# Nearshore surveys with LIDAR

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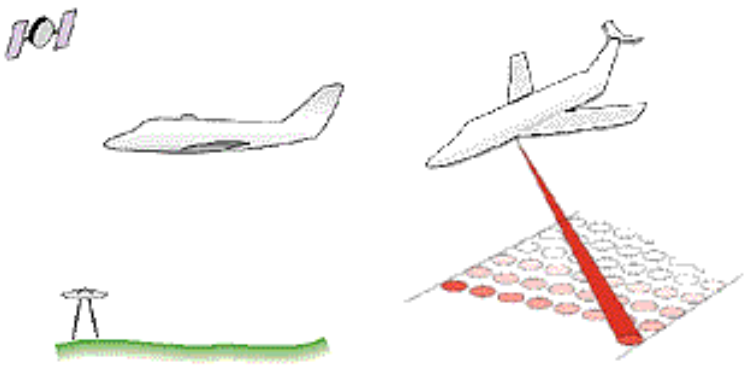
# A lidar survey system



*graphic courtesy Natural Resources Canada*

***Swath width does not depend on water depth***

***Works on featureless targets***

***Avoids hazards of inshore boat work***

- Differential GPS—aircraft position
- IMU (inertial measurement unit)—aircraft orientation
- Scanning laser rangefinder— scan angle, distance
- 3 data streams
  - GPS @ 1-2 Hz
  - IMU @ 1-200 Hz
  - rangefinder @ 2-100 kHz
- Extensive computer processing to get ground coordinates

power supply
GPS
inertial measurement unit

scanning laser rangefinder

a lidar instrument

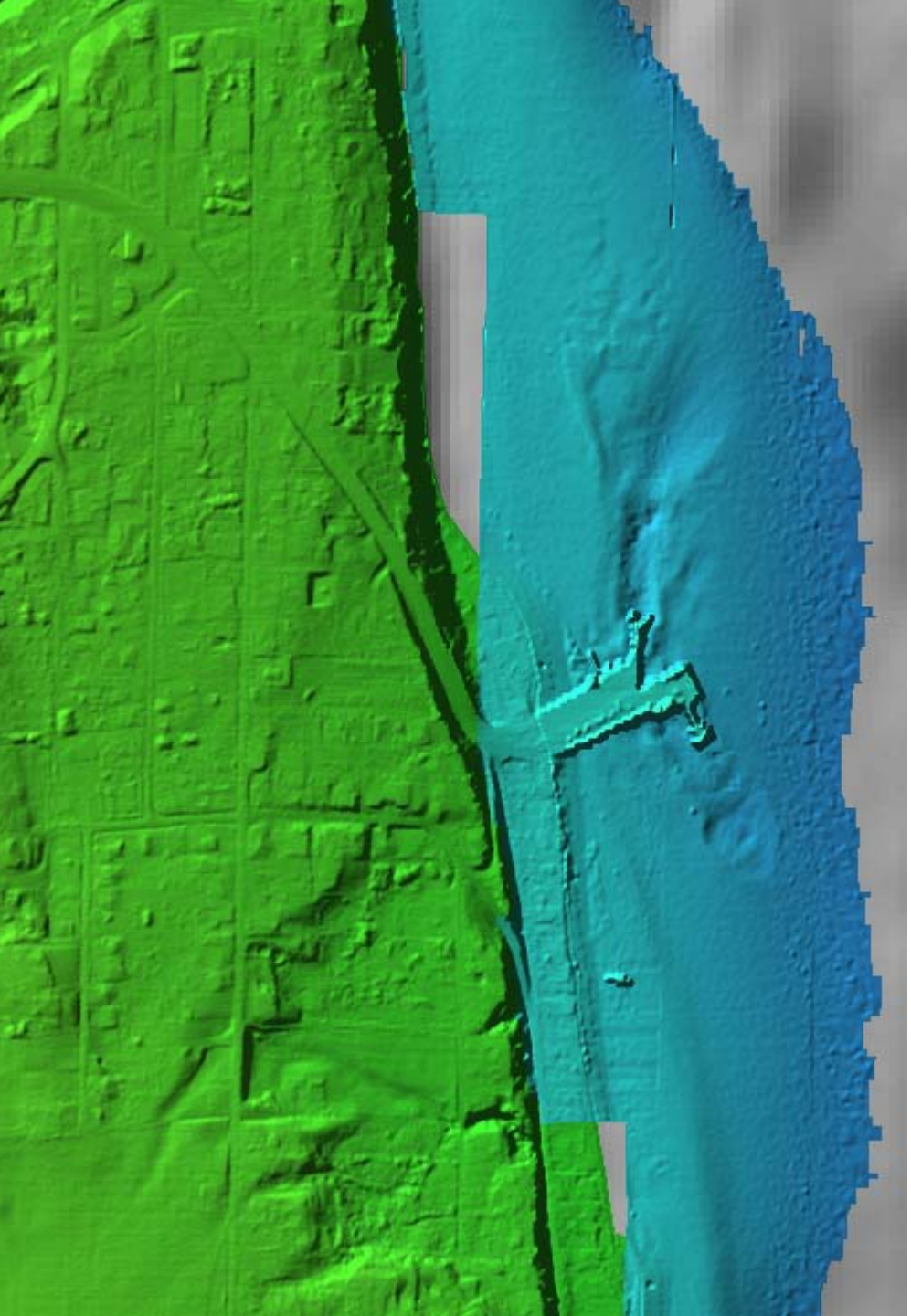
# 3 flavors of interest

- Commercial near-infrared (1026 nm) discrete-return systems

  *fast, high resolution, many instruments available, does not penetrate water*
- CHARTS (also SHOALS, LADS) green (523 nm) full waveform systems

  *slow, expensive, limited availability, low resolution, depths to 25m depending on clarity*
- EAARL lightweight green full waveform system

