Results of the St. Kitts & Nevis Protected Area Ecological GAP Workshops
November 13-14, 2008 & June 22 & 23, 2009

Overview

Experts from the Nature Conservancy (TNC), a US-based non-profit environmental organization, visited St Kitts & Nevis during the weeks of November 13-14, 2008 and June 22 & 23, 2009 to assist the Department of Planning & Natural resources and the Organization of Eastern Caribbean States (OECS) conduct a protected area ecological gap assessment. Results of these workshops are being used to determine where and how to scientifically strengthen the design of St. Kitts & Nevis's protected area network in order to fully represent the wide variety of biodiversity that exists on the islands and surrounding marine waters.

The first workshop was geared towards identifying the terrestrial, freshwater, and marine key species and ecological systems (also called *targets*) that need protection, setting conservation goals for each target, and documenting the associated threats to the targets. During this workshop, several mapping gaps were identified and a plan was outlined to fill these data gaps. Notes from this meeting can be found in Appendix I.

Following the first workshop, TNC worked closely with the Department of Planning, Natural Resources, and the Environment to manually digitize many of the missing targets and refine those targets that needed further validation using the 2004 and 2007 IKONOS imagery.

At the second workshop, local experts reviewed the spatial distribution for each of the target layers, paying particular attention to the new targets that had been mapped using the imagery. Prior to the meeting it was difficult to obtain significant information pertaining to Nevis. Great care was taken in the workshop to review each Nevis threat and target and to make necessary changes to the mapped files as needed. Notes from this meeting can be found in Appendix I.

Participants were also given an introduction to the software Marxan, freely available software created by the University of Queensland in Australia (Ball and Possingham, 2000). This software is widely adopted around the world as a tool for spatially optimizing conservation goals and requires the input of conservation targets, goals and corresponding threats. The Marxan software is able to arrive at an optimal conservation solution that efficiently meets all or most target goals. These areas are often times refined by manual inclusion and/or exclusion of areas based on the likelihood that they can be adopted into a government approved protected area plan.

After completing the necessary edits to threats and targets, workshop participants were presented with the results of a Marxan run using their target data, goals and threats. After reviewing the analysis outputs participants felt that additional target information needed to be collected and included in the run before significant work to refine the Marxan analysis could be done.

The final outcome of the second workshop produced a series of maps that show the spatial distribution of marine and terrestrial targets and threats. These maps and can be found in Appendix I. Following the second workshop, the additional targets requested by the workshop participants was collected and included in the Marxan analysis. Two results were chosen for their ability to best meet conservation target goals. These two analysis runs produced a series of maps that show the optimal spatial configuration of a protected area network according to the Marxan software. These maps will need to be reviewed and refined by the Systems Plan consultants and local experts for incorporation into the Systems Plan.

This exercise was undertaken as part of the revision of the System of Protected Areas for St Kitts & Nevis, which is ongoing. The Systems Plan is currently being created with support from the OECS Protected Areas and Associated Livelihoods (OPAAL) Project. Information from this National Ecological Gap Assessment will be used by the Systems Plan consultants, Ecoengineering Caribbean Limited, when they create their final Systems Plan recommendation.

Identification of Targets and Threats

One key step in performing an ecological gap assessment is to determine the conservation targets for the country and the present and potential threats to these targets. Conservation targets are defined as the elements of biodiversity and related cultural features that will be the focus of conservation and management planning efforts. These may be marine or terrestrial, and can include:

- broad habitats and ecosystems;
- important areas for target species;
- rare or imperiled communities;
- places of cultural significance;
- threatened species;
- endemic and flagship species; and
- species of cultural significance, or economic importance.

Threats to the conservation targets are also included in undertaking a gap assessment, and may be natural (natural disasters, climate change, etc) or human-induced (extractive activities, unsustainable land practices, urban development, pollution, etc). In an effort to ensure widespread consultation and participation in the review process, TNC sought input from a large number of natural resource management agencies, local environmental groups, and interested individuals in determining the conservation targets and threats over the course of the two workshops and subsequent one-on-one meetings/interviews.

A distinction was made between coarse-filter targets (habitats, ecosystems, etc) and fine-filter targets (e.g. species). In some cases, critical species were listed as potential conservation targets. However, either due to lack of supporting GIS data, or lack of information on specific habitats, they were not selected as conservation targets. In other cases, although the species were deemed significant, the inability to map specific locations due to widespread occurrences resulted in them not being included on the target list.

In addition, participants at each workshop assisted in verifying the quality and accuracy of data to be used in modeling the ecological gaps, and consequently creating a network of protected areas for effective biodiversity conservation. Where GIS data was unavailable, participants used institutional knowledge to manually mark targets on a map of Saint Lucia. Discussion was also held on potential sources for additions to, or verification of the existing data. Once conservation targets were agreed and finalized, a conservation goal was assigned, so that a draft model of the protected area system can be produced.

Target Descriptions

Table 1 is a list of conservation target that were identified as important to protect in St. Kitts & Nevis. This list reflects edits that were made subsequent to the first meeting and with feedback from the second meeting. Local experts set conservation goals for each target and efforts were made to spatially map each target in the most efficient and accurate way possible in order to be used in the Marxan software. Maps all of each target can be found in Appendix II.

Table 1. Terrestrial and Marine targets for the St. Kitts & Nevis National Ecological Gap Assessment. N/A indicates data not relevant or available at time of the analysis.

Terrestrial					
Target	**Percentage Goal**		**Data Included in Marxan Analysis**		**Notes on Data Source**
	SKB	**NVS**	**SKB**	**NVS**	
Intake springs	100	100	yes	yes	For NVS used the intake springs file only. Did not use the springs file. For SKB used Department of Physical Planning "Intake Springs" file.
Turtle nesting	60	60	yes	**yes**	~~Used combination of data from TNC. Verified with local experts. Removed some sites from TNC file and turned point data into line data to cover entire beaches.~~
Salt water ponds	50	N/A	yes	N/A	File from Department of Physical Planning. Removed fresh water ponds.
Freshwater ponds	100	N/A	yes	N/A	Located by experts. Digitized by TNC.
Brackish ponds	N/A	90	N/A	yes	Used NV_Natres07 and clipped "ponds"
Bird nesting sites	50	60	yes	**yes**	Located by local experts & digitized or digitized at June 09 meeting.
Aquifers	50	50	yes	**no**	SKB digitized by Department of Physical Planning. Data not available for Nevis.
Drought deciduous open woodland	10	25	yes	yes	Land cover*
Deciduous evergreen coastal &	20	25	yes	yes	Land cover*

mixed forest succulent					
Steep and montane non forest vegetation	100	100	yes	yes	Land cover*
Semi-deciduous forest (includes semi-evergreen forest)	20	20	yes	yes	Land cover*
Evergreen forest w/ coconut palms	10	10	yes	yes	Land cover*
Seasonal evergreen forests	50	50	yes	yes	Land cover*
Emergent wetland	100	100	N/A	yes	Land cover*
Elfin and Sierra palm cloud forest	100	100	yes	yes	Land cover*
Sierra palm, transitional an tall cloud forest	100	100	yes	yes	Land cover*
Evergreen forest (including Sierra palm forest)	100	100	yes	yes	Land cover*
Seasonally flooded savannahs and woodlands	N/A	100	N/A	yes	Land cover*
Rain fall greater than 75 inches/year	100	100	yes	no	digitized using rainfall contours. Creating polygon from everything greater than the 75" rainfall contour. Data not available for Nevis.
Marine					
Target	**Percentage Goal**		**Data Included in Marxan Analysis**		**Notes on Data Source**
	SKB	**NVS**	**SKB**	**NVS**	
Mangroves	100	100	yes	yes	~~taken from the land cover* data set for NVS and the TNC data set for SKB---then merged together~~
Fringe coral reefs	90	90	yes	yes	NV taken from NV_CRI_07 "coral" attribute. ~~Added KN_reefFlat.shp and KN_NonReefFlat.shp. SKB used merged/dissolved KN_reefFlat and KNNonReefFlat.~~

SPAG's/nursery (Nags Head)	100	N/A	yes	N/A	Digitized with Department of Physical Planning.
Lobster spawning/ migratory route	60	60	yes	yes	~~Digitized with Department of Physical Planning~~
Rocky shore	40	70	yes	yes	SKB from SK_COASTYPE_01--used the "coble", "rocks", and "cliff& rocks" attributes. Dissolved file and generated a 50meter buffer for SKB_rocky_shores. NV-used the "coastal_sand_rocky_shore_or_bare_ground.shp" file from land cover* file---erased the "NV_Beaches.shp" file (obtained from Planning).
Sea moss	50	80	yes	yes	Digitized with Department of Physical Planning for SKB.
Thermal sea vents	50	80	yes	yes	~~SKB-digitized by Department of Physical Planning.~~
Monkey Shoal	N/A	100	N/A	yes	Digitized from admiral maps.
Southern Bank	N/A	50	N/A	yes	Digitized from admiral maps.
*Land cover data developed by the International Institute of Tropical Forestry, USDA, Forest Service in 2005, as part of a joint project between USFS, USGS - Center for EROS, TNC, NASA, CSU - CEMML, USAID - Caribbean Program Office, Ministry of Agriculture, Fisheries, Cooperatives, Land and Housing, St. Kitts and Nevis, Nevis Island Department of Agriculture, Department of Physical Planning, Environment and Natural Resources, Physical Planning and Environment - Nevis and Physical Planning Division - St. Kitts, and Brimstone Hill National Park. Landsat imagery provided by NASA - GOFC, USGS - Center for EROS, and IITF.					

Threat Model

GIS-based models called Environmental Risk Surfaces (ERS) were developed using mapped risk elements (e.g. human activities) to explore the overlap between risk elements and biodiversity features. A risk element can be defined as anything identified by experts as having a negative influence on the health of conservation targets, such as critical habitats or key species. The ERS models were designed to spatially identify habitats of low (intact) and high (threatened) risk areas, based on the spatial interaction of underlying risk elements, and serve as input cost models for Marxan software (Ball and Possingham, 2000). In this way, an ERS model can be used to focus conservation site selection by steering selection away from high-risk areas where the abatement of pressures on biodiversity seems less likely. The composite or disaggregated individual surfaces can also be used to locate the specific environmental risks on the landscape that may be degrading the viability of particular conservation targets.

The Environmental Risk Surface tool is a freely available GIS-based tool developed in Visual Basic (ArcObjects) within ArcGIS 9.2, GIS software (ESRI, Redlands, CA) (Schill and Raber, 2006; download at http://www.gispatools.org). The first step in creating an ERS model requires assembling a suite of the best available GIS data that spatially represent the risk elements that are most likely to impact the health of terrestrial, freshwater, and/or marine habitat or species. All risk element features must be spatially mapped on the landscape as points, lines, or polygons using expert opinion to create or obtain the most accurate GIS data layers available. Human-induced landscape features such as agricultural and urbanized areas, tourism zones and hotels, roads, industrial areas, and surrogate indicators for human impacts such as population density are examples of risk elements that can be used in the creation of an ERS. The ERS models used for the St. Kitts ecological gap assessment were designed based on available input data and expert assessments for each risk element. The combination of risk elements and their respective intensity values and influence distances varies for each realm surface, thus accounting for the different ways that human activities impact biodiversity in each of the habitat realms (McPherson et al, 2008)

The intensity value represents the relative level of threat that the risk element poses to the targeted habitat or species. Separate intensity values were assigned to each risk element to capture the different relative levels of impact on different biodiversity targets. The intensity scores do not represent an absolute measure of the impact of risk elements on the biodiversity feature but rather the relative degree to which the biodiversity target in question is more likely to survive in one place over another based on the presence of one risk element in comparison to another. After the intensity values have been assigned, the next step is to determine the influence distance of each risk element. The influence distance is the spatial extent or footprint of the activity on the landscape and represents the maximum distance at which the feature has a negative impact on biodiversity. The influence distance is used to attribute an intensity value to risk elements outside of the immediate area of direct impact. As the distance of the buffer increases away from the center of the area (point, line or polygon) where the risk element is taking place, the intensity values of the cells within the buffers diminish progressively (distance decay) and the risk to the habitat is gradually lessened until the limit of the influence distance after which the feature is no longer considered to pose a risk to a given target.

Risk element tables were developed to indicate the intensity and influence distance of each risk element as assigned independently to each class and subclass based on the perceived threat level to terrestrial, freshwater or marine biodiversity (Table 2). These values were incorporated into the GIS coverage tables of each risk element for use in the development of the ERS. The final threat model can be seen in Appendix III and demonstrates how individual polygon, line, and point risk elements translate into modeled risk surfaces with varying intensity values over their influence distances. The red areas represent higher combined risk and the blue areas, lower risk as modeled by the mapped risk element features. For a more detailed explanation on the creation of ERS models, please see McPherson et al, 2008.

Table 2. List of Risk Elements used in the St Kitts & Nevis Environmental Risk Surface Model and Associated Intensity and Influence Distances. N/A indicates data was not applicable or not available at the time of the analysis.

Human Activity	Terrestrial Intensity	Terrestrial Distance (meters)	Marine Intensity	Marine Distance (meters)	Data Sources	Data available or used in final analysis	
						SKB	NVS
ATV Trails	60	100	80	100	~~shp file from Department of Physical Planning~~	yes	N/A
Rail Road	10	25	0	0		yes	N/A
Paved Roads	70	100	60	100		yes	yes
Unpaved roads	80	150	70	100		N/A	yes
Hospital Grey Water Point Source	0	0	95	600	Digitized with Department of Physical Planning for SK. Still need NV.	yes	N/A
Hotel/Resort: Tourism Hotel rooms 1-6	11	100	11	50	~~Final layer was modified to include room data from the TNC shapefile, verified against the Tourism Development Corporation's record keeping and a list of hotel names used by the Physical Planning Department.~~	yes	yes
Hotel/Resort: Tourism Hotel rooms 7-14	25	500	25	300		yes	yes
Hotel/Resort: Tourism Hotel rooms 15-24	27	500	27	300		yes	yes
Hotel/Resort: Tourism Hotel rooms 25-49	35	500	35	500		yes	yes
Hotel/Resort: Tourism Hotel rooms 50-149	40	500	60	1600		yes	yes
Hotel/Resort: Tourism Hotel rooms 150+	40	500	80	1600		yes	yes
Point Source Siltation (ghaut outlets)	40	50	80	1600	~~SKB information gathered at November 2008 GAP meeting then digitized. NVS points digitized at June 09 meeting.~~	yes	yes

Squatters	50	500	50	50	~~shp file from Department of Physical Planning~~	yes	N/A
Airport	100	1000	60	1600	~~Digitized with Department of Physical Planning~~	yes	yes
Anchoring	0	0	75	20	~~Digitized with Department of Physical Planning for SKB— Digitized at June 09 meeting for NVS~~	yes	yes
Boat Yards	90	500	90	1000	~~Digitized with Department of Physical Planning~~	yes	N/A
Marinas	35	300	90	100	~~Digitized with Department of Physical Planning for SKB~~	yes	N/A
Sea Ports (tourists)	80	800	90	3200	~~Data obtained from various planning department data files, which were verified and amended at June 09 meeting.~~	yes	N/A
Industrial Port (commercial)	90	800	60	3200	~~Data obtained from various planning department data files, which were verified and amended at June 09 meeting.~~	yes	yes
Overnight Boating	0	0	30	5	~~Digitized at June 09 meeting. Same file as anchoring.~~	yes	yes
Docks & Piers	60	100	70	1600	~~Digitized & verified at June 09 meeting. Groins were not included.~~	yes	yes
Jetties	25	15	50	150	Digitized with Department of Physical Planning for SKB-- Jetties built on pillars were left out. Only solid jetties were included. With this definition, Nevis did not have any jetties.	yes	yes
Golf Course	40	50	40	100	~~Nevis is 50 terrestrial-distance- Digitized from imagery for both SKB & NVS. Expert verification~~.	yes	yes

Landfills	100	800	30	30	Digitized with Department of Physical Planning for SKB—NVS Digitized at June 09 meeting	yes	yes
Livestock Facility	90	50	10	25	~~Nevis: same as a marina distance//intensity=80--Digitized SKB file with Department of Physical Planning for SK. NVS was digitized at the June 09 meeting.~~	yes	yes
Power Plant	100	500	0	0	~~SKB shp file from Department of Physical Planning~~. NVS file digitized at June 09 meeting	yes	yes
Quarries	95	800	0	0	~~Nevis: Marine intensity= 90 distance=1000---SK digitized with Department of Physical Planning. NV used land cover file.~~	yes	yes
Sewage Plant @ Frigate Bay	50	0	50	600	~~Digitized with Department of Physical Planning.~~	yes	N/A
Desalinization Plant	60	10	70	200	~~Digitized at June 09 meeting~~	yes	N/A
Low Density	20	100	20	50	~~Used Low Density Build up Land; Rural or residential attribute from the land cover file~~	yes	yes
High & Med Density	40	500	80	1600	~~Used high & medium density residential attribute from the land cover file~~		

Marxan Results
The results of the Marxan analysis can be found in Appendix IV. The two runs that are presented in this report demonstrate possible solutions to achieving the most efficient protection of the selected targets. No solution was able to meet all goals at the set levels. Appendix IV indicates the level to which each run was able to meet the specified targets.

For use in the systems plan it is recommended that these runs be used as a base for the systems plan. However, it should be noted that Monkey Shoal should be added to the portfolio as well as additional mangroves for both St. Kitts and Nevis. Although no run was able to meet the goals set for several other targets, the mapped results, inset tables, and associated graphs indicate that other than Monkey Shoal and mangroves, the other targets were very close to being met.

References

Ball, I & H. Possingham. 2000. *Marxan (v1.8.2): Marine reserve design using spatially explicit annealing. A manual prepared for The Great Barrier Reef Marine Park Authority*.

McPherson, M., S. Schill, G. Raber, K. John, N. Zenny, and K. Thurlow, 2008, GIS-Based Modeling of Environmental Risk Surfaces (ERS) for Conservation Planning in Jamaica," *Journal of Conservation Planning* Vol 4:60-89.

APPENDIX I

Meeting Notes

National Ecological Gap Assessment Workshop Minutes
Thursday 13th to Friday 14th November, 2008
Ocean Terrace Inn
Fishermans Wharf, St. Kitts, W.I.

Opening

The National Ecological Gap Assessment Workshop began at approximately 9:15 A.M. on November 13, 2008. The meeting convened at Ocean Terrace Inn on St. Kitts. Mr. Randolph Edmead from the St. Kitts Department of Physical Planning & Environment opened the meeting. This workshop took place over two days.

Present

See Appendix 1.

Day 1: Welcome & Introductions

Mr. Randolph Edmead from the St. Kitts Department of Physical Planning & Environment welcomed participants and explained the purpose of the two day workshop. He explained that the two day workshop was part of the National Ecological Gap Assessment being undertaken in collaboration with the OECS- Environment and Sustainable Development Unit, working in partnership with The Nature Conservancy. The National Ecological Gap Assessment will be used as a basis for assessing existing biodiversity assets and identifying areas which may be included in a National Protected Areas System.

Mr. Edmead explained that St. Kitts is part of the OECS Protected Areas and Associated Livelihood (OPAAL) Project and that one of its components is the establishment of a Protected Areas Systems Plan. The OPAAL Project is undertaken in the independent member states of the OECS and is aimed primarily at protecting and conserving biological diversity endemic to the region.

The project is financed by the World Bank, the French Government and the OAS. The OPAAL Project falls under the wider umbrella of the Convention on Biological Diversity (CBD). The Project forms part of the CBD's Programme of work on Protected Areas which has as one of its goals, "to establish and strengthen National and Regional Systems of Protected Areas, integrated into a global network, to reduce the rate of biodiversity loss."

In St. Kitts-Nevis there is currently only one officially declared protected area, the Central Forest Reserve. The goal is to develop a system of Protected Areas with both terrestrial and marine areas represented. The Ecological Gap Assessment process will help identify if and where the current Protected Areas System falls short of protecting important biodiversity.

Mr. Edmead explained that in addition to the Central Forest Reserve, which is the OPAAL Project Demonstration Site, the national aim is for the establishment of other Protected Areas in St. Kitts and Nevis. For example:

1. The Basseterre Valley Project which is undertaken as part of Integrated Watershed and Coastal Areas Management (IWCAM) Project.

2. The Proposed Marine Management Area, focusing on the protection of the coastal ecosystem between St. Kitts and Nevis.

3. The proposal by the Nevis Island Administration to declare the area around Nevis Peak protected.

It is anticipated that these areas will be included in the National Protected Areas System. Mr. Edmead explained that The Nature Conservancy (TNC) has agreed to work with the OECS in assisting Member States in undertaking the Ecological Gap Analysis as part of the implementation activities for the OPAAL Project.

Mr. Edmead concluded his welcome by underscoring the workshop objectives:

1. To identify conservation targets for terrestrial and marine ecosystems.

2. To identify the environmental threats for terrestrial and marine ecosystems.

3. To identify data gaps.

4. To set a work plan to fill the gaps.

Agenda Review, and Introduction to The Nature Conservancy & Protected Area System Planning

Ms. Ruth Blyther from The Nature Conservancy, explained that TNC has worked in the Mesoamerica and Caribbean region for the last 30 years. This region is the Conservancy's longest running international program and the relationship with partners here is well established. The Conservancy has been working in the Caribbean for the last 20 years and currently has offices in St. Croix, Jamaica, Bahamas, the Dominican Republic and the Florida Keys.

Ms. Blyther expressed excitement on behalf of The Nature Conservancy to have the opportunity to work with the government and partners of St. Kitts and Nevis to help meet the CBD's goal of marine and terrestrial area protection for 2010 and 2012. This workshop is the first of many to focus on the ecological gap analysis for St. Kitts and Nevis.

Ms Blyther explained that she is the Eastern Caribbean's Partnership Specialist, based in St. Croix, US Virgin Islands. For the past two years she has worked with partner governments and organizations in the Eastern Caribbean to conserve biodiversity and build regional capacity for sustainable management of the environment, especially in and surrounding protected areas

Ms. Blyther then went on to introduce her two colleagues Ms. Shawn Margles and Mr. John English Knowles. Ms. Margles is the Southeastern Caribbean Conservation Planner for the Nature Conservancy's Insular Caribbean Operation Unit also based in St. Croix. She has worked with partners in St. Croix to develop a spatial database and worked on the Jamaica ecological gap.

Mr. Knowles is the Conservation Information Manager for the Conservancy's Insular Caribbean Operation Unit based in the Florida Keys. He supports the spatial data management, map making, analysis and ecological gap work for the Insular Caribbean. Both Ms Margles and Mr. Knowles have extensive experience with geographic information systems (GIS).

Ms. Blyther then introduced Ms. Sarah George from the OECS and the OPAAL project.

Ms. George expressed the pleasure of the OECS to be partnering with TNC in providing this support to St Kitts and Nevis. She explained that the work complements the systems planning element of the OECS Protected Areas and Associated Livelihoods (OPAAL) project which is designed to enable the Participating Member States to update pre-existing PA systems plans or develop new ones for countries where no such plan has existed before. St. Kitts-Nevis is such a case and the gap analysis is an important means to assess what sites and values exists and determine what factors may affect proposed sites which would be necessary to conserve national biodiversity while providing for sustainable livelihoods for local communities.

OPAAL is a five year regional project which works in all 6 independent Member States of the OECS. It supports policy, legal and institutional reform, PA establishment and management, capacity building and public awareness which allows for improved management of PAs within the region. OECS has a Memorandum of Understanding with TNC to collaborate on the above mentioned areas and this jointly facilitated gap analysis workshop is one demonstration of this partnership.

The development objective of OPAAL for projects is that when implemented, they will contribute to the economic development of the participating member states by:

1. Strengthening existing and creating new protected areas

2. Providing environmentally sustainable economic opportunities for communities living in the surrounding areas.

Participating Member States are St. Kitts and Nevis, Antigua and Barbuda, Dominica, Saint Lucia, St. Vincent and the Grenadines, and Grenada.

Introduction to GAP Analysis Components

Ms. Margles explained that the GAP is a participatory process of stakeholders that identifies important biodiversity targets and the threats that impact them.

Conservation targets represent biodiversity across biological scales (species and ecosystems) and biological realms (terrestrial, freshwater, and marine). The aim of defining conservation targets is to capture the full array of biodiversity in the country. The goal of full representation is to conserve representative samples of all species and ecosystems within the country, at sufficient scale to ensure their long term persistence. These focal biodiversity elements define species, communities, and ecological systems to be evaluated in the gap analysis and are intended to represent the full range of biodiversity (freshwater, marine, and terrestrial).

Environmental risk factors are human activities that apply pressure to or threaten the viability of conservation targets. These may include roads, hotels, anchoring sites, agriculture, tourism, and others. Environmental risk factors and their distance of influence and relative intensity must be defined.

Ms. Margles explained that the gap analysis will use coarse and fine filter conservation targets defined at this two day meeting. Coarse filter elements (e.g. all native/natural ecological systems) represent common and widely distributed species, natural communities, and the ecological processes that support them. Fine filter elements are native species, species, assemblages, and communities that are not well captured by the coarse filter and require individual attention in order to be effectively represented in the conservation plan.

