APPENDIX C

St. Kitts and Nevis Habitat Metadata Compilation

ST. KITTS & NEVIS METADATA COMPILATION

Name of Layer: SKN_Ac_palmata_stumps.shp, *Acropora palmata* stumps

Abstract:

Acropora palmata stumps represent one of twelve shallow water benthic habitats mapped around St. Kitts and Nevis. *Acropora palmata* stumps are defined as dense thickets of largely dead *Acropora palmata* colonies interspersed with the occasional living colony of another hard coral species; predominantly either *Montastrea*, or *Siderastrea*. In deeper areas (< 5 m water depth) these stumps remain in an upright growth position and provide high habitat complexity. Shoreward, these corals are often displaced and mingle with rubble substrate. Narrow sand channels (1-2 m across) bifurcate patches of this habitat.

This habitat layer is derived from IKONOS and QuickBird multispectral satellite data. This sensor measures the quantity and quality of light reflecting off the seafloor. Images were corrected for the absorption and scattering of photons through the atmosphere using Modtran radiative transfer code modeled based on a tropical maritime atmosphere. Image scenes compromised by sea-surface-glint were corrected using the algorithm of Hedley et al. (2004), which is based on the relative brightness in the near-infrared region of the spectrum. Spectral probability classifiers and edge-detection techniques were hybridized to create the most accurate map possible. Edge detection was used to efficiently identify boundaries between bright and dark habitats on the seafloor. Spectral classification draws on the fact that different substrates vary in the portion of light that they absorb/reflect at different electromagnetic wavelengths. Ground truth video data was used to collect from-image reflectance statistics. A maximum-likelihood algorithm was then used to calculate the probability that a given pixel belonged to a specific class, with pixels assigned to the class with the highest probability. This algorithm was not applied to areas of land, deepwater or cloud-contaminated pixels. In the case of cloud contaminated pixels, ground truth data and image interpretation were used to interpolate the classification across such gaps. Miss-classification resulting from local aberrations in the remote-sensed image, such as might occur from wave induced surface glint, was guarded against. A median filter was used to remove 'salt and pepper' noise or speckle which is indicative of miss-classification, by replacing isolated pixels with those common in the local neighborhood. In the final step of habitat classification, products were subjected to visual quality control. This ensures that habitats described follow identifiable boundaries in the imagery. Further details on the general approach used can be found in Purkis (2005).

Hedley J. D, Harbourne A. R., Mumby P. J., 2005. Simple and robust removal of sun glint for mapping shallow-water benthos. International Journal of Remote Sensing **26**: 2107-2112.

Purkis, S., 2005. A "reef-up" approach to classifying coral habitats from IKONOS imagery. IEEE Transactions on Geoscience and Remote Sensing **43**:1375-1390.

Purpose:

Acropora palmata stumps are mapped in accordance to their location surrounding St. Kitts and Nevis. This layer accurately represents the size, location and distribution of this habitat off the coast of St. Kitts and Nevis.

Original Projection:

Universal Transverse Mercator (UTM) Zone 20 North, World Geodetic System (WGS) 1984

Date of Completion:

April 29, 2010

Source Citation:

Data are produced using satellite an in-situ field data by the National Coral Reef Institute (NCRI) on behalf of The Nature Conservancy, a USAID sponsored project for the Federation of St. Kitts and Nevis.

IKONOS multispectral satellite image data (GeoEye Ltd., http://www.geoeye.com) 2000-2009

QuickBird multispectral satellite image data (Digital Globe, http://www.digitalglobe.com) 2009.

Georeferenced video archive (NCRI/TNC, Jan 2010)

Compiled By:

Alexandra Dempsey, Gwilym Rowlands, and Sam Purkis

Reference Format:

Data should be referenced as

Rowlands, G. P., Dempsey, A., Purkis., S.J., 2010. Shallow-water benthic and bathymetric mapping: The federation of St. Kitts and Nevis. NCRI technical report.

Contact Layer:

Dr Sam Purkis, National Coral Reef Institute, Oceanographic Center, Nova Southeastern University, purkis@nova.edu, (954) 262-3647

TNC

Restrictions:

Use of this data for whatever purpose is restricted without expressed written consent of:

Dr Sam Purkis, National Coral Reef Institute

TNC

Name of Layer: SKN_Dense_Macroalgae.shp, Algal Hardgrounds

Abstract:

Algal hardgrounds represent one of the twelve habitat classes that comprise the shallow water benthic habitats surrounding St. Kitts and Nevis. A dense macro-algae biota found atop low relief patches of hardground interspersed with mobile sediment. This habitat is either *Sargassum* sp. dominated, typically in the lee of carbonate frameworks and sediment channels, or *Halimeda* dominated on more exposed slopes south of the island of Nevis.

This habitat layer is derived from IKONOS and QuickBird multispectral satellite data. This sensor measures the quantity and quality of light reflecting off the seafloor. Images were corrected for the absorption and scattering of photons through the atmosphere using Modtran radiative transfer code modeled based on a tropical maritime atmosphere. Image scenes

compromised by sea-surface-glint were corrected using the algorithm of Hedley et al. (2004), which is based on the relative brightness in the near-infrared region of the spectrum. Spectral probability classifiers and edge-detection techniques were hybridized to create the most accurate map possible. Edge detection was used to efficiently identify boundaries between bright and dark habitats on the seafloor. Spectral classification draws on the fact that different substrates vary in the portion of light that they absorb/reflect at different electromagnetic wavelengths. Ground truth video data was used to collect from-image reflectance statistics. A maximum-likelihood algorithm was then used to calculate the probability that a given pixel belonged to a specific class, with pixels assigned to the class with the highest probability. This algorithm was not applied to areas of land, deepwater or cloud-contaminated pixels. In the case of cloud contaminated pixels, ground truth data and image interpretation were used to interpolate the classification across such gaps. Miss-classification resulting from local aberrations in the remote-sensed image, such as might occur from wave induced surface glint, was guarded against. A median filter was used to remove 'salt and pepper' noise or speckle which is indicative of miss-classification, by replacing isolated pixels with those common in the local neighborhood. In the final step of habitat classification, products were subjected to visual quality control. This ensures that habitats described follow identifiable boundaries in the imagery. Further details on the general approach used can be found in Purkis (2005).

Hedley J. D, Harbourne A. R., Mumby P. J., 2005. Simple and robust removal of sun glint for mapping shallow-water benthos. International Journal of Remote Sensing **26**: 2107-2112.

