Finding Stuff Underwater

Open-Source Tools for Underwater Field Science

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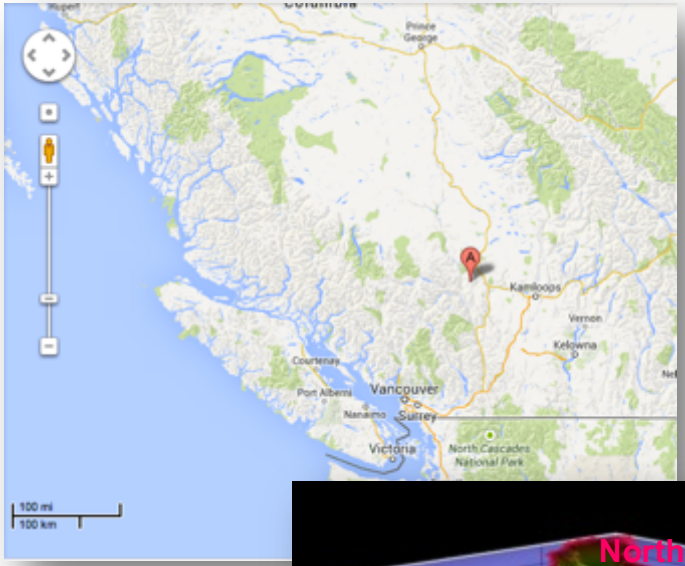
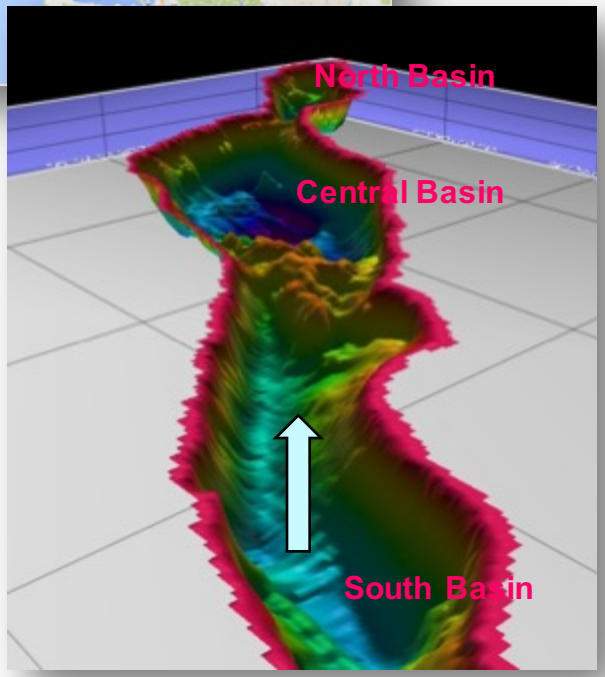
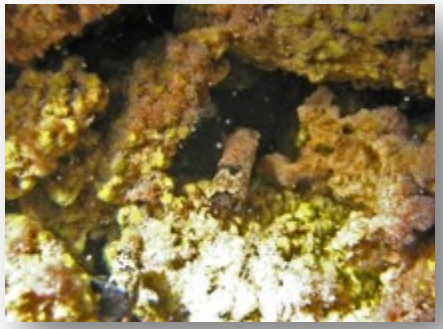
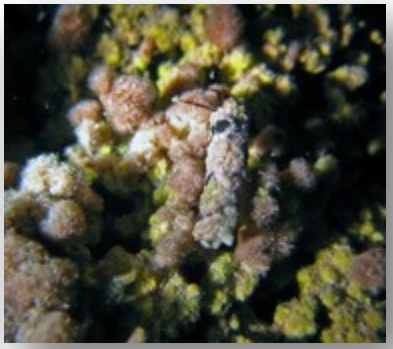
Pavilion Lake Research Project (PLRP)

Microbialite-rich environment

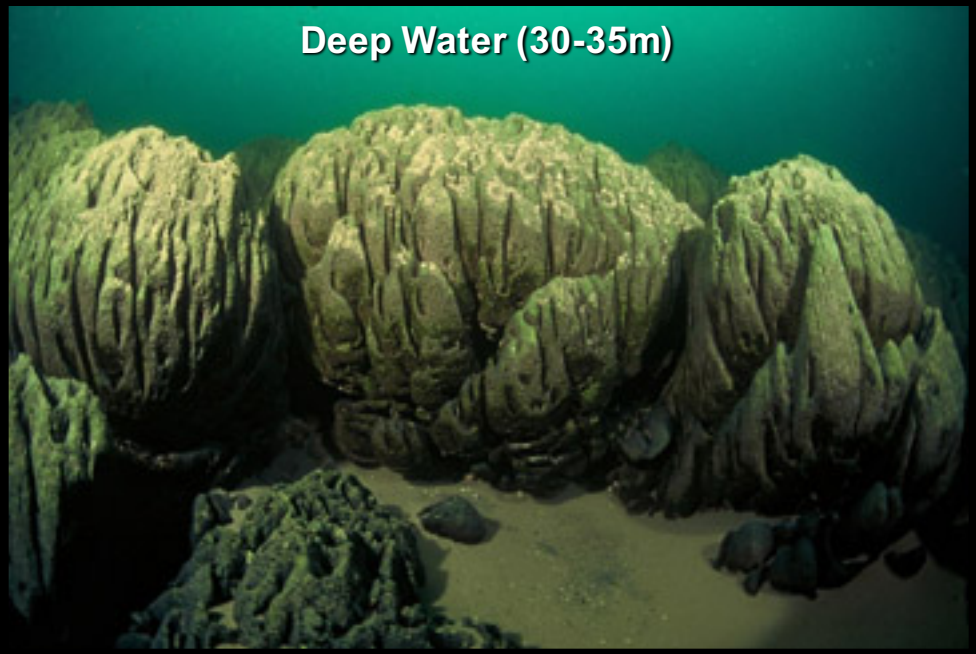








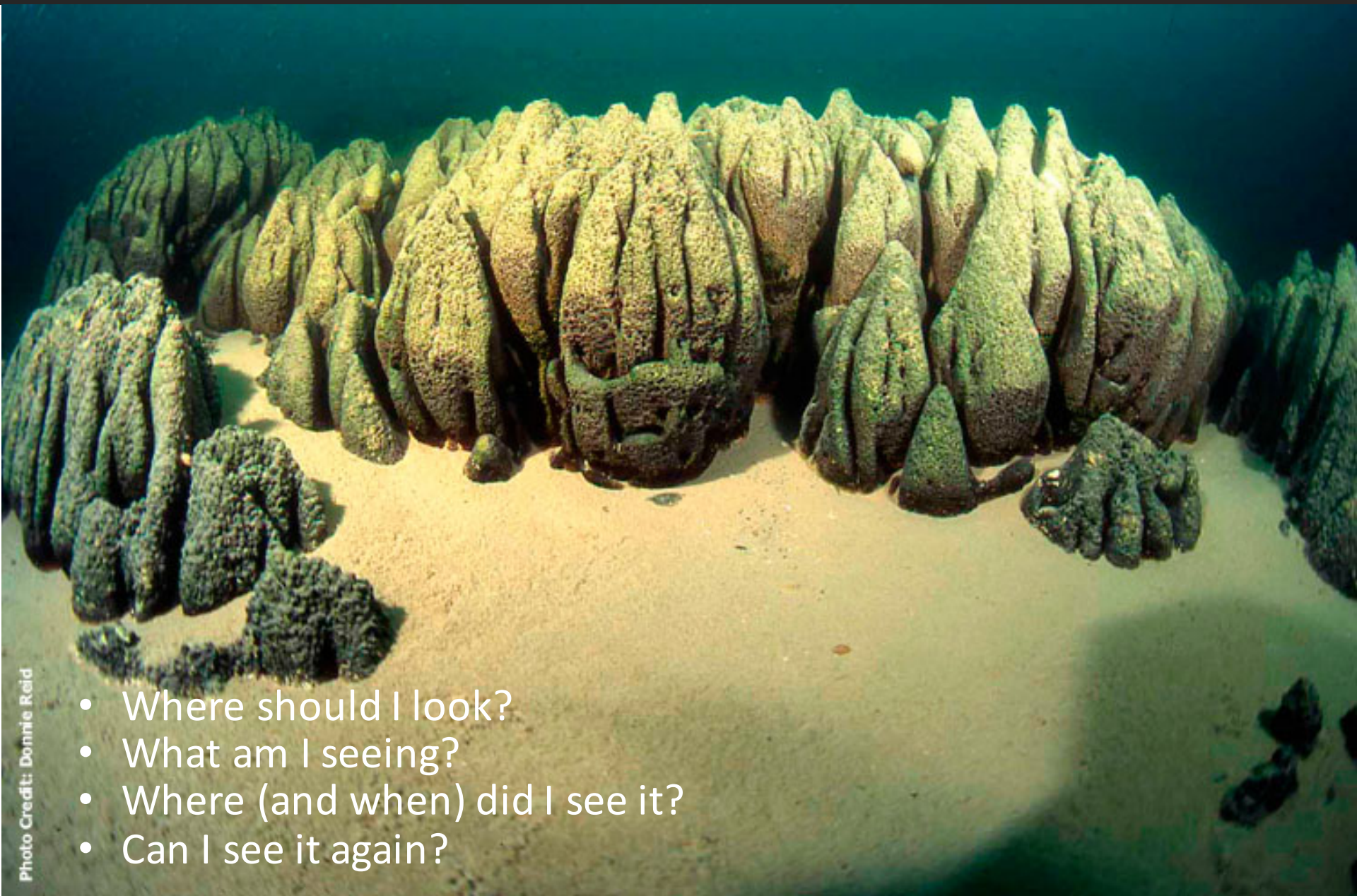
"Non-extreme environment"



What Mechanisms and Associated Interactions Control Microbialite Morphogenesis in Pavilion Lake?