Ms. Margles explained that all data must be:

- Country wide
- Spatial
- Standardized/ collected in a consistent manor
- Directly related to inform this effort

Ms. Margles went on to describe how these data would then be used in a three part analysis. A summary of these calculations are as follows:

Relative Abundance Calculation (RAC): The relative abundance calculation identifies planning units with relative high abundance of the conservation targets. The RAC for each planning unit is directly proportional to the amount of conservation target present in the planning unit (*e.g.* hectares of habitat, length of stream or number of occurrences). This calculation can be used to identify the best remaining areas, in terms of target abundance, for each target or set of targets at the planning unit or the landscape scale. The RAC calculates the relative uniqueness or rareness of a habitat or species across the landscape.

Impact Analysis: The impact analysis is a modeled surface developed using mapped risk elements identified by the expert group. The impact analysis measures cumulative levels of impacts across the landscape. Each identified impact is given a marine and terrestrial impact and distance score by the expert group. The impact analysis is used to determine mean impact scores for each planning unit.

Irreplaceablity Index: The irreplaceablity index is determined using MARXAN software. MARXAN uses stochastic optimization routines (Simulated Annealing), which generates spatial reserve systems that achieve particular biodiversity representation goals with reasonable optimality. The simulated annealing algorithm attempts to minimize the total cost of the reserve system, while achieving a set of conservation goals. During the simulated annealing procedure, an initial portfolio of planning units is selected. Planning units are then added and removed in an attempt to improve the efficiency of the portfolio. Early in the procedure, changes in the portfolio that do not improve efficiency can be made in order to allow the possibility of finding a more efficient overall portfolio. The requirement to accept only those changes that improve efficiency becomes stricter as the algorithm progresses through a set of iterations. For any set of conservation targets and goals, there may be many efficient and representative portfolios that meet all conservation goals, but most of these networks would have a number of planning units in common. Many runs of the algorithm are used to find the most efficient portfolio and to calculate a measure of *irreplaceablity* (used here to indicate the number of times a particular unit is chosen). In some cases, conservation targets are only found in limited sites–areas of high irreplaceablity–that are always chosen in any representative portfolio. Additionally, areas of high irreplaceablity also include planning units, whose exclusion would require a proportionally larger conservation area network to achieve the same level of representation, resulting in a loss of portfolio efficiency. The algorithm attempts to minimize portfolio total '*cost*' whilst meeting conservation goals in a spatially compact network of sites.

Defining the Terrestrial Conservation Targets

Ms. Margles and Mr. Knowles then led the group through an exercise to identify terrestrial conservation targets and percentage goals. The group was asked to brain storm conservation targets while Mr. Knowles recorded each on a flip chart. After a list of conservation targets was exhausted, the group proceeded to set conservation goals that would be used to help guide the Irreplaceablity Index calculation.

Multiple coarse and fine filter targets were identified, but not all will be used in the assessment. A list of conservation targets and goals to be included and a data layer assessment can be found in Appendix 2. The full list of brainstormed items is as follows:

- Heliconia (rare and endemic)/
- Hummingbird
- Littoral forests
- Dry forests
- Rain forest
- Great salt ponds

- Deer
- Beaches/turtle nesting sites (St. Kitts and Nevis)
- Freshwater system
    - Wingfield River
    - Drainage
    - Freshwater river eel
    - Rivers
    - Crawfish in Cayon River
    - Freshwater ponds
- Sand Dunes in Nevis (need to draw)
- Mangroves
- Bassaterre Valley Watershed
- Catchment areas (in Central Forest Reserve)
- New River watersheds - aquifer
- Nevis peak
- Camps Spring watershed
- Bats, frogs, lizards, snakes (Heritage Society)
- Wetlands
- Pelican sites
- Important Bird Area from Birdlife International or migratory bird stopovers
- Clay Slough
- Endemic bird sites
- Pollinating insects, bees, and butterflies
- Cultural targets

Defining Terrestrial Environmental Risk Surface

After completing the conservation targets exercise, Ms. Margles and Mr. Knowles explained how the Environmental Impact Analysis would be conducted. They then led the group through an exercise to identify both Marine and terrestrial threats. Many threats were identified, but not all will be used in the assessment. The finalized threats can be found in Appendix 3. Below is a list of threats that were brained stormed by participants. The threats in bold were incomplete and participants attempted to map them on paper:

- **Mining/Quarrying**
- **Livestock (cows, goats, sheep)**
- Monkeys
- Cuban frog/cane toad
- Snakes
- Fire ants
- Black widow
- Coconut palms
- Insecticide – Agricultural chemicals (fertilizer intensive crops)
- Mongoose
- Power plants
- **Desalinization plant (St. Kitts)**

- Sugar factory
- Industrial port
- (maybe deer)
- Donkey
- Development (Rail, Residential (High and Low), Industrial (proposed and existing), Airport, Roads)
- Tourism (Hotels by size)
- Golf courses
- Illegal dump sites
- Landfill

Specific marine threats were identified. Many threats were identified, but not all will be used in the assessment. The threats in bold were incomplete and participants attempted to map them on paper:

- **Anchoring**
- **Ghost traps**
- Undersize catches (beach seining)
- Siltation
- **Proposed hotels**
- **Jetties**
- Gray water point sources
- Marinas
- **Boat yards**

After reviewing the existing data and missing data the group agreed that further data collection and digitization would be necessary.

Ms. Margles and Mr. Knowles explained that on the following day distance and intensity values would be assigned to each threat. The meeting adjourned at approximately 3 pm.

Day 2: Completing Defining Terrestrial and Marine Intensity and Distance Values for Environmental Risk Surface

To begin the second day Ms. Margles and Mr. Knowles explained that the intensity and distance values for threat factors needed to be assigned by participants. Participants had a group discussion to determine on a scale of 0-100 how intense the impact of each identified activity was and how far from its point source the influence traveled. The distance and intensity scores that were agreed upon by participants can be found in Appendix 3.

Defining the Marine Conservation Targets

After participants completed assigning intensity and distance values, marine conservation targets were brainstormed. Mangroves, seagrass beds, fringe coral reefs (additions need to be made to Nevis), artificial reefs, SPAG's/nursery (Nags Head), lobster spawning and migratory routes, rocky shore, sea moss, thermal sea vents, underwater sea mounts (location unsure) and offshore reef were included in the list. Participants then assigned percentage conservation goals in the same fashion as had been done the previous day for terrestrial conservation targets. A complete list of marine conservation targets and percentage goals can be found in Appendix 4.

Set work plan to fill data gaps

Key participants will be contacted over the next couple of months to clarify and help obtain missing data.

Wrap-up

The next steps were outlined. First the data needed for the analysis needs to be collected and organized. The Conservancy will work with Department of Physical Planning & Environment to coordinate this effort. After the data is ready the analysis will be conducted and an initial portfolio of potential protected areas will be generated. This information will be presented to workshop participants at another meeting so they may review the analysis outputs and make any necessary changes. The objective is to have a portfolio ready for review by February 2009.

Participants were thanked for their hard work, time and focus on getting through a lot of material over the two days of the workshop. Their expertise and acceptance of the process is invaluable to the success of a protected areas system plan.

The meeting adjourned at approximately 3 p.m.

Participant's List of Attendees for the National Ecological Gap Assessment Analysis Workshop, 13-14th November, 2008.

NAMES	ORGANISATION	CONTACT INFORMATION
Randolph Edmead	Department of Physical Planning & Environment	465-2277 phyplskb@sisterisles.kn
Sarah George	OECS	1-758-455-6327 sgeorge@oecs.org
Shawn Margles	The Nature Conservancy	1-340-244-6172 Shwan.margles@gmail.com
John Knowles	The Nature Conservancy	1-980-253-7803 jknowles@tnc.org
James Greene	Department of Maritime Affairs	466-4648 maritimeaffairs@yahoo.om
Karen Douglas	Department of Economic Affairs	467-1252 karendouglas.stk@gmail.com
Racquel Williams	Ministry of Agriculture	racquelw8@gmail.com
Graeme Browne	Department of Physical Planning & Environment	762-6037 mastergraeme@hotmail.com
Eduardo Mattenet	GIS/IT Consultant	ematenet@sisterisles.kn
Stuart Laplace	Clarentz Fitzroy Bryant College (Science Dept.)	667-0778 stuartlaplace@hotmail.com
Joe Simmonds	Department of Fisheries (St. Kitts)	465-8045 msuk@sisterisles.kn
Lemuel Pemberton	Department of Fisheries (Nevis)	469-5522 ext 2088 mugabe@hotmail.com
Ronel Browne	Department of Physical Planning & Environment	663-8341 Kyser56@hotmail.com
Andy Blanchette	Department of Physical Planning & Environment	662-7992, 465-2277 ablanchee@hotmail.com

Edwin Ible	Water Services Department (St. Kitts)	466-3070, 665-0455 incontrolll@hotmail.com
Kenneth Samuel	Kenneth Dive Center	465-2670, 667-9186
Elmo Stevens	Water Services Department (St. Kitts)	466-3070 ext. 231, 663-8781 shaki287@hotmail.com
Paul Benjamin	Department of Agriculture (St. Kitts)	465-2335 doastk@sisterisles.kn

Terrestrial Conservation Target Goals

Target Goal (%)	Target
100	Intake springs
60	Turtle nesting (St. Kitts and Nevis)
50	Salt water ponds
100	Freshwater ponds
90	Brackish ponds (Nevis)
60	Bird nesting sites (Nevis)
50	Bird nesting sites (St. Kitts)
50	Aquifers
25	Drought deciduous open woodland (Nevis)
10	Drought deciduous open woodland (St. Kitts)
20	Deciduous evergreen coastal & mixed forest succulent (St. Kitts)
25	Deciduous evergreen coastal & mixed forest succulent (Nevis)
20	Semi-deciduous forest (includes semi-evergreen forest) (St. Kitts & Nevis)
10	Evergreen forest w/ coconut palms (St. Kitts and Nevis)
50	Seasonal evergreen forests (St. Kitts and Nevis)

Data Layer Assessment

Include	**Data Layer**	**Additions**	**Comments**
Yes	Nesting bird sites	Egrets/trees	Major existing sites, but dwindling.
Yes	Turtle nesting sites		Dc – St. Kitts, Ei – Nevis. Use both in-house and WIDECAST data. Sandy Point has had sand mining.
Yes, but edit	Sandy Beach Layer	"Western White House Bay used to have sand, but it is not coming back."	Some removals
Yes	Aquifer layer		
Yes	Pond	Split file. Brackish water ponds in Nevis	Salt and freshwater (2 center ones).
Yes, partly	Waterwells		Intakes – natural and springs in forest areas (*target). Wells and reservoirs are manmade (not targets). Flagging entire watershed system was suggested by Sarah George.
Yes	Wingsfield Watershed		Designated watershed/catchment
Maybe	Soils	*Need soil layer	Break out fertile soil. Digitize

		for Nevis	hard copy report that breaks down soil by crop type.
	Landcover Data	Mangroves layer needs more, but mostly good. Digitize data from Lemuel on Nevis' mangroves. Management plan has more data.	Dates collected – 2000-2003. This is after the hurricane, which is good. Deciduous, evergreen, coastal and mixed forest includes most of littoral. Combine montane and steep forest.

Terrestrial and Marine Environmental Impact Factors with Distance & Intensity Scores

Human Activity	Type or value range	Terrestrial Intensity	Terrestrial Distance (meters)	Marine Intensity	Marine Distance (meters)	Notes
Power Plant		100	500	100	1600	
Rail Road		10	25	0	0	
Roads		60	100	80	100	
Airport		100	1000	60	1600	
Boat Yards		90	500	90	1000	
ATV Trails		60	100	80	100	
Squatters		50	500	50	50	
Sea Ports		80	800	100	3200	
Quarries		95	800	0	0	Nevis: Marine intensity= 90 distance=1000
Hotel/Resort: Tourism	1-6	11	100	11	50	
Hotel/Resort: Tourism	rooms 7-14	25	500	25	300	
Hotel/Resort: Tourism	15-24	27	500	27	300	
Hotel/Resort: Tourism	25-49	35	500	35	500	
Hotel/Resort: Tourism	50-149	40	500	60	1600	
Hotel/Resort: Tourism	150+	40	500	80	1600	
Anchoring		0	0	75	20	
Ghost Traps		0	0	85	80	
Point Source Siltation (ghauts)		40	50	80	1600	
Overnight Boating		0	0	30	5	
Jetties		25	15	50	150	
Hospital Grey Water Point Source		0	0	95	600	Nevis: has different impact.
Desalinization Plant		60	10	70	200	
Residential - High		40	500	80	1600	
Residential - Medium		35	500	35	500	
Residential - Low		11	100	11	50	
Illegal Dumping sites		85	10	85	50	
Landfills		100	800	30	30	
Golf Course		40	50	40	100	Nevis is 50 terrestrial-distance
Marinas		35	300	90	100	Nevis Marine Intensity=90//Terrestrial Intensity=90
Livestock Facility		90	50	10	25	Nevis: same as a marina distance//intensity=80
Invasive: Monkey						
Invasive: Cuban Frog/Cane Toad						
Invasive: Snakes						
Invasive: Fire ants						
Invasive: Black widows		Needs to be dealt with in the system plan.				
Invasive: Mongoose						
Invasive: Deer						
Invasive: Coconut Palms						
Invasive: Donkey						
Industrial Port						
Sewage Plant @ Frigate Bay		50	0	50	600	

Marine Conservation Targets and Conservation Goals

Target Goal (%)		**Target**
St. Kitts	**Nevis**	
100	100	Mangroves
100	100	Seagrass beds
90	90	Fringe coral reefs
100	100	Artificial reefs
100		SPAG's/nursery (Nags Head)
60		Lobster spawning/ migratory route
40	70	Rocky shore
50	80	Sea moss
50	80	Thermal sea vents
		Underwater sea mounts (location unsure)
100	100	Offshore reef

National Ecological Gap Assessment Workshop Notes
Monday 22 & 23 June, 2009
Nevis

Notes on Threats

All-terrain-vehicles (ATVs) are on Nevis, but there is no data. The Nevis roads can be split between paved and unpaved. Unpaved roads were determined to have higher intensity levels and paved roads were determined to have less impact. The final road layer used placed main and secondary roads into the paved category and trails and tracks into the unpaved category.

	Marine Intensity	Distance	Terrestrial Intensity	Distance
Unpaved roads	80	150	70	100
Paved roads	70	100	60	100

For boat yards, we have the most current layer for St. Kitts. There are individual boat yards in Nevis, but optioned not to include those in the final analysis.

Hospital gray water – St. Kitts has just the two and this was validated for the final analysis. Nevis has a treatment plant at present, but it is not a problem and wasn't used in the final analysis.

Hotels – the final hotel layer was modified to include room data from the TNC shapefile, verified against the Tourism Development Corporation's record keeping and a list of hotel names used by the Physical Planning Department. Nevis hotels were verified by the manager of the Hermitage Plantation Inn on Nevis.

Point source siltation – There are many ghauts that have significant anthropogenic effects. The ones for St. Kitts were drawn on a map in November 2008 and these were sufficient. Many Nevis ghauts were added, but will keep the same intensity level and distance number as listed for the St. Kitts ghauts. The Nevis ghauts include Kemp's River (point 1), Bath Stream (point 2), Nelson Spring Wetland (point 3), Big Pond (point 4), Paris Point (point 5), golf course sedimentation (point 6), Caye Bay Pond (point 7), Mosquito Bay (point 8), Long Hall Bay (point 9), Fountain Gut (point 10), quarry siltation/Mombo ghaut (point 12), jackass (point 11), Little Bay (point 13), stock pin (point 14), New River Ghaut (point 15), Business Ghaut (point 16), Plantings Ghaut (point 17), Kitt Ghaut (point 18), Fountain Ghaut (point 19), Granden Ghaut (point 20), Bridge Ghaut (point 21), Sulfur Gut (point 22) and two additional ghauts that didn't have names (points 23 and 24).

Landfill – The Nevis landfill was mapped.

Squatters – Squatters in St. Kitts is complete for the coast areas, but points are missing for squatters in the mountains. Nevis does not really have squatters.

Airport – The two airports were correct for St. Kitts and Nevis.

Golf courses – St. Kitts has 3 golf courses. One (1) is established and two (2) are in development. The golf course at Sandy Point was drawn in by the group and the site plans for the new golf courses were also drawn in. Nevis has one (1) golf course.

Anchoring – There were a few modifications for the anchoring sites for St. Kitts. The Northern Bay site was brought closer to shore. The Turtle Bay site was increase. Monkey Shoals was added as an anchoring spot. For Nevis, many anchoring sites were added. The first was off of the Four Seasons property. Second was the Gallows Bay in Charlestown. Third was the official anchoring area off Charlestown (polygon 4). Fourth was Mosquito Bay, fifth was Jones Bay, sixth was New Castle, seventh was Long Horn and last was the Delta Anchorage.

Jetties – Jetties built on pillars were left out. Only solid jetties were included.

Docks and Piers – The sea bridge and ferry terminal were added for Nevis. Groins were not included. For Nevis only, the intensity and distance value are as follows:

Terrestrial		Marine	
Intensity	Distance	Intensity	Distance
60	100m	70	1 miles

Seaports and industrial ports – For St. Kitts seaports were considered as tourist facilities and industrial ports were considered as commercial facilities. Nevis has Long Point and it has the same intensity and distance values as Basseterre. In Nevis, it is considered a deep water harbor. The intensity and distance value for these facilities in St. Kitts are as follows:

	Terrestrial		Marine	
	Intensity	Distance	Intensity	Distance
Seaports (tourists)	80	Same	80	Same
Industrial Ports (commercial)	90	Same	60	Same

Livestock – Unmanaged livestock has a big impact, but is not mapped. For St. Kitts there were some additions. These include Philips Egg Farm, a 200 acre facility and a pig facility by the airport. The historic dairy farm on the east coast was deleted from the threat layer. The Nevis additions include the following: a northeast piggery was added (200 pigs), 2 north end piggeries were added next to the airport, chicken farm in the east, and a 200 pig Blackwell piggery. A northeast end pasture was not added and a big grazing land in the south was deleted.

Power plant –The boundary and location of the St. Kitts power plant war verified. The Nevis power plant was drawn in. However, the marine intensity and distance was changed to zero for all power plants.

Quarries – The quarry in St. Kitts was determined to not be affecting the marine area, however there was some disagreement among some. Four (4) were added for Nevis.

Low Density – For low residential, it was determined that the marine and terrestrial intensity would both be 20.

Desalinization plant – There is one (1) on St. Kitts

Ghost traps – this was omitted from the final analysis, but it should be mentioned in the report.

Illegal dumping sites - this was omitted from the final analysis, but it should be mentioned in the report. Illegal dumping is indiscriminate on land.

Greg from the Nevis Historical Society wanted to include the local drag strip and the horse race trap as a threat. Both of these did not make the final cut.

Notes on Targets

Intake springs – Green hill was in question.

IBA (Important Bird Areas) – For St. Kitts, Nags head was included. It was stated that nesting and foraging sites should be separate, but they were eventually merged into one polygon layer.

Seamounts – present on admiralty maps and need to be mapped.

Sea moss – mapped for Nevis

Thermal sea vents – 3 at least. Kenneth Samuels can tell you were they are, but are likely included in the point data he handed over to Mr. Hobson of Maritime Affairs.

Lobster – a large polygon was drawn along the coast of Nevis and in the Narrows.

Birds – For Nevis, four sites were included.

Turtles – Three sites were added and mapped for Nevis.

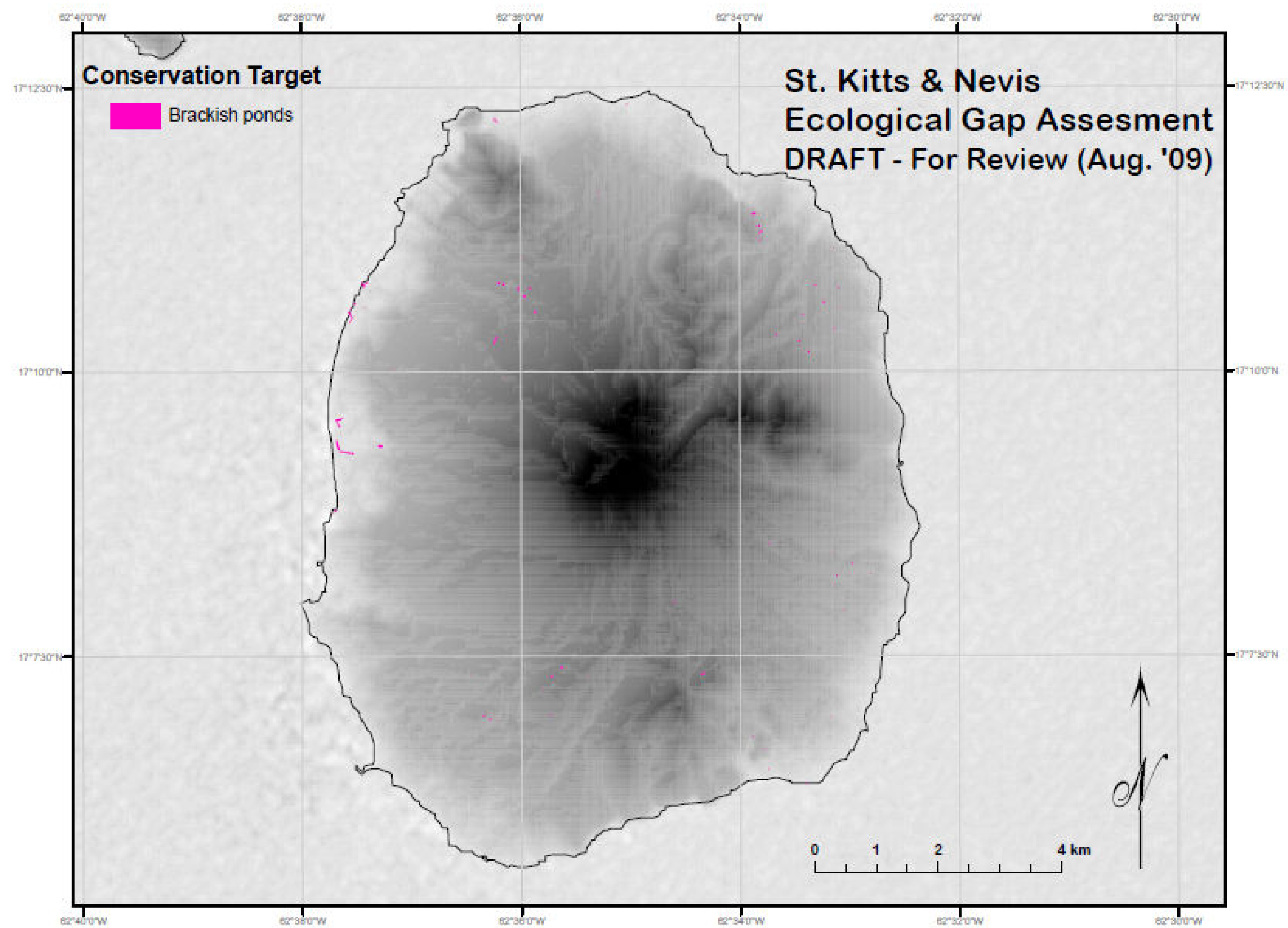
Attendees

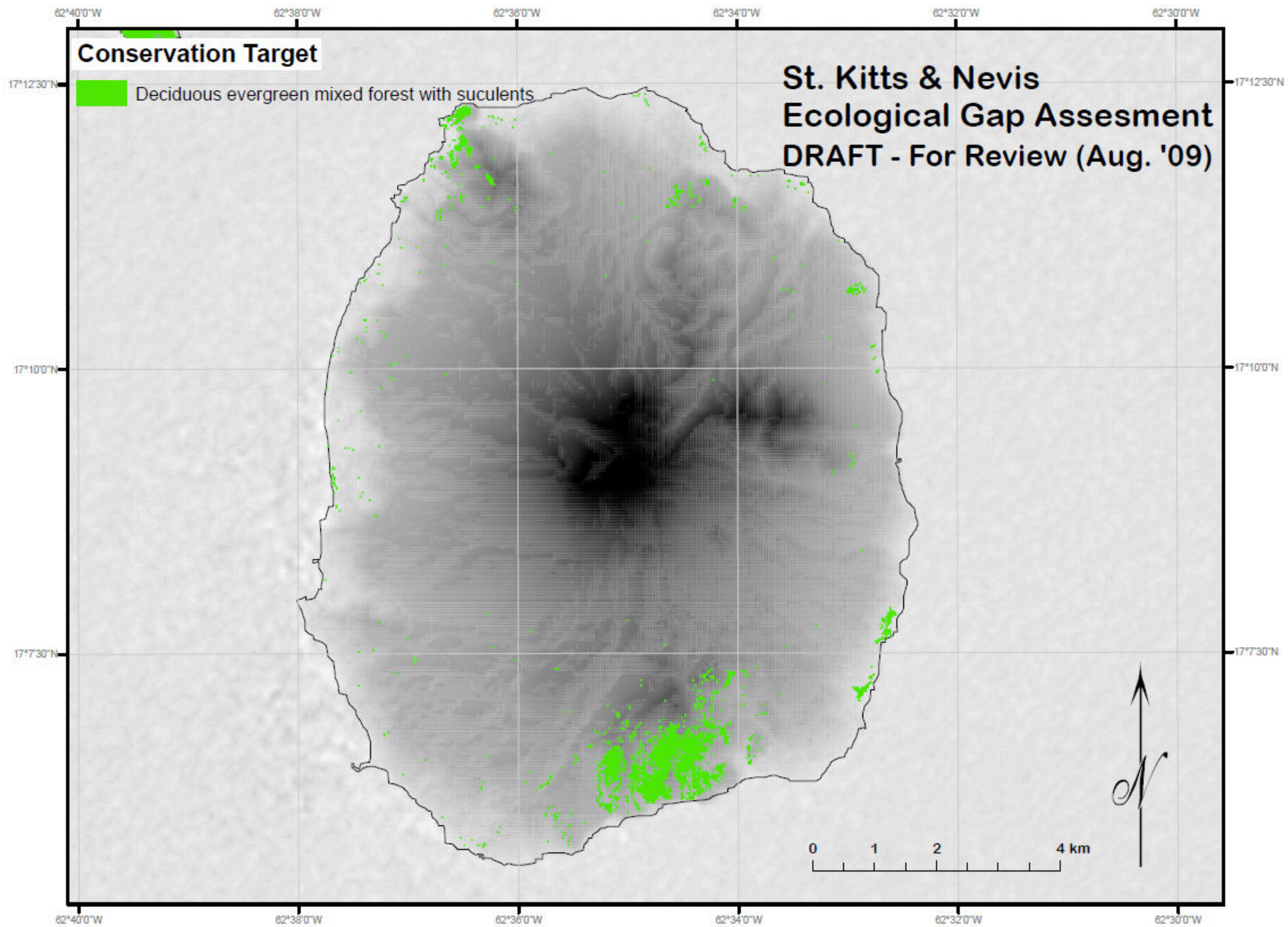
Ecological GAP Analysis June 22-23, 2009 Nevis (Day 1)		
Name	**Organization**	**Contact No. and/or Email**
D. Reyes	Ecoengineering Consultants Ltd.	868-645-4420 ecocaribe@mail.tt
G. K. Sammy	Ecoengineering Consultants Ltd.	868-645-4420 ecocaribe@mail.tt
J. C. Meerman	Ecoengineering Consultants Ltd.	meerman@biological_diversity.??
Andy Blanchette	Department of Physical Planning and Environment (SKB)	ajblanchette@live.com
Ronel Browne	Department of Physical Planning and Environment (SKB)	kyser@hotmail.com
Eduardo Mattenet	Department of Physical Planning and Environment (SKB)	emattenet@sisterisles.kn
Angela Delpeche	Department of Physical Planning and Environment (SKB)	nevplan@yahoo.com
James Greene	Department of Maritime Affairs	maritimeaffairs@yahoo.com
Erin Haney	Nevis Historical and Conservation Society	haneyek@gmail.com
Greg DeVries	Nevis Historical and Conservation Society	gregorydevries@gmail.com
Joe Simmonds	Department of Fisheries - St. Kitts	fmusk@sisterisles.kn
Daisy Mottram	St. Christopher Heritage Society	daisymottram@gmail.com
George Morris	Nevis Water Department	663-2253 gmorris@niagov.com
June Hughes	Department of Physical Planning and Environment (SKB)	ccodoe@sisterisles.kn
Emile Pemberton	Department of Fisheries - Nevis	fisheries@niagov.com
Carl Williams	Ministry of Tourism - Nevis	mintor@niagov.com
Lewis Newton	Department of Physical Planning and Environment (SKB)	le_newton@hotmail.com
Rene Walters	Department of Physical Planning and Environment (SKB)	renewalters@gmail.com
Michael Daniel	Department of Fisheries - Nevis	663-8908
Jacqueline Armory	St. Christopher Heritage Society	764-2942 jackie@jalatuka.com
Clivin Christmas	Department of Fisheries - Nevis	663-3301 clivinchristmas@hotmail.com

