

Finding Stuff Underwater

Open-Source Tools for Underwater Field Science



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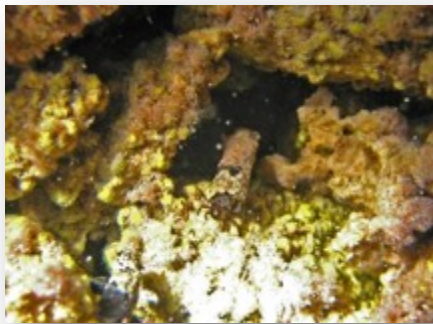


Pavilion Lake Research Project (PLRP)

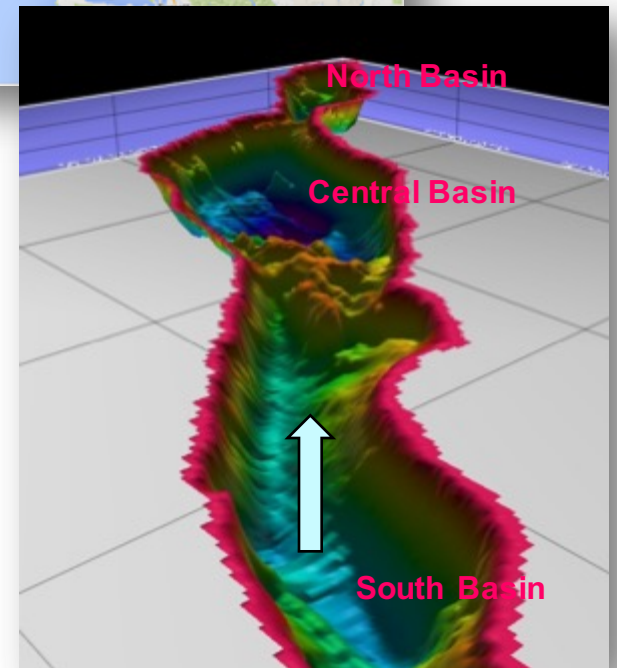
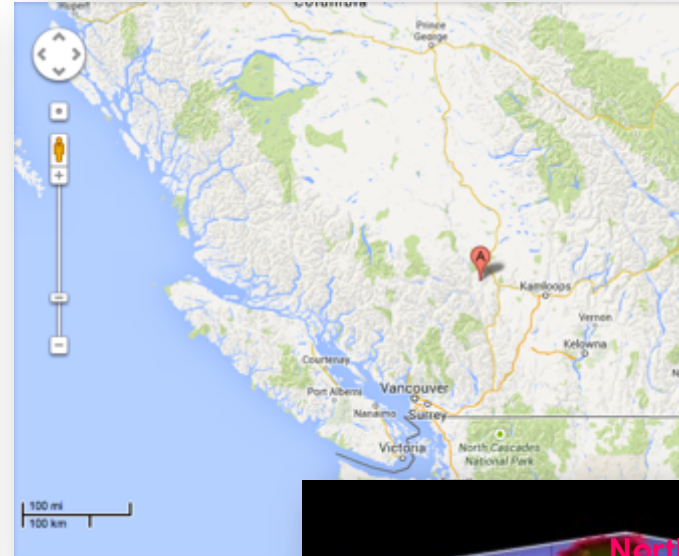


Credit: Neil McDaniel

Microbialite-rich environment



“Non-extreme environment”



Shallow to Upper Intermediate
(5-15m)

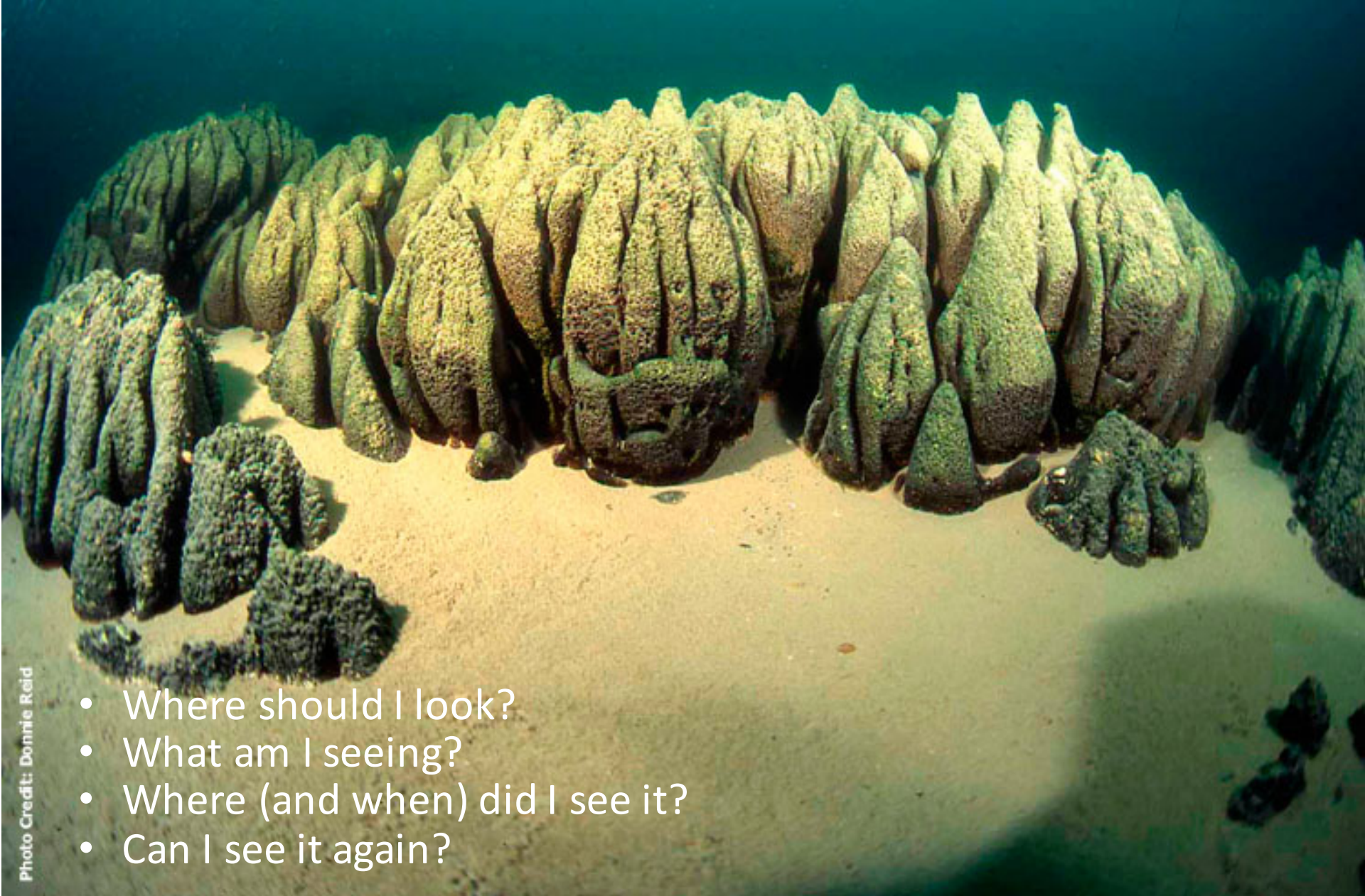


Deep Water (30-35m)