All photos: copyright Donnie Reid Photography

Some Key Questions (for us)



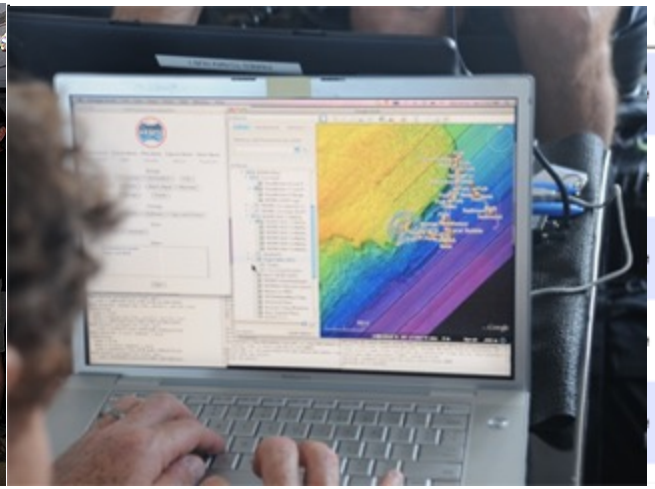
- Where should I look?
- What am I seeing?
- Where (and when) did I see it?
- Can I see it again?

Photo Credit: Donnie Reid

What is xGDS?

- Web-based tools for science operations & data collection
  - Accessible in-field and at home base.
  - Multiple users and remote collaboration.
- Sharing with xGDS
  - Users can upload precursor data and collaborate on planning
  - Live data is mapped as it is gathered: vehicle tracks, video feeds and data annotation (yours and others).
- Customizable
  - Every deployment is different
  - Components can be added or removed from xGDS
  - Branding & colors can be customized
- End-to-end support for science ops
  - Plan, Monitor, Archive, Explore

xGDS Phases



Label	Note	Still	Video
sponge	area of barrel sponges		Full Video Compressed Video
sponge	space sponges		Full Video Compressed Video
other	completed first pass		Full Video Compressed Video
other	going in reverse		Full Video Compressed Video
other	start moving to waypoint		Full Video Compressed Video

