ESRI International User Conference,
San Diego 2012

GIS, GPS and Marine Benthic Surveys

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Presentation by: David Klap

AECOM

Introduction

Who am I

Where am I from

What do I do

?

Outline

Our Problem

Our Approach

Our Results

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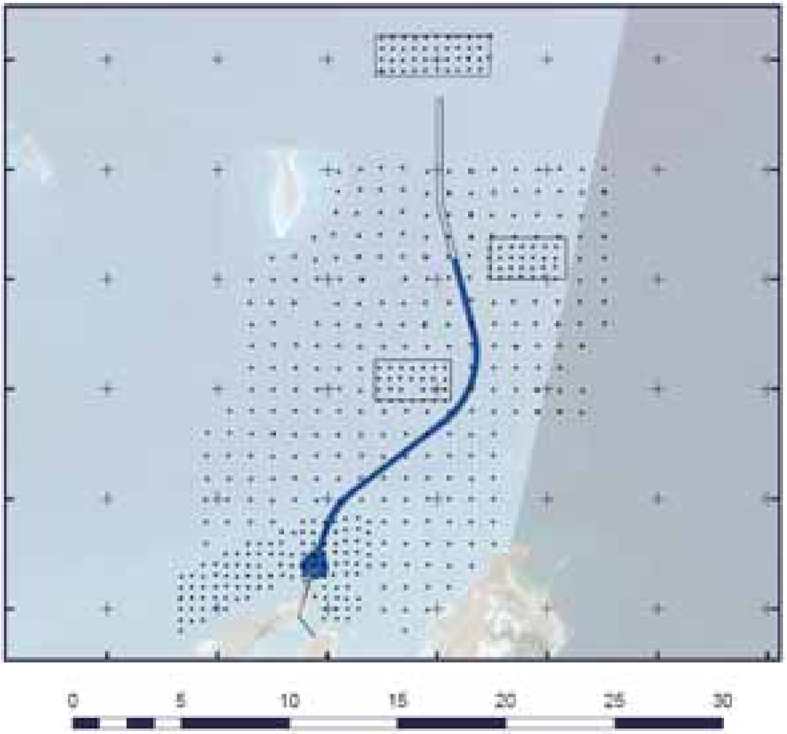
Your Questions

Our Problem

Challenges

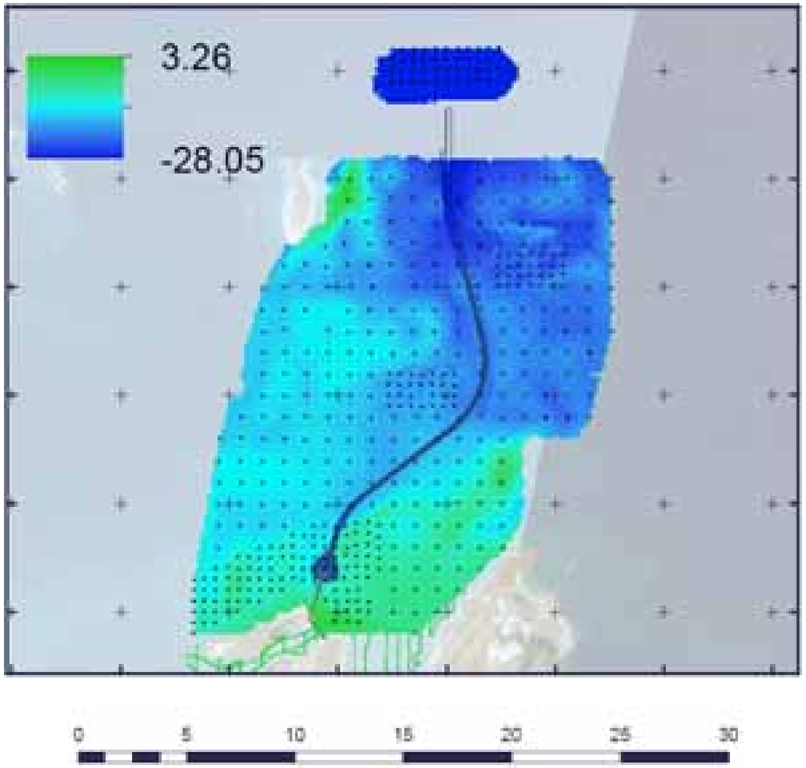
- Develop a method to conduct a benthic survey to map critical habitats in a port development area.
- Environmental approval for this large port project hinged on providing an adequate habitat map as a basis for assessing impacts on the marine flora and fauna.
- A large survey area, turbid waters with low visibility and strong currents making other commonly used methods such as diver operated video transects or photo quadrats and remote sensing unsuitable.



Our Problem

Opportunities

- Improve current methods to develop a safer and more efficient data collection process.
- Ability to record and present a greater level of detail
- Enhance data interpretation and analysis techniques.
- Provision of a more detailed analysis



Our Problem

Previous method

- Record GPS Location of survey point
- Dive or drop camera on location to inspect sea floor
- Record benthic species densities on a hard copy field log.
- Repeat approx. 500 times
- Transcribe field logs to excel spreadsheet.
- View videos and interpret footage
- Record interpretations to excel spreadsheet

Our Approach

Improve Current Method – Build on Existing Technologies

- Combine technologies such as GPS, underwater video cameras and depth sounders to capture and map information.