  *one only, modest resolution, depths to 20m?*

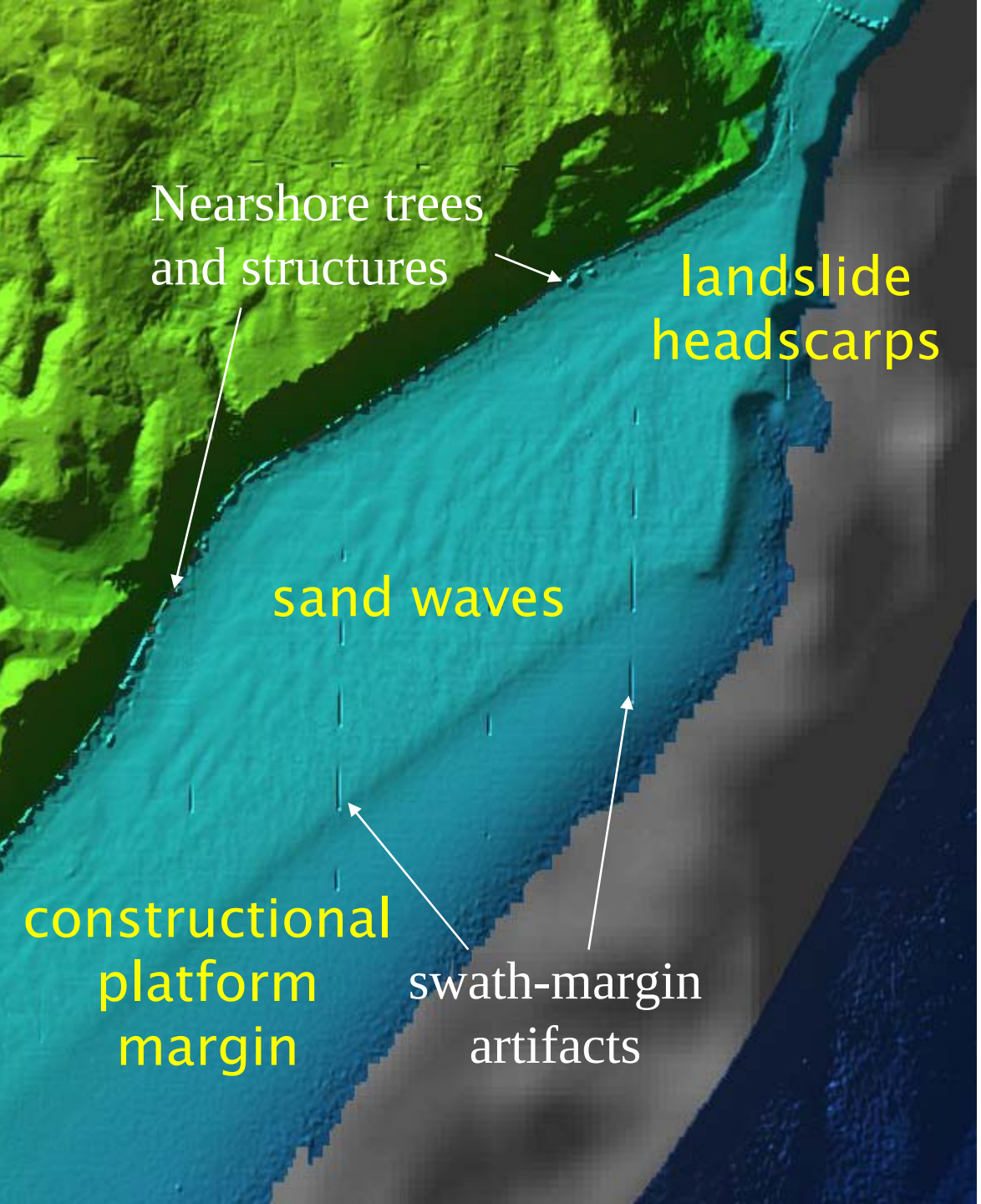


# Clinton, SE Whidbey Island

TerraPoint terrestrial infrared lidar, 2001

Tenix-LADS green full-waveform lidar, 2001

30m integrated DEM (Finlayson et al.)