Purkis, S., 2005. A "reef-up" approach to classifying coral habitats from IKONOS imagery. IEEE Transactions on Geoscience and Remote Sensing **43**:1375-1390.

Purpose:

Algal Hardgrounds are mapped in accordance to their location surrounding St. Kitts and Nevis. The purpose of this layer is to accurately represent the size, location and distribution of these very dense macro-algae patches atop sparse rubble and sand.

Original Projection:

Universal Transverse Mercator (UTM) Zone 20 North, World Geodetic System (WGS) 1984

Date of Completion:

April 29, 2010

Source Citation:

Data are produced using satellite an in-situ field data by the National Coral Reef Institute (NCRI) on behalf of The Nature Conservancy, a USAID sponsored project for the Federation of St. Kitts and Nevis.

IKONOS multispectral satellite image data (GeoEye Ltd., http://www.geoeye.com) 2000-2009

QuickBird multispectral satellite image data (Digital Globe, http://www.digitalglobe.com) 2009.

Georeferenced video archive (NCRI/TNC, Jan 2010)

Compiled By:

Alexandra Dempsey, Gwilym Rowlands, and Sam Purkis

Reference Format:

Data should be referenced as

Rowlands, G. P., Dempsey, A., Purkis., S.J., 2010. Shallow-water benthic and bathymetric mapping: The federation of St. Kitts and Nevis. NCRI technical report.

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Dr Sam Purkis, National Coral Reef Institute

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Name of Layer: SKN_Dense_Seagrass.shp, Dense Seagrass

Abstract:

Dense Seagrass represents one of the twelve habitat classes that comprise the shallow water benthic habitats surrounding St. Kitts and Nevis. Sand sheets with a dense seagrass community (> 50% cover) dominated by *Thallassia tesdudium*, and secondarily *Syringodium filiforme.* Associated with the grass are green algae (Chlorophyta) - especially *Halimedia, Udotea, Turbinaria,* etc).

This habitat layer is derived from IKONOS and QuickBird multispectral satellite data. This sensor measures the quantity and quality of light reflecting off the seafloor. Images were corrected for the absorption and scattering of photons through the atmosphere using Modtran radiative transfer code modeled based on a tropical maritime atmosphere. Image scenes compromised by sea-surface-glint were corrected using the algorithm of Hedley et al. (2004), which is based on the relative brightness in the near-infrared region of the spectrum. Spectral probability classifiers and edge-detection techniques were hybridized to create the most accurate map possible. Edge detection was used to efficiently identify boundaries between bright and dark habitats on the seafloor. Spectral classification draws on the fact that different substrates vary in the portion of light that they absorb/reflect at different electromagnetic wavelengths. Ground truth video data was used to collect from-image reflectance statistics. A maximum-likelihood algorithm was then used to calculate the probability that a given pixel belonged to a specific class, with pixels assigned to the class with the highest probability. This algorithm was not applied to areas of land, deepwater or cloud-contaminated pixels. In the case of cloud contaminated pixels, ground truth data and image interpretation were used to interpolate the classification across such gaps. Miss-classification res ulting from local aberrations in the remote-sensed image, such as might occur from wave induced surface glint, was guarded against. A median filter was used to remove 'salt and pepper' noise or speckle which is indicative of miss-classification, by replacing isolated pixels with those common in the local neighborhood. In the final step of habitat classification, products were subjected to visual quality control. This ensures that habitats described follow identifiable boundaries in the imagery. Further details on the general approach used can be found in Purkis (2005).

Hedley J. D, Harbourne A. R., Mumby P. J., 2005. Simple and robust removal of sun glint for mapping shallow-water benthos. International Journal of Remote Sensing **26**: 2107-2112.

Purkis, S., 2005. A "reef-up" approach to classifying coral habitats from IKONOS imagery. IEEE Transactions on Geoscience and Remote Sensing **43**:1375-1390.

Purpose:

Dense seagrass are mapped in accordance to their location surrounding St. Kitts and Nevis. This layer is to accurately represent the size, location and distribution which extend substantially in the channel between St. Kitts and Nevis.

Original Projection:

Universal Transverse Mercator (UTM) Zone 20 North, World Geodetic System (WGS) 1984

Date of Completion:

April 29, 2010

Source Citation:

Data are produced using satellite an in-situ field data by the National Coral Reef Institute (NCRI) on behalf of The Nature Conservancy, a USAID sponsored project for the Federation of St. Kitts and Nevis.

IKONOS multispectral satellite image data (GeoEye Ltd., http://www.geoeye.com) 2000-2009

QuickBird multispectral satellite image data (Digital Globe, http://www.digitalglobe.com) 2009.

Georeferenced video archive (NCRI/TNC, Jan 2010)

Compiled By:

Alexandra Dempsey, Gwilym Rowlands, and Sam Purkis

Reference Format:

Data should be referenced as

Rowlands, G. P., Dempsey, A., Purkis., S.J., 2010. Shallow-water benthic and bathymetric mapping: The federation of St. Kitts and Nevis. NCRI technical report.

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Name of Layer: SKN_Gorgonian_Hardgrounds.shp, Flat Gorgonian Hardgrounds

Abstract:

Gorgonian Hardgrounds represent one of the twelve habitat classes that comprise the shallow water benthic habitats surrounding St. Kitts and Nevis. The Gorgonian Hardground class is comprised as a thin layer of fine sediment exhibiting a dense gorgonian cover with sparse macro-algae (typically *Halimedia*, *Udotea* etc).

This habitat layer is derived from IKONOS and QuickBird multispectral satellite data. This sensor measures the quantity and quality of light reflecting off the seafloor. Images were corrected for the absorption and scattering of photons through the atmosphere using Modtran radiative transfer code modeled based on a tropical maritime atmosphere. Image scenes compromised by sea-surface-glint were corrected using the algorithm of Hedley et al. (2004), which is based on the relative brightness in the near-infrared region of the spectrum. Spectral probability classifiers and edge-detection techniques were hybridized to create the most accurate map possible. Edge detection was used to efficiently identify boundaries between bright and dark habitats on the seafloor. Spectral classification draws on the fact that different substrates vary in the portion of light that they absorb/reflect at different electromagnetic wavelengths. Ground truth video data was used to collect from-image reflectance statistics. A maximum-likelihood algorithm was then used to calculate the probability that a given pixel belonged to a specific class, with pixels assigned to the class with the highest probability. This algorithm was not applied to areas of land, deepwater or cloud-contaminated pixels. In the case of cloud contaminated pixels, ground truth data and image interpretation were used to interpolate the classification across such gaps. Miss-classification resulting from local aberrations in the remote-sensed image, such as might occur from wave induced surface glint, was guarded against. A median filter was used to remove 'salt and pepper' noise or speckle which is indicative of miss-classification, by replacing isolated pixels with those common in the local neighborhood. In the final step of habitat classification, products were subjected to visual quality control. This ensures that habitats described follow identifiable boundaries in the imagery. Further details on the general approach used can be found in Purkis (2005).