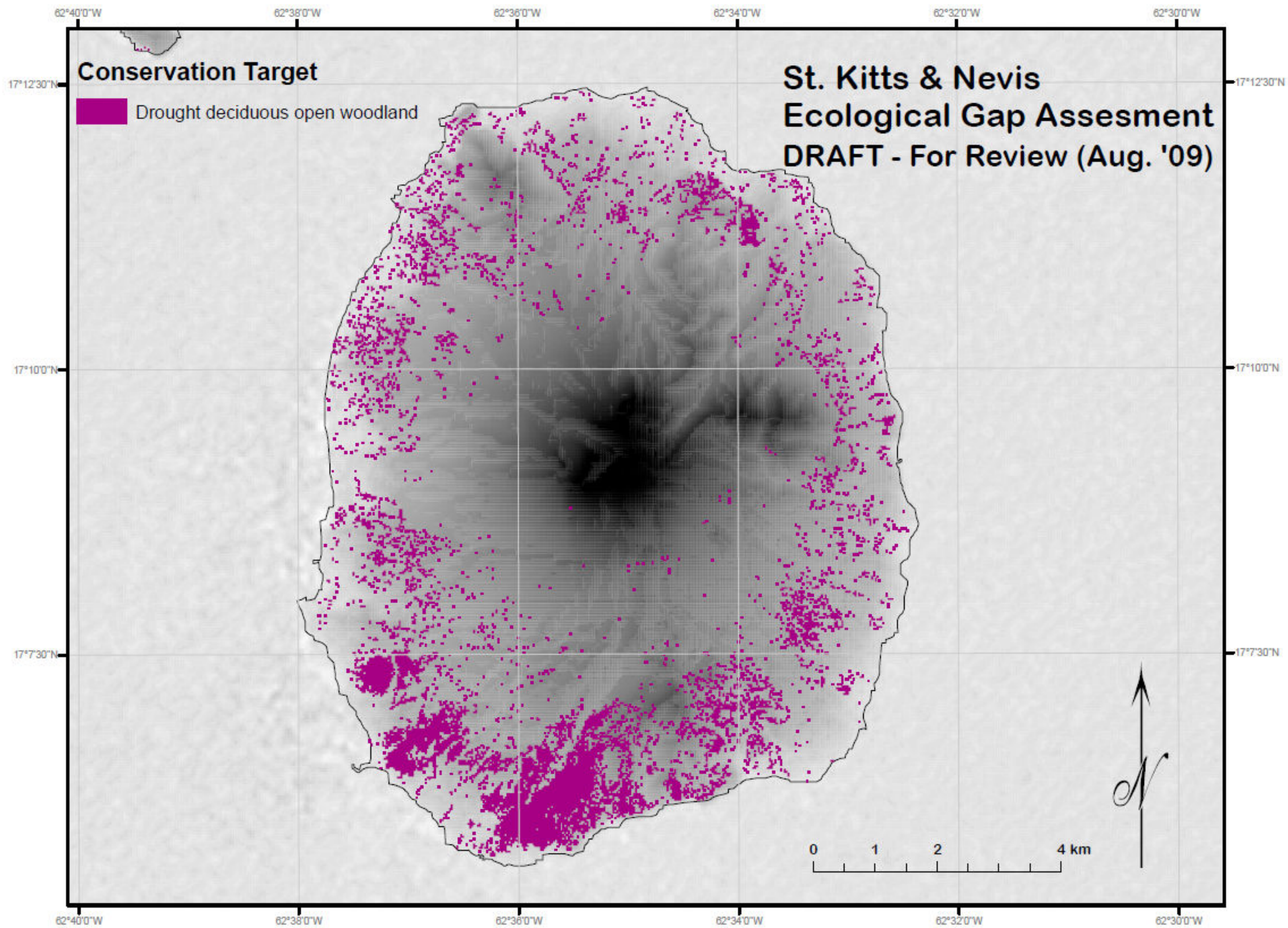
Ecological GAP Analysis June 22-23, 2009 Nevis (Day 2)		
Name	**Organization**	**Contact No. and/or Email**
D. Reyes	Ecoengineering Consultants Ltd.	868-645-4420 ecocaribe@mail.tt
J. C. Meerman	Ecoengineering Consultants Ltd.	meerman@biological_diversity.??
James Greene	Department of Maritime Affairs	maritimeaffairs@yahoo.com
Carl Williams	Ministry of Tourism - Nevis	mintor@niagov.com
June Hughes	Department of Physical Planning and Environment (SKB)	ccodoe@sisterisles.kn
Eduardo Mattenet	Department of Physical Planning and Environment (SKB)	emattenet@sisterisles.kn
Shawn Margles	TNC	(340) 718-5575 smargles@tnc.org
John Knowles	TNC	jknowles@tnc.org
Ruth Blyther	TNC	rblyther@tnc.org
Lemuel Pemberton	Department of Fisheries - Nevis	mugabe@hotmail.com
Lewis Newton	Department of Physical Planning and Environment (SKB)	le_newton@hotmail.com
Rene Walters	Department of Physical Planning and Environment (SKB)	renewalters@gmail.com
Ronel Browne	Department of Physical Planning and Environment (SKB)	kyser@hotmail.com
Erin Haney	Nevis Historical and Conservation Society	haneyek@gmail.com
Greg DeVries	Nevis Historical and Conservation Society	gregorydevries@gmail.com
Andy Blanchette	Department of Physical Planning and Environment (SKB)	ajblanchette@live.com
George Morris	Nevis Water Department	663-2253 gmorris@niagov.com
Angela Delpeche	Department of Physical Planning and Environment (SKB)	nevplan@yahoo.com

APPENDIX II

ST. KITTS & NEVIS
MARINE & TERRESTRIAL
TARGETS


Conservation Target
Brackish ponds
St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
0
1
2
4 km
N
62°40'0"W
62°38'0"W
62°36'0"W
62°34'0"W
62°32'0"W
62°30'0"W
17°12'30"N
17°10'0"N
17°7'30"N


Conservation Target
Deciduous evergreen mixed forest with suculents
St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
0
1
2
4 km
62°40'0"W
62°38'0"W
62°36'0"W
62°34'0"W
62°32'0"W
62°30'0"W
17°12'30"N
17°10'0"N
17°7'30"N


Conservation Target
Drought deciduous open woodland
St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
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2
4 km
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62°38'0"W
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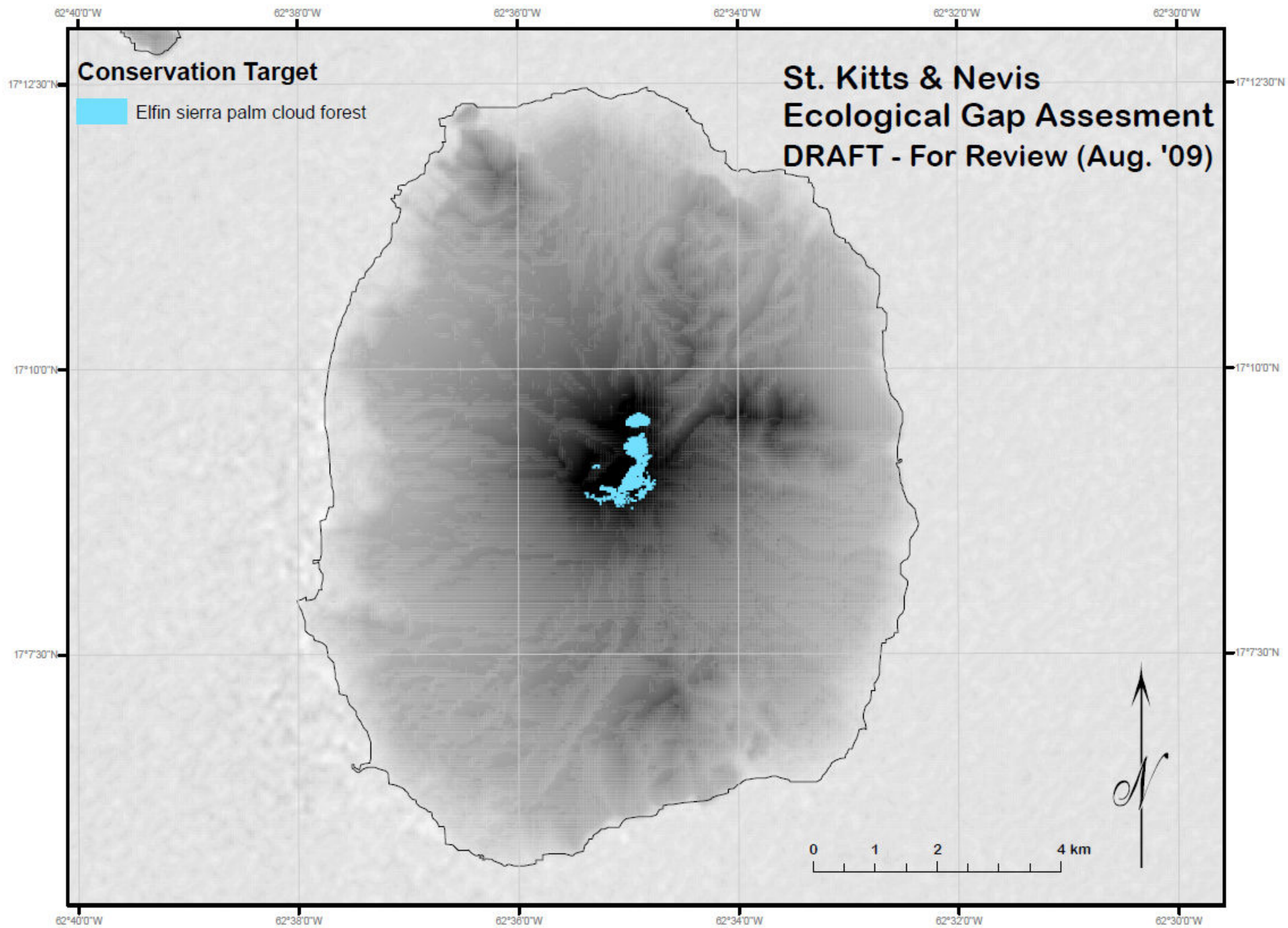
17°10'0"N
17°7'30"N



Conservation Target
Elfin sierra palm cloud forest
St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
0
1
2
4 km
62°40'0"W
62°38'0"W
62°36'0"W
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62°32'0"W
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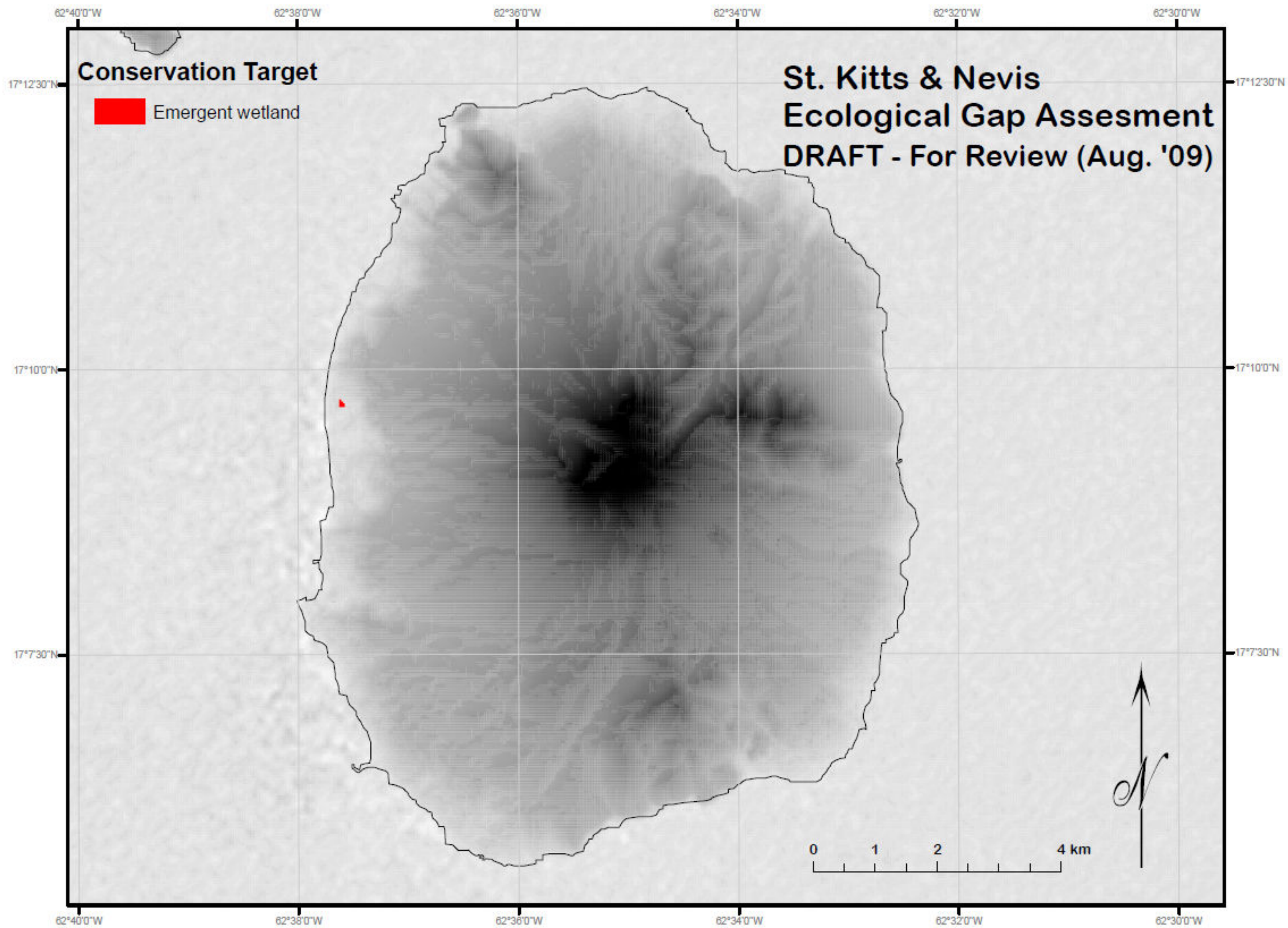
17°12'30"N
17°10'0"N
17°7'30"N


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Emergent wetland
0
1
2
4 km
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62°38'0"W
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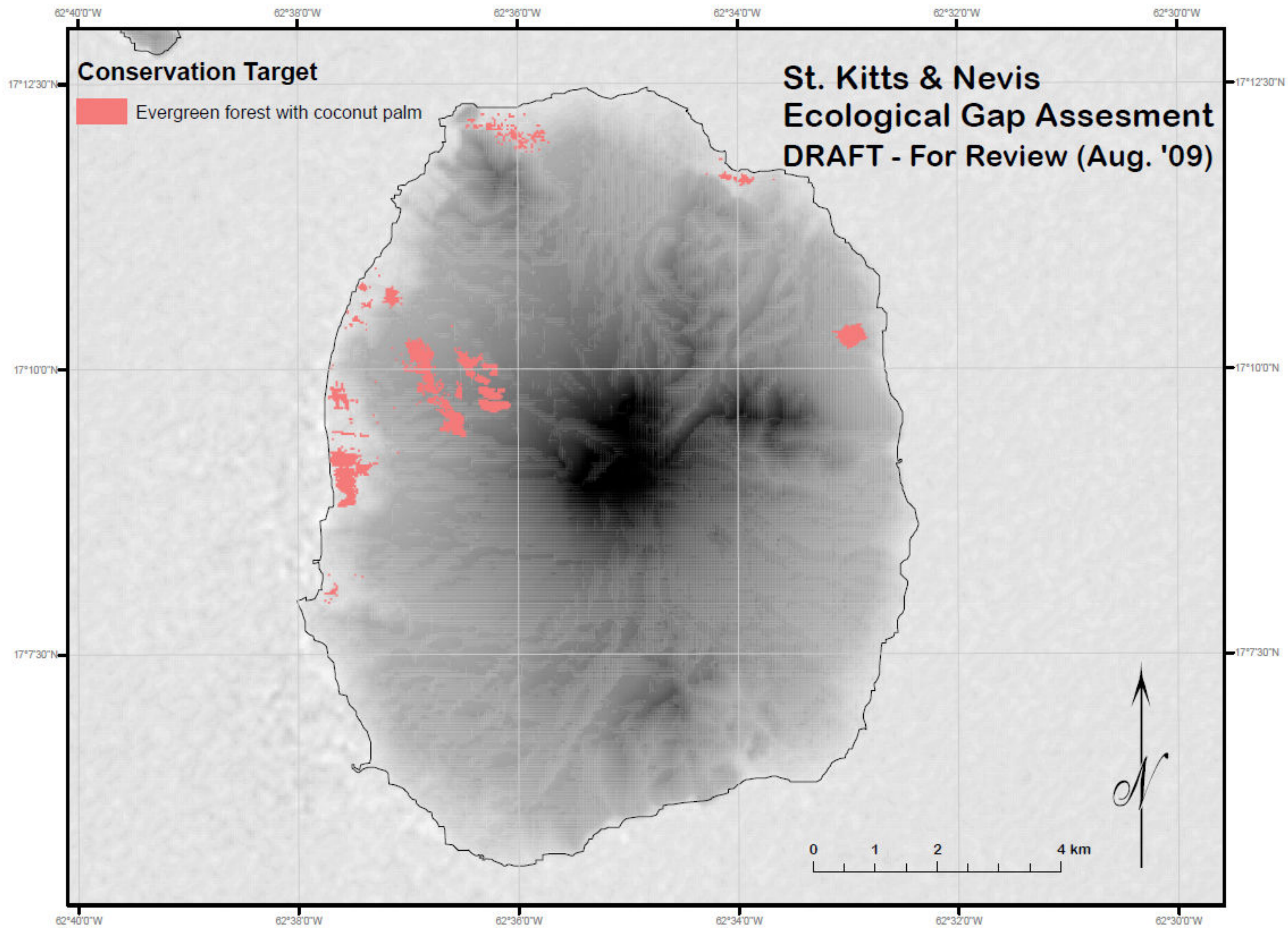
17°7'30"N



Conservation Target
Evergreen forest with coconut palm
St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
0
1
2
4 km
62°40'0"W
62°38'0"W
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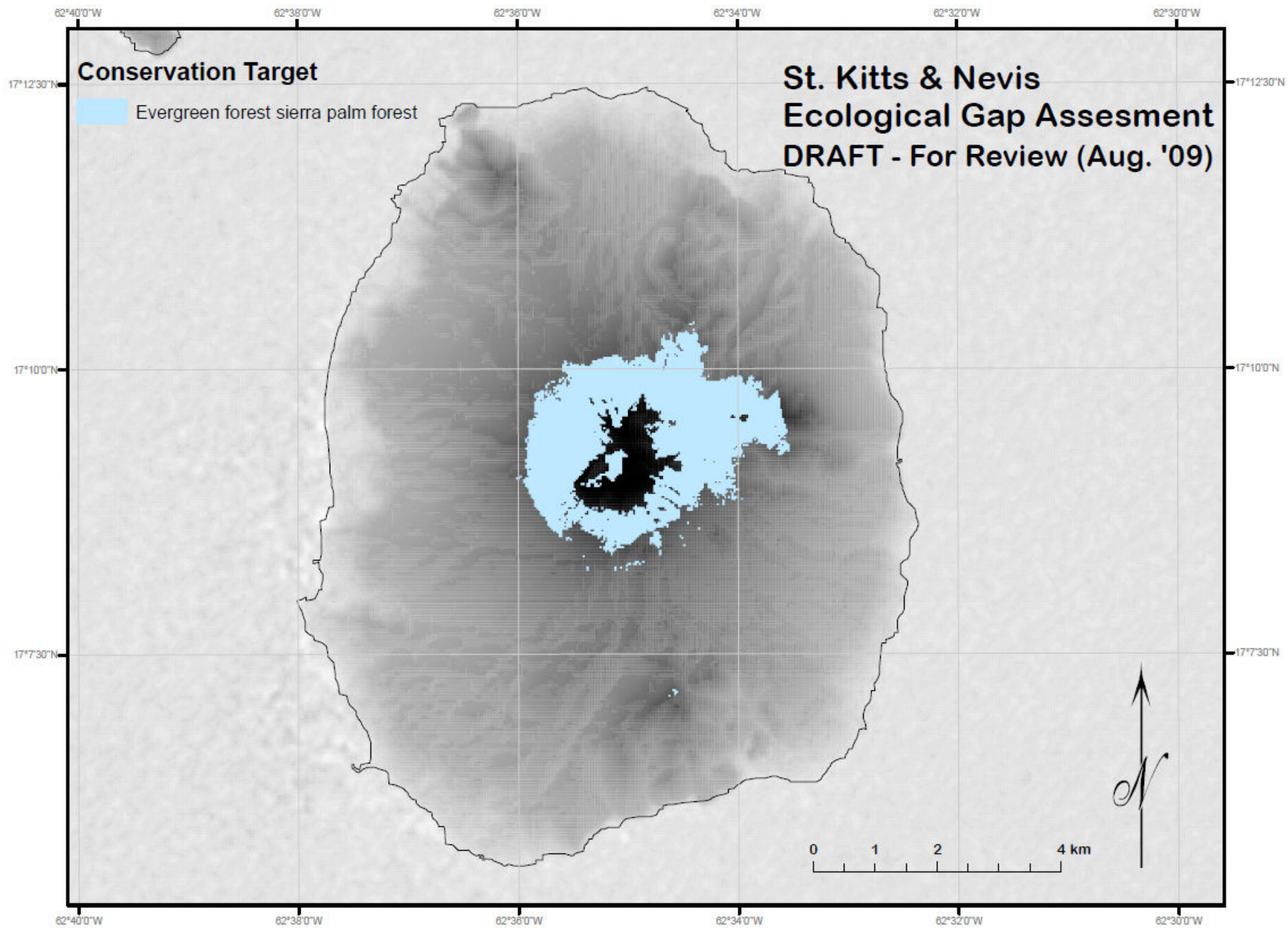
17°7'30"N


