CLALLAM COUNTY MARINE RESOURCES ASSESSMENT OF CLALLAM COUNTY SHORELINE FEATURES

Prepared For:
Clallam Marine Resources Committee

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November 11, 2008

This report was funded in part through a cooperative agreement with the National Oceanic and Atmospheric Administration.

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PNWD-4016

November 11, 2008

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Acknowledgements

We appreciate the important contributions to this project made by many colleagues. David Freed and Cathy Lear (Clallam County Marine Resources Committee) provided funding and guidance throughout both project phases. Lee Miller (Battelle) helped conduct preliminary system tests in the laboratory and in the field. Rhonda Karls (Battelle) piloted the R/V Strait Science during the video assessment. Ron Thom and Dana Woodruff (Battelle) reviewed and edited this report. Erin Nave and Susan Brown (Battelle) provided contracting support.

Overview

The vast expanse of coastline within Clallam County contains a diverse array of shoreline features that are ecologically important to the functioning of the adjacent marine ecosystem. Documentation of shoreline features using a video mapping system from Red Hen Systems Inc. is valuable for assessing the current state of the environment, prioritizing potential sites for conservation, restoration or monitoring, and establishing a baseline which can be used to determine changes to the shoreline over time. This information is beneficial to the Clallam County Marine Resources Committee (MRC) as well as county planners, resource managers, and other local and regional jurisdictions that have an interest in the overall health of Puget Sound. Information gathered and data derived through this assessment will be directly applicable to the Clallam County Shoreline Master Program because it will allow for evaluation of nearshore health, and can be used to evaluate potential sites for restoration.

This project focused on the development and use of a video mapping system for the rapid collection and documentation of shoreline feature information in a spatially explicit manner that could then be incorporated into a Geographic Information System (GIS) for further analysis. Briefly, the Red Hen System consists of a video camera coupled to a GPS encoder/decoder hardware device that allows the collection of video information from a moving vessel travelling along the shoreline, the classification of features of interest, and the ultimate display and analysis of the information in a GIS system.

This study contained two primary objectives: 1) testing of the Red Hen System; and 2) conducing a boat-based video survey to capture shoreline features of interest along a 44 mile stretch of shoreline within Clallam County extending from the west end of Freshwater Bay to the lighthouse at the east end of the Dungeness Spit. Under objective one, we conducted a field study on May 29, 2008 supported by numerous hours of system testing. On May 29, 2008 a preliminary boat-based survey was conducted by Battelle to test the Red Hen system. System tests included determining proper boat speed, proper distance from shore, and camera settings. During that survey we recorded georeferenced video data from test locations between the west end of the Dungeness Spit to the Battelle dock at the entrance of Sequim Bay. Under objective two, a boat-based survey aboard the R/V Strait Science was performed on July 22, 2008 capturing a total of 6 hours and 8 min of video-footage. Two deliverables are part of this second objective, (a) original shoreline video, clipped into segments for each shorezone unit in the study area, and (b) mapped areas and underlying GIS datasets for large woody debris (LWD), armoring and feeder bluffs. We selected these features in consultation with Clallam County staff as they are likely to be better characterized from a horizontal perspective than from aerial photography or satellite imagery.

Methods

Field Methodology

The following paragraphs describe the boat-based field methods used to collect the information in Clallam County followed by the GIS post-processing methodology.

Equipment

- VMS (Video Mapping System) 300 unit (lithium battery, GPS antenna, 3.5mm stereo cable, feature trigger)
- Canon ZR45 MC Digital Video Camcorder
- Mini DV 60 minute video cassettes
- Camera tripod
- Canon Power Shot A95 Digital camera (5.0 mega pixels)
- Field notebook

The VMS 300 unit (Figure 1) connects to the video camera using a 3.5mm stereo cable (Figure 2) between the VMS 300 microphone/headphone connector and the video camera's microphone input connector. To acquire the precise location and time of video data being recorded, the VMS 300 unit encodes GPS coordinates to one of the videotape's audio tracks. The VMS 300 unit contains a standard GPS circuit board that monitors the satellite signals, converts this information into a data stream consisting of longitude (X), latitude (Y), actual time/date, and a variety of supporting data. The direct recording of "where and when" on the tape greatly facilitates field data collection—as long as there is GPS reception, the information is automatically recorded on the same medium (videotape) as the imagery. The internal GPS is accurate to a range of < 5 meters. The feature trigger, which is installed in the VMS 300 auxiliary port, allows a user to mark a particular point on the video tape such as a dock, seawall, or kelp bed as the video is being recorded. The feature was stamped with a GPS location for use in future mapping exercises. Additional equipment included a tripod for providing a stable platform for the video camera during video transects.