Hedley J. D, Harbourne A. R., Mumby P. J., 2005. Simple and robust removal of sun glint for mapping shallow-water benthos. International Journal of Remote Sensing **26**: 2107-2112.

Purkis, S., 2005. A "reef-up" approach to classifying coral habitats from IKONOS imagery. IEEE Transactions on Geoscience and Remote Sensing **43**:1375-1390.

Purpose:

Gorgonian Hardgrounds are mapped in accordance to their location surrounding St. Kitts and Nevis. This layer accurately represents the size, location and distribution of Gorgonian hardgrounds.

Original Projection:

Universal Transverse Mercator (UTM) Zone 20 North, World Geodetic System (WGS) 1984

Date of Completion:

April 29, 2010

Source Citation:

Data are produced using satellite an in-situ field data by the National Coral Reef Institute (NCRI) on behalf of The Nature Conservancy, a USAID sponsored project for the Federation of St. Kitts and Nevis.

IKONOS multispectral satellite image data (GeoEye Ltd., http://www.geoeye.com) 2000-2009

QuickBird multispectral satellite image data (Digital Globe, http://www.digitalglobe.com) 2009.

Georeferenced video archive (NCRI/TNC, Jan 2010)

Compiled By:

Alexandra Dempsey, Gwilym Rowlands, and Sam Purkis

Reference Format:

Data should be referenced as

Rowlands, G. P., Dempsey, A., Purkis., S.J., 2010. Shallow-water benthic and bathymetric mapping: The federation of St. Kitts and Nevis. NCRI technical report.

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TNC

Name of Layer: SKN_Hard_Coral, Hard coral framework

Abstract:

Hard coral framework represents one of the twelve habitat classes that comprise the shallow water benthic habitats surrounding St. Kitts and Nevis. Moderately rugose frameworks with sparse coral cover (typically <10 %). Colonies are predominantly small (sub-meter) in size. The coral community is composed primarily of *Siderastrea*, *Montastrea*, *Diploria*, and *Colpophylia* spp.. Crustose coralline algae and fleshy algae (*Sargassum*, *Dictyota*) along with gorgonians dominate the remainder of substrate. This hard coral framework tends to form a semi-continuous barrier, broken by narrow sediment filled channels. Live stony corals are present at relatively low densities and can be found typically in spur and groove morphology.

This habitat layer is derived from IKONOS and QuickBird multispectral satellite data. This sensor measures the quantity and quality of light reflecting off the seafloor. Images were corrected for the absorption and scattering of photons through the atmosphere using Modtran radiative transfer code modeled based on a tropical maritime atmosphere. Image scenes

compromised by sea-surface-glint were corrected using the algorithm of Hedley et al. (2004), which is based on the relative brightness in the near-infrared region of the spectrum. Spectral probability classifiers and edge-detection techniques were hybridized to create the most accurate map possible. Edge detection was used to efficiently identify boundaries between bright and dark habitats on the seafloor. Spectral classification draws on the fact that different substrates vary in the portion of light that they absorb/reflect at different electromagnetic wavelengths. Ground truth video data was used to collect from-image reflectance statistics. A maximum-likelihood algorithm was then used to calculate the probability that a given pixel belonged to a specific class, with pixels assigned to the class with the highest probability. This algorithm was not applied to areas of land, deepwater or cloud-contaminated pixels. In the case of cloud contaminated pixels, ground truth data and image interpretation were used to interpolate the classification across such gaps. Miss-classification resulting from local aberrations in the remote-sensed image, such as might occur from wave induced surface glint, was guarded against. A median filter was used to remove 'salt and pepper' noise or speckle which is indicative of miss-classification, by replacing isolated pixels with those common in the local neighborhood. In the final step of habitat classification, products were subjected to visual quality control. This ensures that habitats described follow identifiable boundaries in the imagery. Further details on the general approach used can be found in Purkis (2005).

Hedley J. D, Harbourne A. R., Mumby P. J., 2005. Simple and robust removal of sun glint for mapping shallow-water benthos. International Journal of Remote Sensing **26**: 2107-2112.

Purkis, S., 2005. A "reef-up" approach to classifying coral habitats from IKONOS imagery. IEEE Transactions on Geoscience and Remote Sensing **43**:1375-1390.

Purpose:

Hard coral framework is mapped in accordance to their location surrounding St. Kitts and Nevis. This layer accurately represents the size, location and distribution of hard coral.

Original Projection:

Universal Transverse Mercator (UTM) Zone 20 North, World Geodetic System (WGS) 1984

Date of Completion:

April 29, 2010

Source Citation:

Data are produced using satellite an in-situ field data by the National Coral Reef Institute (NCRI) on behalf of The Nature Conservancy, a USAID sponsored project for the Federation of St. Kitts and Nevis.

IKONOS multispectral satellite image data (GeoEye Ltd., http://www.geoeye.com) 2000-2009

QuickBird multispectral satellite image data (Digital Globe, http://www.digitalglobe.com) 2009.

Georeferenced video archive (NCRI/TNC, Jan 2010)

Compiled By:

Alexandra Dempsey, Gwilym Rowlands, and Sam Purkis

Reference Format:

Data should be referenced as

Rowlands, G. P., Dempsey, A., Purkis., S.J., 2010. Shallow-water benthic and bathymetric mapping: The federation of St. Kitts and Nevis. NCRI technical report.

Contact Layer:

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Dr Sam Purkis, National Coral Reef Institute

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Name of Layer: SKN_Lagoonal_Muds.shp. , Lagoonal muds

Abstract:

Lagoonal muds represent one of the twelve habitat classes that comprise the shallow water benthic habitats surrounding St. Kitts and Nevis. This classification can best be described as an enclosed muddy embayment. The salt water content of these areas varies with tidal fluctuations, with water typically percolating through the surrounding land matrix.