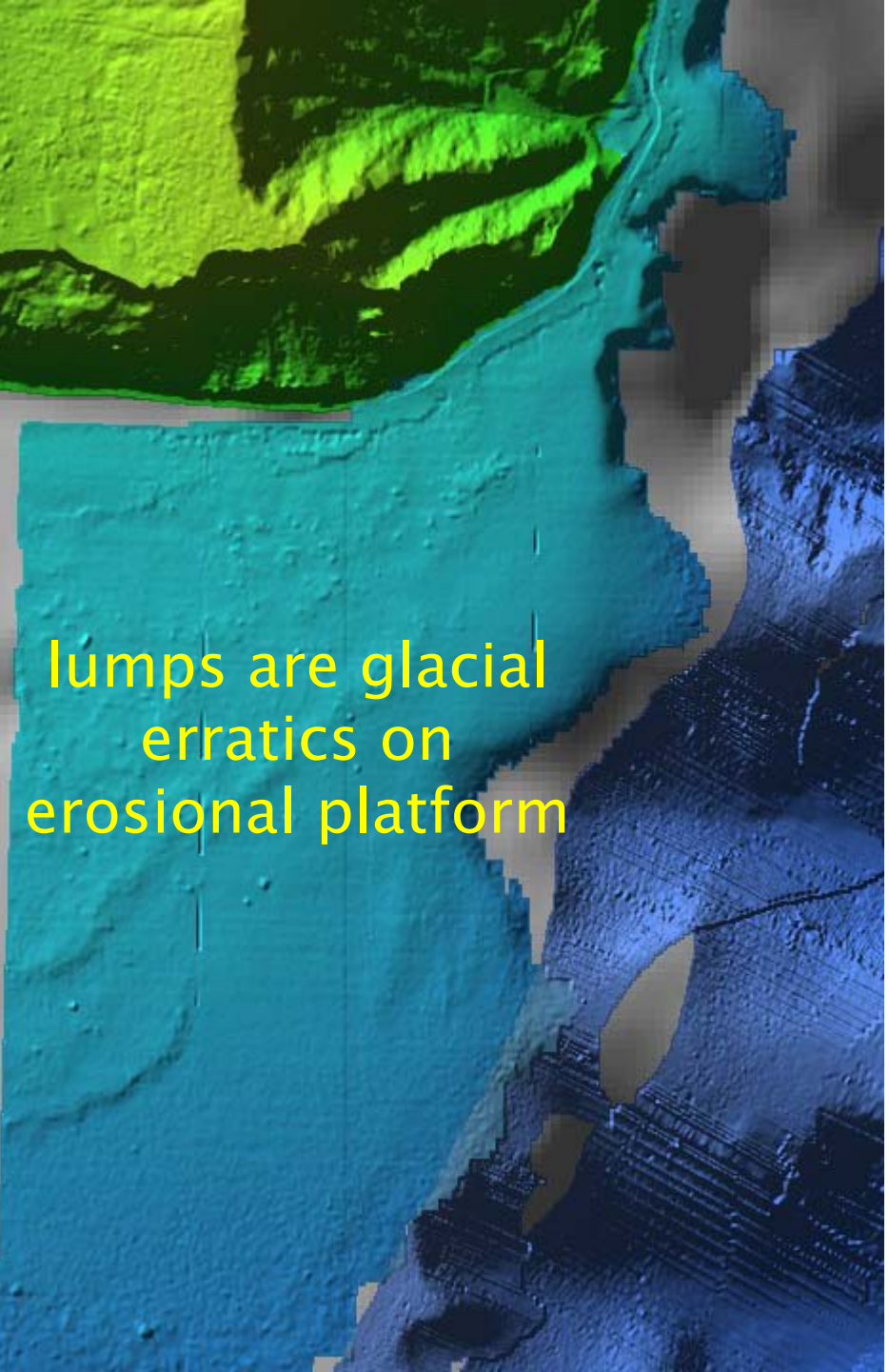

Glendale, SE Whidbey Island

TerraPoint terrestrial infrared lidar, 2001

Tenix-LADS green full waveform lidar, 2001

30m integrated DEM (Finlayson et al.)

RV Thompson multibeam sonar



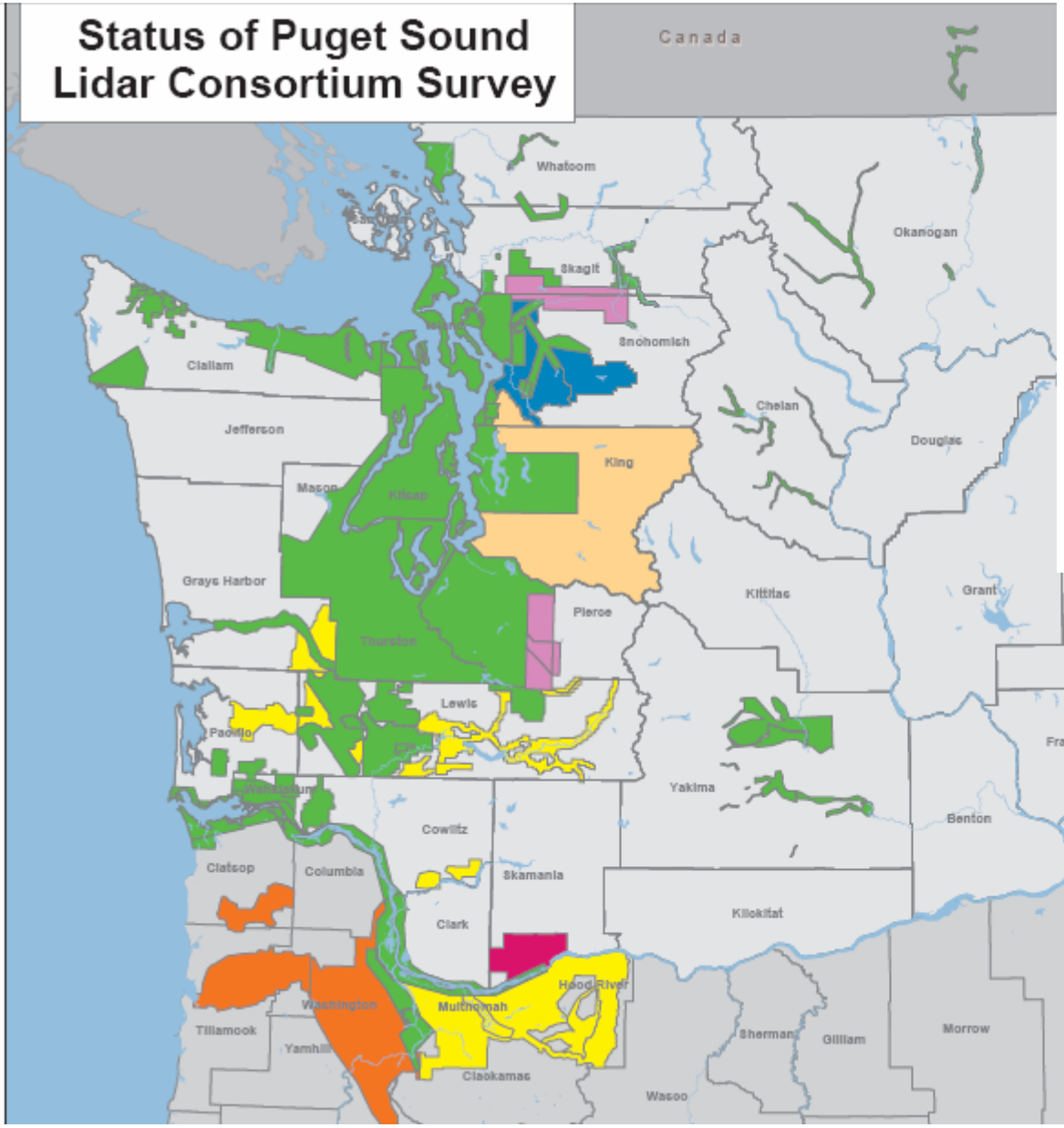

Possession Point,
SE Whidbey Island

TerraPoint terrestrial infrared lidar, 2001

Tenix-LADS green full waveform lidar, 2001

30m integrated DEM (Finlayson et al.)

