Annotating Video Acquired from a Benthic Sled Towed over Ocean Dredged Material Disposal Sites

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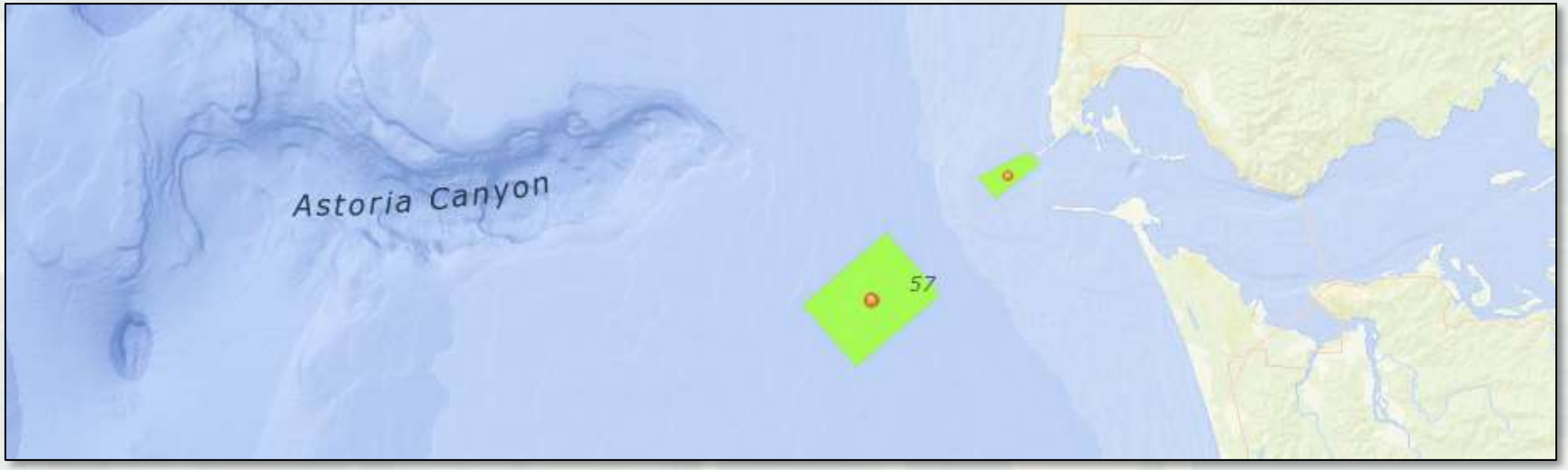
Presentation Outline

1. Monitoring open water placement sites
2. Differences between bottom trawl and benthic sled survey data
3. Video annotation
4. Automated or semi-automated video annotation

Monitoring open water placement sites

- USACE Portland District maintains waterways through a variety of dredge projects
- Nearshore beneficial use sites used for the Mouth of Columbia River Federal Navigation Project
- Before, during and after placement, sites are commonly monitored



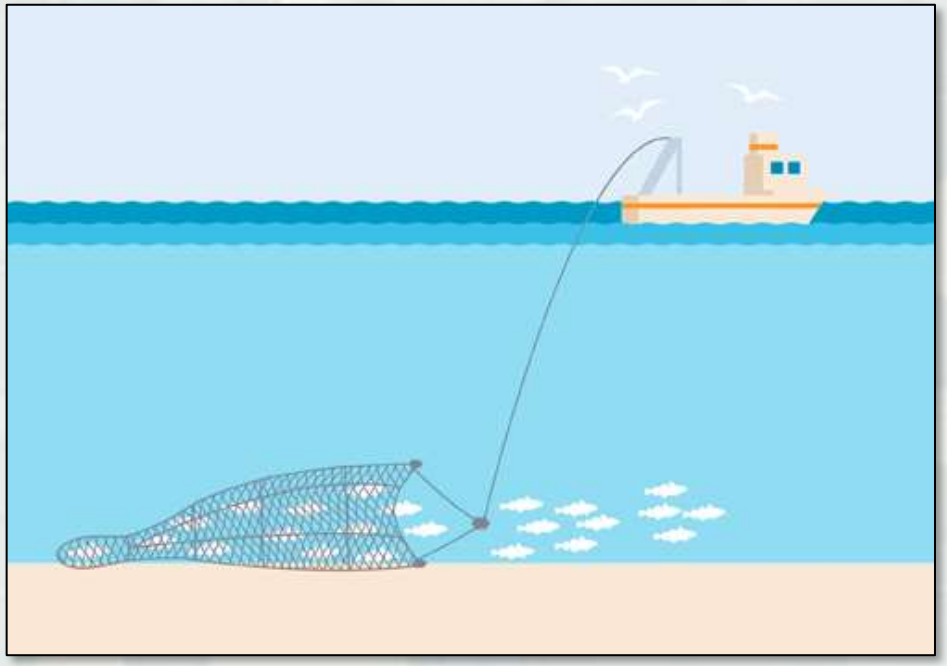
Credit: USEPA Ocean Disposal Map website https://www.epa.gov/ocean-dumping/ocean-disposal-map\

