Hurricane Mitch: Mapping Coastal Habitats

by Lawrence R. Handley, Jesse L. Thibodeaux II, Jason L. Dugas, Kelly Mouton, and Bryan Haviland

USGS Open File Report
OF 03-283

U.S. Department of the Interior
U.S. Geological Survey

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards.

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Citation:

Handley, L. R., Thibodeaux II, J.L., Dugas, J.L., Mouton, K., and Haviland, B., 2002, Hurricane Mitch: Mapping coastal habitats: U.S.G.S. Open File Report 02-xx, x p.

List of Tables and Appendixes

Tables:

Appendixes:

Background

Coastal habitats play a crucial role in the protection of inland habitats and human-made structures from maritime storm events such as hurricanes. Coastal habitats are the first to receive the full impact from storms and may be severely damaged.

The coastal habitats of Honduras were greatly affected by Hurricane Mitch, which passed through in October 1998. Many coastal habitats, including mangroves were devastated from the result of wind damage, erosion, and accretion. The habitat maps of the Gulf of Fonseca and the Bay Islands described in this document provided the first quantitative habitat mapping of the region. Thus, we established the baseline for any future trend analysis of the region. For this project, the habitats in the Gulf of Fonseca around the municipalities of San Lorenzo, Nacaome, Amapala, and Choluteca were mapped to provide an inventory for the wetland and upland habitats in these areas. The coastal habitats of Guanaja and Roatan were mapped in the same fashion for these non-metropolitan areas. All wetland habitats in these above-mentioned areas were classified using the U.S. Fish and Wildlife Service Wetland and Deepwater Habitats Classification System (Cowardin and others, 1979, Appendix A). Upland habitats were mapped using the Anderson Classification System (Anderson and others, 1976, as modified by Handley, Appendix A). The products of this project include posters, habitat data, individual aerial photos used in the interpretation, maps, metadata, and scanned aerial photography. Two sets of compact discs of these products have been produced. One set contains the

posters, habitat data, individual aerial photos used in the interpretation, maps, and metadata. The other set contains scanned aerial photography. Poster displays of the maps and the area coverages of each habitat will be created and included in Tagged Interchange File format (.tif). All habitat data will be provided in ArcInfo (Environmental Systems Research Institute, Inc. (ESRI) for Windows NT 4.0) Interchange format (.e00). All of the aerial photography that was acquired from the USGS EROS Data Center for the Bay Islands, Cayos Cochinos, and the Gulf of Fonseca were scanned at 600 dots per inch and put onto compact discs which were sent to the USGS EROS Data Center for archiving. Thirty-seven compact discs were compiled for the Bay Islands aerial photography, six compact discs for Cayos Cochinos, and sixty-four (64) compact discs for the Gulf of Fonseca. The individual photos that were used to classify the wetland and upland habitats in the photointerpretation process are provided in .tif format. Basemaps used in the transfer of the interpreted data are also be included in .tif format with their respective world files.

Data Source

Black and white aerial photography was collected for the Gulf of Fonseca at 1:40,000 scale in December 1998 by the Open Skies Program of the Defense Threat Reduction Agency. This photography was used in the mapping of the municipality of Choluteca. Natural color aerial photography was collected in January, March, and April of 1999 at 1:20,000 scale by Spain and was used in seagrass, coral reef, and coastal mangrove mapping for the island of Guanaja. Natural color aerial photography was collected at 1:20,000 scale in July 1999 by

Spain and was used in seagrass, coral reef, and coastal mangrove habitat mapping for the island of Roatan. Natural color aerial photography was collected at 1:10,000 scale in December 1999 for Cayos Cochinos. This photography was rectified so that basemaps could be created for Cayos Cochinos. Color-infrared aerial photography was collected by the U.S. Geological Survey's EROS Data Center for the Gulf of Fonseca at 1:20,000 scale in April 2000. This photography was used in the mapping of the municipalities of San Lorenzo, Nacaome, and Amapala. Other areas of the Gulf of Fonseca were also mapped using the color-infrared aerial photography. Copies of this photography were made at the USGS EROS Data Center. Base maps were developed by the National Imagery and Mapping Agency (NIMA) using 1:50,000 scale paper maps and scanning them. The scanned paper maps were then clipped of their collar information, rectified, and mosaicked into the 1:250,000 scale quad maps. Each mosaicked 1:250,000 scale quad map therefore contained approximately nine individual 1:50,000 scale quad maps. Each 1:250,000 scale quad map was then reprojected from NAD27 UTM Zone 16 into a geographic projection (latitude\longitude). Compact discs of the mosaicked 1:250,000 scale quad maps were produced for distribution. These compact discs containing the NIMA maps for the countries of Honduras, Nicaragua, and El Salvador were acquired from the USGS EROS Data Center. These base maps were used for the rectification by zoom transfer of the interpreted habitat linework.

Methods

Mapping Process

The mapping process for the Hurricane Mitch project consisted of several sequential steps. These steps included the acquisition of the aerial photography, the preparation of the photography, ground-truthing, photointerpretation, the preparation of the basemaps, zoom transfer of the habitat linework, digitization, and data analysis. All of these steps were completed in order to create habitat maps for the municipalities of San Lorenzo, Nacaome, Choluteca, and Amapala. Other areas in the Gulf of Fonseca and the islands of Roatan and Guanaja were mapped using the same process.

Photo-Acquisition and Photo-Preparation

The first step in the mapping process is the acquisition of aerial photography for the project areas. For the Hurricane Mitch Project, aerial photography was acquired from the USGS EROS Data Center for the project areas that would be mapped (Appendix G). After acquiring the photography, individual duplicate transparencies were created for photointerpretation so that the rolls of aerial photography could be kept intact. These copies were then prepared for the interpretation process to avoid writing directly on the film emulsion. A mylar overlay was taped over each transparency onto which linework was drawn and then the frames were organized into the appropriate project areas.

Review and Ground-Truthing

Stereoscopes were used to examine the paired stereo photographs for potential problem areas. Signatures of the different habitats were reviewed prior to ground-truthing to guide planning for field trips. After studying the photography, a field evaluation was performed at the Bay Islands and the Gulf of Fonseca in January of 2001. The trip to the Bay Islands did not result in successful ground-truthing due to problems with the weather. However, the trip to the Gulf of Fonseca proved to be more successful because the weather cooperated and we were able to travel with scientists from the National Wetlands Research Center to various study sites. Traveling to these sites enabled development of signatures for several of the coastal habitats in the Gulf of Fonseca and also enabled us to look at problem areas identified in the previous photographic review. Check site sheets (Appendix C) were filled out at various sites and the appropriate observational notes and photographs were taken.

Photointerpretation

The actual photointerpretation began upon return from Honduras after organizing and reviewing notes and field photographs (Appendix C). We delineated wetland and upland habitats in the Gulf of Fonseca project areas and the coastal mangroves, seagrasses, and coral reefs of the islands of Guanaja and Roatan using the U.S. Fish and Wildlife Service Wetland and Deepwater Habitats Classification System (Cowardin and others, 1979, Appendix A) for the wetland habitats. For Guanaja and Roatan, the uplands were not classified by type. Field transect data from scientists at the National Wetlands Research Center were used in the delineations of Guanaja and Roatan because of the limited ground-truthing.

The minimum mapping unit for this project was nominally one acre however certain habitat types were often interpreted at one quarter of an acre. Throughout the interpretation process, quality control checks were performed to assure the accuracy of the habitat classifications. As each project area was completed and checked, it was then turned over to the cartographic clerk so that the linework could be rectified and transferred from the photographs to the basemap.

Basemap Preparation and Zoom-Transfer of Linework

In order to use the NIMA maps as basemaps, they were clipped and reprojected. The 1:250,000 scale quad maps were converted from .tif format into ArcInfo 7+ (Environmental Systems Research Institute, Inc. (ESRI) for Windows NT 4.0) grid format and clipped into the individual 1:50,000 scale quad maps using ArcInfo 7+. Using ArcInfo 7+, the clipped quad maps were reprojected into NAD27 UTM Zone 16 and then converted back into .tif format. The clipped quad maps then matched the 1:50,000 scale publicly available paper basemaps. For this project, each 1:50,000 scale basemap was subdivided into 1:25,000 scale quarter quads, and then plotted at 1:25,000 scale to allow the interpretation linework of the photographs to be preserved in the rescaling and rectification processes. The linework on the interpreted photos was then manually transferred using a zoom transfer scope onto the 1:25,000 basemaps. As with the interpretation process, quality control checks were performed on the maps as they were drawn so that corrections could be made before they would be sent out for digitization.

Digitization

The maps were digitized for entry into a geographic information system. When the maps were returned from the digitizing process, corrections were made to ensure the digital information was free of errors. The corrected data were entered into geographic information system software, and analysis was performed. The software used for the analysis of the data was ArcView 3.2 and ArcInfo 7+ (both from Environmental Systems Research Institute, Inc. (ESRI) for Windows NT 4.0). Area coverage was calculated from the digitized habitat data and tables were created summarizing the area of each habitat in each study area. Metadata was created for the digital habitat data for the two main project areas, the northern half and the southern half. The metadata for the northern half contained the regions of Roatan and Guanaja. The metadata for the southern half contained the regions in the Gulf of Fonseca.

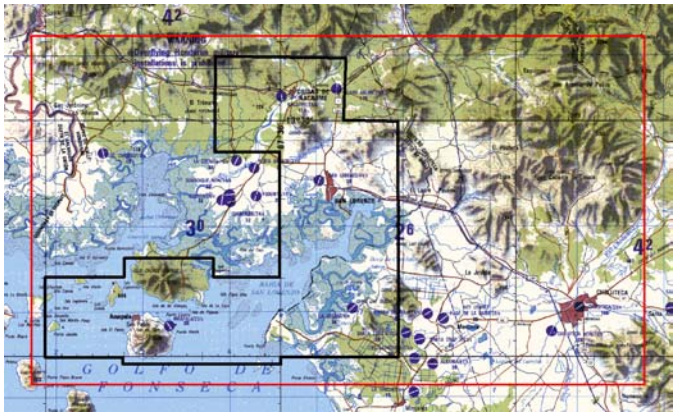
Rectification of Cayos Cochinos Aerial Photography

The aerial photography for Cayos Cochinos was scanned, rectified and mosaicked. After the images were scanned, they were rectified using ERDAS Imagine software and ground control points collected in April 2001 by the USGS Center for Coastal and Regional Marine Studies, St. Petersburg, Florida. The ground control points used in the rectification process were collected with a combination of Ashtech Z XII and Z-surveyor GPS units. Once the rectification and mosaic processes were completed, the mosaicked image was written to compact disc in ERDAS Imagine (.img) format.

Analysis

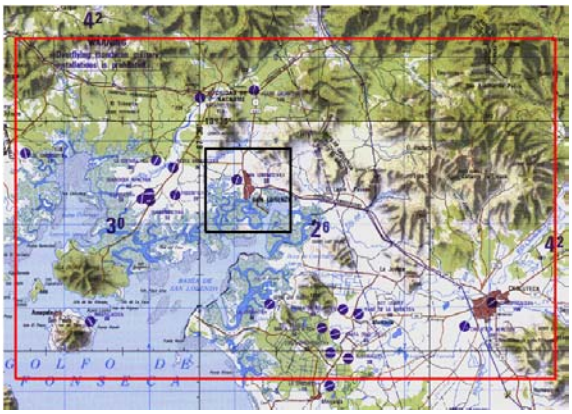
These tables illustrate the interpreted area in the following regions; mapped area in the Gulf of Fonseca, complete coverage for the municipalities of San Lorenzo and Amapala, partial coverage for the municipalities of Nacaome and Choluteca, the island of Guanaja, and the island of Roatan.

I. Gulf of Fonseca -- Area Mapped



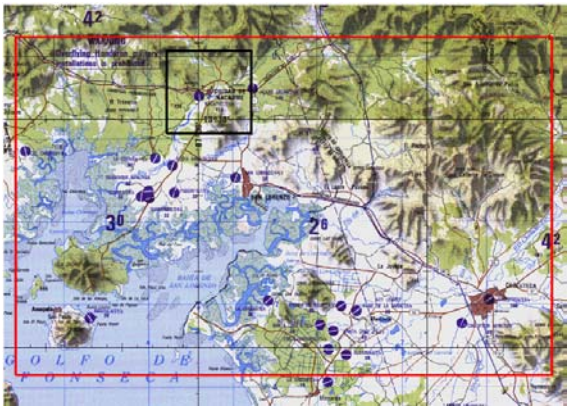
HABITAT CLASSES	ACRES	HECTARES
Salt Open Water	67214.6	27201.3
Beaches, Bars, and Flats	6153.8	2481.8
Salt Marsh	1.8	0.7
Mangrove Scrub Shrub, Regularly Flooded	1019.1	412.3
Mangrove Scrub Shrub, Irregularly Flooded	8561.2	3463.4
Wetland Dead Scrub Shrub	883.0	356.8
Mangrove Forest, Regularly Flooded	8509.4	3443.7
Mangrove Forest, Irregularly Flooded	1982.4	802.7
Wetland Dead Forest	81.5	33.1
Salinas	1397.8	565.4
Shrimp Pond	6536.4	2645.0
Debris on Flat	19.7	8.1
Fresh Open Water	496.7	200.5
Intermittent Stream	458.8	185.3
Fresh Marsh	129.0	52.3
Wetland Scrub Shrub	35.6	14.5
Wetland Forest	101.1	40.9
Barren	1498.0	605.4
Agriculture	5355.8	2166.9
Upland Range	12320.0	4983.3
Upland Forest	7506.2	3036.1
Urban	6154.8	2490.8
Landslide	97.2	39.2
No Aerial Photography Available	226.3	91.6
Total	136740.2	55321.1

II. Municipality of San Lorenzo



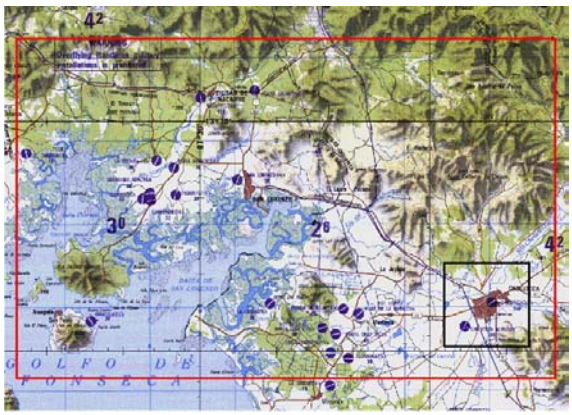
HABITAT CLASSES	ACRES	HECTARES
Salt Open Water	2571.6	1040.7
Beaches, Bars, and Flats	2017.2	816.3
Mangrove Scrub Shrub, Regularly Flooded	6.1	2.4
Mangrove Scrub Shrub, Irregularly Flooded	2425.8	981.7
Wetland Dead Scrub Shrub	298.2	120.7
Mangrove Forest, Regularly Flooded	2457.2	994.4
Mangrove Forest, Irregularly Flooded	867.3	351.0
Wetland Dead Forest	31.4	12.7
Salinas	310.5	125.7
Shrimp Pond	1257.7	509.0
Fresh Open Water	27.7	11.2
Intermittent Stream	62.0	25.1
Fresh Marsh	3.2	1.3
Wetland Forest	4.0	1.6
Barren	157.3	63.7
Agriculture	133.7	54.1
Upland Range	2905.7	1175.9
Upland Scrub Shrub	6678.1	2702.6
Upland Forest	234.7	95.0
Urban	2225.9	900.8
Landslides	16.6	6.7
Total	24691.9	9992.6