This habitat layer is derived from IKONOS and QuickBird multispectral satellite data. This sensor measures the quantity and quality of light reflecting off the seafloor. Images were corrected for the absorption and scattering of photons through the atmosphere using Modtran radiative transfer code modeled based on a tropical maritime atmosphere. Image scenes compromised by sea-surface-glint were corrected using the algorithm of Hedley et al. (2004), which is based on the relative brightness in the near-infrared region of the spectrum. Spectral probability classifiers and edge-detection techniques were hybridized to create the most accurate map possible. Edge detection was used to efficiently identify boundaries between bright and dark habitats on the seafloor. Spectral classification draws on the fact that different substrates vary in the portion of light that they absorb/reflect at different electromagnetic wavelengths. Ground truth video data was used to collect from-image reflectance statistics. A maximum-likelihood algorithm was then used to calculate the probability that a given pixel belonged to a specific class, with pixels assigned to the class with the highest probability. This algorithm was not applied to areas of land, deepwater or cloud-contaminated pixels. In the case of cloud contaminated pixels, ground truth data and image interpretation were used to interpolate the classification across such gaps. Miss-classification resulting from local aberrations in the remote-sensed image, such as might occur from wave induced surface glint, was guarded against. A median filter was used to remove 'salt and pepper' noise or speckle which is indicative of miss-classification, by replacing isolated pixels with those common in the local neighborhood. In the final step of habitat classification, products were subjected to visual quality control. This ensures that habitats described follow identifiable boundaries in the imagery. Further details on the general approach used can be found in Purkis (2005).

Hedley J. D, Harbourne A. R., Mumby P. J., 2005. Simple and robust removal of sun glint for mapping shallow-water benthos. International Journal of Remote Sensing **26**: 2107-2112.

Purkis, S., 2005. A "reef-up" approach to classifying coral habitats from IKONOS imagery. IEEE Transactions on Geoscience and Remote Sensing **43**:1375-1390.

Purpose:

Lagoonal muds are mapped in accordance to their location surrounding St. Kitts. Lagoonal muds were absent circumventing the Island of Nevis; therefore this layer pertains mainly to the island of St. Kitts.

Original Projection:

Universal Transverse Mercator (UTM) Zone 20 North, World Geodetic System (WGS) 1984

Date of Completion:

April 29, 2010

Source Citation:

Data are produced using satellite an in-situ field data by the National Coral Reef Institute (NCRI) on behalf of The Nature Conservancy, a USAID sponsored project for the Federation of St. Kitts and Nevis.

IKONOS multispectral satellite image data (GeoEye Ltd., http://www.geoeye.com) 2000-2009

QuickBird multispectral satellite image data (Digital Globe, http://www.digitalglobe.com) 2009.

Georeferenced video archive (NCRI/TNC, Jan 2010)

Compiled By:

Alexandra Dempsey, Gwilym Rowlands, and Sam Purkis

Reference Format:

Data should be referenced as

Rowlands, G. P., Dempsey, A., Purkis., S.J., 2010. Shallow-water benthic and bathymetric mapping: The federation of St. Kitts and Nevis. NCRI technical report.

Contact Layer:

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Dr Sam Purkis, National Coral Reef Institute

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Name of Layer: SKN_Reef_Flat.shp, Algal reef flat

Abstract:

Algal reef flat represents one of the twelve habitat classes that comprise the shallow water benthic habitats surrounding St. Kitts and Nevis. Consolidated hardgrounds with fine turf macro-algae and low lying fleshy macro-algae. This habitat is typically found in shallow environments (1-4 m water depth) atop carbonate frameworks.

This habitat layer is derived from IKONOS and QuickBird multispectral satellite data. This sensor measures the quantity and quality of light reflecting off the seafloor. Images were corrected for the absorption and scattering of photons through the atmosphere using Modtran radiative transfer code modeled based on a tropical maritime atmosphere. Image scenes compromised by sea-surface-glint were corrected using the algorithm of Hedley et al. (2004), which is based on the relative brightness in the near-infrared region of the spectrum. Spectral probability classifiers and edge-detection techniques were hybridized to create the most accurate map possible. Edge detection was used to efficiently identify boundaries between bright and dark habitats on the seafloor. Spectral classification draws on the fact that different substrates vary in the portion of light that they absorb/reflect at different electromagnetic wavelengths. Ground truth video data was used to collect from-image reflectance statistics. A maximum-likelihood algorithm was then used to calculate the probability that a given pixel belonged to a specific class, with pixels assigned to the class with the highest probability. This algorithm was not applied to areas of land, deepwater or cloud-contaminated pixels. In the case of cloud contaminated pixels, ground truth data and image interpretation were used to interpolate the classification across such gaps. Miss-classification resulting from local aberrations in the remote-sensed image, such as might occur from wave induced surface glint, was guarded against. A median filter was used to remove 'salt and pepper' noise or speckle which is indicative of miss-classification, by replacing isolated pixels with those common in the local neighborhood. In the final step of habitat classification, products were subjected to visual quality control. This ensures that habitats described follow identifiable boundaries in the imagery. Further details on the general approach used can be found in Purkis (2005).

Hedley J. D, Harbourne A. R., Mumby P. J., 2005. Simple and robust removal of sun glint for mapping shallow-water benthos. International Journal of Remote Sensing **26**: 2107-2112.

Purkis, S., 2005. A "reef-up" approach to classifying coral habitats from IKONOS imagery. IEEE Transactions on Geoscience and Remote Sensing **43**:1375-1390.

Purpose:

Algal reef flats were mainly found atop carbonate frameworks and were mapped according to the size and distribution as is relates to the location of the flat.

Original Projection:

Universal Transverse Mercator (UTM) Zone 20 North, World Geodetic System (WGS) 1984

Date of Completion:

April 29, 2010

Source Citation:

Data are produced using satellite an in-situ field data by the National Coral Reef Institute (NCRI) on behalf of The Nature Conservancy, a USAID sponsored project for the Federation of St. Kitts and Nevis.

IKONOS multispectral satellite image data (GeoEye Ltd., http://www.geoeye.com) 2000-2009

QuickBird multispectral satellite image data (Digital Globe, http://www.digitalglobe.com) 2009.

Georeferenced video archive (NCRI/TNC, Jan 2010)

Compiled By:

Alexandra Dempsey, Gwilym Rowlands, and Sam Purkis

Reference Format:

Data should be referenced as

Rowlands, G. P., Dempsey, A., Purkis., S.J., 2010. Shallow-water benthic and bathymetric mapping: The federation of St. Kitts and Nevis. NCRI technical report.

