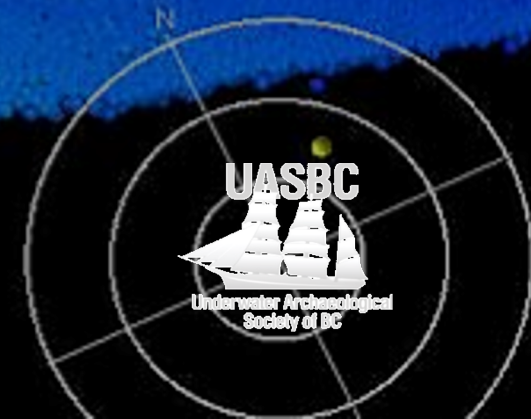


SEARCH TECHNIQUES

Module 4: Visual Searches, Remote Sensing & Position Fixing

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SEARCH TECHNIQUES & POSITION FIXING

By the end of this module you will know:

- What visual search techniques exist
- What remote sensing technology exists
- How to record the location of an underwater site

SEARCH TECHNIQUES

VISUAL SEARCH

- Aerial
- Circular
- Contour
- Jackstay (Corridor)
- Pendulum Search
- Diver Propulsion Vehicle
- Towed
- Metal Detector

REMOTE SENSING

- Depth Sounder
- Side Scan Sonar
- Sub Bottom Profiler
- Magnetometer
- Multibeam Sonar
- Remotely Operated Vehicle
- Autonomous Underwater Vehicle



VISUAL SEARCHES

Visual searches **rely on eye sight** to locate sites. Considerable **pre-search planning** is required, including narrowing down search areas by doing background research.

When conducting a search:

- ▶ know where you **start**.
- ▶ know where you are **going**.
- ▶ know where you **finish**.

AERIAL SEARCH

Aerial searches involve using still imagery or aerial video to identify shallow sites or features.

- ▶ Can be done at home using Google Earth
- ▶ Images are also available through municipal/regional websites
- ▶ Historical air photos can also be used
- ▶ Live searches on small budgets by unmanned aerial vehicle (UAV; drone)



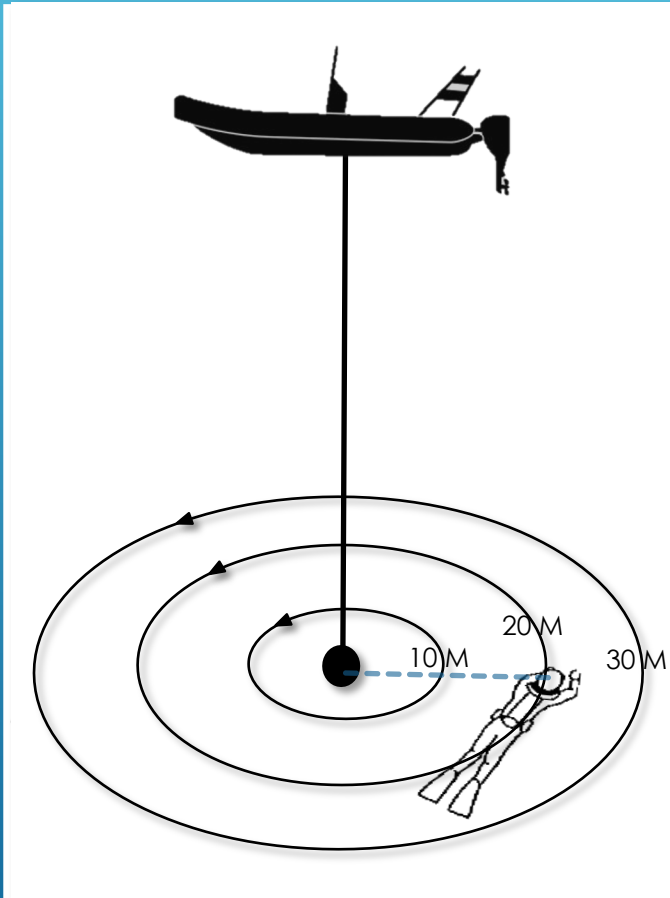
Google Earth View of Sub Chaser Wreck in Fraser River

49°07'07.40" N 123°03'34.13"



Aerial Photo of Hartlock in Nanoose Bay

CIRCULAR SEARCH



A **weighted shot line** is dropped to the bottom and coordinates are recorded with GPS.

A diver descends to the bottom and swims out from the weight at **specific intervals** in **concentric circles**.

Vessel moves to a nearby location overlapping previous circle and new area is searched.

This technique was used to search the featureless gravel bottom of Restoration Bay in BC's Central Coast.

CONTOUR SEARCH

Contour searches work well on a sloping sea floor or lake bottom.