Monitoring cont'd…

- Monitor ecological conditions of the placement sites
- Focuses on survey of fish and epibenthic invertebrates
- Helps to:
  - ►assess changes in population or community structure, and
  - ►to establish diversity indices over time

Bottom trawl survey

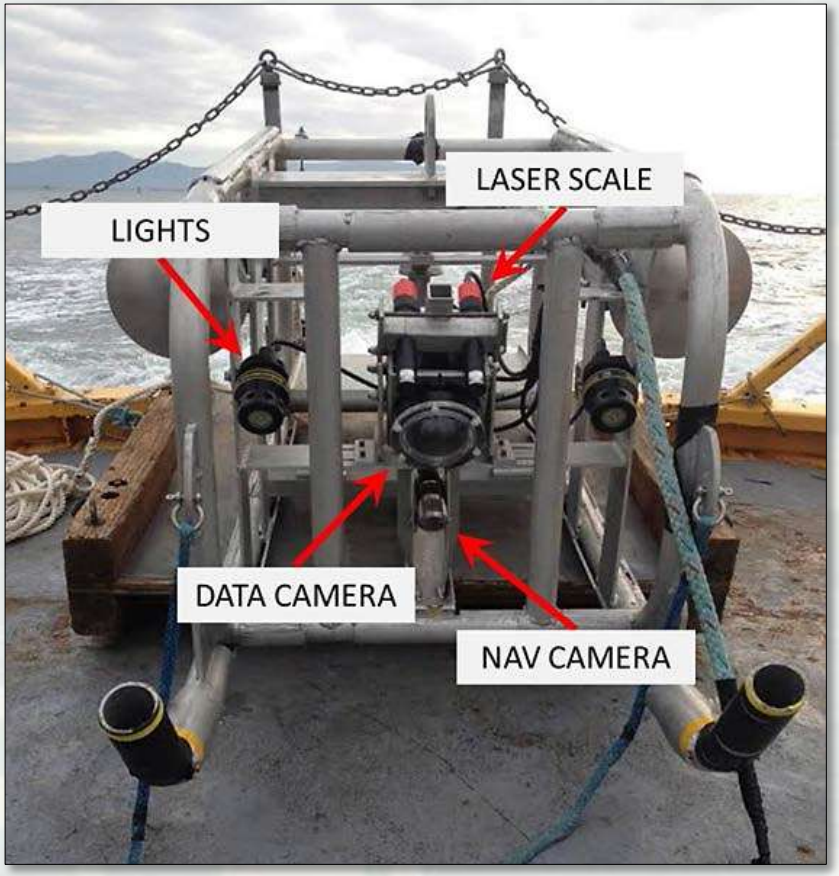
- Net is dragged along a pre-selected part of the ocean floor for a specific time and distance
- The net is retrieved and aquatic life is more closely examined and sorted into species
- Other data such as weight, length, condition can be recorded



