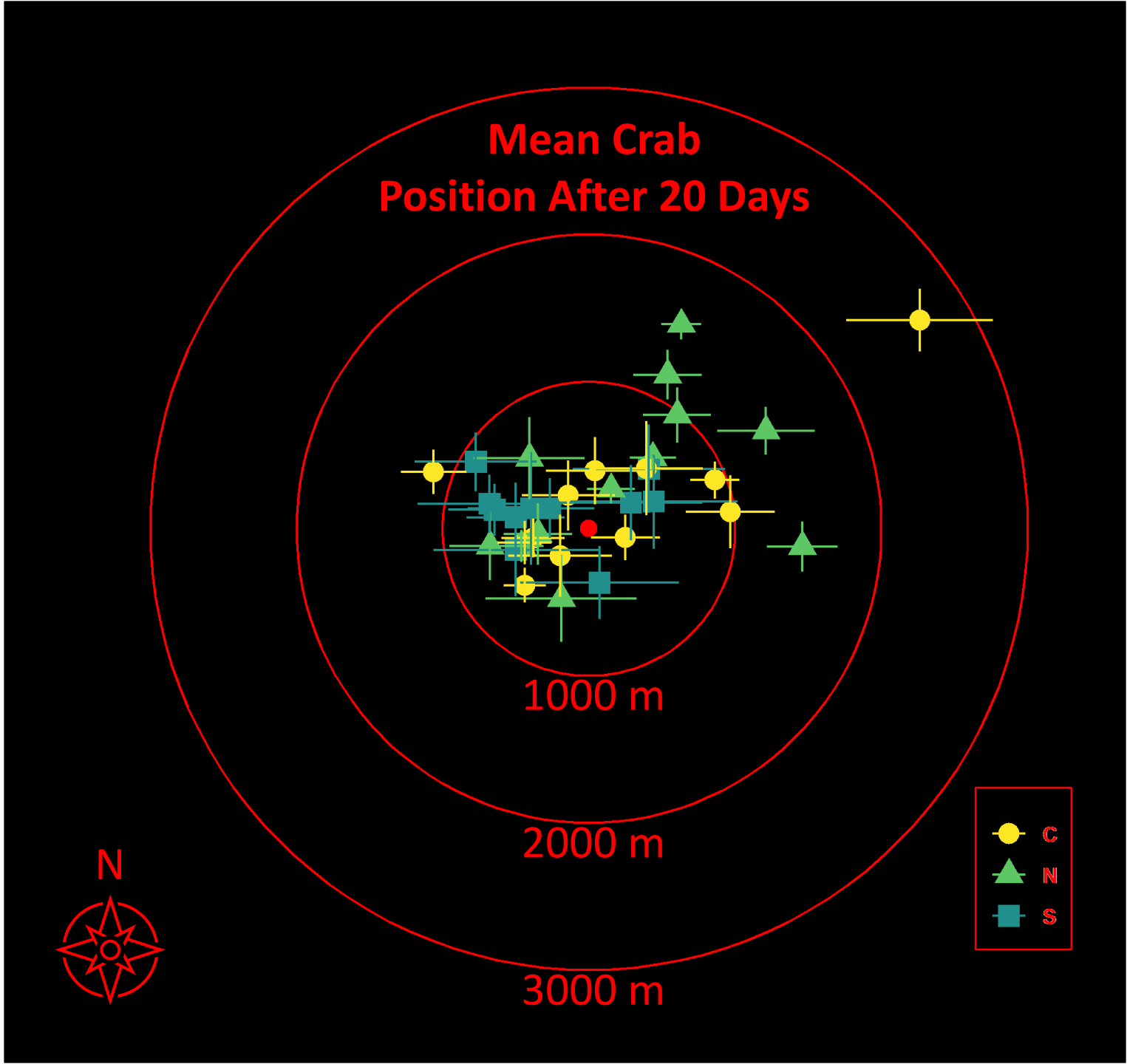
- Objective 4 – Track Tanner Crab
  - Crab only
  - Range still ~ 1000 m
  - Maximum Crab ~ 4000 m



