Exploratory Video-Sidescan and Echosounder Surveys of Two Finfish Aquaculture Sites

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ABSTRACT

Vandermeulen, H. 2016. Exploratory video-sidescan and echosounder surveys of two finfish aquaculture sites. Can. Tech. Rep. Fish. Aquat. Sci. 3188: vi + 27 p.

Towfish (sidescan and video) and echosounder surveys were utilized to examine bottom type and macrophyte cover within the area of two coastal marine finfish aquaculture sites, one in New Brunswick and one in Nova Scotia. Both towfish and echosounder data could be used independently of one another. However, the towfish data were very useful for ground truthing echosounder based classifications. All survey data were placed into a GIS which could be used to answer management questions such as the placement of cages at sites, benthic impacts and baseline conditions to determine long term changes.

RÉSUMÉ

Vandermeulen, H. 2016. Relevés de deux sites d'aquaculture des poissons à nageoires par vidéo à balayage latéral et par échosondeur de prospection. Rapp. tech. can. sci. halieut. aquat. 3188: vi + 27 p.

On a utilisé un poisson muni d'équipement vidéo et de balayage latéral, et un échosondeur afin d'examiner le type de fond et la couverture de macrophytes dans la zone de deux sites marins côtiers d'aquaculture des poissons à nageoires, un au Nouveau-Brunswick et un en Nouvelle-Écosse. Les données obtenues par le poisson muni de l'équipement vidéo et de l'échosondeur peuvent être utilisées indépendamment les unes des autres. Cependant, les données obtenues par le poisson muni de l'équipement vidéo étaient très utiles pour les classifications en fonction des vérifications sur terrain de l'échosondeur. Toutes les données d'enquête ont été saisies dans un système d'information géomatique, et on pourrait s'en servir pour répondre à des questions de gestion telles que l'emplacement des cages sur les sites, les incidences sur le milieu benthique et l'état de référence afin de déterminer les changements à long terme.

INTRODUCTION

The potential benthic impacts of finfish aquaculture have long been a matter of interest in Canada (e.g. Sutherland 2004). This paper describes the use of a video-sidescan towfish package and an echosounder for benthic surveys of two coastal marine finfish aquaculture sites, one in New Brunswick and one in Nova Scotia. A GIS package was created from the survey results and is also described here.

2.0 MATERIALS AND METHODS

2.1 Survey Methods

Vandermeulen (2011a) describes the video and sidescan hardware on the towfish, and survey methodology. Vandermeulen (2011b) describes the echosounder, a BioSonics Inc. DT-X with dual transducers and its survey protocol. Although these two survey platforms can be used independently of one another, the towfish/echosounder combination makes it possible to cover larger areas compared to the towfish alone. Also, the more detailed information provided by the towfish package was very useful for ground truthing the echosounder data. Echosounder data was processed utilizing the new 'Visual Habitat' software from BioSonics. In the author's experience, Visual Habitat is far superior to previous BioSonics software for determining bottom classifications and macrophyte cover.

2.2 Survey Sites

2.2.1 Welch Cove, New Brunswick

The Welch Cove finfish aquaculture area is shown in Figure 1. This image is a screenshot taken from the GIS (MapInfo Pro v.10.5). There is only one cage site. Its site code is MF–404 and has been in operation with salmon since 2001. An echosounder survey was performed at the site on August 20, 2012. At this time, the farm was growing salmon that were stocked as smolts in the previous year.

2.2.2 Jordan Bay, Nova Scotia

The proposed Jordan Bay finfish aquaculture area is shown in Figure 2. This image is a screenshot taken from the GIS. Note the layer control box which allows for multiple views of the data. There was no aquaculture infrastructure in this area at the time of the survey, and there had been no previous aquaculture activity. However, two cage sites were proposed for this area; a northern site (lease number 1358 – 'Jordan Bay') and a deeper southern site (lease number 1359 – 'Blue Island'). An echosounder survey was performed around these sites on November 14, 2012. A corresponding towfish survey occurred on November 16, 2012.

2.3 Pre-operation Sediment Grab Samples

Pre-operation sediment grab samples were collected by contractors at both Welch Cove and Jordan Bay. The reports are unpublished, but some of the data were used here to assist with ground truthing the towfish and echosounder data. The Welch Cove samples were collected in February 2001. The Jordan Bay samples were collected in November 2010.

3.0 RESULTS

3.1 Welch Cove

The echosounder path for Welch Cove is shown in Figure 3. Although this is a relatively dark Google Earth image embedded by the Visual Habitat software, one can clearly see the shoreline to the east and the reef area just to the west of the cage site. The echosounder path is shown in different shades of blue corresponding to different echosounder file sections.

A portion of an echosounder file echogram is shown in Figure 4. In this image lines from the cage array show up as white streaks (arrows). Note that the water depth here is approximately 22 m and most of the water column appears “cloudy” or containing particulate material. This can be determined by the lighter blue streaks in the water column which correspond to an energy return of approximately -60 dB versus the much darker blue of the water column in general, a region of much lower energy return of approximately -80 dB. In other words, something in the water column is reflecting energy back to the transducer at the surface after each ping cycle. Since the transducer was running at a high frequency of 430 kHz, relatively small particles should be discernible in the water column. This can be determined by the following formula (BioSonics pers. comm.):

$$\text{Wavelength} = \text{speed of sound in salt water} / \text{frequency of echosounder}$$

or

$$\text{Wavelength} = (\sim 1.5 \text{ km/s}) / (430 \text{ kHz})$$

$$\text{Wavelength} \approx 0.0035\text{m or } 3.5\text{mm}$$

Using this rough calculation, and an equally rough estimate of resolution equalling about one half of wavelength, particles of approximately 2 mm in size should be the *smallest* discernible by the echosounder. That detection limit should be able to trace fecal material and remnant food pellets emanating from the cages. The echosounder was also quite good at picking out bottom features (Fig. 5).

Figure 6 is a screenshot of the GIS displaying the data layers associated with the depth contours created from the echograms using Visual Habitat software from BioSonics. Note the humps of material arranged in a linear pattern on the bottom which appeared to follow the cage array boundaries (red rectangle).

Figure 7 shows a six cluster bottom type classification from Visual Habitat. The legend in this figure indicates six different types of acoustic signatures derived by the software.

Note that yellow symbols (signatures 5 and 6) predominate in the cage area (red rectangle).

Figure 8 indicates the sediment sample data collected before the site became active with stocked cages in 2001. Although over ten years had passed between these grab samples and our echosounder survey, the samples remain helpful to interpret the Visual Habitat bottom type classification.

The grab sample sites are shown as stars in Figure 8. The two light green stars at about 20 – 22m were samples dominated by sand in 2001; while the two dark blue stars in the 23m range were a finer sand/silt mixture. It is reasonable to assume that there would be more silt on the flatter, deeper bottom between 22 and 23m. The two red dots to the west (outside of our survey zone) occur right at the edge of the reef area, and it makes sense that those samples were dominated by cobble.

In the decade of operations since 2001, it is reasonable to assume that the bottom may have changed within the area delineated by the echosounder track in Figure 8. One of the light green stars occurs right on some of the yellow dots of the Visual Habitat classification. Do the yellow dots still mean 'sand' in 2012? Probably not, and it would be a simple matter to collect new grab samples here and in the area of other yellow dots to determine exactly what bottom type is linked to that acoustic signature.

3.2 Jordan Bay

The echosounder path for Jordan Bay is shown in Figure 9. This survey covered a much larger area than at Welch Cove. Two separate regions were surveyed in the bay, corresponding to two separate potential cage sites. The echosounder path is shown in different shades of blue corresponding to different echosounder file sections.

Figure 10 shows the depth contours created by the Visual Habitat software. The northern site is approximately 6 m shallower than the southern site. Note the shallow reef area just to the west of the southern site.

The results of a six cluster bottom type classification from Visual Habitat are shown in Figure 11. In this instance, it was possible to take acoustic signatures and create bottom types (see below for towfish based ground truthing). The six 'acoustic signatures' binned into two main bottom types, sand and a cobble/gravel mix. The northern site was predominantly sand while the deeper southern site had more cobble/gravel, particularly to the west in the shallow reef area.

Figure 12 is a canopy height classification from Visual Habitat. The red dots represent a canopy height of 0.2 m or less, essentially the detection limit of the system. Red dots mean no canopy, and they are mainly associated with the sandy regions in the survey area (Fig. 11). The next canopy height bin, 0.2 to 0.4 m, includes shorter turf algae and *Agarum* (a brown alga[1] commonly found on cobble at depth, this was confirmed by towfish based ground truthing – see below). The tallest bin, 0.4 to 1.3 m, is usually

[1] *Agarum clathratum* Dumortier

associated with taller algae such as kelp[2]. Note that this taller canopy estimate is mainly associated with the shallow reef area to the south and west.

The echosounder classifications mentioned above were ground truthed by running towfish transects through the survey area (Fig. 13). The southern transect was labeled J1, with video sections labeled ‘a’ through ‘f’. The shallower northern transect was called J2, with video sections ‘a’ – ‘d’. These video sections and the accompanying sidescan imagery were used to create ‘towfish classifications’ to ground truth the echosounder classifications. Video screen shots are shown in Figures 14 and 15. The laser scale is 10 cm. Each frame of video has towfish latitude/longitude position to submeter precision, plus time and date stamp.

An example towfish classification for bottom type is shown in Figure 16. Note the legend in this figure, sand, gravel, and cobble/gravel bottom types were discernible. If we add the Visual Habitat echosounder classification just to the south of this area (Fig. 17), one can see that the towfish classification matches the Visual Habitat classification of sand at the cross point. This was done for all cross points in the GIS, and confirmed a good correspondence between echosounder and towfish based classifications.

Similar comparisons were made between towfish and Visual Habitat classifications for macrophytes (Figs. 18 and 19). Once again, the correspondence between towfish and Visual Habitat classifications was quite good. There were a few false positive canopy points in the Visual Habitat classification at some towfish cross points where no canopy was found[3]. Conversely, the Visual Habitat classification did not “see” the *Agarum* canopy at the only cross point where this was possible in the GIS. This does not invalidate the Visual Habitat classification, however, as the *Agarum* thalli were quite sparsely distributed in general and “bare” bottoms did corresponded quite well with towfish results. Unfortunately, there were no towfish transects or other sources of ground truth data in the region of the shallow reef area where the Visual Habitat classification indicated a tall canopy.