III. Municipality of Nacaome



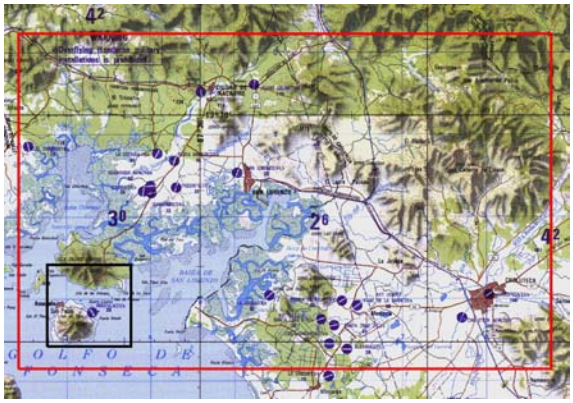
HABITAT CLASSES	ACRES	HECTARES
Beaches, Bars, and Flats	1.1	0.5
Fresh Open Water	346.7	140.3
Intermittent Stream	248.4	100.5
Fresh Marsh	11.2	4.5
Wetland Scrub Shrub	0.5	0.2
Wetland Forest	13.4	5.4
Barren	256.7	103.9
Agriculture	709.1	287.0
Upland Range	1125.8	455.6
Upland Scrub Shrub	16945.6	6857.8
Upland Forest	336.3	136.1
Urban	1746.5	706.8
Landslide	48.5	19.6
No Aerial Photography Available	2908.4	1177.0
Total	24698.5	9995.2

IV. Municipality of Choluteca



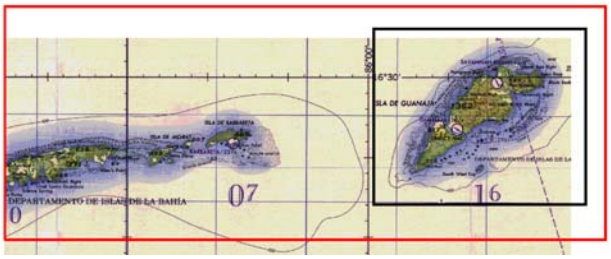
HABITAT CLASSES	ACRES	HECTARES
Fresh Open Water	397.4	160.8
Intermittent Stream	842.7	341.0
Wetland Scrub Shrub	60.7	24.6
Barren	1337.4	541.2
Agriculture	1383.9	560.1
Upland Range	2972.8	1203.1
Upland Scrub Shrub	9799.4	3965.8
Urban	4276.9	1730.9
No Aerial Photography Available	3623.1	1466.3
Total	24694.4	9993.8

V. Municipality of Amapala



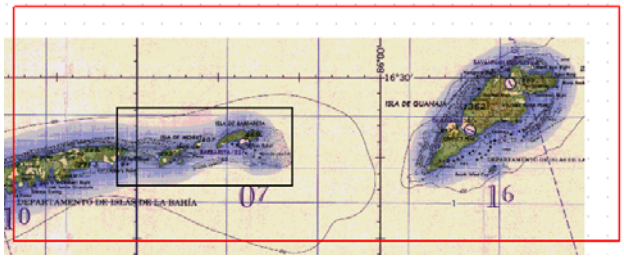
HABITAT CLASSES	ACRES	HECTARES
Salt Open Water	13346.2	5401.1
Fresh Open Water	14.9	6.0
Mangrove Forest, Regularly Flooded	35.0	14.3
Mangrove Forest, Irregularly Flooded	48.6	19.6
Mangrove Scrub Shrub, Regularly Flooded	43.8	17.6
Mangrove Scrub Shrub, Irregularly Flooded	65.3	26.5
Beaches, Bars, and Flats	228.8	92.5
Salinas	26.3	10.5
Fresh Marsh	6.5	2.6
Barren	135.8	55.1
Upland Forest	3403.6	1377.1
Upland Scrub Shrub	5981.6	2420.5
Upland Range	505.1	203.9
Urban	664.2	268.8
Landslide	4.4	1.8
Total	24510.1	9917.9

VI. Island of Guanaja



HABITAT CLASSES	ACRES	HECTARES
SALT OPEN WATER	91248.4	36927.7
BEACHES, BARS, AND FLATS	752.4	304.5
REEF	4476.1	1811.4
SEAGRASS	2280.8	923.0
SALT MARSH	17.7	7.1
MANGROVE SCRUB SHRUB, REGULARLY FLOODED	13.7	5.5
WETLAND DEAD SCRUB SHRUB	18.8	7.6
MANGROVE FOREST, REGULARLY FLOODED	32.9	13.3
MANGROVE FOREST, IRREGULARLY FLOODED	8.7	3.5
WETLAND DEAD FOREST	504.7	204.2
UPLAND	13398.5	5422.3
NO AERIAL PHOTOGRAPHY AVAILABLE	3972.5	1607.7
TOTAL	116725.2	47238.0

VII. Roatan -- Area Mapped



HABITAT CLASSES	ACRES	HECTARES
SALT OPEN WATER	59940.9	24257.9
BEACHES, BARS, AND FLATS	1767.1	714.9
REEF	3124.3	1264.6
SEAGRASS	1340.0	542.2
SALT MARSH	5.8	2.3
MANGROVE SCRUB SHRUB, REGULARLY FLOODED	91.9	37.2
MANGROVE FOREST, REGULARLY FLOODED	157.9	63.9
MANGROVE FOREST, IRREGULARLY FLOODED	34.7	14.0
WETLAND DEAD FOREST	18.9	7.7
UPLAND	2109.9	854.0
TOTAL	68591.4	27758.7

Results

The Bay Islands and the region around the Gulf of Fonseca suffered a extensive damage from Hurricane Mitch. Mangrove forests on the Bay Islands and in the Gulf of Fonseca died as a result of Hurricane Mitch. Along the northern coast of Honduras, the islands of Guanaja and Roatan, the damage was mainly from high winds, extreme wave action and storm surge. In the coastal areas of the Gulf of Fonseca, river flooding mainly caused the damage. The extended rainfall that caused landslides damaged the inland mountainous areas of the Gulf of Fonseca. Land was also eroded in both the northern and southern regions. In the Gulf of Fonseca region, sediment accretion, caused the majority of the damage to the mangrove forests and scrub shrub communities.

Bay Islands - Guanaja and Roatan

Hurricane Mitch brought destruction to the country of Honduras. It brought high winds, flooding, landslides, and erosion. In the northern area of the country, Hurricane Mitch destroyed mangroves and eroded land. It also damaged and in some areas destroyed the fragile seagrass beds and coral reefs along the island's coast.

Guanaja

HABITAT CLASSES	ACRES	HECTARES
SALT OPEN WATER	91248.4	36927.7
BEACHES, BARS, AND FLATS	752.4	304.5
REEF	4476.1	1811.4
SEAGRASS	2280.8	923.0
SALT MARSH	17.7	7.1
MANGROVE SCRUB SHRUB, REGULARLY FLOODED	13.7	5.5
WETLAND DEAD SCRUB SHRUB	18.8	7.6
MANGROVE FOREST, REGULARLY FLOODED	32.9	13.3
MANGROVE FOREST, IRREGULARLY FLOODED	8.7	3.5
WETLAND DEAD FOREST	504.7	204.2
UPLAND	13398.5	5422.3
NO AERIAL PHOTOGRAPHY AVAILABLE	3972.5	1607.7
TOTAL	116725.2	47238.0

The island of Guanaja sustained damage from the high winds and wave action that was caused by the storm. In some areas, the increased salinity also caused problems as well. On the islands, 58% of all mangroves under twenty feet and 92% of all mangroves over twenty feet tall were killed by the strong winds and increased salinity. Along the island, seagrass beds covered 923.0 hectares and reefs covered 1811.4 hectares. These seagrass beds and reefs were damaged or destroyed by the extremely rough wave action. There was also evidence of erosion along the coast where sand had been completely removed and the shoreline had moved adjacent to the structures built along the island shore.

Roatan

HABITAT CLASSES	ACRES	HECTARES
SALT OPEN WATER	59940.9	24257.9
BEACHES, BARS, AND FLATS	1767.1	714.9
REEF	3124.3	1264.6
SEAGRASS	1340.0	542.2
SALT MARSH	5.8	2.3
MANGROVE SCRUB SHRUB, REGULARLY FLOODED	91.9	37.2
MANGROVE FOREST, REGULARLY FLOODED	157.9	63.9
MANGROVE FOREST, IRREGULARLY FLOODED	34.7	14.0
WETLAND DEAD FOREST	18.9	7.7
UPLAND	2109.9	854.0
TOTAL	68591.4	27758.7

The island of Roatan sustained damage from many of the same forces that destroyed vegetation on Guanaja. High winds, extreme wave action and increased salinity destroyed many of the mangroves that lived along the lower areas of the island resulting in 9% of all mangroves over twenty feet to be destroyed. Along the island, seagrass beds covered 542.2 hectares and reefs covered 1264.6 hectares. These seagrass beds and reefs were damaged or destroyed by the extremely rough wave action.

Gulf of Fonseca

HABITAT CLASSES	ACRES	HECTARES
Salt Open Water	67214.6	27201.3
Beaches, Bars, and Flats	6153.8	2481.8
Salt Marsh	1.8	0.7
Mangrove Scrub Shrub, Regularly Flooded	1019.1	412.3
Mangrove Scrub Shrub, Irregularly Flooded	8561.2	3463.4
Wetland Dead Scrub Shrub	883.0	356.8
Mangrove Forest, Regularly Flooded	8509.4	3443.7
Mangrove Forest, Irregularly Flooded	1982.4	802.7
Wetland Dead Forest	81.5	33.1
Salinas	1397.8	565.4
Shrimp Pond	6536.4	2645.0
Debris on Flat	19.7	8.1
Fresh Open Water	496.7	200.5
Intermittent Stream	458.8	185.3
Fresh Marsh	129.0	52.3
Wetland Scrub Shrub	35.6	14.5
Wetland Forest	101.1	40.9
Barren	1498.0	605.4
Agriculture	5355.8	2166.9
Upland Range	12320.0	4983.3
Upland Forest	7506.2	3036.1
Urban	6154.8	2490.8
Landslide	97.2	39.2
No Aerial Photography Available	226.3	91.6
Total	136740.2	55321.1

The wetland areas around the gulf were greatly affected in the area of the Rio Choluteca. In this area, there were not only visible areas of erosion but also accretion. There were also large piles of debris on the ground as well. Due to the fact that there were no previous mapping efforts in that area, there wasn't any baseline data to compare our work to. However, in comparison to older topographical maps, there was a visible change as far as the number of human-made ponds built for the production of shrimp. In this area, there were 2,645 hectares of shrimp ponds, which replaced the mangroves that had died or were removed to build these ponds. There were however 412.3 hectares of mangroves below twenty feet in height exposed on a regular basis (at least once daily) that were flooded and 3463.4 hectares of mangroves below the height of twenty feet exposed irregularly (less often than daily)that were flooded. As well there were 3443.7 hectares of mangroves above twenty feet in height that were regularly flooded and 802.7 hectares of mangroves above twenty feet in height that were flooded irregularly. The rain from the storm caused the Rio Choluteca to flow with such great force that it carried tons of eroded soil with it. As this soil was deposited as sediment, it covered mangrove trees, both partially and completely. Those trees that were partially covered either died or were

stressed to the point that they eventually died. Large mangrove trees were killed by this storm also. In the area that was mapped in the Gulf of Fonseca, especially the area previous talked about, the death of these trees were quite evident and covered a large enough area that they could be delineated in the photography. The delineation illustrated that 356.8 hectares of mangroves below twenty feet in height were killed by the storm event. There were 33.1 hectares of mangroves above twenty feet in height that were killed also. Throughout the Gulf, not only were wetland areas affected but upland areas as well. There were many signs on the mountainsides of landslides. These landslide scars counted for 39.2 hectares of damage from Hurricane Mitch.

San Lorenzo

HABITAT CLASSES	ACRES	HECTARES
Salt Open Water	2571.6	1040.7
Beaches, Bars, and Flats	2017.2	816.3
Mangrove Scrub Shrub, Regularly Flooded	6.1	2.4
Mangrove Scrub Shrub, Irregularly Flooded	2425.8	981.7
Wetland Dead Scrub Shrub	298.2	120.7
Mangrove Forest, Regularly Flooded	2457.2	994.4
Mangrove Forest, Irregularly Flooded	867.3	351.0
Wetland Dead Forest	31.4	12.7
Salinas	310.5	125.7
Shrimp Pond	1257.7	509.0
Fresh Open Water	27.7	11.2
Intermittent Stream	62.0	25.1
Fresh Marsh	3.2	1.3
Wetland Forest	4.0	1.6
Barren	157.3	63.7
Agriculture	133.7	54.1
Upland Range	2905.7	1175.9
Upland Scrub Shrub	6678.1	2702.6
Upland Forest	234.7	95.0
Urban	2225.9	900.8
Landslides	16.6	6.7
Total	24691.9	9992.6

For the municipality of San Lorenzo, the area was studied by establishing a ten-kilometer by ten-kilometer boundary that was placed around the municipality. Much of the damage is this area was a result of flooding. Sediment accretion was evident along some of the areas southwest of San Lorenzo. Within that area of the municipality, upland scrub shrub covered most of the territory with a total of 2702.6 hectares out of a total of 9992.6 hectares for the municipality or 27%. The next most abundant habitat was upland range, which includes mostly grassland, at 12% of the municipality area. Hurricane Mitch and its aftermath killed 120.7 hectares of mangroves under the height of twenty

feet and 12.7 hectares of mangroves that were over twenty feet in height primarily through burial by sediment. In the mountainous areas of the boundary, the hurricane caused an estimate of 6.7 hectares of landslides.

Nacaome

HABITAT CLASSES	ACRES	HECTARES
Beaches, Bars, and Flats	1.1	0.5
Fresh Open Water	346.7	140.3
Intermittent Stream	248.4	100.5
Fresh Marsh	11.2	4.5
Wetland Scrub Shrub	0.5	0.2
Wetland Forest	13.4	5.4
Barren	256.7	103.9
Agriculture	709.1	287.0
Upland Range	1125.8	455.6
Upland Scrub Shrub	16945.6	6857.8
Upland Forest	336.3	136.1
Urban	1746.5	706.8
Landslide	48.5	19.6
No Aerial Photography Available	2908.4	1177.0
Total	24698.5	9995.2

The municipality of Nacaome contained mostly upland classes due to its location. The ten-kilometer by ten-kilometer boundary contained mostly upland scrub shrub. There was also a great percentage of rangeland also. The entire area could not be interpreted due to the adequate unavailability of photography in the northeast corner.