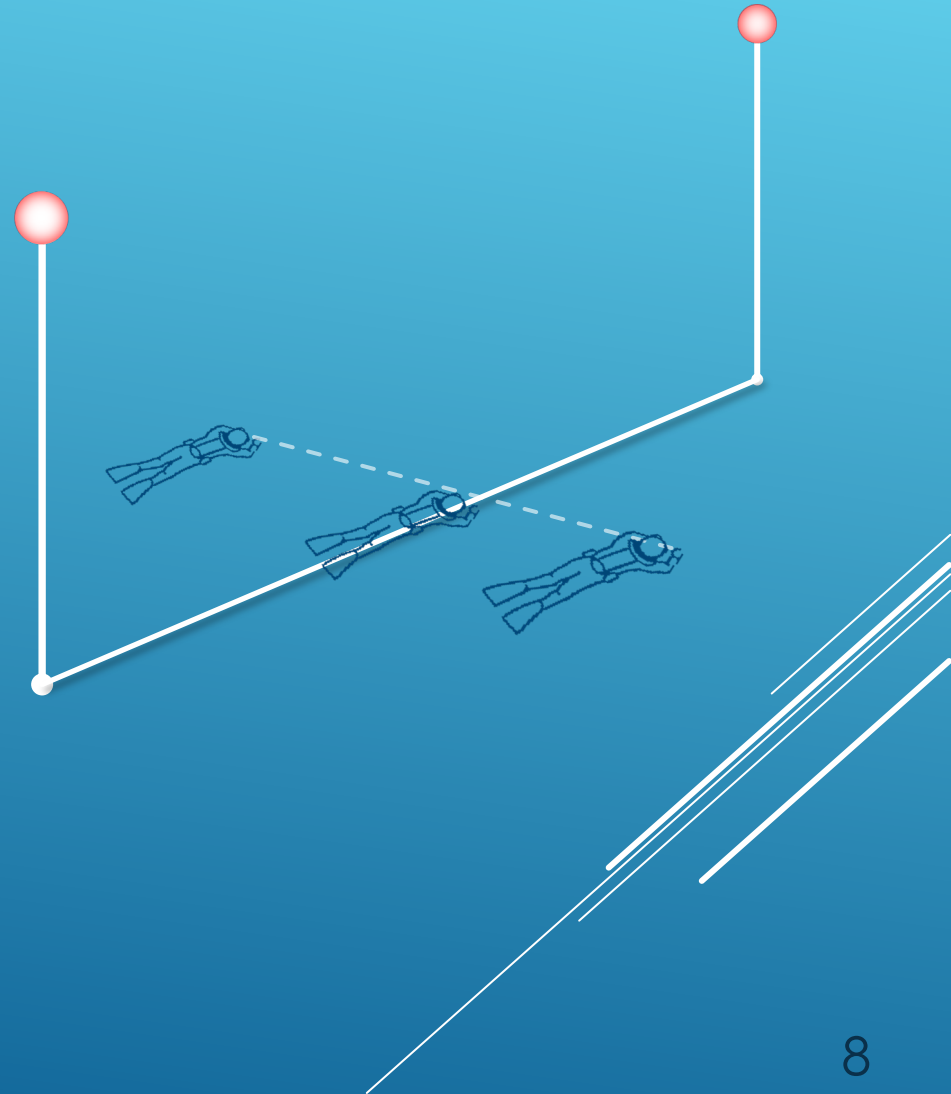
- ▶ Diver teams swim a **transect** along a **specific depth** contour (10 m, 15 m, 20 m).
- ▶ The **start and end** of each transect (diver entry and exit) is recorded, usually by GPS.

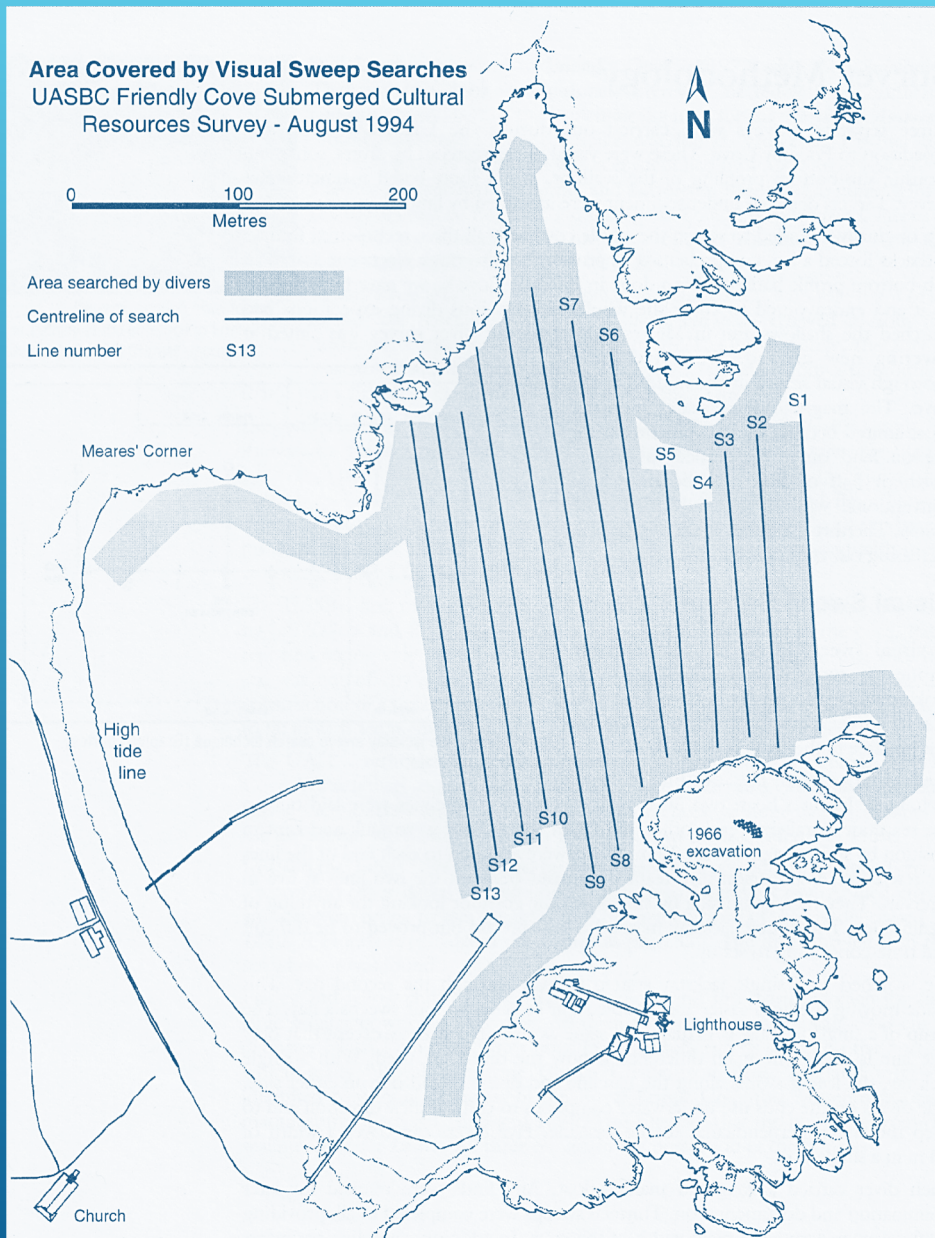


JACKSTAY SEARCH

The jackstay method allows **pre-determined search transects**.

- ▶ A **fixed line**, anchored by two buoys is laid out across the lake bottom or seafloor.
- ▶ Diver team descends one of the buoy lines and spread out at **right angles** to the baseline.
- ▶ The team swim from one buoy to the other.
- ▶ Divers may hold a light line **at fixed intervals** to maintain position.
- ▶ GPS is collected at start and finish positions.