RV Thompson multibeam sonar




Commercial IR discrete-return systems

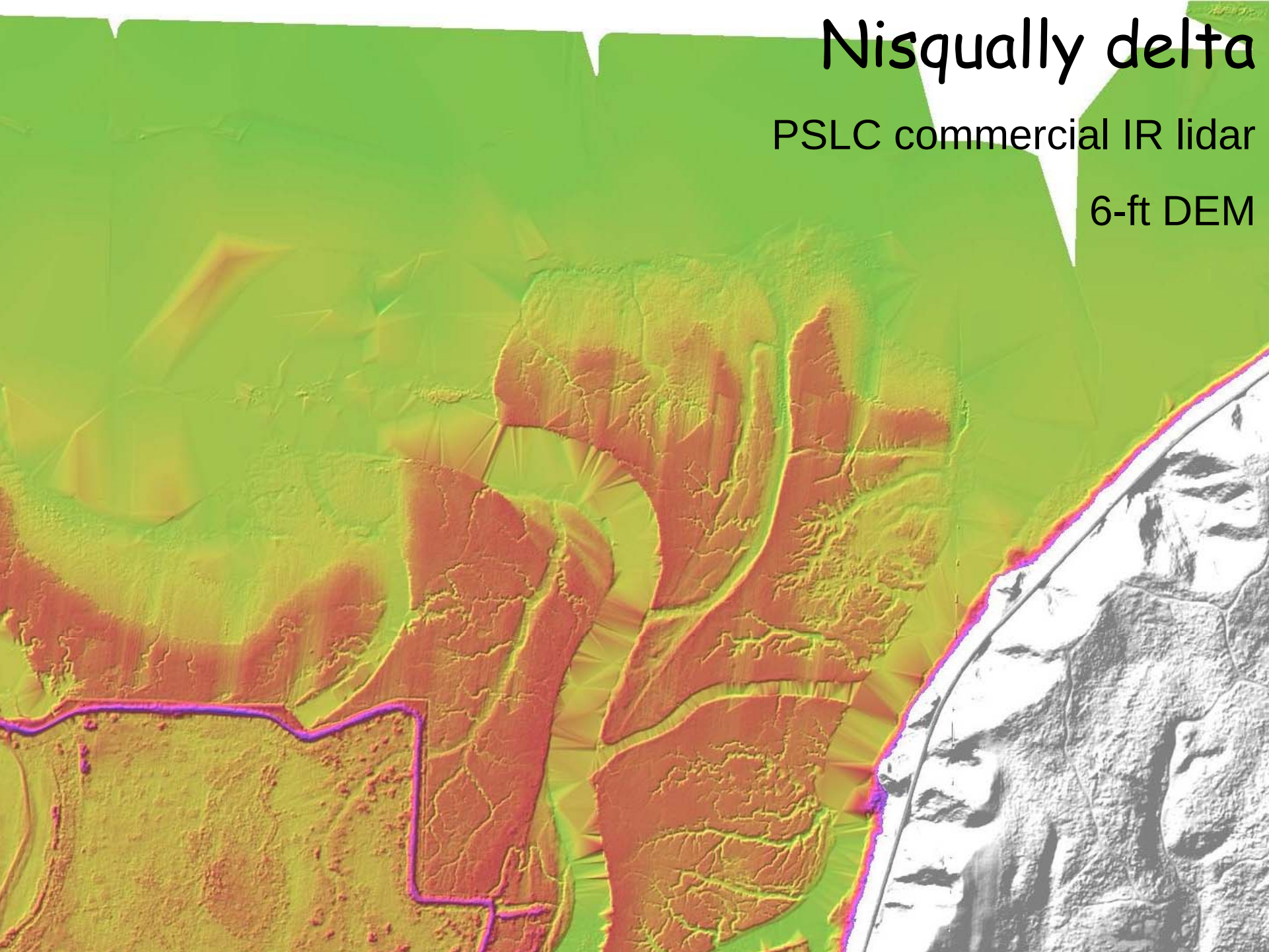
Surveyed in wintertime, mostly during day