Choluteca

HABITAT CLASSES	ACRES	HECTARES
Fresh Open Water	397.4	160.8
Intermittent Stream	842.7	341.0
Wetland Scrub Shrub	60.7	24.6
Barren	1337.4	541.2
Agriculture	1383.9	560.1
Upland Range	2972.8	1203.1
Upland Scrub Shrub	9799.4	3965.8
Urban	4276.9	1730.9
No Aerial Photography Available	3623.1	1466.3
Total	24694.4	9993.8

The municipality of Choluteca contained mostly upland classes due to its inland location. There were only 24.6 hectares of scrub shrub wetlands in the ten-kilometer by ten-kilometer boundary. Hurricane Mitch impacted the Rio Choluteca in this area and damaged roads and bridges with the force of the floodwaters in both the old Rio Choluteca and the new branch that was created.

Amapala

HABITAT CLASSES	ACRES	HECTARES
Salt Open Water	13346.2	5401.1
Fresh Open Water	14.9	6.0
Mangrove Forest, Regularly Flooded	35.0	14.3
Mangrove Forest, Irregularly Flooded	48.6	19.6
Mangrove Scrub Shrub, Regularly Flooded	43.8	17.6
Mangrove Scrub Shrub, Irregularly Flooded	65.3	26.5
Beaches, Bars, and Flats	228.8	92.5
Salinas	26.3	10.5
Fresh Marsh	6.5	2.6
Barren	135.8	55.1
Upland Forest	3403.6	1377.1
Upland Scrub Shrub	5981.6	2420.5
Upland Range	505.1	203.9
Urban	664.2	268.8
Landslide	4.4	1.8
Total	24510.1	9917.9

The municipality of Amapala sustained damage from the high winds and wave action of the storm. However, there was no evidence in the photography of mangroves that had been killed by the storm. However, there was evidence of landslide scars on this island. Problems with the scale and angle of the photography did not allow us to delineate all of the landslide scars but we were able to delineate 1.8 hectares of them.

In the southern area of the country, Hurricane Mitch destroyed mangroves and paved the way for the establishment of shrimp ponds. The storm also left large piles of debris along the riverbanks of the Rio Choluteca, which will slow the recovery of vegetation and increase the chances of further problems. The landslides caused by the storm destroyed many roads and homes in the region around the Gulf of Fonseca. The resulting sedimentation from the flooding accounted for the majority of the destruction of the wetland habitats, particularly mangroves, surrounding the Gulf of Fonseca.

References Cited:

Anderson, J.R., Hardy, E.E., Roach, J.T., and Witmer, R.E., 1976, A Land Use and Land Cover Classification System for Use with Remote Sensor Data: U.S. Geological Survey USGS Professional Paper 964.

Cowardin, L.M., Carter, V., Golet, F.C., and LaRoe, E.T., 1979, Classification of Wetlands and Deepwater Habitats of the United States: U.S. Fish and Wildlife Service FWS/OBS-79-31, 131 p.

APPENDIX A

Wetland and Upland Classification Systems (Anderson et al., 1976, Cowardin et al., 1979)

ANDERSON UPLAND CLASSIFICATION SYSTEM (Modified by Handley)

Upland Classes

U = Urban or Developed
A = Agricultural
F = Forest
SS= Scrub/Shrub
R = Range
B = Barren

Modifying Terms - added to the above classes as appropriate

o = oil and/or gas
r = rice field
6 = deciduous
7 = evergreen
8 = mixed (for example, mixed deciduous and evergreen)
p = park
s = spoil
d = dune
t = transportation
ls = land slide

U.S. FISH AND WILDLIFE SERVICE, COWARDIN ET AL. WETLANDS AND DEEPWATER HABITATS CLASSIFICATION SYSTEM

M = Marine

1 = Subtidal
- RB = Rock Bottom
  - 1 = bedrock
  - 2 = rubble
- UB = Unconsolidated Bottom
  - 1= cobble-gravel
  - 2= sand
  - 3 = mud
  - 4 = organic
- AB = Aquatic Bed
  - 1 = algal
  - 3 = rooted vascular
  - 5 = unknown submerged
- RF = Reef
  - 1 = coral
  - 3 = worm
- OW = Open Water/ Unknown Bottom

2 = Intertidal
- AB = Aquatic Bed
  - 1 = algal bed
  - 3 = rooted vascular

5 = unknown submerged
RF = Reef
1 = coral
3 = worm
RS = Rocky Shore
1 = bedrock
2 = rubble
US = Unconsolidated Shore
1 = cobble-gravel
2 = sand
3 = mud
4 = organic

E = Estuarine
1 = Subtidal
RB = Rock Bottom
1 = bedrock
2 = rubble
UB = Unconsolidated Bottom
1 = cobble-gravel
UB = Unconsolidated Bottom
2 = sand
3 = mud
4 = organic
AB = Aquatic Bed
1 = algal
3 = rooted vascular
4 = floating vascular
5 = unknown submerged
6 = unknown surface
RF = Reef
2 = mollusc
3 = worm
OW = Open Water/Unknown Bottom
2 = Intertidal
AB = Aquatic Bed
1 = algal
3 = rooted vascular
4 = floating vascular
5 = unknown submerged
6 = unknown surface
RF = Reef
2 = mollusc
3 = worm
SB = Streambed
1 = cobble-gravel

2 = sand
3 = mud
4 = organic

RS = Rocky Shore
1 = bedrock
2 = rubble

US = Unconsolidated Shore
1 = cobble-gravel
2 = sand
3 = mud
4 = organic

EM = Emergent
1 = persistent
2 = nonpersistent

SS = Scrub- Shrub
1 = broad-leaved deciduous
2 = needle-leaved deciduous
3 = broad-leaved evergreen
4 = needle-leaved evergreen
5 = dead
6 = deciduous
7 = evergreen

FO = Forested
1 = broad-leaved deciduous
2 = needle-leaved deciduous
3 = braod-leaved evergreen
4 = needle-leaved evergreen
5 = dead
6 = deciduous
7 = evergreen

R = Riverine

NOTE: Riverine is one of the following numbered subsystem,
matched with one of the classes below,
but according to any special stipulations specified below.

1 = Tidal
2 = Lower Perennial
3 = Upper Perennial
4 = Intermittent
5 = Unknown Perennial

RB = Rock
1 = bedrock
2 = rubble

UB = Unconsolidated Bottom
1 = cobble-gravel
2 = sand
3 = mud
4 = organic

*SB = Streambed
(*=Streambed is limited to TIDAL
(*Streambed is limited to TIDAL and INTERMITTENT SUBSYSTEMS and comprises the only class in the INTERMITTENT SUBSYSTEM.)

1 = bedrock
2 = rubble
3 = cobble-gravel
4 = sand
5 = mud
6 = organic
7 = vegetated

AB = Aquatic Bed
1 = algal
2 = aquatic moss
3 = rooted vascular
4 = floating vascular
5 = unknown submerged
6 = unknown surface

RS = Rocky Shore
1 = bedrock
2 = rubble

US = Unconsolidated Shore
1 = cobble-gravel
2 = sand
3 = mud
4 = organic
5 = vegetated

**EM = Emergent
(** Emergent is limited to TIDAL and LOWER PERENNIAL SUBSYSTEMS.)
2 = nonpersistent

OW = Open Water/Unknown Bottom

RB = Rock
1 = bedrock
2 = rubble

UB = Unconsolidated Bottom
1 = cobble-gravel
2 = sand
3 = mud
4 = organic

AB = Aquatic Bed
1 = algal
2 = aquatic moss
3 = rooted vascular
4 = floating vascular
5 = unknown submerged
6 = unknown surface
RS = Rocky Shore
1 = bedrock
2 = rubble
US = Unconsolidated Shore
1 = cobble-gravel
2 = sand
3 = mud
4 = organic
5 = vegetated
**EM = Emergent
2 = nonpersistent
OW = Open Water/Unknown Bottom

L = Lacustrine
1 = Limnetic
RB = Rock Bottom
1 = bedrock
2 = rubble
UB = Unconsolidated Bottom
1 = cobble-gravel
2 = sand
3 = mud
4 = organic
AB = Aquatic Bed
1 = algal
2 = aquatic moss
3 = rooted vascular
4 = floating vascular
5 = unknown submergent
6 = unknown surface
OW = Open Water/Unknown Bottom
2 = Littoral
RB = Rock Bottom
1 = bedrock
2 = rubble
UB = Unconsolidated Bottom
1 = cobble-gravel
2 = sand
3 = mud

4 = organic
AB = Aquatic Bed
1 = algal
2 = aquatic moss
3 = rooted vascular
4 = floating vascular
5 = unknown submergent
6 = unknown surface
RS = Rocky Shore
1 = bedrock
2 = rubble
US = Unconsolidated Shore
1 = cobble-gravel
2 = sand
3 = mud
4 = organic
5 = vegetated
EM = Emergent
2 = nonpersistent
OW = Open Water/Unknown Bottom

P = Palustrine

RB = Rock Bottom
1 = bedrock
2 = rubble
UB = Unconsolidated Bottom
1 = cobble-gravel
2 = sand
3 = mud
4 = organic
AB = Aquatic Bed
1 = algal
2 = aquatic moss
3 = rooted vascular
4 = floating vascular
5 = unknown submergent
6 = unknown suface
US = Unconsolidated Shore
1 = cobble-gravel
2 = sand
3 = mud
4 = organic
5 = vegetated
ML = Moss Lichen
1 = moss

2 = lichen
EM = Emergent
1= persistent
2 = nonpersistent
SS = Scrub-Shrub
1 = broad-leaved deciduous
2 = needle-leaved deciduous
3 = broad-leaved evergreen
4 = needle-leaved evergreen
5 = dead
6 = deciduous
7 = evergreen
FO = Forested
1 = broad-leaved deciduous
2 = needle-leaved deciduous
3 = broad-leaved evergreen
4 = needle-leaved evergreen
5 = dead
6 = deciduous
7 = evergreen
OW = Open Water/Unknown Bottom

Modifers

Water Regime
Non-Tidal
A = Temporarily Flooded
B = Saturated
C = Seasonally Flooded
D = Seasonally Flooded/Well Drained
E = Seasonally Flooded/Saturated
F = Semipermantly Flooded
G = Intermittently Exposed
H = Permantly Flooded
J = Intermittently Flooded
K = Artificially Flooded
W = Intermittently Flooded/Temporary
Y = Saturated/Semipermanent/Seasonal
Z = Intermittently Exposed/Permanent
U = Unknown
Tidal
K = Artificially Flooded
L = Subtidal
M = Irregularly Exposed

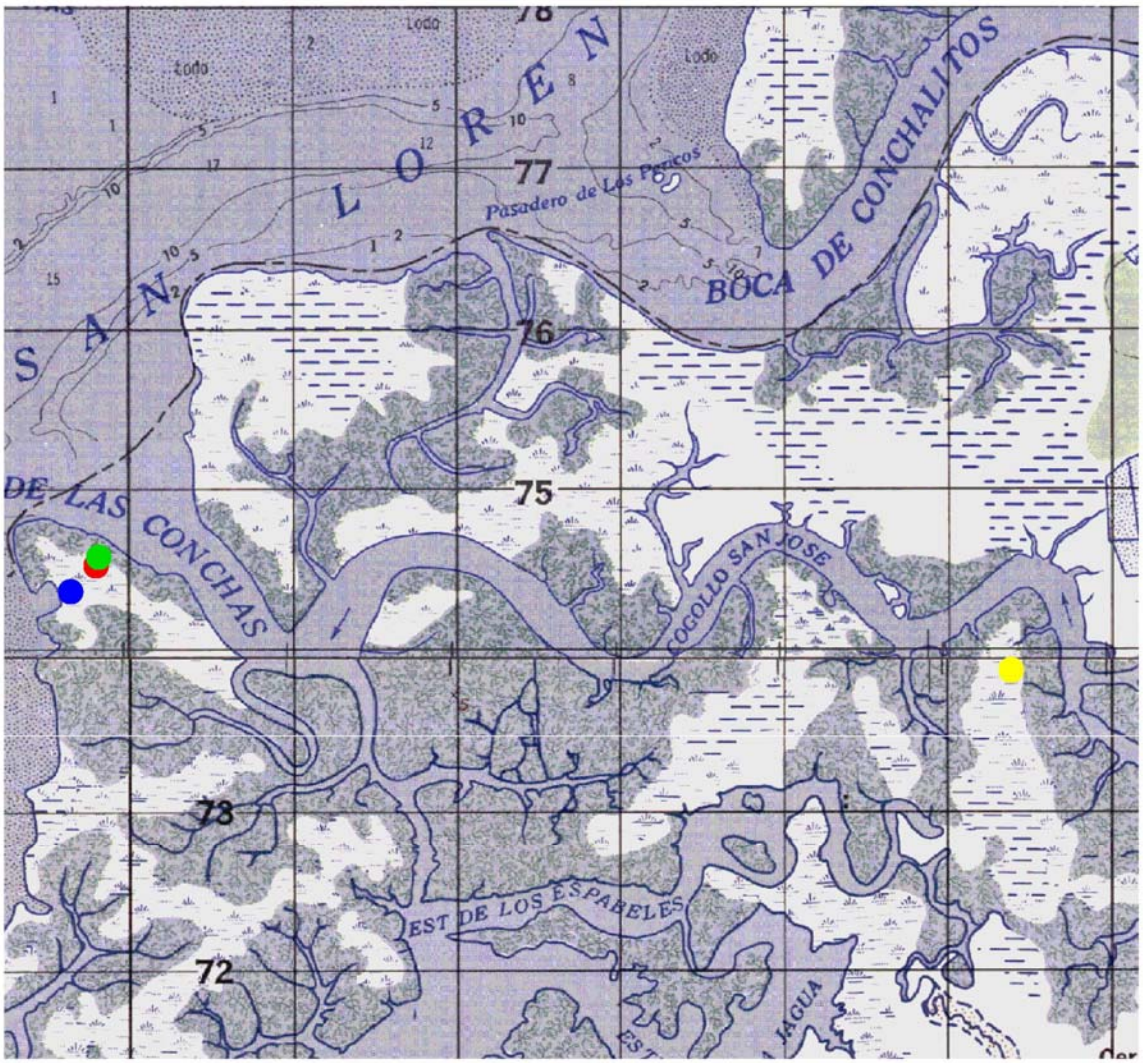
N = Regularly Flooded
P = Irregularly Flooded
S = Temporary-Tidal (only used in tidally influenced freshwater systems.)
R = Seasonal-Tidal (only used in tidally influenced freshwater systems.)
T = Semipermanent-Tidal (only used in tidally influenced freshwater systems.)
V = Permanent-Tidal (only used in tidally influenced freshwater systems.)
U = Unknown

Special Modifers
b = Beaver
d = Partially Drained/Ditched
f = Farmed
h = Diked/Impounded
r = Artificial Substrate
s = Spoil
x = Excavated
sh = Shrimp Ponds
db = Debris Beds

APPENDIX B

Field Check Sites Reference Map

FIELD CHECK SITES



FIELD CHECK SITES
- Check Site 1
- Check Site 2
- Check Site 3
- Check Site 4

APPENDIX C

Check Site Field Data Sheets

Check Site No.: 1	Roll No.: 008	Frame No.: 010	Date: 01-22-01	Time: 2:18 p.m.