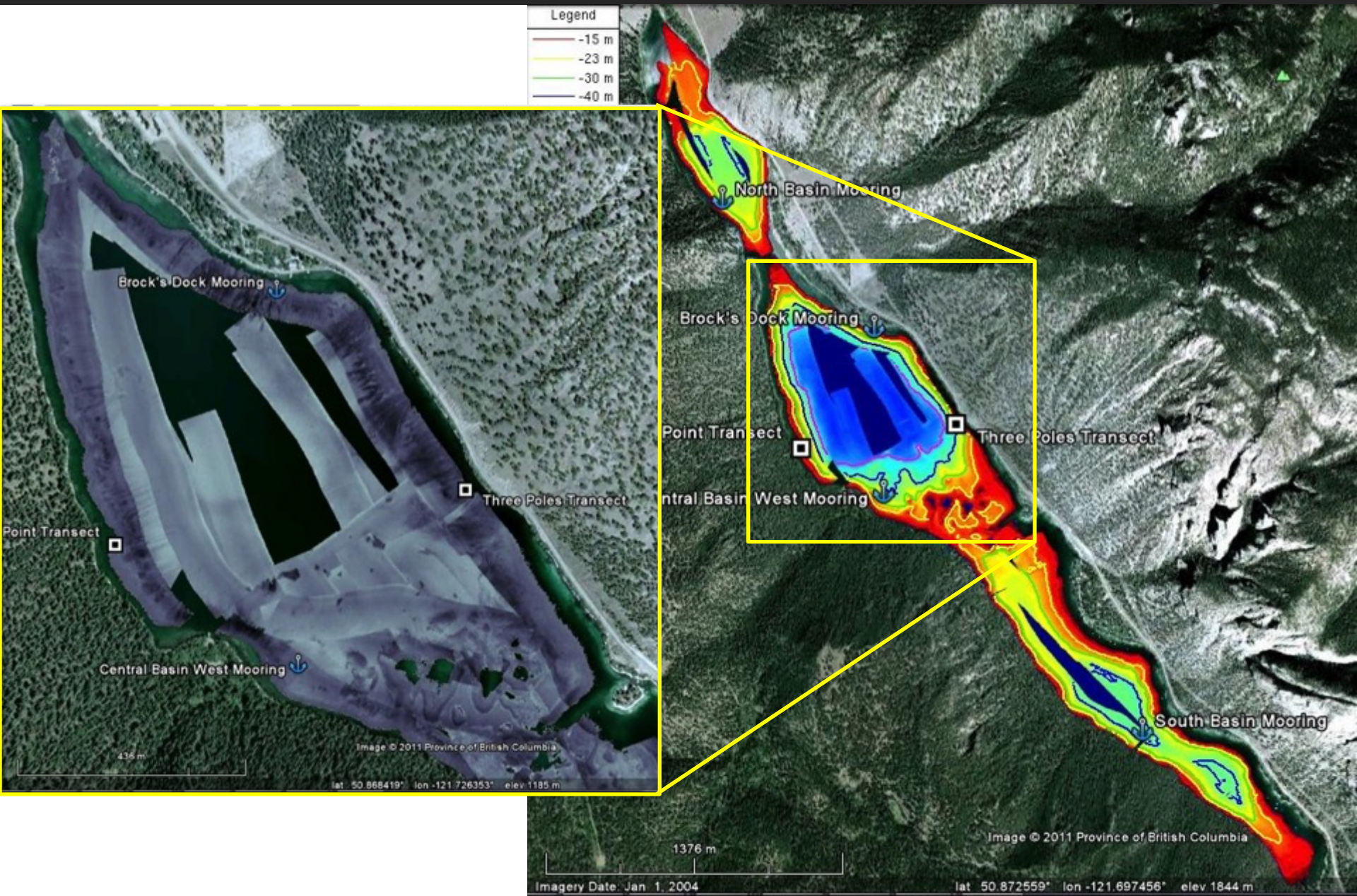
Plan

Monitor & Archive

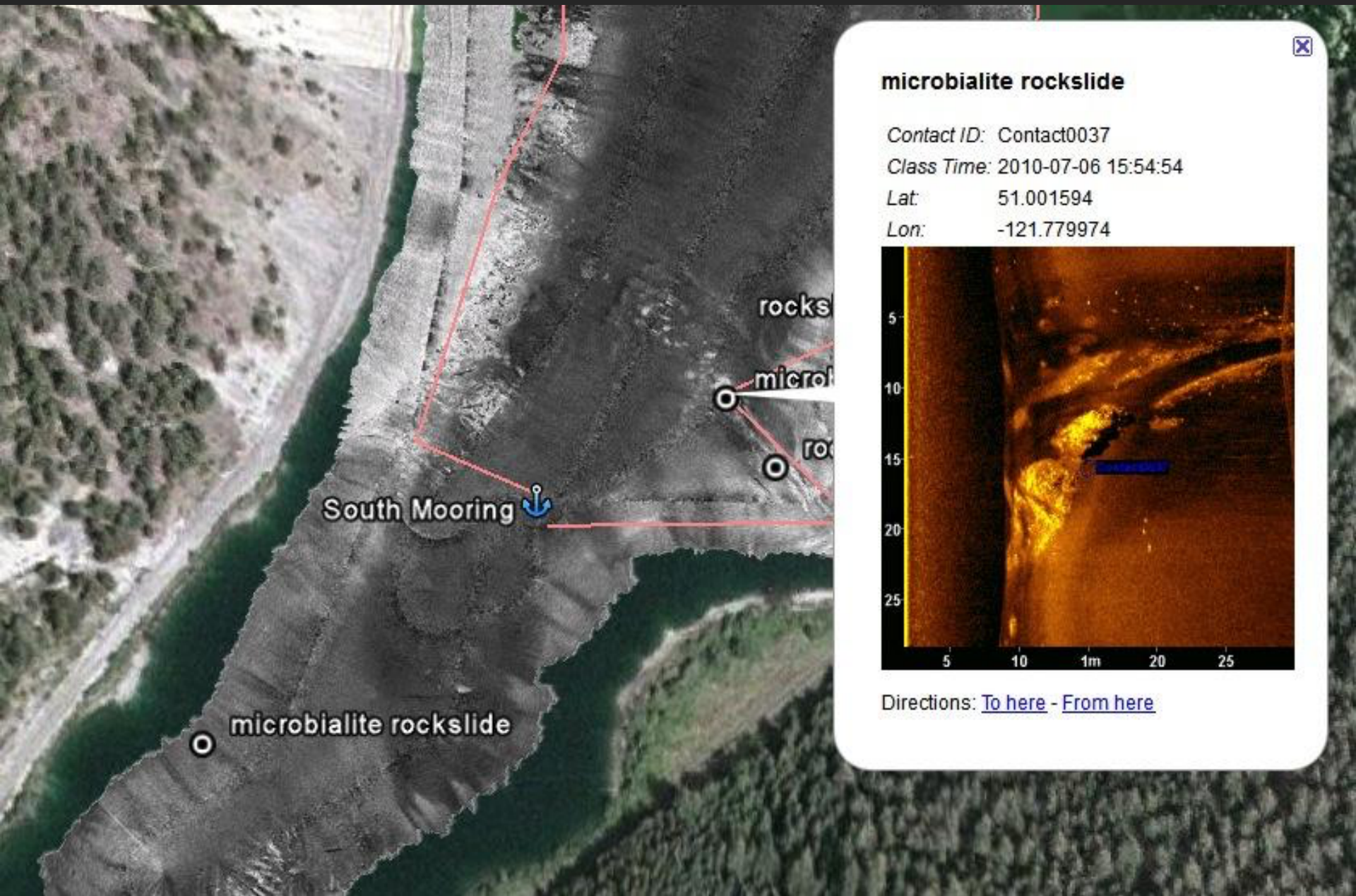
Explore

Pre-Mission | **During Mission** | **Post-Mission**

Map Layer – Sonar & Bathymetry



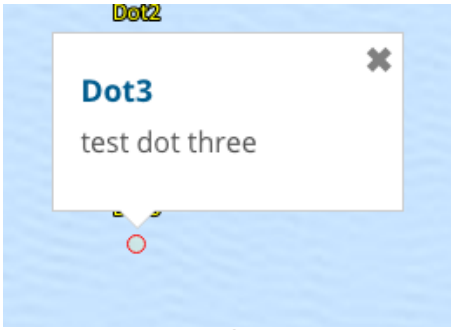
Points of interest



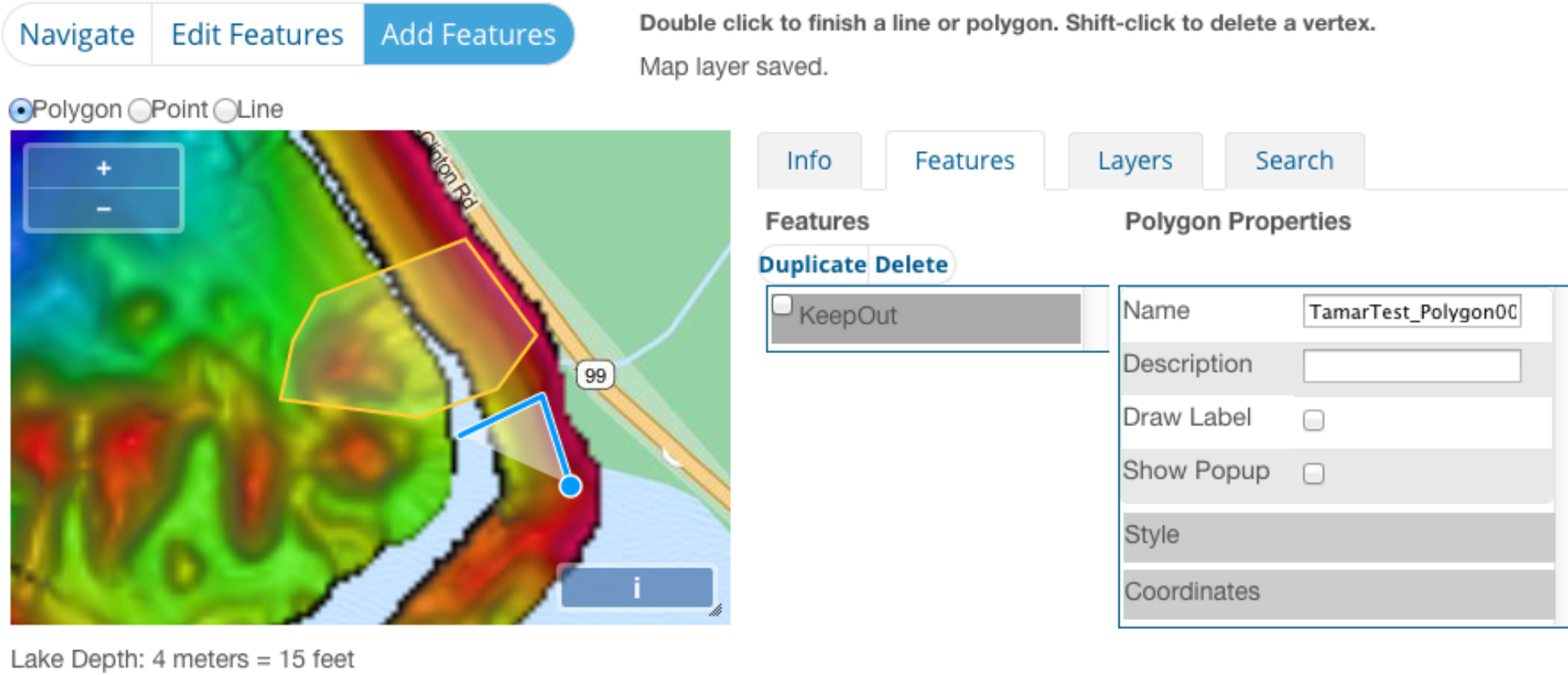
Map Content Authoring

Create and edit map content in xGDS

- Create points, lines and polygons
- Use these to indicate important areas
- Optionally display label & popup



Point with popup



Lake Depth: 4 meters = 15 feet

Traverse Planning

Easily create traverse plans by clicking to add stations.
As stations are added the distance and duration update in the list on the right.
Depth from bathymetry displays under the map as the cursor moves.
Users can export plans, including KML, PML, json and other formats.

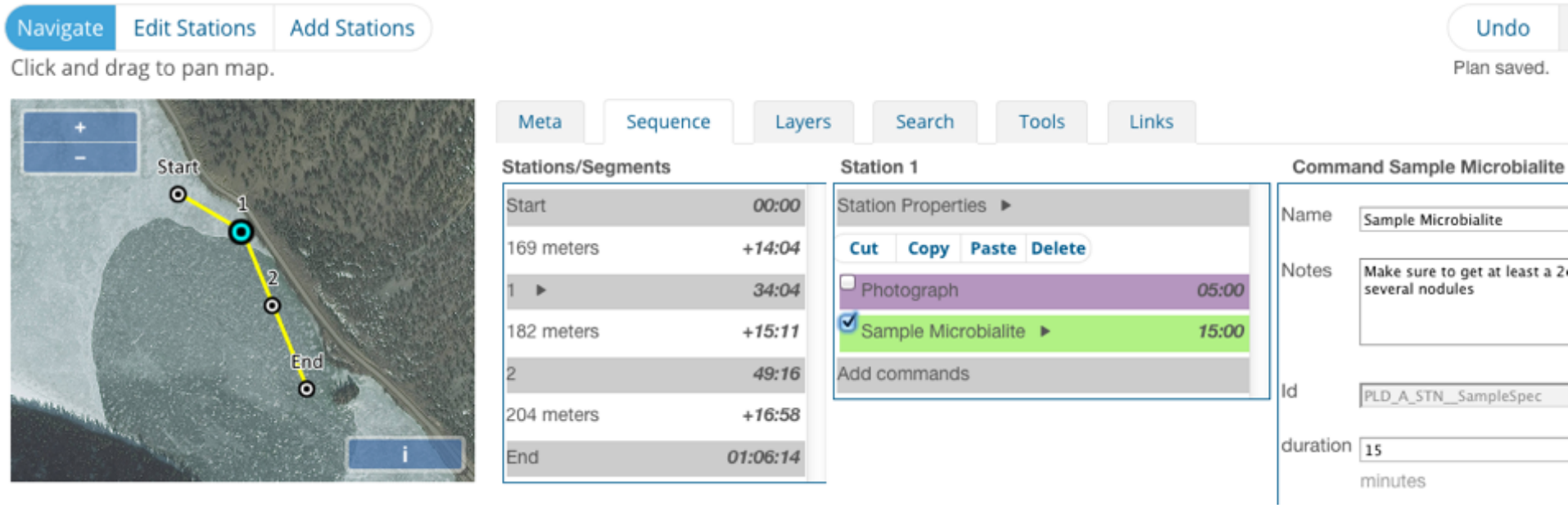
Station = a stopping or turning point

Segment = a line between stations

Traverse plans are lists of stations with segments between them.