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Dr Sam Purkis, National Coral Reef Institute

TNC

Name of Layer: SKN_Rubble.shp, Semi-Consolidated Rubble

Abstract:

Semi-consolidated rubble represents one of the twelve habitat classes that comprise the shallow water benthic habitats surrounding St. Kitts and Nevis. This habitat can be described as skeletal rubble originating from reef structures and bonded by coralline algae to form a semi-consolidated framework with patchy macro algae. This habitat may also be found surrounding, or atop, carbonate frameworks.

This habitat layer is derived from IKONOS and QuickBird multispectral satellite data. This sensor measures the quantity and quality of light reflecting off the seafloor. Images were corrected for the absorption and scattering of photons through the atmosphere using Modtran radiative transfer code modeled based on a tropical maritime atmosphere. Image scenes compromised by sea-surface-glint were corrected using the algorithm of Hedley et al. (2004), which is based on the relative brightness in the near-infrared region of the spectrum. Spectral probability classifiers and edge-detection techniques were hybridized to create the most

accurate map possible. Edge detection was used to efficiently identify boundaries between bright and dark habitats on the seafloor. Spectral classification draws on the fact that different substrates vary in the portion of light that they absorb/reflect at different electromagnetic wavelengths. Ground truth video data was used to collect from-image reflectance statistics. A maximum-likelihood algorithm was then used to calculate the probability that a given pixel belonged to a specific class, with pixels assigned to the class with the highest probability. This algorithm was not applied to areas of land, deepwater or cloud-contaminated pixels. In the case of cloud contaminated pixels, ground truth data and image interpretation were used to interpolate the classification across such gaps. Miss-classification resulting from local aberrations in the remote-sensed image, such as might occur from wave induced surface glint, was guarded against. A median filter was used to remove 'salt and pepper' noise or speckle which is indicative of miss-classification, by replacing isolated pixels with those common in the local neighborhood. In the final step of habitat classification, products were subjected to visual quality control. This ensures that habitats described follow identifiable boundaries in the imagery. Further details on the general approach used can be found in Purkis (2005).

Hedley J. D, Harbourne A. R., Mumby P. J., 2005. Simple and robust removal of sun glint for mapping shallow-water benthos. International Journal of Remote Sensing **26**: 2107-2112.

Purkis, S., 2005. A "reef-up" approach to classifying coral habitats from IKONOS imagery. IEEE Transactions on Geoscience and Remote Sensing **43**:1375-1390.

Purpose: Rubble is mapped in accordance to the location surrounding St. Kitts and Nevis. The purpose of this layer is to accurately represent the size, location and distribution of rubble.

Original Projection:

Universal Transverse Mercator (UTM) Zone 20 North, World Geodetic System (WGS) 1984

Date of Completion:

April 29, 2010

Source Citation:

Data are produced using satellite an in-situ field data by the National Coral Reef Institute (NCRI) on behalf of The Nature Conservancy, a USAID sponsored project for the Federation of St. Kitts and Nevis.

IKONOS multispectral satellite image data (GeoEye Ltd., http://www.geoeye.com) 2000-2009

QuickBird multispectral satellite image data (Digital Globe, http://www.digitalglobe.com) 2009.

Georeferenced video archive (NCRI/TNC, Jan 2010)

Compiled By:

Alexandra Dempsey, Gwilym Rowlands, and Sam Purkis

Reference Format:

Data should be referenced as

Rowlands, G. P., Dempsey, A., Purkis., S.J., 2010. Shallow-water benthic and bathymetric mapping: The federation of St. Kitts and Nevis. NCRI technical report.

Contact Layer:

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Restrictions:

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Dr Sam Purkis, National Coral Reef Institute

TNC

Name of Layer: SKN_Rugose_Slope.shp, Rugose gorgonian slope

Abstract:

Rugose gorgonian slope represents one of the twelve habitat classes that comprise the shallow water benthic habitats surrounding St. Kitts and Nevis. Dense gorgonian cover and sparse macro-algae (typically *Halimedia*, *Udotea* etc) found on the edge of carbonate frameworks. Patches of this habitat are often found spanning several meters in water depth.

This habitat layer is derived from IKONOS and QuickBird multispectral satellite data. This sensor measures the quantity and quality of light reflecting off the seafloor. Images were corrected for the absorption and scattering of photons through the atmosphere using Modtran radiative transfer code modeled based on a tropical maritime atmosphere. Image scenes compromised by sea-surface-glint were corrected using the algorithm of Hedley et al. (2004), which is based on the relative brightness in the near-infrared region of the spectrum. Spectral probability classifiers and edge-detection techniques were hybridized to create the most accurate map possible. Edge detection was used to efficiently identify boundaries between bright and dark habitats on the seafloor. Spectral classification draws on the fact that different substrates vary in the portion of light that they absorb/reflect at different electromagnetic wavelengths. Ground truth video data was used to collect from-image reflectance statistics. A maximum-likelihood algorithm was then used to calculate the probability that a given pixel belonged to a specific class, with pixels assigned to the class with the highest probability. This algorithm was not applied to areas of land, deepwater or cloud-contaminated pixels. In the case of cloud contaminated pixels, ground truth data and image interpretation were used to interpolate the classification across such gaps. Miss-classification resulting from local aberrations in the remote-sensed image, such as might occur from wave induced surface glint, was guarded against. A median filter was used to remove 'salt and pepper' noise or speckle which is indicative of miss-classification, by replacing isolated pixels with those common in the local neighborhood. In the final step of habitat classification, products were subjected to visual quality control. This ensures that habitats described follow identifiable boundaries in the imagery. Further details on the general approach used can be found in Purkis (2005).

Hedley J. D, Harbourne A. R., Mumby P. J., 2005. Simple and robust removal of sun glint for mapping shallow-water benthos. International Journal of Remote Sensing **26**: 2107-2112.

Purkis, S., 2005. A "reef-up" approach to classifying coral habitats from IKONOS imagery. IEEE Transactions on Geoscience and Remote Sensing **43**:1375-1390.

Purpose: Rugose slope is mapped in accordance to the location surrounding St. Kitts and Nevis. This layer accurately represents the size, location and distribution of the Rugose gorgonian slope.

Original Projection:

Universal Transverse Mercator (UTM) Zone 20 North, World Geodetic System (WGS) 1984

Date of Completion:

April 29, 2010

Source Citation:

Data are produced using satellite an in-situ field data by the National Coral Reef Institute (NCRI) on behalf of The Nature Conservancy, a USAID sponsored project for the Federation of St. Kitts and Nevis.