JACKSTAY SEARCH

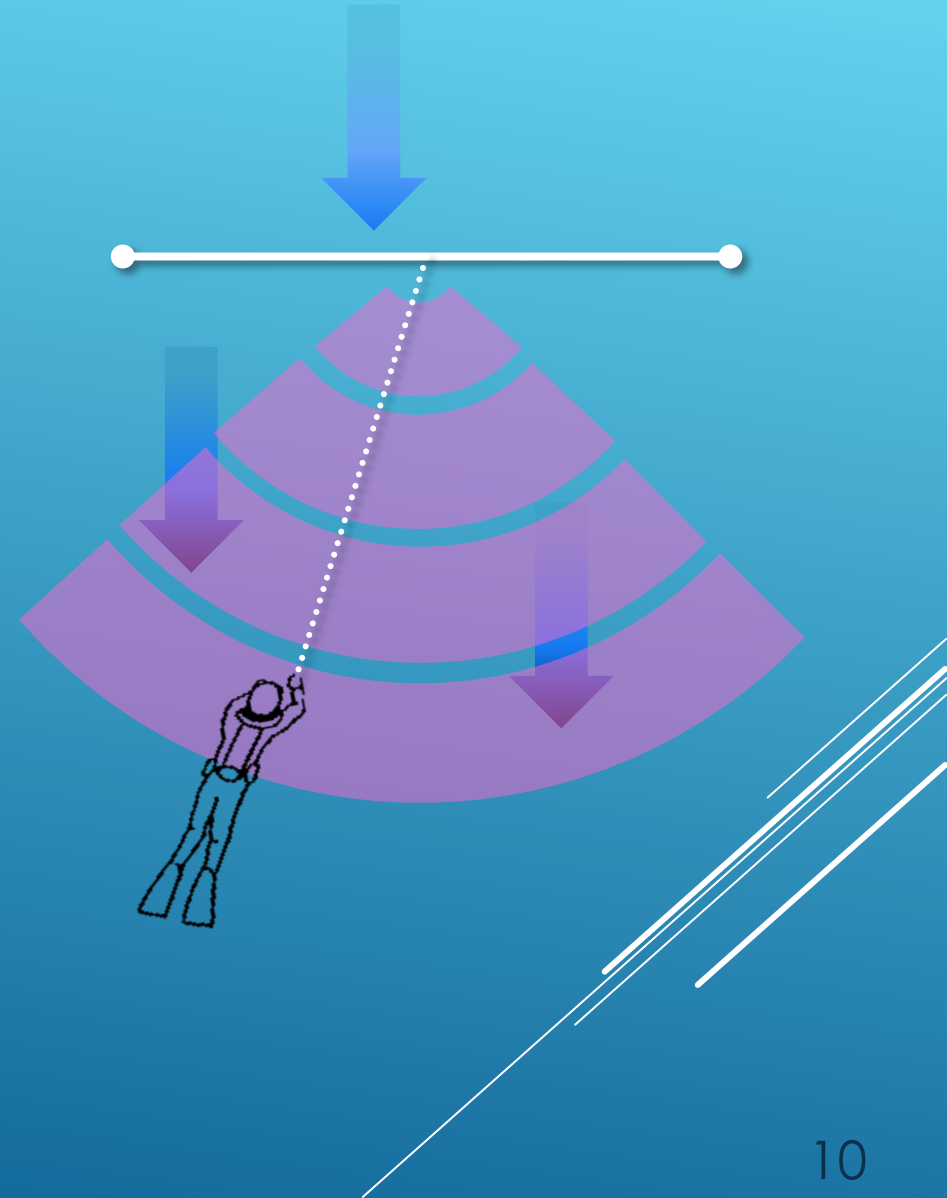
The jackstay method was used by the UASBC at Friendly Cove:

- ▶ A cave line was anchored to the bottom at the start position with a 10 kg wt.
- ▶ A boat following a predetermined compass bearing set the line with weights every 20 m to hold it in place.
- ▶ A 5 person dive team descended on the start buoy and spread out at right angles to the baseline.
- ▶ The team swam from one buoy to the other and marked any finds.

PENDULUM SEARCH

Pendulum searches are well-suited in conditions with strong current or water flow.

- ▶ A fixed line is laid out perpendicular to water flow.
- ▶ A 2nd line is attached to trail downstream
- ▶ Divers swim out on the fixed line and then drift down stream on the trailing line.
- ▶ At predetermined intervals, divers move from side to side using the force of the current.
- ▶ Once an area has been covered the fixed line would be moved up or down stream.



DPV SEARCH

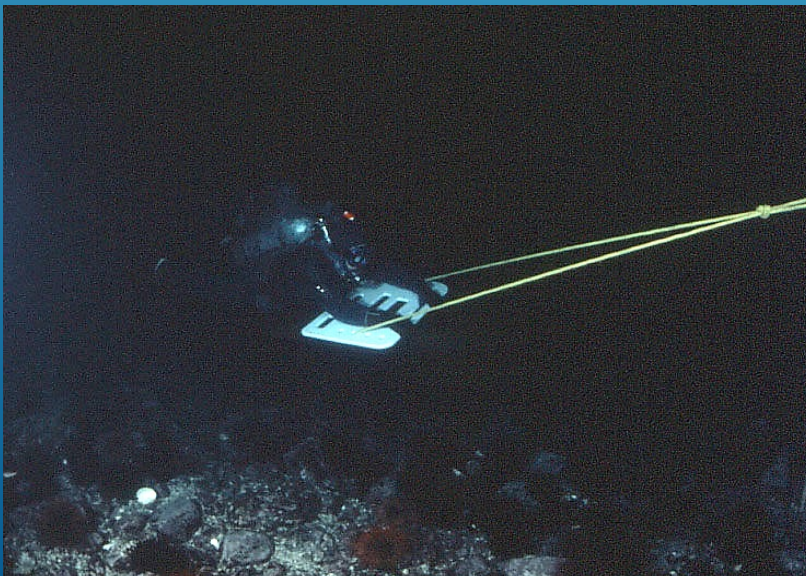
Using **diver propulsion vehicles** (DPVs) can be advantageous when a search must cover a large area, or where strong currents are an issue.

DPV searches are effective in combination with **contour search** methods or along straight transects.

Noting speed, bearing and travel time is very important.



TOWED SEARCH



Towed searches involve towing a diver behind a slow-moving boat.

All navigation – including GPS track recording – is the responsibility of the boat crew. The diver can focus on identifying and marking finds.

Divers can hold onto an underwater sled, controlling depth by simply tilting the board up or down.

Divers can also hold onto a heavy shot line, but this may not be suitable for search areas with depth changes.

A 2nd line can be used for signaling.

A diver is shown underwater, holding a metal detector. The detector has a long shaft and a circular coil at the bottom. The diver is wearing a scuba tank and a mask. The water is a murky green color.