The location of the 2010 sediment grab samples is shown in Figures 20 and 21. All of these samples were over 90% sand, and their locations correspond very well to the towfish and Visual Habitat classification areas which also indicate a sandy bottom. Unfortunately, no grab samples were taken to the west of the deeper southern site where a cobble / gravel bottom predominates (Fig. 21).

DISCUSSION

The exploratory mapping described here indicates the value of towfish and echosounder-based surveys at existing and potential finfish aquaculture sites. It is recommended that both types of equipment be deployed. The use of towfish data in ground truthing echosounder data allows for surveys at a variety of scales within the same bay.

[2] These canopy height bins have been used in other surveys. The tallest bin is almost always kelp or eelgrass.

[3] In the author's experience, this is an ongoing issue with BioSonics software. Visual Habitat does a far better job of removing false positives for canopy over earlier software versions, but some still remain.

While the highest quality of spatial data were obtained from the towfish transects, the echosounder data did prove useful at the aquaculture sites. This was largely driven by the use of Visual Habitat software, which created depth contours and bottom type and canopy height classifications which were often consistent with the towfish based ground-truth classifications at transect cross points in Jordan Bay.

There was a logical consistency in the Visual Habitat results in the GIS, where hard and soft bottoms or macrophyte cover were indicated at locations where one would expect them. For example, a taller macrophyte canopy and harder bottom was indicated in the shallow reef area in Jordan Bay. Also, different bottoms were indicated by Visual Habitat in assumed depositional areas near cages in Welch Cove.

Past grab sample data for the sites was logically consistent with towfish and Visual Habitat bottom classifications. It is recommended that sediment grab samples be taken both before and during production cycles at finfish cage aquaculture sites.

As indicated by the echograms collected at Welch Cove, the 430 kHz transducer may have utility in detecting particle plumes coming off of cage sites. While BioSonics Visual Habitat software is only meant for bottom habitat classifications, there may be other software packages available to analyze for particles in the water column. This should be explored in the future.

The presence of cobble bottoms with *Agarum* in the area of proposed cages in Jordan Bay has management implications. The potential negative impacts of finfish aquaculture operations on macrophytes are discussed in Vandermeulen (2005).

The data embedded into the GIS (bottom type and macrophyte cover) can be used to answer a variety of management based questions at different scales. The GIS package provides information for managers on such issues as where to place cages at aquaculture sites, potential benthic impacts and baseline conditions to determine long term changes.

The video and sidescan data from the towfish can be used to classify and map a wide variety of bottom features of interest to management. Vandermeulen (2014) provides bay-scale maps of bottom features such as eelgrass cover and health; benthic algal growth; bacterial mats and oysters utilizing the same towfish deployed in Bras d'Or Lake. The author is presently developing a fiber-optic-based HD camera system on an upgraded towfish platform to maximize the information gathered by the video stream (e.g. clear screenshots for quantification).

ACKNOWLEDGMENTS

Fred Page supported surveys at both aquaculture sites. The field assistance of Sarah Scouten, Michelle Greenlaw and Jack Fife is appreciated. Blythe Chang provided the lease area boundary and coastal outline files for the GIS; the operational and stocking history of the aquaculture sites; the site code names; and the sediment grab sample reports.

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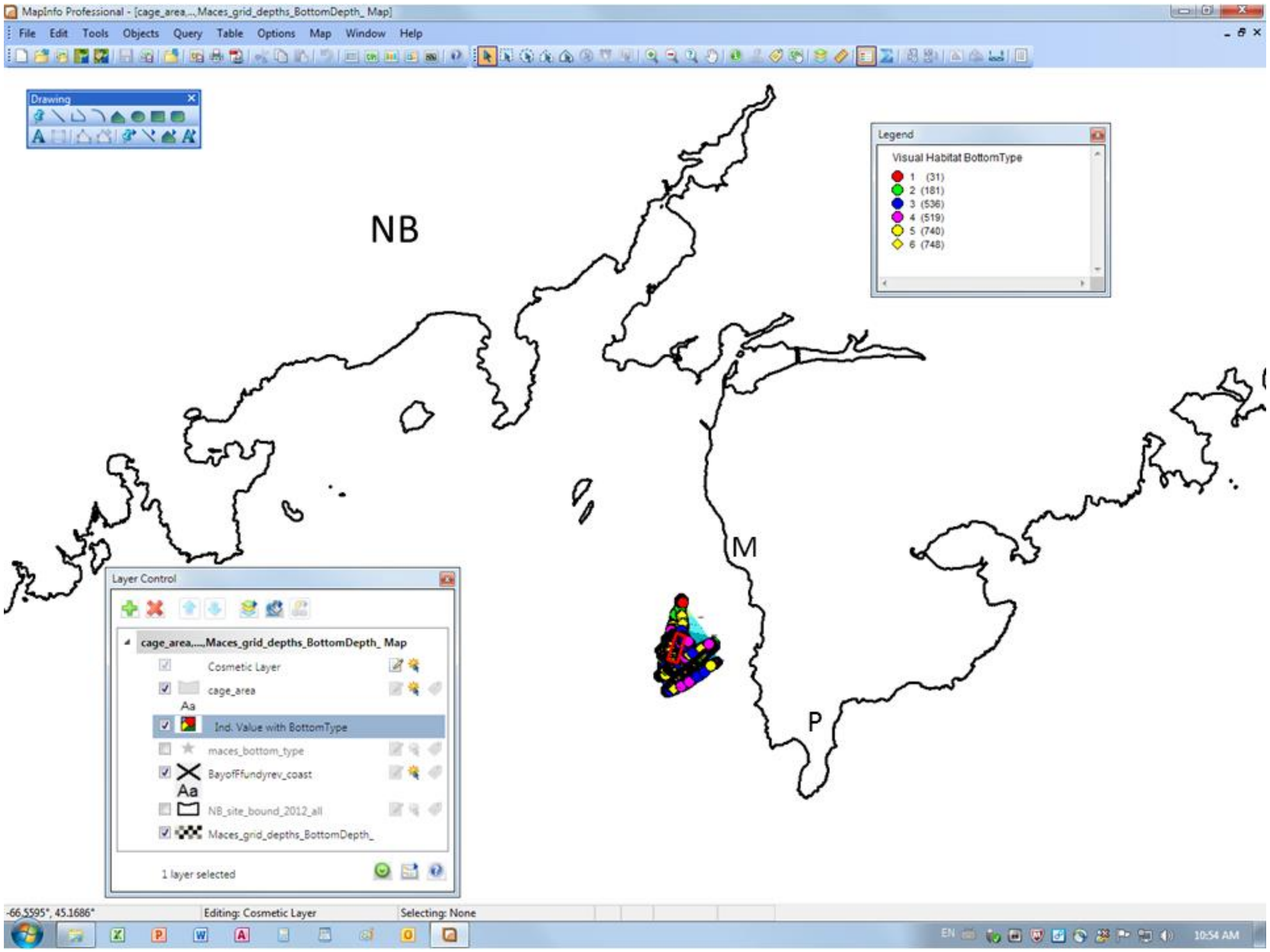

Figure 1: Welch Cove aquaculture area. **NB** – New Brunswick, **M** – the town of Maces Bay, **P** – Point Lepreau. The colored area in the bay indicates the aquaculture site.

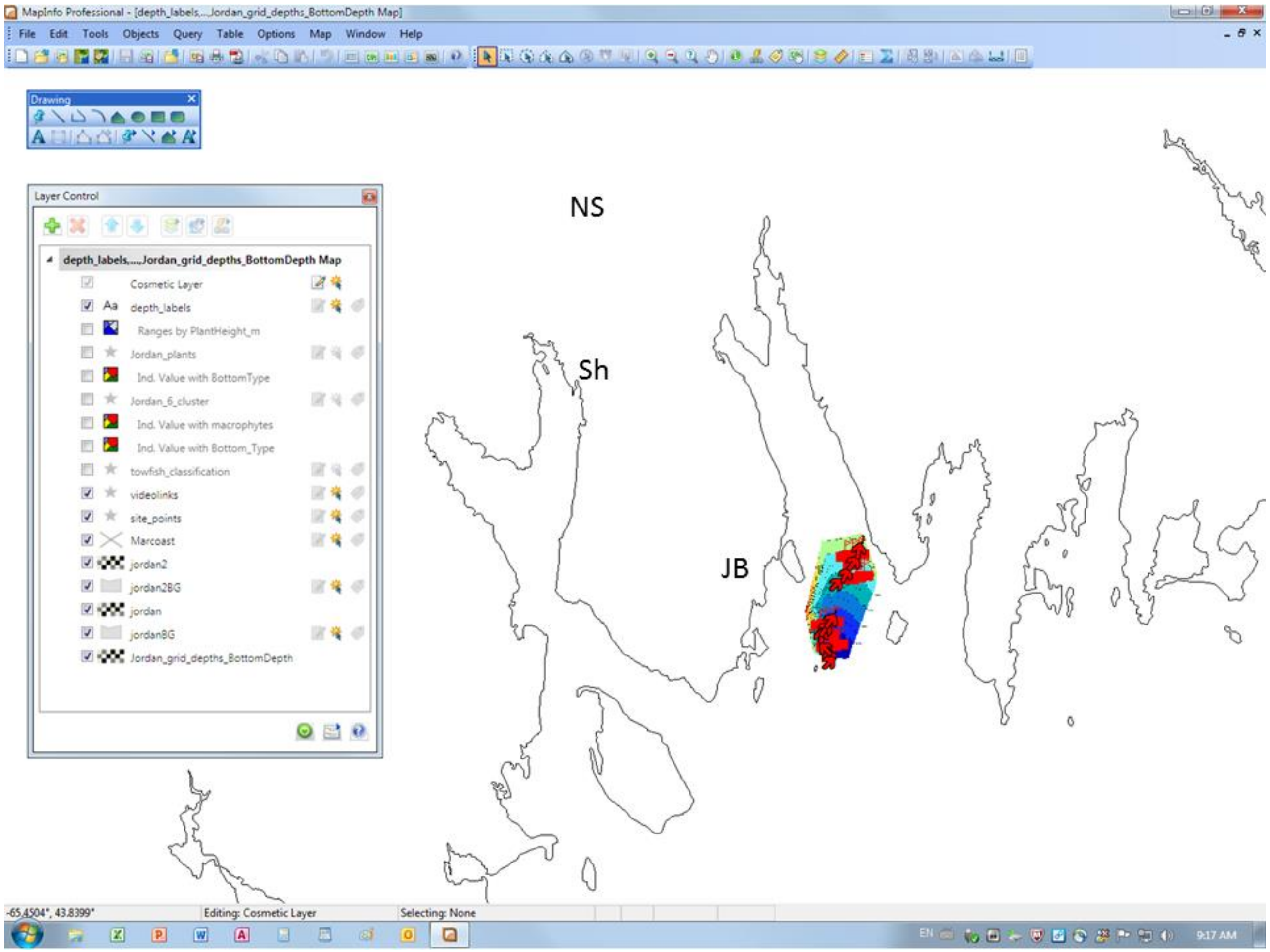

Figure 2: Jordan Bay aquaculture area. **NS** – Nova Scotia, **Sh** – the town of Shelburne, **JB** – the village of Jordan Bay. The colored area in the bay indicates the aquaculture sites.