Conservation Target
Evergreen forest sierra palm forest
St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
0
1
2
4 km
N
62°40'0"W
62°38'0"W
62°36'0"W
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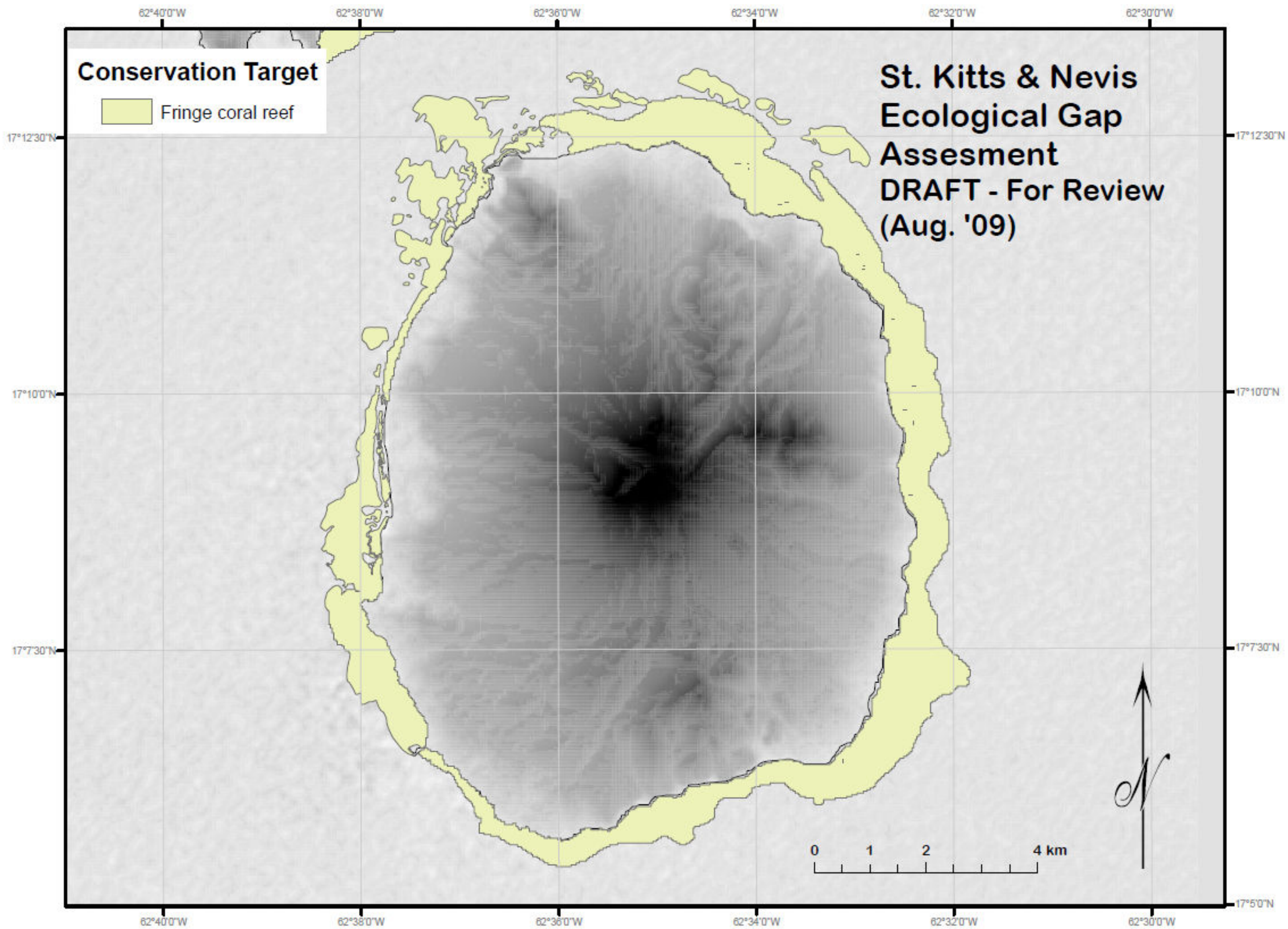
17°7'30"N



St. Kitts & Nevis
Ecological Gap
Assesment
DRAFT - For Review
(Aug. '09)
Conservation Target
Fringe coral reef
0
1
2
4 km
62°40'0"W
62°38'0"W
62°36'0"W
62°34'0"W
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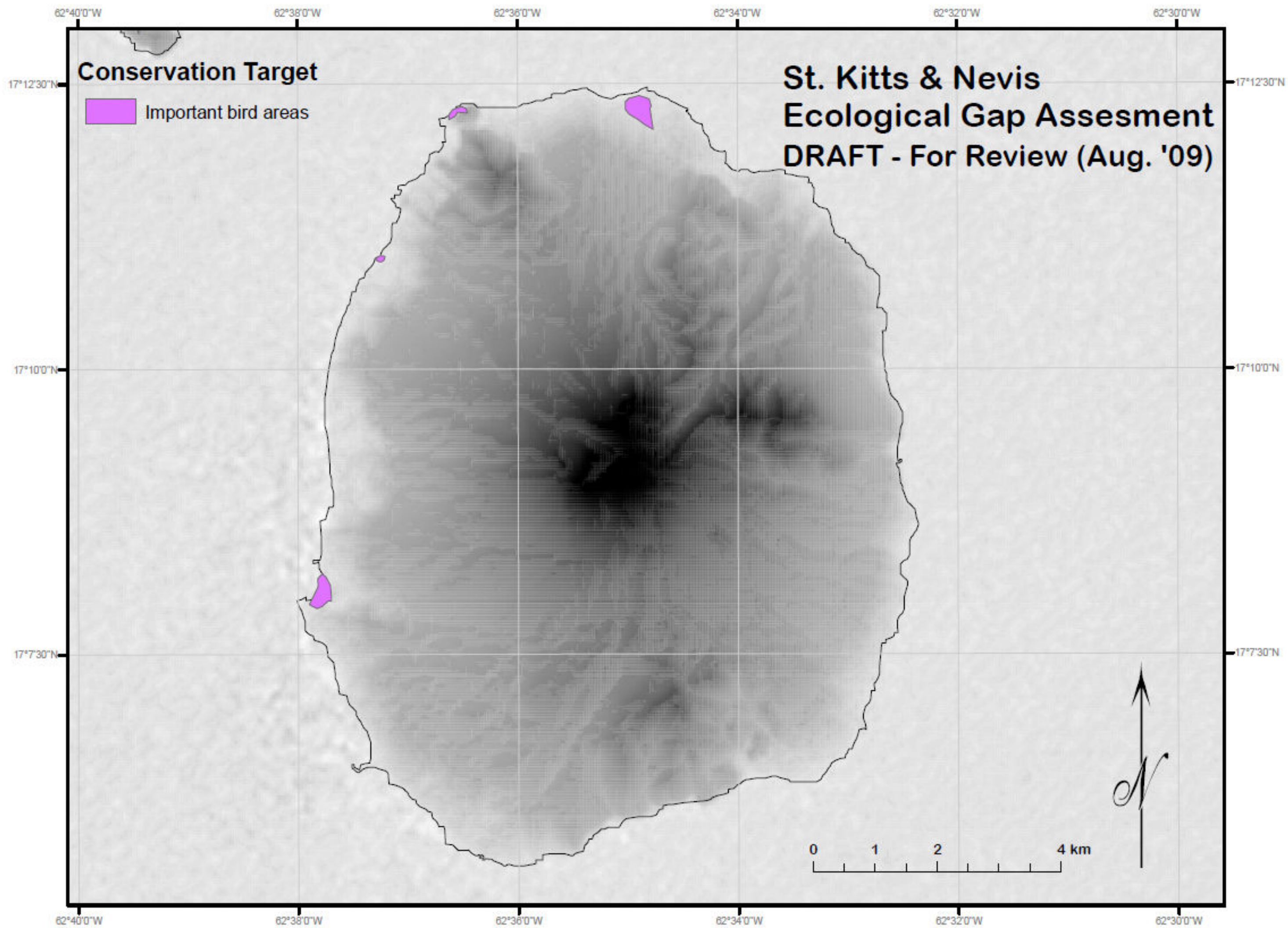
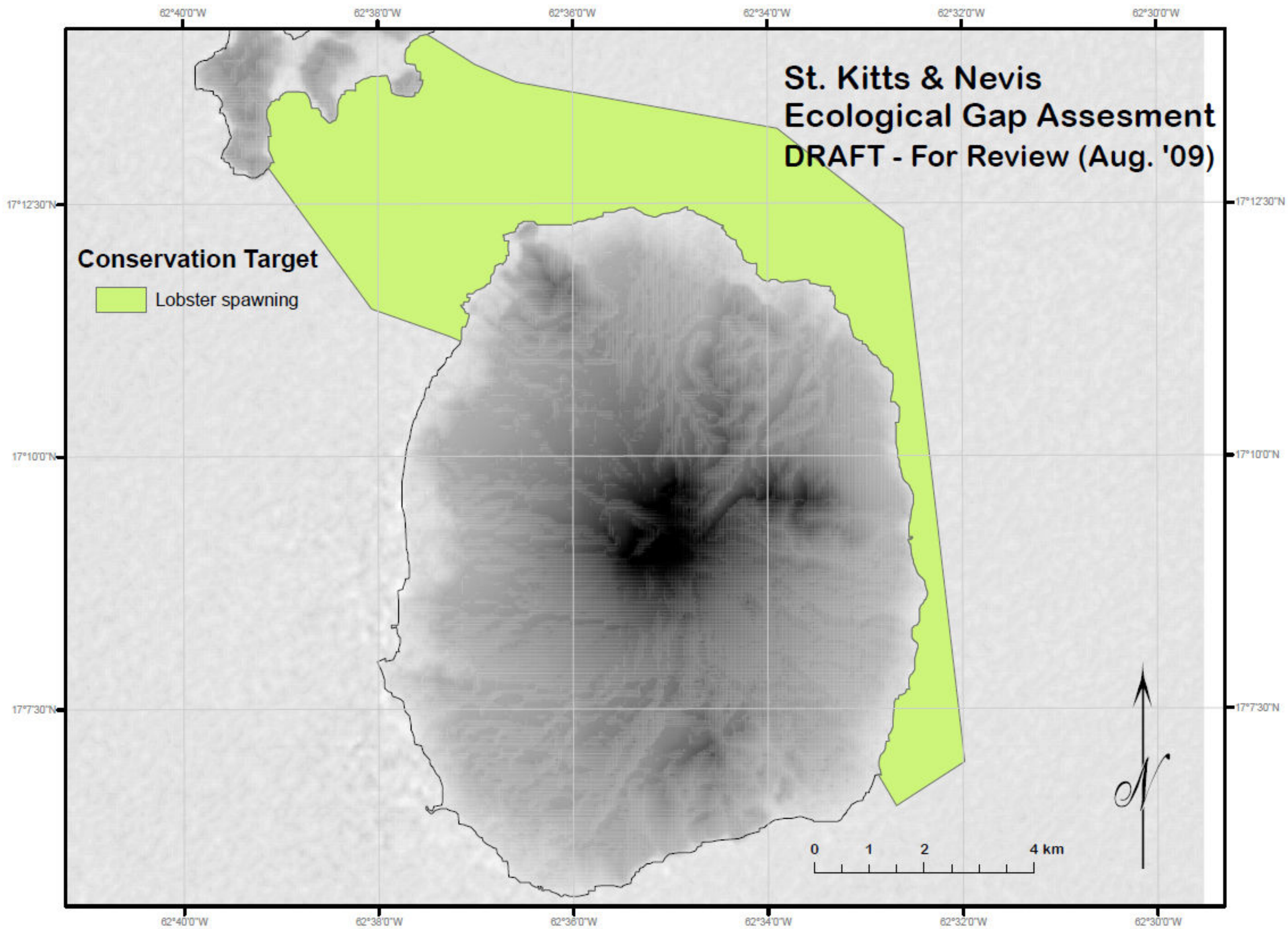
17°5'0"N



St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Important bird areas
0
1
2
4 km
N
62°40'0"W
62°38'0"W
62°36'0"W
62°34'0"W
62°32'0"W
62°30'0"W
17°12'30"N
17°10'0"N
17°7'30"N


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Lobster spawning
0
1
2
4 km
62°40'0"W
62°38'0"W
62°36'0"W
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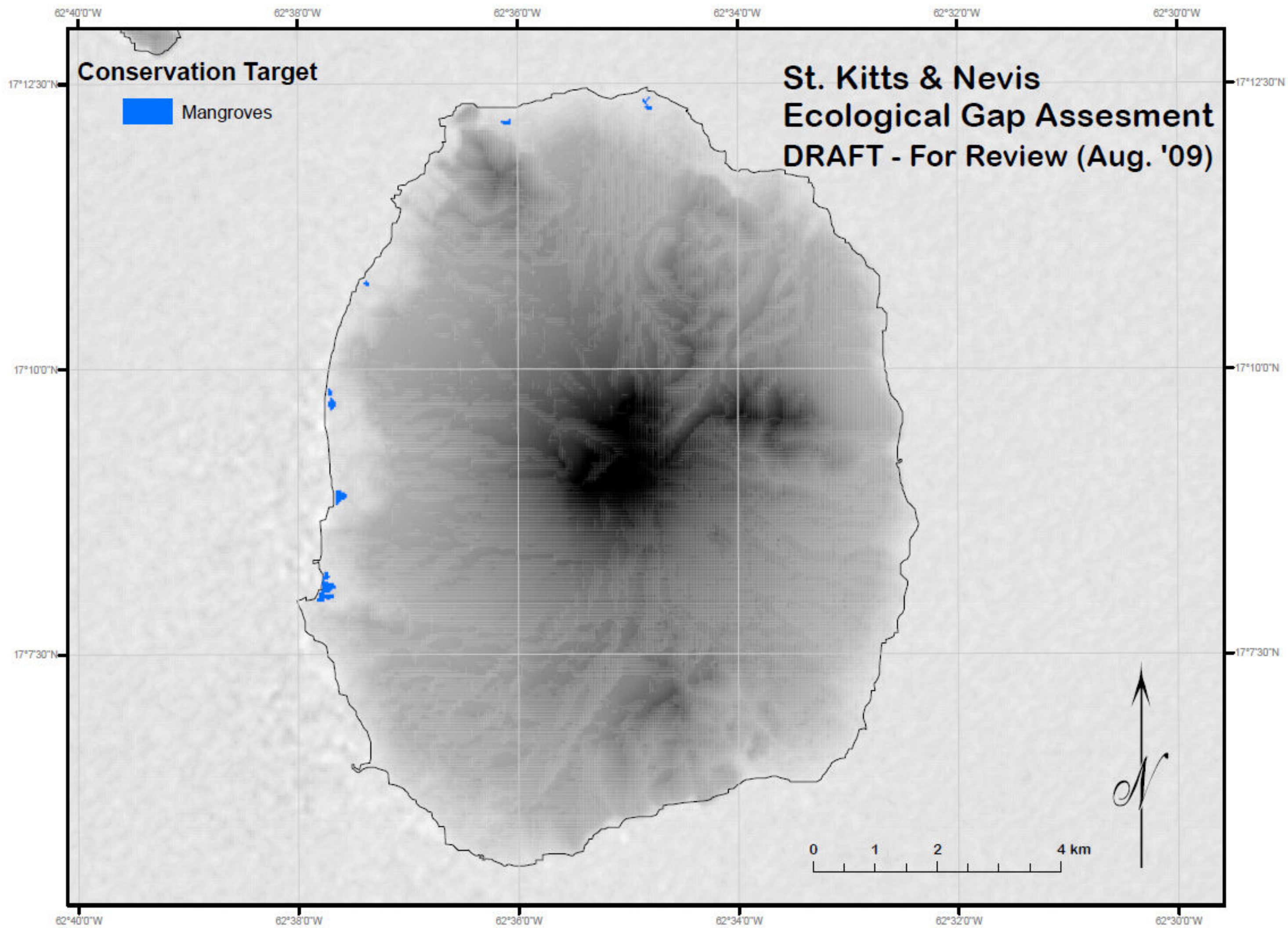
17°7'30"N



St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Mangroves
0
1
2
4 km
62°40'0"W
62°38'0"W
62°36'0"W
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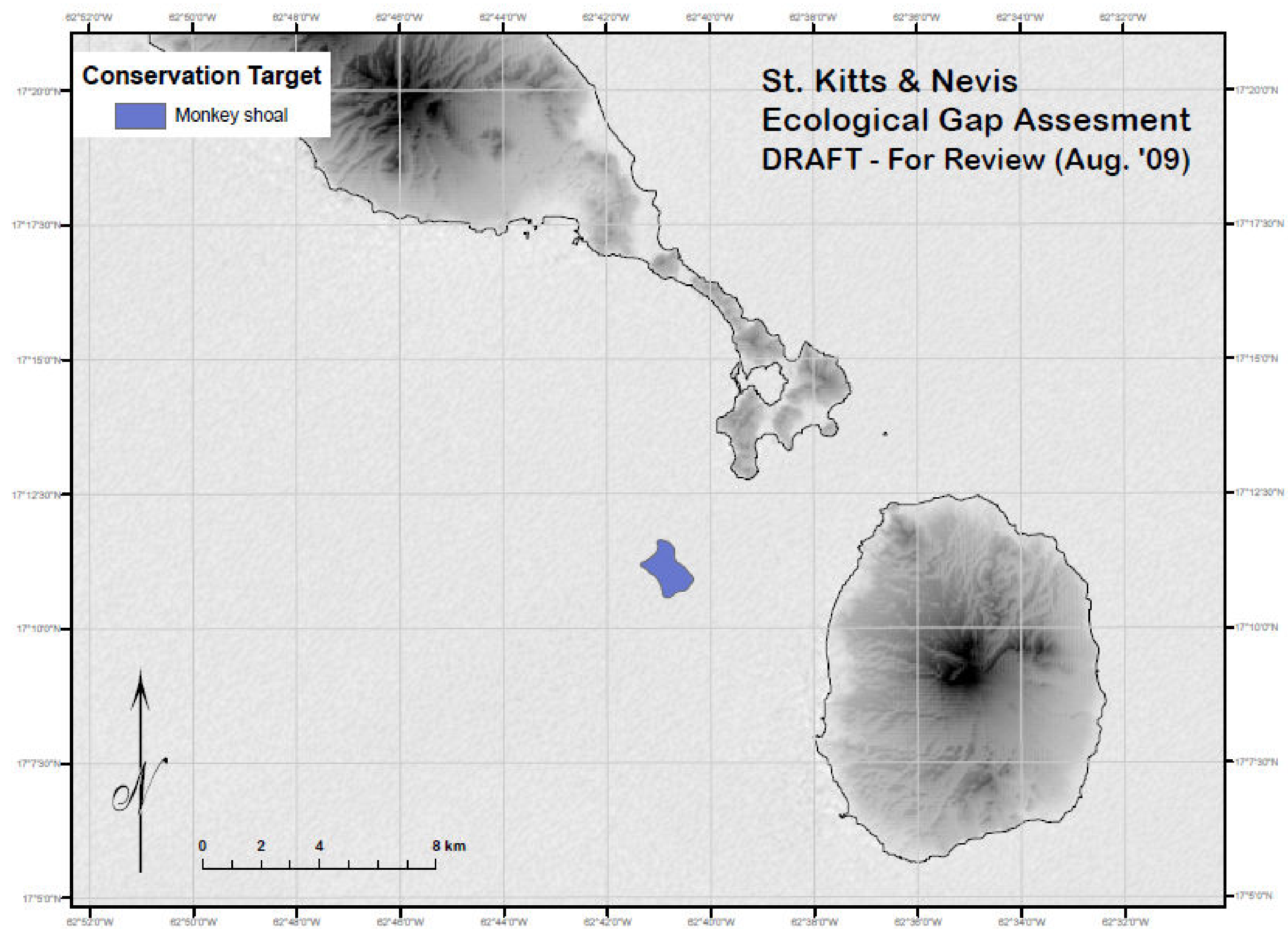
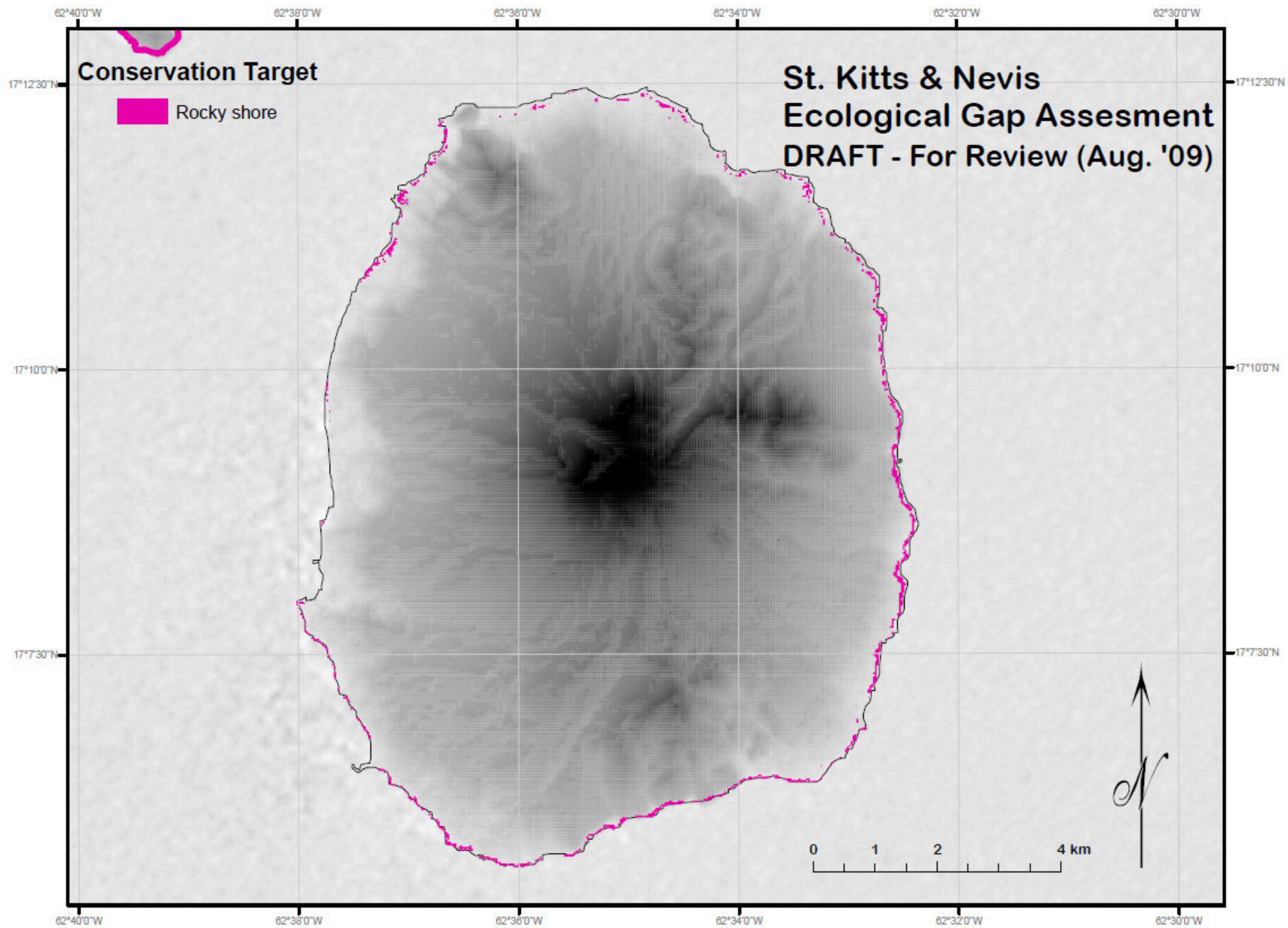
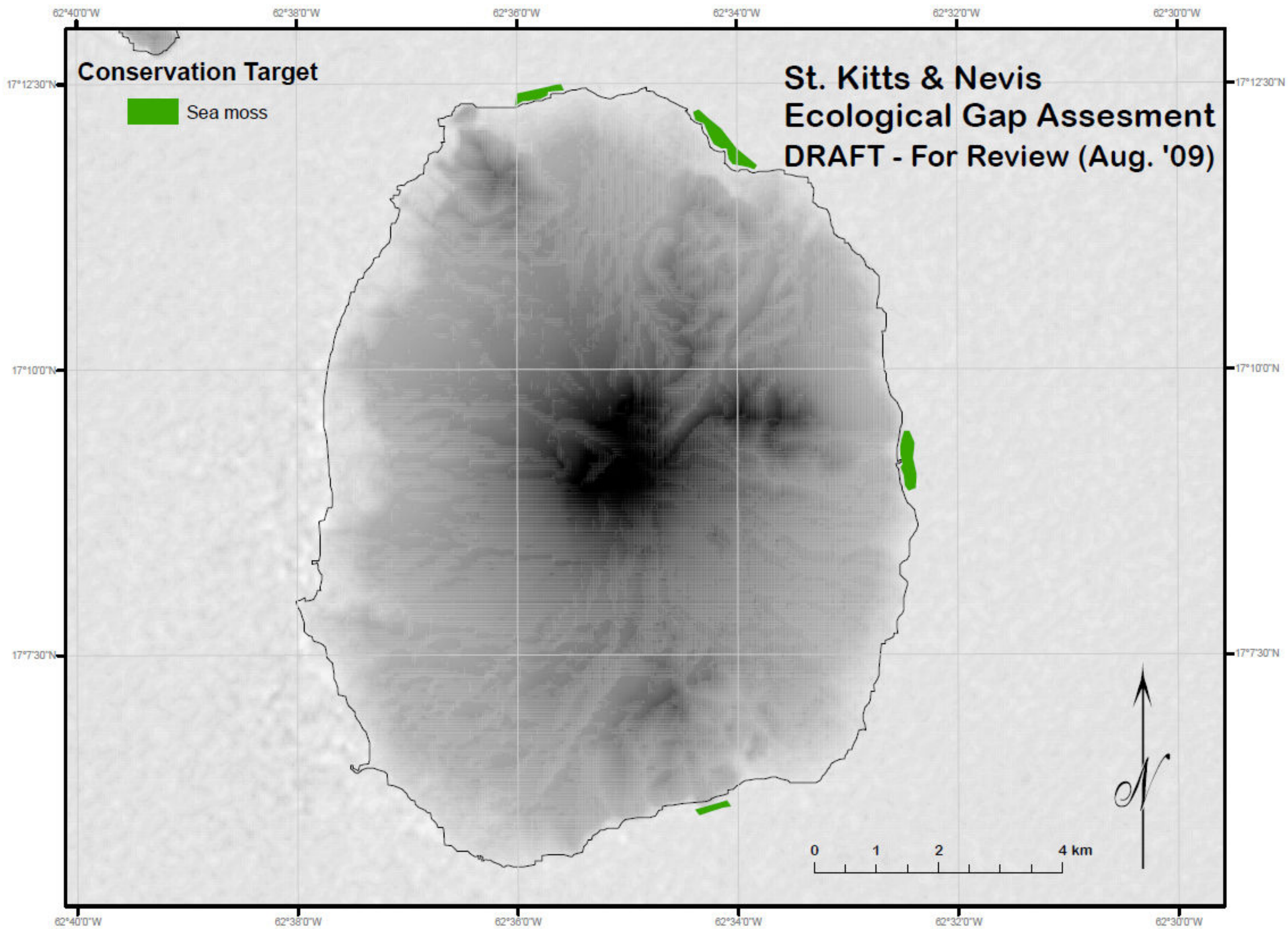
17°7'30"N