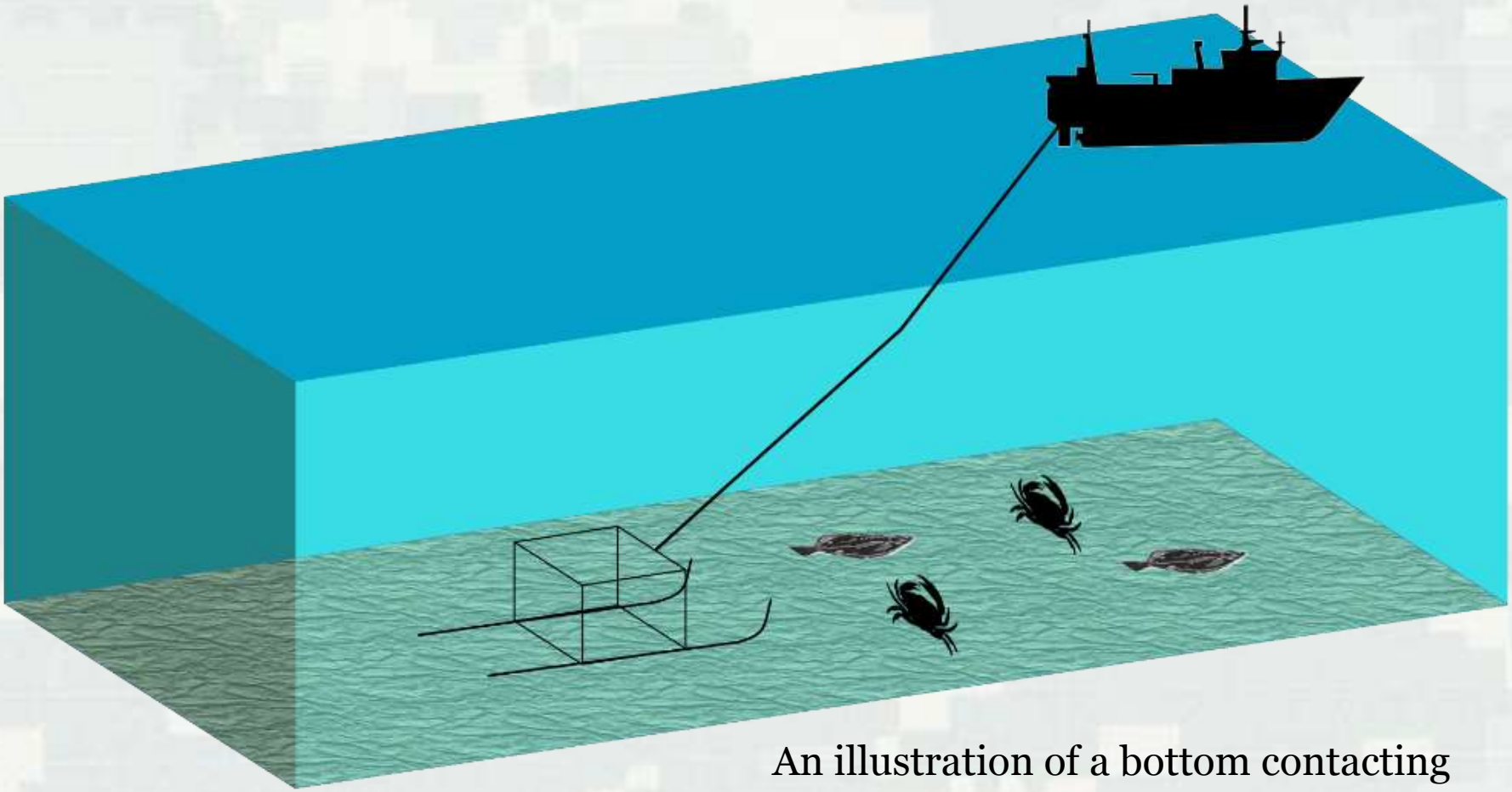
Credit: marine stewardship council www.msc.org

Benthic Sled

- Towed along pre-selected part of the ocean floor for specific time and distance
- Sled usually equipped with an imaging system, lighting, and laser scale
- Post-survey analysis relies on annotations made by human observers



NOAA benthic sled



An illustration of a bottom contacting benthic sled towed along the seafloor. The sled is usually equipped with an image sensor.

Bottom Trawl vs Benthic Sled

Key Questions:

- Is species identification comparable between the methods?
- Is there a difference in overall density of organisms between the methods?