Most data collected at high tide, minimal beach coverage

# Nisqually delta

PSLC commercial IR lidar

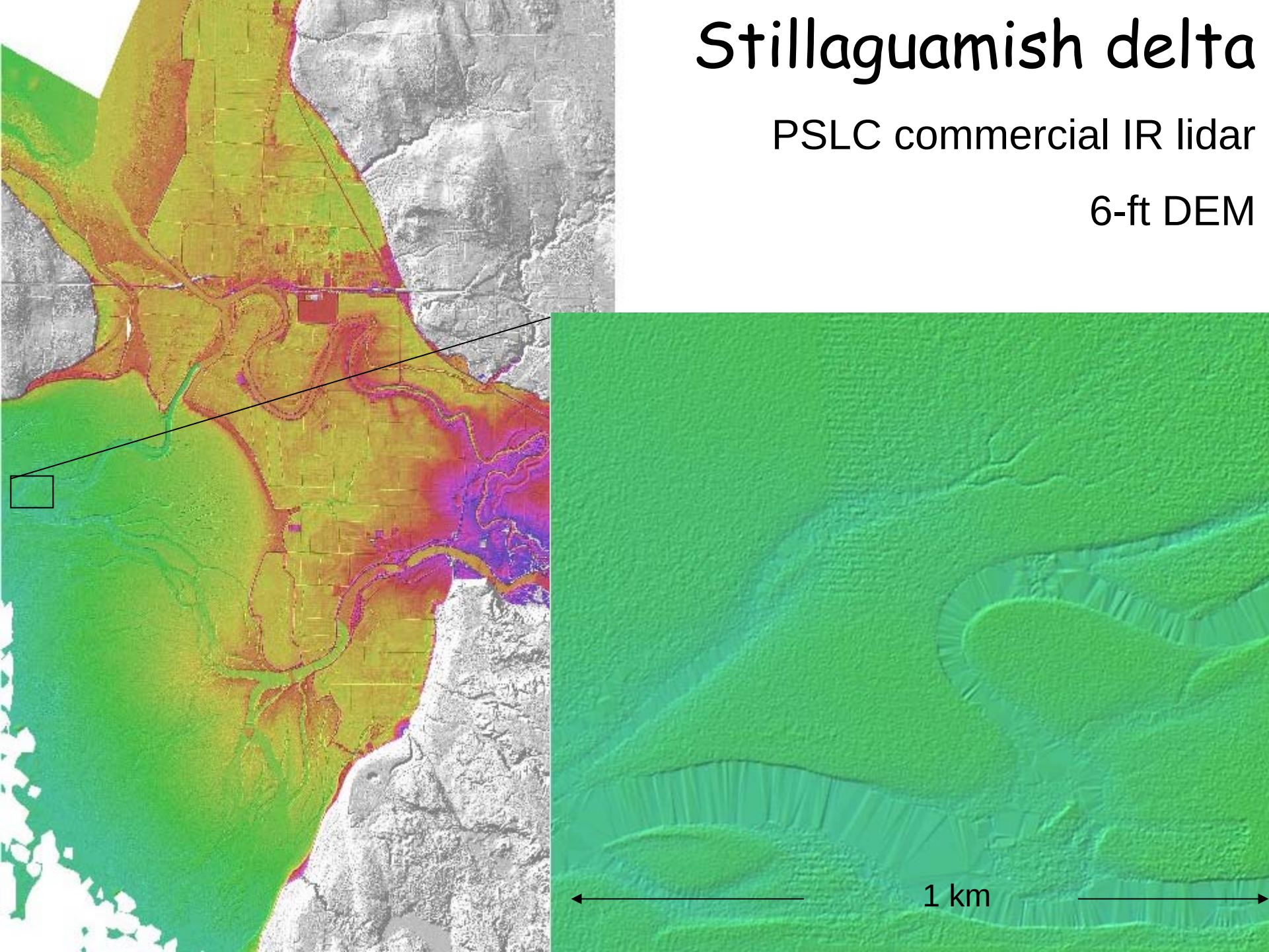
6-ft DEM



# Stillaguamish delta

PSLC commercial IR lidar

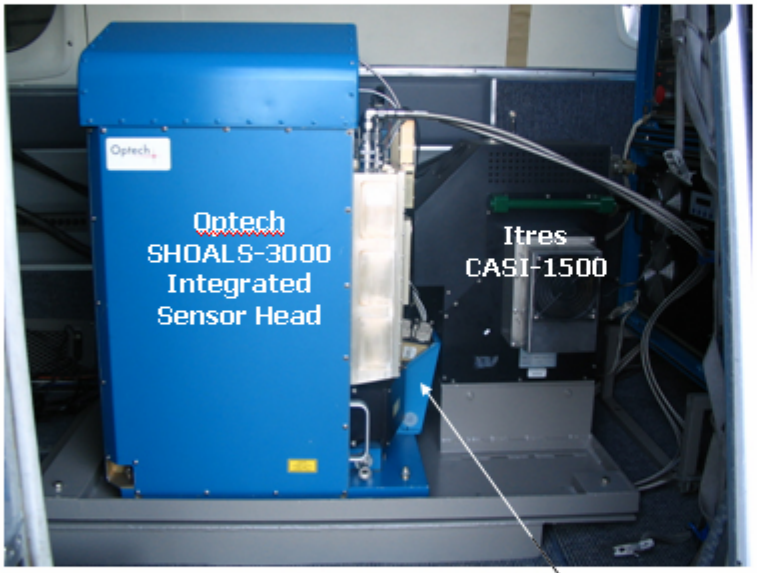
6-ft DEM



# CHARTS

COMPACT HYDROGRAPHIC AIRBORNE RAPID TOTAL SURVEY

## CHARTS sensor suite




DuncanTech-4000
RGB Camera

### SHOALS-3000 System specifications

**Laser pulse rate**
3,000 Hz hydro