Reported by: Jesse Thibodeaux II

1. LAT./LONG.	13.339538860, -87.463551253

2. Location in 1:250,000 quad: nd1644	Location in 1:50,000 quad: 2756-3

3. IN-FIELD WETLAND CLASSIFICATION SYSTEM
(see NWI legend in Appendix A)

System	E
Subsystem	2
Class	SS
Subclass	3
Water Regime	P
Special Modifiers	

Soil Type Observed in Field	Clay
Additional Comments About Soils	
Predominant Plants Observed in the Field	
Dominant Canopy Plants Observed in the Field	Black Mangrove
	Red Mangrove
Predominant Mid-Canopy Plants Observed in the Field	
Predominant Ground Plants Observed in the Field	
Significant Indicator Plants	Black Mangrove
	Red Mangrove

Y/N	Check List of Important Field Observations
N	Standing Water Present
N	Estimated Depth of Water
N	Saturation to Surface Only
N	Depth to Water Table
Y	Tidal Influence
Y	High Tide Presently
N	Low Tide Presently
N	Water Marks on Stems
N	Silt or Sand on Leaves
Y	Debris Washed In
N	Hummocky Surface
N	Deep Stream Entrenchment
N	No Stream Entrenchment
N	Buttressed Trees
Y	Roots Exposed on Surface
N	Areas of Peat Build-up
N	Water Stained Leaves
N	Stream Channelization
N	Major Ditches in Area
N	Small Ditches at Site
N	Silvicultural Bedding Evident at Site
N	Evidence of Farming
N	Evidence of Grazing
N	Dumping of Trash in Area
N	Area Impounded
N	Evidence of Spoil at Site

Photo No.	Comments:
2-18	Dwarf mangroves
2-19	Small portion of area covered by dwarf forest
2-20	Transition from dwarf to normal growth
2-21	Transition again (clipboard is positioned on top of dwarf mangrove to show relative height)

Additional Comments:
- Wrack and debris were present. Debris was mainly from Hurricane Mitch.
- Mangroves are an average of 2-3 feet tall.

2-18. Dwarf mangroves on a mudflat at a low impact site.

2-19. Area at a low impact site covered by a dwarf mangrove forest.

2-20. Transition from a dwarf growth mangrove forest to normal growth mangrove forest.

2-21. Transition again (clipboard is positioned on top of dwarf mangrove to show relative height).

Check Site No.: 2	Roll No.: 008	Frame No.: 010	Date: 01-22-01	Time: 2:54 p.m.

Reported by: Jesse Thibodeaux II

1. LAT./LONG.	13.340026912, -87.463405115

2. Location in 1:250,000 quad: nd1644	Location in 1:50,000 quad: 2756-3

3. IN-FIELD WETLAND CLASSIFICATION SYSTEM (see NWI legend in Appendix A)

System	E
Subsystem	2
Class	FO
Subclass	3
Water Regime	P
Special Modifiers	

Soil Type Observed in Field	Clay
Additional Comments About Soils	
Predominant Plants Observed in the Field	
Dominant Canopy Plants Observed in the Field	Black Mangrove
Predominant Mid-Canopy Plants Observed in the Field	
Predominant Ground Plants Observed in the Field	
Significant Indicator Plants	Black Mangrove

Y/N	Check List of Important Field Observations
N	Standing Water Present
N	Estimated Depth of Water
N	Saturation to Surface Only
N	Depth to Water Table
Y	Tidal Influence
Y	High Tide Presently
N	Low Tide Presently
N	Water Marks on Stems
N	Silt or Sand on Leaves
Y	Debris Washed In
N	Hummocky Surface
N	Deep Stream Entrenchment
N	No Stream Entrenchment
N	Buttressed Trees
Y	Roots Exposed on Surface
N	Areas of Peat Build-up
N	Water Stained Leaves
N	Stream Channelization
N	Major Ditches in Area
N	Small Ditches at Site
N	Silvicultural Bedding Evident at Site
N	Evidence of Farming
N	Evidence of Grazing
N	Dumping of Trash in Area
N	Area Impounded
N	Evidence of Spoil at Site

Photo No.	Comments:
2-22	Mangrove Forest
2-23	Mangrove Forest
2-24	Picture of an old shrimp pond which now has mangroves growing in it
2-25	Picture of levee and borrow pit that is evident on the aerial photo

Additional Comments:

2-22. Mangrove forest at a low impact site.

2-23. Mangrove forest at a low impact site.

2-24. Picture of an old shrimp pond which now has mangroves growing in it.

2-25. Picture of levee and borrow pit that is evident on the aerial photo.

Check Site No.: 3	Roll No.: 008	Frame No.: 010	Date: 01-22-01	Time: 3:46 p.m.

Reported by: Jesse Thibodeaux II

1. LAT./LONG.	13.338067405, -87.464989918

2. Location in 1:250,000 quad: nd1644	Location in 1:50,000 quad: 2756-3

3. IN-FIELD WETLAND CLASSIFICATION SYSTEM (see NWI legend in Appendix A)

System	E
Subsystem	2
Class	SS
Subclass	3
Water Regime	N
Special Modifiers	h

Soil Type Observed in Field	Clay
Additional Comments About Soils	
Predominant Plants Observed in the Field	Black Mangrove
Dominant Canopy Plants Observed in the Field	Red Mangrove
Predominant Mid-Canopy Plants Observed in the Field	
Predominant Ground Plants Observed in the Field	
Significant Indicator Plants	Red Mangrove
	Black Mangrove

Y/N	Check List of Important Field Observations
Y	Standing Water Present
2 FT	Estimated Depth of Water
N	Saturation to Surface Only
N	Depth to Water Table
Y	Tidal Influence
N	High Tide Presently
N	Low Tide Presently
N	Water Marks on Stems
N	Silt or Sand on Leaves
N	Debris Washed In
N	Hummocky Surface
N	Deep Stream Entrenchment
N	No Stream Entrenchment
N	Buttressed Trees
Y	Roots Exposed on Surface
N	Areas of Peat Build-up
N	Water Stained Leaves
N	Stream Channelization
N	Major Ditches in Area
Y	Small Ditches at Site
N	Silvicultural Bedding Evident at Site
Y	Evidence of Farming
N	Evidence of Grazing
N	Dumping of Trash in Area
Y	Area Impounded
Y	Evidence of Spoil at Site

Photo No.	Comments:

Additional Comments:
2. This site is an old pond which has been abandoned. Spoil (levees) and borrow pits are still present
3. There are mangroves on the levees and in the pond
4. These mangroves are natural, they have not been planted in rows as other areas that I have seen

Check Site No.: 4a	Roll No.: 008	Frame No.: 006	Date: 01-23-01	Time: 9:34 a.m.

Reported by: Jesse Thibodeaux II

1. LAT./LONG.	13.333693074, -87.411991669

2. Location in 1:250,000 quad: nd1644	Location in 1:50,000 quad: 2756-3

3. IN-FIELD WETLAND CLASSIFICATION SYSTEM (see NWI legend in Appendix A)

System	E
Subsystem	2
Class	SS
Subclass	3
Water Regime	P
Special Modifiers	

Soil Type Observed in Field	Clay
Additional Comments About Soils	
Predominant Plants Observed in the Field	
Dominant Canopy Plants Observed in the Field	Red Mangrove
	Black Mangrove
Predominant Mid-Canopy Plants Observed in the Field	
Predominant Ground Plants Observed in the Field	Grass
Significant Indicator Plants	Red Mangrove
	Black Mangrove

Y/N	Check List of Important Field Observations
N	Standing Water Present
N	Estimated Depth of Water
N	Saturation to Surface Only
N	Depth to Water Table
Y	Tidal Influence
N	High Tide Presently
Y	Low Tide Presently
N	Water Marks on Stems
N	Silt or Sand on Leaves
Y	Debris Washed In
N	Hummocky Surface
N	Deep Stream Entrenchment
N	No Stream Entrenchment
N	Buttressed Trees
Y	Roots Exposed on Surface
N	Areas of Peat Build-up
N	Water Stained Leaves
Y	Stream Channelization
N	Major Ditches in Area
Y	Small Ditches at Site
N	Silvicultural Bedding Evident at Site
N	Evidence of Farming
N	Evidence of Grazing
Y	Dumping of Trash in Area
N	Area Impounded
N	Evidence of Spoil at Site

Photo No.	Comments:
3-7	Mangroves next to shrimp pond
3-8	Sparse dead mangroves

Additional Comments:

3-7. Mangroves next to an active shrimp pond next to a high impact site.

3-8. Sparse dead mangroves at a high impact site.

Check Site No.: 4b	Roll No.: 008	Frame No.: 006	Date: 01-23-01	Time: 9:34 a.m.

Reported by: Jesse Thibodeaux II

1. LAT./LONG.	13.333693074, -87.411991669

2. Location in 1:250,000 quad: nd1644	Location in 1:50,000 quad: 2756-3

3. IN-FIELD WETLAND CLASSIFICATION SYSTEM (see NWI legend in Appendix A)

System	L
Subsystem	2
Class	US
Subclass	3
Water Regime	C
Special Modifiers	Khsh

Soil Type Observed in Field	Clay
Additional Comments About Soils	
Predominant Plants Observed in the Field	
Dominant Canopy Plants Observed in the Field	
Predominant Mid-Canopy Plants Observed in the Field	
Predominant Ground Plants Observed in the Field	
Significant Indicator Plants	

Y/N	Check List of Important Field Observations
Y	Standing Water Present
<2 FT	Estimated Depth of Water
N	Saturation to Surface Only
N	Depth to Water Table
N	Tidal Influence
N	High Tide Presently
N	Low Tide Presently
N	Water Marks on Stems
N	Silt or Sand on Leaves
N	Debris Washed In
N	Hummocky Surface
N	Deep Stream Entrenchment
N	No Stream Entrenchment
N	Buttressed Trees
N	Roots Exposed on Surface
N	Areas of Peat Build-up
N	Water Stained Leaves
N	Stream Channelization
N	Major Ditches in Area
N	Small Ditches at Site
N	Silvicultural Bedding Evident at Site
N	Evidence of Farming
N	Evidence of Grazing
N	Dumping of Trash in Area
Y	Area Impounded
Y	Evidence of Spoil at Site

Photo No.	Comments:
3-5	Levee around shrimp pond
3-6	Shrimp pond which has been partially drained

Additional Comments:

3-5. Example of a levee around a shrimp pond.

3-6. Shrimp pond which has been partially drained.

APPENDIX D

Bay Islands and Choluteca Overflight Slides

Bay Islands Overflight

Choluteca Overflight

APPENDIX E

Hurricane Mitch Digitized Data Classification System

Each classification in this system has been derived from multiple classifications in the Cowardin et al., 1979 and Anderson et al., 1976 classification systems.

SOW -Salt Open Water

Definition - Areas covered by water. Water is tidal in this class with a salt content of greater than 0.5 parts per thousand (ppt). This is considered salt water. The category will include delta distributary channels, sloughs, bays, sounds, and interior ponds into marsh and mangroves.
Classification - E1UBL, E1UBLx

FOW - Fresh Open Water

Definition - Area covered by water. Water is tidal or non-tidal (mostly non-tidal) in this class with a salt content less than 0.5 ppt. This is considered fresh water. All areas of aquatic beds, both submerged and floating, are incorporated into the open water category. The category will include rivers, creeks, intermittent streams, and inland ponds other than shrimp ponds and lakes.
Classification - PAB4H, PUBH, PUBHh, PUBHx, R3UBH

MFOR - Mangrove Forest, Regularly Flooded

Definition - Mangroves that are greater than 20 feet in height and are flooded and exposed by tidewater at least once daily.
Classification - E2FO3N

MFOI - Mangrove Forest, Irregularly Flooded

Definition - Mangroves that are greater than 20 feet in height and are flooded and exposed by tidewater less often than daily.
Classification - E2FO3P

MSSR - Mangrove Scrub Shrub, Regularly Flooded

Definition - Mangroves that are less than 20 feet in height and are flooded and exposed by tidewater at least once daily.
Classification - E2SS3N

MSSI - Mangrove Scrub Shrub, Irregularly Flooded

Definition - Mangroves that are less than 20 feet in height and are flooded and exposed by tidewater less often than daily.
Classification - E2SS3P

DFO - Dead Forest

Definition - Woody vegetation (mostly mangroves) greater than 20 feet tall that were killed by the effects of Hurricane Mitch.
Classification - E2FO5N, E2FO5P

DSS - Dead Scrub Shrub

Definition - Woody vegetation (mostly mangroves) less than 20 feet tall that were killed by the effects of Hurricane Mitch.
Classification - E2SS5N, E2SS5P

BB - Beaches, Bars, and Flats

Definition - Wetland areas that are intertidal (exposed at low tides, covered at high tides) with less than 30% of the surface covered with vegetation. Tidal mud flats, sandbars, beaches, and shorelines represent most of the flats and beaches category.
Classification - E2USM, E2USN, E2USP, PUSC, PUSCh, PUSJ, R1USN

SP - Shrimp Ponds

Definition - Human made ponds created for the shrimp industry.
Classification - L2EMCKhsh, L2UBHKhsh, L2USCKhsh

WF - Wetland Forest

Definition - Woody vegetation that is greater than 20 feet in height, occupying wet soil and surface conditions.
Classification - PFO3A, PFO3F, PFO3J, PFO3S, PFO7J

WSS - Wetland Scrub Shrub

Definition - Woody vegetation that is less than 20 feet in height, occupying wet soil and surface conditions.
Classification - PSS3A, PSS3C, PSS3J

FM - Fresh Marsh

Definition - Emergent vegetation that is herbaceous hydrophytic species. Marsh species have adapted to predominately non-tidal freshwater conditions and covers more that 30% of the surface. Freshwater marsh is found in low-lying frequently flooded areas, with the water remaining on or near the surface for extended periods of time during growing season. Vegetation is present for most of the growing season and maintains the same general appearance from one year to the next.
Classification - PEM1A, PEM1Ah, PEM1C, PEM1F

DEB - Debris on Flats

Definition - Debris deposited from the floodwaters of Hurricane Mitch on mud flats along rivers and streams
Classification - E2USPdb

IT - Intermittent Stream

Definition - Streams in which the substrate is usually exposed with surface water present at variable times. It may be weeks, months, or years between the time periods of surface water being present.
Classification -R2USC, R4SBJ, R4USC

UA - Agriculture

Definition - Cropland cultivated with row crops such as grain and sugarcane.
Classification -UA

UB - Barren

Definition - Cleared areas that are not wetland, such as non-vegetated areas planned for development, borrow pits, sand pits, but does not include bare agricultural fields.
Classification -UB

UF - Upland Forest

Definition - Woody vegetation greater than 20 feet in height occupying areas that are not flooded or in wet soil conditions for extended periods during the growing season.
Classification - UF7

USS - Upland Scrub Shrub

Definition - Woody vegetation less than 20 feet in height occupying areas that are not flooded or in wet conditions for extended periods during the growing season. This type of woody vegetation is invasive into old fields and timber harvested areas covered greater than 30% of the area.
Classification - USS7, USS7s

UR - Upland Range

Definition - Improved and unimproved pasture, old fields and timber-harvested areas covered with weeds and less than 30% woody scrub shrub and trees.
Classification - UR, URd

UU - Upland Urban

Definition - Developed landscape areas over five acres in size. This category includes residential, commercial, transportation, and industrial land uses.
Classification - UU, UUs

LS - Landslides

Definition - Areas in mountainous regions where there were evidence of landslides that happened prior to, during, and after Hurricane Mitch
Classification - UBls, URls

SM - Salt Marsh

Definition - Emergent vegetation that is herbaceous hydrophytic species. Marsh species have adapted to tidal saltwater conditions. Saltwater marsh includes low-lying frequently flooded and less frequently flooded high marsh. Vegetation is present for most of the growing season and maintains the same general appearance from one year to the next.
Classification - E2EM1N, E2EM1P

RF - Reef

Definition - Ridge-like or mound like structures that may be formed by the colonization and growth of sedentary invertebrates, shellfish beds, or artificial structures.