- Uses mobile mapping technologies and the analytical capabilities of a GIS to capture, process and analyse the survey and video information.

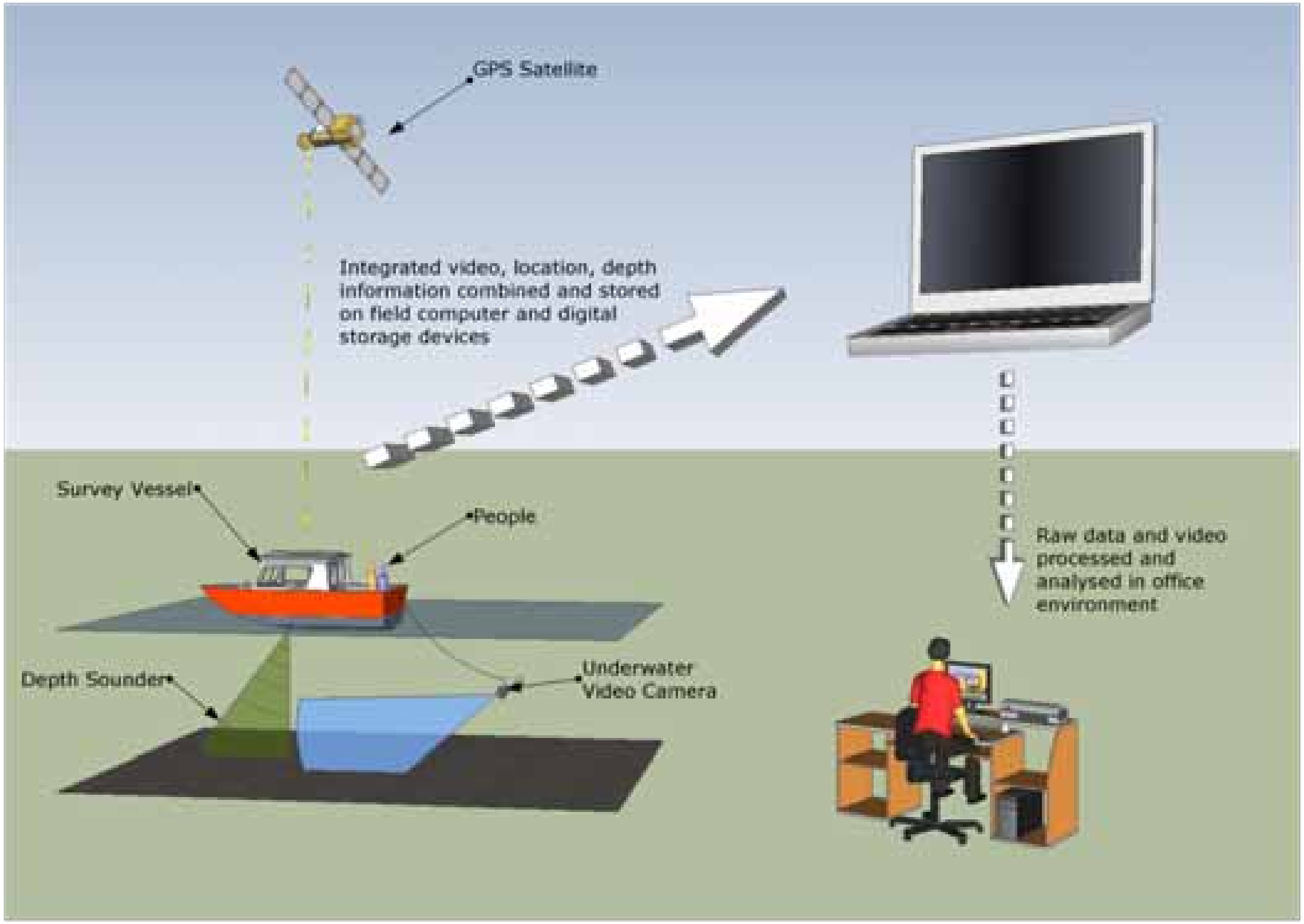
- Uses the scripting technology available within the GIS to develop a tool that assists in transferring the video information from each transect to a geographical location.

- Applies GIS spatial analysis and visualisation techniques to explore the spatial relationships within the data.

- Integrates all collected information by linking it to a geographical reference

Our Approach

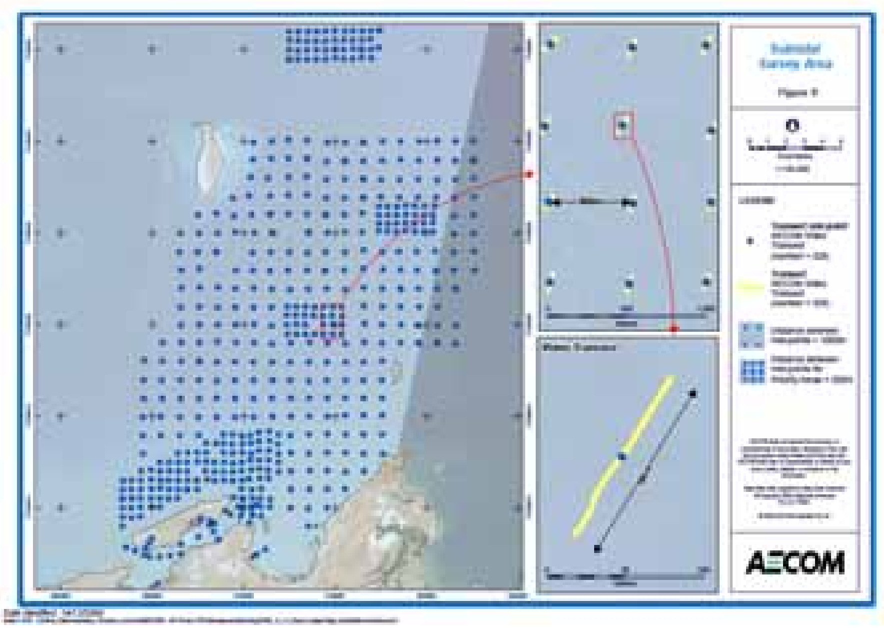
Improve Current Method – Build on Existing Technologies