Traverse Planning - Activities

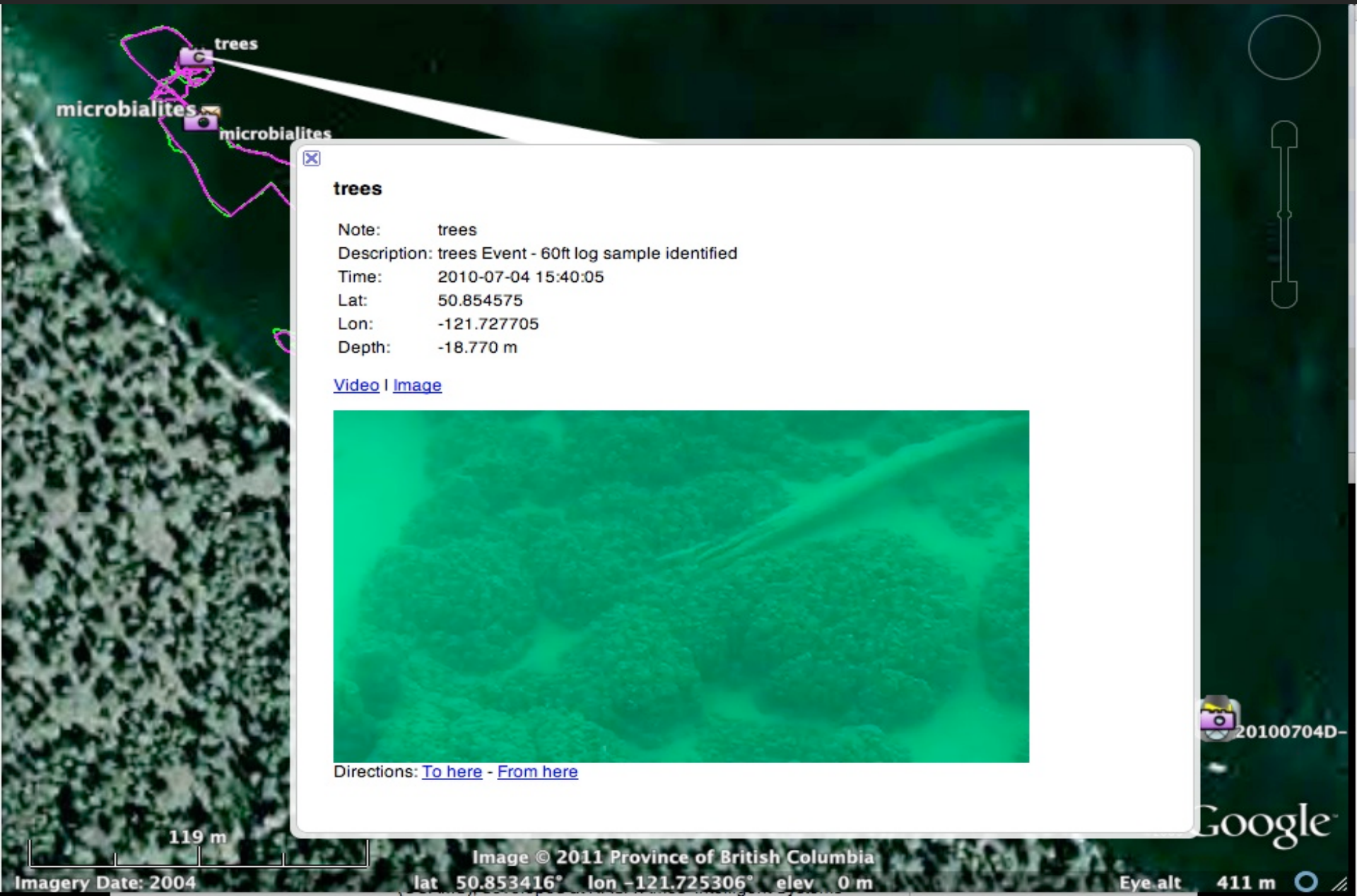
Library of activities can be customized per vehicle.
Users can add activities to each station or segment in a traverse plan.
Durations of activities are included in the time calculations in the first column.



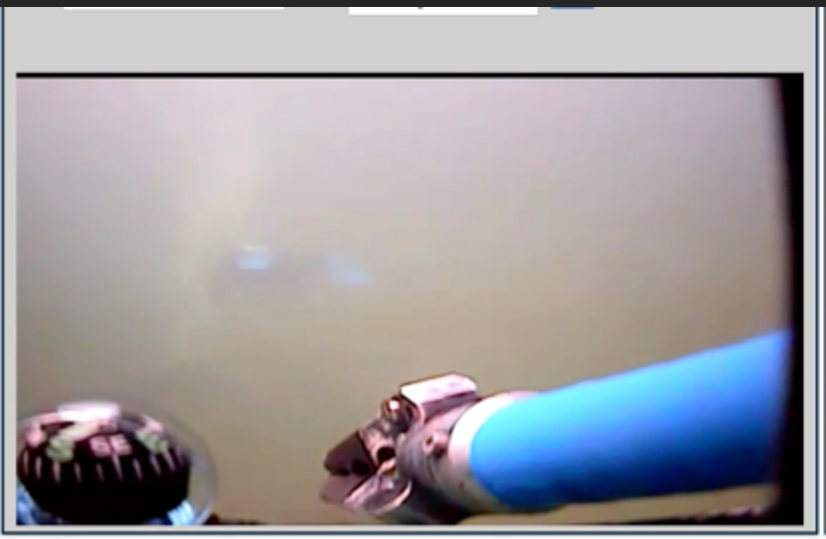
Live Track

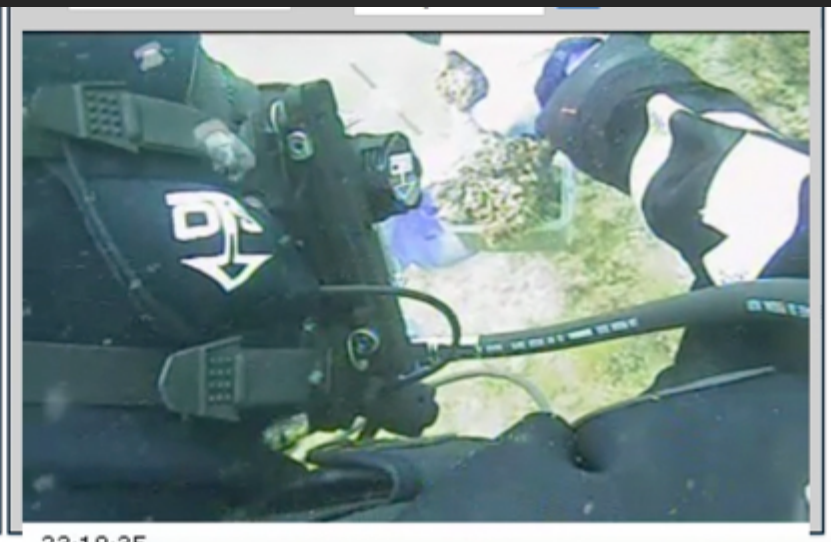

Vehicle
Plan
Track
Notes
End
Note
Note
Other
Algae
Algae
Microbialites
Microbialites
Rocks
Trees
Trees
Note
Algae
Kelly Lake
Clinton Pavilion Rd
191 m
Image © 2011 Province of British Columbia
© 2011 Google
Google
Imagery Date: Dec 31, 2004 lat 51.006849° lon -121.777401° elev 1065 m Eye alt 1.80 km

Real-time Geo-located Annotation

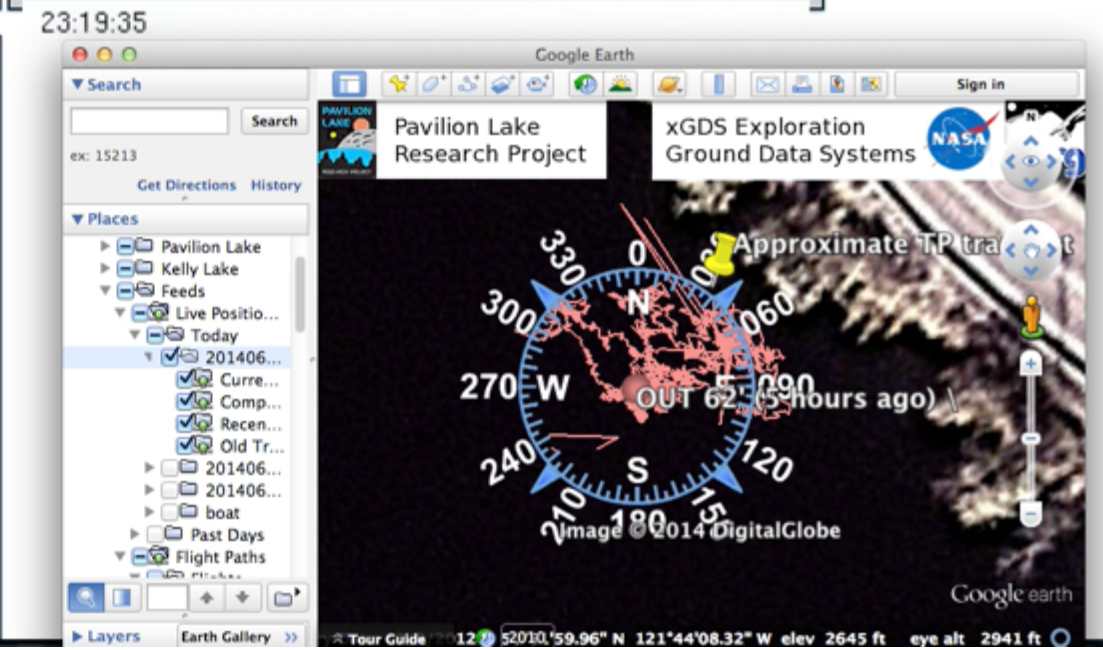


Live Video






Live feed: Research Diver 2
Recorded
Actual Size
Note:
Tags:
add a tag
Save
184min
REC
A