Figure 3: Echosounder path in Welch Cove.

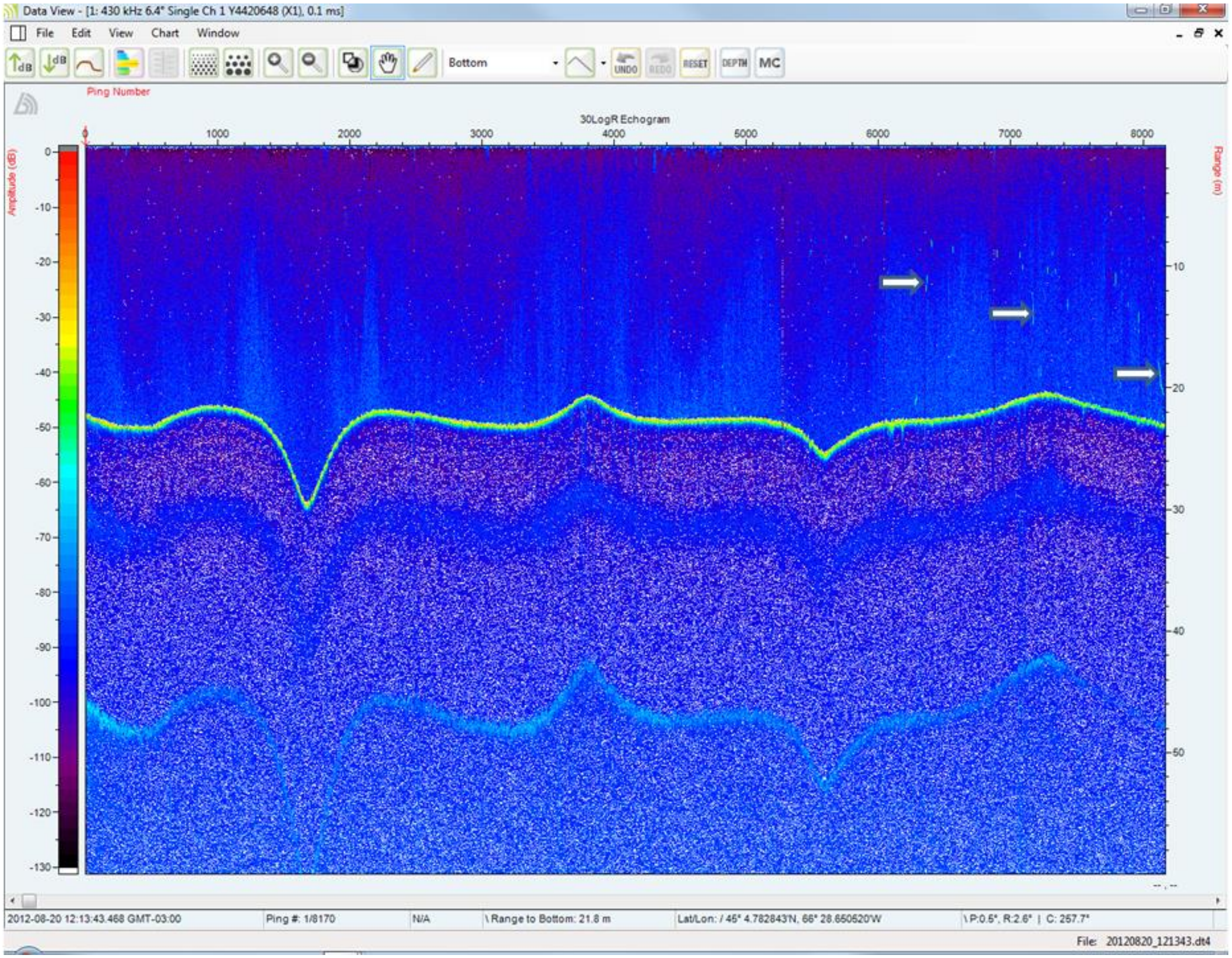

Figure 4: A portion of an echogram from the Welch Cove survey. The solid yellow / green line at approximately 24m depth is the bottom. The cage area is on the right in this image, as defined by support ropes in the water (arrows).

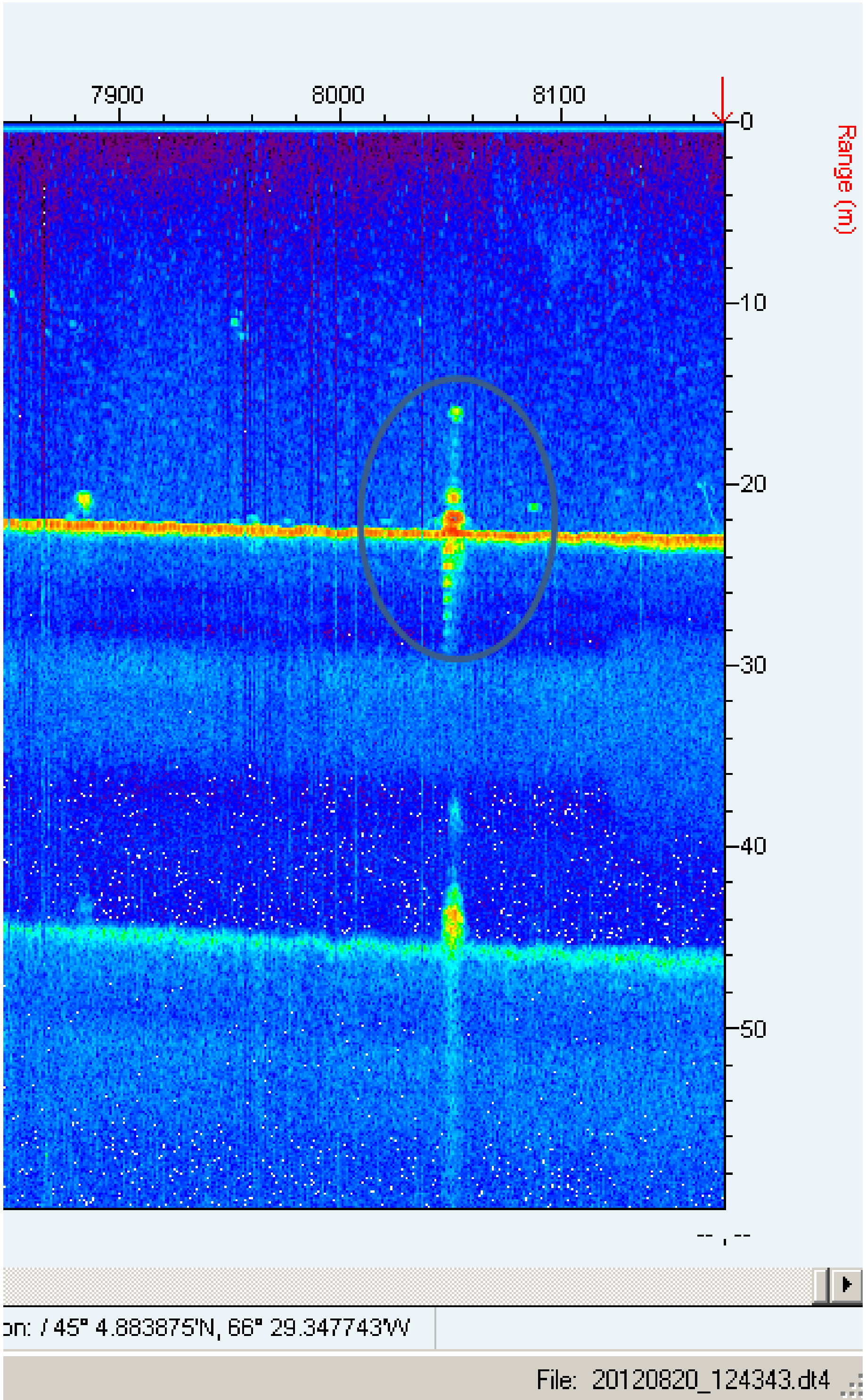

Figure 5: A portion of a Welch Cove echogram showing an equipment tripod that was placed on the bottom for data collection (circle). The solid red / orange line at about 23m is the bottom. The horizontal axis shows the ping numbers.

