The Use of Underwater Robotic & Sonar Technology for Drowning Victim Recovery

Presented by

Tom Wrasse

Underwater Warden

Introduction

- **Tom Wrasse – Underwater Warden**
  - Certified VideoRay Instructor, Pilot and Consultant
  - 30 years experience in law enforcement with the Wisconsin Department of Natural Resources
  - VideoRay end user

Objectives

- Drowning Statistics
- ROV background
  - Classification types
  - Applications
  - Accessories
- Searches
  - Basics
  - Tactics
- Recoveries
- Training
- Case study information

Statistically Speaking

- Worldwide[1] - estimates
  - 1063 unintentional drowning/day ~390,000/yr
  - Ranks 3rd for causes of unintentional deaths
  - 96% occur in low – middle income countries
  - The highest rates are found in the regions of Africa, China and India

Statistically Speaking

- United States
  - 10 drowning/day[2], ~3650/yr
  - Ranks 5th for causes of unintentional deaths[2]
  - 1 in 5 or 20% are less than 14 years of age[3]
  - 80% are male[3]
  - $273 million (USD) in associated costs[1]

Statistically Speaking

- Canada
  - 1.3 drowning/day[9], ~467/yr
  - Ranks 4th for causes of unintentional deaths[9]
  - 15% are less than 14 years of age[9]
  - 83% are male[9]
  - $173 million (USD) in associated costs[1]

Statistically Speaking

- Australia
  - .78 drowning/day[7], ~285/yr
  - $85.5 million (USD) in associated costs[1]
  - 77% are male[7]
  - 16% are 14 years of age or less[7]

Statistically Speaking

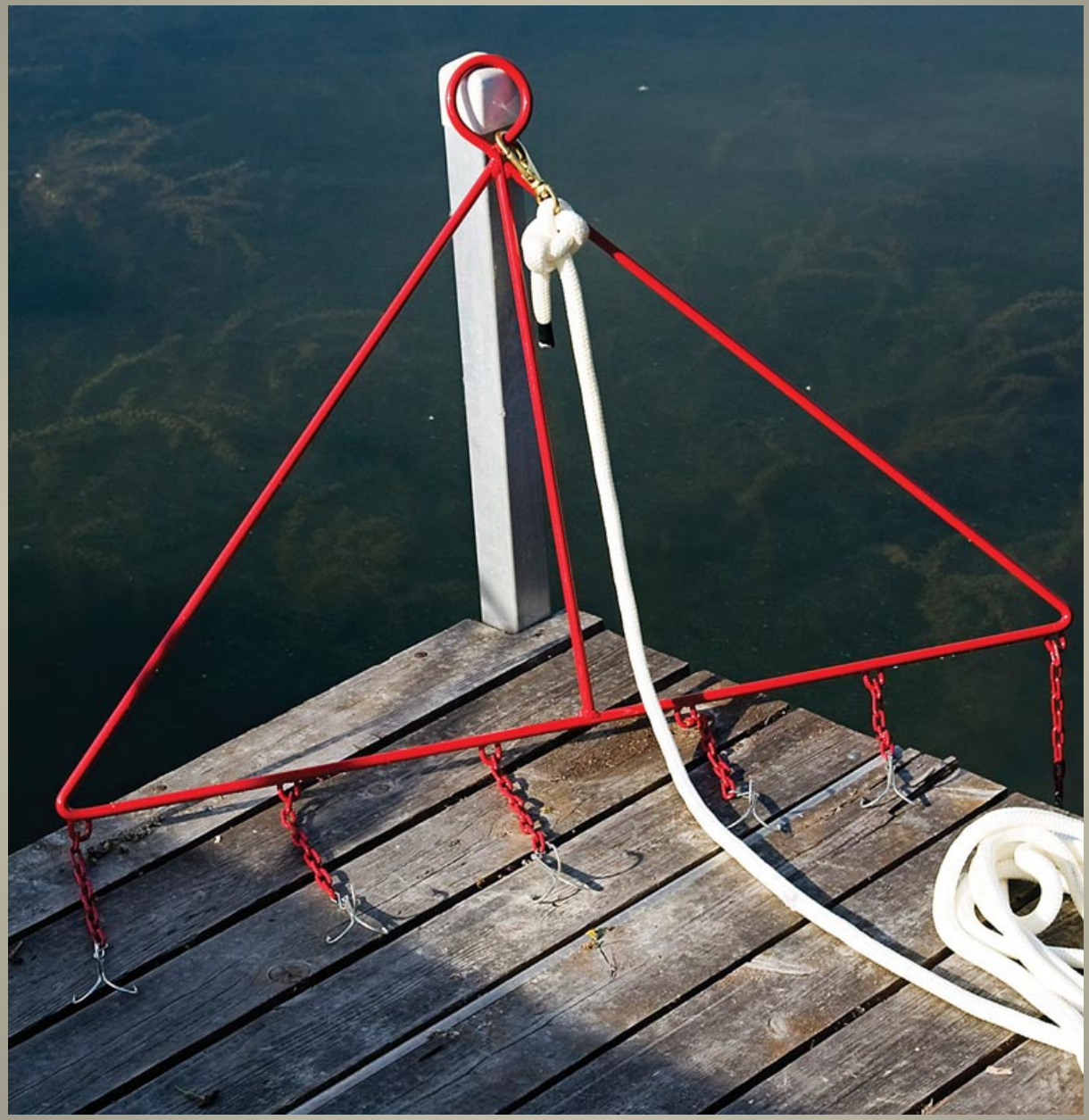
- United Kingdom[8]
  - 1.9 drowning/day, ~700/yr
  - 68% are male
  - 10% are 15 years of age or less

Risk Factors to Natural Water Drowning

- Swimming ability
- Failure to wear life jackets – 88% of those that drown related to a boating accident did not wear a life jacket [4,5]
- Alcohol use – 70% of water related accidents involve alcohol[3,4,6]

Cold Water Drowning

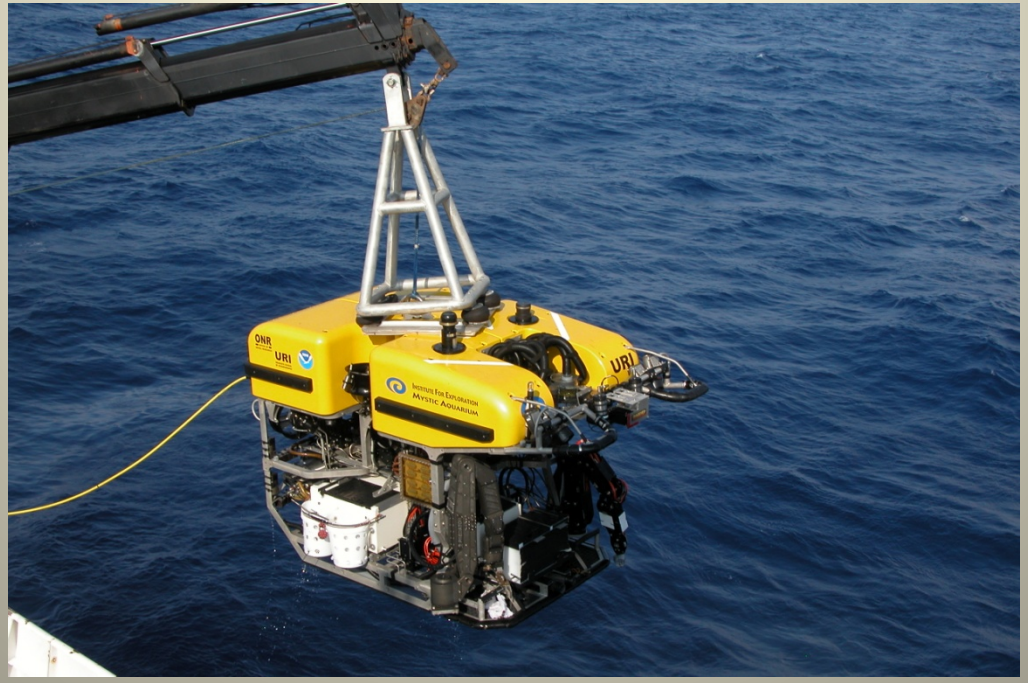
- <58 F/14C
- 90 minutes
- Mammalian diving reflex
  - Shut down in order
  - Begins when the face hits the water



Remotely Operated Vehicles (ROV)

Classifications:

- Work Class – large vehicles, heavy payload capability, multi-person crews



Remotely Operated Vehicles (ROV)

Classifications:

- Observation Class – small suitcase sized, lightweight, portable, easily deployed by one person

Photo: Mr. Msanobu Shibuya

Remotely Operated Vehicles (ROV)