Figure 1. VMS 300 unit consisting of a lithium battery, feature trigger, GPS antenna, and 3.5mm stereo cable for attaching to the video camera.

Figure 2. Canon ZR45 MC Digital Video Camcorder with the 3.5mm stereo cable between the VMS 300 microphone/headphone connector and the video camera's microphone input connector.

Field Video Survey

On July 22, 2008, we conducted a video survey from the west end of Freshwater Bay to the lighthouse at Dungeness Spit covering a distance of 44 miles (Figure 3). A Canon ZR45 MC digital video camcorder was attached to a tripod on the starboard side of the R/V Strait Science and the tripod was attached to the boat using removable cable ties. All cables (stereo cable, GPS antenna, and feature trigger) were attached to the VMS 300 unit (housed in a Pelican case to avoid moisture) and the video camera. The VMS 300 unit was turned on to acquire a satellite fix (the GPS antenna was placed at the highest point of the boat to help acquire a GPS fix) and a mini DV 60 minute cassette was installed in the video camera. To ensure the system was fully operational, a few minutes of video was recorded, rewound, and played back to listen for a modem sound from the speaker. This sound indicates that GPS data are being recorded to the video tape. Video transects were run parallel to the shoreline at approximately 100 yards from shore at an average speed of 5.3 knots. Video was collected in a 16:9 format and ran close to 50 minutes per tape. All efforts were made to maintain a constant distance and speed; however, navigational hazards such as kelp beds, shallow water, sand shoals, or underwater pilings resulted in a deviation from our intended course. In areas where bottom bathymetry allowed, we were able to get closer to the shore. There were two instances on the tape where video was not continuously recorded due to prop fouling by kelp within Freshwater Bay. The boat was re-positioned and the kelp was removed from the prop. We recorded a total of 6 hours and 8 min of video collected over 8 tapes numbered in sequential order (1-8) starting at the west end of Freshwater Bay (tape 1) and ending at the Dungeness Spit Lighthouse (tape 8). The total time recorded on each tape ranged from approximately 27 to 51 minutes (Table 1). In addition, digital pictures taken on a Canon Power Shot A95 of the project were taken to document the project in progress. GPS coordinates and features are recorded on the path of the boat travelling parallel to shore.

Figure 3. Geographic extent of the Clallam County video mapping survey.

Table 1. Total minutes of recorded video per tape.

	Tape Number	Total Minutes of Recorded Video
West End FW Bay	1	00:47:10
↓	2	00:51:34
↓	3	00:50:01
↓	4	00:48:27
↓	5	00:48:21
↓	6	00:48:12
↓	7	00:47:31
Dungeness Spit Lighthouse	8	00:27:00
	TOTAL	**06:08:16**

GIS Methodology

Importing georeferenced video into ArcGIS

Video tapes were post-processed using Ulead Video Studio 8, and point shapefiles were created marking the boat track for each tape. The following equipment and software was used to convert video into an ArcGIS compatible format.

- Sony Handcam DCR-HC90[1]
- Plextor PX-M402U converter (converts video tape to digital movie formats)
- Computer with the following software:
    - Ulead VideoStudio 8 (program used convert video tape to DVD digital movie format)
    - ArcMap
        - GeoVideo Extension
        - PixPoint Extension

Detailed instructions for converting tape to digital video and for creating a map with associated video in ArcMap are provided in Appendix A.

Creating video segments based on shorezone units

In 2001, the Washington Department of Natural Resources conducted a shoreline inventory of Washington. Features such as eelgrass, kelp, and anthropogenic factors were recorded for each unit. Changes in beach morphology were used to determine breakpoints for individual shoreline units (Berry et al. 2001). Units based on these breakpoints, or shorezone units, have been used in other assessments across Puget Sound and the Salish Sea as a starting point for current shoreline inventories and shoreline master program updates (Diefenderfer et al. 2006). To create a resource that could be used by planners, biologists, and the general

[1] We used different video camera to convert the mini DV tapes to digital format because the Canon did not have all of the ports required. The Sony Handycam had the correct AV port for connecting to the Plextor converter. However, in the future, if the video camera used has all the ports necessary to complete the survey, then only one video camera is necessary.

public alike, we created video clips that correspond to the 34 shorezone units that are found along this stretch of shoreline. Some video clips were further segmented, so as no clip would exceed 15 minutes. A new GIS shapefile was created that held the original shorezone unit ID and a new attribute corresponding to the filename of the video clip.