IKONOS multispectral satellite image data (GeoEye Ltd., http://www.geoeye.com) 2000-2009

QuickBird multispectral satellite image data (Digital Globe, http://www.digitalglobe.com) 2009.

Georeferenced video archive (NCRI/TNC, Jan 2010)

Compiled By:

Alexandra Dempsey, Gwilym Rowlands, and Sam Purkis

Reference Format:

Data should be referenced as

Rowlands, G. P., Dempsey, A., Purkis., S. J., 2010. Shallow-water benthic and bathymetric mapping: The federation of St. Kitts and Nevis. NCRI technical report.

Contact Layer:

Dr Sam Purkis, National Coral Reef Institute, Oceanographic Center, Nova Southeastern University, purkis@nova.edu, (954) 262-3647

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Dr Sam Purkis, National Coral Reef Institute

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Name of Layer: SKN_Sand.shp, Bare carbonate sand

Abstract:

Bare carbonate sand represent one of the twelve habitat classes that comprise the shallow water benthic habitats surrounding St. Kitts and Nevis. Expansive sand sheets encompass much of the benthic habitat. These are found across the whole of the mapped area, particularly to the

leeward side of the barrier reef system, east of the islands, and extending at least to 30 m on the west coast.

This habitat layer is derived from IKONOS and QuickBird multispectral satellite data. This sensor measures the quantity and quality of light reflecting off the seafloor. Images were corrected for the absorption and scattering of photons through the atmosphere using Modtran radiative transfer code modeled based on a tropical maritime atmosphere. Image scenes compromised by sea-surface-glint were corrected using the algorithm of Hedley et al. (2004), which is based on the relative brightness in the near-infrared region of the spectrum. Spectral probability classifiers and edge-detection techniques were hybridized to create the most accurate map possible. Edge detection was used to efficiently identify boundaries between bright and dark habitats on the seafloor. Spectral classification draws on the fact that different substrates vary in the portion of light that they absorb/reflect at different electromagnetic wavelengths. Ground truth video data was used to collect from-image reflectance statistics. A maximum-likelihood algorithm was then used to calculate the probability that a given pixel belonged to a specific class, with pixels assigned to the class with the highest probability. This algorithm was not applied to areas of land, deepwater or cloud-contaminated pixels. In the case of cloud contaminated pixels, ground truth data and image interpretation were used to interpolate the classification across such gaps. Miss-classification resulting from local aberrations in the remote-sensed image, such as might occur from wave induced surface glint, was guarded against. A median filter was used to remove 'salt and pepper' noise or speckle which is indicative of miss-classification, by replacing isolated pixels with those common in the local neighborhood. In the final step of habitat classification, products were subjected to visual quality control. This ensures that habitats described follow identifiable boundaries in the imagery. Further details on the general approach used can be found in Purkis (2005).

Hedley J. D, Harbourne A. R., Mumby P. J., 2005. Simple and robust removal of sun glint for mapping shallow-water benthos. International Journal of Remote Sensing **26**: 2107-2112.

Purkis, S., 2005. A "reef-up" approach to classifying coral habitats from IKONOS imagery. IEEE Transactions on Geoscience and Remote Sensing **43**:1375-1390.

Purpose: Sand is mapped in accordance to the location surrounding St. Kitts and Nevis. This layer accurately represents the size, location and distribution of sand sheets.

Original Projection:

Universal Transverse Mercator (UTM) Zone 20 North, World Geodetic System (WGS) 1984

Date of Completion:

April 29, 2010

Source Citation:

Data are produced using satellite an in-situ field data by the National Coral Reef Institute (NCRI) on behalf of The Nature Conservancy, a USAID sponsored project for the Federation of St. Kitts and Nevis.

IKONOS multispectral satellite image data (GeoEye Ltd., http://www.geoeye.com) 2000-2009

QuickBird multispectral satellite image data (Digital Globe, http://www.digitalglobe.com) 2009.

Georeferenced video archive (NCRI/TNC, Jan 2010)

Compiled By:

Alexandra Dempsey, Gwilym Rowlands, and Sam Purkis

Reference Format:

Data should be referenced as

Rowlands, G. P., Dempsey, A., Purkis., S.J., 2010. Shallow-water benthic and bathymetric mapping: The federation of St. Kitts and Nevis. NCRI technical report.

Contact Layer:

Dr Sam Purkis, National Coral Reef Institute, Oceanographic Center, Nova Southeastern University, purkis@nova.edu, (954) 262-3647

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Restrictions:

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Dr Sam Purkis, National Coral Reef Institute

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Name of Layer: SKN_Sparse_Seagrass, Sparse seagrass

Abstract:

Sparse seagrass represent one of the twelve habitat classes that comprise the shallow water benthic habitats surrounding St. Kitts and Nevis. This habitat class comprises of expansive sand sheets with a sparse seagrass community (< 50% cover), dominated by *Thallassia tesdudium*, and secondarily *Syringodium filiforme.* Associated with the grass are green algae (Chlorophyta) - especially *Halimedia, Udotea, Turbinaria,* etc).

This habitat layer is derived from IKONOS and QuickBird multispectral satellite data. This sensor measures the quantity and quality of light reflecting off the seafloor. Images were corrected for the absorption and scattering of photons through the atmosphere using Modtran radiative transfer code modeled based on a tropical maritime atmosphere. Image scenes compromised by sea-surface-glint were corrected using the algorithm of Hedley et al. (2004), which is based on the relative brightness in the near-infrared region of the spectrum. Spectral probability classifiers and edge-detection techniques were hybridized to create the most accurate map possible. Edge detection was used to efficiently identify boundaries between bright and dark habitats on the seafloor. Spectral classification draws on the fact that different substrates vary in the portion of light that they absorb/reflect at different electromagnetic wavelengths. Ground truth video data was used to collect from-image reflectance statistics. A maximum-likelihood algorithm was then used to calculate the probability that a given pixel belonged to a specific class, with pixels assigned to the class with the highest probability. This algorithm was not applied to areas of land, deepwater or cloud-contaminated pixels. In the case of cloud contaminated pixels, ground truth data and image interpretation were used to interpolate the classification across such gaps. Miss-classification resulting from local aberrations in the remote-sensed image, such as might occur from wave induced surface glint, was guarded against. A median filter was used to remove 'salt and pepper' noise or speckle which is indicative of miss-classification, by replacing isolated pixels with those common in

the local neighborhood. In the final step of habitat classification, products were subjected to visual quality control. This ensures that habitats described follow identifiable boundaries in the imagery. Further details on the general approach used can be found in Purkis (2005).