Classifications:

- Special Use – built for a specific task, not very common due to high associated costs

Remotely Operated Vehicles (ROV)

Observation Class – further defined

- Micro - very small, “hobby” type, primarily a swimming eyeball used for inspections, shallow depths
- Mini – small, equipped with camera, lights, manipulator and sensors

Remotely Operated Vehicles (ROV)

Applications:

- Inspection
- Observation
- Documentation
- Recovery
- Sensory Platform

Remotely Operated Vehicles (ROV)

Application Fields (to name just a few):

- Aquaculture
- Law Enforcement
- Offshore Oil and Gas
- Military
- Science and Research
- Potable Water Supply
- Infrastructure

Accessories to the mini-ROV

Video

- Front high resolution color camera with tilt, rear/external black and white
- HD is available with some modifications
- Has snapshot capability
- Video enhancements

Accessories to the mini-ROV

Lights

- LED’s
- Video quality is improved where the lights are mounted separate of the camera
- Provide excellent dimming capability

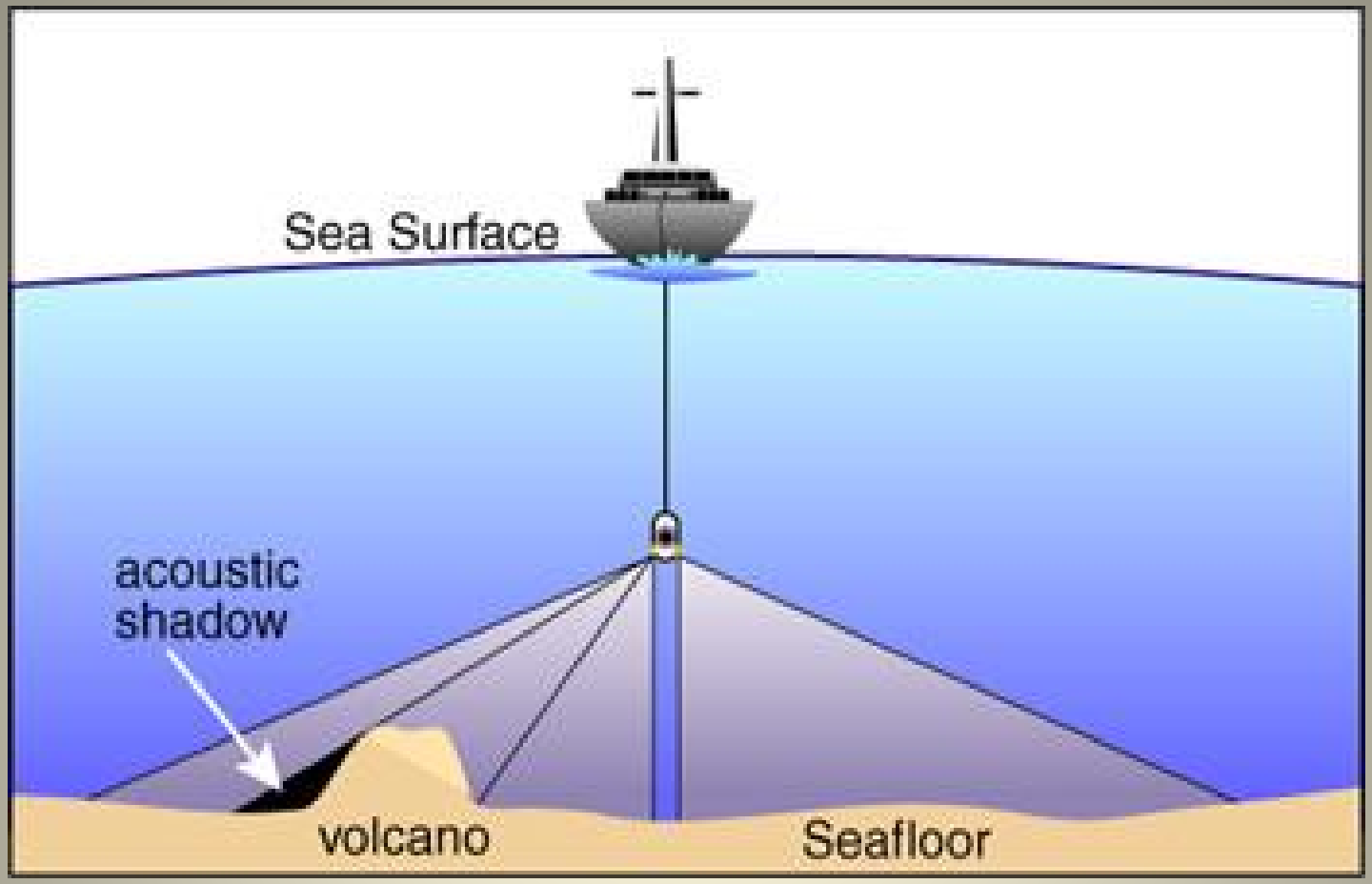
Accessories to complement the mini-ROV

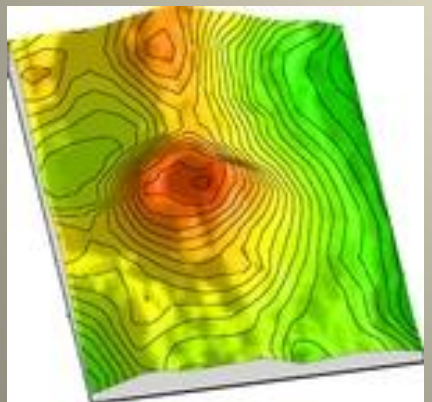
Sonar

- Ability to “see” beyond the video
- Frequencies dictate the end result
- Practice required to interpret images