Mapping shoreline features

Through discussions with Clallam County, we selected three features for mapping: (a) large woody debris, (b) shoreline armoring, and (c) feeder bluffs. Each feature was mapped using the generalized shoreline from the shorezone inventory as the linear basis for mapping the features. A summary of classification scheme is provided in Table 2. Aerial and satellite imagery and oblique photographs supplemented the video segments for improved feature classification. Three GIS shapefiles were created, one representing each feature mapped. Examples of mapped features are provided in Figures 4, 5 and 6.

Table 2. Information regarding how shoreline features were classified.

Feature	Classification	Description
Shoreline Armoring	Present Absent	Areas with shoreline armoring are designated as present, those without as absent. Minimum mapping distance is 100ft. In other words, breaks or small amounts of armoring are not designated.
Large Woody Debris	Present – common Present –sparse Absent	Areas with less than 5% of shoreline with large woody debris are mapped Absent, those with 5-20% of shoreline length are mapped as Present–sparse. Those with over 20% of shoreline length with LWD are mapped as Present-common
Feeder Bluffs	No bluff; Bluff-vegetated Bluff-unvegetated	Shoreline with no bluffs are classified as 'No Bluff'; those with bluffs but vegetated are classified as 'bluff-vegetated', and those with unvegetated bluffs are classified as 'bluff-unvegetated'

Figure 4. Bluffs- The feature to the left is classified as a vegetated bluff, while the feature in the right is an unvegetated bluff.

Figure 5. Armoring- While the gravel slope to the water in the left figure provides a break in the shoreline armoring to both sides, this break is less than the minimum mapping distance of 100ft, so it was not characterized as a break in armoring. Likewise, the vegetated hill falling between the two armored shorelines in the right picture is not captured.

Figure 6. Large Woody Debris -In the figure to the left, large woody debris covers about 80% of the shoreline from the camera's view. This shoreline is classified as Present-abundant; while the area to the right has about 10% LWD. The area to the right is classified as Present-sparse.

Results & Discussion

Characterizing Shoreline Features

Through use of the Red Hen video system, over 14 miles of shoreline armoring was mapped, large woody debris was present and identified for 21 miles of shoreline, and nearly 14 miles of bluffs characterized (Figure 7a, 7b, 7c).

Figure 7a. Results of the feature mapping exercise depicting shoreline armoring.

Figure 7b. Results of the feature mapping exercise depicting feeder bluffs.

Figure 7c. Results of the feature mapping exercise depicting large woody debris.

Use of ancillary data sources in mapping

Mapping these three features provided insight into some additional recommendations into the best mapping methods. Feeder bluffs, though not easily characterized from aerial photography, can be identified through the Washington Department of Ecology Oblique photos. However, using the oblique photos in conjunction with the georeferenced video permitted us additional accuracy in identifying the starting and stopping points of the bluffs (Figure 8).

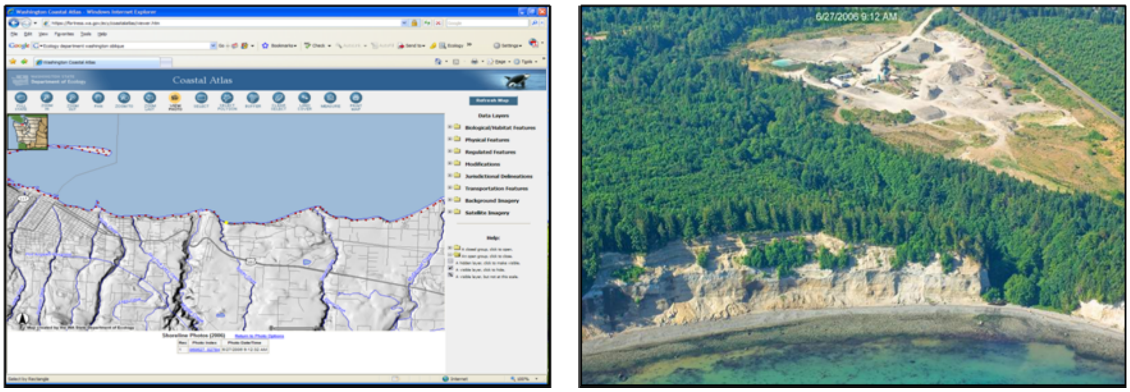

Figure 8. Oblique photos are generally georeferenced (left). However, the georeferenced video provides additional geo-spatial precision to better characterize the beginning and ending of feeder bluffs.