20,000 Hz topo

**Laser spot spacing**
2 – 5 m hydro
1 – 2 m topo

**Elevation accuracy**
±30 cm at 95% hydro
±15 cm at 95% topo

**Flight altitude**
300 – 400 m hydro
300 – 1200 m topo

**Flight speed**
135-185 knots

**RGB images**
Georeferenced
1 Hz, 60% alongtrack overlap
20 – 50 cm pixel resolution
jpg format

### CASI-1500 Sys

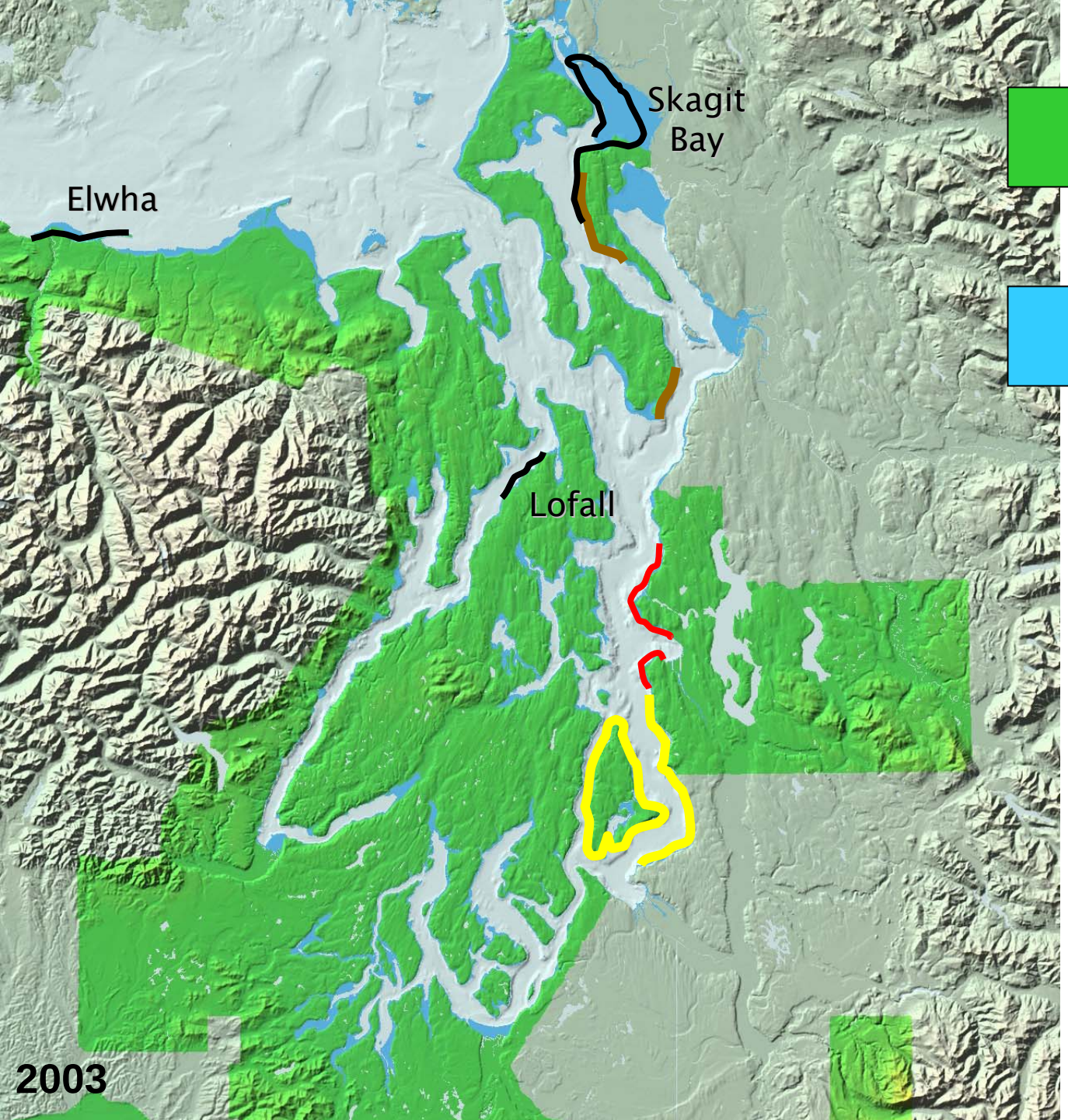
**Field of view**
40° acrosstrack
0.028 ° alongtrack