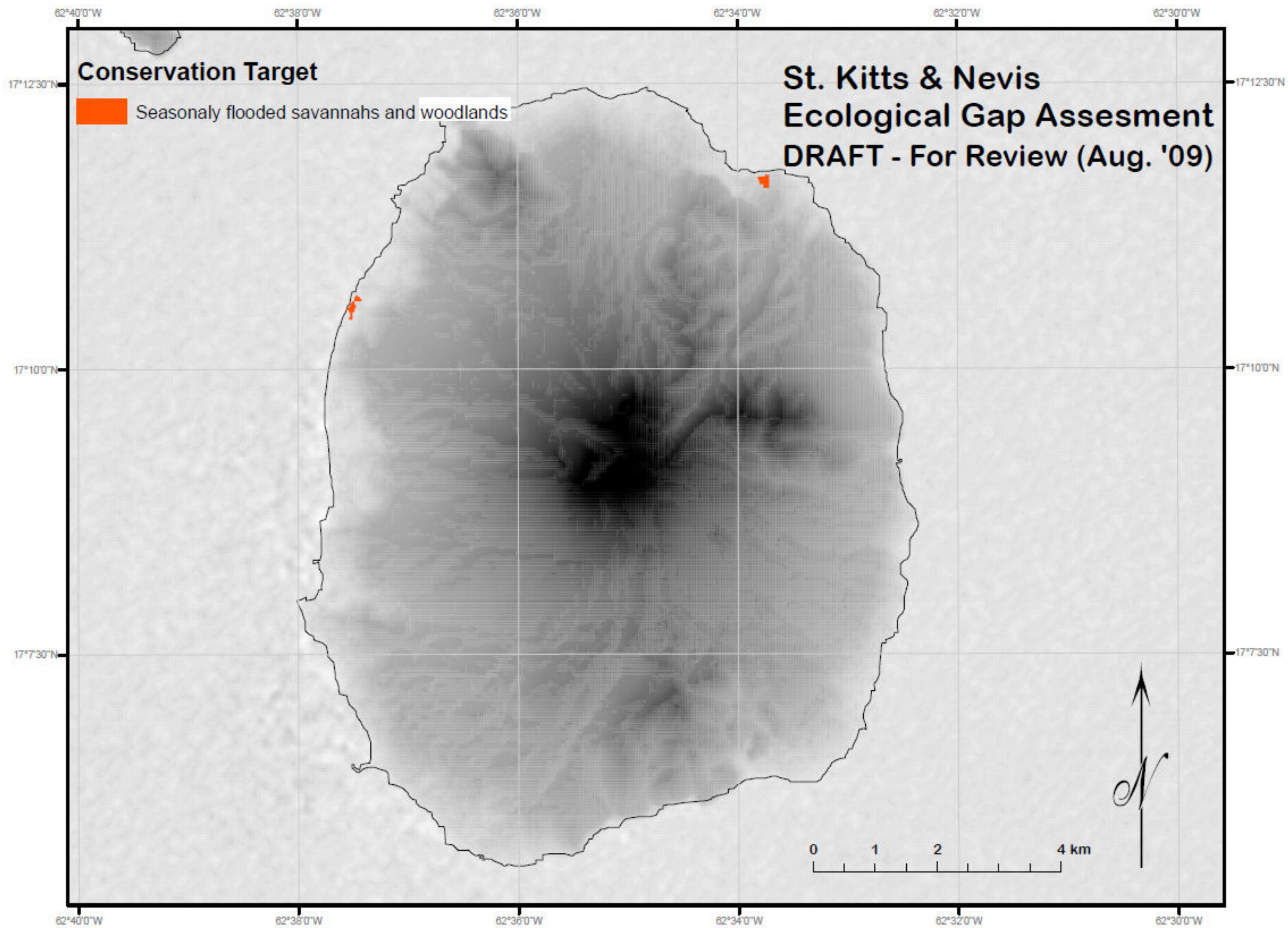


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Monkey shoal
0
2
4
8 km

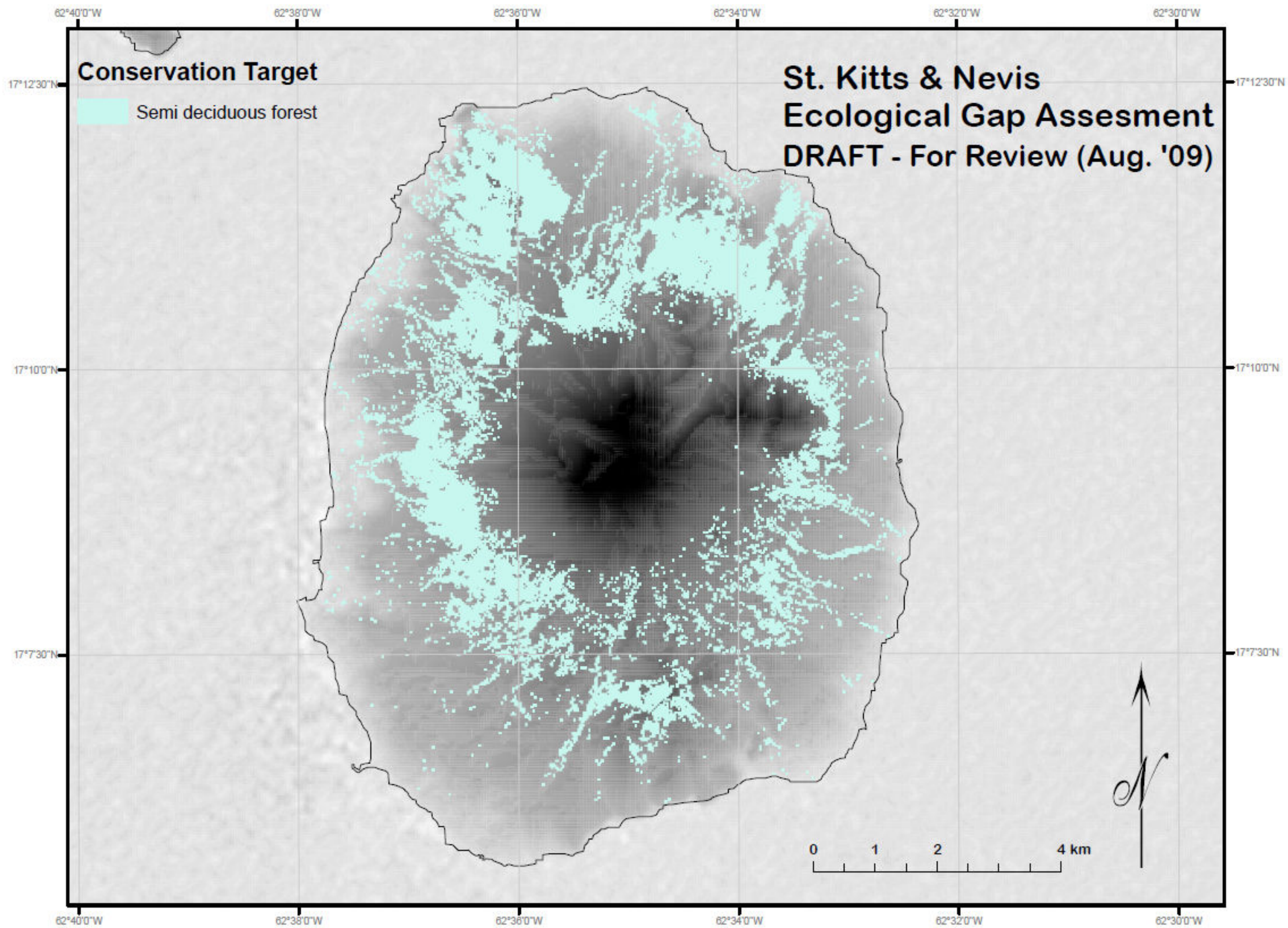


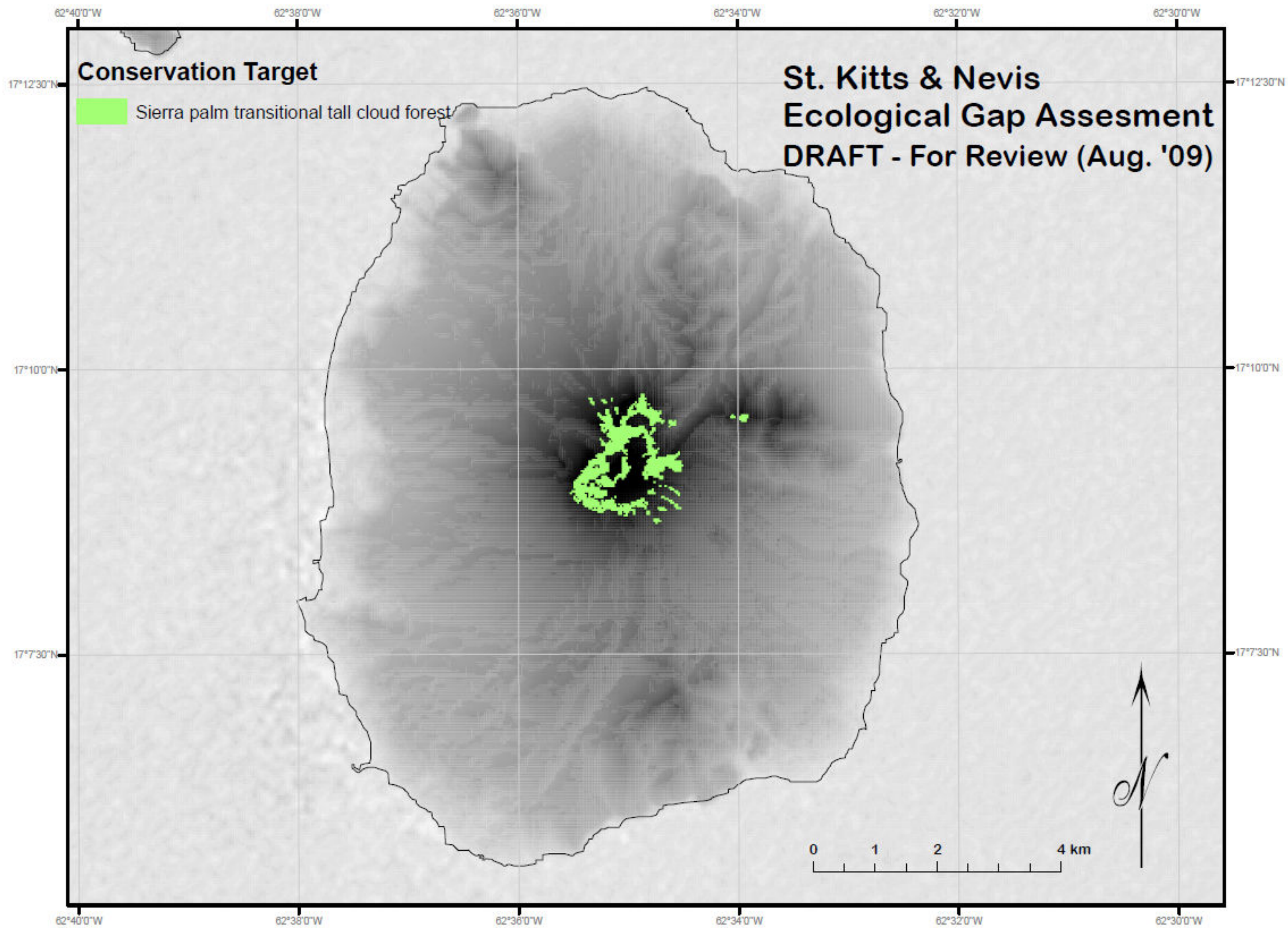
St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Rocky shore
62°40'0"W
62°38'0"W
62°36'0"W
62°34'0"W
62°32'0"W
62°30'0"W
17°12'30"N
17°10'0"N
17°7'30"N
0
1
2
4 km
N


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Sea moss
0
1
2
4 km
62°40'0"W
62°38'0"W
62°36'0"W
62°34'0"W
62°32'0"W
62°30'0"W
17°12'30"N
17°10'0"N
17°7'30"N

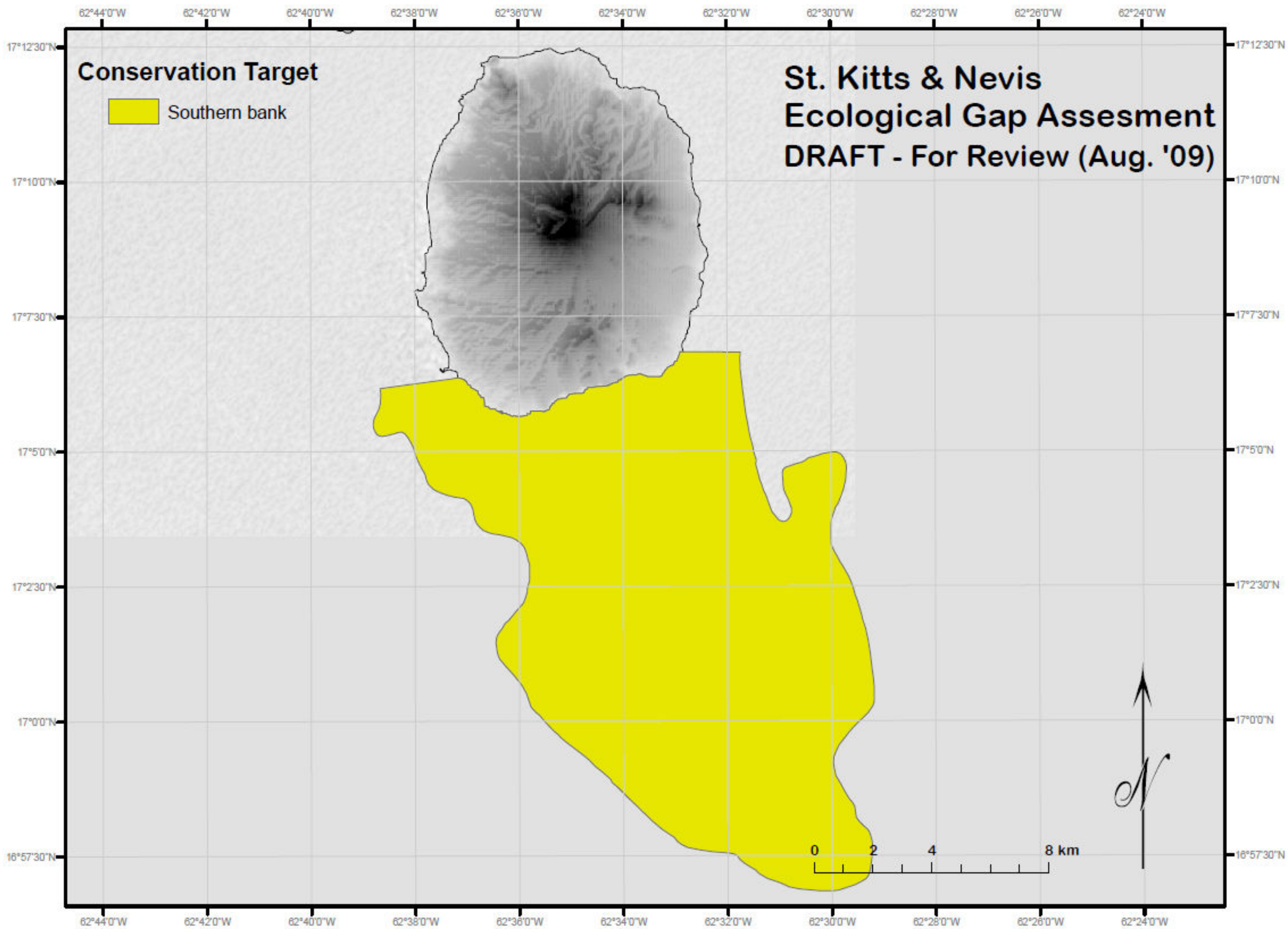


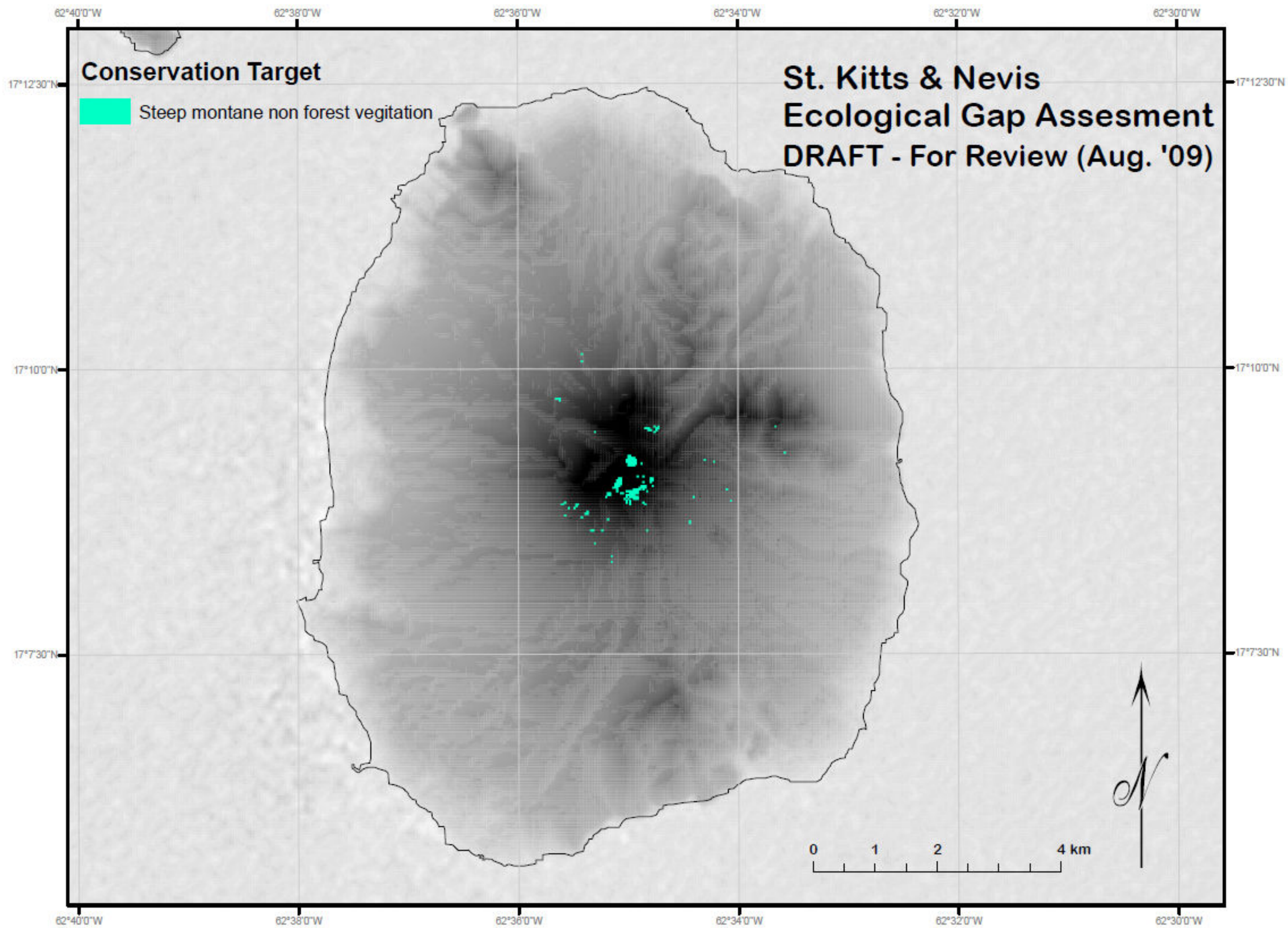
Conservation Target
Seasonaly flooded savannahs and woodlands
St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
0
1
2
4 km
N
62°40'0"W
62°38'0"W
62°36'0"W
62°34'0"W
62°32'0"W
62°30'0"W
17°12'30"N
17°10'0"N
17°7'30"N

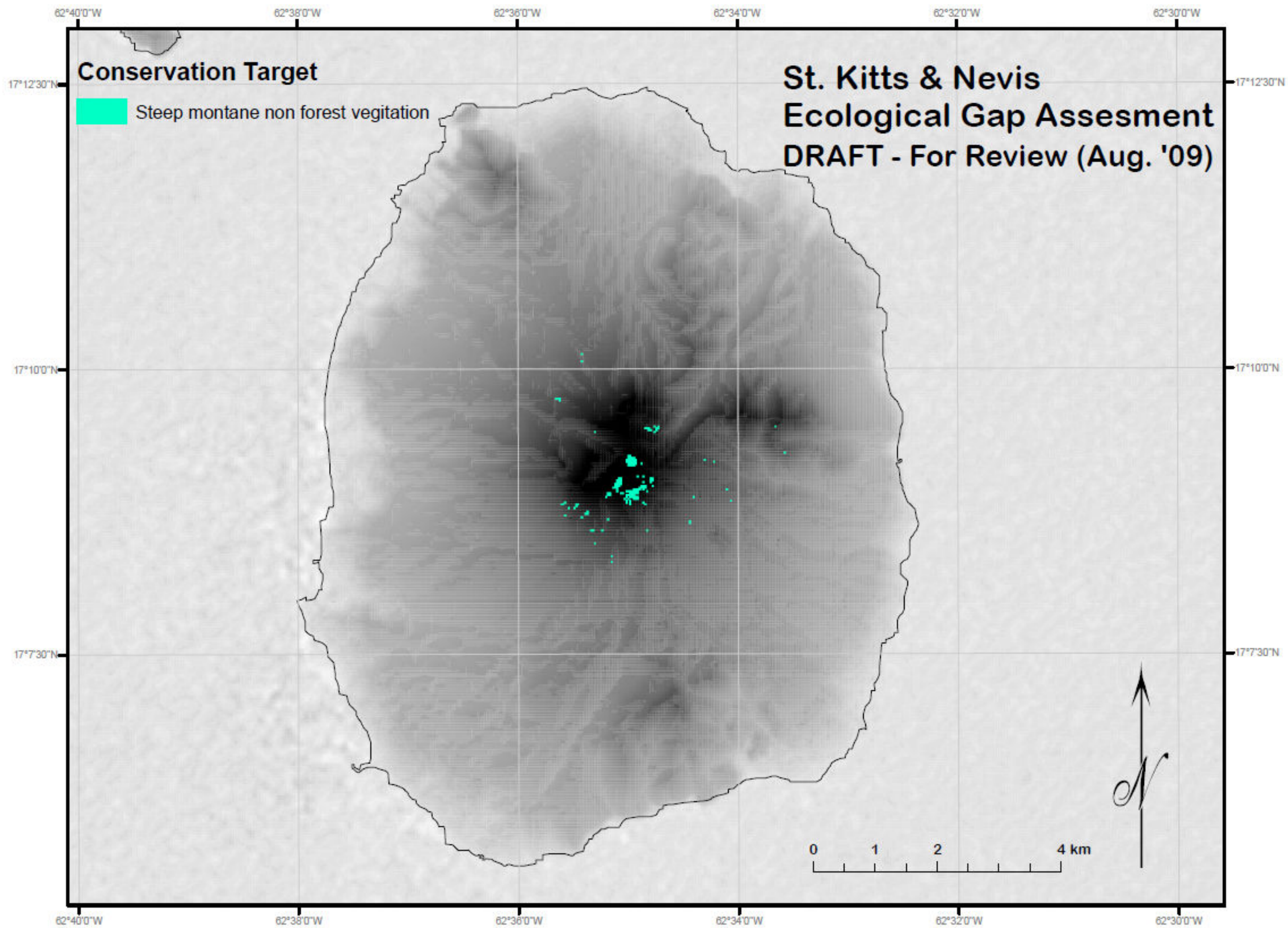

St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Semi deciduous forest
0
1
2
4 km
62°40'0"W
62°38'0"W
62°36'0"W
62°34'0"W
62°32'0"W
62°30'0"W
17°12'30"N
17°10'0"N
17°7'30"N