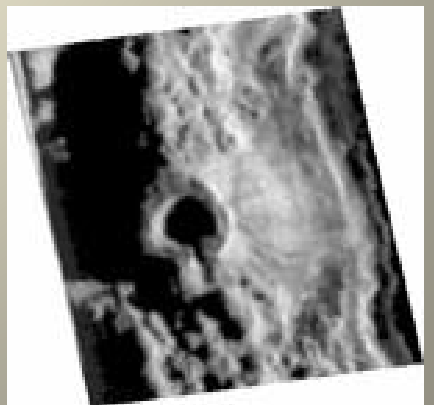
Sonar Types

- Side Scan
  - Towed
  - Hull mounted
  - GPS capabilities





Side scan



Accessories to the mini-ROV

Sonar Types

- Mechanical Scanning
  - ROV mounted
  - Fixed mounted

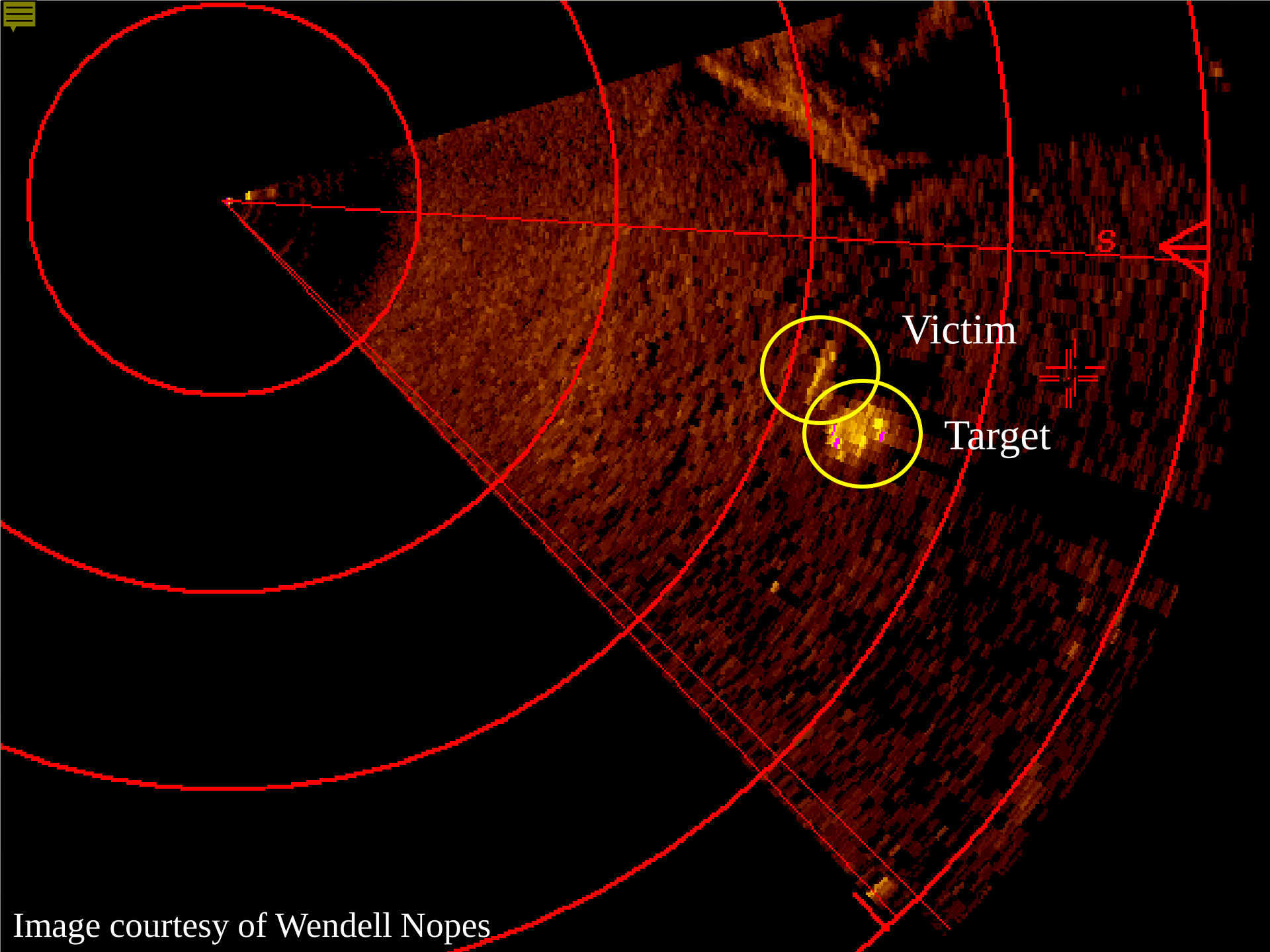
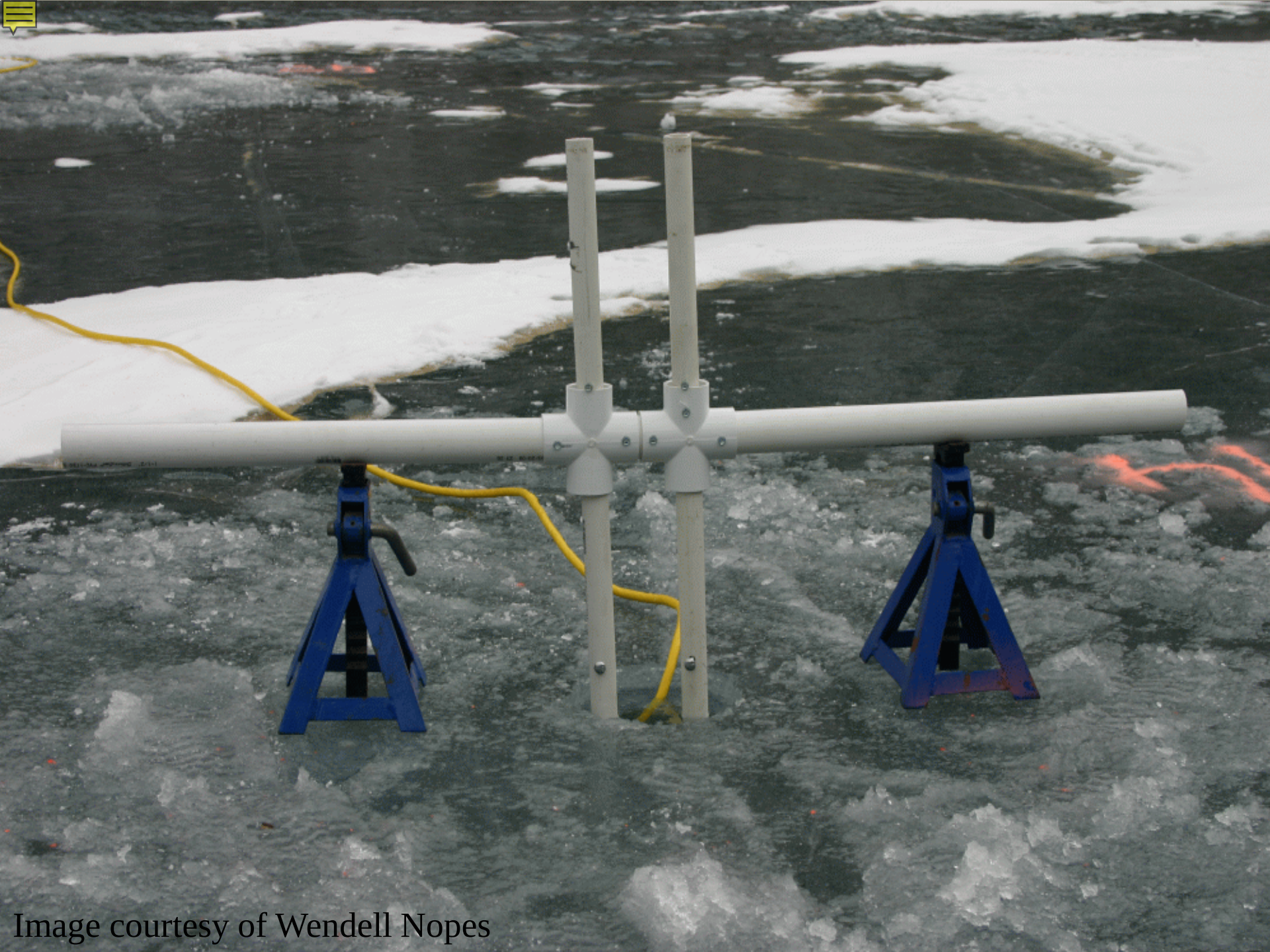