23:19:35
Google Earth
Search
Search
ex: 15213
Get Directions
History
Places
Pavilion Lake
Kelly Lake
Feeds
Live Positio...
Today
201406...
Curre...
Comp...
Recen...
Old Tr...
201406...
201406...
boat
Past Days
Flight Paths
Layers
Earth Gallery
Sign in
Pavilion Lake Research Project
xGDS Exploration Ground Data Systems
NASA
Approximate TP tra
OUT 62 (5 hours ago)
Image © 2014 DigitalGlobe
Google earth
Tour Guide
52010,'59.96" N 121°44'08.32" W elev 2645 ft
eye alt 2941 ft

Temporal View: Video with Notes

Episode (Flight) Name: 20140623A
Local Time: 10:18:46 PDT

Jump to: HH:MM:SS

OUT
RD1
RD2

Display 10 Search: sample

event_time	author	content	tags	depth	lat	lon	flight
10:16:39	Zena Cardman	pink marker is down at sample option 2. SBT has 3 minutes to pick between pink rebar and b&w pole		62'	50.8527016666667	-121.72479	OUT
10:22:30	Allyson Brady	Steve collecting the water samples		62'	50.8526933333333	-121.724781666667	OUT
10:23:00	Zena Cardman	Steve finished with all four water samples		61'	50.8527	-121.724791666667	OUT
10:23:19	Zena Cardman	56ft for Steve's water samples		61'	50.8527	-121.724791666667	OUT