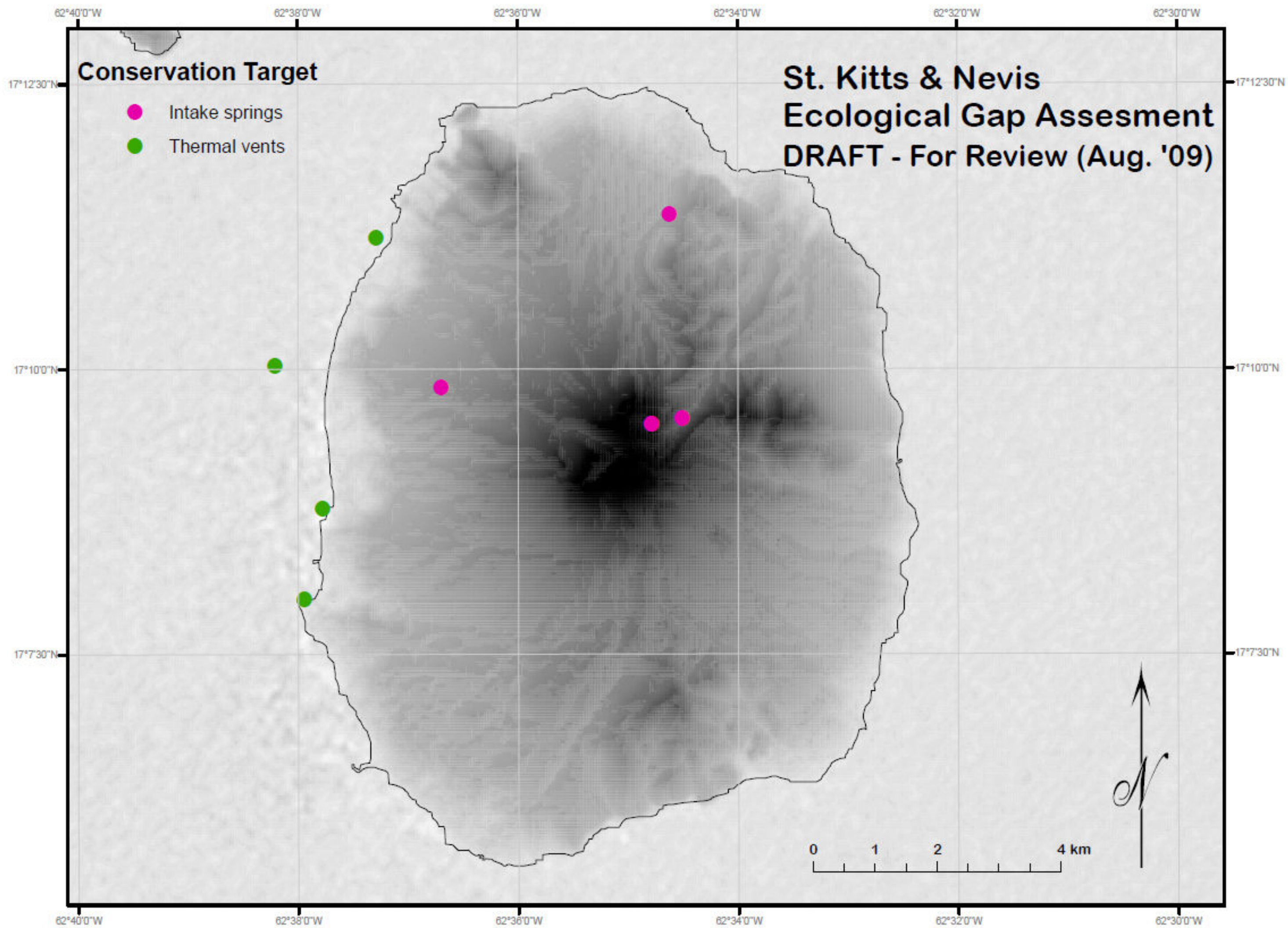
62°40'0"W
62°38'0"W
62°36'0"W
62°34'0"W
62°32'0"W
62°30'0"W
17°12'30"N
17°10'0"N
17°7'30"N
Conservation Target
Sierra palm transitional tall cloud forest
St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
0
1
2
4 km
N


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Southern bank
0
2
4
8 km

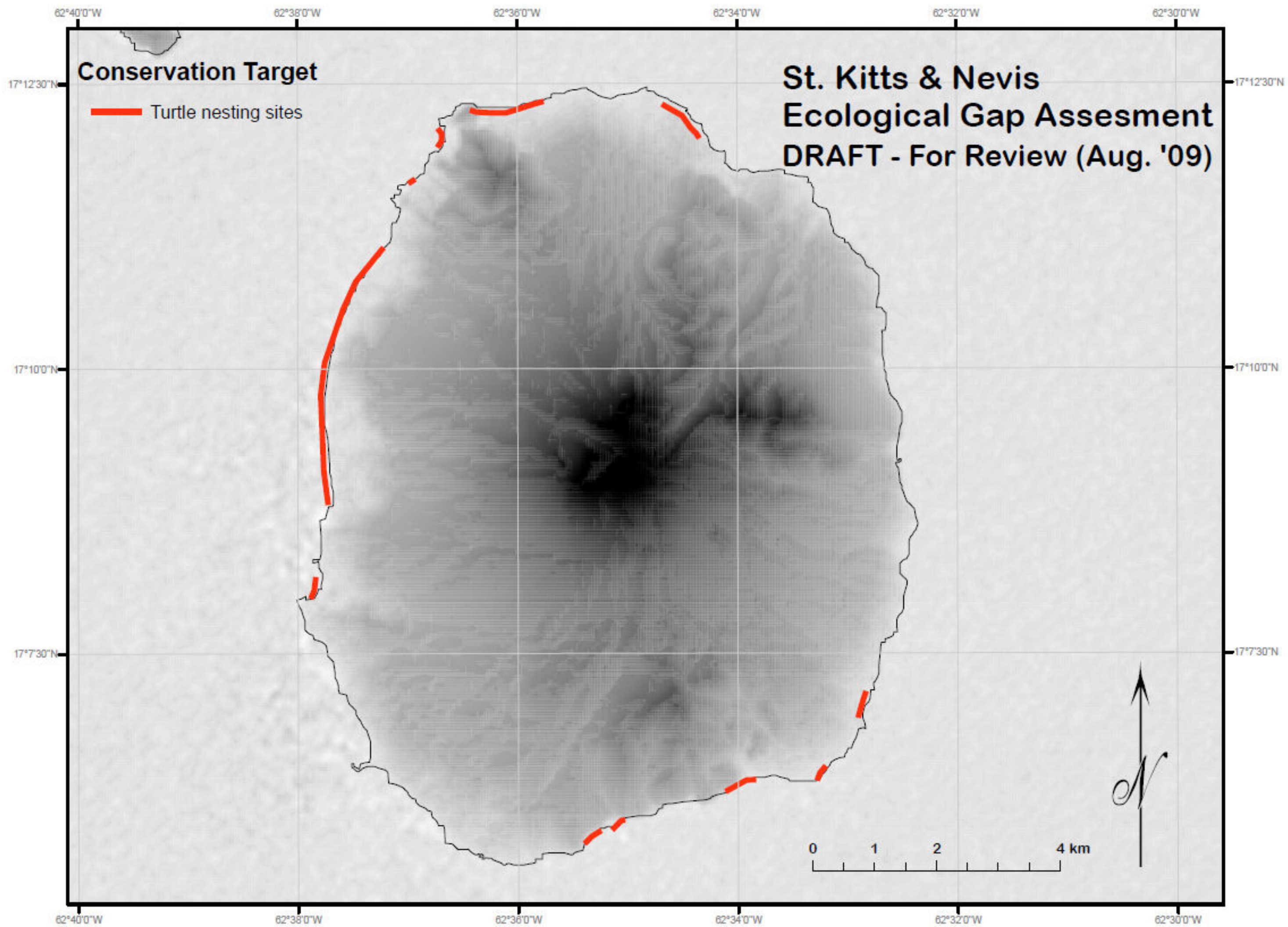

St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Steep montane non forest vegitation
0
1
2
4 km
62°40'0"W
62°38'0"W
62°36'0"W
62°34'0"W
62°32'0"W
62°30'0"W
17°12'30"N
17°10'0"N
17°7'30"N

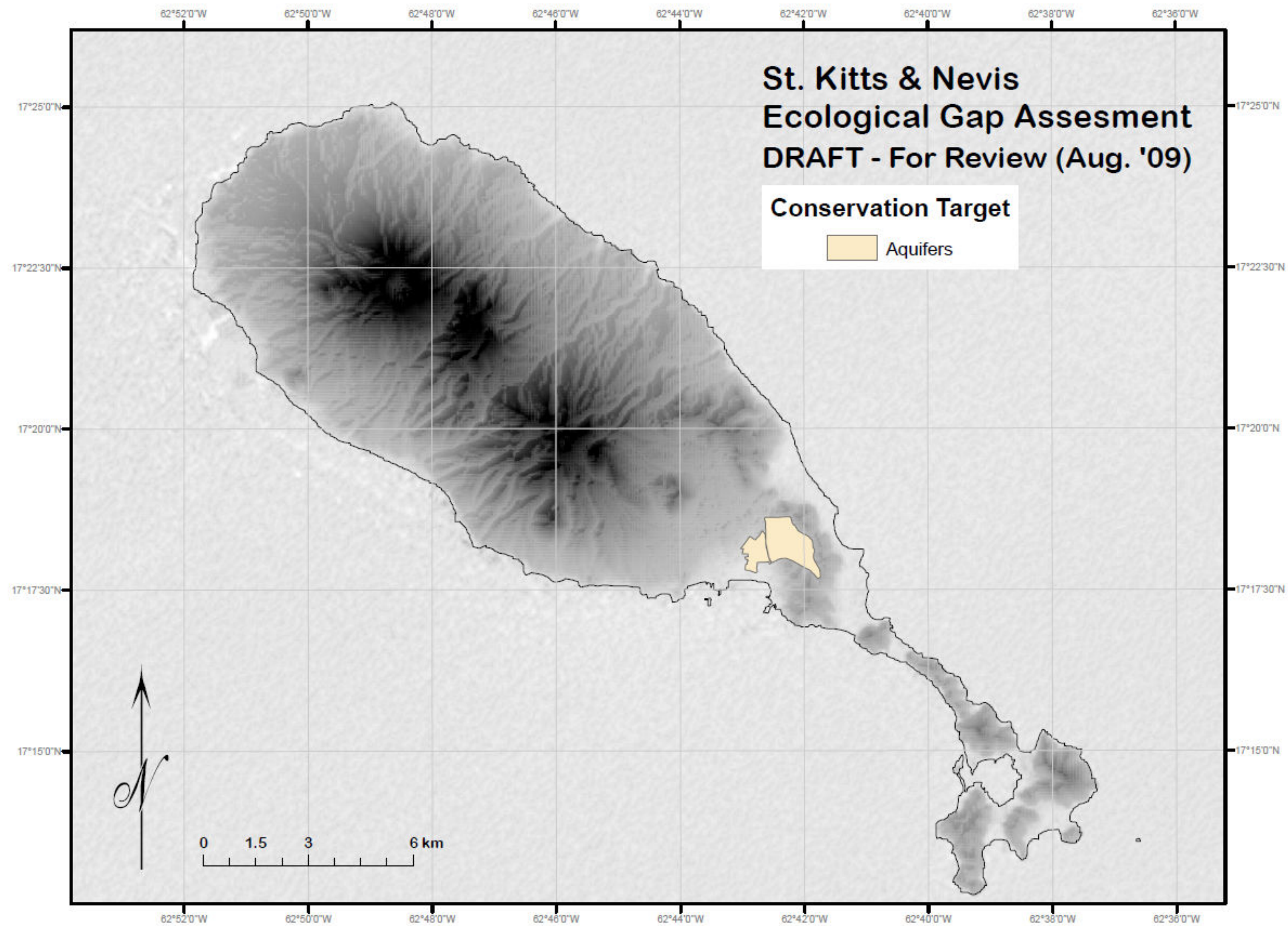


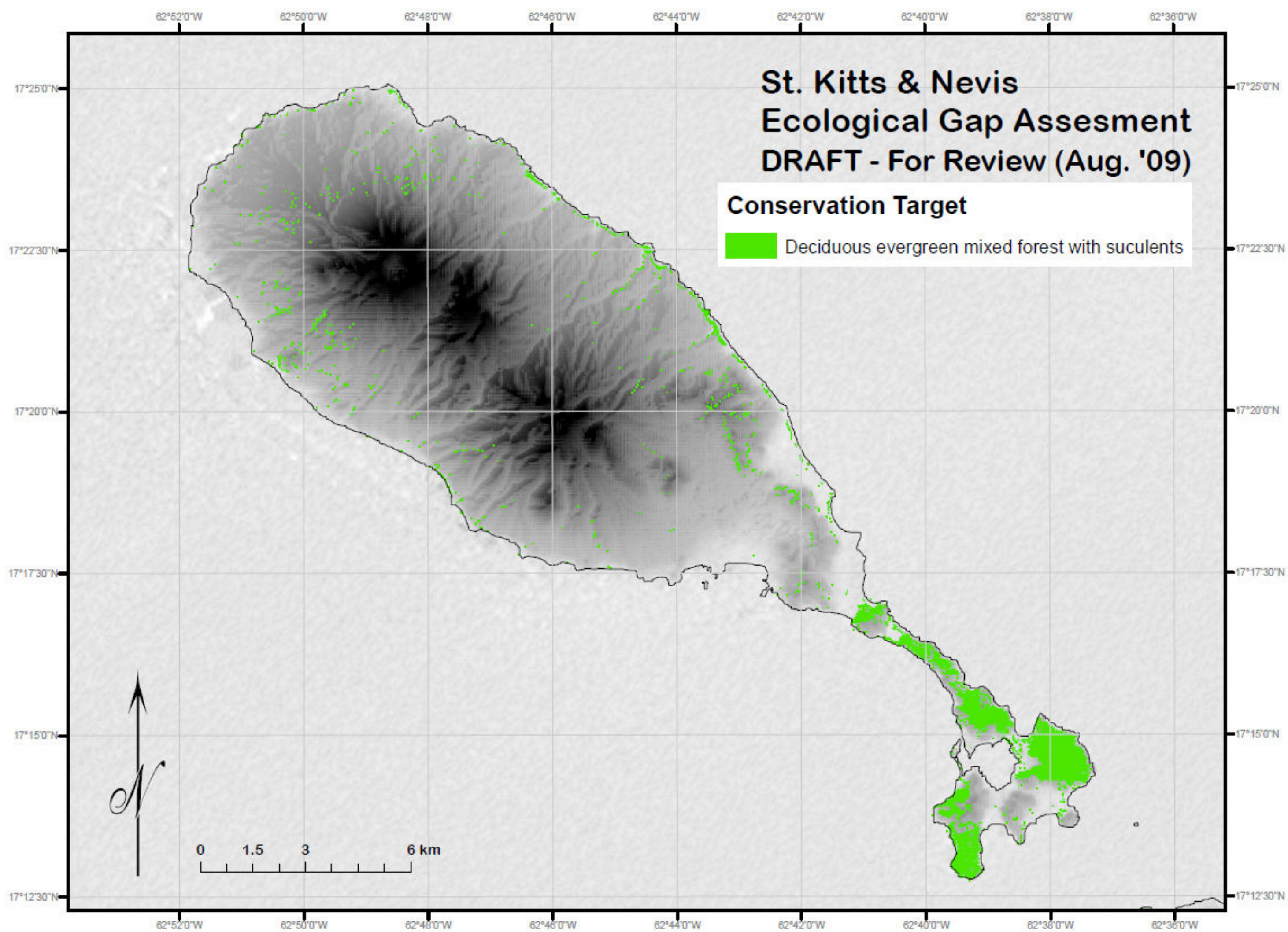
Conservation Target
Steep montane non forest vegitation
St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
0
1
2
4 km
62°40'0"W
62°38'0"W
62°36'0"W
62°34'0"W
62°32'0"W
62°30'0"W
17°12'30"N
17°10'0"N
17°7'30"N

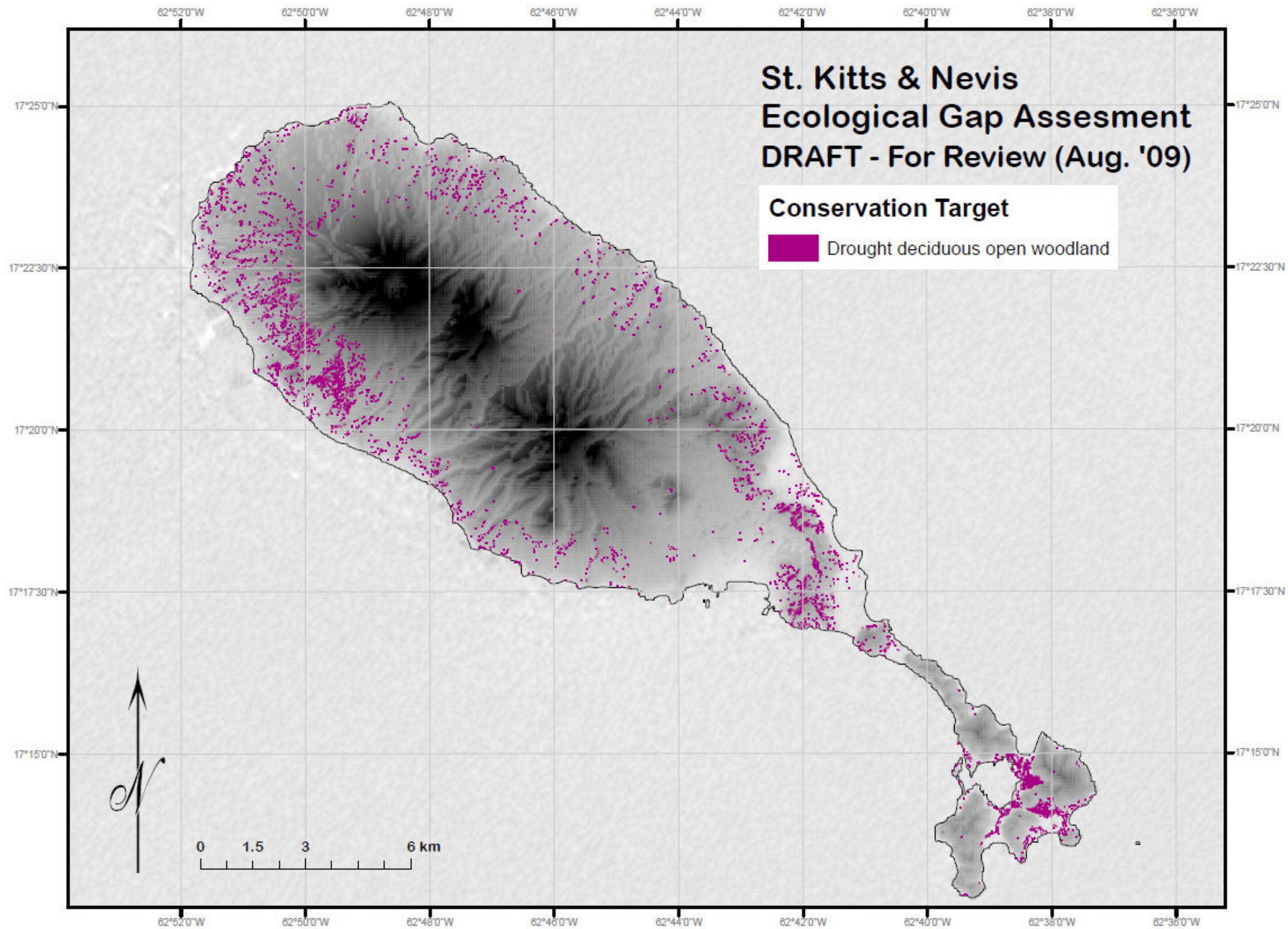


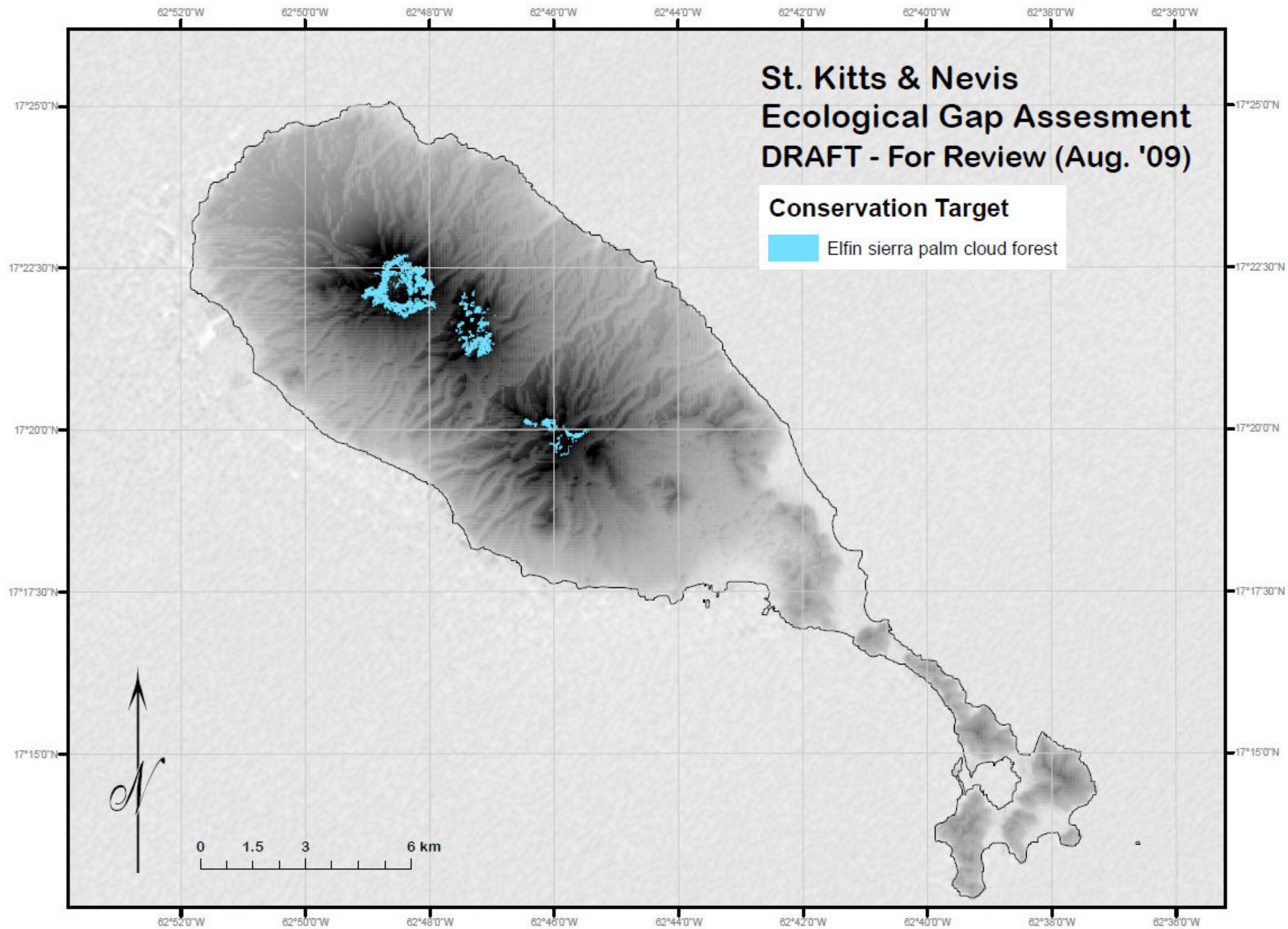
St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Intake springs
Thermal vents
0
1
2
4 km
62°40'0"W
62°38'0"W
62°36'0"W
62°34'0"W
62°32'0"W
62°30'0"W
17°12'30"N
17°10'0"N
17°7'30"N


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Turtle nesting sites
62°40'0"W
62°38'0"W
62°36'0"W
62°34'0"W
62°32'0"W
62°30'0"W
17°12'30"N
17°10'0"N
17°7'30"N
0
1
2
4 km
N