Image courtesy of Wendell Nopes



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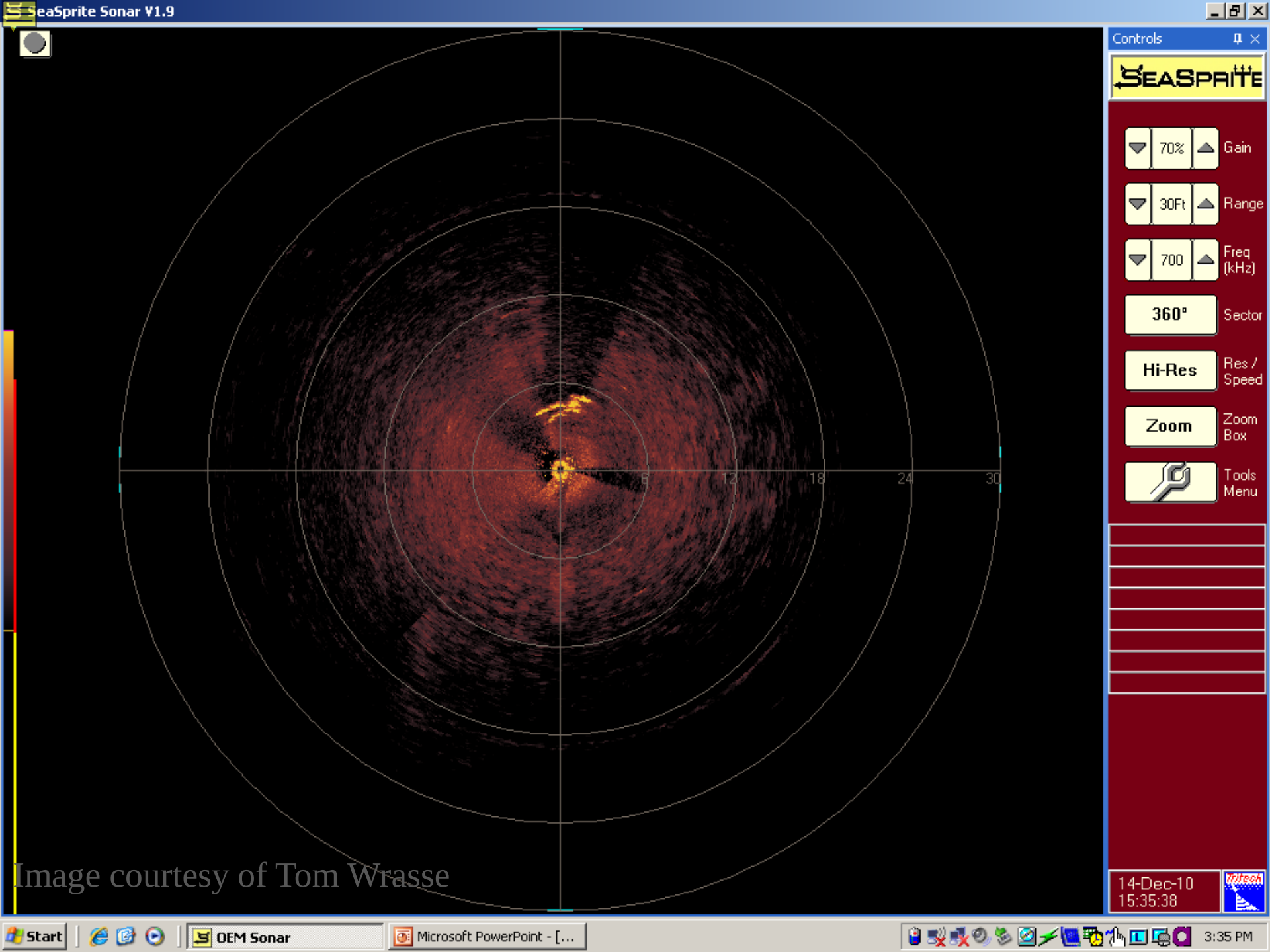
SeaSprite Sonar V1.9
Controls
SeaSprite
70%
Gain
30Ft
Range
700
Freq (kHz)
360°
Sector
Hi-Res
Res / Speed
Zoom
Zoom Box
Tools Menu
6
12
18
24
30
Image courtesy of Tom Wrasse
14-Dec-10
15:35:38
Start
OEM Sonar
Microsoft PowerPoint - [...
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Image courtesy
of Tom Wrasse
D:006.9FT
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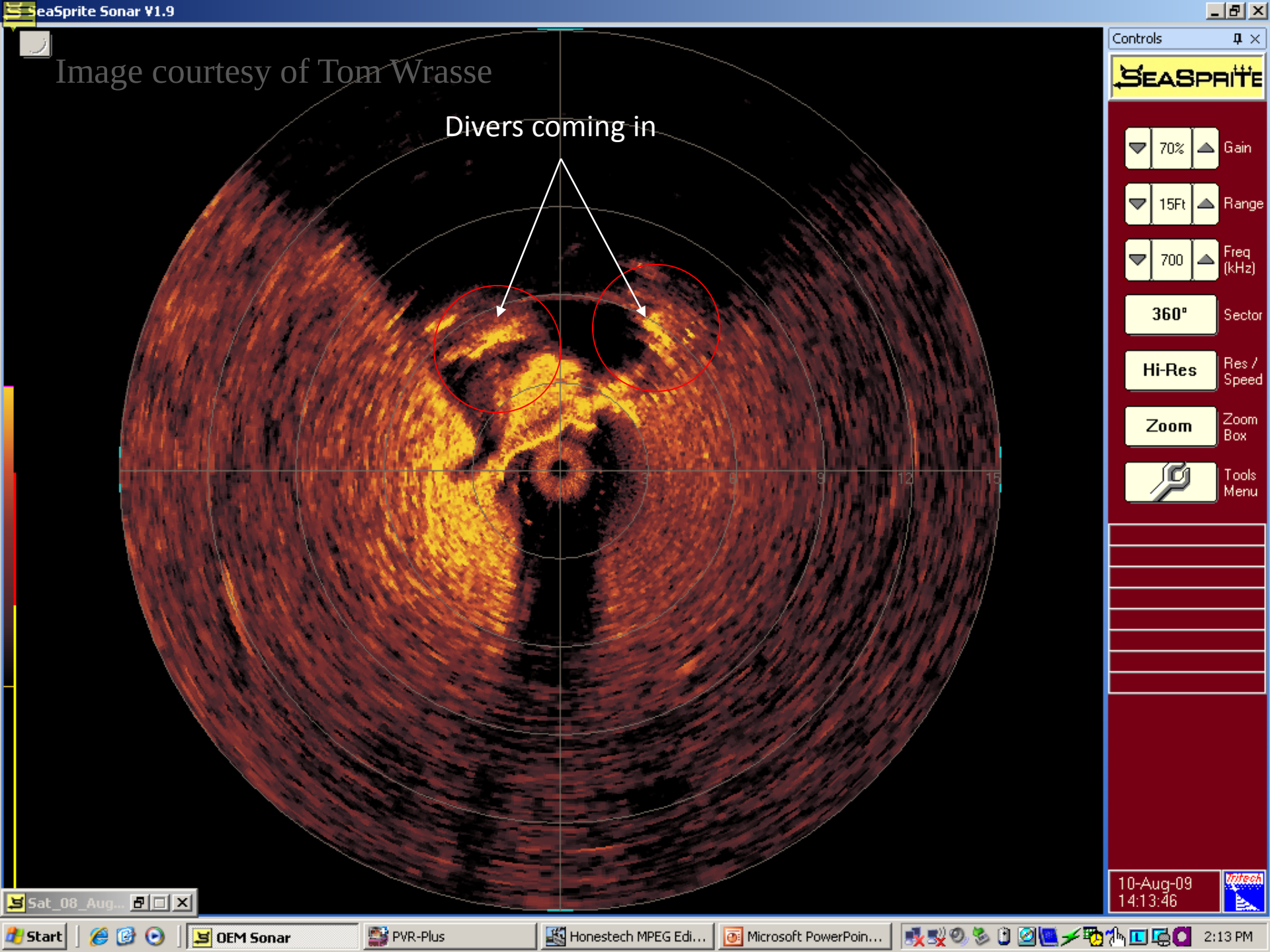
SeaSprite Sonar V1.9
Image courtesy of Tom Wrasse
Divers coming in
Controls
SeaSprite
70%
Gain
15Ft
Range
700
Freq (kHz)
360°
Sector
Hi-Res
Res / Speed
Zoom
Zoom Box
Tools Menu
10-Aug-09
14:13:46
Sat_08_Aug...
Start
OEM Sonar
PVR-Plus
Honestech MPEG Edi...
Microsoft PowerPoin...
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Accessories to the mini-ROV