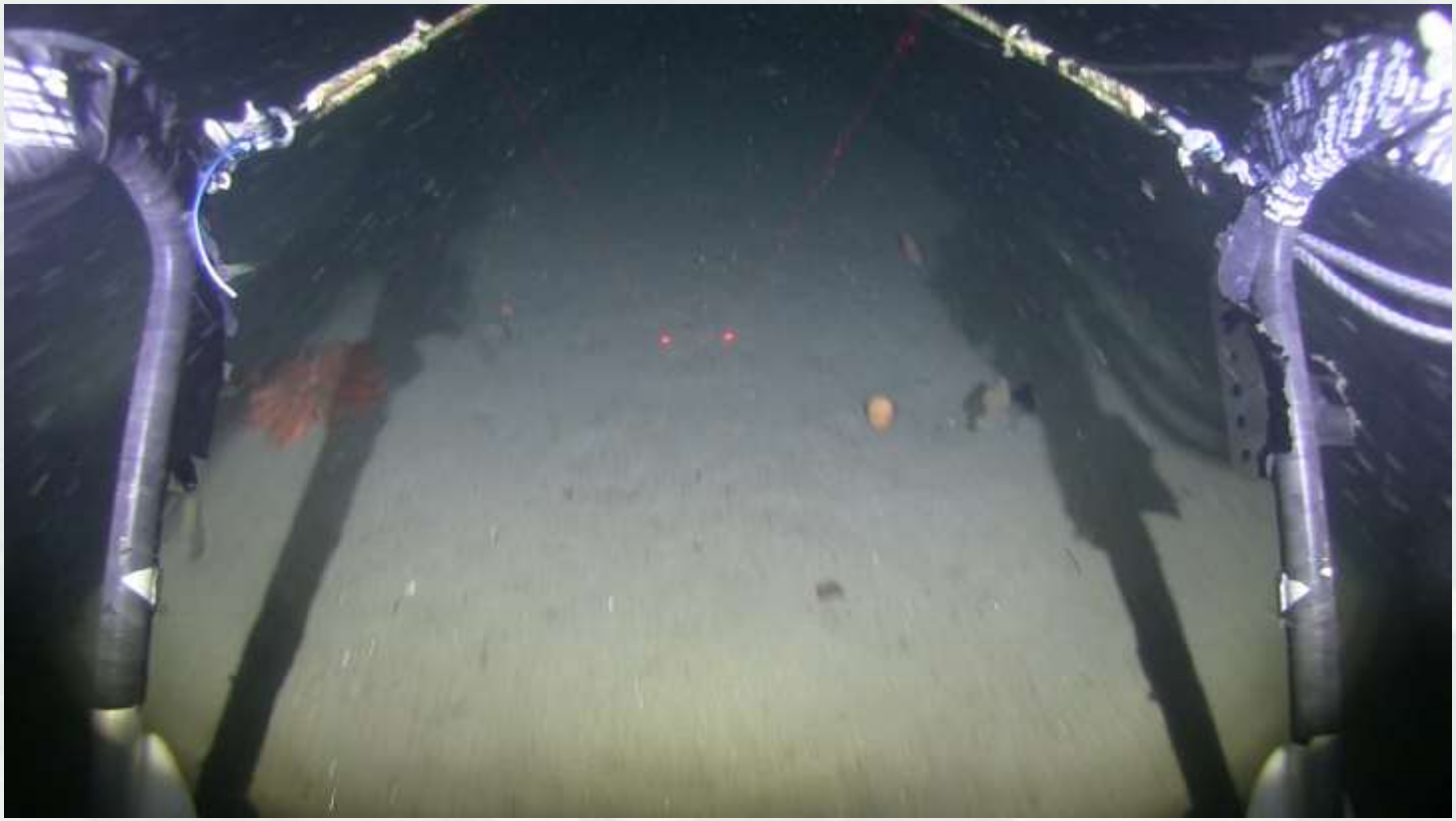
Selection of studies comparing methods

Species Density					
species	**Benthic sled**	**bottom trawl**	**image type**	**note**	**source**
Flatfish	94*	15	video	Density averaged for sites; mean and standard deviation of individuals per 100 m^2	Spencer et al. 2005
Crabs	15*	2			
Age-0 flatfish	30	18			
Age 1+ flatfish	4	3			
shells	13*	3			
Chimaera	121	839*	video	Individual per km^2	McIntyre et al. 2015
Macrourids	189	497			
Molva sp.	62	43			
Mora moro	28	96			
Skates and Rays	64*	5			
Sharks	14	134*			
number of individuals	≈ >4 x	-	images	Individual per 100 m^2	Nybakken et al. 1998
	18,145	2,291	images	N/A	Williams et al. 2015
Species Richness					
number of taxa	57	190	images	N/A	Williams et al. 2015
	14	19	images	N/A	Uzmann et al. 1977

Video Annotation

How do you annotate videos?