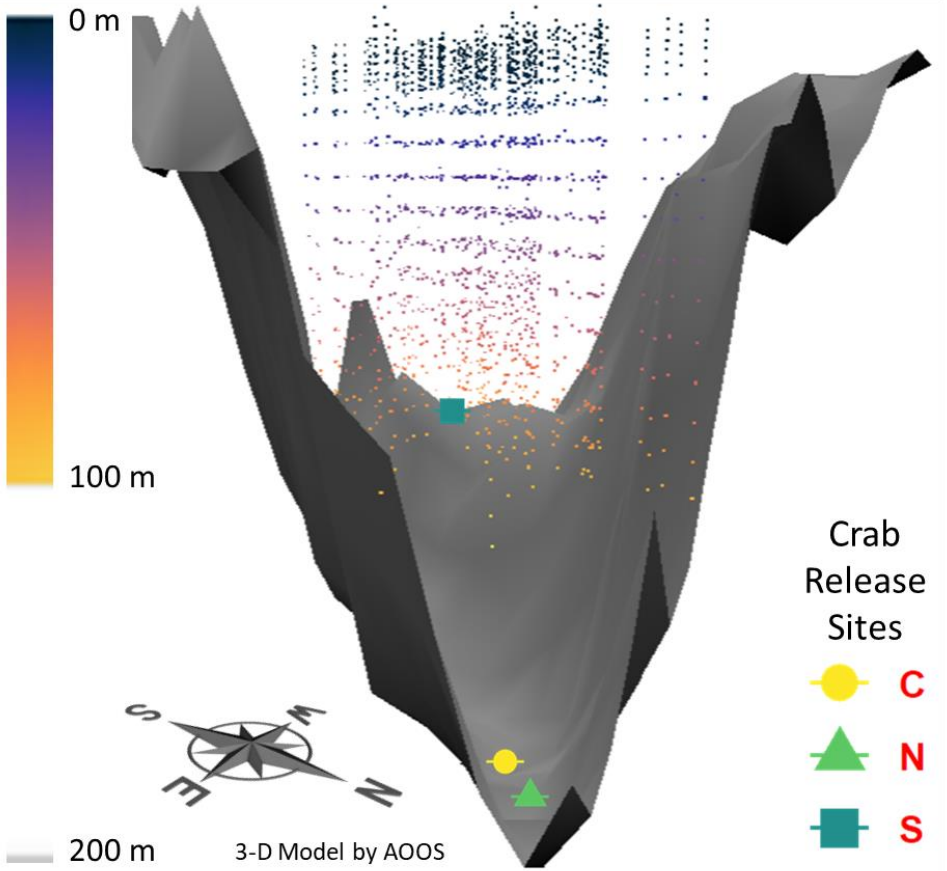
Results

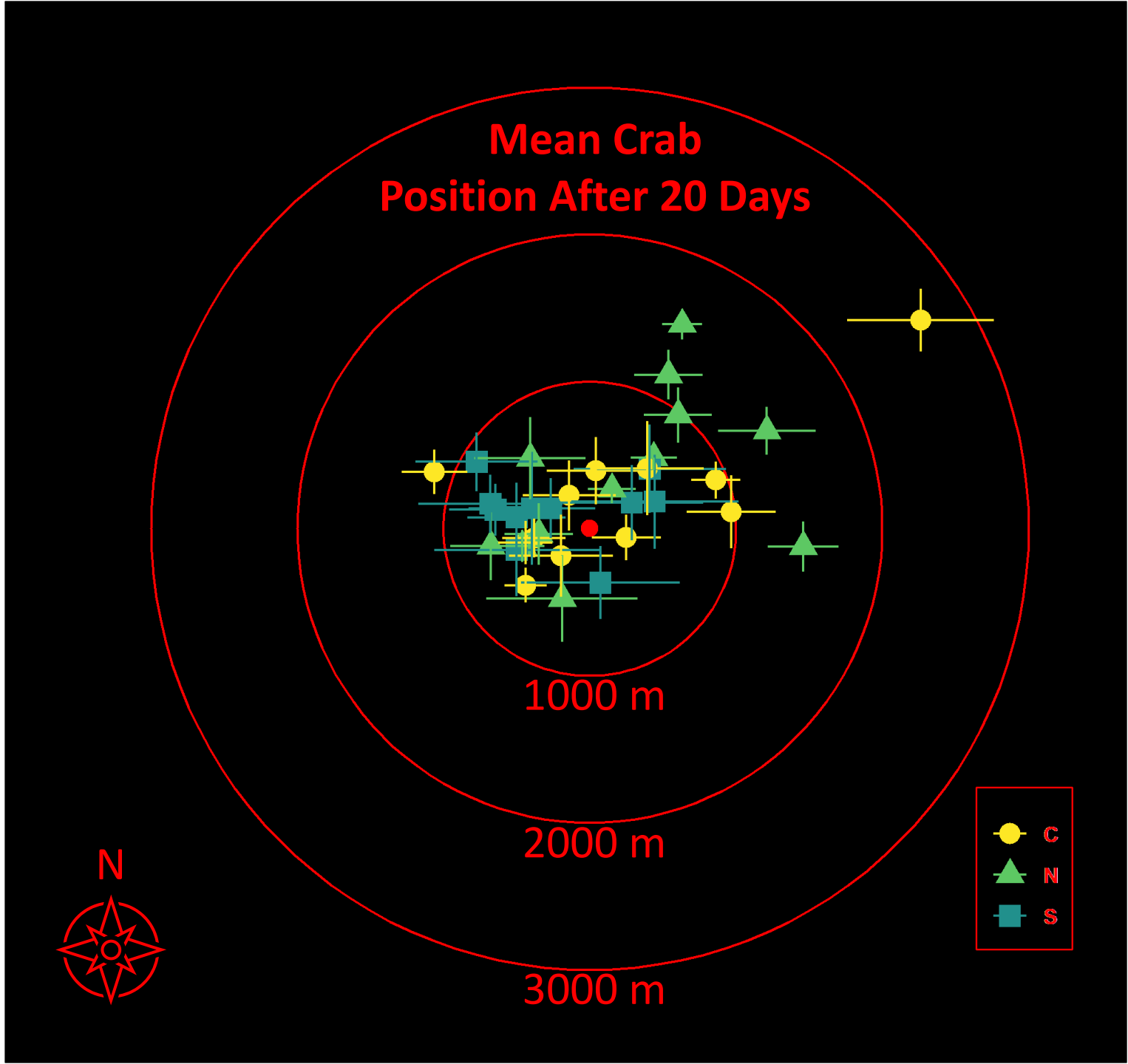
- Objective 4 – Track Tanner Crab

- Preliminary Movement
  - Maximum Crab ~ 3000 m
  - Mean crab position was estimated for each glider transect with two or more tag detections
  - Non-weighted error
    - Precision vs Accuracy