Sonar Types

- Multi-beam Scanning
  - ROV mounted
  - Fixed mounted

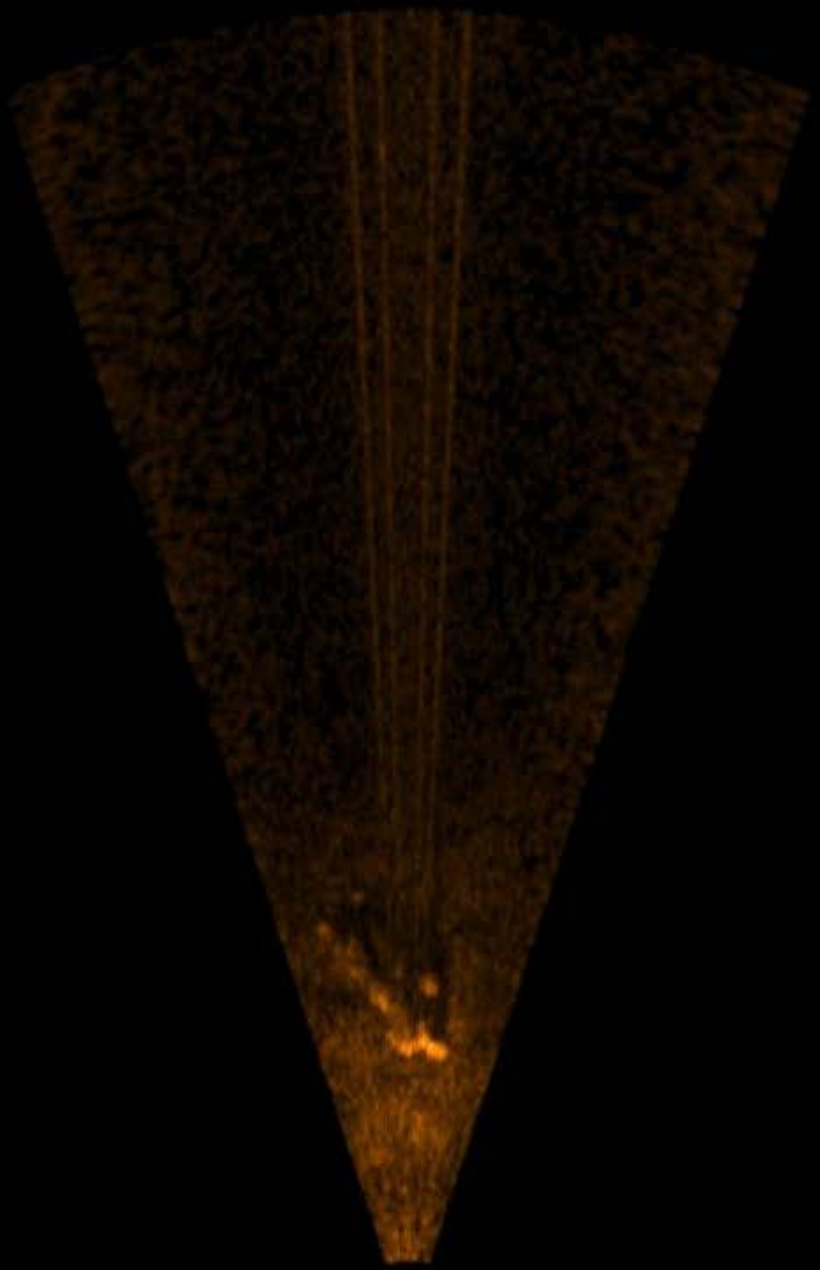


Image courtesy of Craig Thorngren – Submerged Recovery and Inspection Services

BlueView®
TECHNOLOGIES

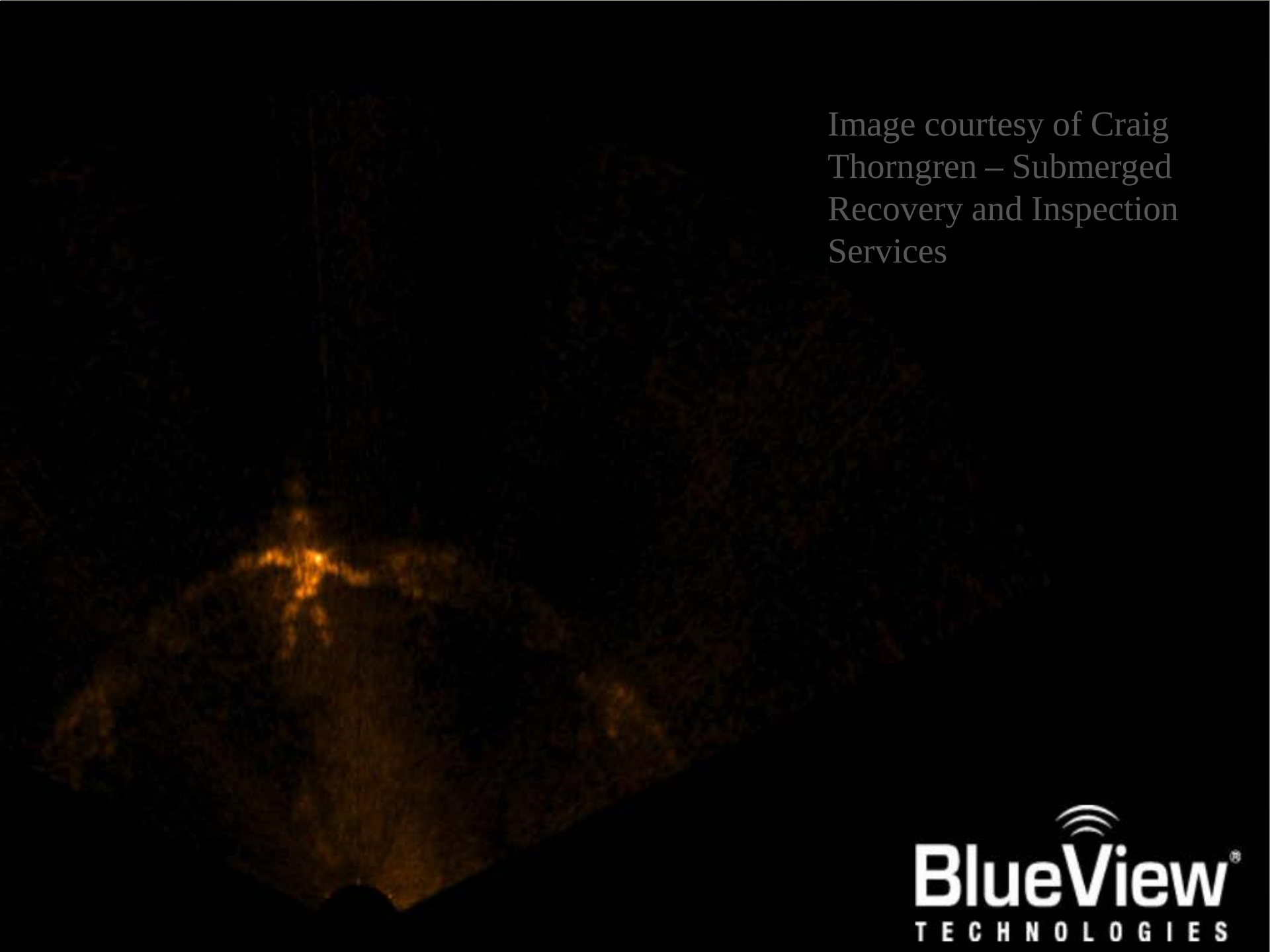


Image courtesy of Craig Thorngren – Submerged Recovery and Inspection Services

BlueView®
TECHNOLOGIES

Accessories to the mini-ROV

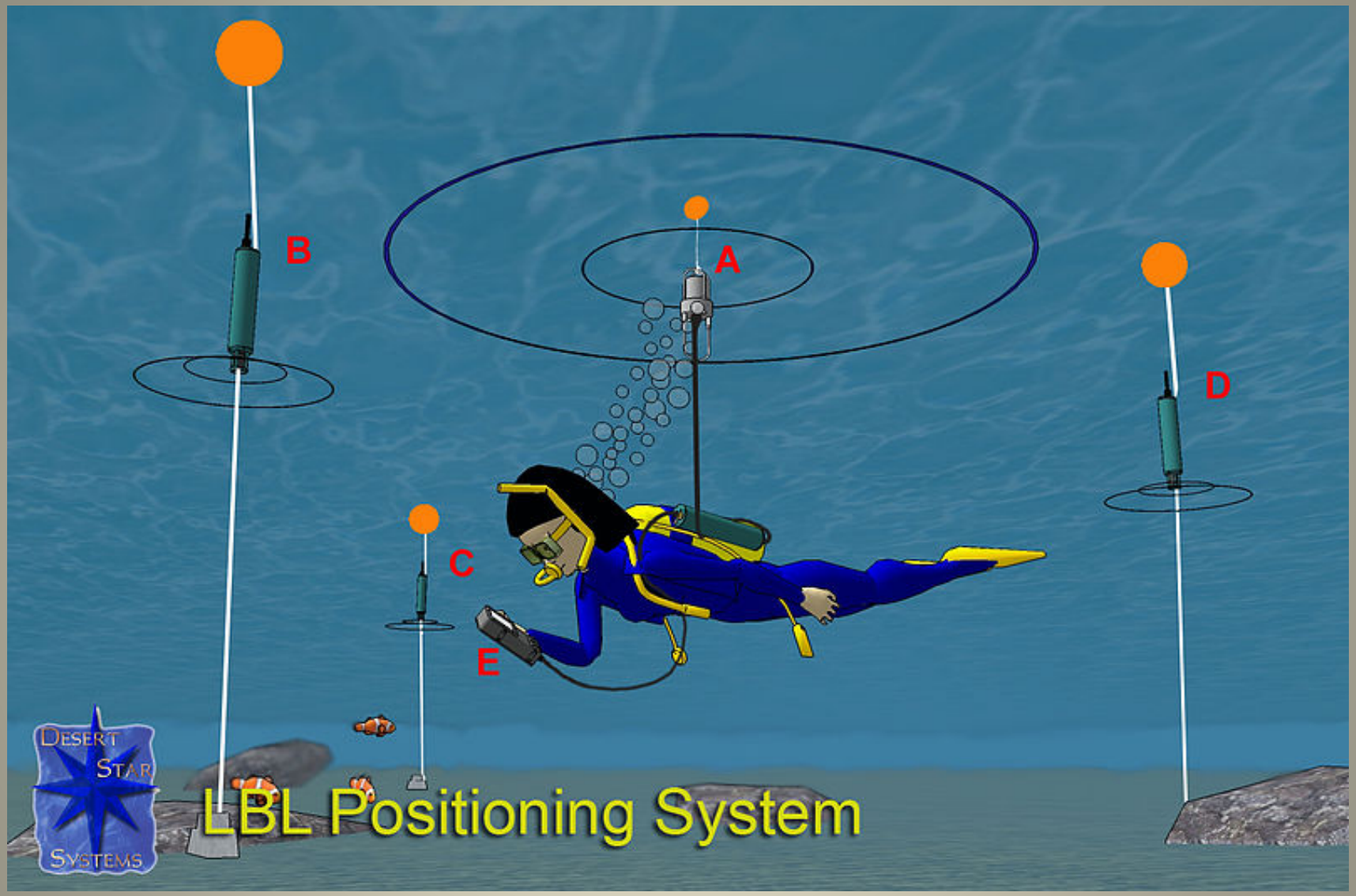
Manipulators

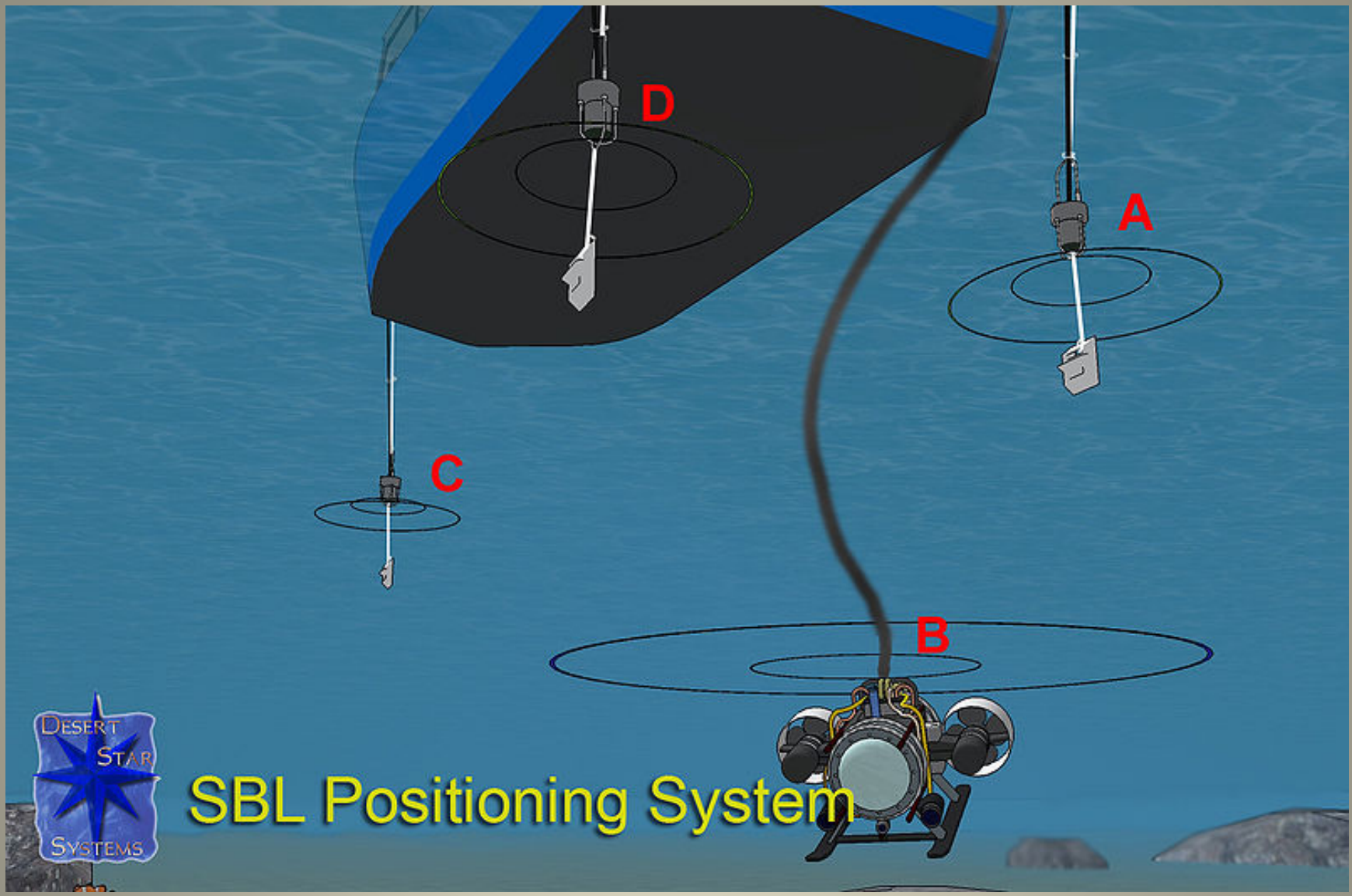
- There is a wide range of manipulators available for most ROV's
- Typically single function
- Attachments for cutting heads
- Used in rescues/recoveries

Accessories to the mini-ROV

Tracking/Navigation Systems

- Acoustic – interprets sound pulses through pingers, transponders and responders
  - Long Baseline - LBL
  - Short Baseline - SBL
  - Ultra Short Baseline - USBL


B
A
D
C
E
Desert Star Systems
LBL Positioning System


D
A
C
B
DESERT
STAR
SYSTEMS
SBL Positioning System

Accessories to the mini-ROV

Tracking/Navigation Systems

- Non-acoustic
  - Tether based – uses a series of sensor embedded nodes
    - Acceleration - distance
    - Magnetics - direction
    - Rate-gyro – position
  - Provides position history
  - GPS enabled

Searches

Where to begin

- **<u>Point Last Seen</u>** – interviewing as many “witnesses” as possible
  - Triangulate
  - Mark the spot
  - Eliminate sectors
- Gather all the facts prior to entering the water