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

Some Key Questions (for us)

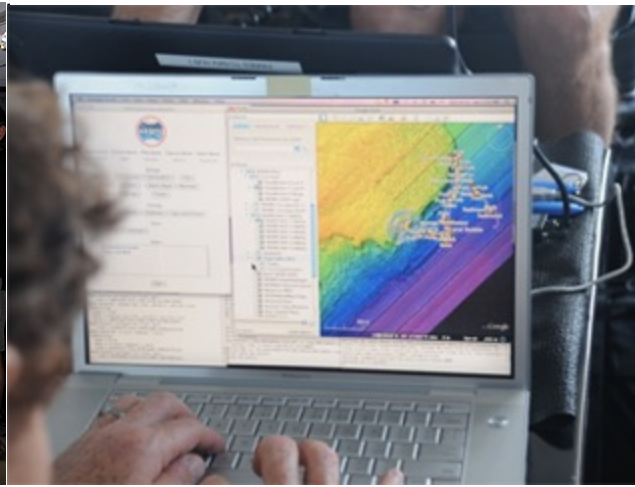


- Where should I look?
- What am I seeing?
- Where (and when) did I see it?
- Can I see it again?

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

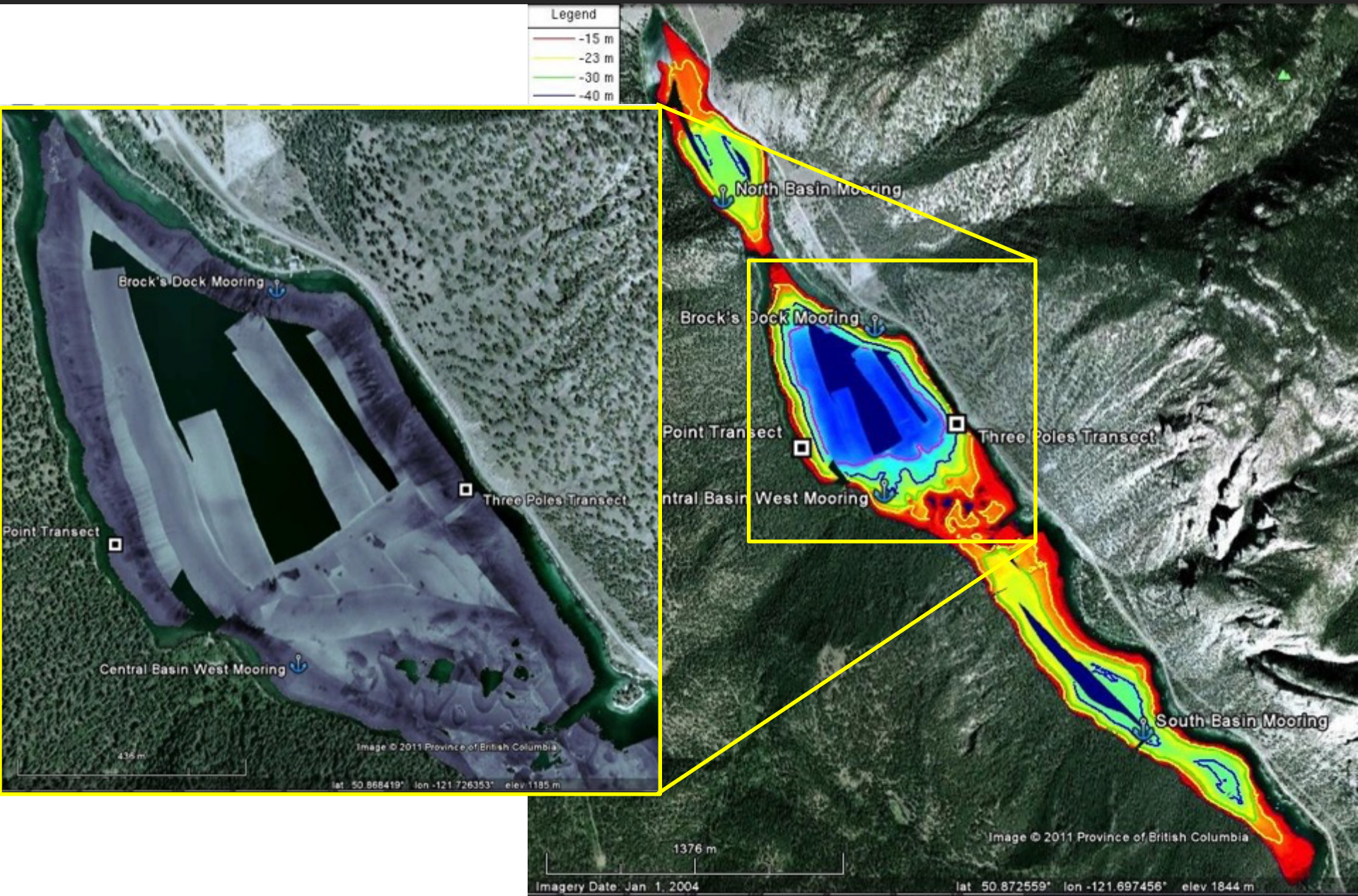
Explore

Pre-Mission

During Mission

Post-Mission

Map Layer – Sonar & Bathymetry



Points of interest



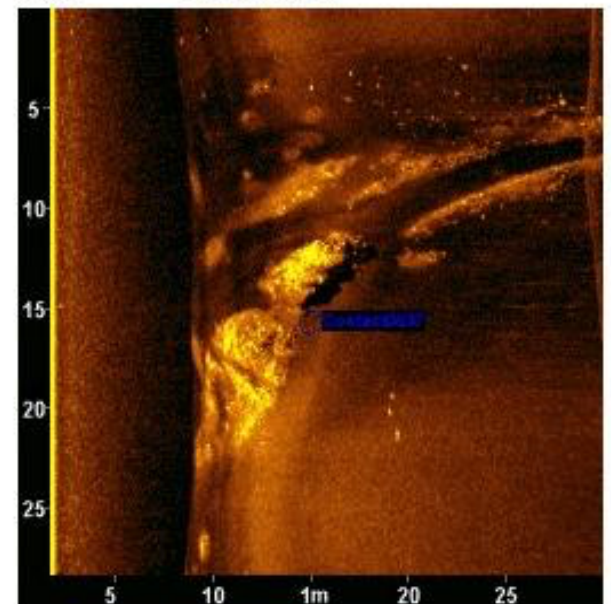
microbialite rockslide

Contact ID: Contact0037

Class Time: 2010-07-06 15:54:54

Lat: 51.001594

Lon: -121.779974

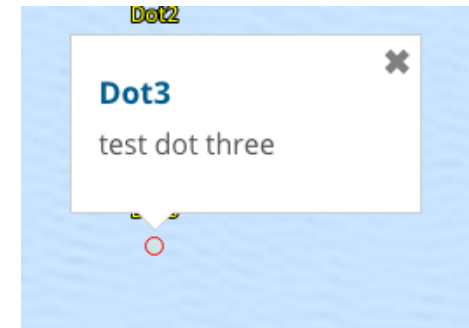


Directions: [To here](#) - [From here](#)