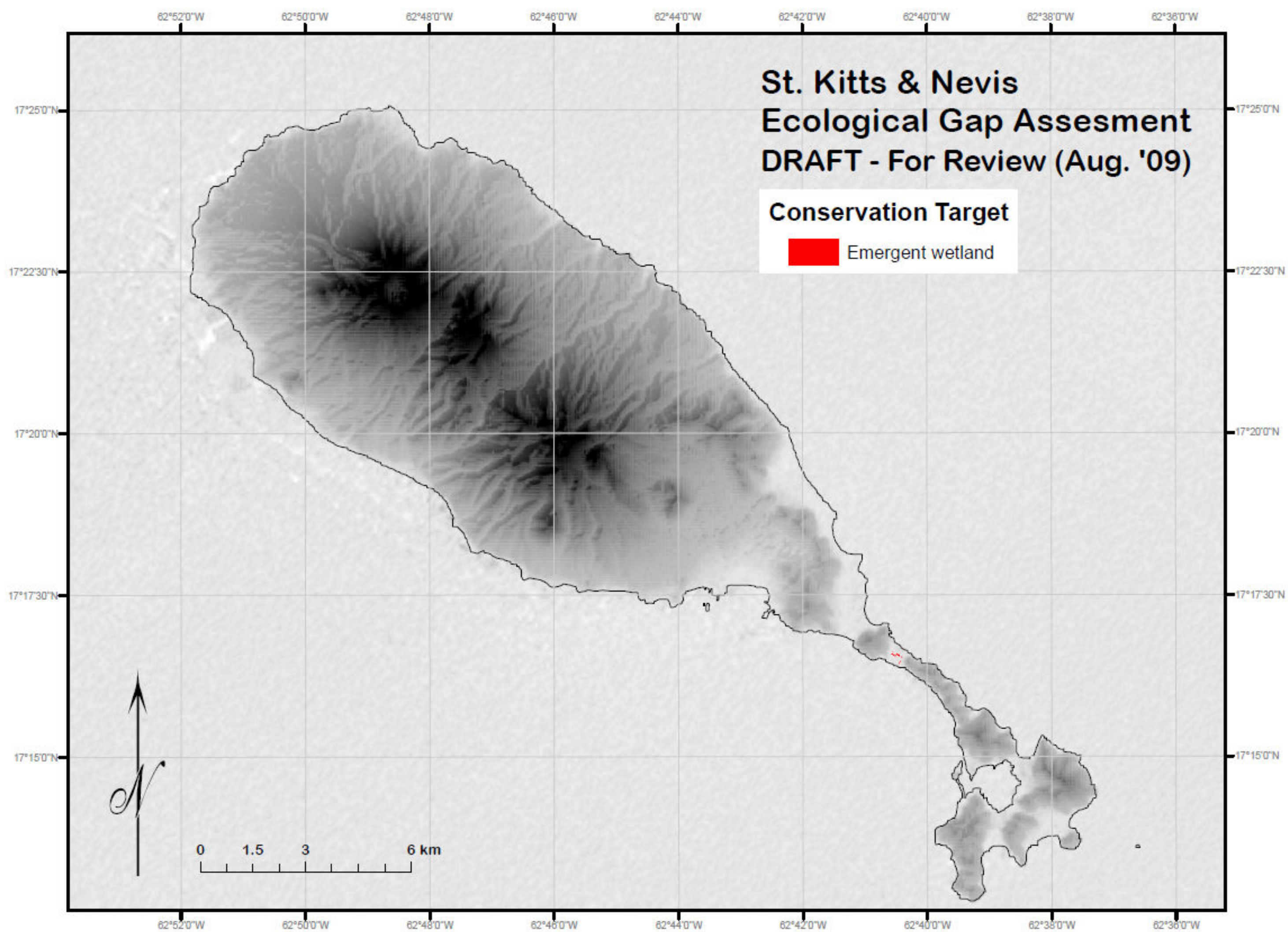

St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Aquifers
0
1.5
3
6 km
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N

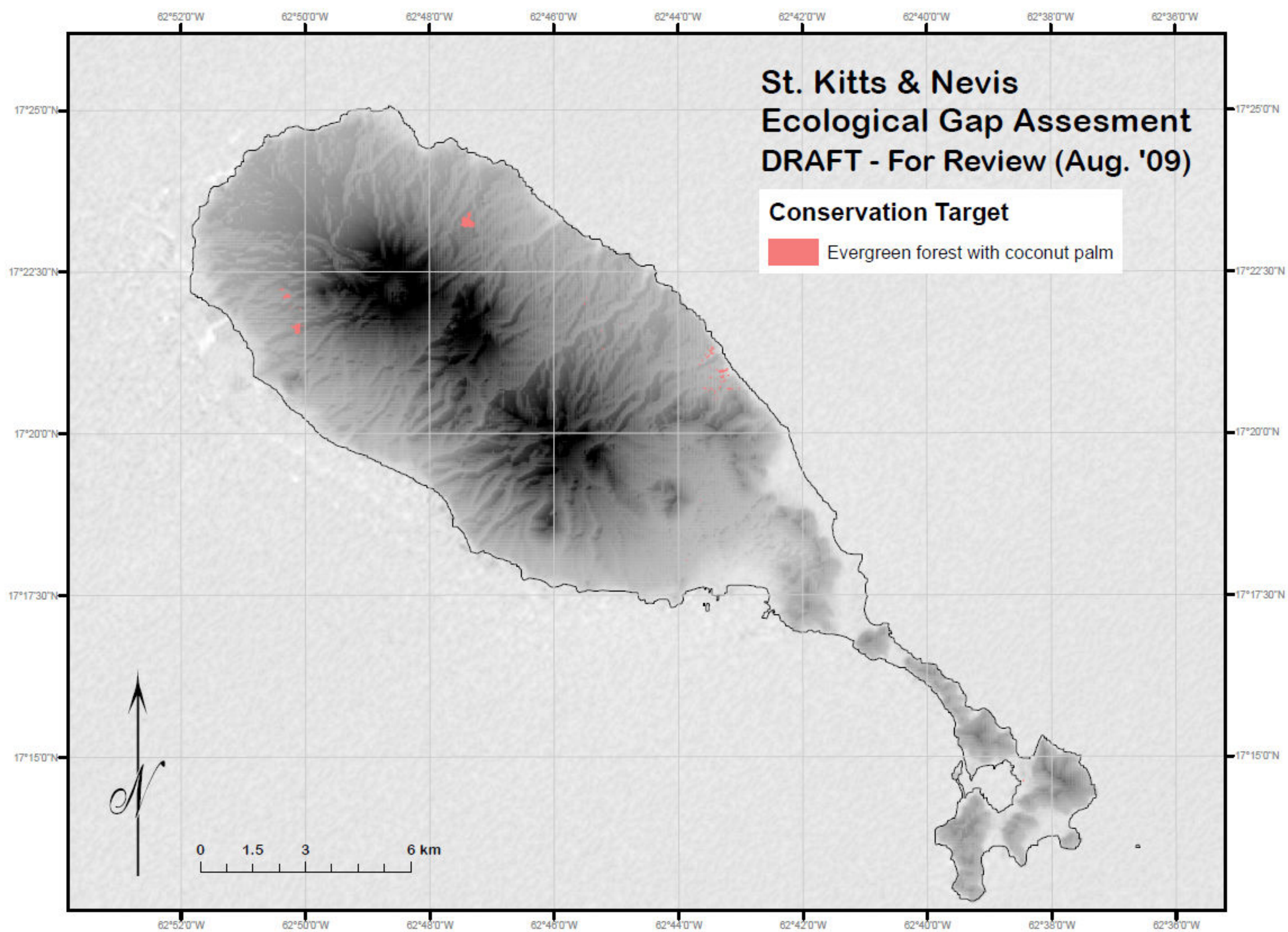

St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Deciduous evergreen mixed forest with suculents
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N
17°12'30"N
0 1.5 3 6 km
N

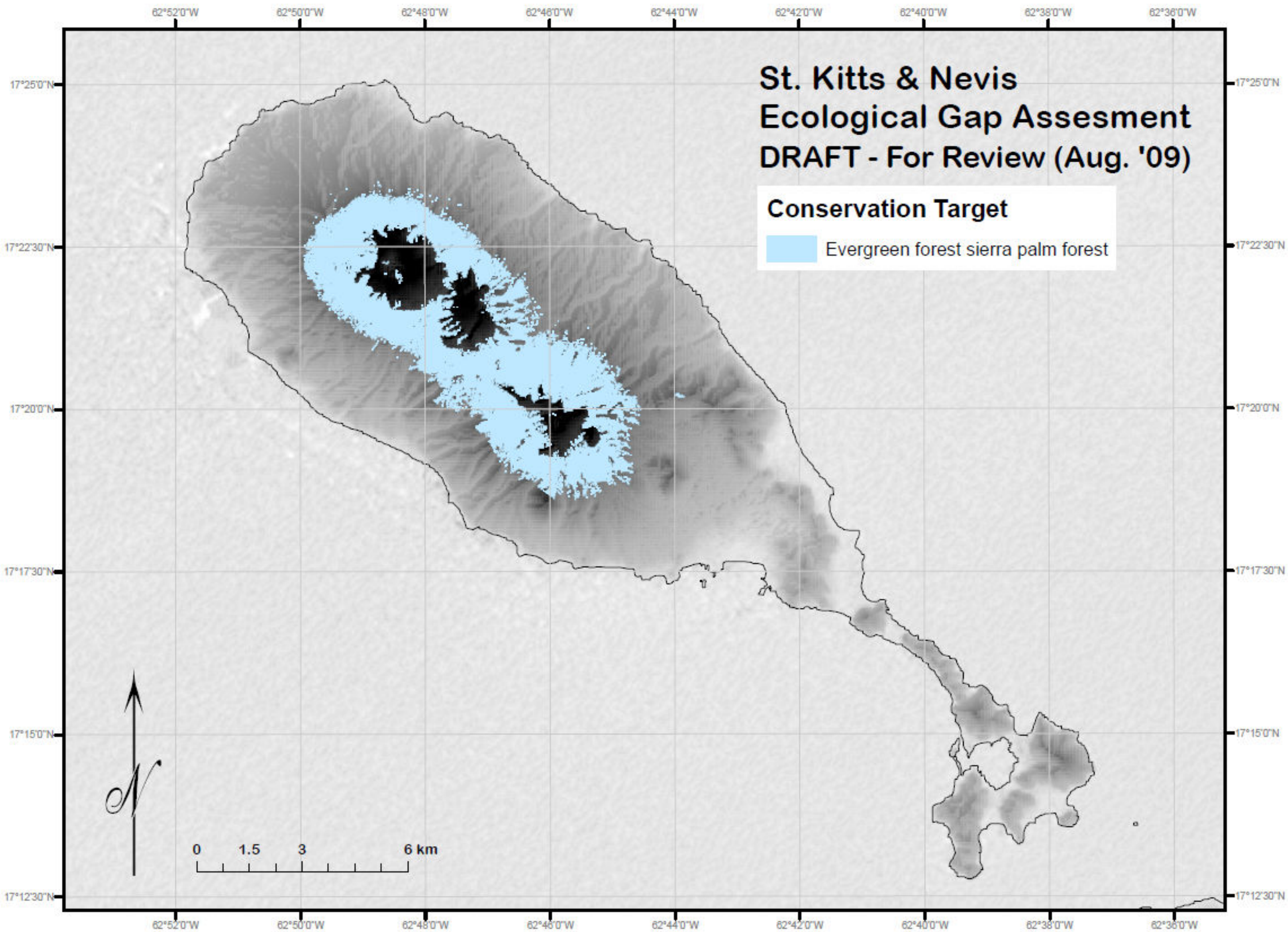

St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Drought deciduous open woodland
0
1.5
3
6 km
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N

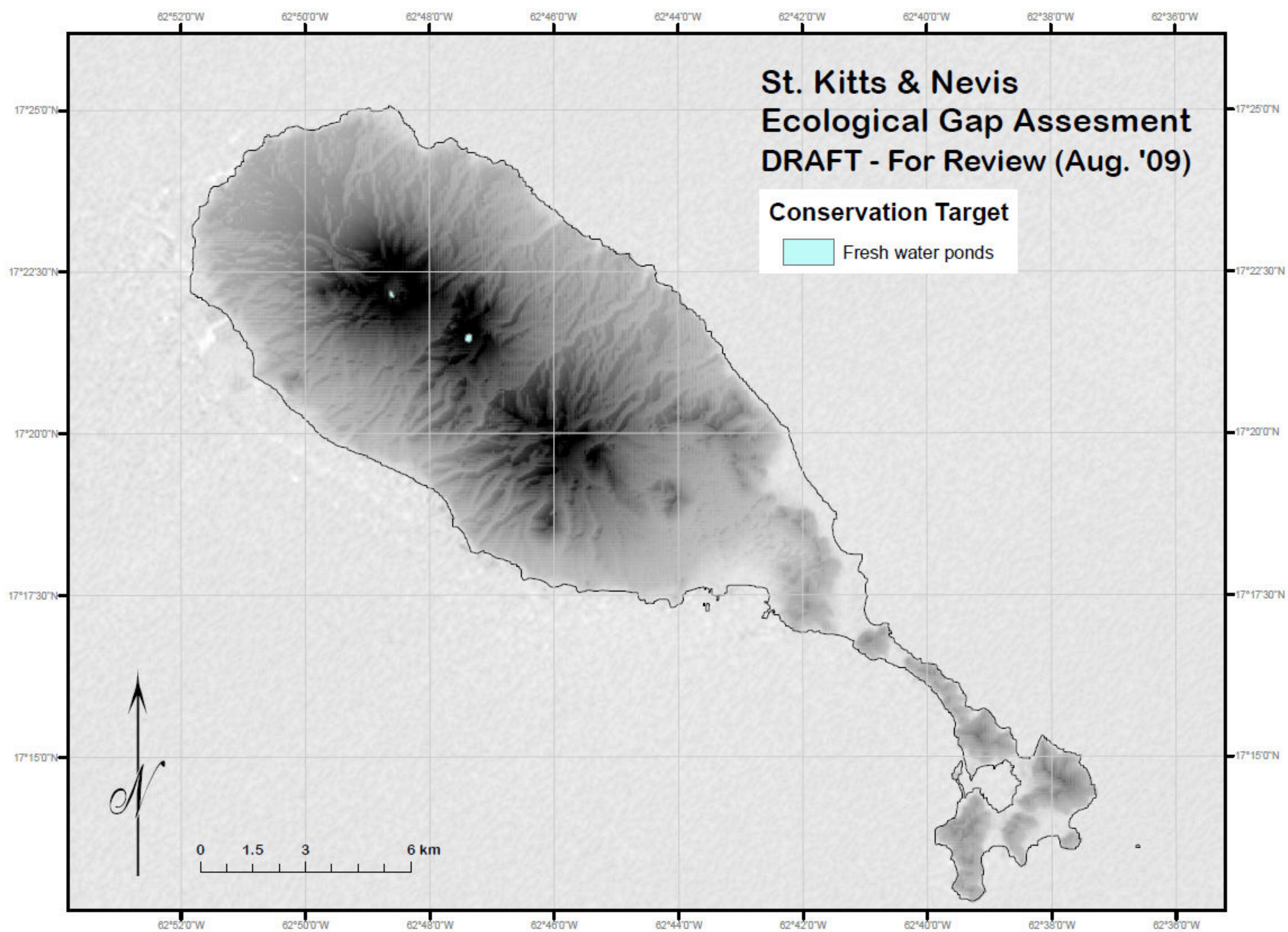


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Elfin sierra palm cloud forest
0
1.5
3
6 km
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N

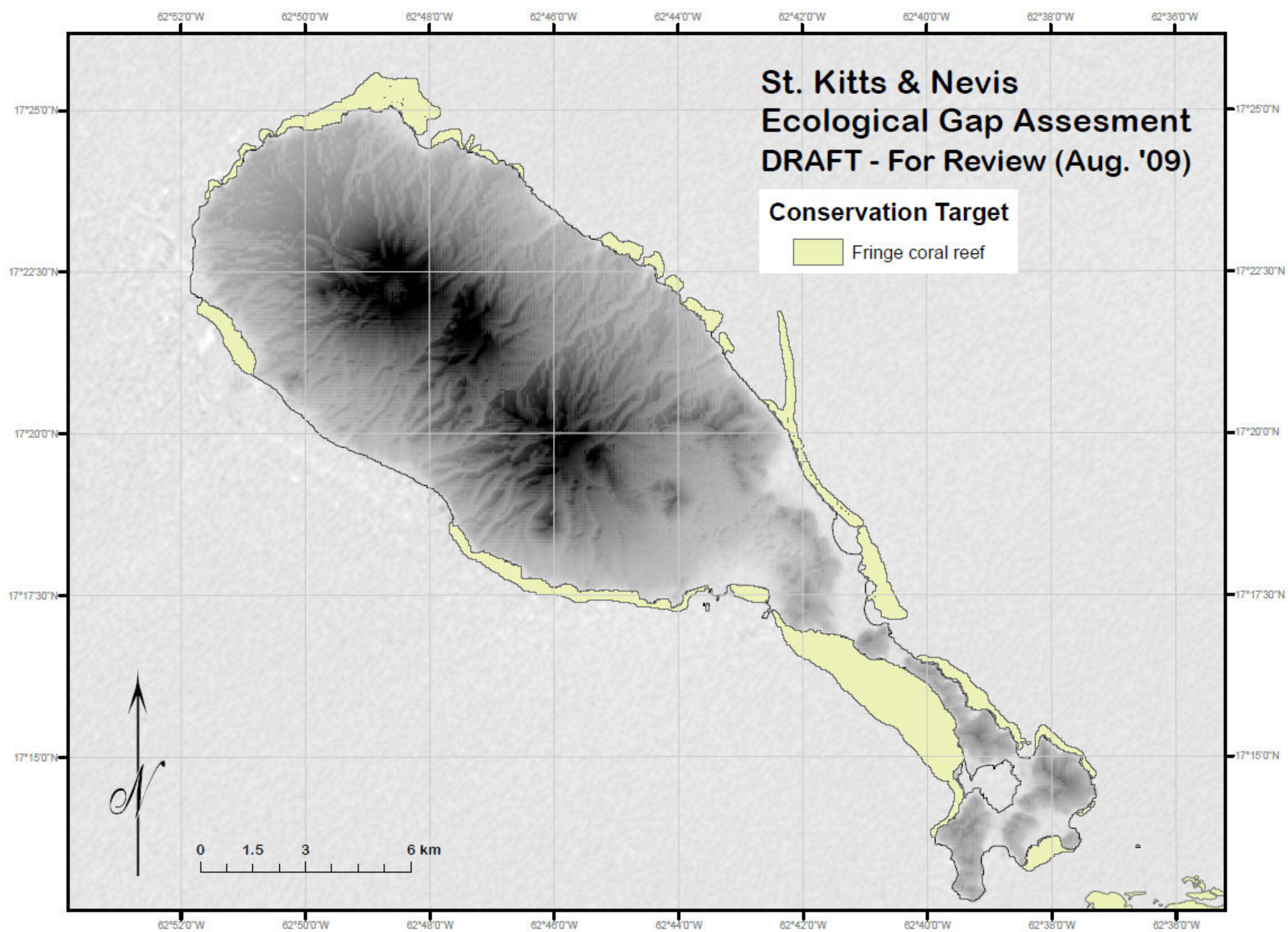

St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Emergent wetland
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N
0
1.5
3
6 km
N


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Evergreen forest with coconut palm
0 1.5 3 6 km
N
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N

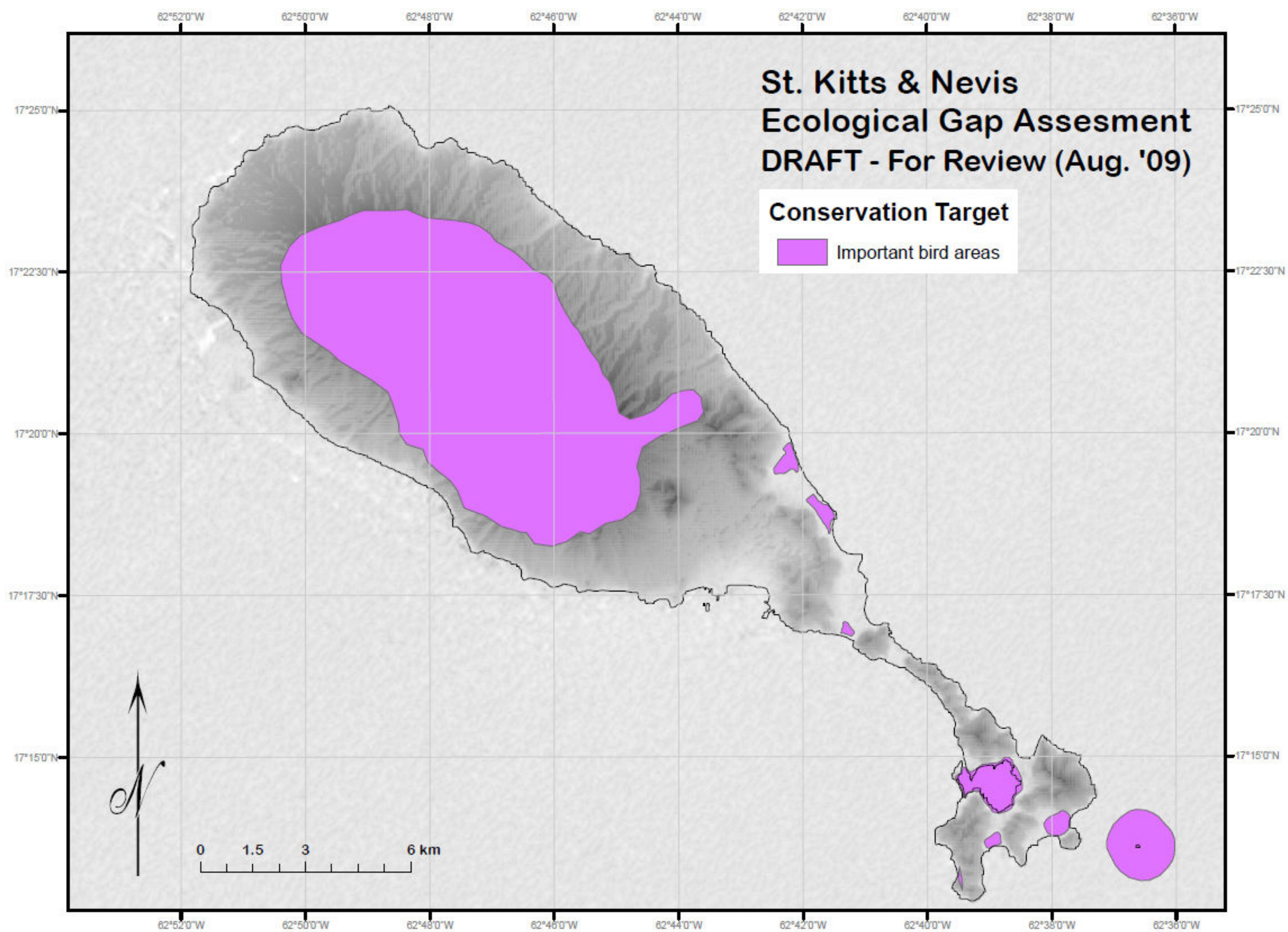

St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Evergreen forest sierra palm forest
0 1.5 3 6 km
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N
17°12'30"N