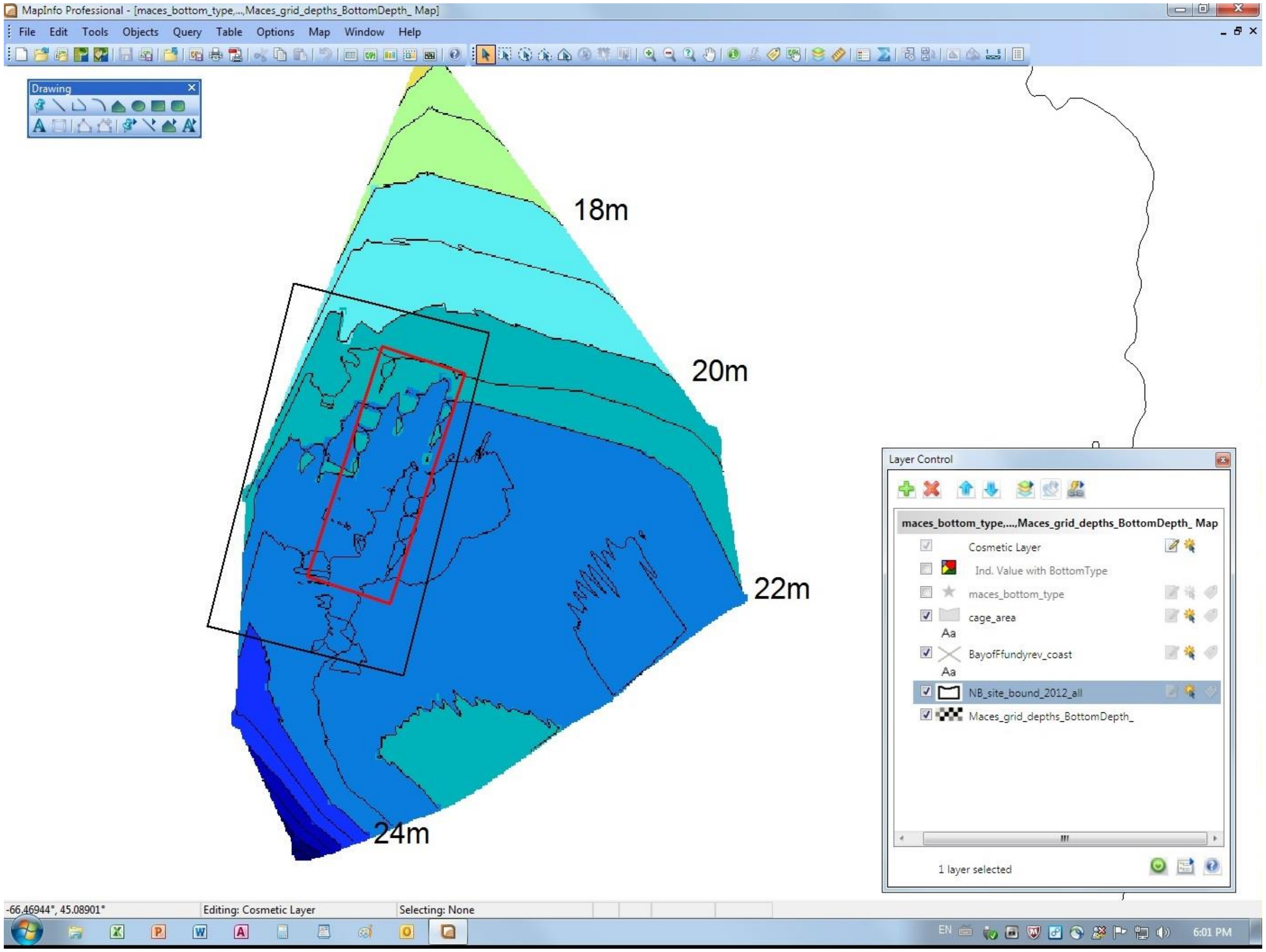

Figure 6: Depth contours for the Welch Cove site created by Visual Habitat software. The implied footprint of the cages is indicated by the red rectangle, while the lease area is indicated by the black rectangle.

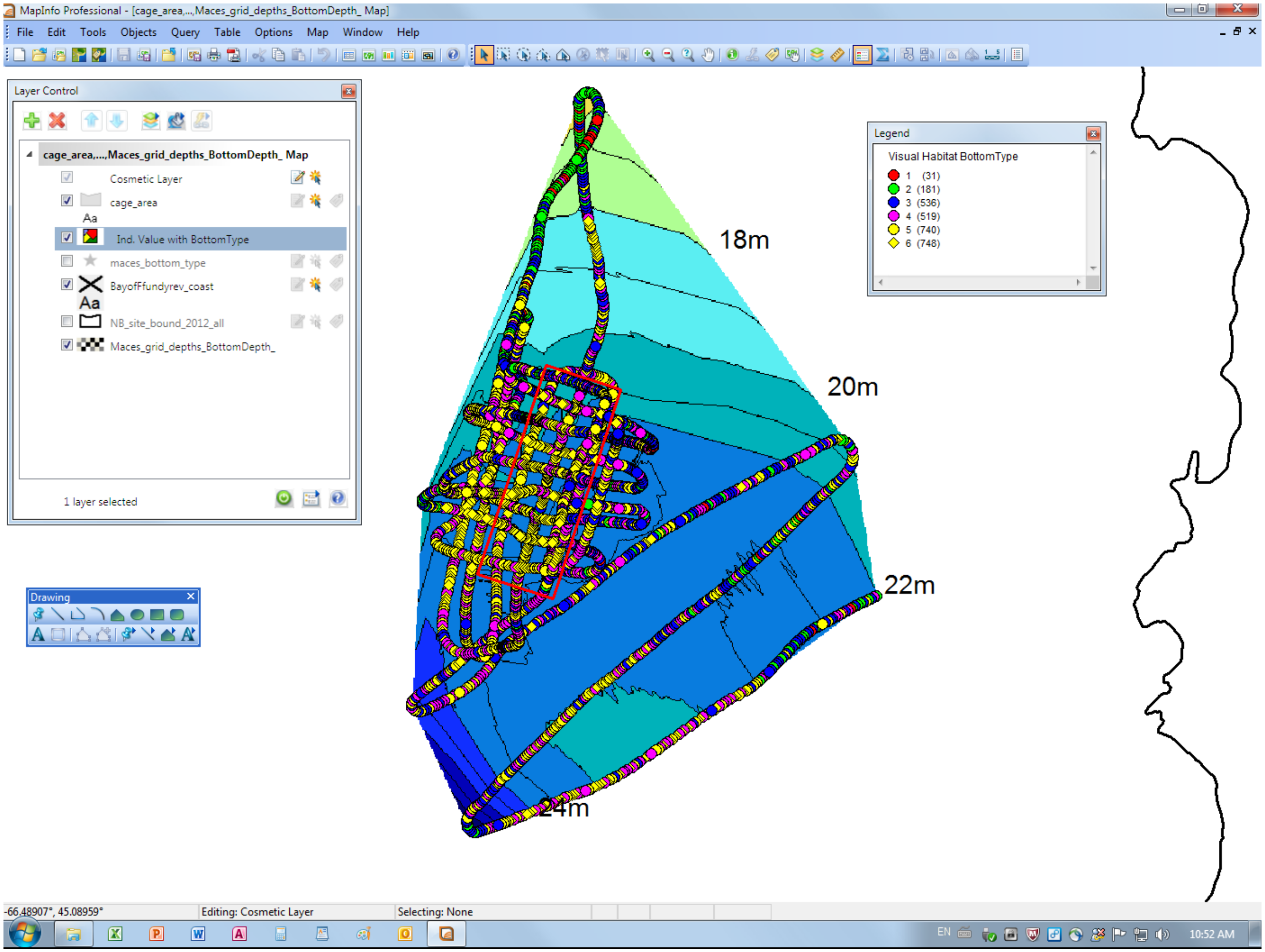

Figure 7: The results of a six cluster bottom type classification from Visual Habitat at Welch Cove.

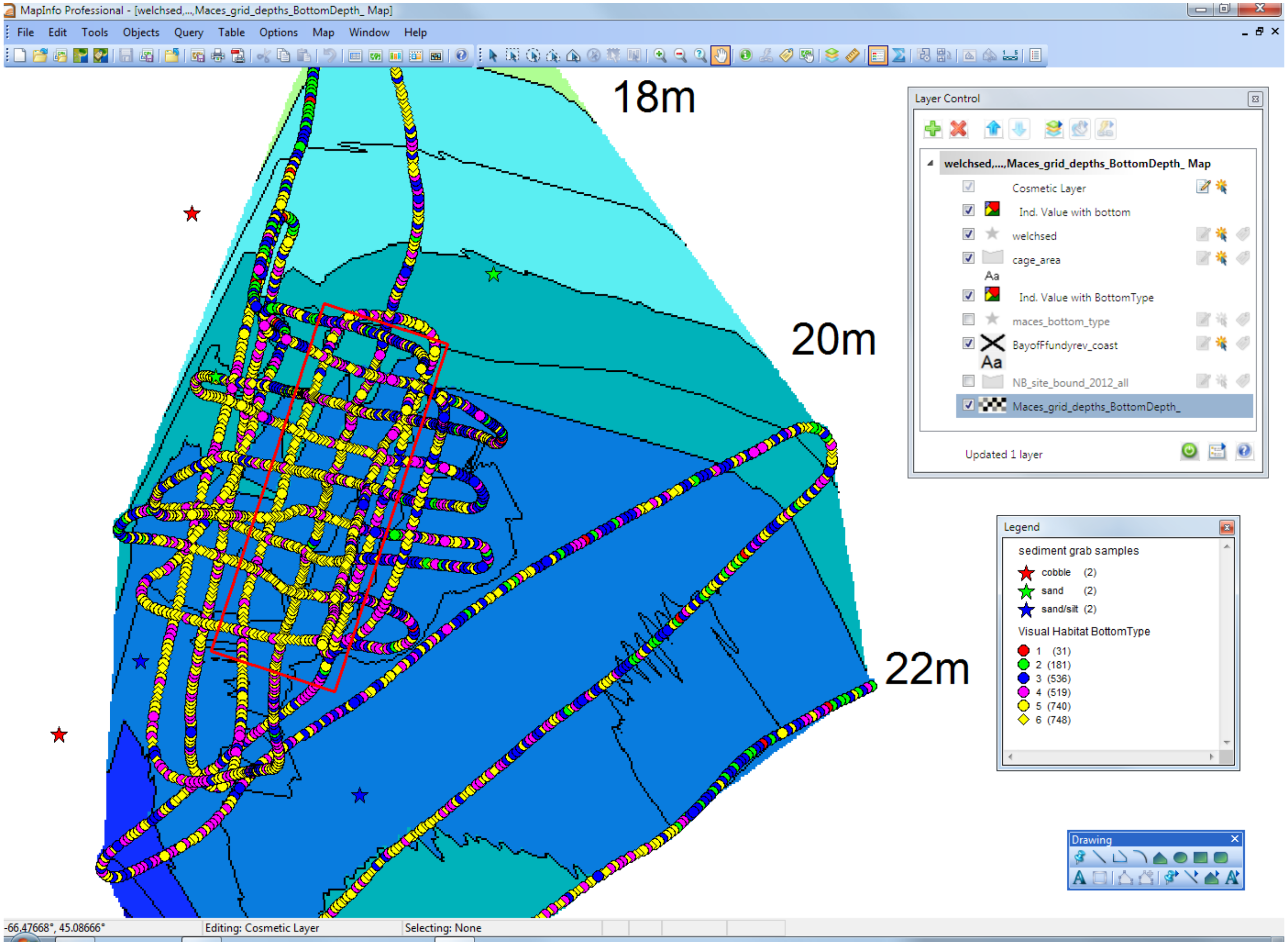

Figure 8: 2001 sediment grab samples (stars) at Welch Cove.