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



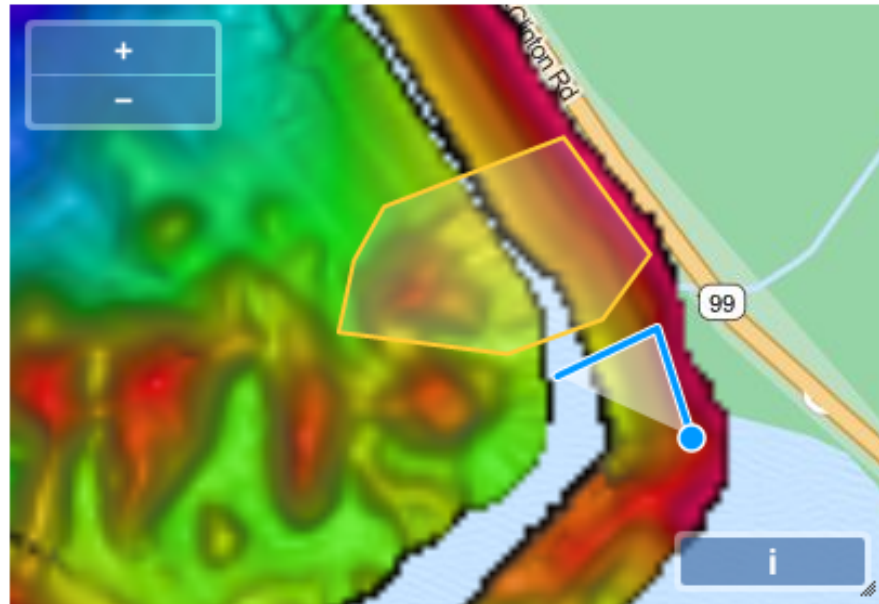
Point with popup

Navigate Edit Features Add Features

Double click to finish a line or polygon. Shift-click to delete a vertex.

Map layer saved.

Polygon Point Line



Lake Depth: 4 meters = 15 feet

Info Features Layers Search

Features

Polygon Properties

Duplicate Delete

KeepOut

Name TamarTest_Polygon0C

Description

Draw Label

Show Popup

Style

Coordinates

Traverse Planning

Easily create traverse plans by clicking to add stations.

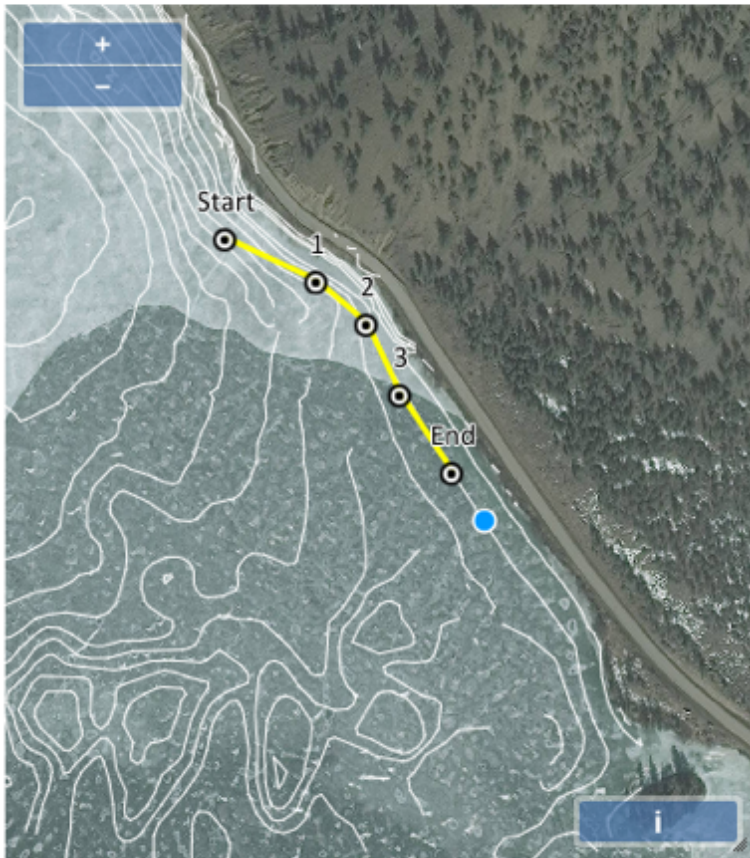
As stations are added the distance and duration update in the list on the right.

Depth from bathymetry displays under the map as the cursor moves.

Users can export plans, including KML, PML, json and other formats.



Click to add stations to end. Double-click last station.



Lake Depth: 6 meters = 18 feet

Stations/Segments	
Start	00:00
82 meters	+06:47
1	06:47
53 meters	+04:27
2	11:14
63 meters	+05:16
3	16:31
76 meters	+06:20
End	22:51

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.

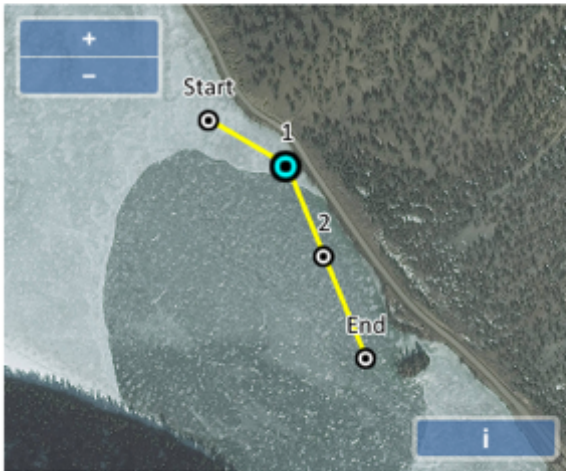
Durations of activities are included in the time calculations in the first column.

Navigate Edit Stations Add Stations

Undo

Click and drag to pan map.

Plan saved.