Classification - E1RFL, E2RFM

SG - Seagrass

Definition - Plants that predominantly grow below the surface of the water for most the growing season.

Classification - E1AB3L

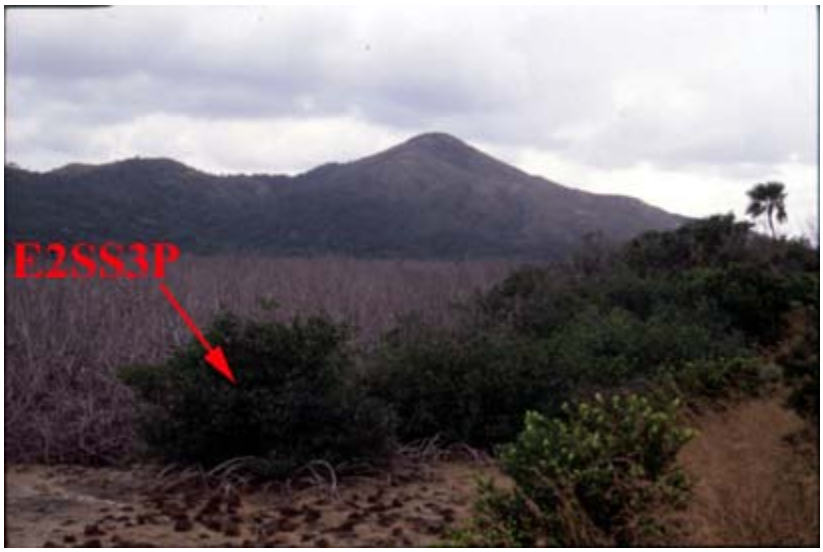
APPENDIX F

Examples of Classified Habitats using the Wetland and Upland Classification Systems

Classification Schema Examples

E1AB3L - Seagrass

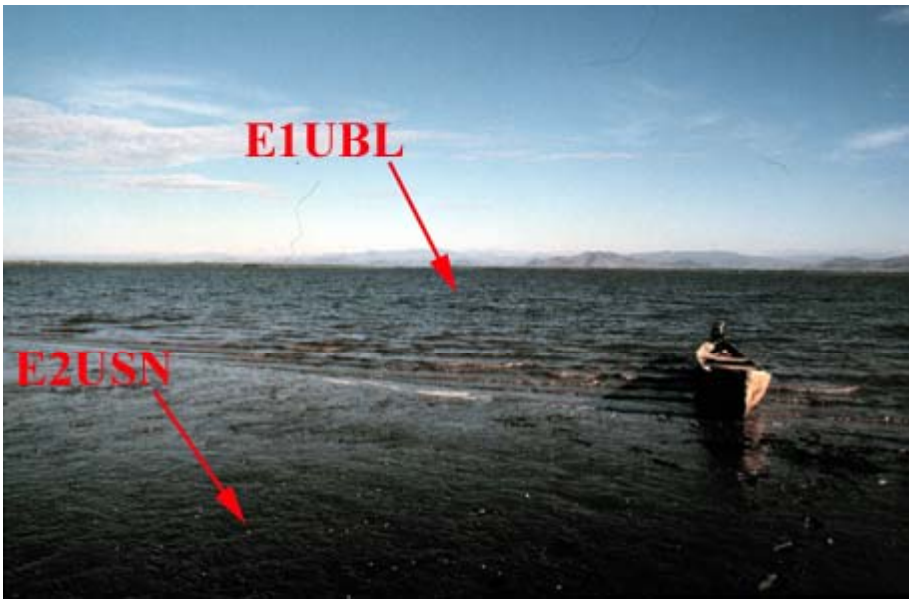
E2FO3N - Mangrove Forest, Regularly Flooded



E2SS3P - Mangrove Scrub Shrub, Irregularly Flooded

E2SS5P - Dead Scrub Shrub (Mangroves)

E2USN - Beaches, Bars, and Flats



E1UBL - Salt Open Water
E2USN - Beaches, Bars, and Flats

E2USPdb - Debris Bed

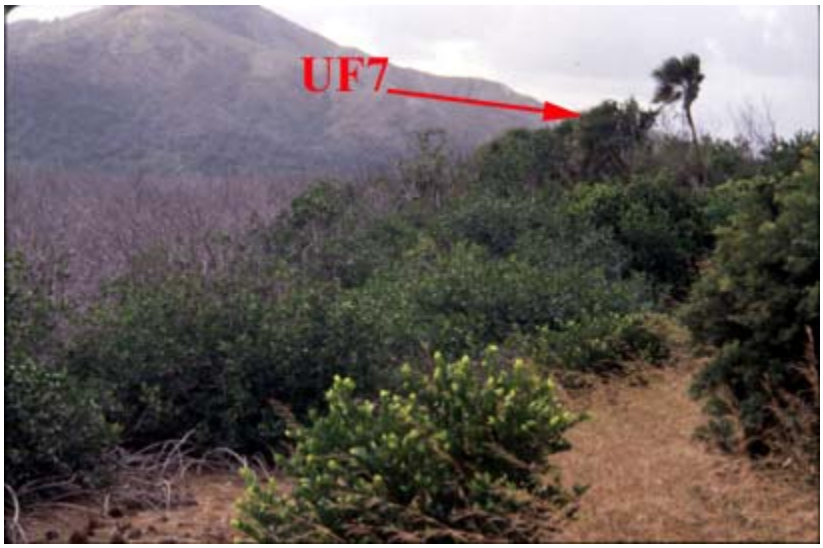
L2UBHKhsh - Shrimp Pond
L2USCKhsh - Shrimp Pond

R2UBH - Fresh Open Water

UU - Urban
UB - Barren

Ubd - Barren Dune

Ubls - Landslide



UF7 - Upland Forest, Evergreen

UF7 - Upland Forest, Evergreen

UR - Upland Range

USS7 - Upland Scrub Shrub, Evergreen

APPENDIX G

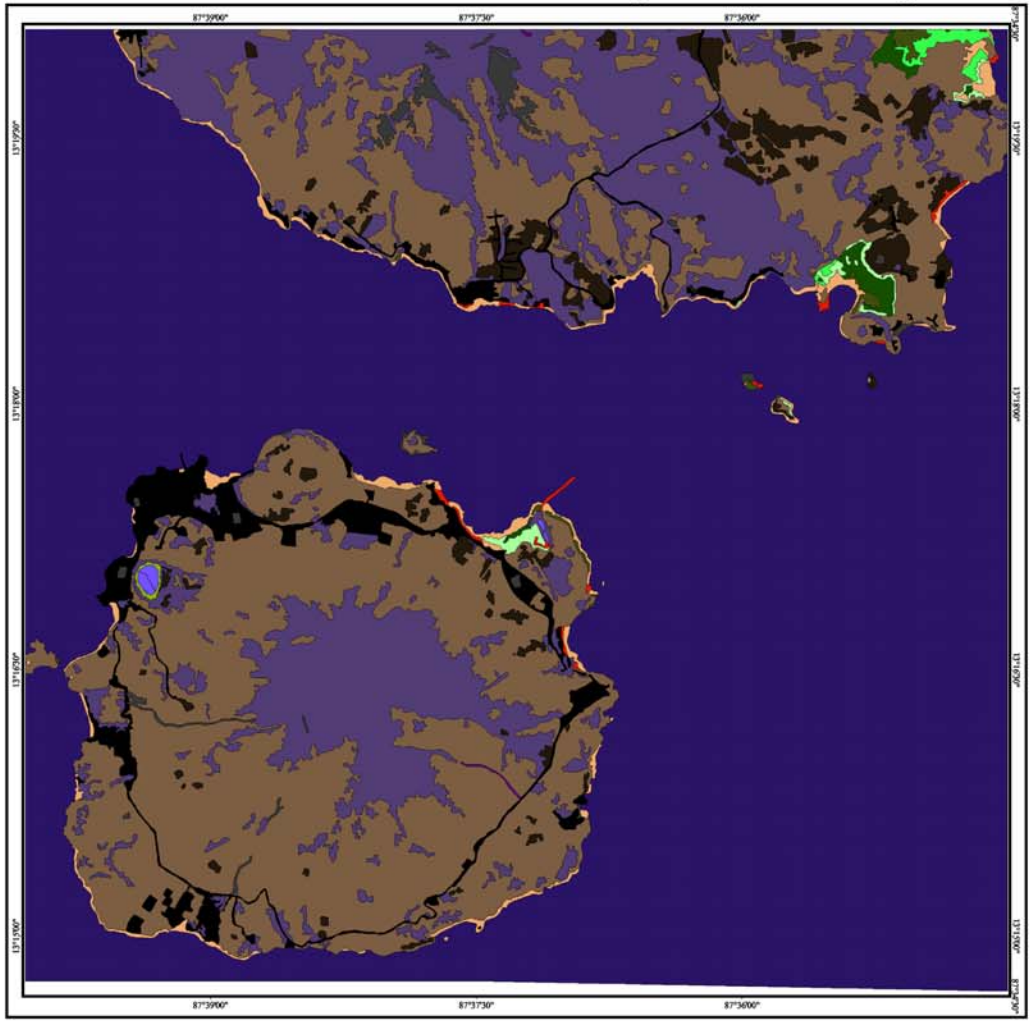
List of Acquired Aerial Photography for the Hurricane Mitch Project

AREA	DATE	SCALE	EMULSION	CAN	ROLL	FRAMES
Gulf of Fonseca	Apr-00	1:20,000	CIR	1	L-01	F-01 to F-25
Gulf of Fonseca	Apr-00	1:20,000	CIR	1	L-02	F-01 to F-27
Gulf of Fonseca	Apr-00	1:20,000	CIR	1	L-03	F-01 to F-26
Gulf of Fonseca	Apr-00	1:20,000	CIR	1	L-04	F-01 to F-26
Gulf of Fonseca	Apr-00	1:20,000	CIR	1	L-05	F-01 to F-29
Gulf of Fonseca	Apr-00	1:20,000	CIR	1	L-06	F-01 to F-31
Gulf of Fonseca	Apr-00	1:20,000	CIR	1	L-07	F-01 to F-30
Gulf of Fonseca	Apr-00	1:20,000	CIR	2	L-08	F-01 to F-28
Gulf of Fonseca	Apr-00	1:20,000	CIR	2	L-09	F-01 to F-24
Gulf of Fonseca	Apr-00	1:20,000	CIR	2	L-10	F-01 to F-21
Gulf of Fonseca	Apr-00	1:20,000	CIR	2	L-11	F-01 to F-23
Gulf of Fonseca	Apr-00	1:20,000	CIR	2	L-12	F-01 to F-10
Gulf of Fonseca	Apr-00	1:20,000	CIR	2	L-13	F-01 to F-10
Gulf of Fonseca	Apr-00	1:20,000	CIR	2	L-14	F-01 to F-22
Cayos Cachinos	Dec-99	1:10,000	NC	1	L-01	F-01 to F-24
Cayos Cachinos	Dec-99	1:10,000	NC	1	L-02	F-01 to F-20
Roatan	Jul-99	1:20,000	NC	1	1	1-139, 154-168
Utila	8-Jan-99	1:20,000	NC	1	2	0309-0376
Guanaja	07-Mar-99	1:20,000	NC	1	1	140-149
Guanaja	08-Jan-99	1:20,000	NC	1	2	382-387
Guanaja	08-Apr-99	1:20,000	NC	1	3	413-484
Guanaja	08-Apr-99	1:20,000	NC	1	3	502-514
Roatan	4-Dec-98	1:40,000	NC	Box	3V	651-656, 640-645, 571-574, 540-549
Gulf of Fonseca	4-Dec-98	1:40,000	BW	Box	3V	32-39, 44-48, 70-81, 84-86
Gulf of Fonseca	4-Dec-98	1:40,000	BW	Box	2V	331-343, 278-291, 256-266, 120-127
Gulf of Fonseca	4-Dec-98	1:40,000	BW	Box	1V	1188-1191

APPENDIX H

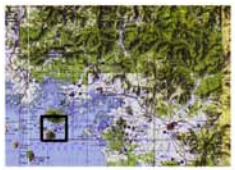
Habitat Data Posters for the municipalities of Amapala, San Lorenzo, Nacaome, and Choluteca, the island of Guanaja, the eastern end of the island of Roatan, and a portion of the Gulf of Fonseca.