Large woody debris, if very abundant, can be characterized by the oblique photos as well, but the lateral view of the video provided additional information to differentiate between areas with sparse LWD or no LWD. It also helps identify areas not captured well by the photography (Figure 9).

Figure 9. Large woody debris can be seen on the tip of Dungeness Spit in the oblique photo to the left, but the area near the Lighthouse is not as clear. The video mapping system (right) provides an additional source of information to help map these areas.

Finally, armoring is not well characterized by most oblique photography nor by aerial imagery. The lateral view of the video mapping system is best at capturing these features (Figure 10). The only drawback was the lack of depth perception with the lateral view.

Figure 10. Though armoring is apparent in the right side of the picture, the rocks apparent past the lamp post are set back. This lack of depth perception made shoreline armoring difficult to characterize in places.

Suggestions for Future Surveys and Assessments

For future shoreline surveys using the Red Hen System we recommend the use of a stabilizing mechanism for the video camera such as a gimbal to reduce the pitch and roll effects of the boat in rough seas. This would significantly enhance the picture quality and provide a stable platform in which to conduct the video assessment. We also recommend that the county purchase the Red Hen video extensions for ArcView (GeoVideo and PixPoint), so that they have the capability to review the collected video data and conduct their own analyses that may be beneficial to updating their Shoreline Master Program.

The data generated through this assessment should be directly applicable to the Clallam County Shoreline Master Program as it will allow for evaluation of nearshore features in a geo-spatial context. We have used this type of data previously in the following jurisdictions to develop a scientific methodology to assess cumulative impacts and prioritize restoration opportunities based on changes in stressors, controlling factors and functional habitats within an appropriate decision unit as determined by scientists and managers within each jurisdiction:

- Bainbridge Island
- Jefferson County
- Kitsap County
- Lower Columbia River Estuary Partnership
- Gulf of Mexico (www.gomrc.org)

Within each jurisdiction, the condition of the nearshore habitat is scored relative to the level of various stressors (e.g. overwater structures, armoring, loss of riparian nearshore vegetation) affecting sections of the shoreline. Scoring requires a score for the level of stress on a particular controlling factor. For example, overwater structures would have a high stress score on *light* reaching the nearshore vegetation. Light is a major controlling factor. In addition the functions of shoreline sections are scored relative to observed or reported functions such as baitfish spawning habitat, shellfish harvest areas, etc. Thus the Red Hen system supplies data directly required for the scoring model now commonly applied to nearshore areas in Puget Sound (Diefenderfer et al. in review). Understanding the probability of success of restoration as represented by site and landscape scale stressors and functions provides a critical variable in a general formula for prioritizing restoration projects:

$$\textit{Site score} = (\Delta \textit{function} \times \textit{size} \times \textit{success}) \div \textit{cost}$$

A proposed restoration project receives a higher score if it provides better change in ecological function, covers a larger area, has a higher probability of success, and costs less (Diefenderfer et al. 2006). The video data collected in this project, provides scoring at the level of the stressor and the level of ecological function (Diefenderfer et al. 2006, Evans et al. 2006, Williams et al. 2004).

This type of analysis could be used by local jurisdictions, such as Clallam County, for site assessments and shoreline planning processes (e.g. shoreline master plan updates). Incorporation of data collected by the Red Hen system, or additional information such as forage fish habitat data, or other natural resource or physical characteristic data can also be incorporated into this process once the goals and objectives are determined.

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Appendix A

Instructions for Converting Tape to Digital Video
To begin, insert a mini DV tape into the Sony Handycam. On the computer open the Ulead VideoStudio 8 program and select the VideoStudio Movie Wizard (Figure 1). Select the Capture tab at the top of the screen. On the Capture tab set the source to Plextor ConvertX M402U AV Capture, set the format to DVD, and under the capture folder menu choose the folder where the video file is to be placed. To capture the video, push play on the Sony video camera, and select the Capture Video button in the movie wizard. Note that if 15 minutes of video were collected, it will take 15 minutes to convert the video. Fifteen minutes of video requires approximately 410MB of storage space. Once the video has been converted then exit out of the Ulead software.