Meta Sequence Layers Search Tools Links

Stations/Segments	
Start	00:00
169 meters	+14:04
1 ▶	34:04
182 meters	+15:11
2	49:16
204 meters	+16:58
End	01:06:14

Station 1

Station Properties ▶

Cut Copy Paste Delete

- Photograph 05:00
- Sample Microbialite ▶ 15:00

Add commands

Command Sample Microbialite

Name

Notes

Id

duration
minutes

Live Track




Real-time Geo-located Annotation

The image shows a Google Earth interface with a satellite view of a coastal area. A pink line traces a path along the shore, with several camera icons placed at specific points. Two of these icons are labeled 'microbialites', and one is labeled 'trees'. A white information window is open over the 'trees' icon, displaying the following data:

trees

Note: trees
Description: trees Event - 60ft log sample identified
Time: 2010-07-04 15:40:05
Lat: 50.854575
Lon: -121.727705
Depth: -18.770 m

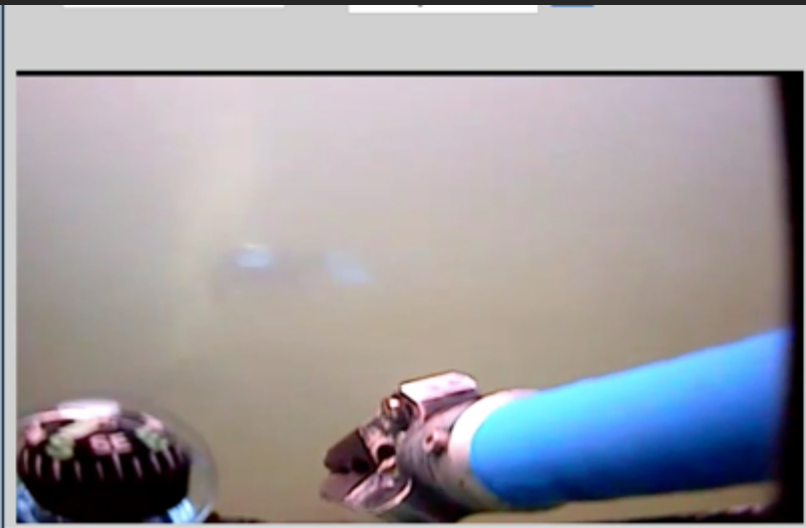
[Video](#) | [Image](#)



Directions: [To here](#) - [From here](#)

At the bottom of the screen, there is a scale bar showing 119 m, the text 'Image © 2011 Province of British Columbia', and coordinates: 'lat 50.853416° lon -121.725306° elev 0 m'. The Google logo and 'Eye alt 411 m' are also visible.

Live Video



23:19:35

Live feed: Research Diver 2 Recorded Actual Size

Note: Tags: add a tag Save

184min REC LA

The live video feed shows a diver in a dark environment, wearing a wetsuit and a mask, with a blue arm visible. The video is recorded and has a duration of 184 minutes.

Google Earth

Search Search

ex: 15213 Get Directions History

Places

- Pavillion Lake
- Kelly Lake
- Feeds
- Live Positio...
- Today
- 201406...
- Curre...
- Comp...
- Recen...
- Old Tr...
- 201406...
- 201406...
- boat
- Past Days
- Flight Paths

Pavillion Lake Research Project

xGDS Exploration Ground Data Systems

Approximate TP tra

OUT 62 (5 hours ago)

Image © 2014 DigitalGlobe

Google earth

Tour Guide 12 52010, 59.96° N 121°44'08.32" W elev 2645 ft eye alt 2941 ft

The Google Earth interface shows a map of the Pavillion Lake Research Project area. The map displays a circular track with a red line indicating the approximate TP trajectory. The track is labeled with coordinates and time. The interface includes a search bar, a list of places, and a tour guide.

Temporal View: Video with Notes

Episode (Flight) Name: 20140623A

Jump to:

Local Time: 10:18:46 PDT

OUT
RD1
RD2

Display 10

Search:

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



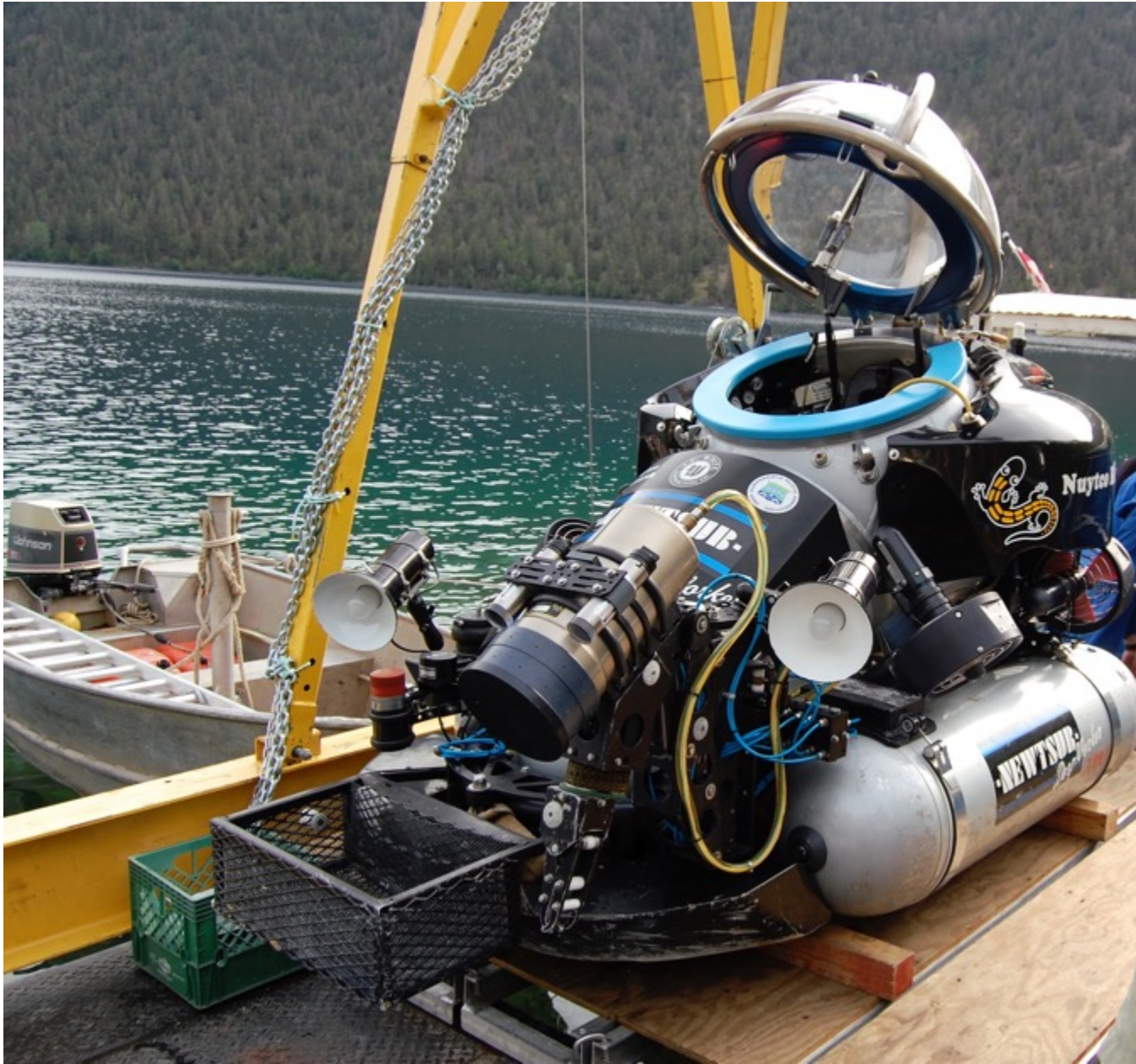
Autonomous AUV



“Chase” Boat



Piloted Submersible



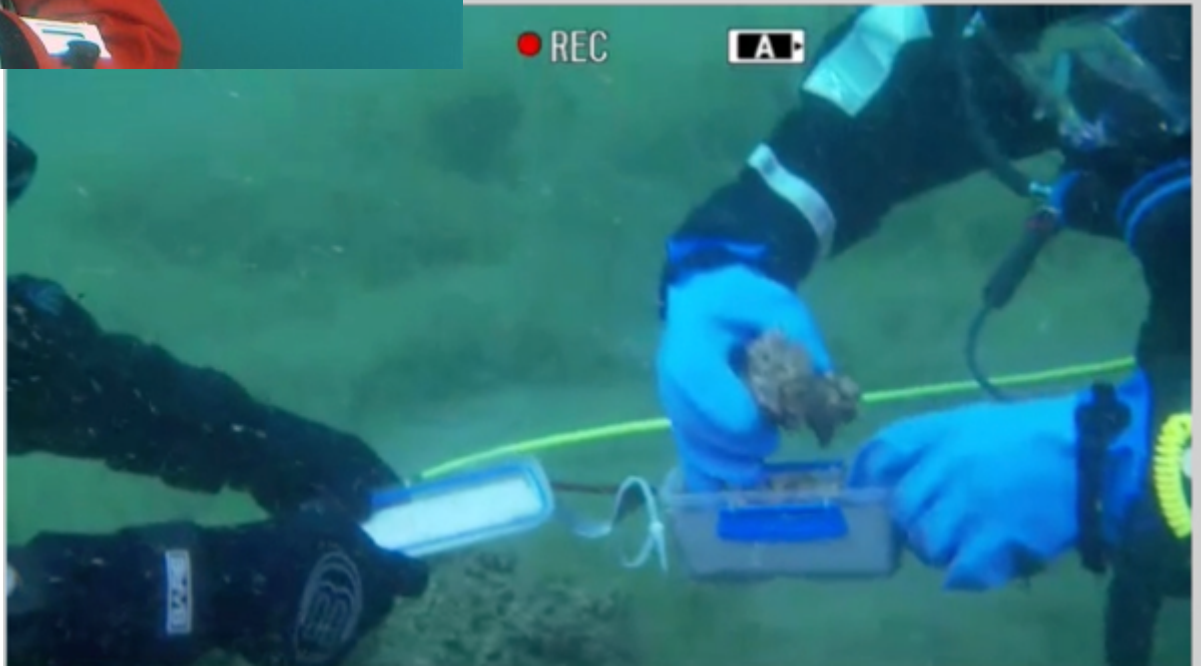
ROV with Sonar Transponder



Divers



REC

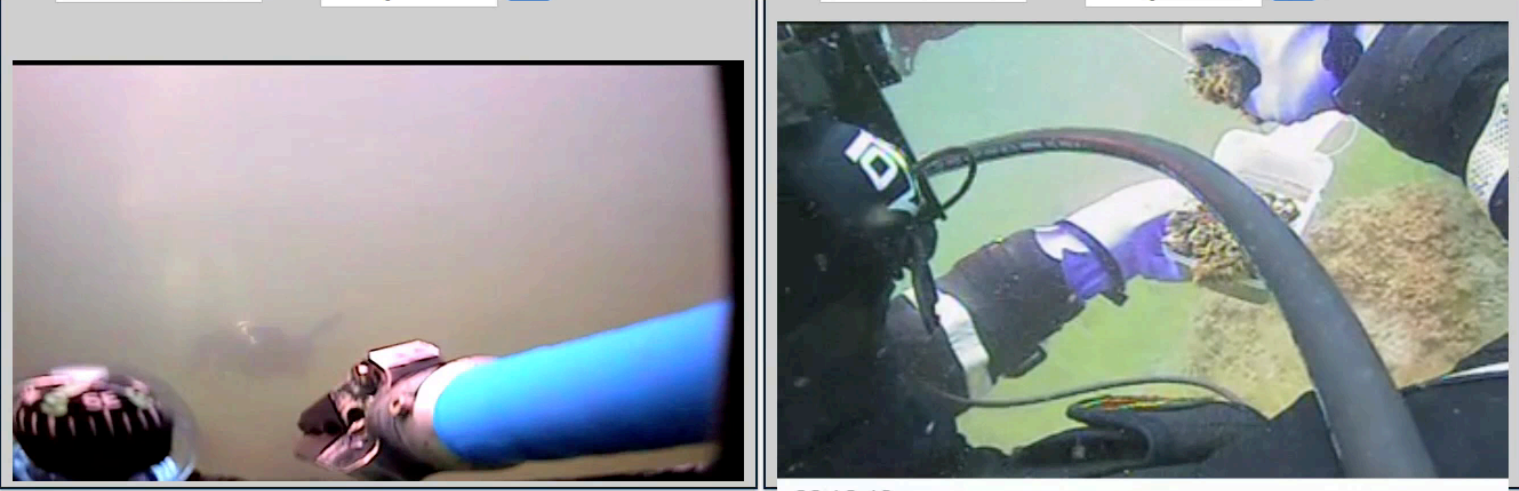


Divers

Google Earth File Edit View Tools Add Window Help

10.0.3.15/plrpExplorer/re x Home - PLRP Video - PLRP Maps - PLRP

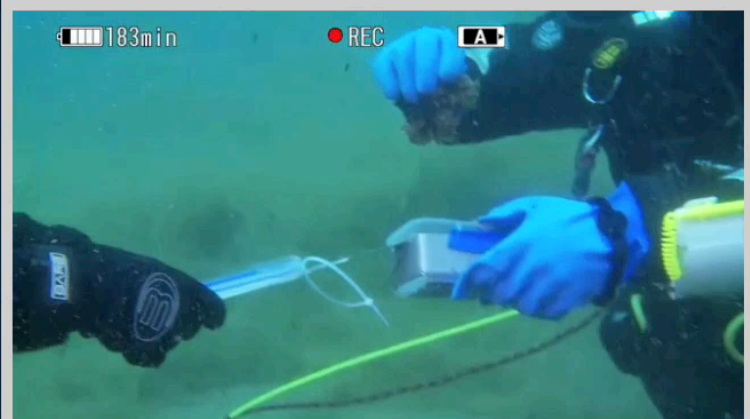
sid/xgds_video/liveVideoFeed/All



23:19:48

Live feed: Research Diver 2 Recorded Actual Size

Note: Tags: add a tag Save



Google Earth

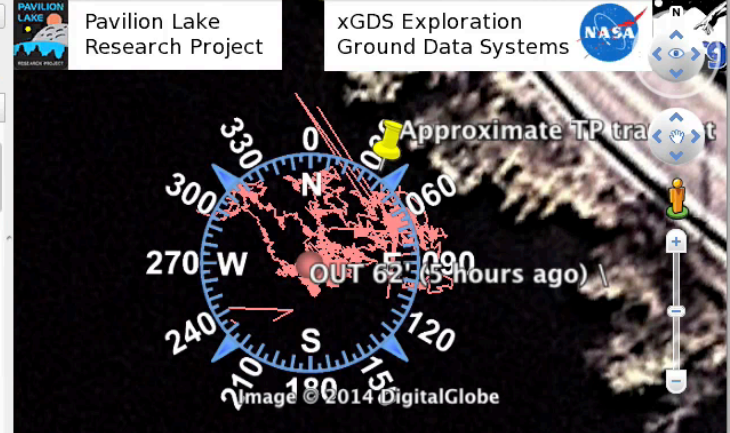
Search Sign in

Pavilion Lake Research Project xGDS Exploration Ground Data Systems NASA

ex: 15213 Get Directions History

Places

- Pavilion Lake
- Kelly Lake
- Feeds
- Live Positio...
- Today
- 201406...
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- 201406...
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- Past Days
- Flight Paths