Showing 1 to 10 of 12 entries (filtered from 67 total entries) Previous 1 2 Next

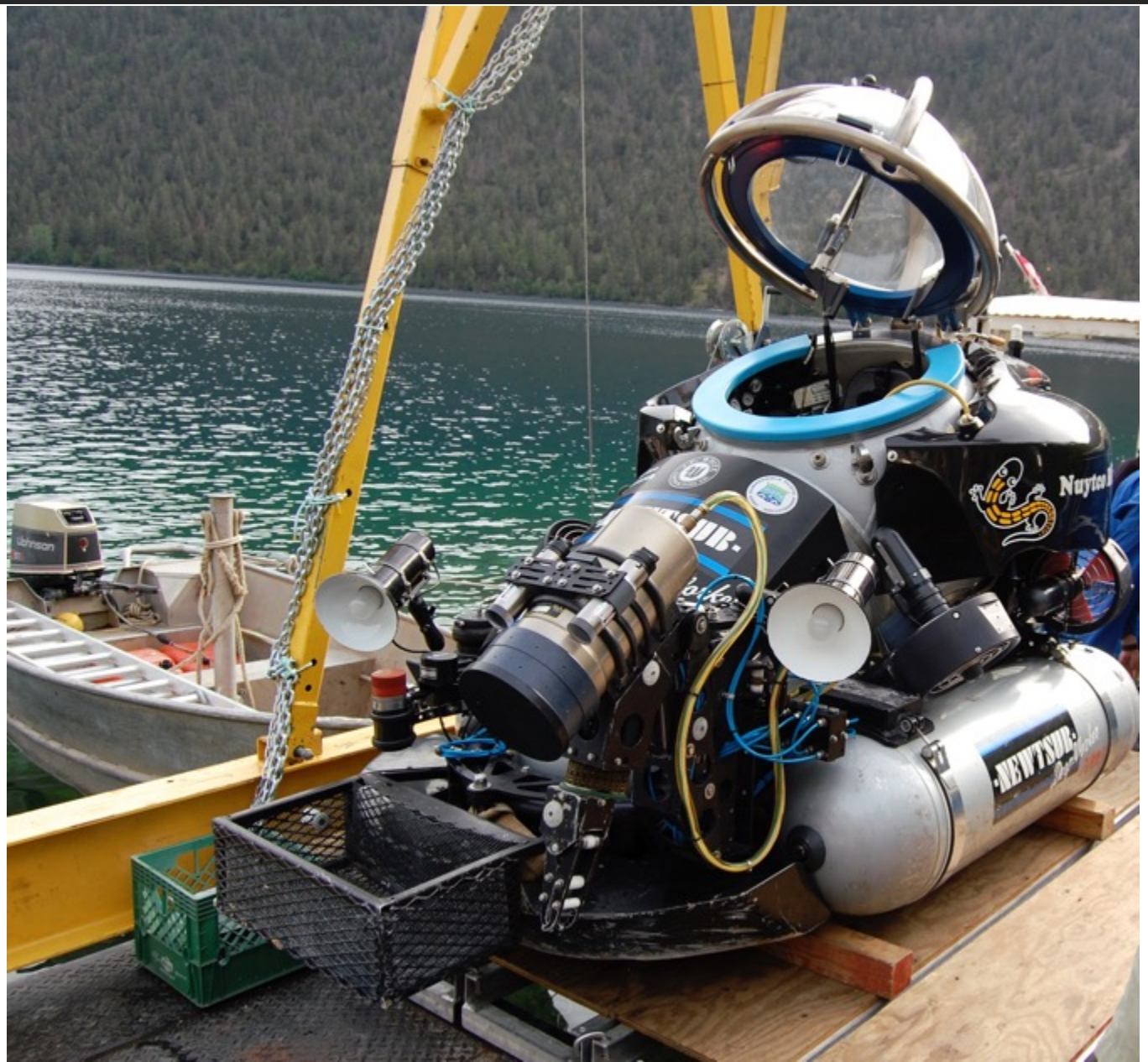
RD2 Take Note Still New Window

RD1 Take Note Still New Window

Autonomous AUV

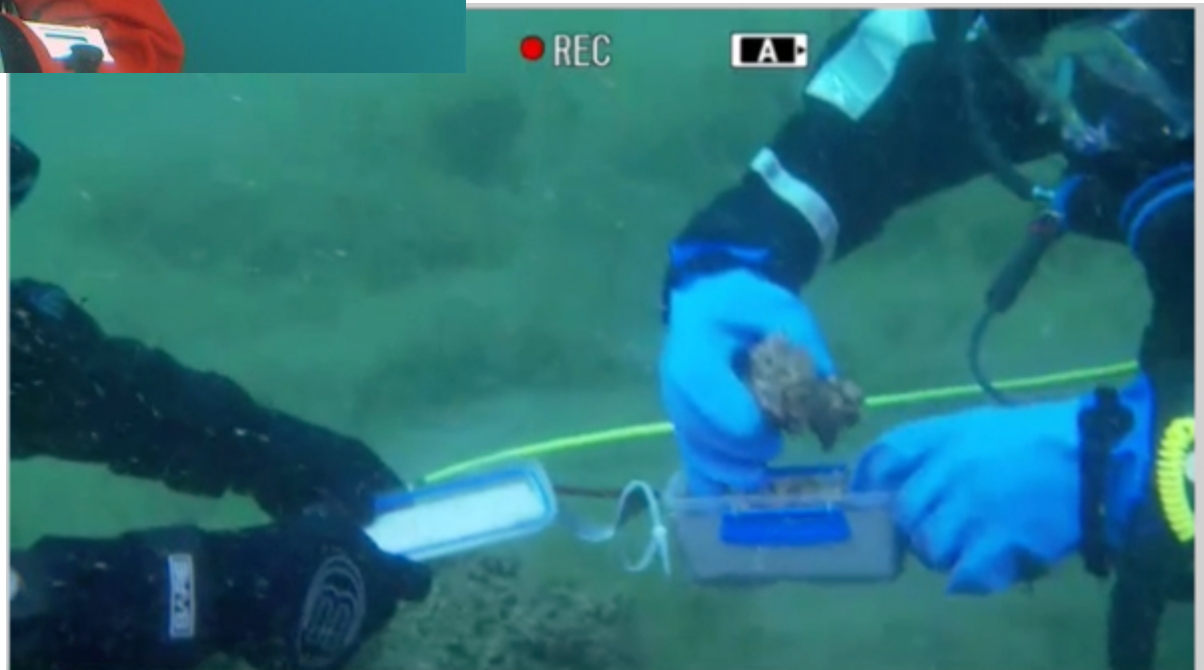
“Chase” Boat

Piloted Submersible

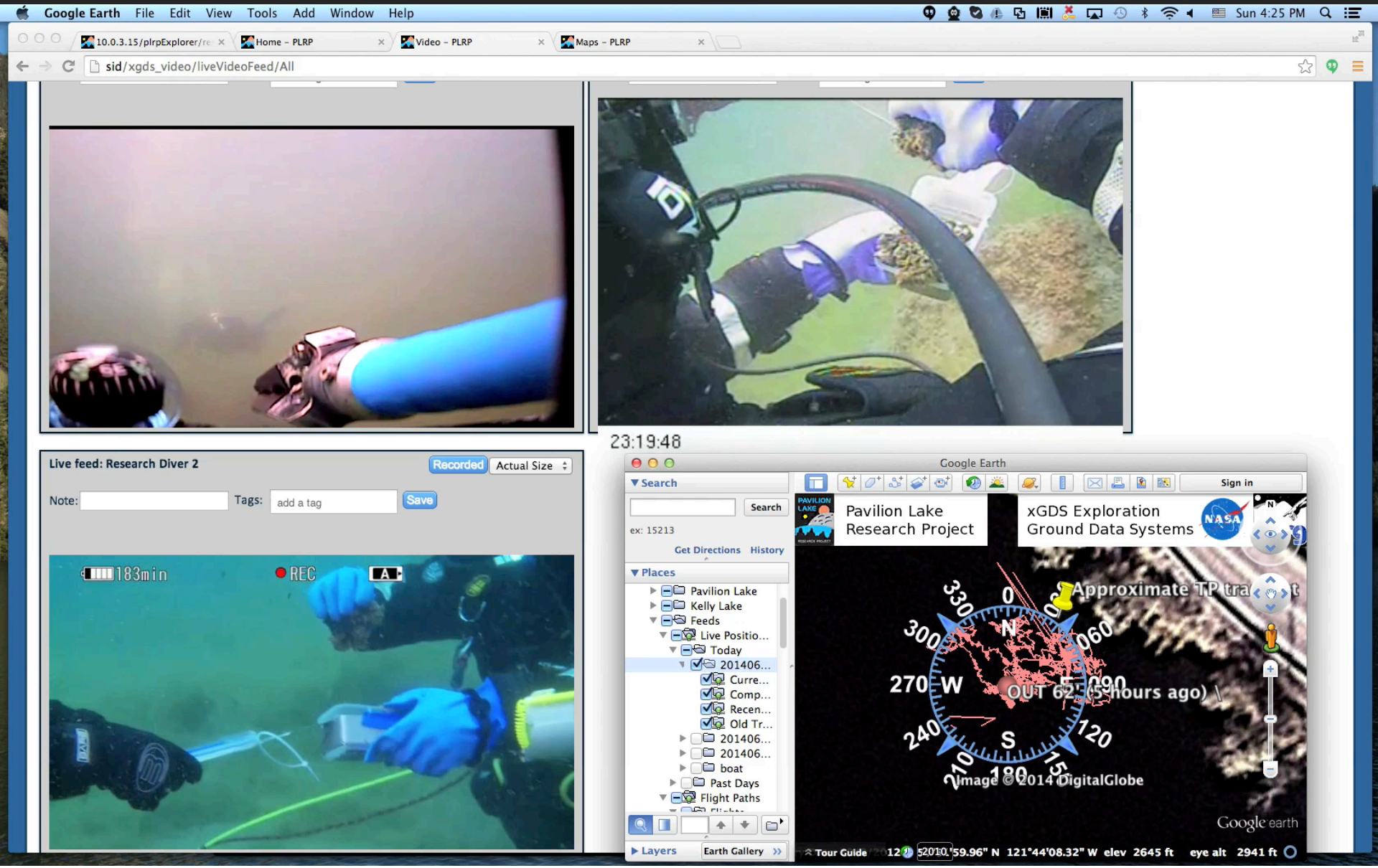


ROV with Sonar Transponder

Divers



Divers


Google Earth File Edit View Tools Add Window Help
Sun 4:25 PM
10.0.3.15/plrpExplorer/re
Home - PLRP
Video - PLRP
Maps - PLRP
sid/xgds_video/liveVideoFeed/All
23:19:48
Live feed: Research Diver 2
Recorded
Actual Size
Note:
Tags:
add a tag
Save
183min
REC
A
Google Earth
Search
Get Directions
History
Places
Pavilion Lake
Kelly Lake
Feeds
Live Positio...
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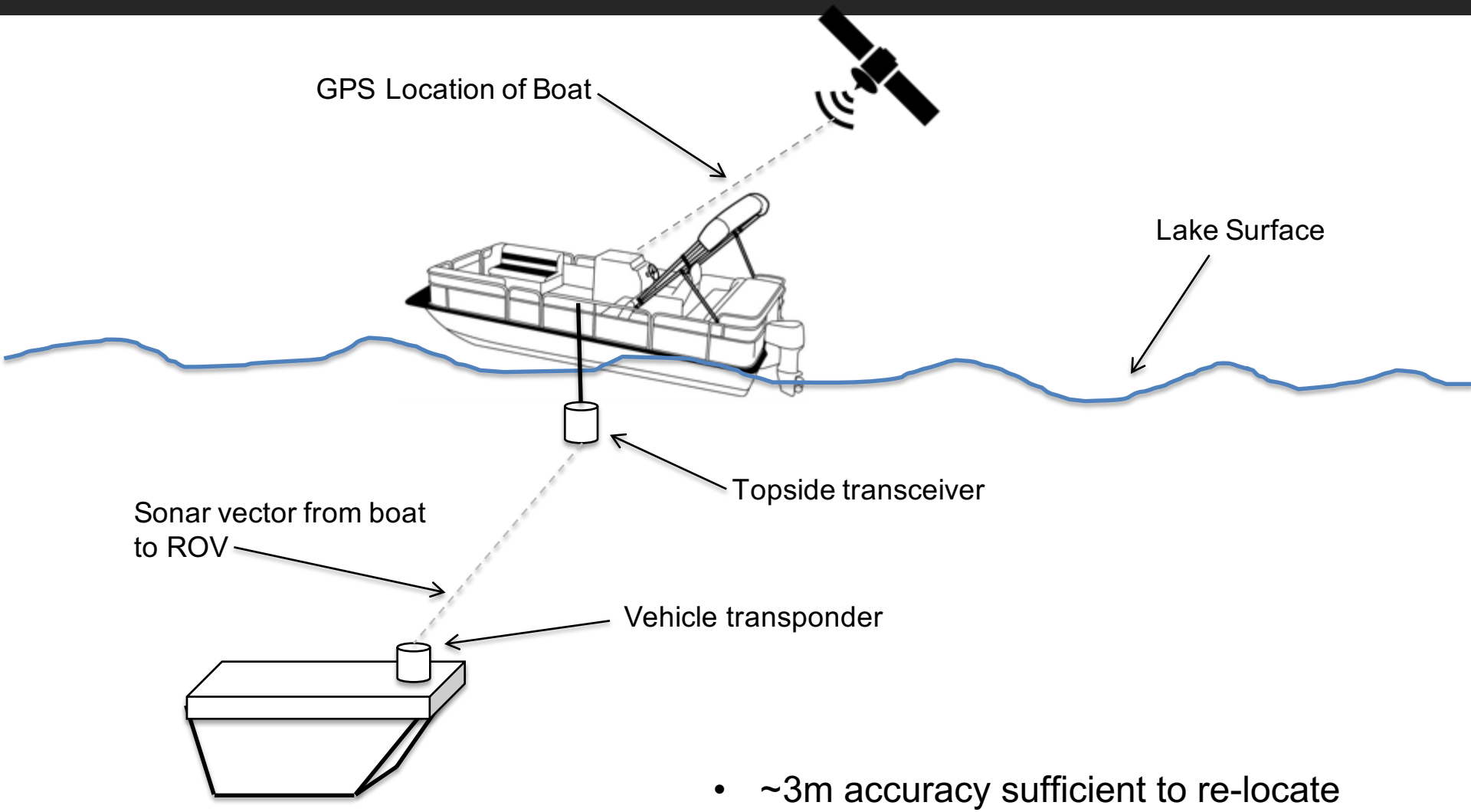
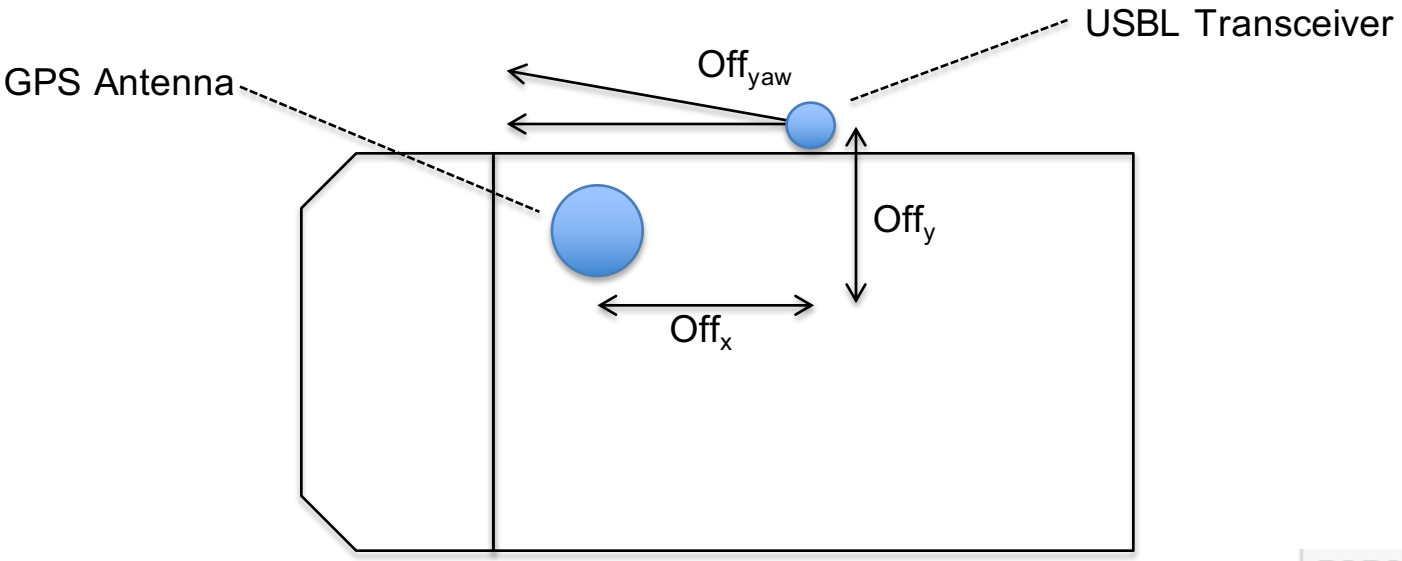
Old Tr...
boat
Past Days
Flight Paths
Layers
Earth Gallery
Sign in
Pavilion Lake Research Project
xGDS Exploration Ground Data Systems
NASA
Approximate TP tra
OUT 62
hours ago)
Image © 2014 DigitalGlobe
Google earth
Tour Guide
52010.59.96" N 121°44'08.32" W elev 2645 ft
eye alt 2941 ft