Hedley J. D, Harbourne A. R., Mumby P. J., 2005. Simple and robust removal of sun glint for mapping shallow-water benthos. International Journal of Remote Sensing **26**: 2107-2112.

Purkis, S., 2005. A "reef-up" approach to classifying coral habitats from IKONOS imagery. IEEE Transactions on Geoscience and Remote Sensing **43**:1375-1390.

Purpose: Sparse seagrass is mapped in accordance to the location surrounding St. Kitts and Nevis. This layer accurately represents the size, location and distribution of sand sheets.

Original Projection:

Universal Transverse Mercator (UTM) Zone 20 North, World Geodetic System (WGS) 1984

Date of Completion:

April 29, 2010

Source Citation:

Data are produced using satellite an in-situ field data by the National Coral Reef Institute (NCRI) on behalf of The Nature Conservancy, a USAID sponsored project for the Federation of St. Kitts and Nevis.

IKONOS multispectral satellite image data (GeoEye Ltd., http://www.geoeye.com) 2000-2009

QuickBird multispectral satellite image data (Digital Globe, http://www.digitalglobe.com) 2009.

Georeferenced video archive (NCRI/TNC, Jan 2010)

Compiled By:

Alexandra Dempsey, Gwilym Rowlands, and Sam Purkis

Reference Format:

Data should be referenced as

Rowlands, G. P., Dempsey, A., Purkis., S.J., 2010. Shallow-water benthic and bathymetric mapping: The federation of St. Kitts and Nevis. NCRI technical report.

Contact Layer:

Dr Sam Purkis, National Coral Reef Institute, Oceanographic Center, Nova Southeastern University, purkis@nova.edu, (954) 262-3647

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Dr Sam Purkis, National Coral Reef Institute

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Name of Layer: SKN_UnconsolidatedSediment.shp, Unconsolidated sand with algae

Abstract:

Unconsolidated sand represents one of the twelve habitat classes that comprise the shallow water benthic habitats surrounding St. Kitts and Nevis. Coarse, often rippled, sand sheets found in areas with higher energy flow along with small patches of *Halimedia* algae is observed when classifying unconsolidated sand patches.

This habitat layer is derived from IKONOS and QuickBird multispectral satellite data. This sensor measures the quantity and quality of light reflecting off the seafloor. Images were corrected for the absorption and scattering of photons through the atmosphere using Modtran radiative transfer code modeled based on a tropical maritime atmosphere. Image scenes compromised by sea-surface-glint were corrected using the algorithm of Hedley et al. (2004), which is based on the relative brightness in the near-infrared region of the spectrum. Spectral probability classifiers and edge-detection techniques were hybridized to create the most accurate map possible. Edge detection was used to efficiently identify boundaries between bright and dark habitats on the seafloor. Spectral classification draws on the fact that different substrates vary in the portion of light that they absorb/reflect at different electromagnetic wavelengths. Ground truth video data was used to collect from-image reflectance statistics. A maximum-likelihood algorithm was then used to calculate the probability that a given pixel belonged to a specific class, with pixels assigned to the class with the highest probability. This algorithm was not applied to areas of land, deepwater or cloud-contaminated pixels. In the case of cloud contaminated pixels, ground truth data and image interpretation were used to interpolate the classification across such gaps. Miss-classification resulting from local aberrations in the remote-sensed image, such as might occur from wave induced surface glint, was guarded against. A median filter was used to remove 'salt and pepper' noise or speckle which is indicative of miss-classification, by replacing isolated pixels with those common in the local neighborhood. In the final step of habitat classification, products were subjected to visual quality control. This ensures that habitats described follow identifiable boundaries in the imagery. Further details on the general approach used can be found in Purkis (2005).

Hedley J. D, Harbourne A. R., Mumby P. J., 2005. Simple and robust removal of sun glint for mapping shallow-water benthos. International Journal of Remote Sensing **26**: 2107-2112.

Purkis, S., 2005. A "reef-up" approach to classifying coral habitats from IKONOS imagery. IEEE Transactions on Geoscience and Remote Sensing **43**:1375-1390.

Purpose: Unconsolidated sand is mapped in accordance to the location surrounding St. Kitts and Nevis. This layer accurately represents the size, location and distribution of sand sheets.

Original Projection:

Universal Transverse Mercator (UTM) Zone 20 North, World Geodetic System (WGS) 1984

Date of Completion:

April 29, 2010

Source Citation:

Data are produced using satellite an in-situ field data by the National Coral Reef Institute (NCRI) on behalf of The Nature Conservancy, a USAID sponsored project for the Federation of St. Kitts and Nevis.

IKONOS multispectral satellite image data (GeoEye Ltd., http://www.geoeye.com) 2000-2009

QuickBird multispectral satellite image data (Digital Globe, http://www.digitalglobe.com) 2009.

Georeferenced video archive (NCRI/TNC, Jan 2010)

Compiled By:

Alexandra Dempsey, Gwilym Rowlands, and Sam Purkis

Reference Format:

Data should be referenced as

Rowlands, G. P., Dempsey, A., Purkis., S.J., 2010. Shallow-water benthic and bathymetric mapping: The federation of St. Kitts and Nevis. NCRI technical report.

Contact Layer:

Dr Sam Purkis, National Coral Reef Institute, Oceanographic Center, Nova Southeastern University, purkis@nova.edu, (954) 262-3647

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Name of Layer: SKN_Bathy.tif, Bathymetry

Abstract:

An optical model was applied to IKONOS multispectral satellite imagery to describe the water depth gradient surrounding St. Kitts and Nevis from the sea surface to a depth of ~30 m. Satellite images were corrected for the absorption and scattering of photons through the atmosphere using a Modtran radiative transfer algorithm based on a tropical maritime atmosphere. Image scenes compromised by sea-surface-glint were corrected using the algorithm of Hedley et al. 2004, which is based on the relative brightness in the near-infrared region of the spectrum. Light is attenuated differently as it passes through the water column. The water depth derivation algorithm (Stumpf et. al 2003) is based on the ratio of reflectance in the blue and green image bands. Pixel values are extracted from the image corresponding to georeferenced water depth measurements (collected Jan. 2010 using georeferenced single-beam sonar). Depth is derived on a scene by scene basis with individual products joined into a single mosaic for the two islands. Below 30 meters optical derivation cannot be achieved as signal return to the satellite sensor from the seabed is too low. Vertical accuracy is typically in the range of ±0.5-2 m to a depth of 15 m, below which vertical accuracy is typically within ±3 m. As such, this data is not considered suitable for navigation. This particular layer does not mask out cloud. Depth values derived for cloud influenced areas are therefore likely spurious due to the high albedo of cloud.