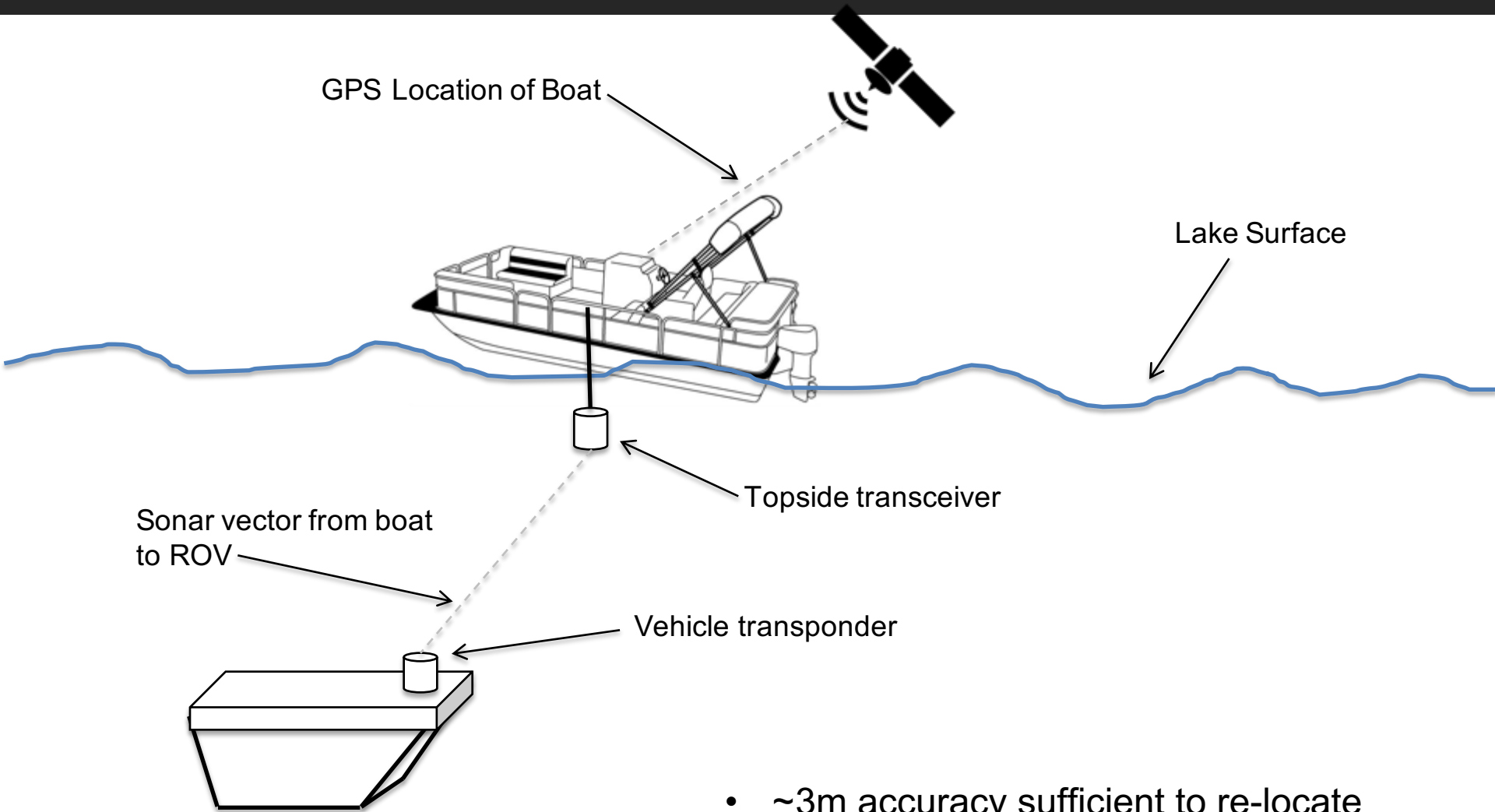


Approximate TP tra...
OUT 62 (5 hours ago)
Image © 2014 DigitalGlobe

Google earth

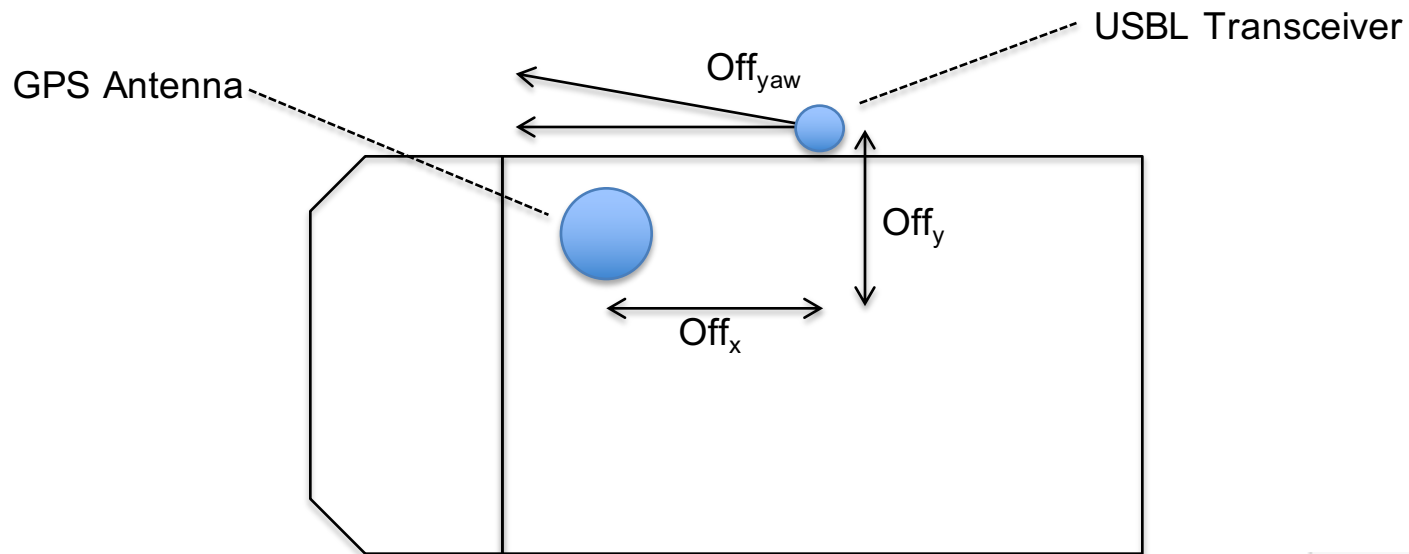
Tour Guide 12 52010°59.96' N 121°44'08.32' W elev 2645 ft eye alt 2941 ft

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.