Figure 9: Echosounder path in Jordan Bay.

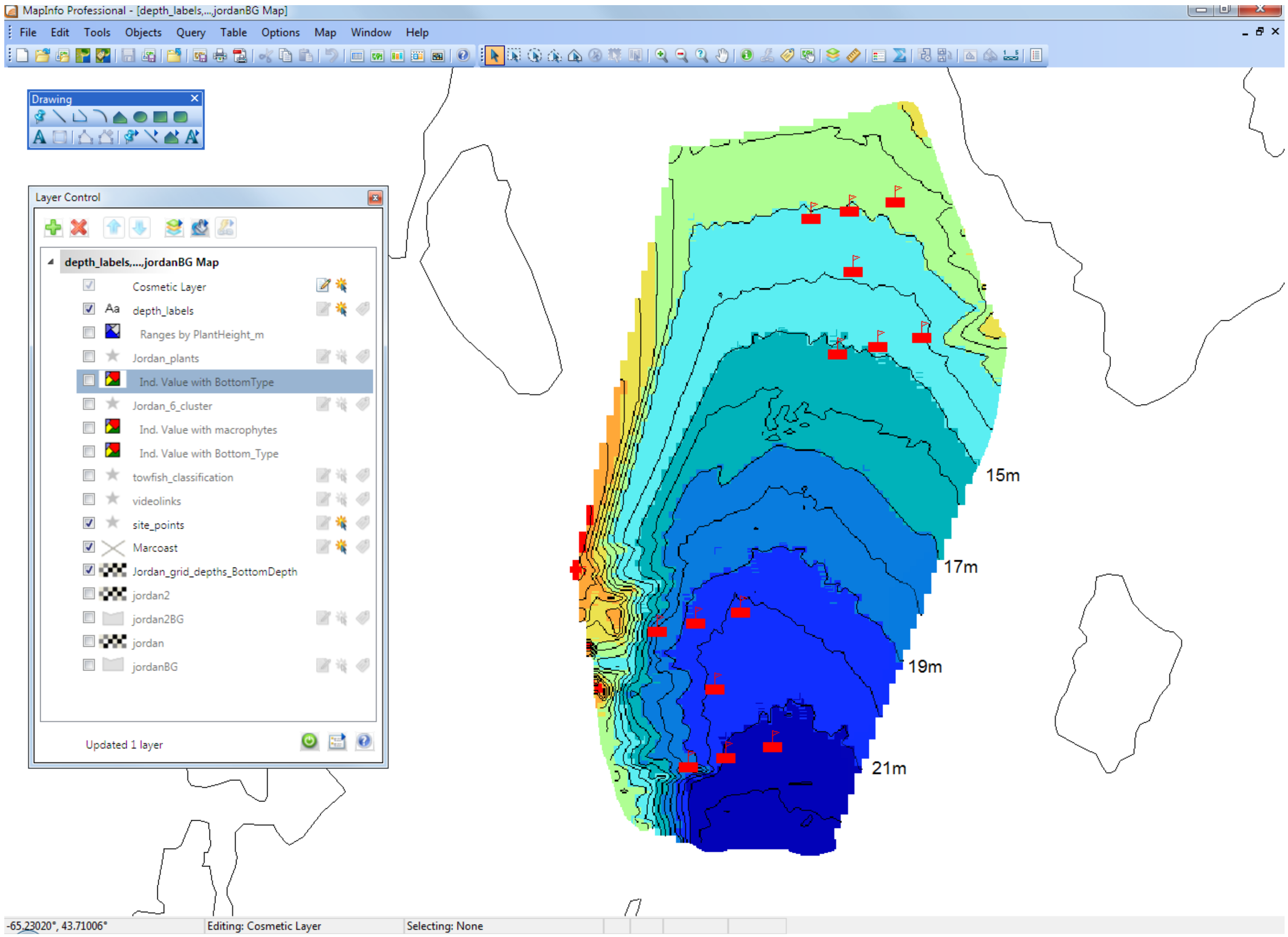

Figure 10: Depth contours for the Jordan Bay sites created by Visual Habitat software. The red symbols indicate the approximate boundaries of the two proposed cage sites.

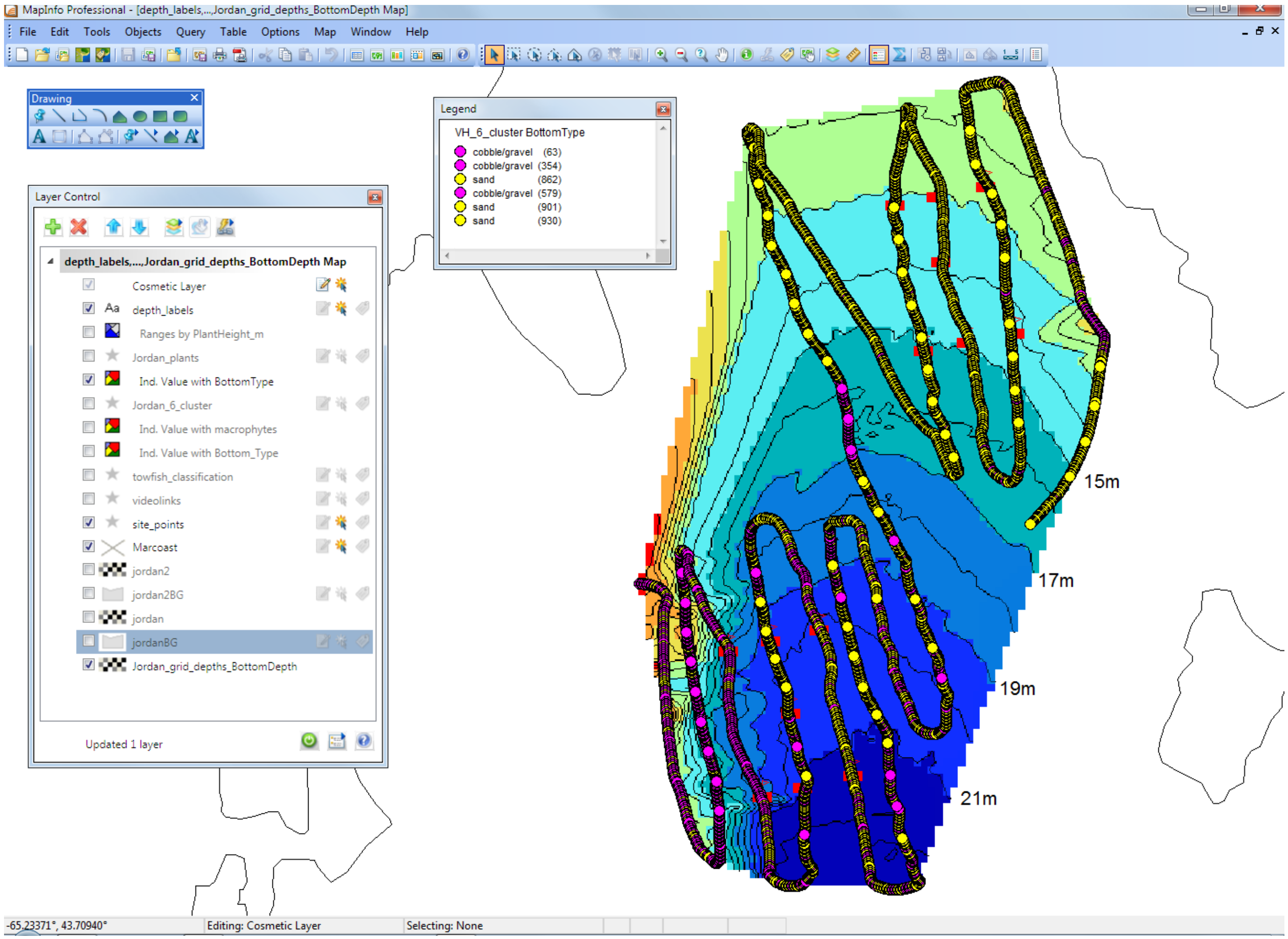

Figure 11: The results of a six cluster bottom type classification from Visual Habitat at Jordan Bay.

