Improving Oil Spill Environmental Sensitivity Maps with ShoreZone Imagery, Examples from Prince William Sound

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Summary

Environmental Sensitivity Index (ESI) mapping proposes to provide accurate representation of an area's shoreline categorized as to shoreline type on a scale of 1 to 10 determined by sensitivity to spilled oil. Originally, field work utilized the hand-drawing of categories onto USGS topographic maps while seated in an aircraft flying the coastline. ESI categorization could only be verified by photographs taken at the time and by intermittent ground truthing. ESI maps could not be verified by others, especially if remote coastline was involved.

Today large sections of the Alaskan coastline have been flown by the ShoreZone program which has captured high-resolution still photographs (able to resolve shoreline features of ~0.3 m and less) and lower resolution continuous video imaging taken from a low- and slow-flying helicopter. Both video and still photographs are readily available at (http://alaskafisheries.noaa.gov/habitat/shorezone/szintro.htm) enabling a desk-side review of any specific location at any time. A voice-over recorded during the survey is also available, but not online.

Prince William Sound (PWS) has been ESI-categorized several times, most recently in 1999 (2007 digital re-release). I compared several parts of the current PWS ESI shoreline with ShoreZone imagery using the ESI maps in ESRI ArcMap and supported by GoogleEarth. Multiple examples find that the current ESI maps commonly do not take into account features less than ~100 m in length (thereby omitting many pocket gravel beaches and rock platforms), may overlook features (e.g. large tidal flats as in the Port Chalmers and Lower Passage areas), have the wrong location for divisional boundaries between shoreline types, are inconsistent within a shoreline type category (particularly sheltered rubble slopes (8D)) and, while getting the overall features generally correct, are commonly in error at many specific locations.

A thorough review of current ESI shoreline maps using the readily available ShoreZone images will improve both the accuracy and resolution of these maps, not only in Prince William Sound but in other areas where ShoreZone images are available.

Background

Historically, shorelines in the area of study were characterized for ESI maps by one or two observers flying in aircraft and physically noting the shoreline type on paper maps (1:24,000 scale if available; 1:63,360 in Alaska). The first maps were hand-colored and reproduced photographically, making their distribution costly and very limited. The advent of GIS (Geographic Information System) and web-based technologies enabled the low-cost reproduction and distribution of these maps (e.g. NOAA website: www.response.restoration.noaa.gov/). In addition, maps are able to be produced at far greater scale and detail than the original base map, and can be verified using a field based GPS (Geographical Positioning System). Continuing in this same line of progress, GoogleEarth (and other space-based imaging) enables viewing of the shoreline at unprecedented detail. Lastly, and the focus of this paper, ShoreZone enables the linkage of video digital imaging, high-resolution digital photographs, and a web-based reader which allows a viewer to literally fly the shoreline (and confirm shoreline type characterization) from the viewer's desk.

Figure 1 shows the location of ShoreZone images in Alaska and a view of the new user interface showing the location of video and high-definition still photographs. References associated with the program are found at: http://alaskafisheries.noaa.gov/habitat/shorezone/szintro.htm. This review uses the digital files from "Prince William Sound, Alaska – July 2000, Environmental Sensitivity Index Maps, Digital Data re-release, April 2007". Digital files were projected and compared in ArcMap.

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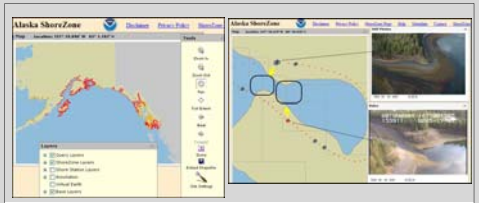

Figure 1. ShoreZone Alaska interactive query screens. Left: Available image areas are colored. Right: Details of the query screen with the location of high resolution photos and video images indicated. From: http://mapping.fakr.noaa.gov/shorezone/.

Areas Reviewed – ESI Shoreline Types

Figure 2. Four sites in Prince William Sound are included in this review. The shoreline index used in Prince William Sound is shown at right.

Example 1: Northern Port Chalmers, Montague Island

Figure 3 compares the existing ESI shoreline characterization with that derived by using ShoreZone images. Example supporting ShoreZone images are shown in Figure 4. Major changes to the existing ESI shoreline characterization (from north to south) include:

- Exposed tidal flat along north shore added.
- Sheltered tidal flat and marsh extent added in the small embayment in northeast corner.
- Marsh (10A) is reduced in the central area and gravel beach (6A) added.
- Sheltered (9A) and exposed (7) tidal flats, and marsh (10A) are added in the south.