METAL DETECTOR SEARCH

Hand-held metal detectors can be used underwater to detect ferrous and non-ferrous metals using **pulse induction** (PI) or **very-low frequency** (VLF) principles.

There are many low-cost models available.

Typical range is 0.1 – 2 m.

Metal Detectors can be used to:

- verify magnetometer targets
- conduct pre-disturbance surveys
- detect the location of buried objects during excavation work



REMOTE SENSING

Remote sensing techniques allow searches to be conducted from a vessel, or from shore. These types of searches typically involve **expensive equipment**, **trained operators**, or significant **data processing**.

Most underwater remote sensing techniques fall into one or more of these categories:

- ▶ Bottom profiling using reflected sound.
- ▶ Detecting anomalies in the Earth's magnetic field.
- ▶ Remotely operated or autonomous underwater vehicle (ROV or AUV)

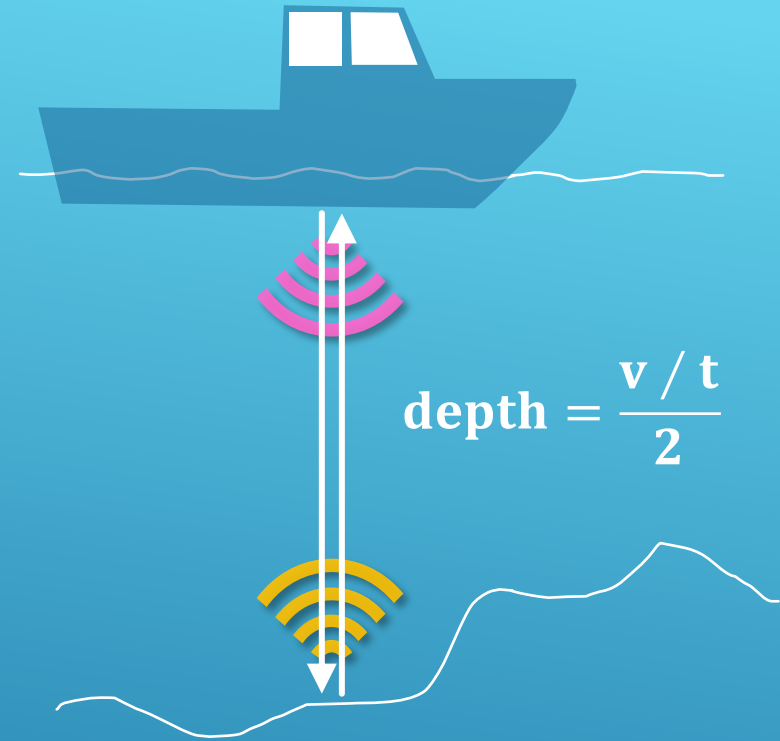
DEPTH SOUNDERS



Depth sounders are used in marine navigation to determine water depth below a vessel. “Fish finders” are a type of sounder which can locate and visualize objects on the bottom or in the water column.

Sounders transmit an acoustic signal or pulse and measures the time in which this sound is returned. The faster the return the shallower the water.

Modern sounders display live data graphically as a profile or 3D image.



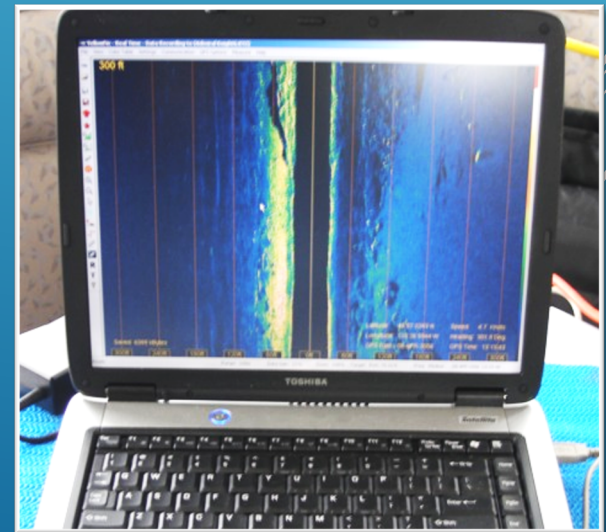
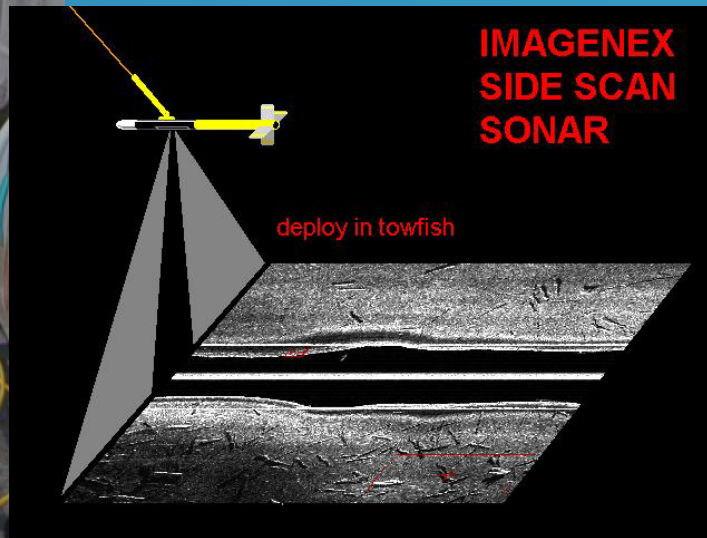
SIDE-SCAN SONAR