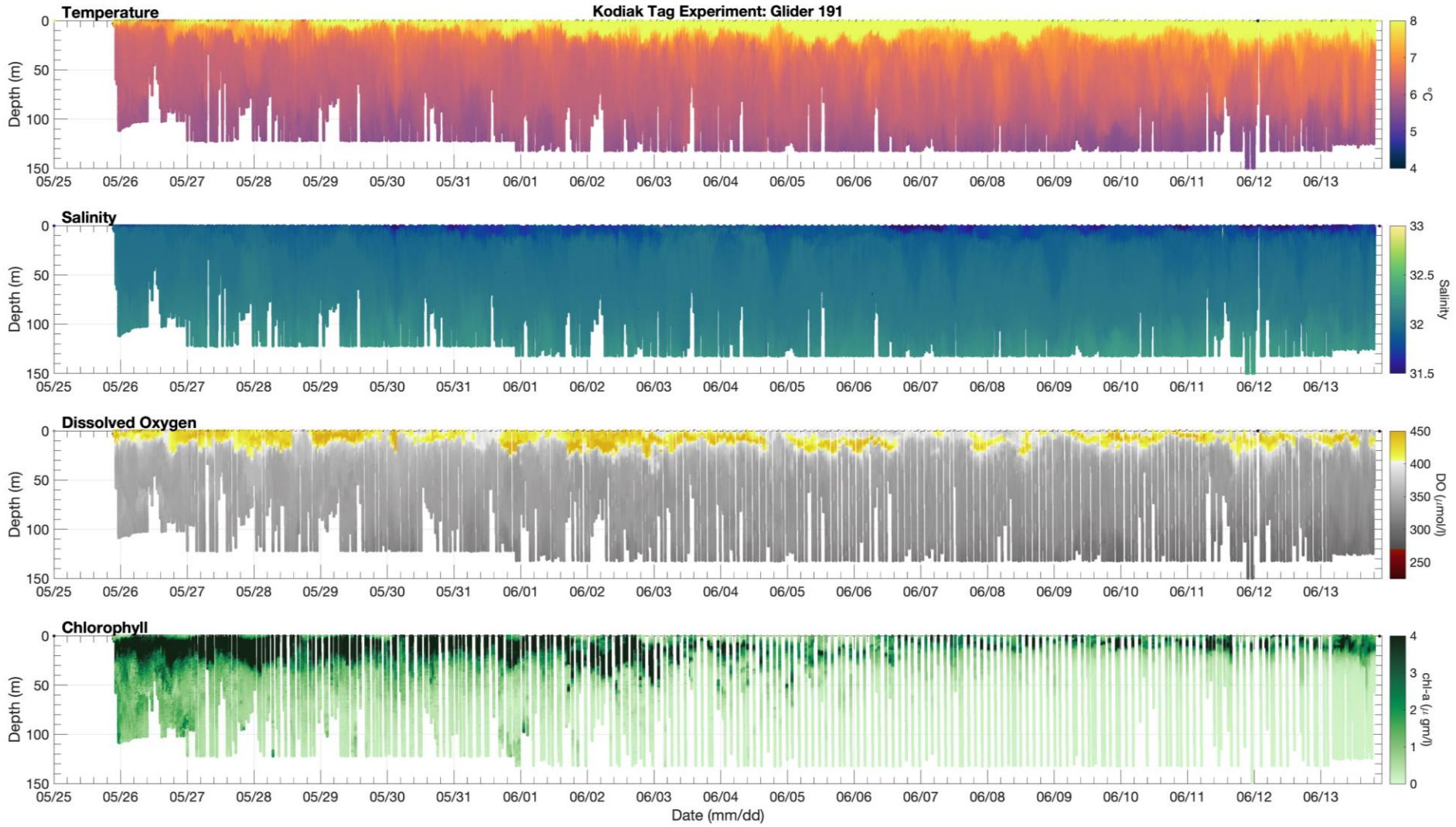
Results


0 m
100 m
200 m
3-D Model by AOOS
Crab
Release
Sites
C
N
S


Mean Crab
Position After 20 Days
1000 m
2000 m
3000 m
N
C
N
S

Results

- Oceanography
  - Real-time subset data
  - Full data after recovery
  - Descriptive / quantitative use of env. data being explored
  - Additional instruments?
    - E.g. pH, PAR, etc.



Conclusions

- Preliminary assessment
- Successfully recaptured all tagged crabs, multiple times, with glider acoustic receiver.
- Crab tracking and environmental data can be collected simultaneously.
- Short term movement of Tanners in deep fjords can be detected.
- Building upon existing research for analyses

Courtesy of Alaska Department of Fish and Game

Alaska Department of Fish and Game crab biologists use Shackleton — an autonomous underwater glider — to track Tanner crab near Marmot Bay.

Shackleton helps scientists track crab movement

By DEREK CLARKSTON
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Was that a yellow submarine in Marmot Bay? Nope. It was Shackleton.

Over the past few weeks, Shackleton — an autonomous underwater glider painted bright yellow — was deployed between Spruce Island and Cape Kazakof to track crab movement. The first-of-its-kind study was conducted by the Alaska Department of Fish and Game in collaboration with the Westward Region Shellfish Research Group and the University of Alaska Fairbanks' College of Fisheries and Ocean Sciences Department of Oceanography Autonomous Remote Technology Lab.

"This is the first project that has ever tried to do this with crab and a glider," said Jarred Weems, a Fish and Game crab research biologist stationed in Kodiak. "It worked out really well."

The data from the pilot project, which will not be completed until next spring, will show the short-term movements of local Tanner crab in fjord settings. The ultimate goal is to use an autonomous underwater glider to track the seasonal activity of Bering Sea crab stocks, such as Bristol Bay red king crab and East Bering Sea snow crab.

That would be a gamechanger for the lucrative fishery.

"The test went fantastic. We are going to learn a bunch from it," Weems said. "The next few months we'll be getting the data and processing it."