Ultra-Short Baseline (USBL) Acoustic Tracking



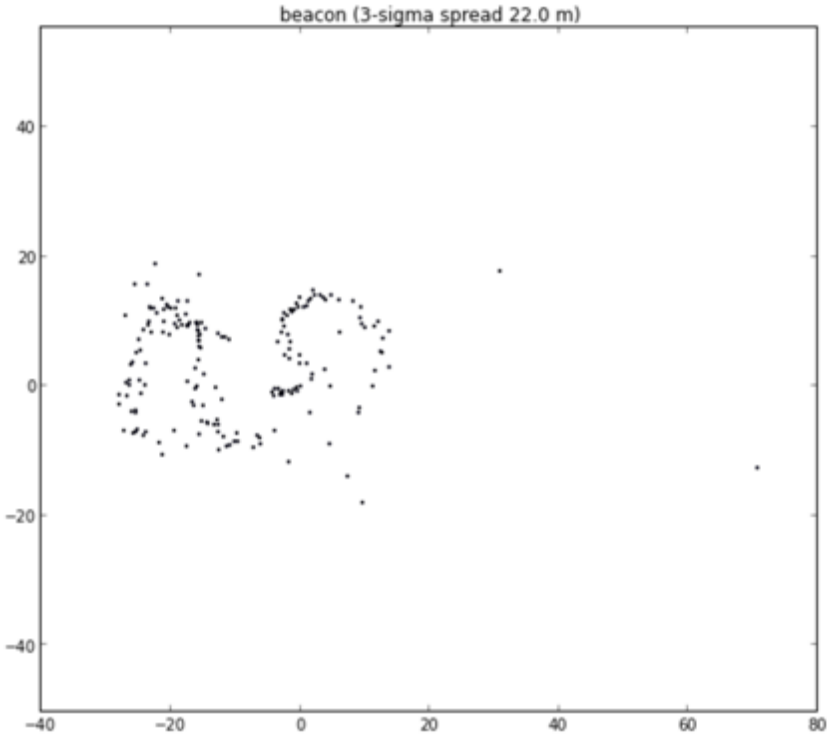
- ~3m accuracy sufficient to re-locate sample sites
- Laptop with USBL vendor supplied SW integrates GPS and sonar data.

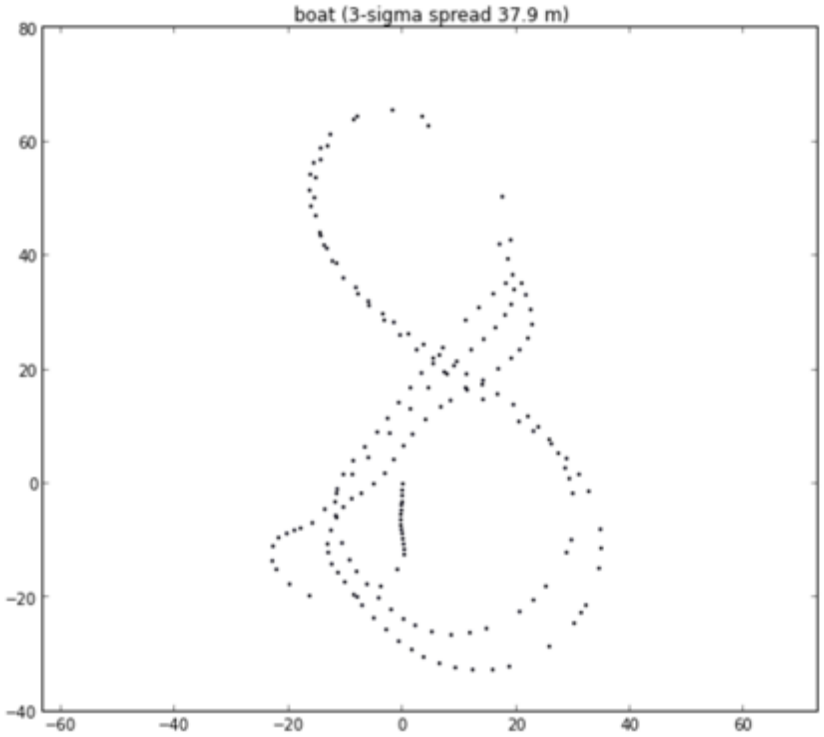
Calibration is Critical

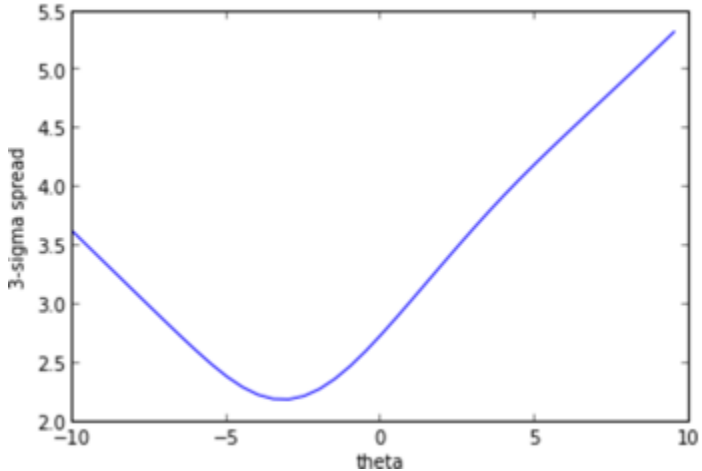



```
PARAM_LIST = [
    # 'roll',
    # 'pitch',
    'yaw',
    'xoff',
    'yoff'
]
```