Our Approach

Preparation: planning and design

- Prior to fieldwork a sampling program is designed.
- Based on the size of the survey area, the detail of information required, knowledge of the marine environment and the costs and resources involved in conducting the field program, transect length and spacing are determined.
- A pilot study is conducted testing all equipment, assessing logistics and time requirements for local conditions.
- Budget and timeframe are reassessed.
- A field deployment time plan is finalised and staff resources are allocated.



The Example: Port Development (Pilbara, WA)

- Covering a survey area of 31,650 hectares
- Over 500 underwater video transects
- Areas of special interest with denser sampling grid (spoil deposition grounds, infrastructure)
- Depth range from 3 to 25 metres

Courtesy Australian Premium Iron Pty Ltd

Our Approach

Improve Current Method - Mobile Mapping

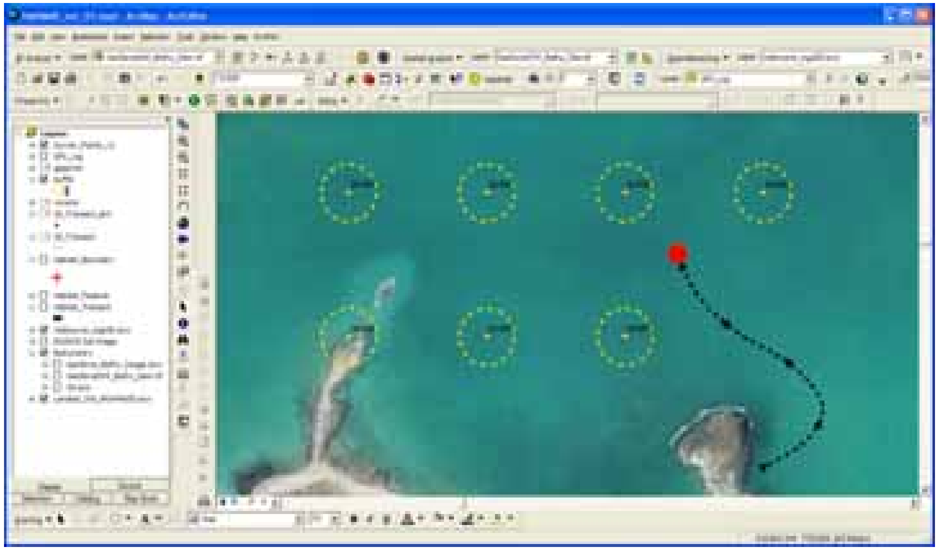
- Allows to visually track the teams position and progress during field work.
- Allows the field team to navigate to survey locations in a more efficient and confident manner reducing the time taken to complete the survey.
- Live tracking of the vessel position also assists in performing the drop camera work.

Applying Mobile Mapping in the field:

The field team is provided with a laptop and GIS software loaded with aerial imagery and survey information. The GIS is linked to a GPS that provides dynamic location information used to track their location on the map and to log their position to file. The laptop is also connected to the boats depth sounder to capture and record depth information.

Screenshot right:

The map displays 100m buffer regions around each survey location. They are used as a guide to indicate when 100m footage had been collected.



Our Approach

Underwater Video data Collection

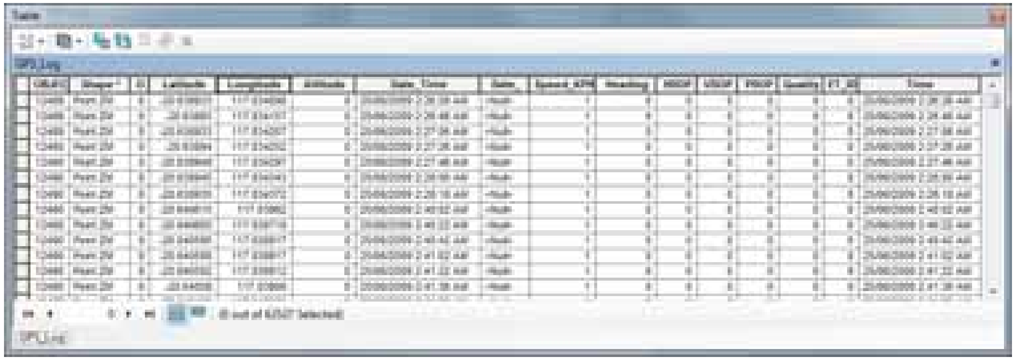
- Marine habitat information is collected as visual recording using a drop camera