Hedley J. D, Harbourne A. R., Mumby P. J., 2005. Simple and robust removal of sun glint for mapping shallow-water benthos. International Journal of Remote Sensing **26**: 2107-2112.

Stumpf, R., Holderied, K., Sinclair M., 2003. Determination of water depth with high-resolution satellite imagery over variable bottom types. Limnology and Oceanography **48**:547–556.

Purpose:

This Digital Elevation Model (DEM) layer provides an estimate of water depth to a depth of 30 meters for the shallow shelf of St. Kitts and Nevis. DEMs provide a scene wide overview of the variation of depth that can be expected. They are useful for such tasks as: viewing the 3D structure of the seascape, planning ongoing environmental survey, oor as an input for more involved geological, ecological, and hydrological analyses.

Date of Completion:

May 7, 2010

Original Projection:

Universal Transverse Mercator (UTM) Zone 20 North, World Geodetic System (WGS) 1984

Source Citation:

Data are produced by the National Coral Reef Institute (NCRI) on behalf of The Nature Conservancy, a USAID sponsored project using satellite an in-situ soundings.

IKONOS multispectral satellite image data (GeoEye Ltd., http://www.geoeye.com) 2000-2009. Bathymetric soundings (NCRI/TNC, Jan 2010).

Images Used:

00300000 00800000 01000000 01600000 01700000 02300000 01800000 0240000 02000000

Compiled By:

Alexandra Dempsey, Gwilym Rowlands, and Sam Purkis

Reference Format:

Data should be referenced as

Rowlands, G. P., Dempsey, A., Purkis., S.J., 2010. Shallow-water benthic and bathymetric mapping: The federation of St. Kitts and Nevis. NCRI technical report.

Contact Layer:

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Name of Layer: SKN_Bathy_CloudMasked.tif, Bathy_CloudMasked

Abstract:

An optical model was applied to IKONOS multispectral satellite imagery to describe the water depth gradient surrounding St. Kitts and Nevis from the sea surface to a depth of ~30 m. Satellite images were corrected for the absorption and scattering of photons through the atmosphere using a Modtran radiative transfer algorithm based on a tropical maritime atmosphere. Image scenes compromised by sea-surface-glint were corrected using the algorithm of Hedley et al. 2004, which is based on the relative brightness in the near-infrared region of the spectrum. Light is attenuated differently as it passes through the water column. The water depth derivation algorithm (Stumpf et. al 2003) is based on the ratio of reflectance in the blue and green image bands. Pixel values are extracted from the image corresponding to georeferenced water depth measurements (collected Jan. 2010 using georeferenced single-beam sonar). Depth is derived on a scene by scene basis with individual products joined into a single mosaic for the two islands. Below 30 meters optical derivation cannot be achieved as signal return to the satellite sensor from the seabed is too low. Vertical accuracy is typically in the range of ±0.5-2 m to a depth of 15 m, below which vertical accuracy is typically within ±3 m. As such, this data is not considered suitable for navigation. Depth values derived from cloud influenced areas are likely spurious due to the high albedo of cloud and are therefore masked out in this particular layer.

Hedley J. D, Harbourne A. R., Mumby P. J., 2005. Simple and robust removal of sun glint for mapping shallow-water benthos. International Journal of Remote Sensing **26**: 2107-2112.

Stumpf, R., Holderied, K., Sinclair M., 2003. Determination of water depth with high-resolution satellite imagery over variable bottom types. Limnology and Oceanography **48**:547–556.

Purpose:

This Digital Elevation Model (DEM) layer provides an estimate of water depth to a depth of 30 meters for the shallow shelf of St. Kitts and Nevis. DEMs provide a scene wide overview of the variation of depth that can be expected. They are useful for such tasks as: viewing the 3D structure of the seascape, planning ongoing environmental survey, or as an input for more involved geological, ecological, and hydrological analyses.

Date of Completion:

May 7, 2010

Original Projection:

Universal Transverse Mercator (UTM) Zone 20 North, World Geodetic System (WGS) 1984

Source Citation:

Data are produced by the National Coral Reef Institute (NCRI) on behalf of The Nature Conservancy, a USAID sponsored project using satellite an in-situ soundings.

IKONOS multispectral satellite image data (GeoEye Ltd., http://www.geoeye.com) 2000-2009. Bathymetric soundings (NCRI/TNC, Jan 2010).

Images Used:

00300000 00800000 01000000 01600000 01700000 02300000 01800000 0240000 02000000

Compiled By:

Alexandra Dempsey, Gwilym Rowlands, and Sam Purkis

Reference Format:

Data should be referenced as

Rowlands, G. P., Dempsey, A., Purkis., S.J., 2010. Shallow-water benthic and bathymetric mapping: The federation of St. Kitts and Nevis. NCRI technical report.

Contact Layer:

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Name of Layer:

Monkey_ Shoals.shp, Monkey shoals

Abstract:

Monkey Shoals consists of an area of reef located off the southwest coast of St. Kitts. Groundtruth was collected and surveyed for this area, though satellite imagery was not available. This layer demarcates the broad geographical location of the Monkey Shoals reef.

Purpose:

The creation of the layer Monkey Shoals is to map its broad geographical location in relation to St. Kitts and Nevis. Only an approximation of the size and location is represented, and no indication of benthic cover is provided.

Date of Completion:

April 29, 2010

Original Projection:

Universal Transverse Mercator (UTM) Zone 20 North, World Geodetic System (WGS) 1984

Source Citation:

Data are produced using satellite an in-situ field data by the National Coral Reef Institute (NCRI) on behalf of The Nature Conservancy, a USAID sponsored project for the Federation of St. Kitts and Nevis.

IKONOS multispectral satellite image data (GeoEye Ltd., http://www.geoeye.com) 2000-2009

QuickBird multispectral satellite image data (Digital Globe, http://www.digitalglobe.com) 2009.

Georeferenced video archive (NCRI/TNC, Jan 2010)

Compiled By:

Alexandra Dempsey, Gwilym Rowlands, and Sam Purkis

Reference Format:

Data should be referenced as

Rowlands, G. P., Dempsey, A., Purkis., S.J., 2010. Shallow-water benthic and bathymetric mapping: The federation of St. Kitts and Nevis. NCRI technical report.

Contact Layer:

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