Calibration is Critical

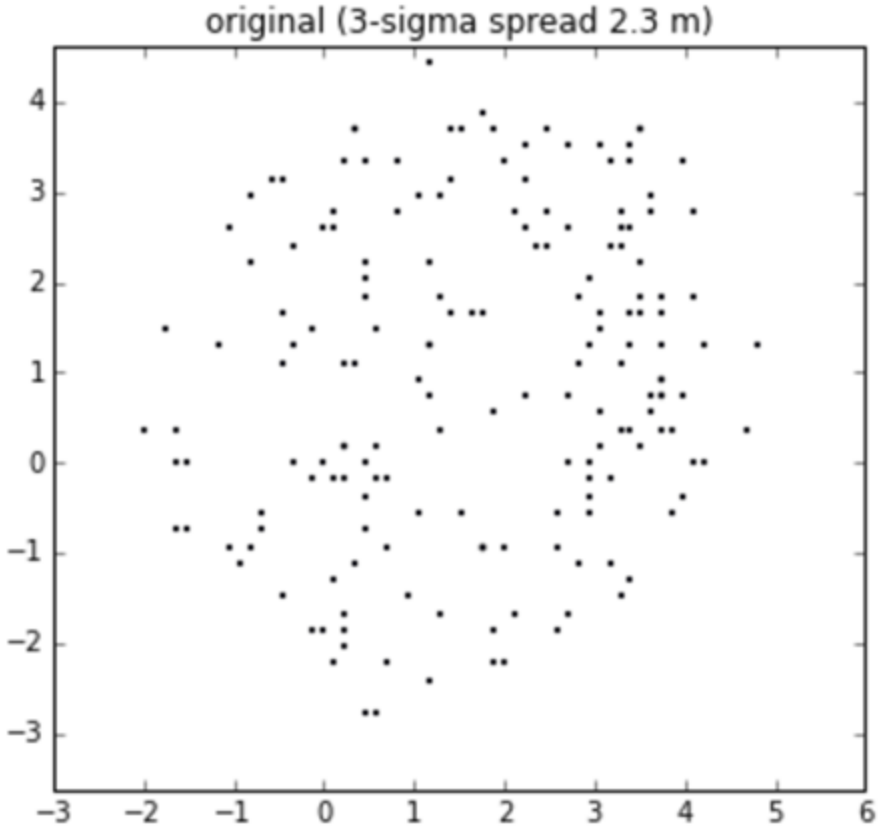




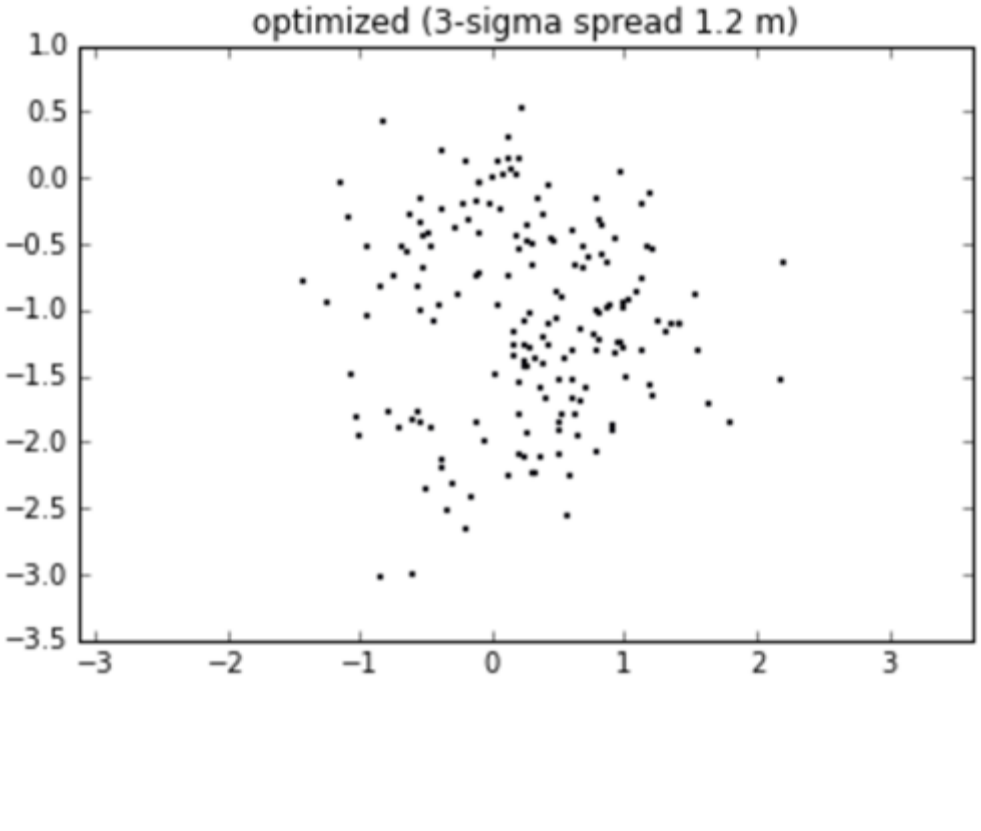



```
# optimizer = scipy.optimize.fmin_powell
optimizer = scipy.optimize.fmin
vec = optimizer(applyVector,
                x0=unpackParams(TRACLINK_PARAMS),
                disp=True
                )
```

Calibration is Critical

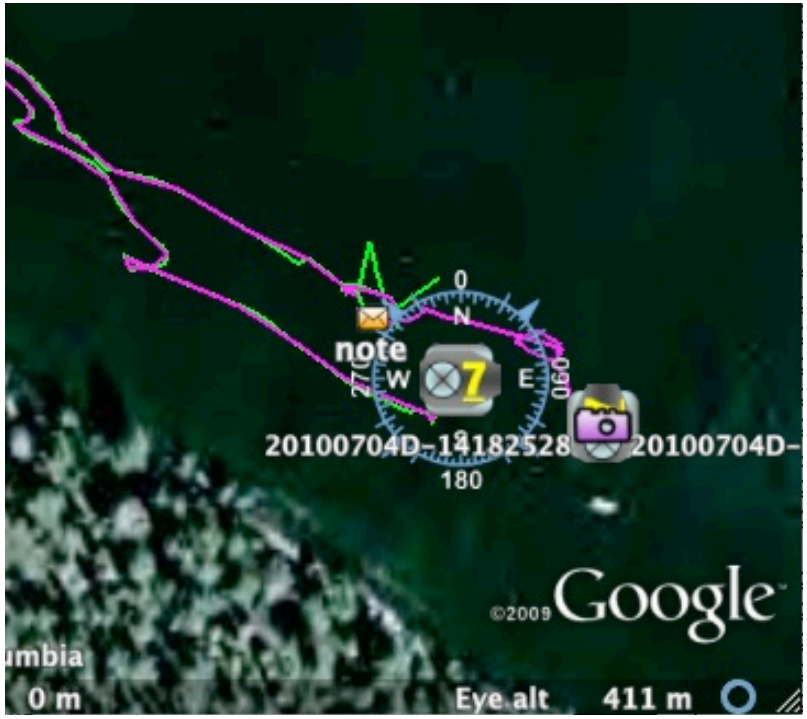


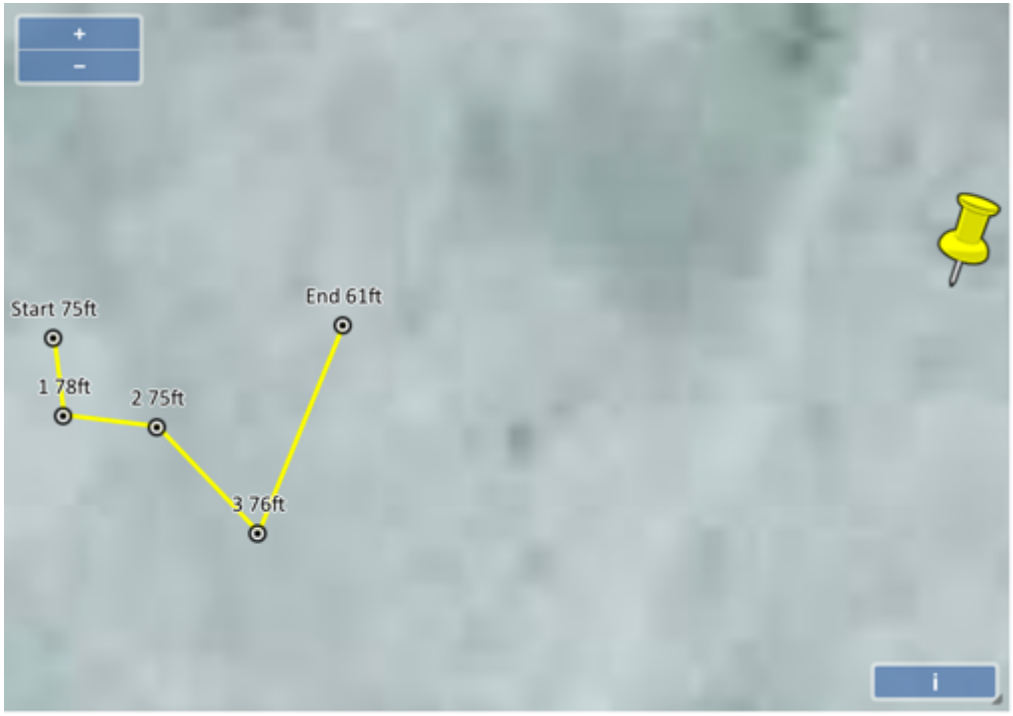
Before (7m x 7m)



After (3m x 3m)

Google Earth and Open Layers





- Ready to go out of the box.
- Nice, but restricted, API.

- A bit more setup & debugging.
- Very flexible & customizable.

Conclusions

- Successfully located and returned to science POIs using:
  - GPS plus Sonar
  - Notes
  - Video
- 2D maps (+overlays) get the job done.