Figure 1. Ulead VideoStudio 8 Movie Wizard.

Instructions for Creating a Map with Video in ArcMap
To begin, open ArcMap and enable the GeoVideo and PixPoint extensions (Figure 2). Go to the GeoVideo tool bar and select the Import Media button (Globe icon), the Add Media Wizard box will appear (Figure 3). Select the Geospatially Encoded Media box and select Next. In the second screen, click on the Media Files button and search for the folder where the converted media file was placed, select it and click on the check box. Once the file has been located, under Destination Options, select Shapefile, and under Projection select GCS_WGS_1984. Using the default settings the recorded video will be in geographic decimal degrees; however, once imported into ArcMap they will need to be assigned in ArcToolbox. Select Next and the program will create supporting folders and copy the media

file (this step takes a few minutes as the media is being imported). Finally, select Finish in the Media Wizard box.

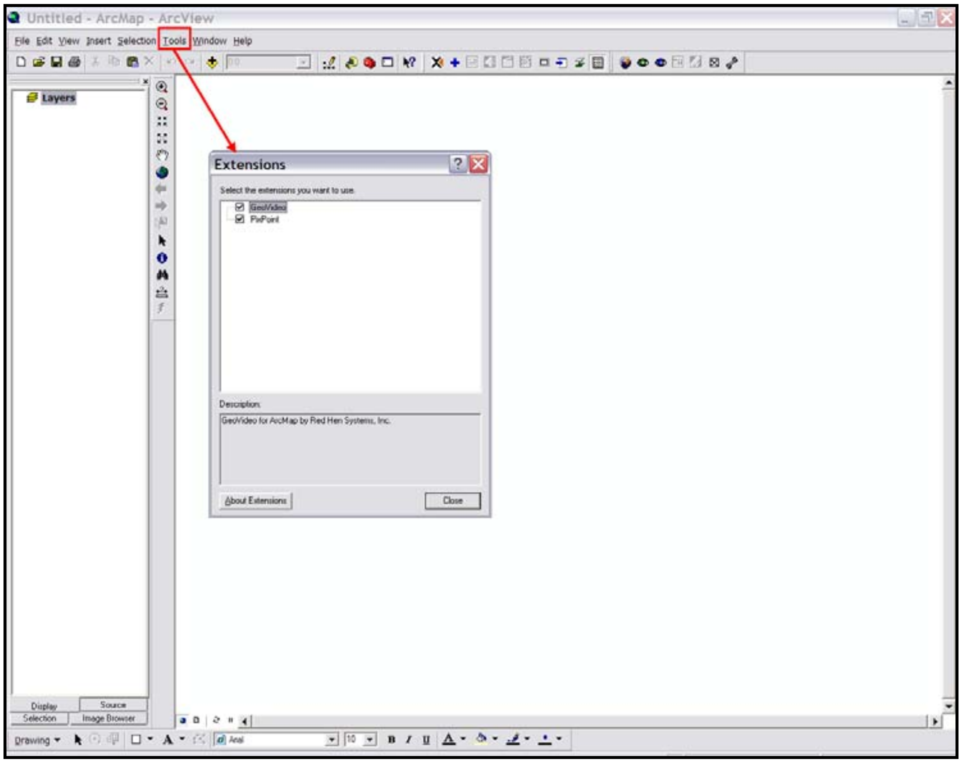

Figure 2. Extensions in ArcView used to create and view video data.