Habitat Map for Amapala, Honduras



HABITAT CATEGORIES
- Salt Open Water
- Beaches, Bars, and Flats
- Salt Marsh
- Mangrove Scrub Shrub, Regularly Flooded
- Mangrove Scrub Shrub, Irregularly Flooded
- Wetland Dead Scrub Shrub
- Mangrove Forest, Regularly Flooded
- Mangrove Forest, Irregularly Flooded
- Wetland Dead Forest
- Salinas
- Shrimp Pond
- Debris on Flat
- Fresh Open Water
- Intermittent Stream
- Fresh Marsh
- Wetland Scrub Shrub
- Wetland Forest
- Barren
- Agriculture
- Upland Range
- Upland Scrub Shrub
- Upalnd Forest
- Urban
- Landslide
- No Aerial Photography Available

N



HABITAT CLASSES	ACRES	HECTARES
Salt Open Water	13346.2	5401.1
Fresh Open Water	14.9	6.0
Mangrove Forest, Regularly Flooded	35.0	14.3
Mangrove Forest, Irregularly Flooded	48.6	19.6
Mangrove Scrub Shrub, Regularly Flooded	43.8	17.6
Mangrove Scrub Shrub, Irregularly Flooded	65.3	26.5
Beaches, Bars, and Flats	228.8	92.5
Salinas	26.3	10.5
Fresh Marsh	6.5	2.6
Barren	135.8	55.1
Upland Forest	3403.6	1377.1
Upland Scrub Shrub	5981.6	2420.5
Upland Range	505.1	203.9
Urban	664.2	268.8
Landslide	4.4	1.8
Total	24510.1	9917.9

1 0 1 2 Miles

1000 0 1000 2000 3000 4000 Meters

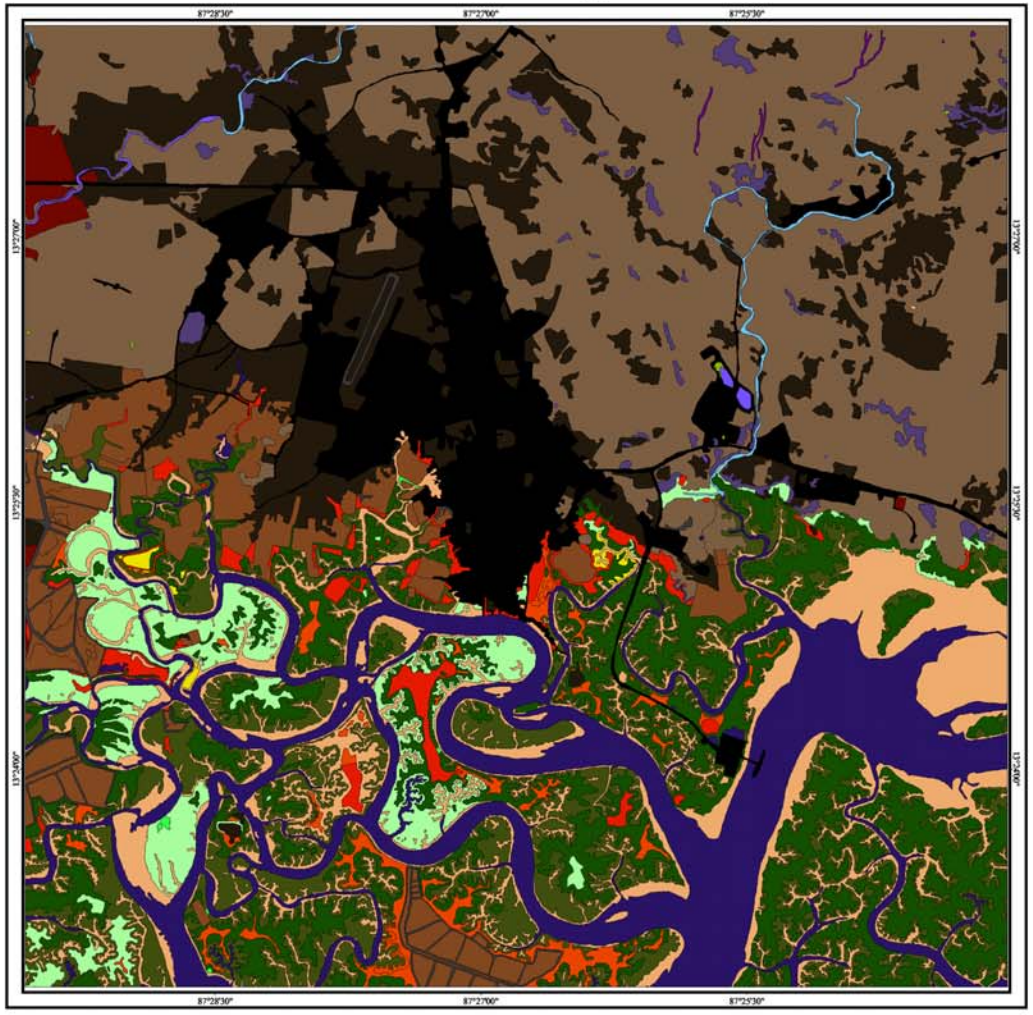
1 0 1 2 3 Kilometers

Data Source:
CIR aerial photography collected at 1:20,000 scale
in April 2000 and mapped by using 1:25,000 scale base maps.
Literature Cited:
Cowardin, L.M., Carter, V., Golet, F.C., and LaRoe, E.T., 1979, Classification of Wetlands and Deepwater Habitats of the United States: U.S. Fish and Wildlife Service FWS/OBS-79-31, 131 p.

Produced by:
U.S. Geological Survey
National Wetlands Research Center
Lafayette, LA

RN: OF 03-283
Map ID: 02-1-0025

Habitat Map for San Lorenzo, Honduras



HABITAT CATEGORIES

- Salt Open Water
- Beaches, Bars, and Flats
- Salt Marsh
- Mangrove Scrub Shrub, Regularly Flooded
- Mangrove Scrub Shrub, Irregularly Flooded
- Wetland Dead Scrub Shrub
- Mangrove Forest, Regularly Flooded
- Mangrove Forest, Irregularly Flooded
- Wetland Dead Forest
- Salinas
- Shrimp Pond
- Debris on Flat
- Fresh Open Water
- Intermittent Stream
- Fresh Marsh
- Wetland Scrub Shrub
- Wetland Forest
- Barren
- Agriculture
- Upland Range
- Upland Scrub Shrub
- Upalnd Forest
- Urban
- Landslide
- No Aerial Photography Available

HABITAT CLASSES	ACRES	HECTARES
Salt Open Water	2571.6	1040.7
Beaches, Bars, and Flats	2017.2	816.3
Mangrove Scrub Shrub, Regularly Flooded	6.1	2.4
Mangrove Scrub Shrub, Irregularly Flooded	2425.8	981.7
Wetland Dead Scrub Shrub	298.2	120.7
Mangrove Forest, Regularly Flooded	2457.2	994.4
Mangrove Forest, Irregularly Flooded	867.3	351.0
Wetland Dead Forest	31.4	12.7
Salinas	310.5	125.7
Shrimp Pond	1257.7	509.0
Fresh Open Water	27.7	11.2
Intermittent Stream	62.0	25.1
Fresh Marsh	3.2	1.3
Wetland Forest	4.0	1.6
Barren	157.3	63.7
Agriculture	133.7	54.1
Upland Range	2905.7	1175.9
Upland Scrub Shrub	6678.1	2702.6
Upland Forest	234.7	95.0
Urban	2225.9	900.8
Landslides	16.6	6.7
Total	24691.9	9992.8

1 0 1 2 Miles

1000 0 1000 2000 3000 4000 Meters

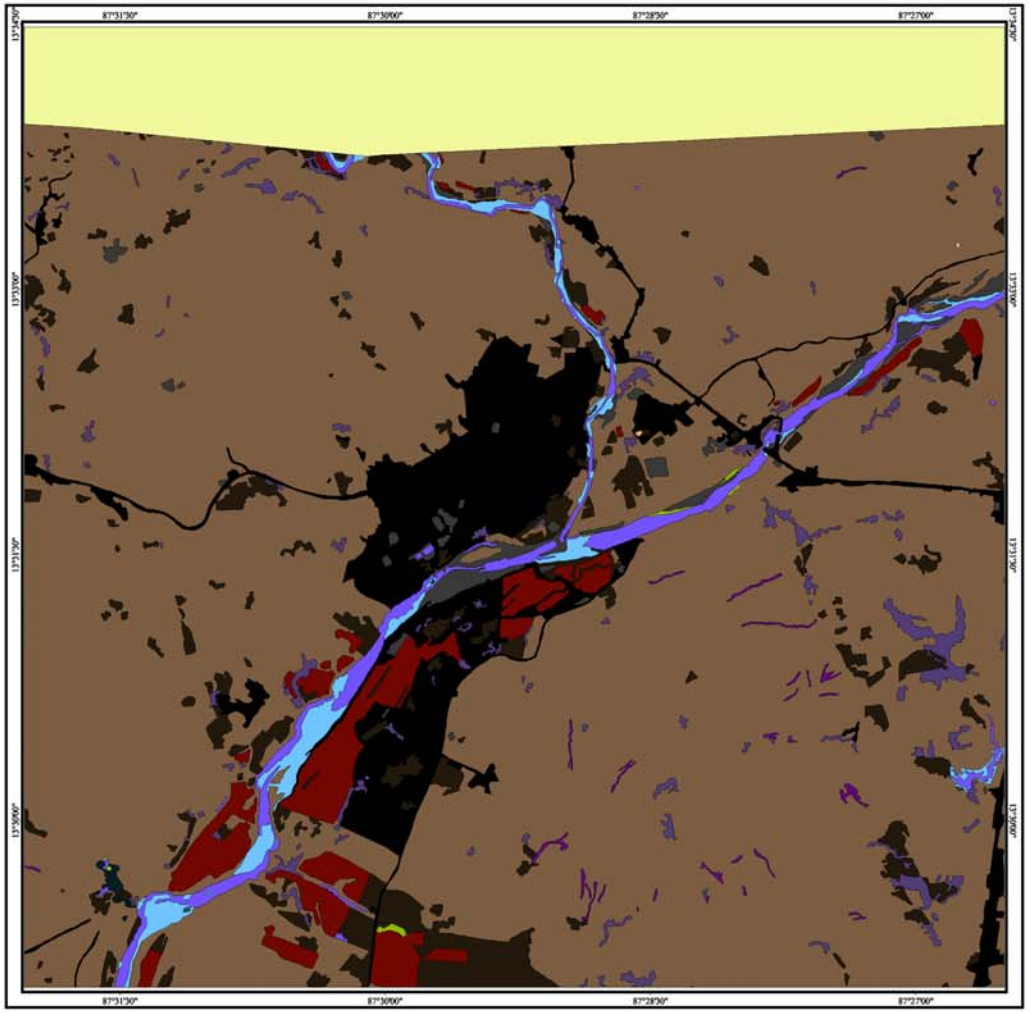
1 0 1 2 3 Kilometers

Data Source:
CIR aerial photography collected at 1:20,000 scale
in April 2000 and mapped by using 1:25,000 scale base maps.
Literature Cited:
Cowardin, L.M., Carter, V., Golet, F.C., and LaRoe, E.T., 1979, Classification of Wetlands and Deepwater Habitats of the United States: U.S. Fish and Wildlife Service FWS/OBS-79-31, 131 p.

Produced by:
U.S. Geological Survey
National Wetlands Research Center
Lafayette, LA

RN: OF 03-283
Map ID: 02-1-008

Habitat Map for Nacaome, Honduras



HABITAT CATEGORIES

- Salt Open Water
- Beaches, Bars, and Flats
- Salt Marsh
- Mangrove Scrub Shrub, Regularly Flooded
- Mangrove Scrub Shrub, Irregularly Flooded
- Wetland Dead Scrub Shrub
- Mangrove Forest, Regularly Flooded
- Mangrove Forest, Irregularly Flooded
- Wetland Dead Forest
- Salinas
- Shrimp Pond
- Debris on Flat
- Fresh Open Water
- Intermittent Stream
- Fresh Marsh
- Wetland Scrub Shrub
- Wetland Forest
- Barren
- Agriculture
- Upland Range
- Upland Scrub Shrub
- Upalnd Forest
- Urban
- Landslide
- No Aerial Photography Available

HABITAT CLASSES	ACRES	HECTARES
Beaches, Bars, and Flats	1.1	0.5
Fresh Open Water	346.7	140.3
Intermittent Stream	248.4	100.5
Fresh Marsh	11.2	4.5
Wetland Scrub Shrub	0.5	0.2
Wetland Forest	13.4	5.4
Barren	256.7	103.9
Agriculture	709.1	287.0
Upland Range	1125.8	455.6
Upland Scrub Shrub	16945.6	6857.8
Upland Forest	336.3	136.1
Urban	1746.5	706.8
Landslide	48.5	19.6
No Aerial Photography Available	2908.4	1177.0
Total	24698.5	9995.4

1 0 1 2 Miles

1000 0 1000 2000 3000 4000 Meters

1 0 1 2 3 Kilometers

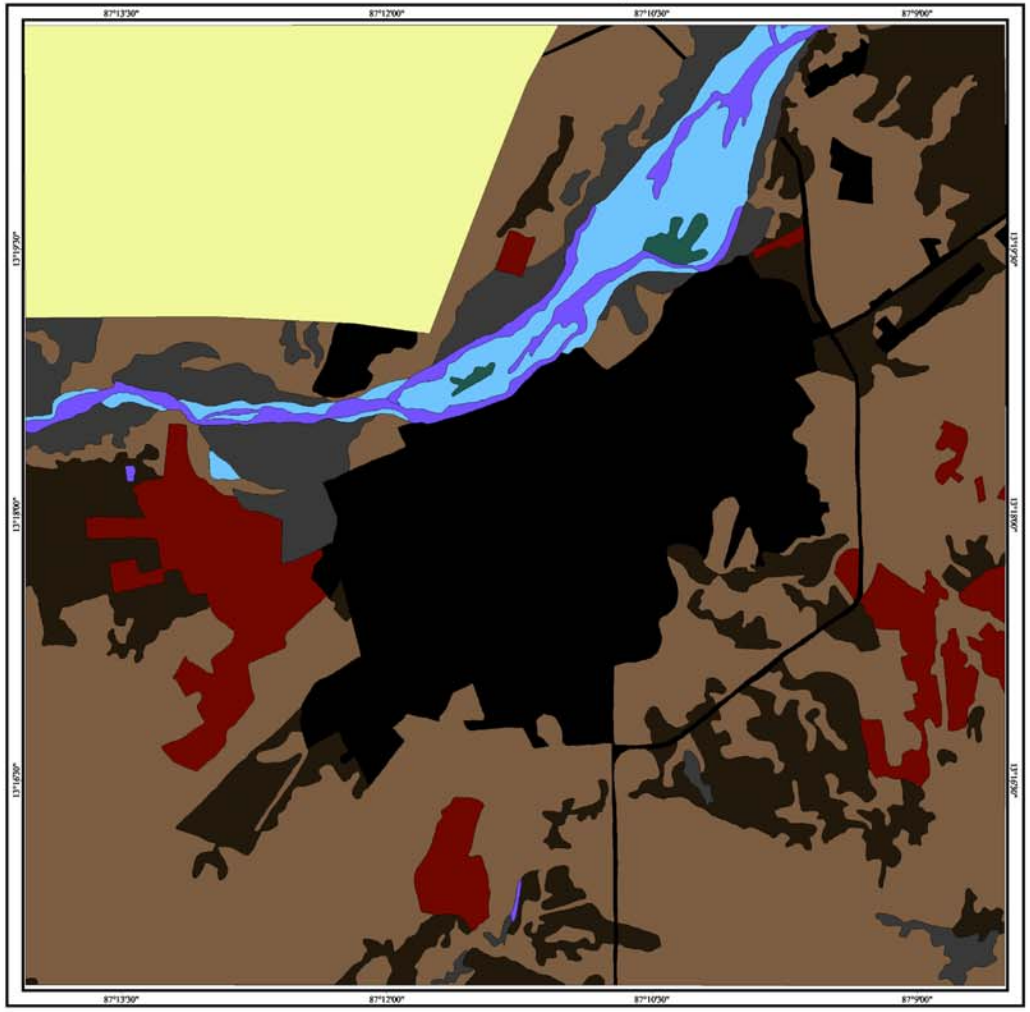
Data Source:
CIR aerial photography collected at 1:20,000 scale
in April 2000 and mapped by using 1:25,000 scale base maps.