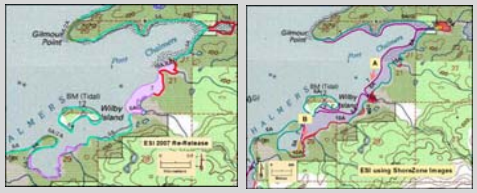

Figure 3. Northern Port Chalmers, Montague Island. Left: Shoreline types from ESI 2007 re-release digital files. Right: Shoreline types determined using ShoreZone images. "A" and "B" refer to ShoreZone images in Figure 4.

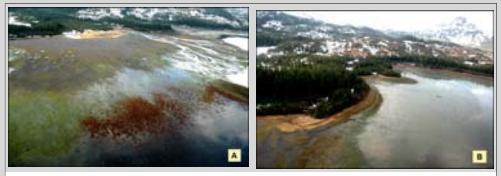

Figure 4. ShoreZone high-definition digital images north Port Chalmers, Montague Island, showing large tidal flats and marsh that are not marked on the ESI maps (2007 re-release).

Example 2: South Port Chalmers – Montague Island

Figure 5 shows the southern end of Port Chalmers. The ShoreZone images show that both exposed and sheltered tidal flats (7 and 9A) as well as marshes (10A) are omitted from the ESI shoreline characterizations.

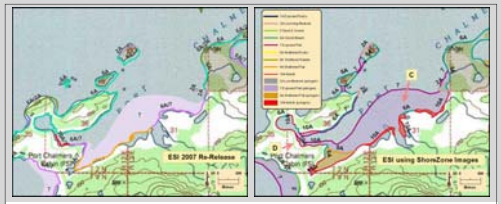

Figure 5. Southern Port Chalmers, Montague Island. Left: Shoreline types from ESI 2007 re-release digital files. Right: Shoreline types determined using ShoreZone images. "C" and "D" refer to ShoreZone images in Figure 6.

Figure 6. ShoreZone high-definition digital images of southern Port Chalmers showing marshes and tidal flats that are not marked on the ESI maps (2007 re-release).

Example 3: Stockdale Harbor – Montague Island

Figure 7 shows shoreline types from Stockdale Harbor. The ShoreZone images show that many sections of exposed and sheltered tidal flats (7 and 9A) as well as marshes (10A) were omitted or wrongly classified on the 2007 sensitivity maps.

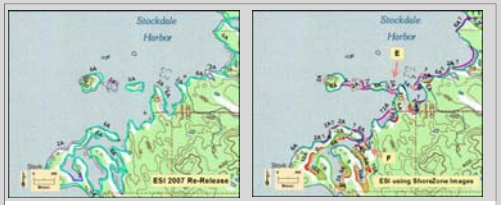

Figure 7. Stockdale Harbor, Montague Island. Left: Shoreline types from ESI 2007 re-release digital files. Right: Shoreline types determined using ShoreZone images. "E" and "F" refer to ShoreZone images in Figure 8.

Example 4: Stockdale Harbor (cont.)

Figure 8. Stockdale Harbor ShoreZone images showing omitted tidal flats (exposed in image "E" and sheltered in image "F").

Example 5: Disk Island)

This example from Disk Island shows that the ShoreZone images enables a much more detailed and accurate characterization of the shoreline.

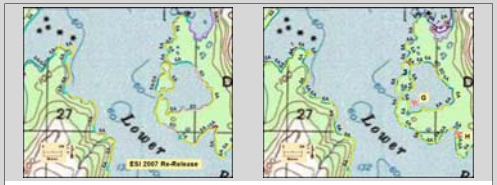

Figure 9. Disk Island and Lower Passage. Left: Shoreline types from ESI 2007 re-release digital files. Right: Shoreline types determined using ShoreZone images. "G" and "H" refer to ShoreZone images in Figure 10.

Figure 10. ShoreZone high-definition digital images of Disk Island. "G" shows several pocket gravel beaches (6A) not indicated on the ESI 2007 maps. "H" shows a pocket cove classified by ESI 2001 as Marsh (10A) whereas image shows it is gravel (6A).

Conclusions

ShoreZone imagery offers an economical method of improving the quality of ESI shoreline characterization. The high-definition digital photographs offered are particularly useful. The available digital video images are less able to differentiate shoreline details but assist in locating the specific site of the digital photograph and to fill in locations where digital photographs are not available. The ability to access these images from the web enables a reproducibility and verification of results not previously available to shoreline mappers.