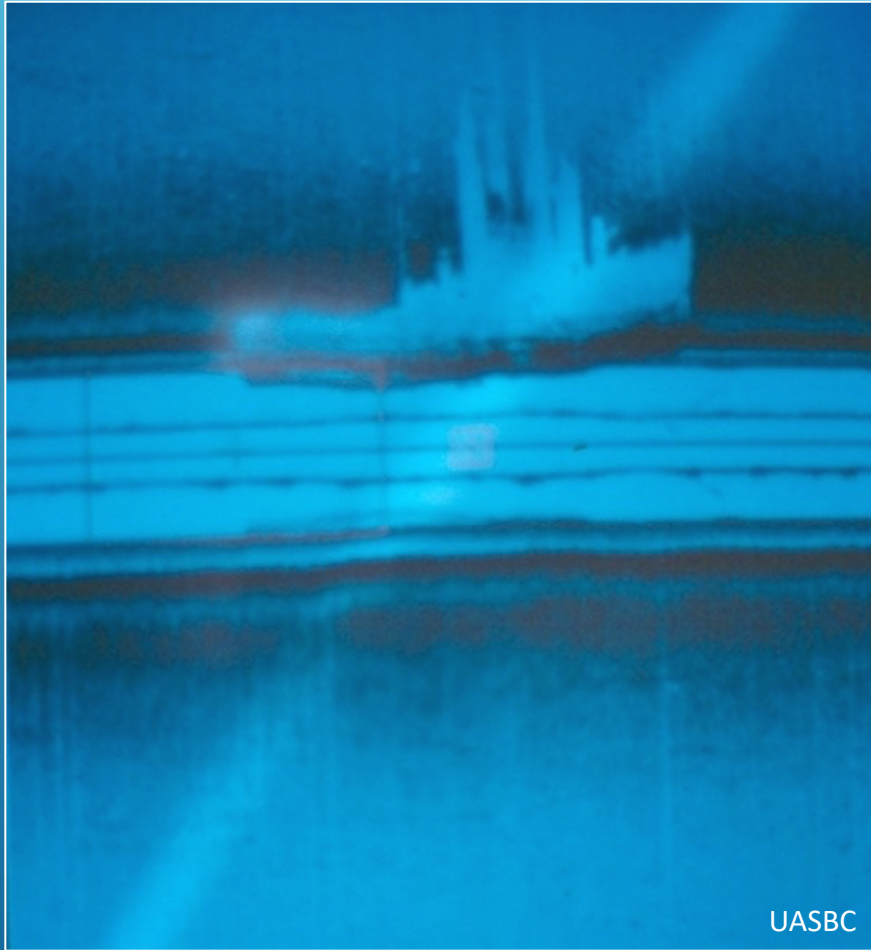
Side-scan sonar uses **fan-shaped pulses of sound** to “paint” a picture of large areas of sea floor.

This method typically uses a **towed sonar array** – or “towfish”.

A shipwreck or large structure will block sound waves creating a **distinctive shadow**.

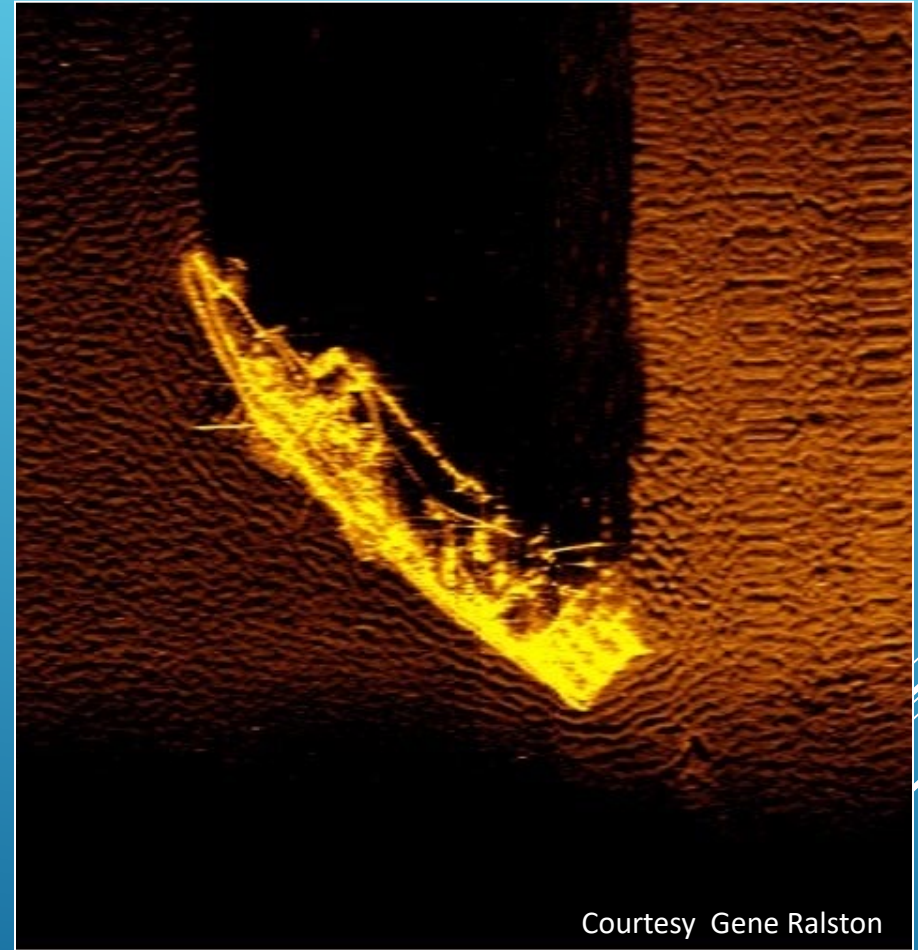


SIDE-SCAN SONAR



HMCS MacKenzie

© UASBC 2021



SS City of Ainsworth

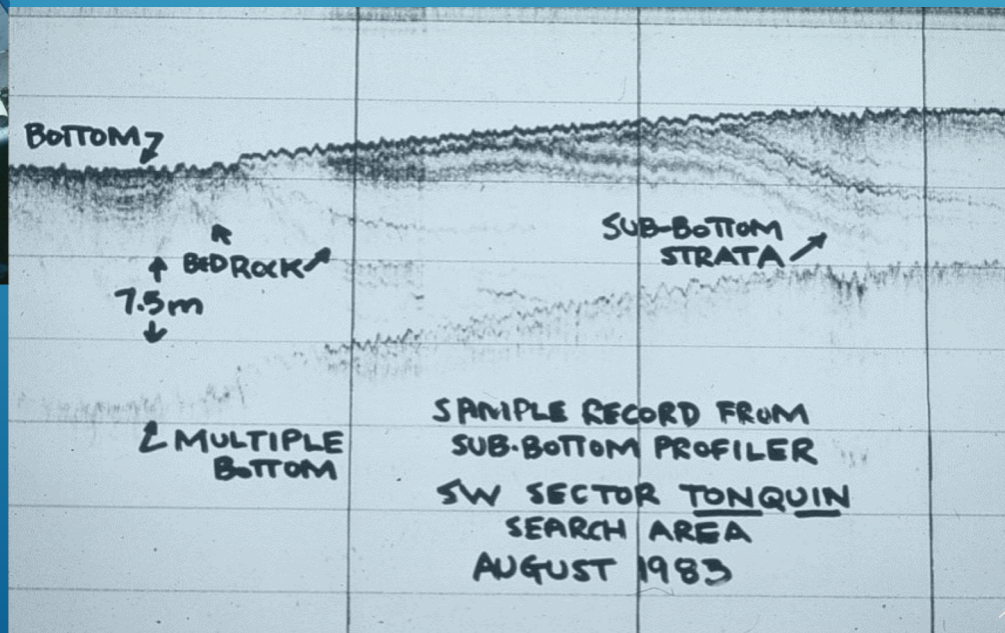
SUB-BOTTOM PROFILER



Uses sound pulses to penetrate the seafloor and make profiles of buried sediments and bedrock.