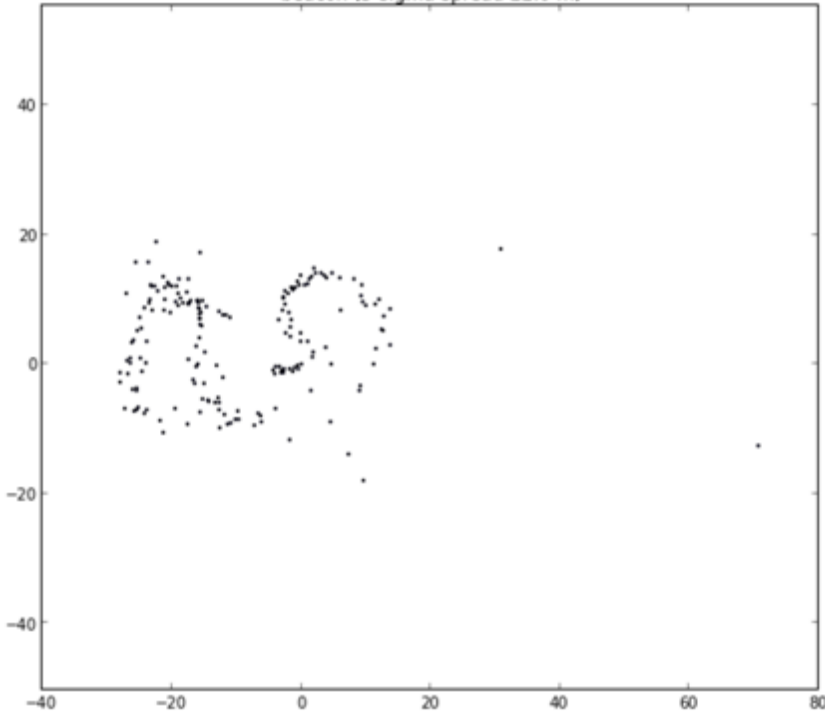
Calibration is Critical



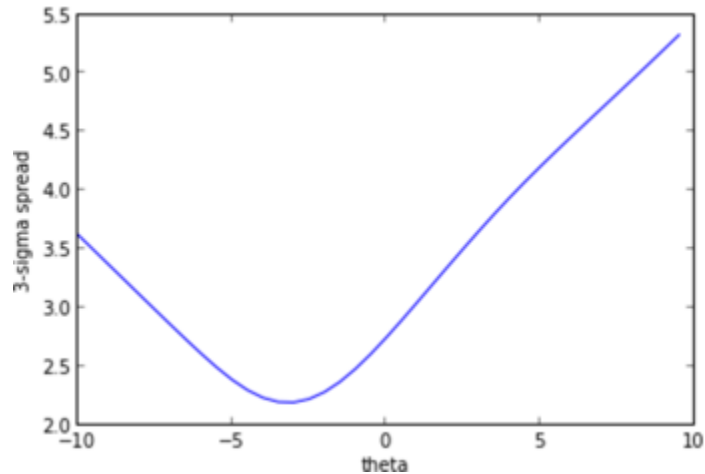
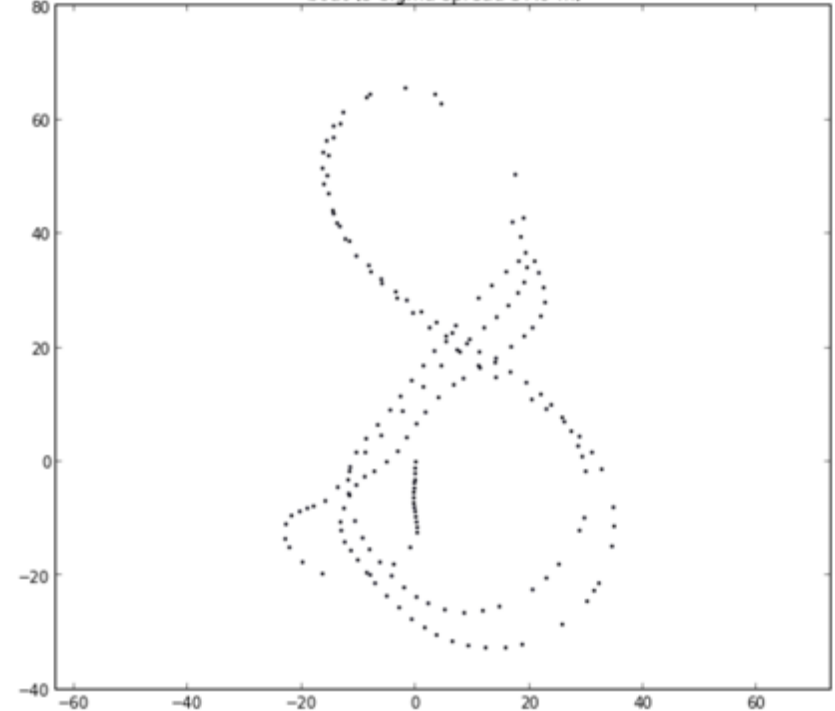
```
PARAM_LIST = [  
    # 'roll',  
    # 'pitch',  
    'yaw',  
    'xoff',  
    'yoff'  
]
```