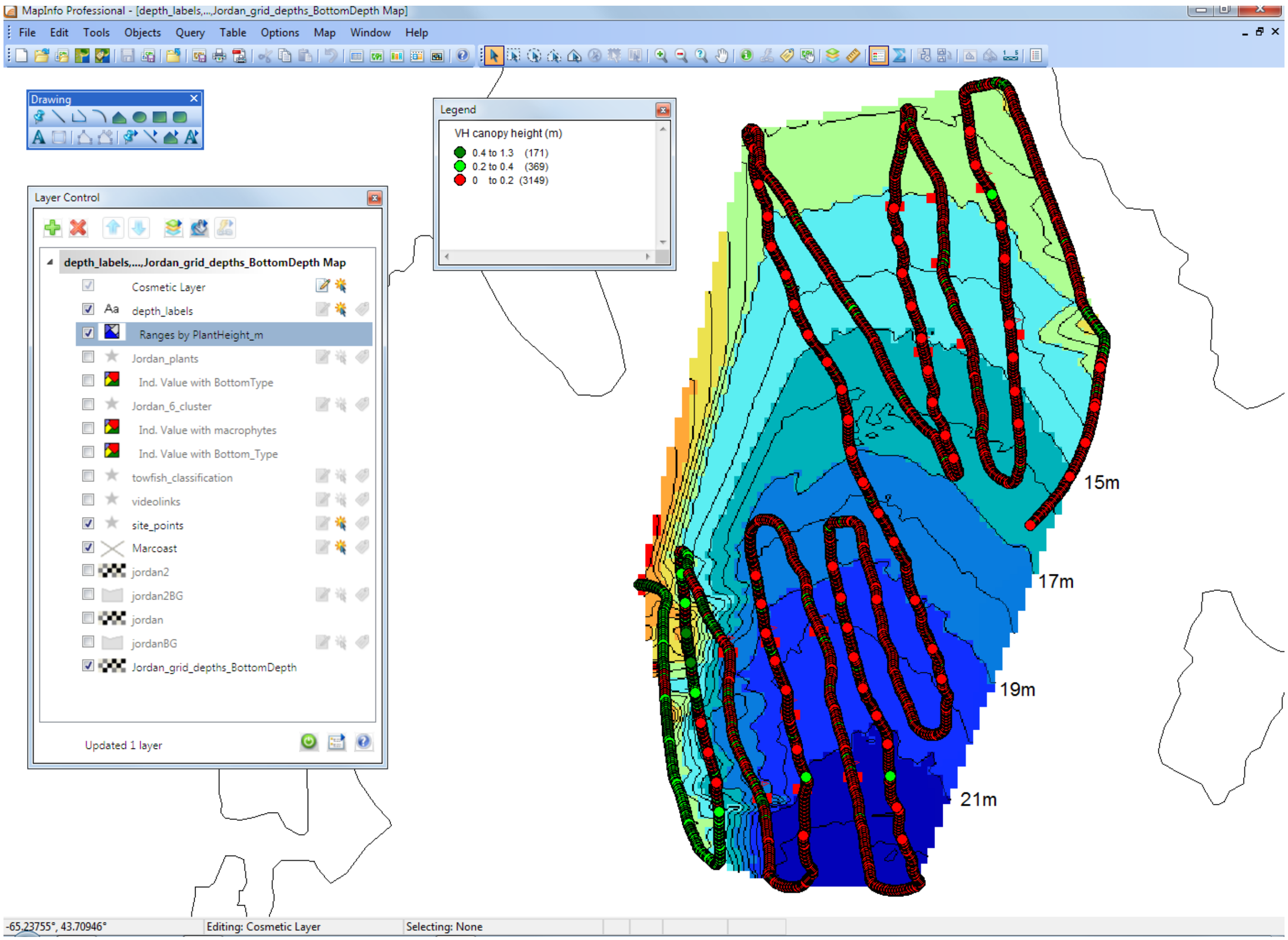

Figure 12: The results of a canopy height classification from Visual Habitat at Jordan Bay.

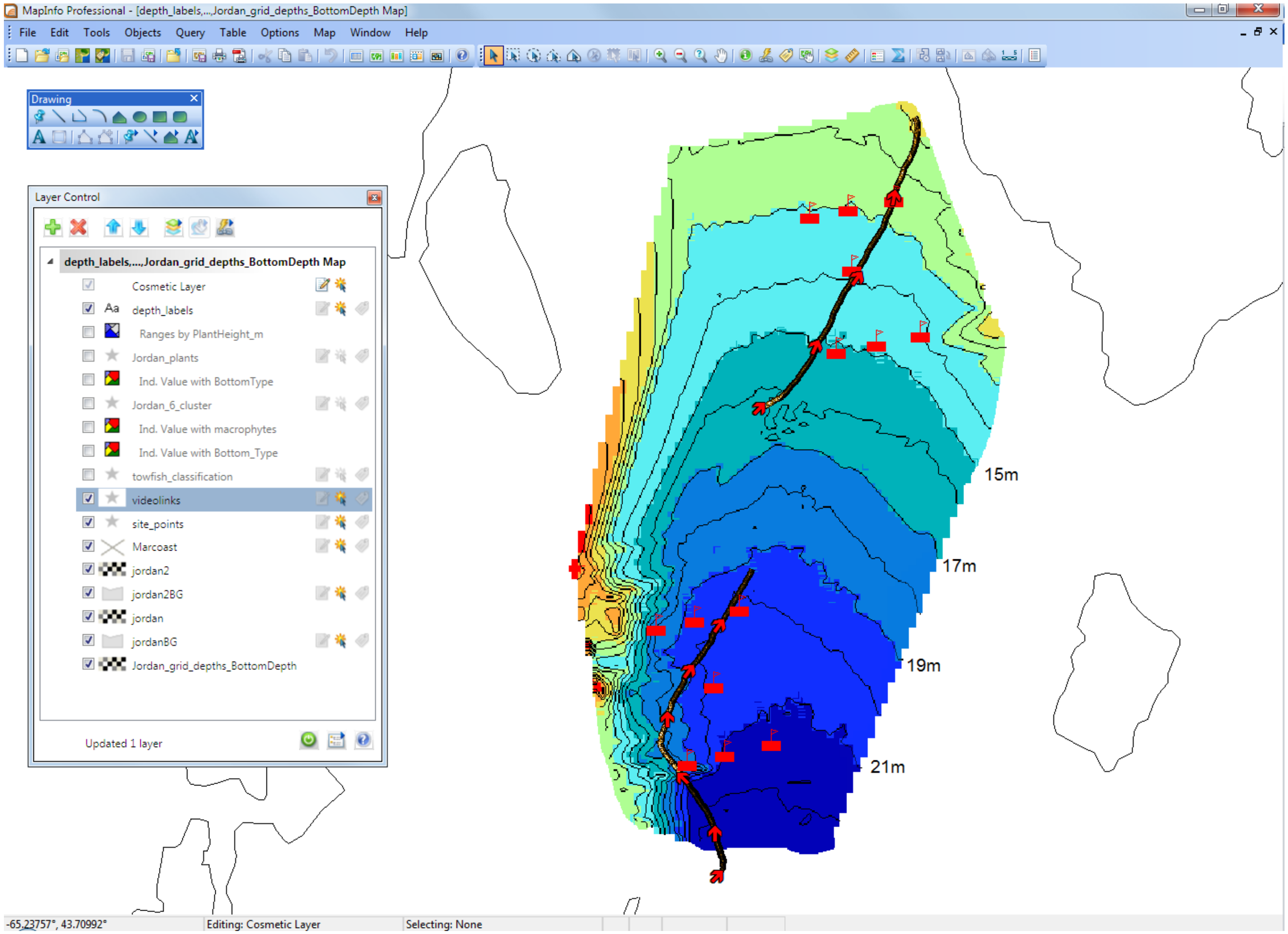

Figure 13: Towfish transects (dark lines) run through the Jordan Bay survey area. The red arrows indicate the direction of tow and points where video clips were embedded into the GIS.

Figure 14: Screen shot from video taken at section J1c at Jordan Bay. The cobble is pink due to the presence of coralline algae. The dark splotches are *Agarum*.

Figure 15: Screen shot from video taken at section J1f at Jordan Bay. This is a bare sand bottom with ripples.

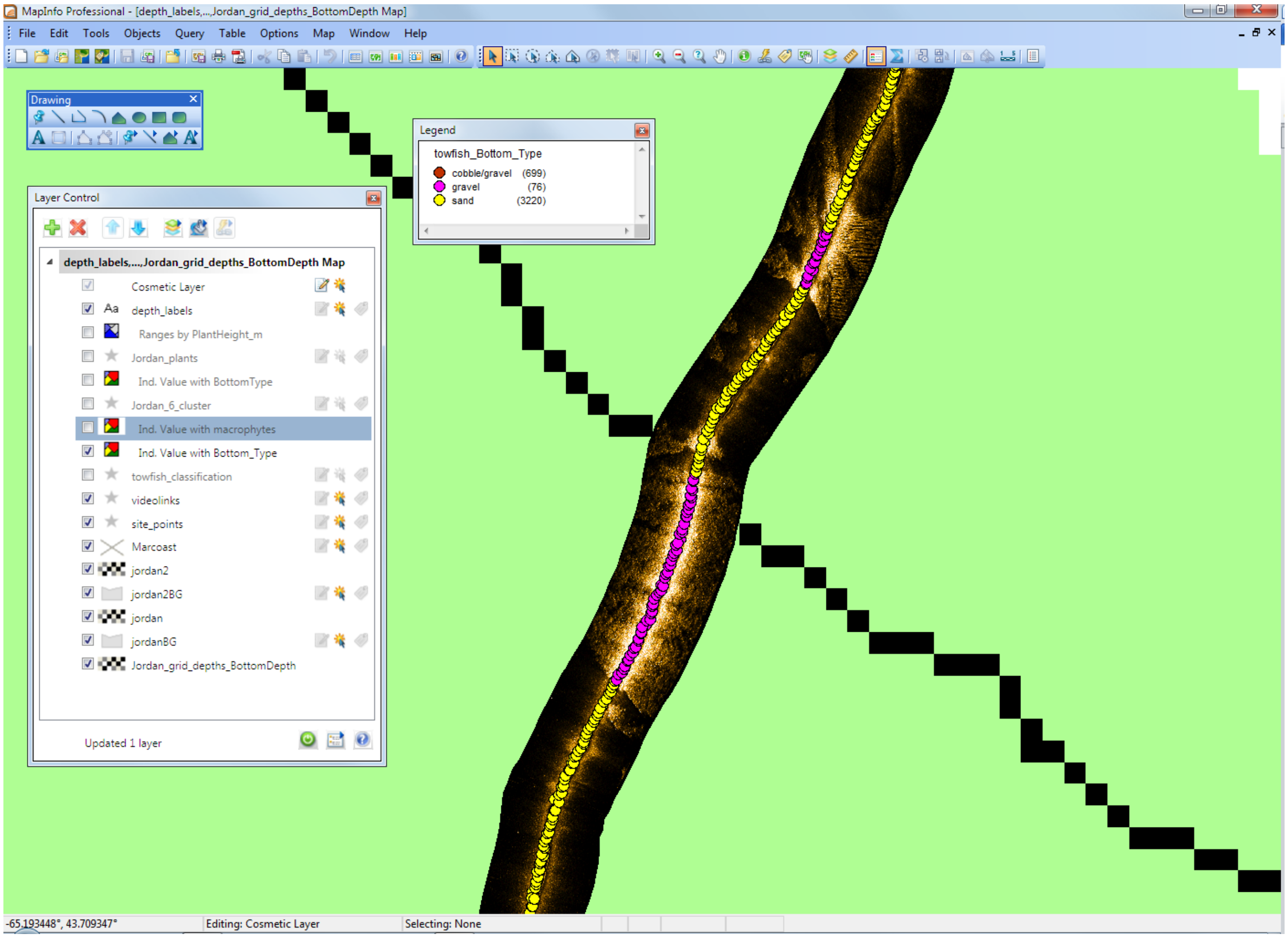

Figure 16: Towfish bottom classification in a portion of J2 at Jordan Bay.