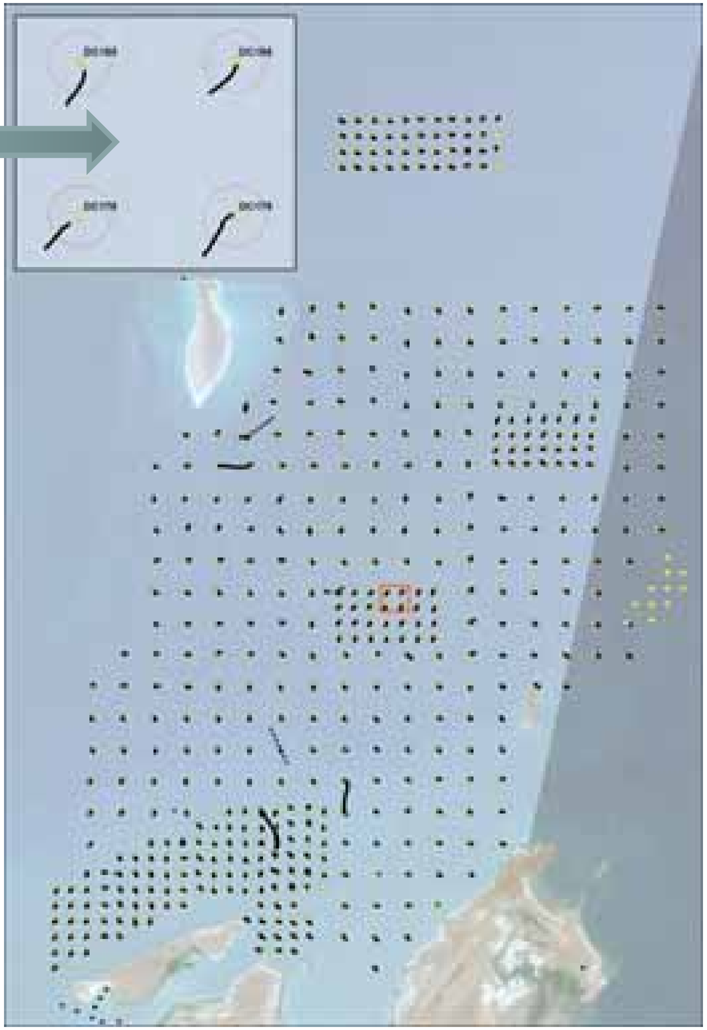
- GPS data integrated with video during collection as a visual overlay onto the actual video footage

- Logging of GPS track data to shapefile during each video transect

Our Approach

GPS Log Data

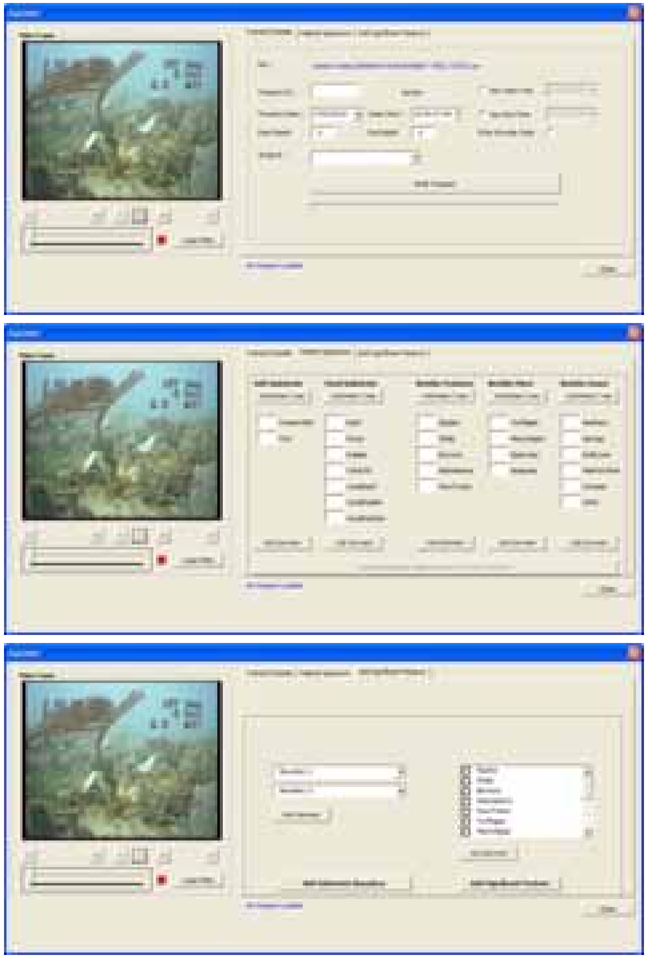




Our Approach

Linking geographical location to video transect

- Large numbers of video transects required an efficient method for transferring the information from the video to the spatial database.
- By using the time stamp data from the GPS log we could link position to the start time of the video. We then used the video duration to set the end time.
- A query to the GPS time stamp information located the corresponding GPS points to build a line that represented the transect.
- Developed code and user interface to visually correspond frame location in the video to a position along the transect. This allows the user to move forward and backwards through the video and see their relative position along the transect line.
- This feature allows the user to add features to the spatial database as they appear in the video. This direct transfer of video information to attributed spatial data was one the major innovations in increasing the efficiency of data input.
- Added capability of mapping individual significant features and boundaries of distinct changes of habitat increased the level of knowledge and understanding of the project area.