Sound pulses bounce off layers depending on their impedance (hardness).

Used in underwater archaeology to locate large buried objects.

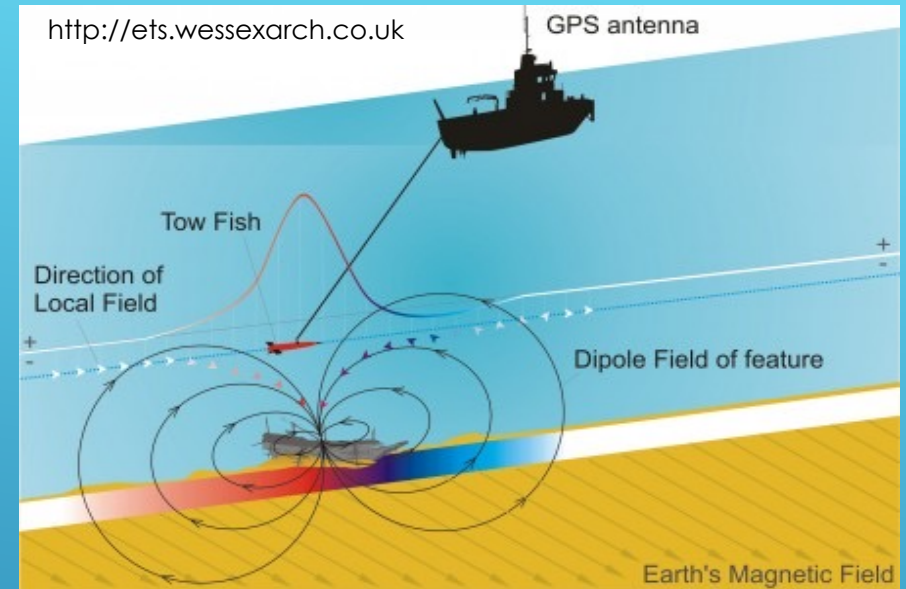
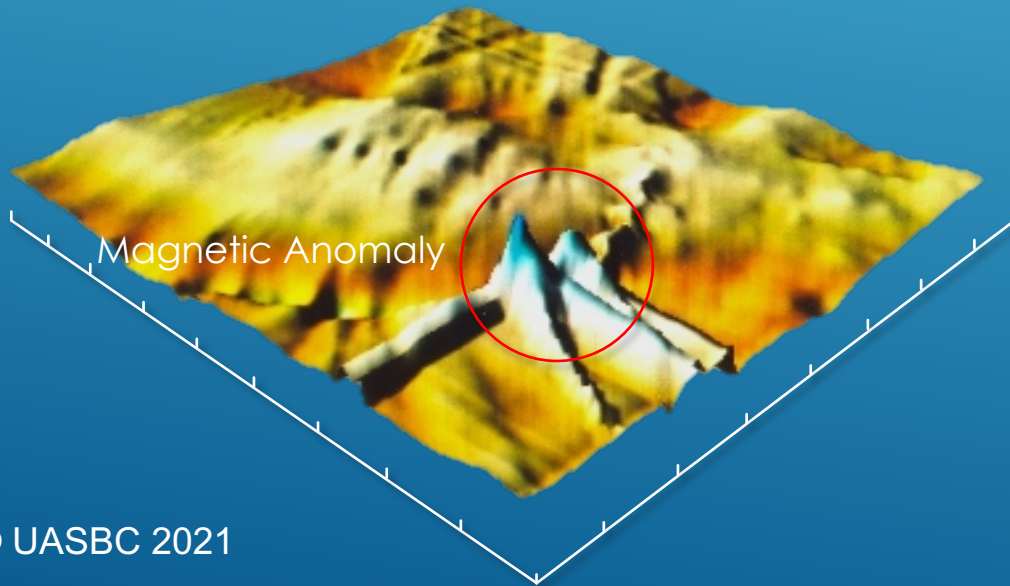


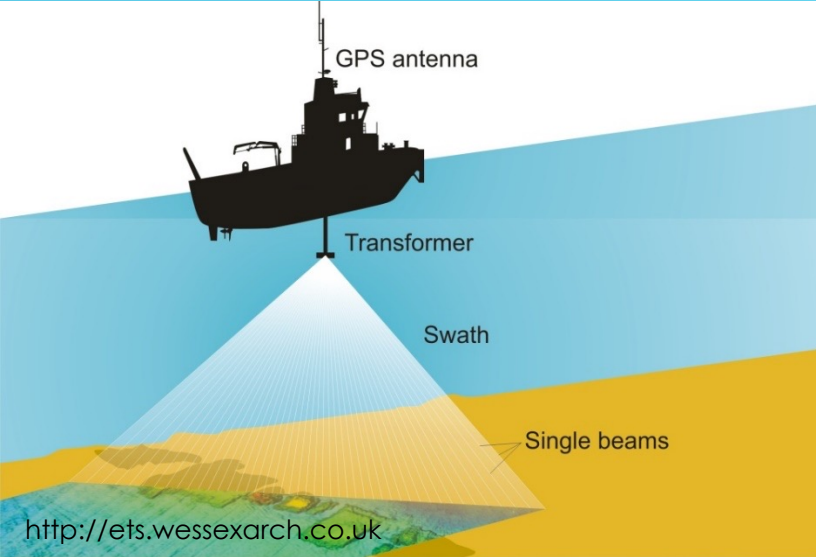
MAGNETOMETER

Magnetometers detect variations in the Earth's magnetic field caused by ferrous materials.

Detector is usually tow-fish mounted, and is towed well behind the towing vessel.

Used to detect iron metal parts in shipwrecks.