Calibration is Critical

beacon (3-sigma spread 22.0 m)



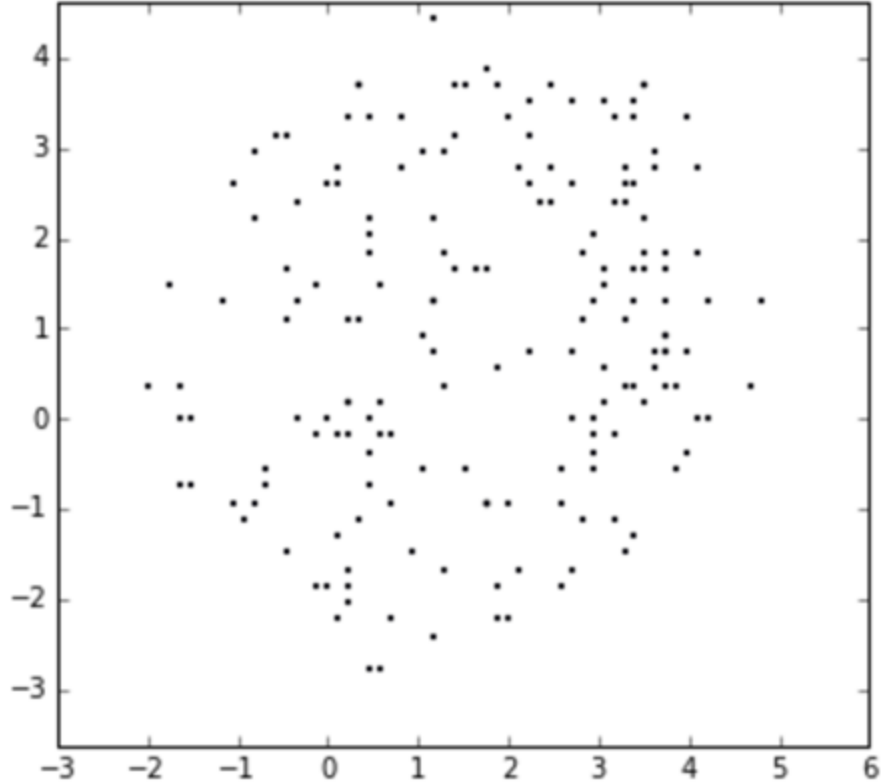
boat (3-sigma spread 37.9 m)



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

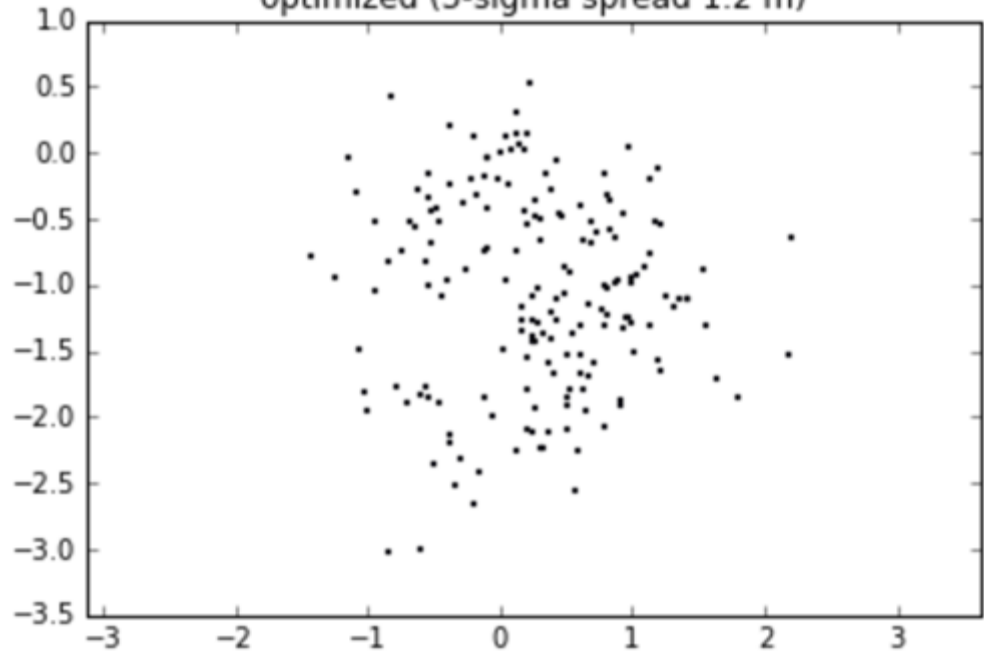
Calibration is Critical

original (3-sigma spread 2.3 m)



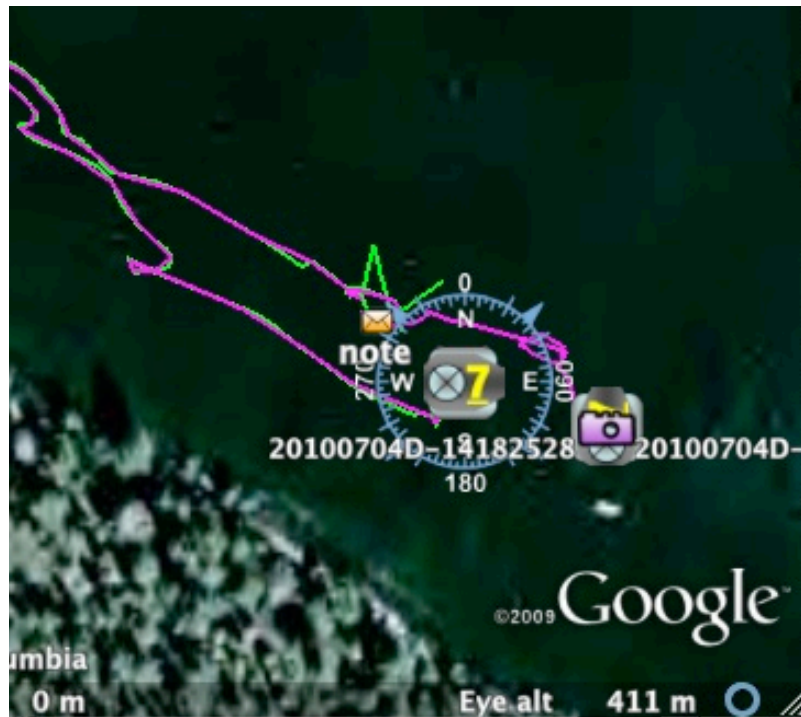
Before (7m x 7m)

optimized (3-sigma spread 1.2 m)



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.