Literature Cited:
Cowardin, L.M., Carter, V., Golet, F.C., and LaRoe, E.T., 1979, Classification of Wetlands and Deepwater Habitats of the United States: U.S. Fish and Wildlife Service FWS/OBS-79-31, 131 p.

Produced by:
U.S. Geological Survey
National Wetlands Research Center
Lafayette, LA

RN: OF 03-283
Map ID: 02-1-009

Habitat Map for Choluteca, Honduras



HABITAT CATEGORIES

- Salt Open Water
- Beaches, Bars, and Flats
- Salt Marsh
- Mangrove Scrub Shrub, Regularly Flooded
- Mangrove Scrub Shrub, Irregularly Flooded
- Wetland Dead Scrub Shrub
- Mangrove Forest, Regularly Flooded
- Mangrove Forest, Irregularly Flooded
- Wetland Dead Forest
- Salinas
- Shrimp Pond
- Debris on Flat
- Fresh Open Water
- Intermittent Stream
- Fresh Marsh
- Wetland Scrub Shrub
- Wetland Forest
- Barren
- Agriculture
- Upland Range
- Upland Scrub Shrub
- Upalnd Forest
- Urban
- Landslide
- No Aerial Photography Available

N

HABITAT CLASSES	ACRES	HECTARES
Fresh Open Water	397.4	160.8
Intermittent Stream	842.7	341.0
Wetland Scrub Shrub	60.7	24.6
Barren	1337.4	541.2
Agriculture	1383.9	560.1
Upland Range	2972.8	1203.1
Upland Scrub Shrub	9799.4	3965.8
Urban	4276.9	1730.9
No Aerial Photography Available	3623.1	1466.3
Total	24694.4	9993.7

1 0 1 2 Miles

1000 0 1000 2000 3000 4000 Meters

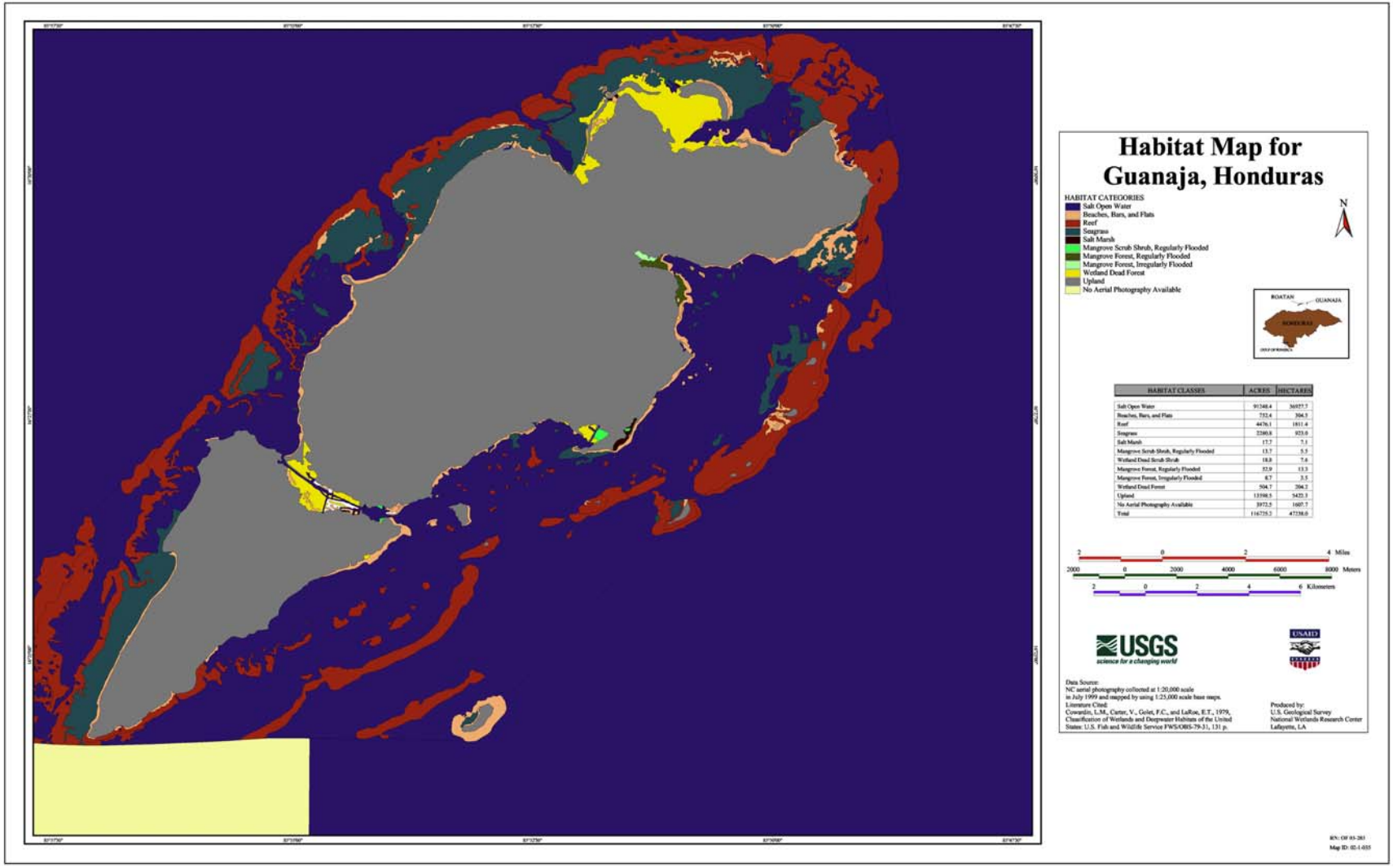
1 0 1 2 3 Kilometers

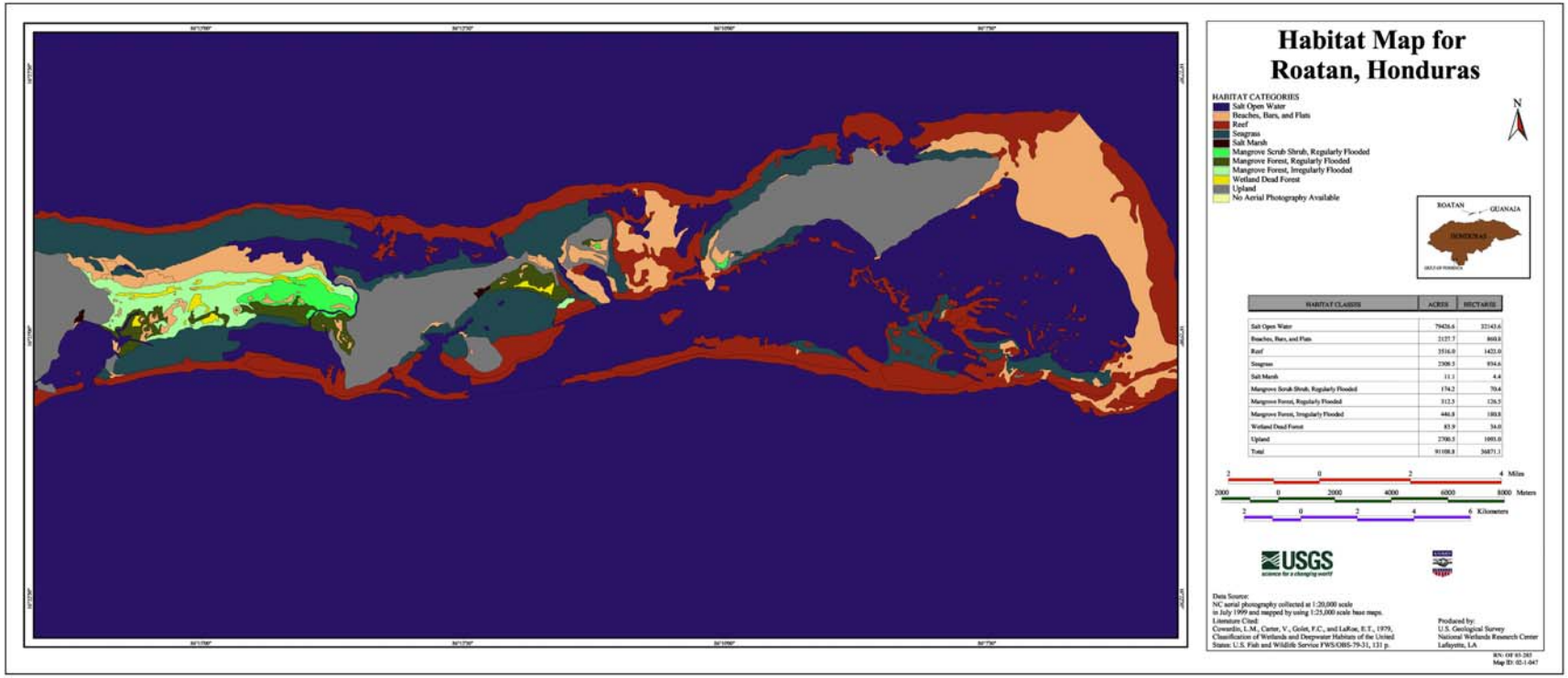
Data Source:
CIR aerial photography collected at 1:40,000 scale in December 1998 and mapped by using 1:25,000 scale base maps.

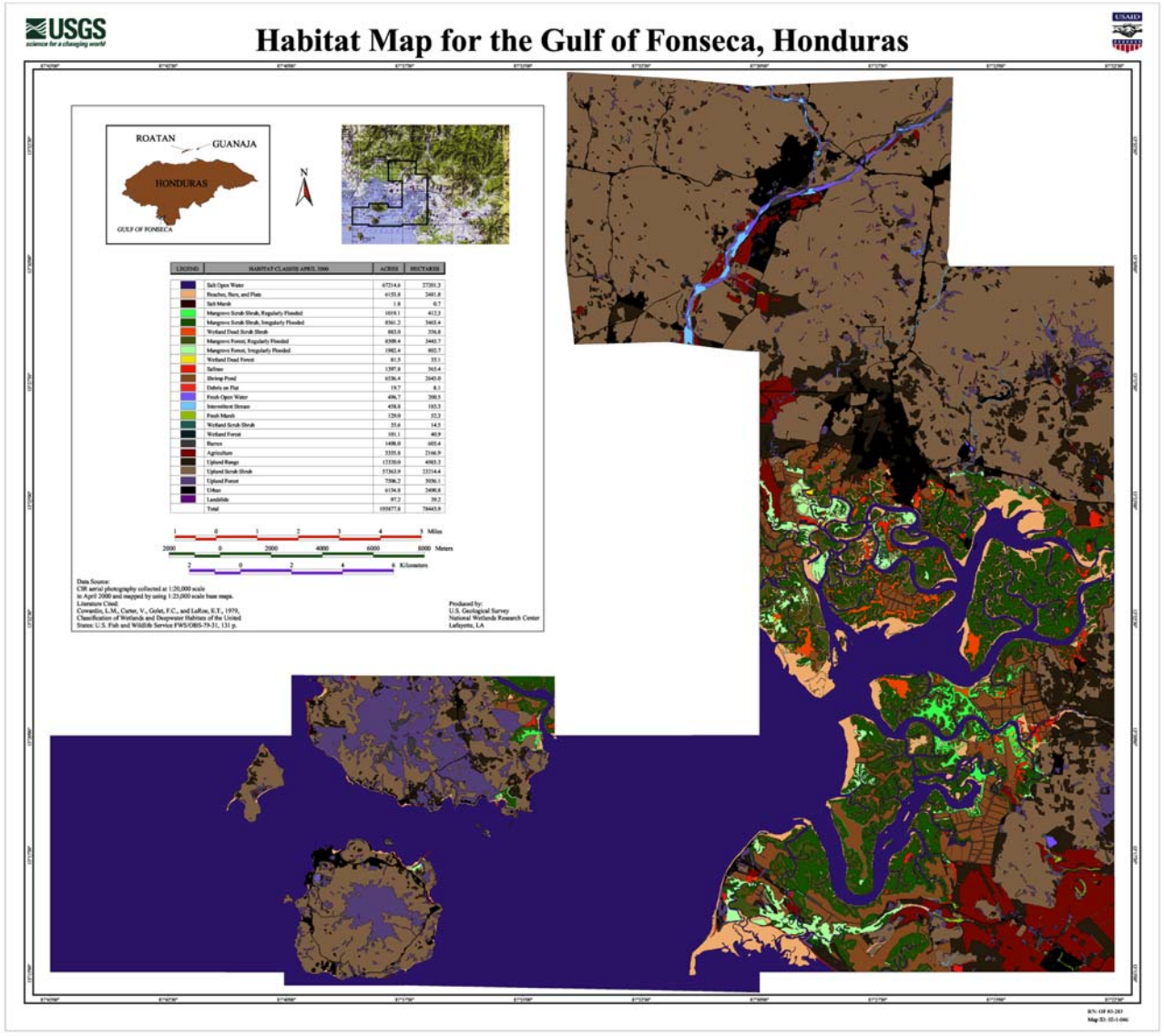
Literature Cited:
Cowardin, L.M., Carter, V., Golet, F.C., and LaRoe, E.T., 1979, Classification of Wetlands and Deepwater Habitats of the United States: U.S. Fish and Wildlife Service FWS/OBS-79-31, 131 p.