Screenshot of data entry window, user friendly interface allows viewing video and data entry simultaneously

Our Approach

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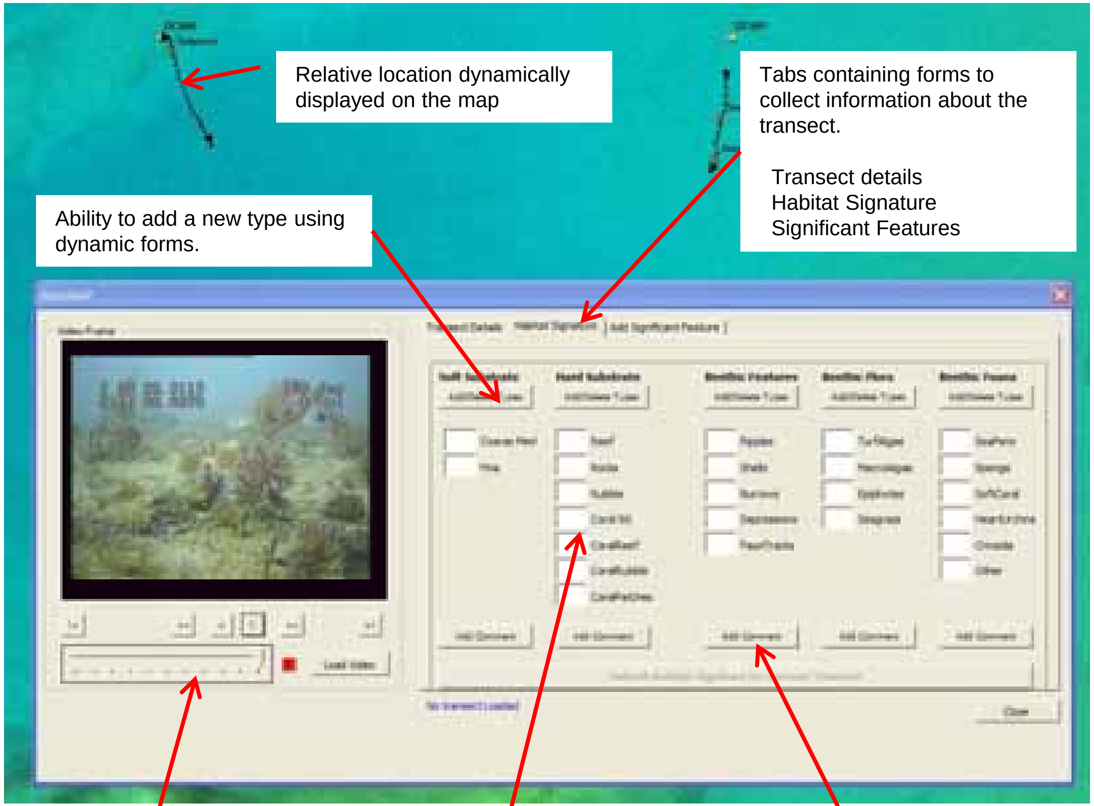


Video controls allowing the user to traverse through the video

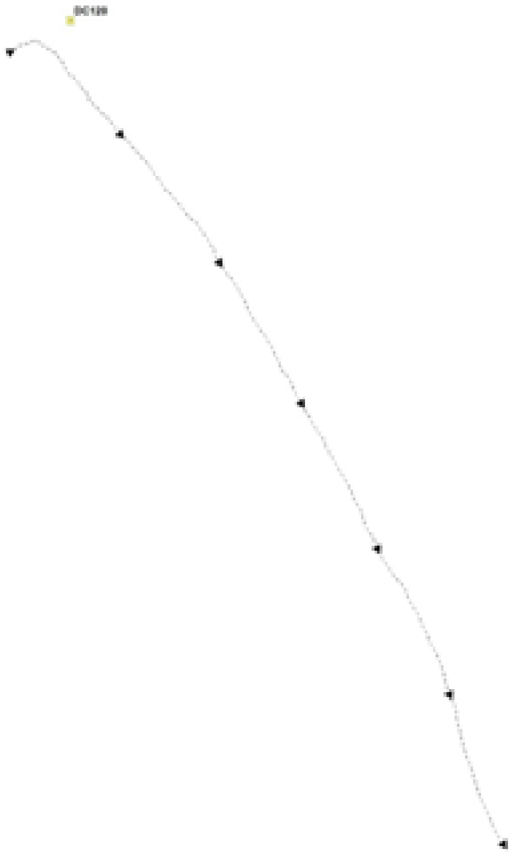
Input boxes to record the relative densities of the various types of benthic features associated with the video