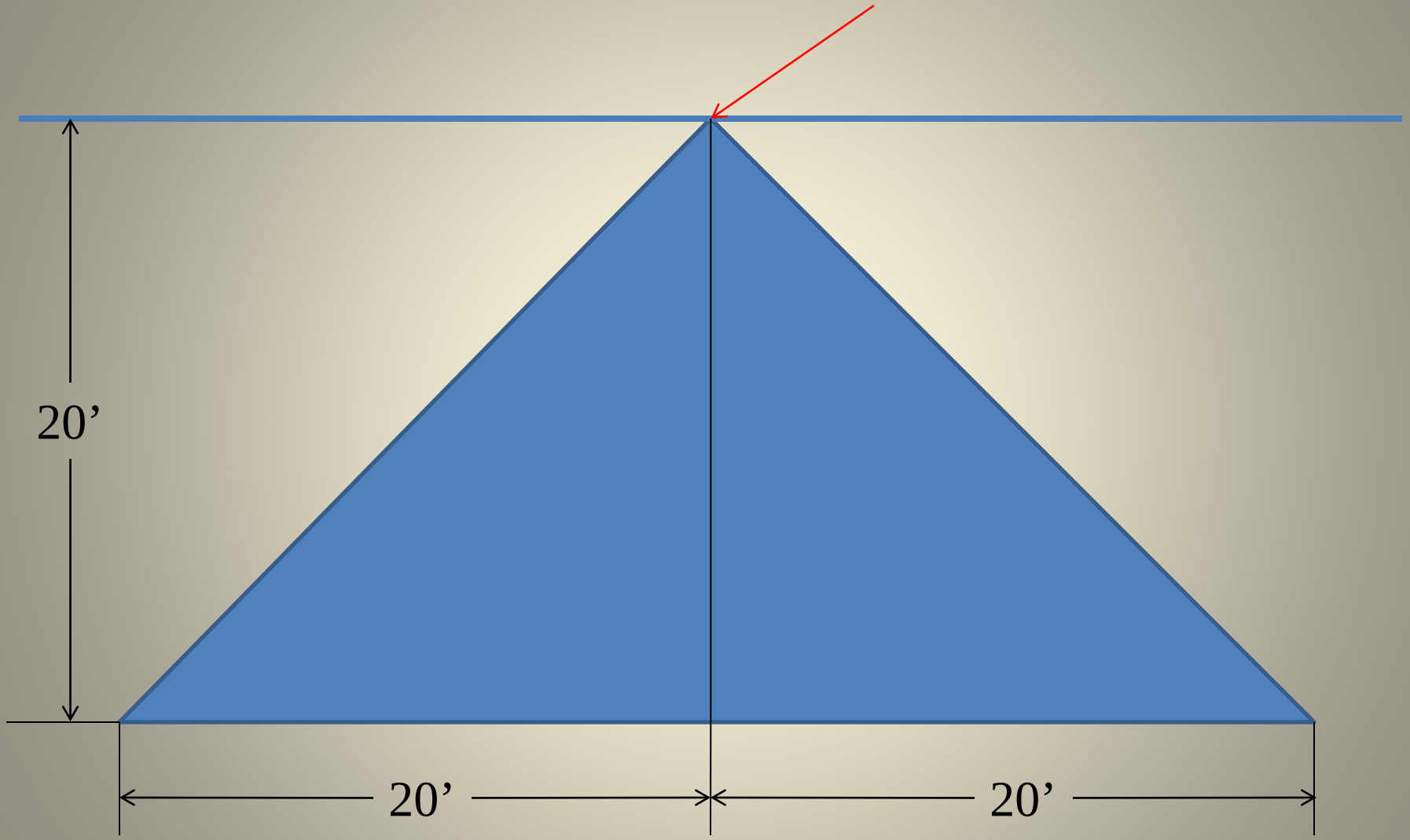
Searches

Where to begin

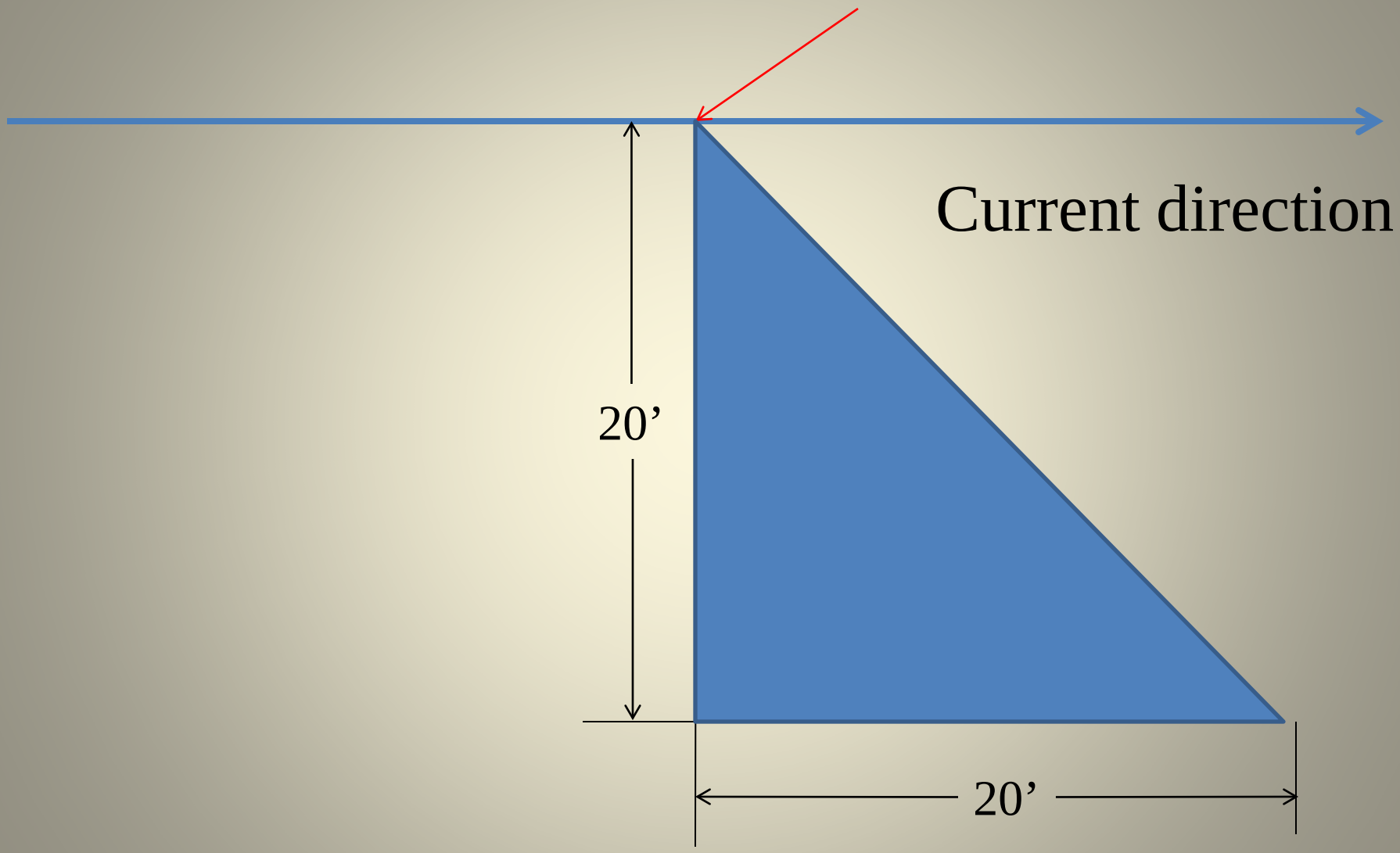
- What area to search
  - Wind, current, tide, water depth
  - Victim descent
    - Without current
    - With current
- Bayesian Search Theory[10] – concept of evidential probability through mathematics
  - Measurable, mapable, obtainable

Without current

Point Last Seen



With current



Searches

Where to begin

- Method to search
  - Apply the tools right for the job
  - Adjust the job to the tools available
  - Side Scan – large area coverage
  - Scanning – mid range coverage
  - Tracking/navigation system – ensures complete coverage
  - ROV w/video and sonar – small search areas and target truthing
  - Targets need to be marked

Searches

Search tactics

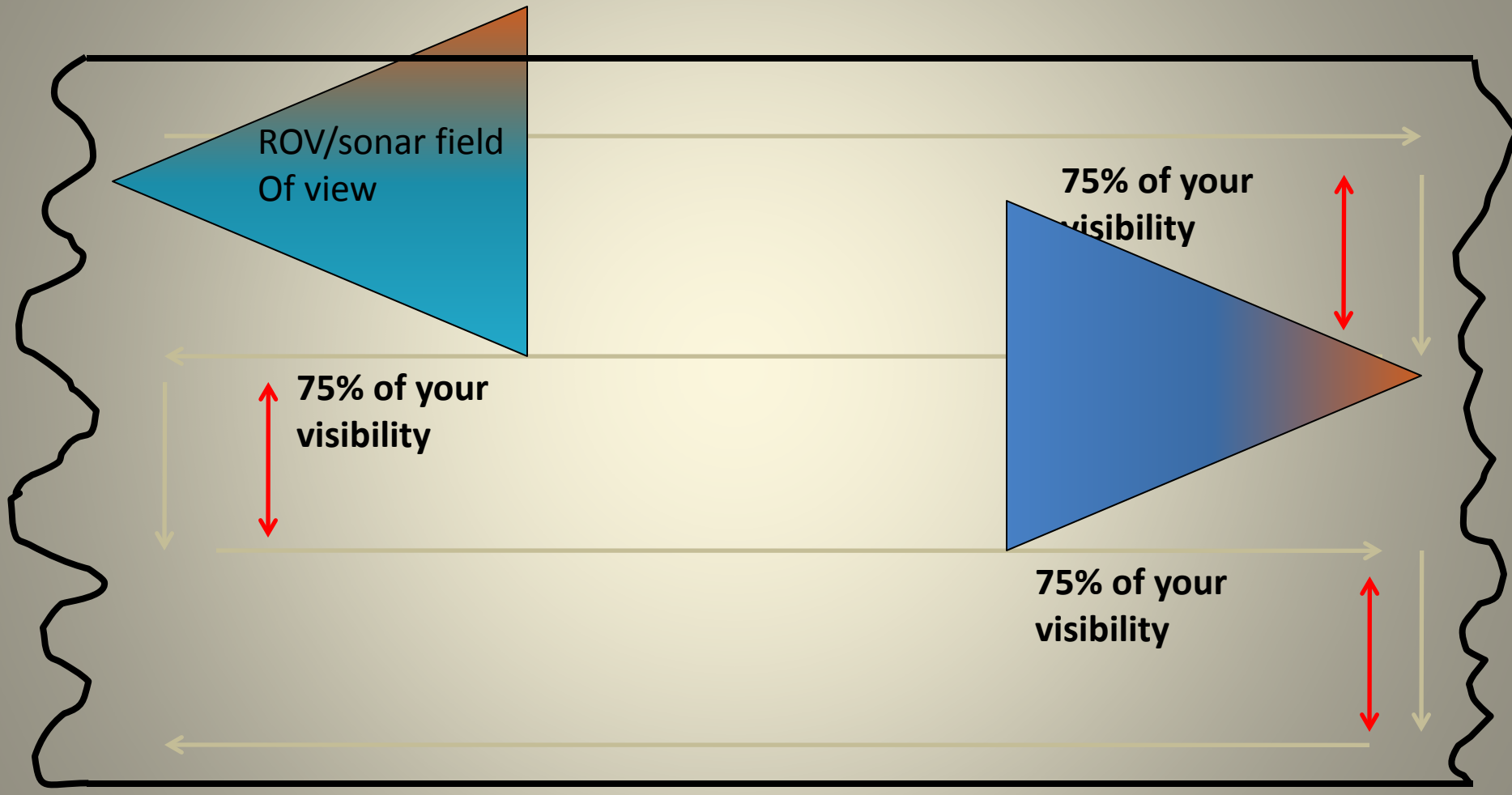
- Search Area
  - Divided into smaller sections
  - Primary – secondary sections
  - Documentation – systematic coverage identifying sections completed and those yet to be