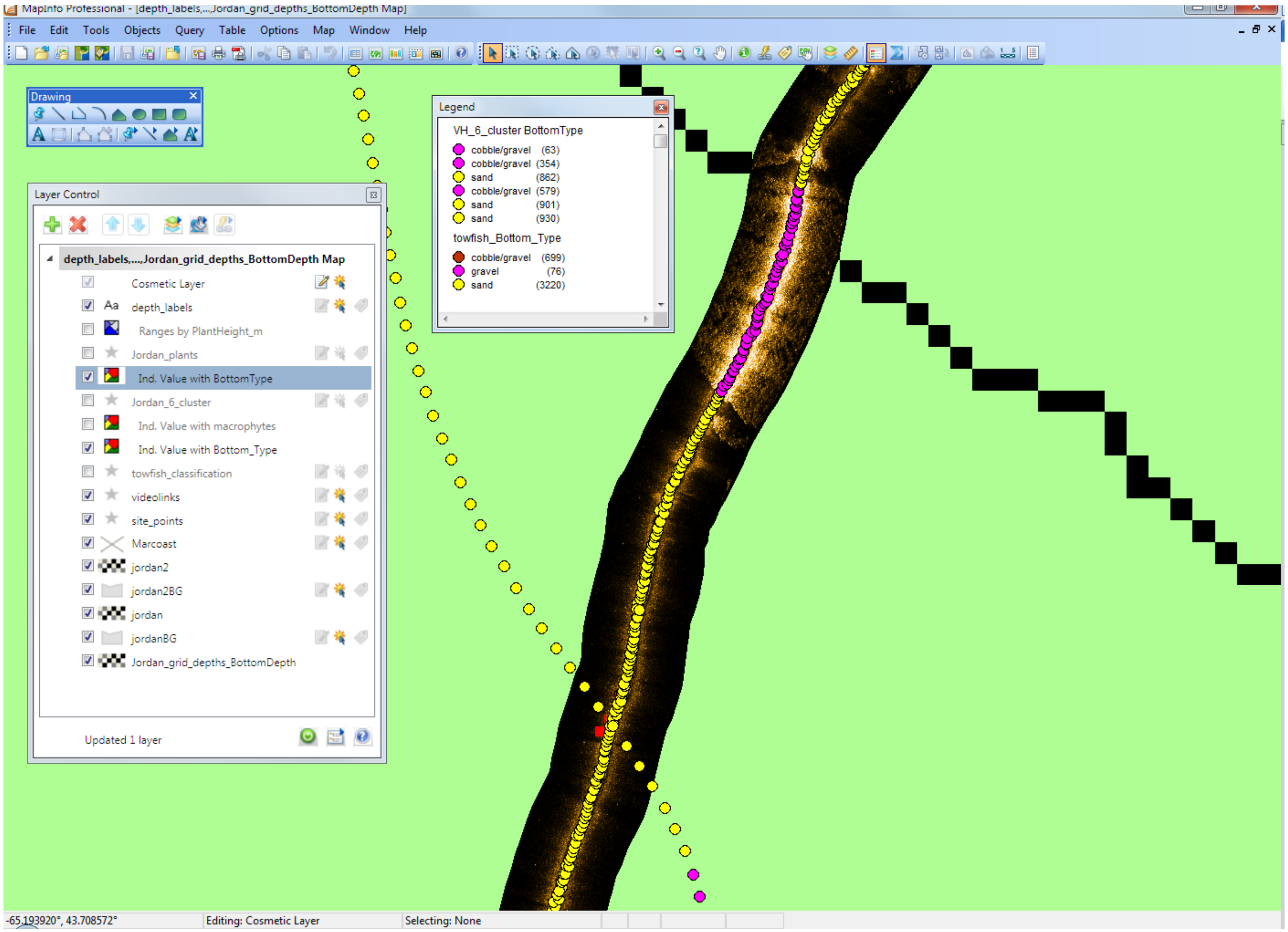

Figure 17: Similar to Figure 16, but now adding the Visual Habitat bottom classification.

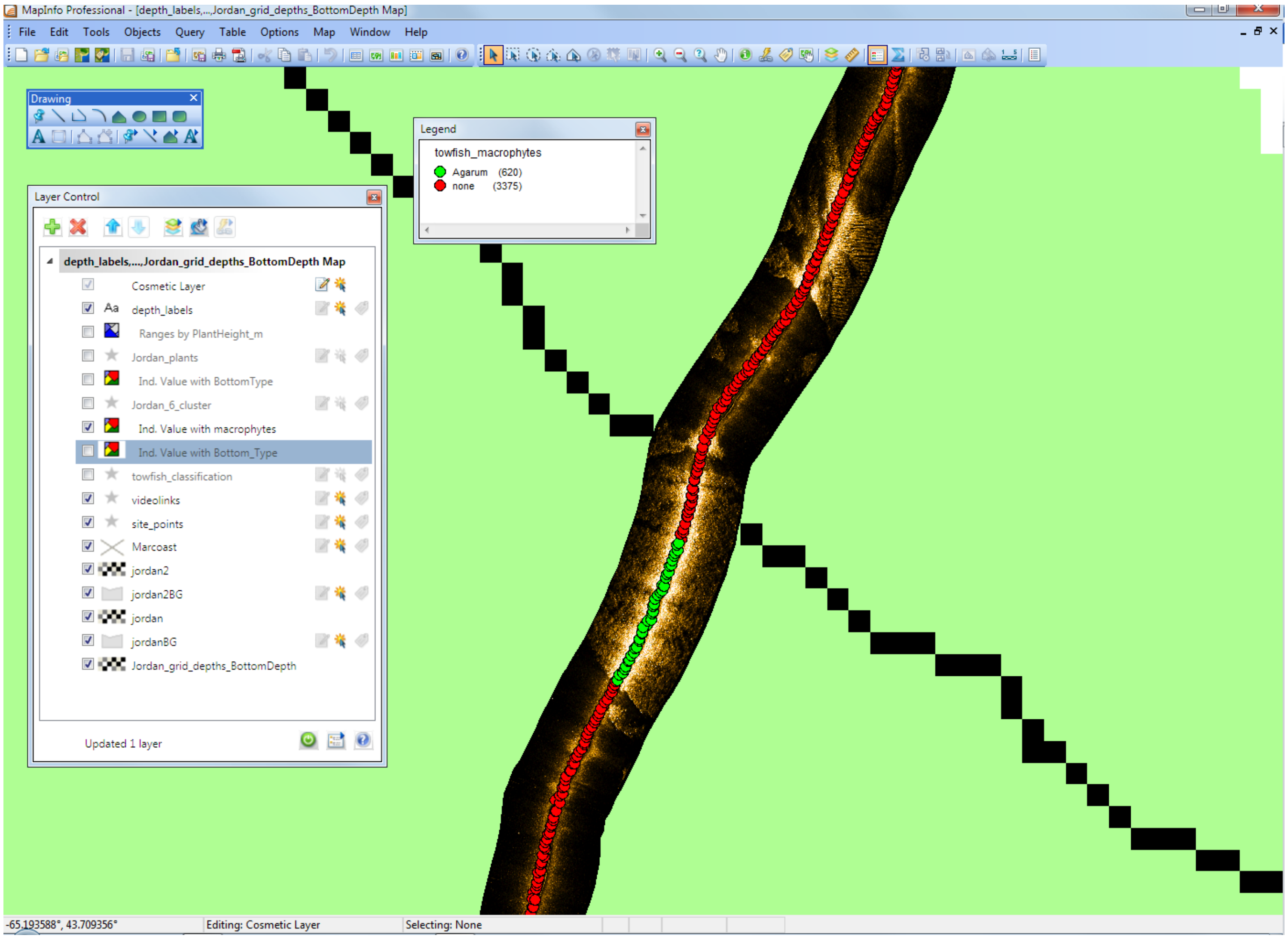

Figure 18: Towfish macrophyte classification for the same portion of J2 as in Figure 16.