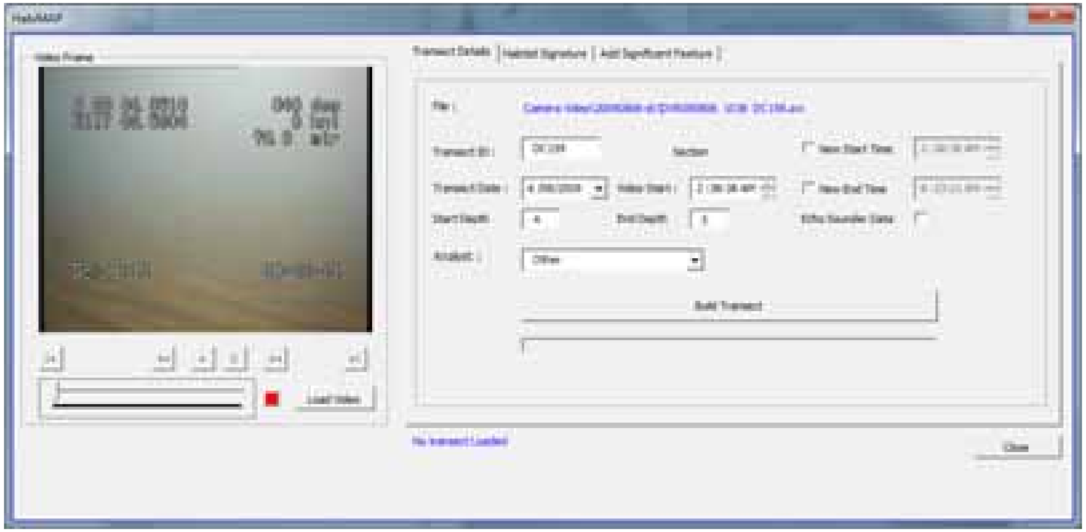
Ability to record a comment on the benthic feature type

The GIS tool

- Allows user to load the transect video into the GIS environment.
- GPS overlay information on the video provides start time and date of the video.
- Use of start time and video duration to build query to retrieve the GPS point locations that fall within a specified time period.
- Use of these points to build a line that represented the transect.
- Establishment of dynamic link between the video position and the relative geographical position along the transect. As the video plays an indicator traverse along the transect showing the relative position along the line. By doing this the user could add features to the database as they appeared in the video.
- Assigning of a 'Habitat Signature' to each transect consisting of the habitat category and coverage/density rating This signature forms the basis of the habitat analysis by locating and identifying transects that had similar signatures.
- Storage of all information in linked database