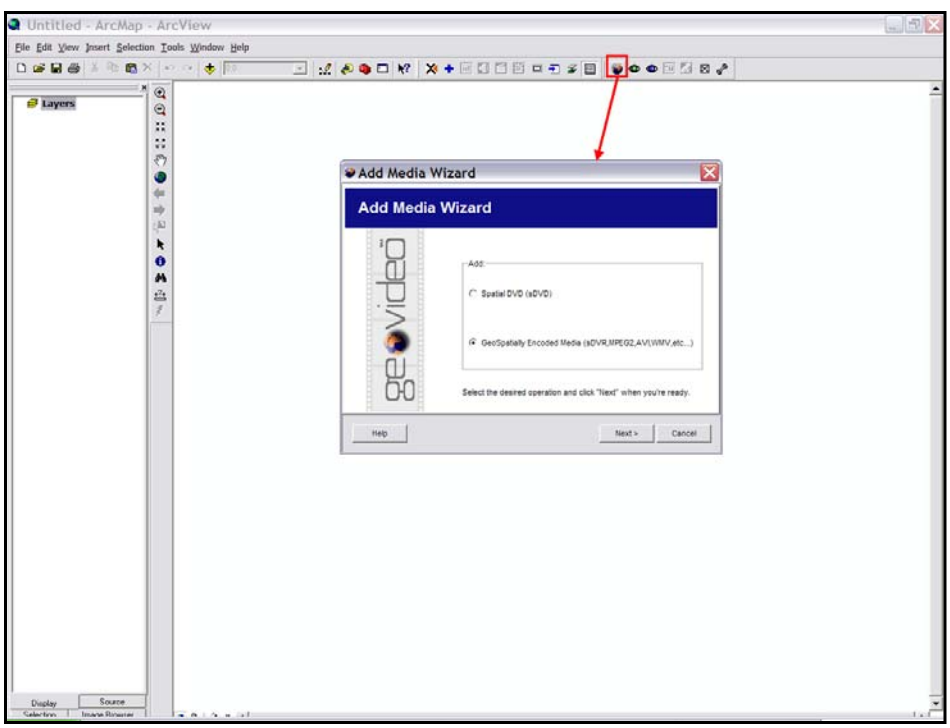

Figure 3. Add Media Wizard within the GeoVideo extension.

At this point, a map with the transect that was downloaded should appear in ArcMap. To view the video at any point along the transect, go back to the GeoVideo tool bar and select the green button with the arrow (plays video from a selected point button, Figure 4). Then move the cursor over the transect at any point and click the mouse button. The video will start to play from that point forward. As the video plays, there will be an icon moving across the transect (blue arrow in figure 4) in ArcMap that shows the user where along the shoreline the video was captured. Other features within the video pane include the video clip or snap image features. These buttons allow a user to take a still image from a selected point or clip a video between two points.

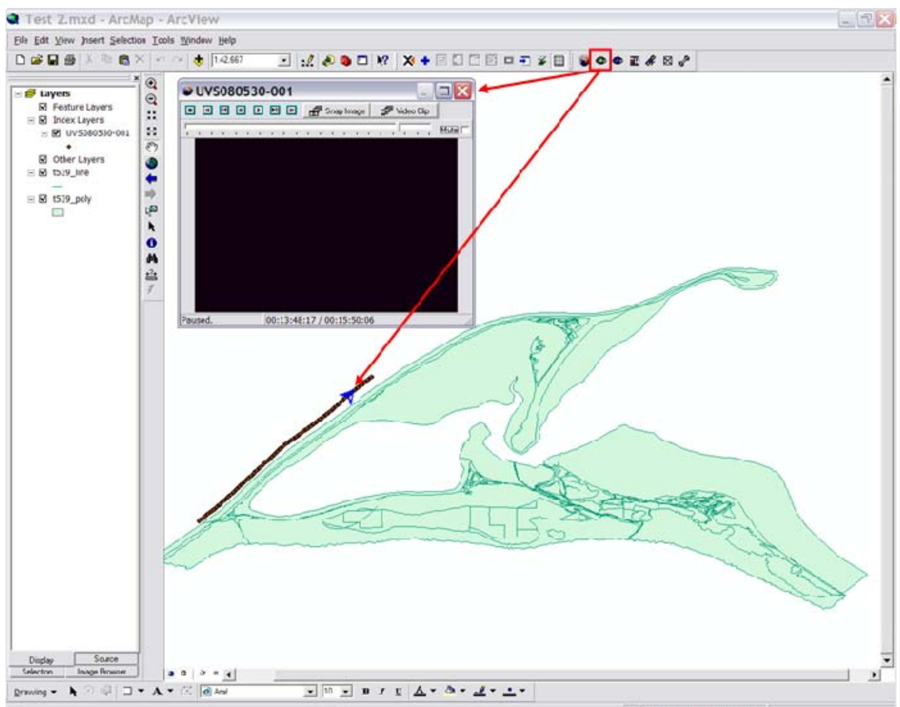

Figure 4. Button for playing video back from a selected point along the transect.