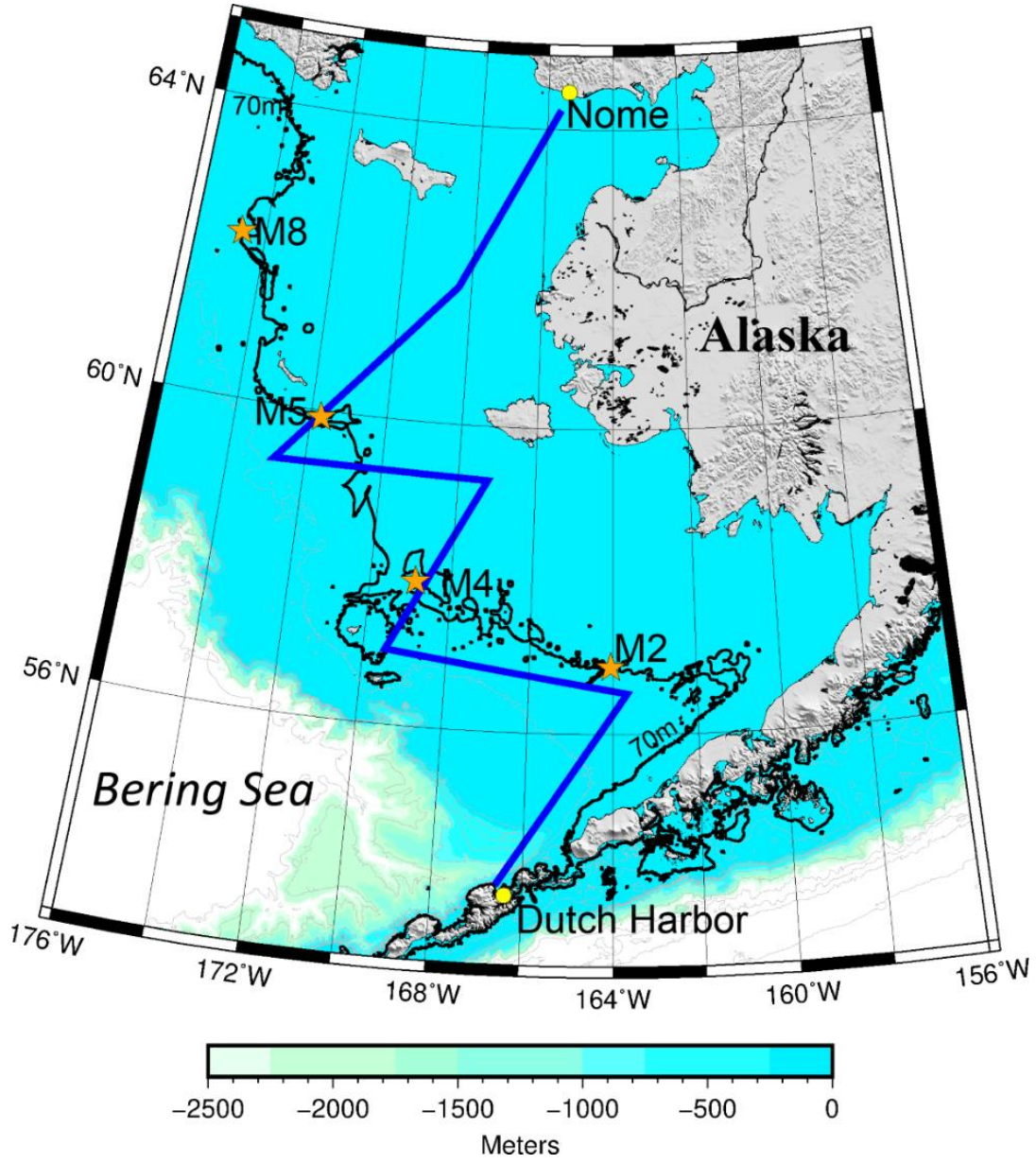
In the pilot project, Weems' crew acoustically tagged Tanner crabs and unleashed them into Marmot Bay. The team

■ See CRAB, Page 3

Kodiak Daily Mirror article, June 21 2022

Piloting for the Future

- Crab declines and fisheries issues in the Bering Sea are of high importance in current research.
- Gliders, along with other stationary and mobile platforms, can be deployed in tandem for increased recapture over space and time.
- Acoustic tags can also have variable sizes, ping rates, and battery life. Allows for simultaneous study across:
  - crab species,
  - size/age classes, and
  - monitoring time (question or molting)



A proposed annual oceanographic glider transect for the Bering Sea Shelf. (S. Danielson and H. Statscewich)