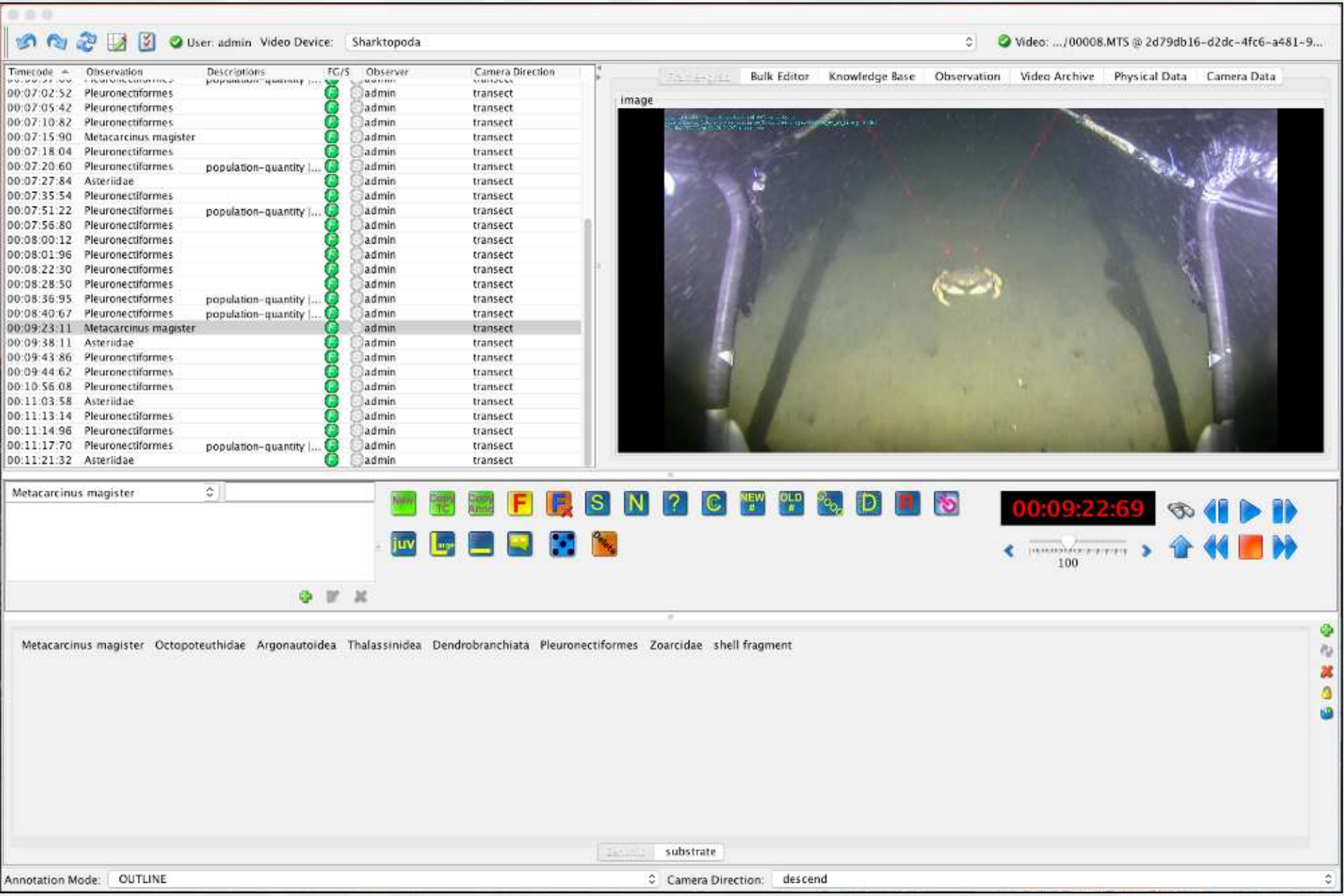
VARS- Annotation



Credit: NOAA benthic sled video footage at nearshore placement site, Mouth of Columbia River Federal Navigation Project (USACE)

Video Annotation and Reference System (VARS)

- Developed and used by the Monterey Bay Aquarium Research Institute for their deep-sea video annotations
- Users annotate a video frame, store the annotation in a database along with a frame grab and any ancillary data
- VARS includes three applications
  - ►Knowledgebase
  - ►Annotation
  - ►Query


User: admin Video Device: Sharktopoda
Video: .../00008.MTS @ 2d79db16-d2dc-4fc6-a481-9...
Timecode Observation Descriptions FG/S Observer Camera Direction
00:07:02:52 Pleuronectiformes admin transect
00:07:05:42 Pleuronectiformes admin transect
00:07:10:82 Pleuronectiformes admin transect
00:07:15:90 Metacarcinus magister admin transect
00:07:18:04 Pleuronectiformes admin transect
00:07:20:60 Pleuronectiformes population-quantity |... admin transect
00:07:27:84 Asteriidae admin transect
00:07:35:54 Pleuronectiformes admin transect
00:07:51:22 Pleuronectiformes population-quantity |... admin transect
00:07:56:80 Pleuronectiformes admin transect
00:08:00:12 Pleuronectiformes admin transect
00:08:01:96 Pleuronectiformes admin transect
00:08:22:30 Pleuronectiformes admin transect
00:08:28:50 Pleuronectiformes admin transect
00:08:36:95 Pleuronectiformes population-quantity |... admin transect
00:08:40:67 Pleuronectiformes population-quantity |... admin transect
00:09:23:11 Metacarcinus magister admin transect
00:09:38:11 Asteriidae admin transect
00:09:43:86 Pleuronectiformes admin transect
00:09:44:62 Pleuronectiformes admin transect
00:10:56:08 Pleuronectiformes admin transect
00:11:03:58 Asteriidae admin transect
00:11:13:14 Pleuronectiformes admin transect