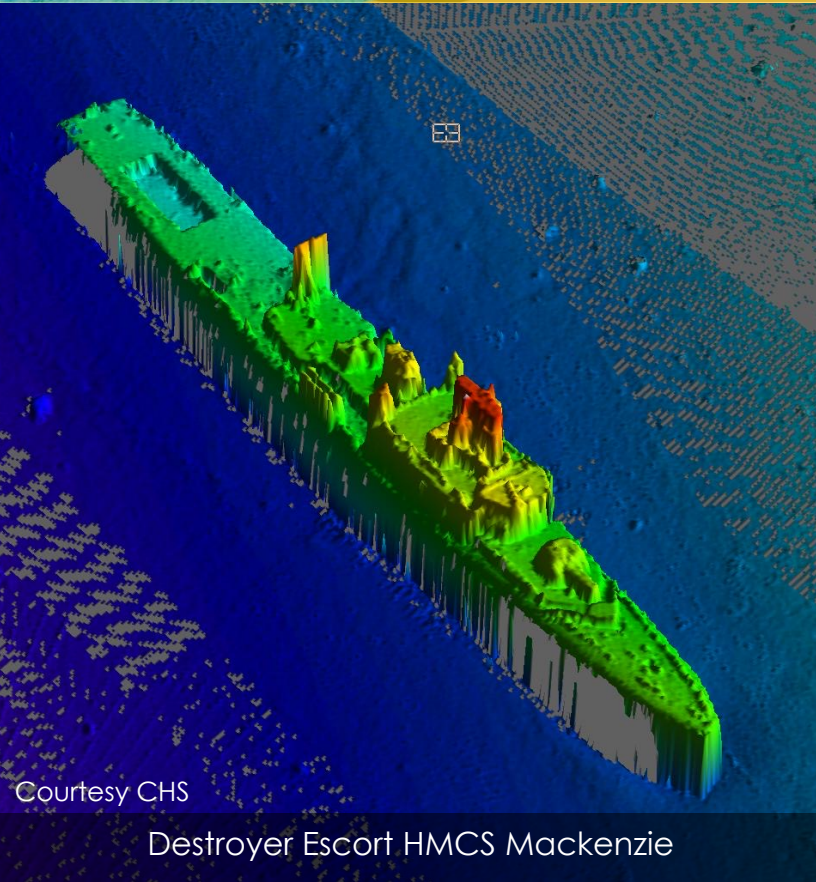
MULTI-BEAM SONAR

Multiple sound pulses are emitted from an array of transducers aimed straight down.

The sound waves are reflected off the bottom and or an obstruction, and three-dimensional positions are recorded.

Paired with a vessel's GPS, multi-beam sonar is useful for very accurate mapping.

High-precision equipment is very expensive.



Courtesy CHS

Destroyer Escort HMCS Mackenzie



REMOTELY OPERATED VEHICLE (ROV)

ROV's are tethered underwater vehicles controlled from the surface.

Can be mounted with a variety of tools including lights, cameras, samplers and manipulator arms.

Can be used to explore deep targets visually.

Require a vessel, skilled operator and power.



AUTONOMOUS UNDERWATER VEHICLE (AUV)



J. Marc Photo

AUV's are an untethered, self-powered vehicle.

Follow pre-programmed survey routes.

Can be mounted with a variety of instruments.

Require less equipment than ROVs, but have a fixed range.

POSITION FIXING

Establishing the location of a site relative to know places and is critical for relocating underwater sites.

There are several methods to record or “fix” the position of a site from the surface. Three methods are covered here:

LINE-OF-SIGHT

TRIANGULATION

GLOBAL
POSITIONING
SYSTEM

LINE-OF-SIGHT

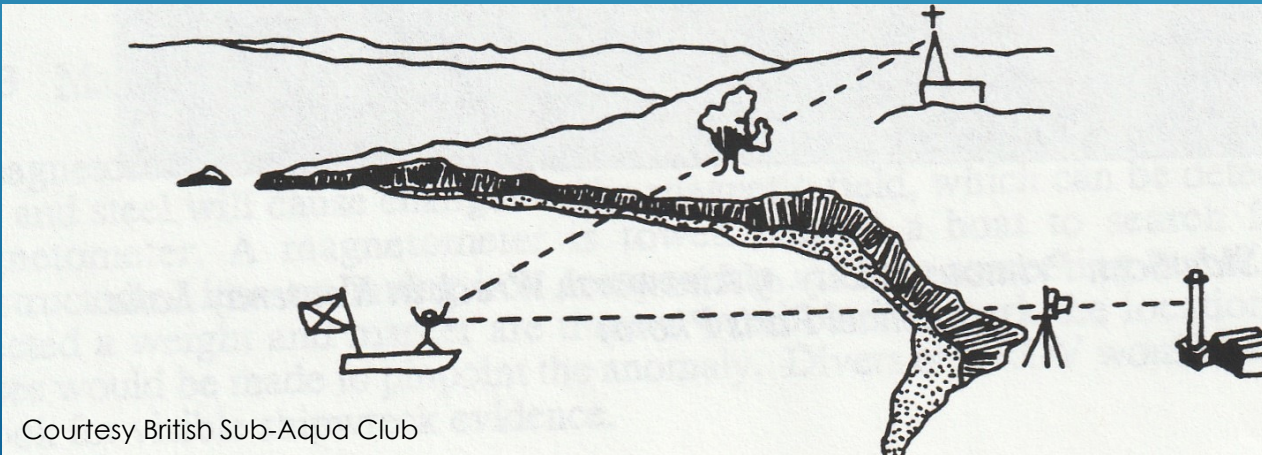
Line-of-sight fixes are established from a vessel anchored above an underwater site.

Look for permanent natural or man-made objects which align with each other.

- ▶ Tall buildings (churches, lighthouses)
- ▶ Prominent landforms (hills or mountains)
- ▶ Other permanent structures (bridges, breakwaters, quarries)

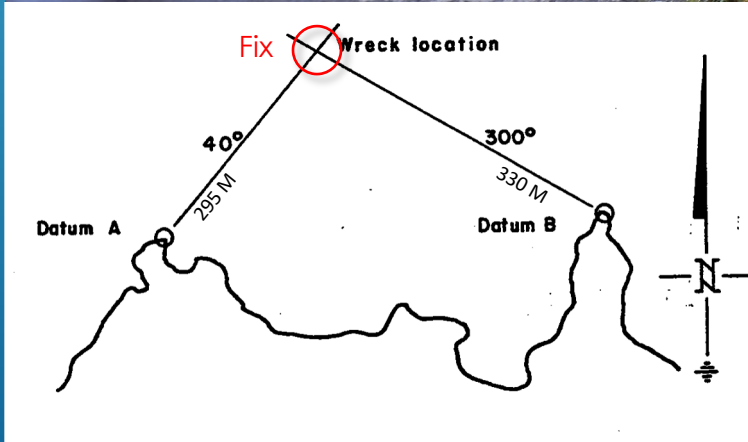
Describe the aligned objects. Ideally, objects appear on existing maps or charts.