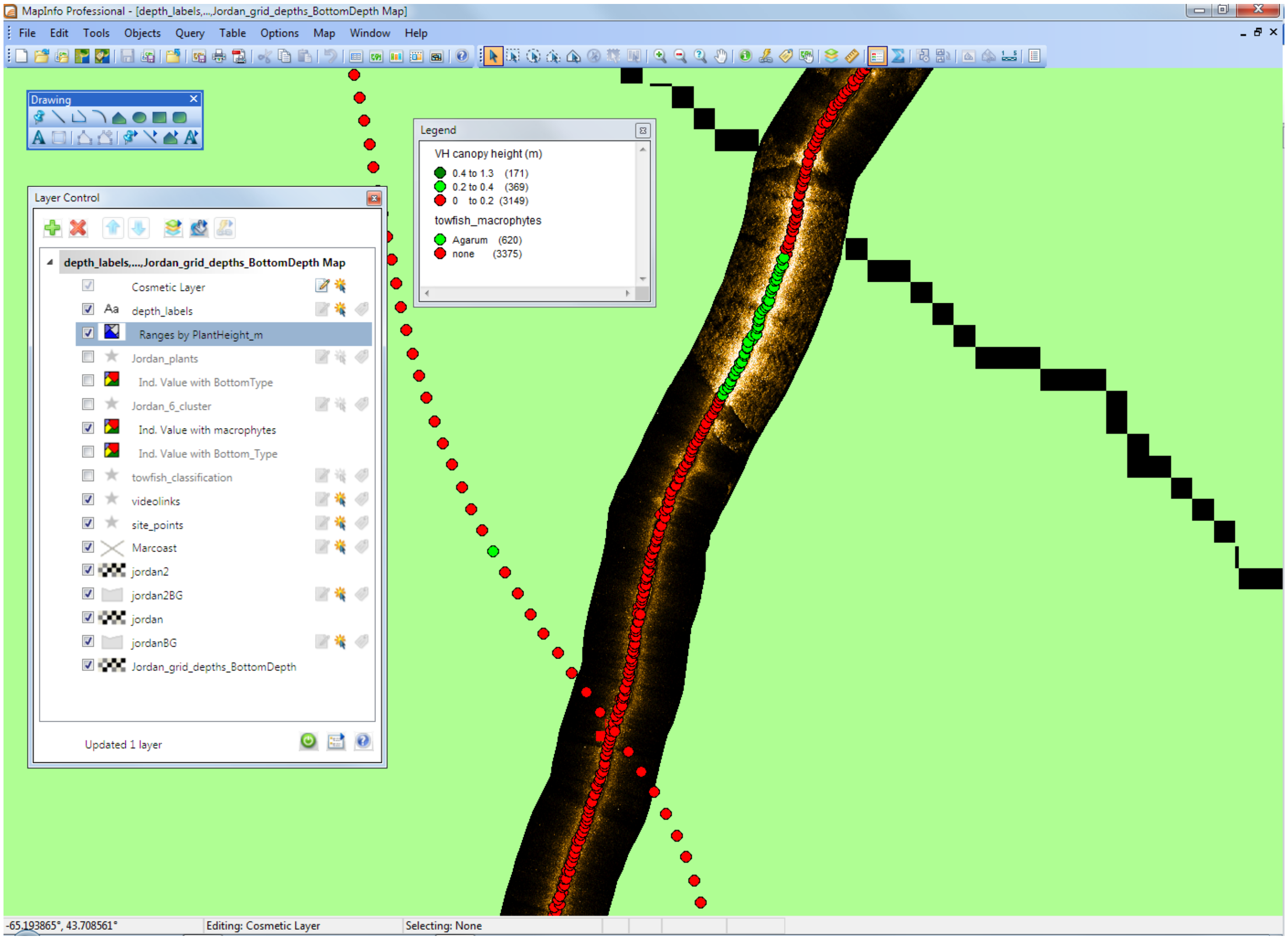

Figure 19: The same location as Figure 17, but now adding the Visual Habitat canopy height classification.

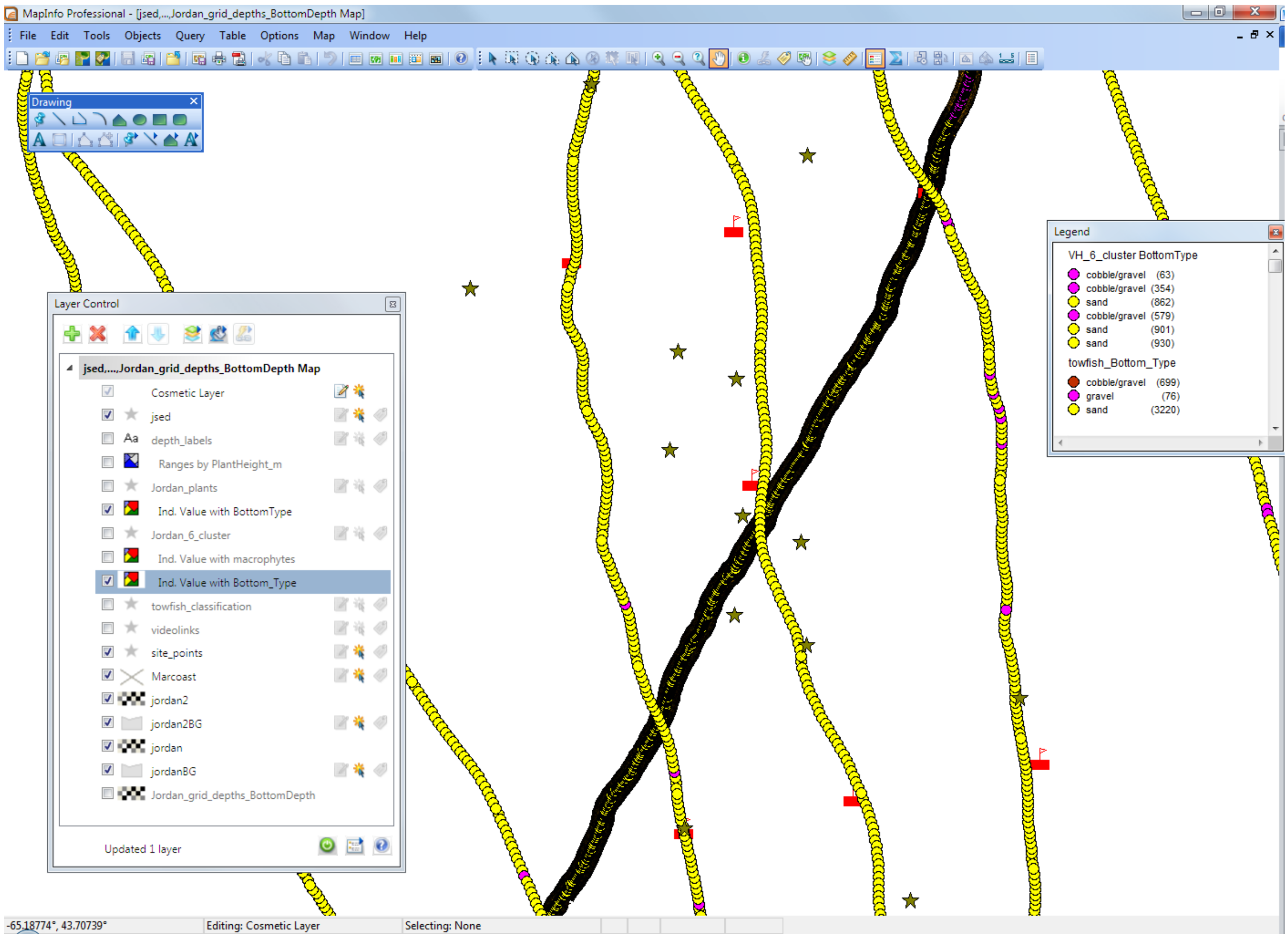

Figure 20: Location of 2010 sediment grab samples (stars) in northern site at Jordan Bay.

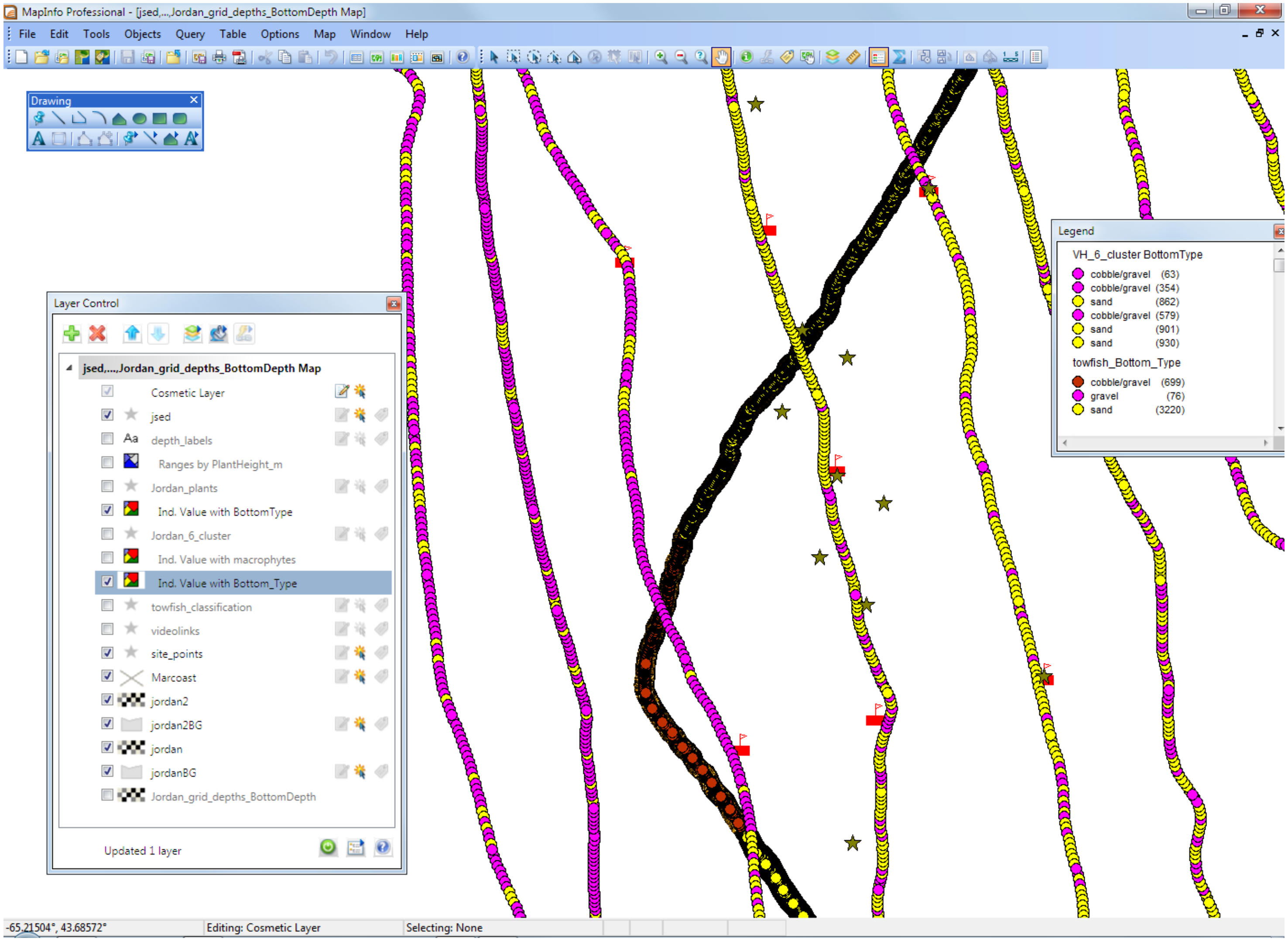

Figure 21: Location of 2010 sediment grab samples (stars) in southern site at Jordan Bay.