00:11:14:96 Pleuronectiformes admin transect
00:11:17:70 Pleuronectiformes population-quantity |... admin transect
00:11:21:32 Asteriidae admin transect
Bulk Editor
Knowledge Base
Observation
Video Archive
Physical Data
Camera Data
image
Metacarcinus magister
00:09:22:69
100
Metacarcinus magister Octopoteuthidae Argonautoidea Thalassinidea Dendrobranchiata Pleuronectiformes Zoarcidae shell fragment
substrate
Annotation Mode: OUTLINE
Camera Direction: descend

Automated Video Annotation

- Semi-automatically or automatically detect, classify and quantify animals in underwater video
- Limit the need and cost of a human annotator
- Potential to reduce the environmental impact of physically collected samples (e.g., bottom trawls) by improving the usefulness and effectiveness of underwater video surveys

Annotation automation

Credit: Danelle Cline, MBARI AVEDAC lead

Annotation automation

- Algorithms can successfully detect and track objects of interest
- Software is customized, computer intensive, commonly designed for specific needs, and often requires support to use successfully
- Limitations: images, lighting, turbidity and background noise
- Often limited to megafauna which are easier to detect and classify
- Regulatory and other biological assessments often focus on megafauna, so automation is achievable

Summary

- Mean density of aquatic organisms often times much greater for a benthic sled compared to a trawl survey, but species identification is limited
- Post-processing of video can be achieved by using video annotation software
- Automated software is customized, computer intensive, and requires support
- Because regulatory assessments often focus on megafauna the automatic detection systems should be the goal

Acknowledgements

- USACE Portland District

- Danelle Cline and Brian Schilling, MBARI