Two lines-of-sight (transits) minimum; additional transits increase the accuracy of the fix.



Courtesy British Sub-Aqua Club

TRIANGULATION FROM SHORE



Triangulation can be used where there are few aligned landmarks.

Two shore stations (datums) are established on features of **known position**.

A survey transit with an electronic distance measurer is used to take a bearing and distance to the wreck from each location.

Accurate measurements from fixed locations are critical.

These measurements can be plotted to establish a fix i.e. the wreck location.

GLOBAL POSITIONING SYSTEM (GPS)

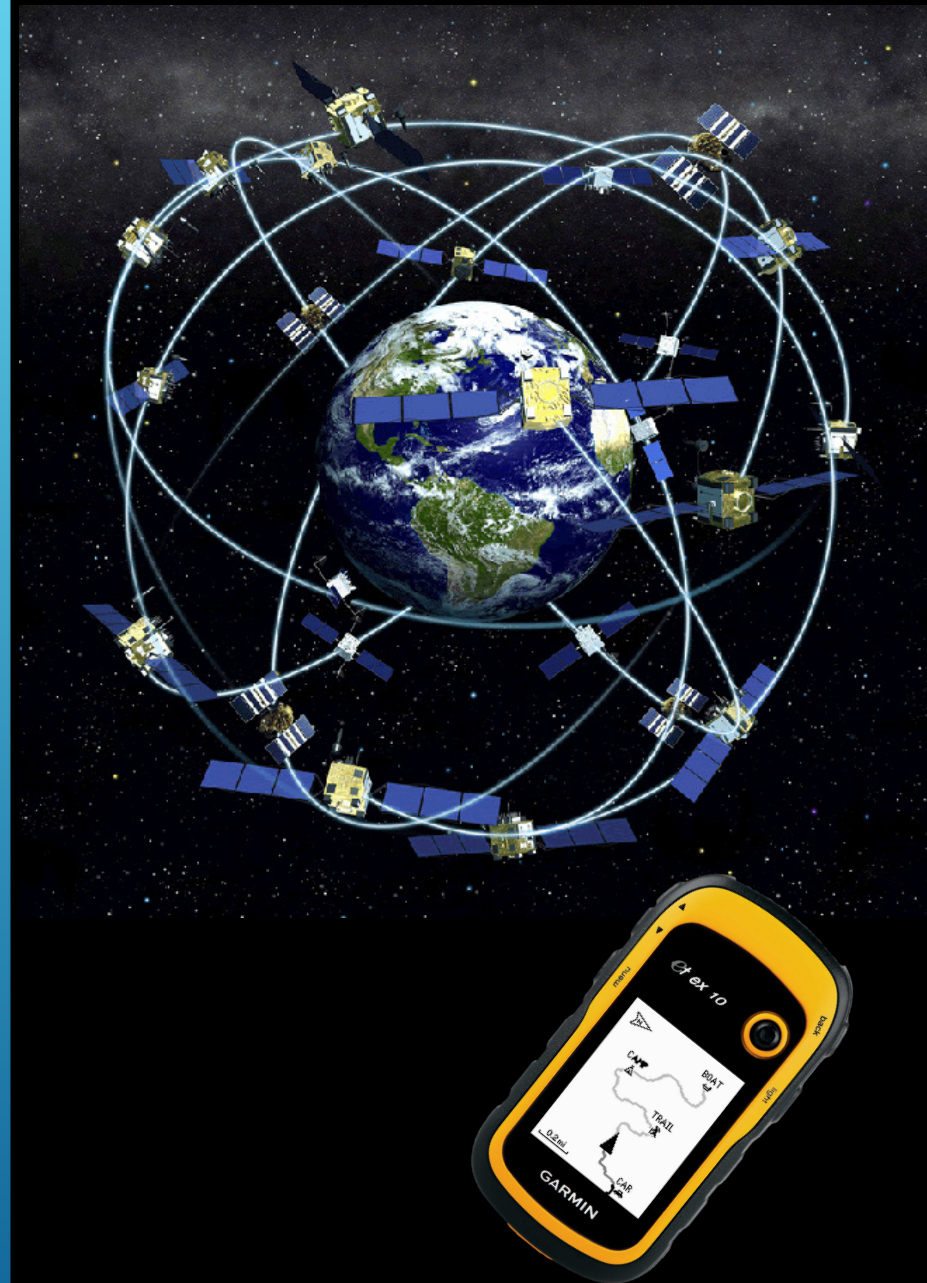
The most common (and easiest) method of determining a position is to use a GPS receiver.

Based on a constellation of 30+ satellites operated by the US Government. A GPS receiver listens for signals from these satellites.

The GPS receiver obtains a position fix once it locks on to 4 or more satellite signals.

Hand-held receivers include most smart-phones (3 m accuracy).

Vessel-mounted DGPS or survey-grade RTK-GPS can record <1 cm accuracy points.



END

QUIZ

1. What are the two main search techniques?

☐ Visual

☐ Remote Sensing

☐ Diver

☐ Side Scan

2. Which search technique(s) uses a fixed line?

☐ Contour

☐ Circle

☐ Jackstay

☐ Pendulum

3. Which remote sensing technique creates a shadow?

- ☐ Depth Sounder
- ☒ Side Scan Sonar
- ☐ Sub Bottom Profiler
- ☐ Multibeam Sonar

4. Which remote sensing tool penetrates the bottom strata?

- ☐ Depth Sounder
- ☐ Side Scan Sonar
- ☒ Sub Bottom Profiler
- ☐ Multibeam Sonar

5. A line of Sight fix does not require any equipment?

☒ True ☐ False

6. How many satellites does GPS need to create a fix?

☐ One

☒ Four

☐ Two

☐ Six

https://en.wikipedia.org/wiki/Underwater_sea_arches#Search_by_underwater_vehicles

<https://ets.wessexarch.co.uk/teachers/physics/nggallery/physics/how-do-we-map-the-seafloor>