**Spectral range**
375-1050 nm

**Spectral samples**
288 at 1.9 nm intervals

**Aperture**

**J**oint
**A**irborne
**L**aser
**B**athymetry
**T**echnical
**C**enter of
E**X**pertise




Existing PSLC lidar data

Potential for bathymetric lidar survey

2001 Tenix-LADS
2002 SHOALS 400

2003 CHARTS

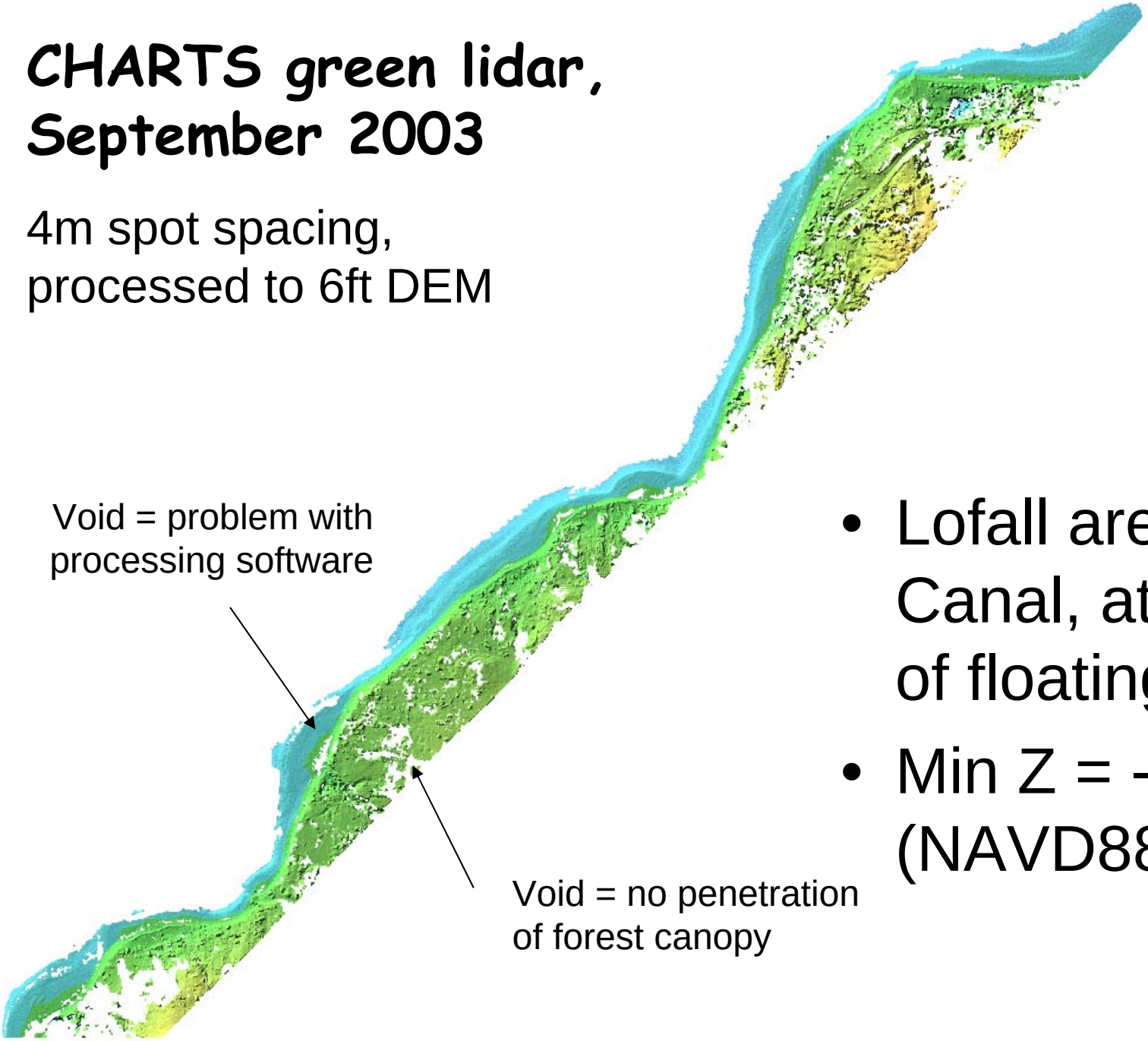
ACE-USGS
<$165K (?!)
w/ mobilization

City of Seattle
$37K
no mobilization

? KC - WRIA 9
$62K ??

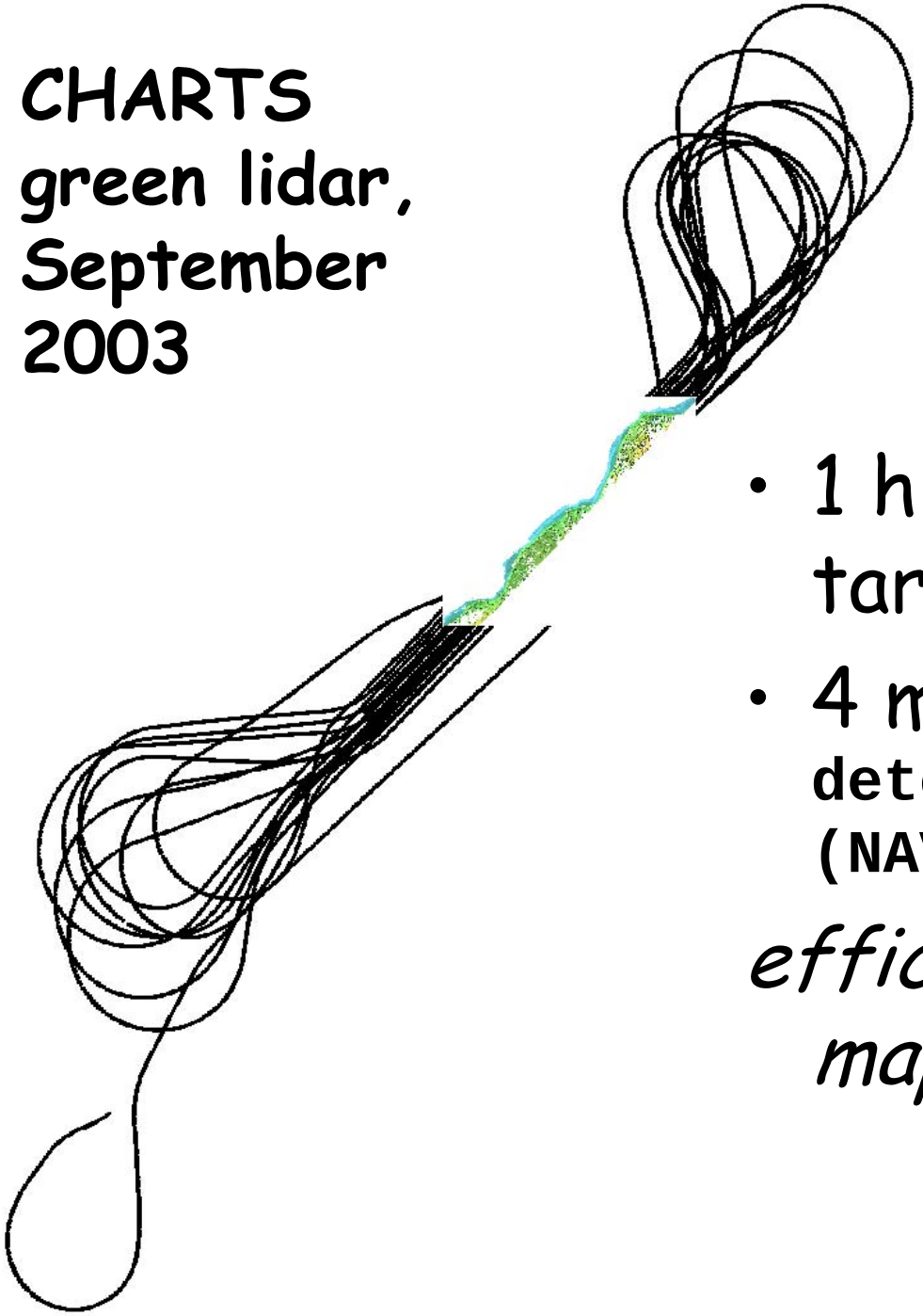
# CHARTS green lidar, September 2003

4m spot spacing, processed to 6ft DEM




- Lofall area, Hood Canal, at and SW of floating bridge
- Min Z = -50 ft (NAVD88)

**CHARTS green lidar, September 2003**



- 1 hr 54 minutes in target area
- 4 minutes useful data
  **detection limit < Z < 0 (NAVD88)**