Produced by:
U.S. Geological Survey
National Wetlands Research Center
Lafayette, LA

RN: OF 03-283
Map ID: 02-1-010


Habitat Map for
Guanaja, Honduras
HABITAT CATEGORIES
Salt Open Water
Beaches, Bars, and Flats
Reef
Seagrass
Salt Marsh
Mangrove Scrub Shrub, Regularly Flooded
Mangrove Forest, Regularly Flooded
Mangrove Forest, Irregularly Flooded
Wetland Dead Forest
Upland
No Aerial Photography Available
N
ROATAN
GUANAJA
HONDURAS
HABITAT CLASSES
ACRES
HECTARES
Salt Open Water 91340.4 36957.7
Beaches, Bars, and Flats 752.4 304.5
Reef 4476.1 1811.4
Seagrass 2280.8 923.0
Salt Marsh 17.7 7.1
Mangrove Scrub-Shrub, Regularly Flooded 13.7 5.5
Wetland Dead Scrub-Shrub 18.8 7.6
Mangrove Forest, Regularly Flooded 32.9 13.3
Mangrove Forest, Irregularly Flooded 8.7 3.5
Wetland Dead Forest 504.7 204.2
Upland 13398.5 5420.3
No Aerial Photography Available 3972.5 1607.7
Total 116775.2 47258.0
2 0 2 4 Miles
2000 0 2000 4000 6000 8000 Meters
2 0 2 4 6 Kilometers
USGS
science for a changing world
USAID
Data Source:
NC aerial photography collected at 1:20,000 scale
in July 1999 and mapped by using 1:25,000 scale base maps.
Literature Cited:
Cowardin, L.M., Carter, V., Golet, F.C., and LaRoe, E.T., 1979,
Classification of Wetlands and Deepwater Habitats of the United
States: U.S. Fish and Wildlife Service FWS/OBS-79-31, 131 p.
Produced by:
U.S. Geological Survey
National Wetlands Research Center
Lafayette, LA
RN: OF 03-283
Map ID: 02-1-035


Habitat Map for
Roatan, Honduras
HABITAT CATEGORIES
Salt Open Water
Beaches, Bars, and Flats
Reef
Seagrass
Salt Marsh
Mangrove Scrub Shrub, Regularly Flooded
Mangrove Forest, Regularly Flooded
Mangrove Forest, Irregularly Flooded
Wetland Dead Forest
Upland
No Aerial Photography Available
N
ROATAN
GUANAJA
HONDURAS
HABITAT CLASSES
ACRES
HECTARES
Salt Open Water 79436.6 32143.6
Beaches, Bars, and Flats 2137.7 865.0
Reef 3516.0 1422.0
Seagrass 2308.5 934.6
Salt Marsh 11.1 4.4
Mangrove Scrub Shrub, Regularly Flooded 174.2 70.4
Mangrove Forest, Regularly Flooded 312.5 126.5
Mangrove Forest, Irregularly Flooded 446.0 180.5
Wetland Dead Forest 83.9 34.0
Upland 2700.5 1093.0
Total 91108.8 36871.1
2 0 2 4 Miles
2000 0 2000 4000 6000 8000 Meters
2 0 2 4 6 Kilometers
USGS
science for a changing world
Data Source:
NC aerial photography collected at 1:20,000 scale
in July 1999 and mapped by using 1:25,000 scale base maps.
Literature Cited:
Cowardin, L.M., Carter, V., Golet, F.C., and LaRoe, E.T., 1979,
Classification of Wetlands and Deepwater Habitats of the United
States: U.S. Fish and Wildlife Service FWS/OBS-79-31, 131 p.
Produced by:
U.S. Geological Survey
National Wetlands Research Center
Lafayette, LA
RN: OF 03-283
Map ID: 02-1-047


USGS
science for a changing world
Habitat Map for the Gulf of Fonseca, Honduras
USAID
ROATAN
GUANAJA
HONDURAS
GULF OF FONSECA
N
LEGEND
HABITAT CLASSES APRIL 2000
ACRES
HECTARES
Salt Open Water 6733.4.6 27281.3
Beaches, Bars, and Flats 6155.8 2491.8
Salt Marsh 1.8 0.7
Mangrove Scrub Shrub, Regularly Flooded 1019.1 413.3
Mangrove Scrub Shrub, Irregularly Flooded 8561.2 3463.4
Wetland Dead Scrub Shrub 883.0 356.8
Mangrove Forest, Regularly Flooded 8509.4 3443.7
Mangrove Forest, Irregularly Flooded 1902.4 802.7
Wetland Dead Forest 81.5 33.1
Saltme 1397.0 565.4
Shrimp Pond 6536.4 2645.0
Debris on Flat 19.7 8.1
Fresh Open Water 496.7 200.5
Intermittent Stream 458.0 185.3
Fresh Marsh 129.0 52.3
Wetland Scrub Shrub 35.6 14.5
Wetland Forest 101.1 40.9
Barren 1498.0 605.4
Agriculture 5335.0 2166.9
Upland Range 13330.0 4983.3
Upland Scrub Shrub 57263.9 23214.4
Upland Forest 7506.2 3036.1
Urban 6154.0 2490.8
Landslide 97.2 39.3
Total 193877.0 78443.9
1 0 1 2 3 4 5 Miles
2000 0 2000 4000 6000 8000 Meters
2 0 2 4 6 Kilometers
Data Source:
CIR aerial photography collected at 1:20,000 scale
in April 2000 and mapped by using 1:25,000 scale base maps.
Literature Cited,
Cowardin, L.M., Carter, V., Golet, F.C., and LaRoe, E.T., 1979,
Classification of Wetlands and Deepwater Habitats of the United
States: U.S. Fish and Wildlife Service FWS/OBS-79-31, 131 p.
Produced by:
U.S. Geological Survey
National Wetlands Research Center
Lafayette, LA

APPENDIX I

Indices of Data on Hurricane Mitch Municipality CD's

Municipality of San Lorenzo CD

Aerial Photos

Color_IR

mitch_fonseca_L04_05.tif, mitch_fonseca_L04_07.tif, mitch_fonseca_L04_09.tif, mitch_fonseca_L04_11.tif, mitch_fonseca_L05_19.tif, mitch_fonseca_L05_21.tif, mitch_fonseca_L05_23.tif, mitch_fonseca_L05_25.tif, mitch_fonseca_L06_05.tif, mitch_fonseca_L06_07.tif, mitch_fonseca_L06_09.tif, mitch_fonseca_L06_11.tif, mitch_fonseca_L07_20.tif, mitch_fonseca_L07_22.tif, mitch_fonseca_L07_24.tif, mitch_fonseca_L07_26.tif

Basemaps

25k

2756_3nw_utm.tfw, 2756_3nw_utm.tif, 2756_3sw_utm.tfw, 2756_3sw_utm.tif

50k

2756-3utm.tfw, 2756-3utm.tif

Habitat Data

ms_lorenzo.e00, ms_lorenzo_2.e00

Metadata

mithabs.html, mithabs.txt

Posters

Mitch_Center_Review.ppt, san_lorenzo.tif, san_lorenzo_8.5x11.tif

Report

Mitch_Report.doc

Municipality of Nacaome CD

Aerial Photos

Color_IR

mitch_fonseca_L01_15.tif, mitch_fonseca_L01_17.tif, mitch_fonseca_L01_19.tif, mitch_fonseca_L01_21.tif, mitch_fonseca_L02_05.tif, mitch_fonseca_L02_07.tif, mitch_fonseca_L02_09.tif, mitch_fonseca_L02_11.tif, mitch_fonseca_L03_12.tif, mitch_fonseca_L03_14.tif, mitch_fonseca_L03_16.tif, mitch_fonseca_L03_18.tif, mitch_fonseca_L03_20.tif, mitch_fonseca_L03_22.tif

Basemaps

25k

2656_1se_utm.tfw, 2656_1se_utm.tif, 2656_2ne_utm.tfw, 2656_2ne_utm.tif, 2756_3nw_utm.tfw, 2756_3nw_utm.tif, 2756_4sw_utm.tfw, 2756_4sw_utm.tif

50k

2656-1utm.tfw, 2656-1utm.tif, 2656-2utm.tfw, 2656-2utm.tif
2756-3utm.tfw, 2756-3utm.tif, 2756-4utm.tfw, 2756-4utm.tif

Habitat Data

mnacaome.e00, mnacaome_2.e00

Metadata

mithabs.html, mithabs.txt

Posters

Mitch_Center_Review.ppt, nacaome.tif, nacaome_8.5x11.tif

Report

Mitch_Report.doc

Municipality of Choluteca CD

Aerial Photos

Black and White

2V_120.tif, 2V_256.tif, 2V_258.tif

Basemaps

25k

2755_1nw_utm.tfw, 2755_1nw_utm.tif, 2756_2sw_utm.tfw, 2756_2sw_utm.tif

50k

2755-1utm.tfw, 2755-1utm.tif, 2756-2utm.tfw, 2756-2utm.tif

Habitat Data

mcholuteca.e00, mcholuteca_2.e00

Metadata

mithabs.html, mithabs.txt

Posters

Mitch_Center_Review.ppt, choluteca.tif, choluteca_8.5x11.tif

Report

Mitch_Report.doc

Municipality of Amapala CD

Aerial Photos

Color_IR

mitch_fonseca_L08_17.tif, mitch_fonseca_L08_19.tif, mitch_fonseca_L08_21.tif, mitch_fonseca_L09_02.tif, mitch_fonseca_L09_04.tif, mitch_fonseca_L09_06.tif, mitch_fonseca_L09_08.tif, mitch_fonseca_L10_17.tif, mitch_fonseca_L10_19.tif, mitch_fonseca_L10_21.tif, mitch_fonseca_L11_03.tif, mitch_fonseca_L11_05.tif

Basemaps

25k

2655_1ne_utm.tfw, 2655_1ne_utm.tif, 2655_1nw_utm.tfw, 2655_1nw_utm.tif, 2656_1se_utm.tfw, 2656_1se_utm.tif, 2656_2sw_utm.tfw, 2656_2sw_utm.tif

50k

2655-1utm.tfw, 2655-1utm.tif, 2656-1utm.tfw, 2656-1utm.tif, 2656-2utm.tfw, 2656-2utm.tif

Habitat Data

mamapala.e00, mamapala_2.e00

Metadata

mithabs.html, mithabs.txt

Posters

Mitch_Center_Review.ppt, amapala.tif, amapala_8.5x11.tif

Report

Mitch_Report.doc

Guanaja CD

Aerial Photos

Natural Color

Guanaja_140.tif, Guanaja_142.tif, Guanaja_146.tif, Guanaja_386.tif, Guanaja_413.tif, Guanaja_415.tif, Guanaja_417.tif, Guanaja_419.tif, Guanaja_421.tif, Guanaja_425.tif, Guanaja_427.tif, Guanaja_429.tif, Guanaja_433.tif, Guanaja_435.tif, Guanaja_438.tif, Guanaja_440.tif, Guanaja_444.tif, Guanaja_448.tif, Guanaja_450.tif, Guanaja_455.tif, Guanaja_457.tif, Guanaja_459.tif, Guanaja_461.tif, Guanaja_465.tif, Guanaja_467.tif, Guanaja_471.tif, Guanaja_475.tif, Guanaja_477.tif, Guanaja_479.tif, Guanaja_483.tif

Basemaps

50k

image19.tfw, image19.tif

Habitat Data

guanaja99.e00

Metadata

mithabn.html, mithabn.txt

Posters

guanaja.tif, guanaja_8.5x11.tif

Report

Mitch_Report.doc

Roatan CD

Aerial Photos

Natural Color

1_001.tif, 1_005.tif, 1_009.tif, 1_022.tif, 1_026.tif, 1_030.tif, 1_034.tif, 1_038.tif

Basemaps

50k

image18.tfw, image18.tif

Habitat Data

roatan99.e00

Metadata

mithabn.html, mithabn.txt

Posters

roatan.tif, roatan_small.tif

Report

Mitch_Report.doc

Municipality of Fonseca CD 1

Aerial Photos

Color_IR

mitch_fonseca_L01_15.tif, mitch_fonseca_L01_17.tif, mitch_fonseca_L01_19.tif, mitch_fonseca_L01_21.tif, mitch_fonseca_L02_05.tif, mitch_fonseca_L02_07.tif, mitch_fonseca_L02_09.tif, mitch_fonseca_L02_11.tif, mitch_fonseca_L03_12.tif, mitch_fonseca_L03_14.tif, mitch_fonseca_L03_16.tif, mitch_fonseca_L03_18.tif, mitch_fonseca_L03_20.tif, mitch_fonseca_L03_22.tif, mitch_fonseca_L04_05.tif, mitch_fonseca_L04_07.tif, mitch_fonseca_L04_09.tif, mitch_fonseca_L04_11.tif, mitch_fonseca_L05_19.tif, mitch_fonseca_L05_21.tif, mitch_fonseca_L05_23.tif, mitch_fonseca_L05_25.tif

Municipality of Fonseca CD 2

Aerial Photos

Color_IR

mitch_fonseca_L06_05.tif, mitch_fonseca_L06_07.tif,
mitch_fonseca_L06_09.tif, mitch_fonseca_L06_11.tif,
mitch_fonseca_L07_20.tif, mitch_fonseca_L07_22.tif,
mitch_fonseca_L07_24.tif, mitch_fonseca_L07_26.tif,
mitch_fonseca_L08_01.tif, mitch_fonseca_L08_03.tif,
mitch_fonseca_L08_05.tif, mitch_fonseca_L08_07.tif,
mitch_fonseca_L08_09.tif, mitch_fonseca_L08_11.tif
mitch_fonseca_L08_17.tif, mitch_fonseca_L08_19.tif,
mitch_fonseca_L08_21.tif, mitch_fonseca_L09_02.tif,
mitch_fonseca_L09_04.tif, mitch_fonseca_L09_06.tif,
mitch_fonseca_L09_08.tif, mitch_fonseca_L09_10.tif

Municipality of Fonseca CD 3

Aerial Photos

Color_IR

mitch_fonseca_L09_12.tif, mitch_fonseca_L09_14.tif, mitch_fonseca_L09_16.tif, mitch_fonseca_L09_18.tif, mitch_fonseca_L09_20.tif, mitch_fonseca_L10_05.tif, mitch_fonseca_L10_07.tif, mitch_fonseca_L10_09.tif, mitch_fonseca_L10_11.tif, mitch_fonseca_L10_13.tif, mitch_fonseca_L10_17.tif, mitch_fonseca_L10_19.tif, mitch_fonseca_L10_21.tif, mitch_fonseca_L11_03.tif, mitch_fonseca_L11_05.tif, mitch_fonseca_L11_11.tif, mitch_fonseca_L11_13.tif, mitch_fonseca_L11_15.tif, mitch_fonseca_L11_17.tif, mitch_fonseca_L11_19.tif

Municipality of Fonseca CD 4

Basemaps

25k

2655_1ne_utm.tfw, 2655_1ne_utm.tif, 2655_1nw_utm.tfw, 2655_1nw_utm.tif, 2656_1se_utm.tfw, 2656_1se_utm.tif, 2656_2sw_utm.tfw, 2656_2sw_utm.tif, 2756_3sw_utm.tfw, 2756_3sw_utm.tif, 2656_2ne_utm.tfw, 2656_2ne_utm.tif, 2756_3nw_utm.tfw, 2756_3nw_utm.tif, 2756_4sw_utm.tfw, 2756_4sw_utm.tif, 2656_2se_utm.tfw, 2656_2se_utm.tif, 2755_1nw_utm.tfw, 2755_1nw_utm.tif, 2755_4nw_utm.tfw, 2755_4nw_utm.tif, 2756_2sw_utm.tfw, 2756_2sw_utm.tif

50k

2655-1utm.tfw, 2655-1utm.tif, 2656-1utm.tfw, 2656-1utm.tif, 2656-2utm.tfw, 2656-2utm.tif, 2755-1utm.tfw, 2755-1utm.tif, 2755-4utm.tfw, 2755-4utm.tif, 2756-2utm.tfw, 2756-2utm.tif, 2756-3utm.tfw, 2756-3utm.tif, 2756-4utm.tfw, 2756-4utm.tif

Habitat Data

fonseca.e00

Metadata

mithabs.html, mithabs.txt, mitmps.html, mitmps.txt

Posters

Mitch_Center_Review.ppt, fonseca.tif, fonseca_small.tif

Report

Mitch_Report.doc