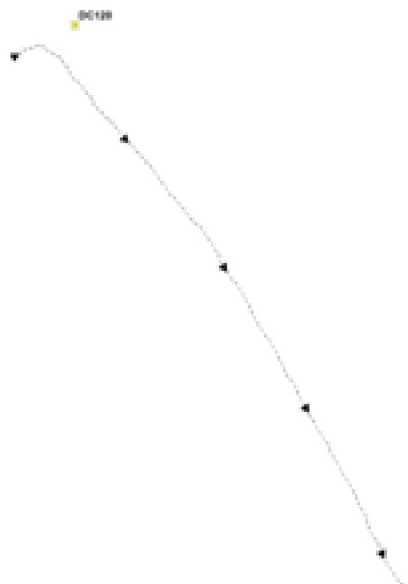
Our Approach



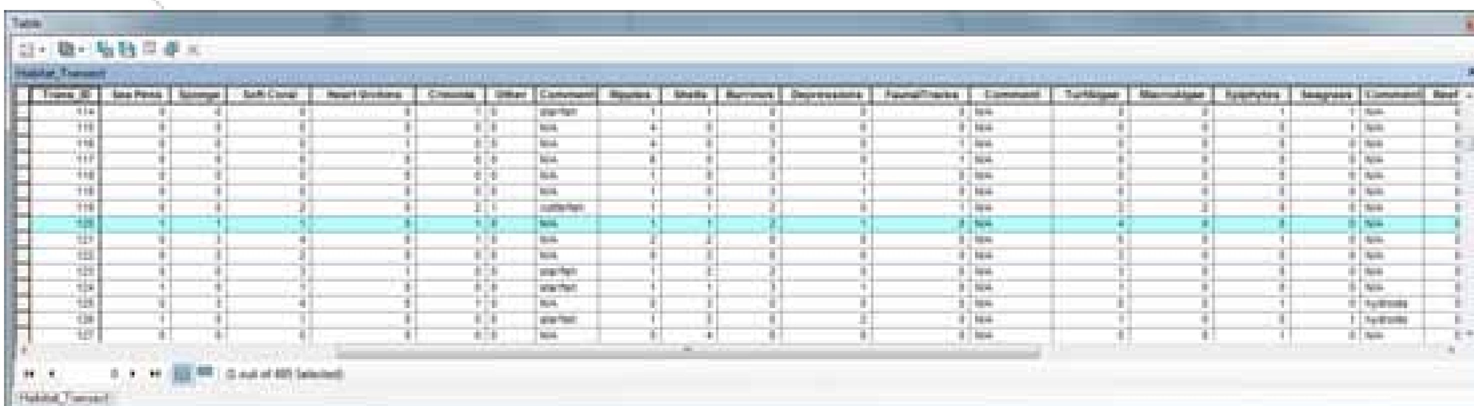


Transect Details

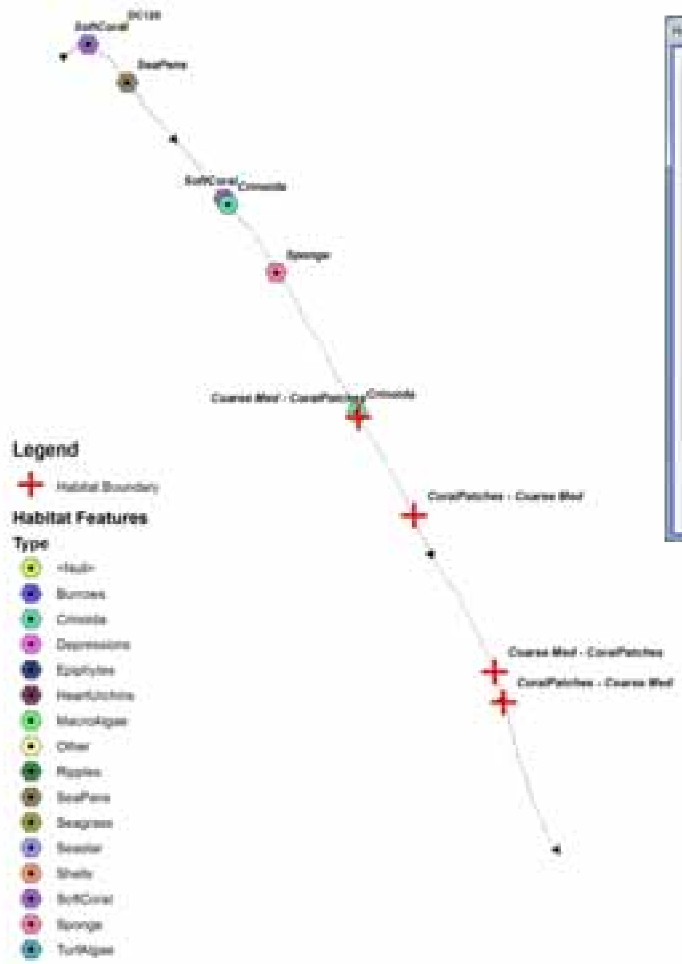
Our Approach



The Habitat Signature



Our Approach



Significant Features & Boundaries

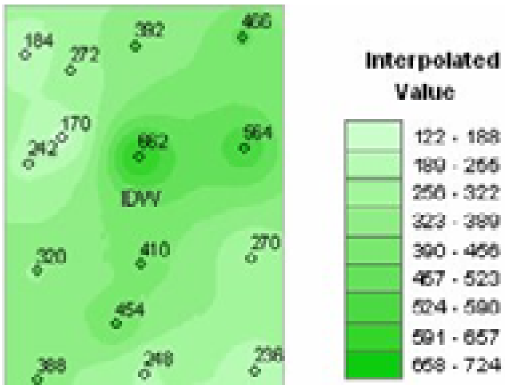
Our Approach

Lights – Camera - Action

Our Results

Processing and analysing transect data

- Data associated with the transect is reduced to a point location that can be analysed using a spatial interpolation technique such as Inverse Distance Weighting.
- The analyst can create a surface treating the density value for a certain feature as a z value.
- The surface can then be represented in 3D by mapping the density 'z' value in 3D space. The result is a 3D that visually describes the extent and density of a particular benthic feature.
- The surfaces can be used to extract different levels of information from the data. For instance, we can ask the database to return all areas where seagrass densities exceed 50% and macroalgae is less than 20%. We can overlay the results of this query with bathymetric data to explore the how depth may be contributing to the habitat.
- This method provides the analyst the flexibility to explore and understand the relationships within the data prior to making definitive habitat classifications.