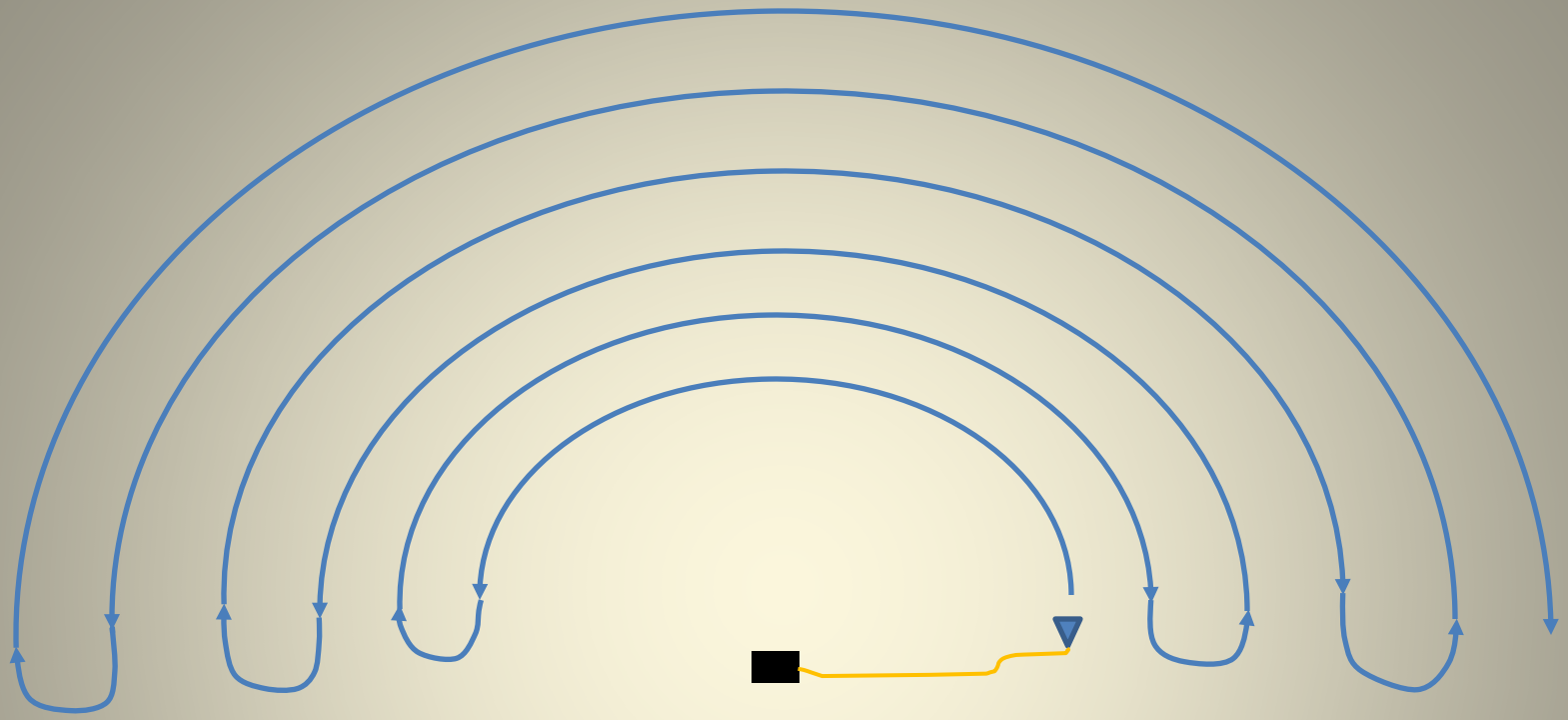
Searches

Search tactics

- Search Patterns
  - Overlap field of view - ~75%
  - Parallel tracks – back and forth
  - Fan/arc – a series of concentric arcs
  - Circle – a series of concentric circles

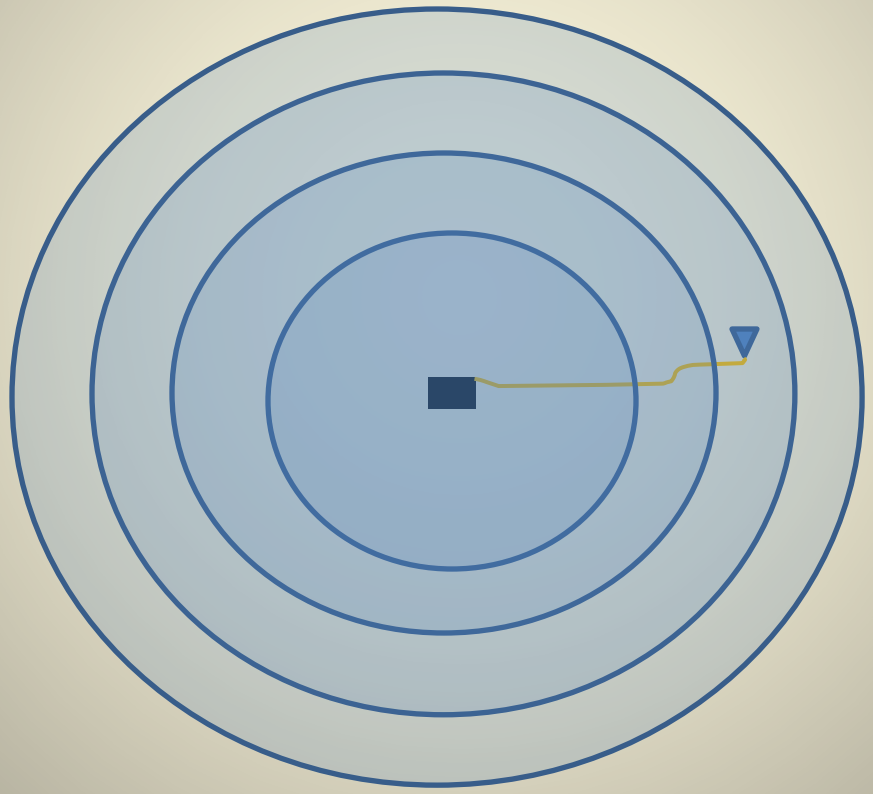
Parallel Track Pattern





Fan/arc Pattern

Circle Pattern



Operations

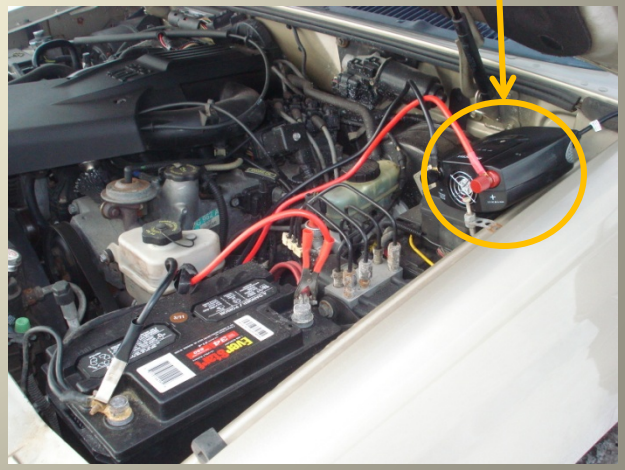
Wall outlet

Shore based

Vessel

Power Source

Inverter



Generator

Searches

Search tactics

- Target Marking
  - Buoys – surface markings
  - Acoustic – subsurface markings
    - Active – pingers that broadcast a signal to a tracking system
    - Passive – reflect sonar waves
  - Tracking/navigation – known fixed point that can be duplicated
  - Holding location

Recoveries

Techniques

- Diver descent – following the tether to the target
- Grip and pull – manipulator and tether used to retrieve the target
- Recovery lines
  - Hooking
  - Threading
  - Wrapping

Training

- Vendor
- In-house
- Refreshers

Case Studies

Rescue
Retention Pond
Marina
Helicopter
Royal Netherlands Navy

Numbers

Vendors – only one vendor contacted provided numbers

- VideoRay – 40-50 recoveries made
- Agencies
  - SARbot UK –
  - St Louis County Sheriff Rescue
  - Wisconsin Department of Natural Resources
- Individuals

References

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Acknowledgments

- Wendell Nopes – Utah Department of Public Safety Dive Team
- Tom Crossman – Captain St. Louis County, MN Sheriff's Rescue
- Jeff Conger – SeaBotix, Inc
- Jesse Rodocker – SeaBotix, Inc
- Duncan Winsbury – SARbot UK
- Dave Phillips – Undersheriff St. Louis County, MN Sheriff Department
- Steve Van Meter – Van Meter Consulting
- Craig Thorngren – Submerged Recovery and Inspection Services
- Victor Smith – Mobile, Al Police Department
- Ian MacDonald – Buccaneer Ltd, UK
- Tom Glebas – VideoRay LLC
- Grampian Police Department, UK
- United States Park Service
- Brian Luzzi – VideoRay LLC