*efficiency at bathymetric mapping = 3.6%*

# CHARTS green lidar, September 2003

4m spot spacing, processed to 6ft DEM

Skagit Bay

| | Commercial survey lidars | CHARTS | EAARL |
|---|---|---|---|
| Laser type | **Infrared laser, no water penetration** | **Green laser, up to ~2.5X Secchi depth (20 m in Puget Sound)** | **Green laser, up to ~2x Secchi depth** |
| Pulses per second | **~100,000** | **3,000** | **3,000** |
| Spot diameter | **15 cm (variable)** | **~1 m** | **20 cm** |
| spot spacing | **0.3–1 m** | **4 m** | **2-4 m** |
| Effective XY resolution | **0.4-1 m** | **4+ m** | **2-4 m** |
| Z reproducibility (1 sigma) | **3-10 cm** | **~15 cm** | **?** |
| XY reproducibility | **20-30 cm** | **~1 m** | **1 m** |
| Usual vertical datum | **Ellipsoid** | **Water surface** | **Ellipsoid** |

| | Commercial survey lidars | CHARTS | EAARL |
|---|---|---|---|
| Associated imagery | **IR intensity (active illum., 0.3-1m resolution)** | **CASI hyperspectral (passive illum., daytime flights)** | |
| | **RGB imagery available as add-on. This is not a good idea** | | |
| Availability | **Many commercial systems** | **1) JALBTCX (USACE + USN + NOAA)**<br>**2) Fugro** | **One research instrument, soon to be USGS** |
| Cost | **$300-$3,000/mi$^2$** | **??** | **?? (less than CHARTS)** |
| | ***Can write contract to specify a complete survey or no payment*** | | |

# How to map nearshore regions?

Jet-ski traverses with single-channel sonar

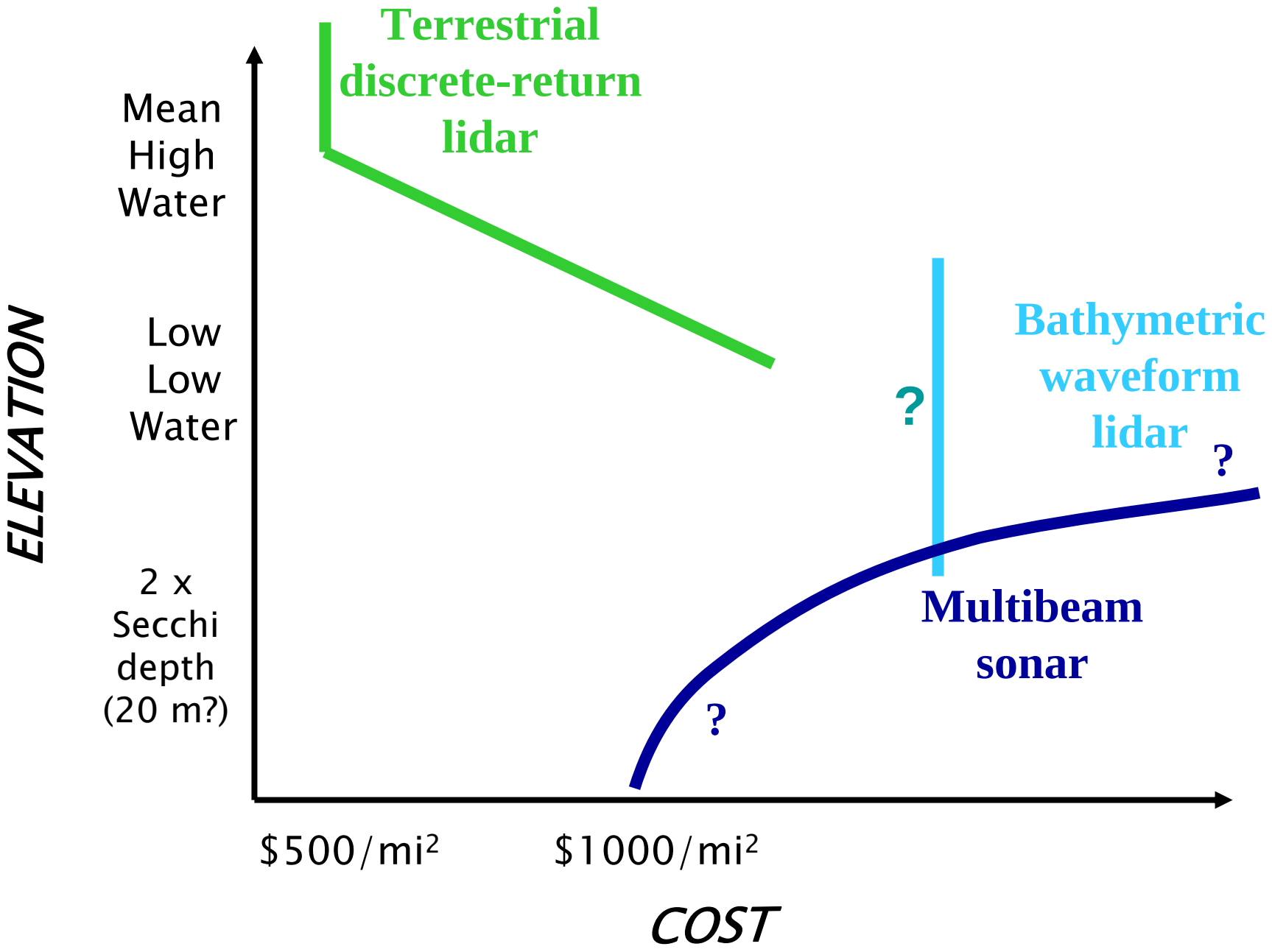
*or*

CHARTS large-footprint green lidar

*or*

Small-boat acoustic survey at high tide, commercial infrared lidar at low tide

**Completeness, Resolution, Accuracy, Cost**


Terrestrial discrete-return lidar
Mean High Water
Low Low Water
2 x Secchi depth (20 m?)
ELEVATION
?
Bathymetric waveform lidar
?
Multibeam sonar
?
$500/mi²
$1000/mi²
COST