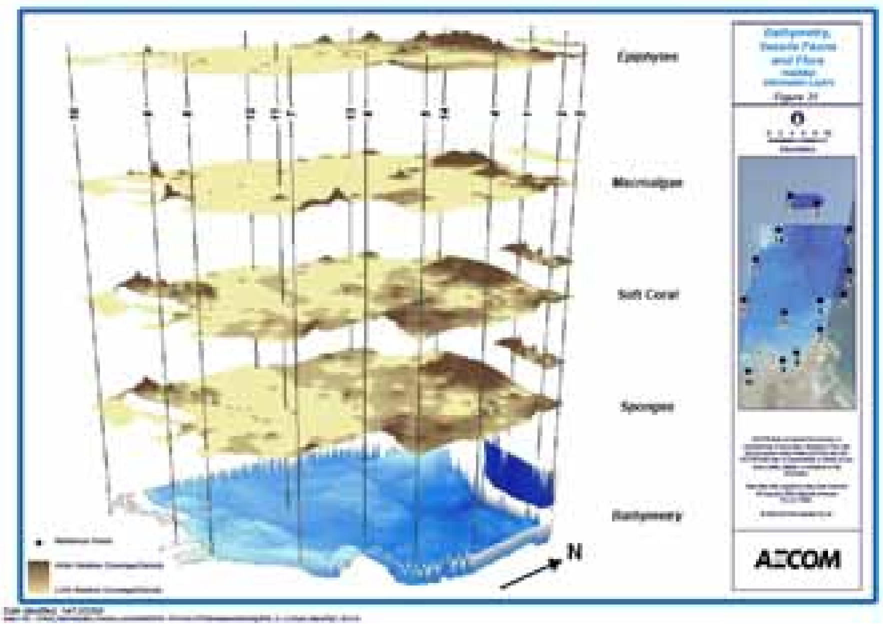


Screenshot of interpolation and resulting surface

Our Results

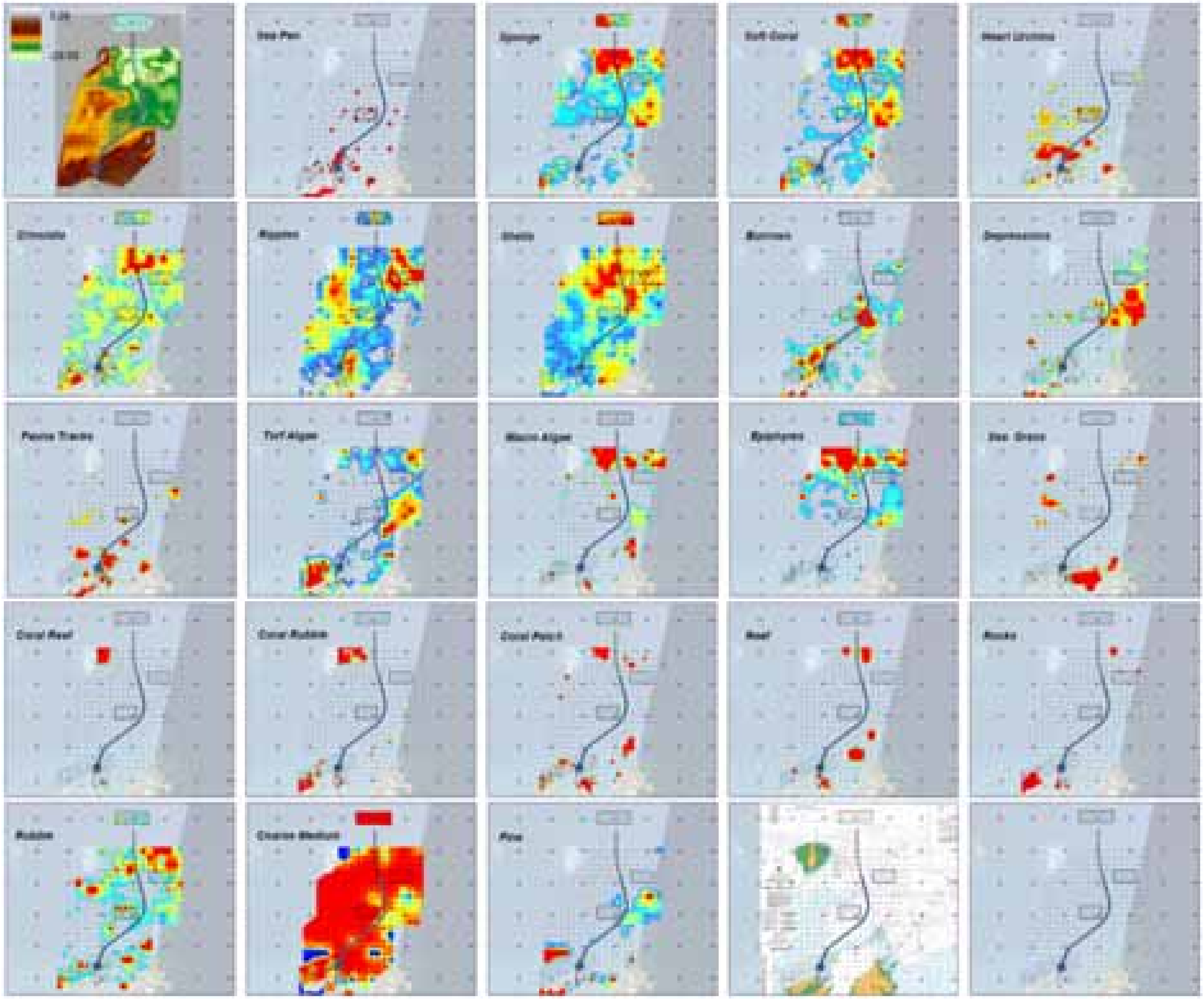
The final product

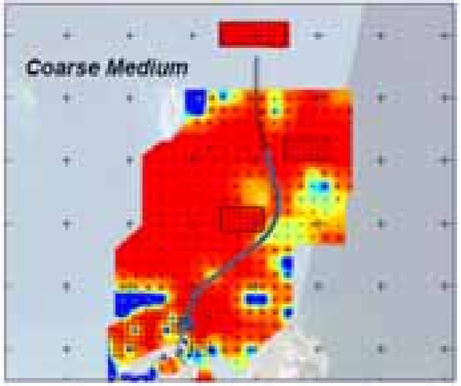
- HabiMAP methodology produces easily comprehensible information layers.
- Visualisation of information in flexible combinations and formats.
- Information layers can visualise single or multiple categories depending on the information required. Single layers showing sponges or soft corals can easily be created. They can also be combined to show soft coral/sponge filter feeder habitat.
- If environmental regulations require the mapping of functional groups such as benthic primary producers, a combined information layer showing, for example, seagrass, turf algae, macroalgae and hard corals can be easily created.
- Density/coverage of biota can be shown as 2D colour gradient or 3D elevation

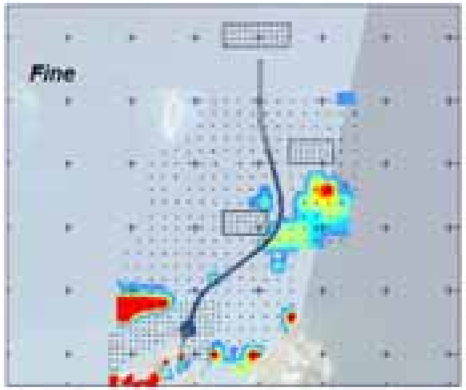


Stacking of 3D information layers, information layers representing single biota categories over bathymetry layer facilitating comprehension and interpretation of results.

Our Results







Questions

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Thank You