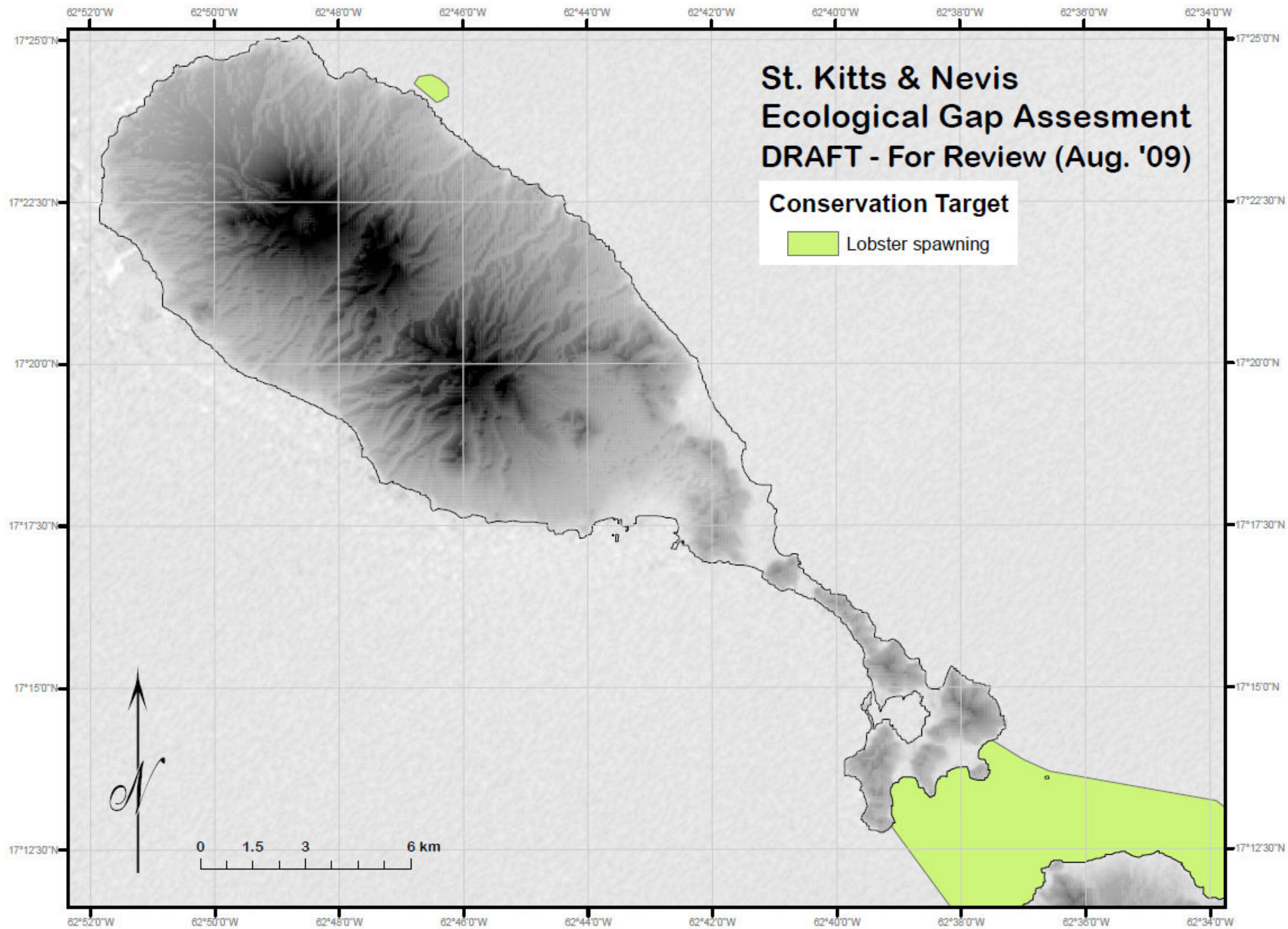
St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Fresh water ponds
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N
0
1.5
3
6 km
N

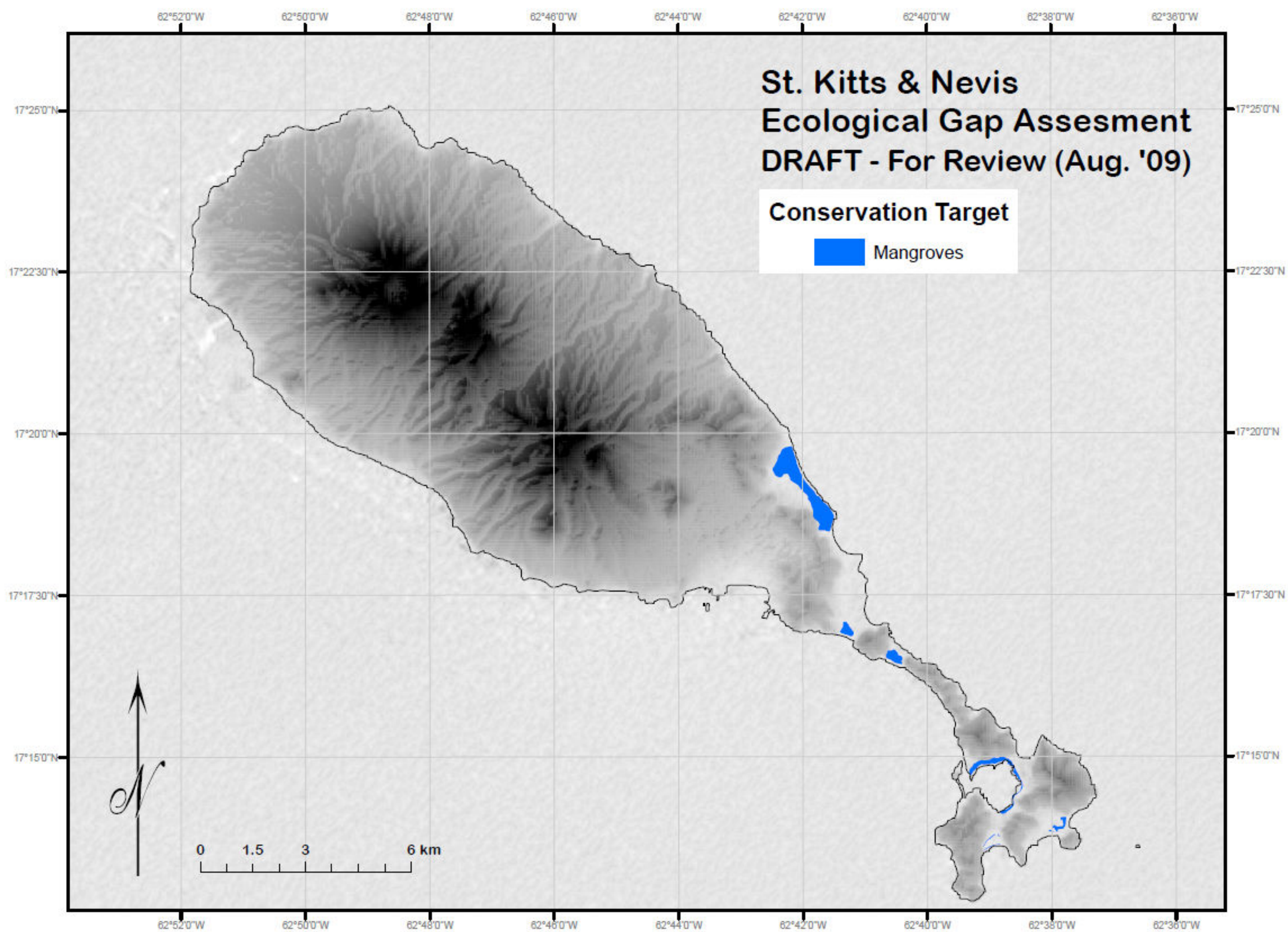


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Fringe coral reef
0
1.5
3
6 km
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N

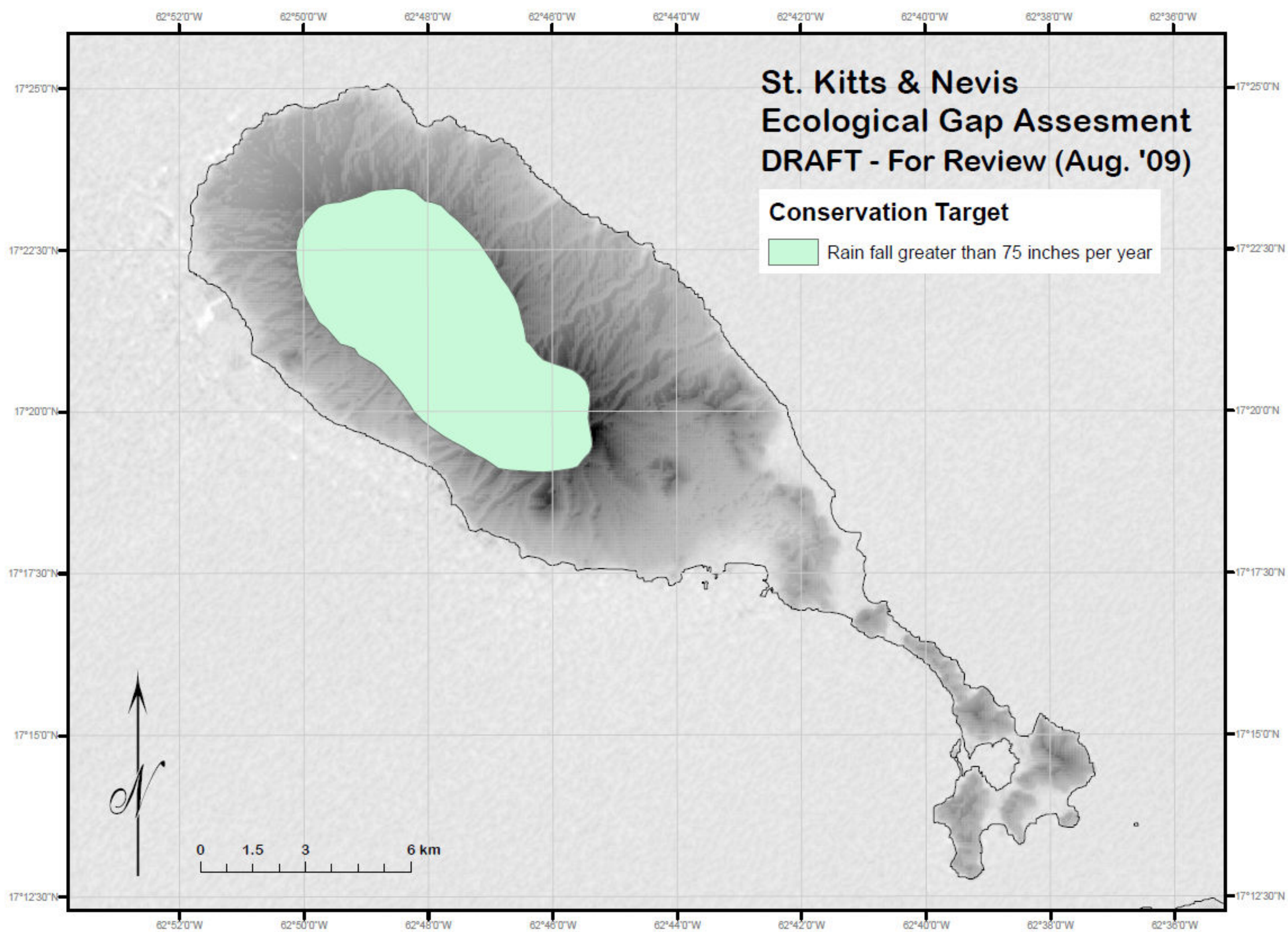


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Important bird areas
0 1.5 3 6 km
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N

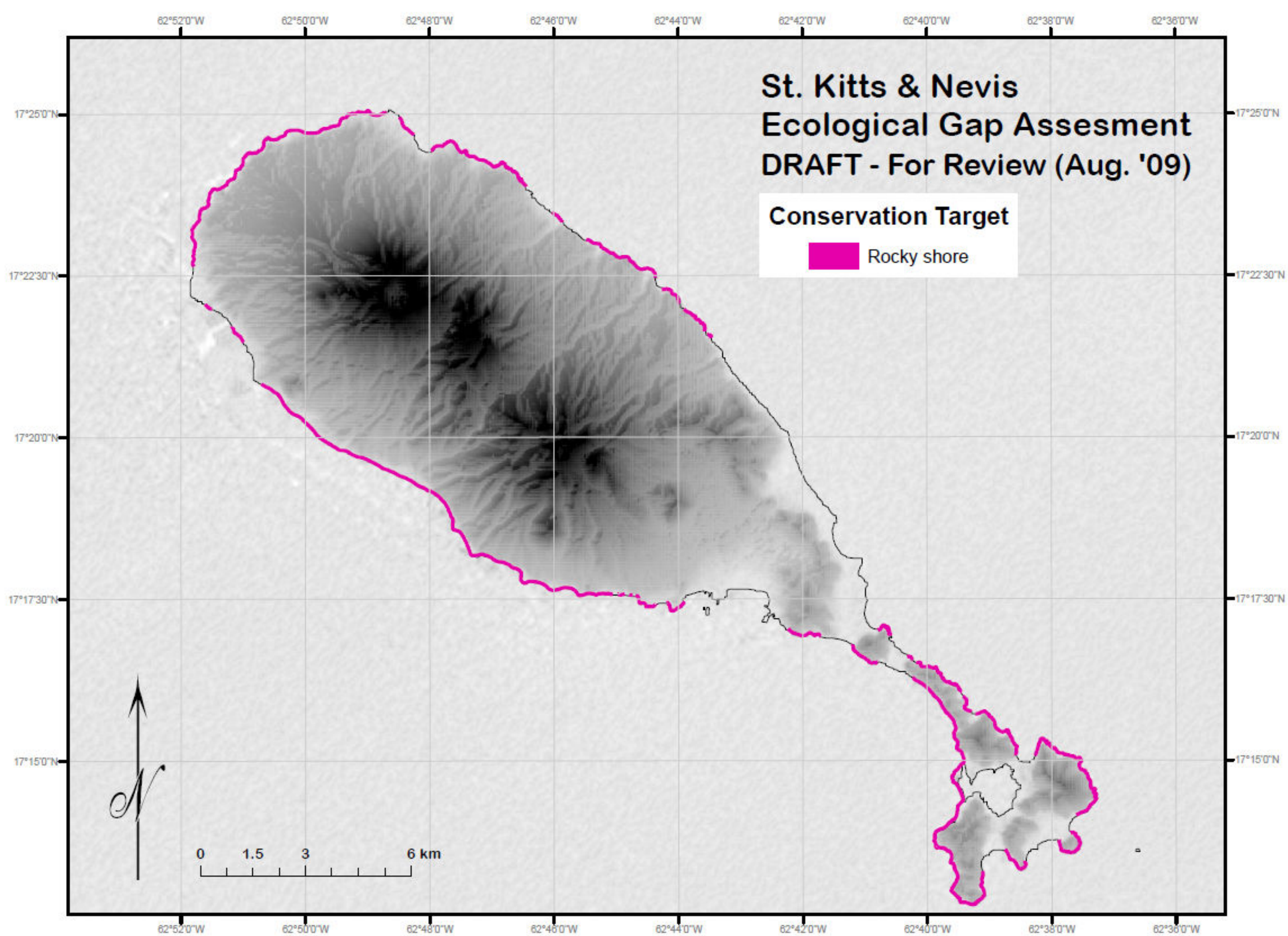

St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Lobster spawning
0
1.5
3
6 km
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
62°34'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N
17°12'30"N

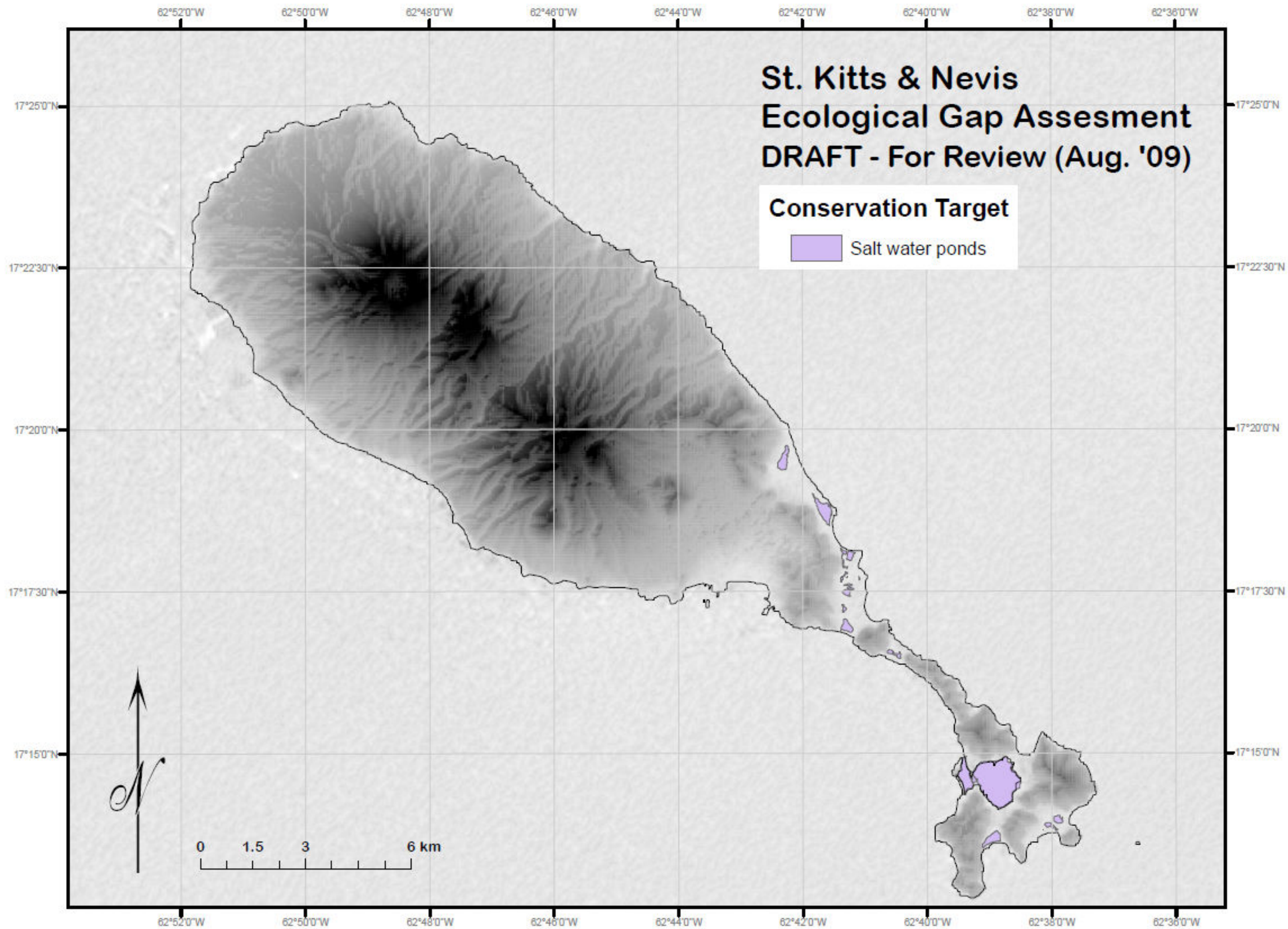


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Mangroves
0
1.5
3
6 km

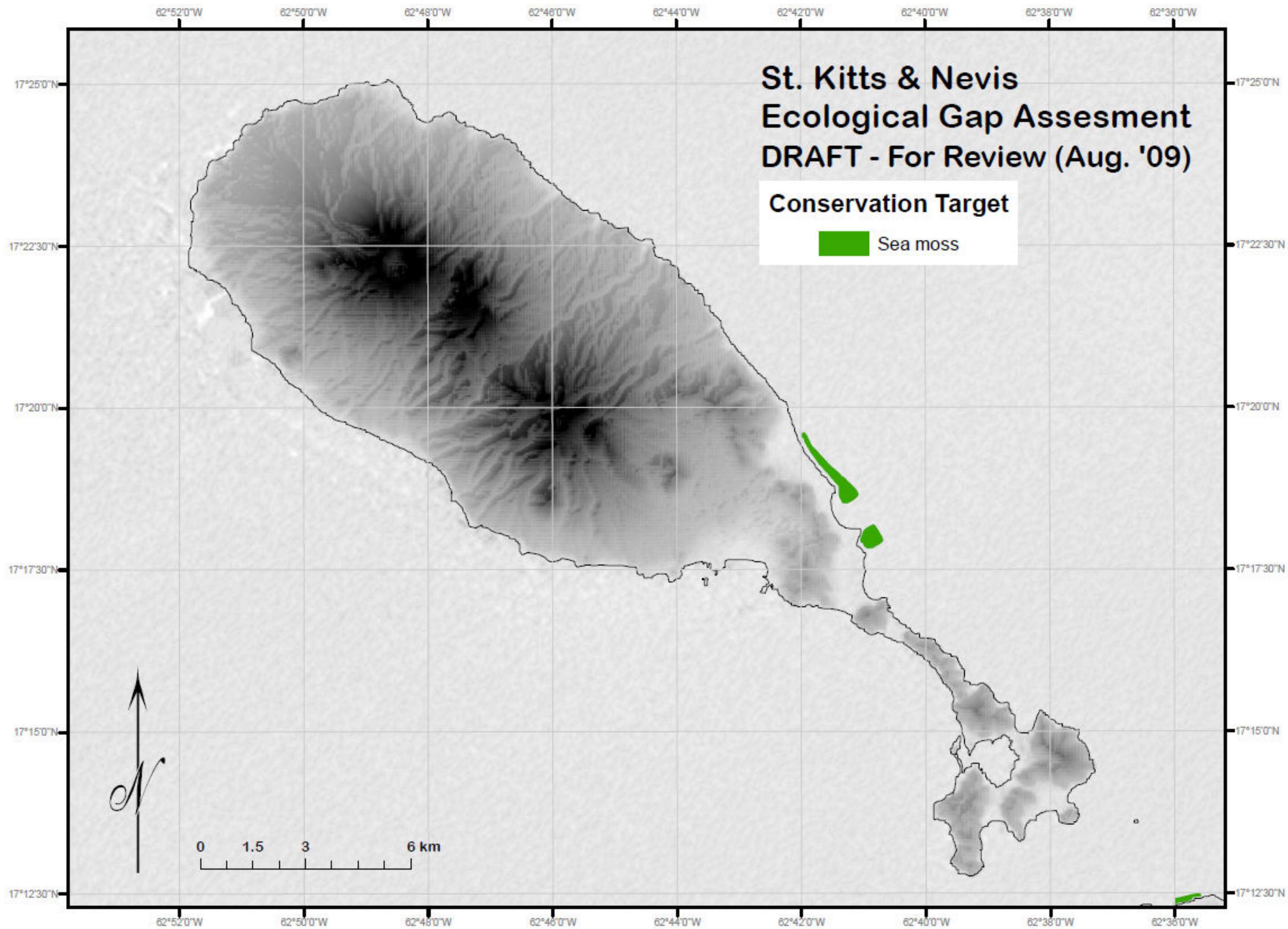


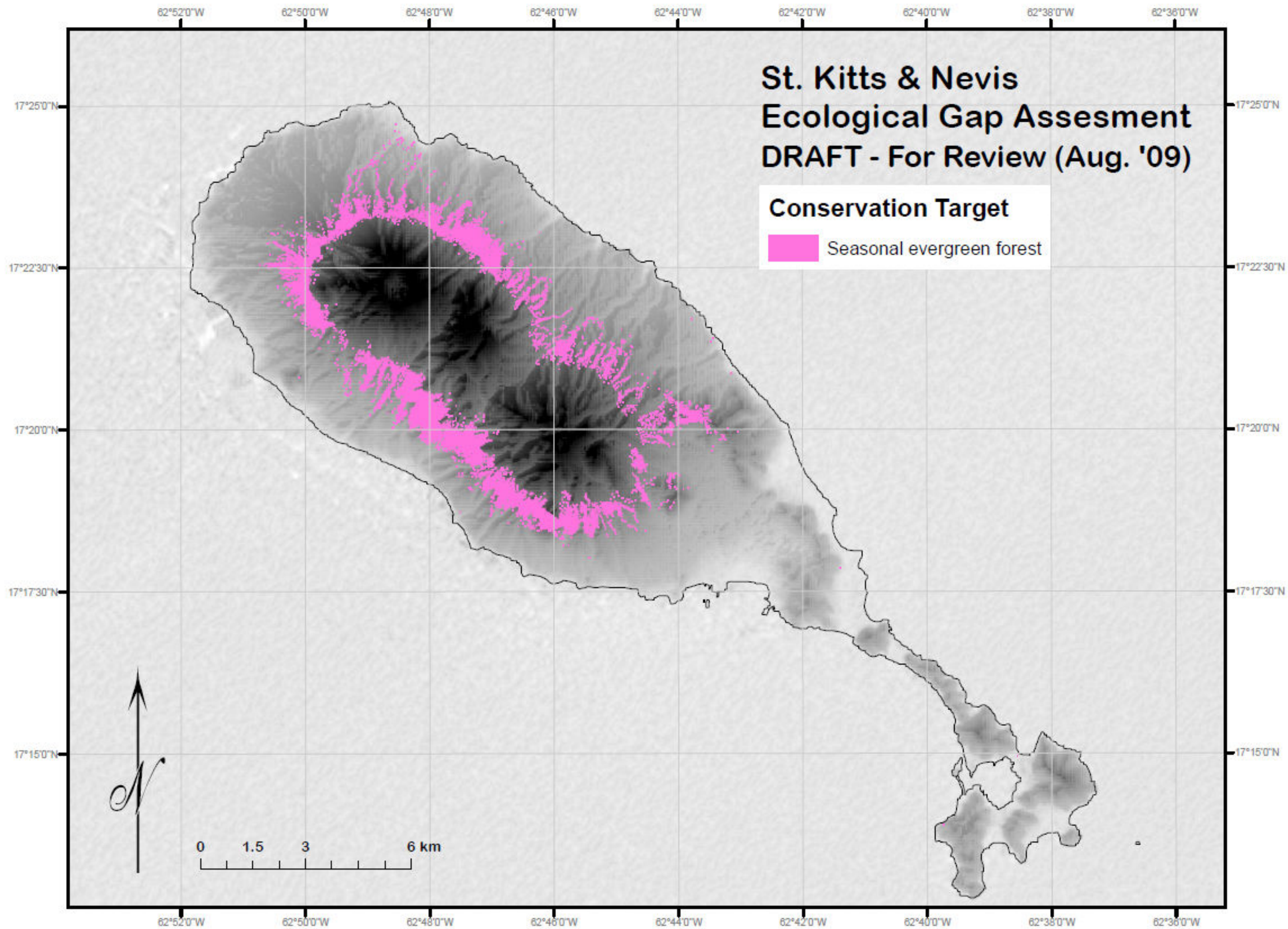
St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Rain fall greater than 75 inches per year
0
1.5
3
6 km
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N
17°12'30"N

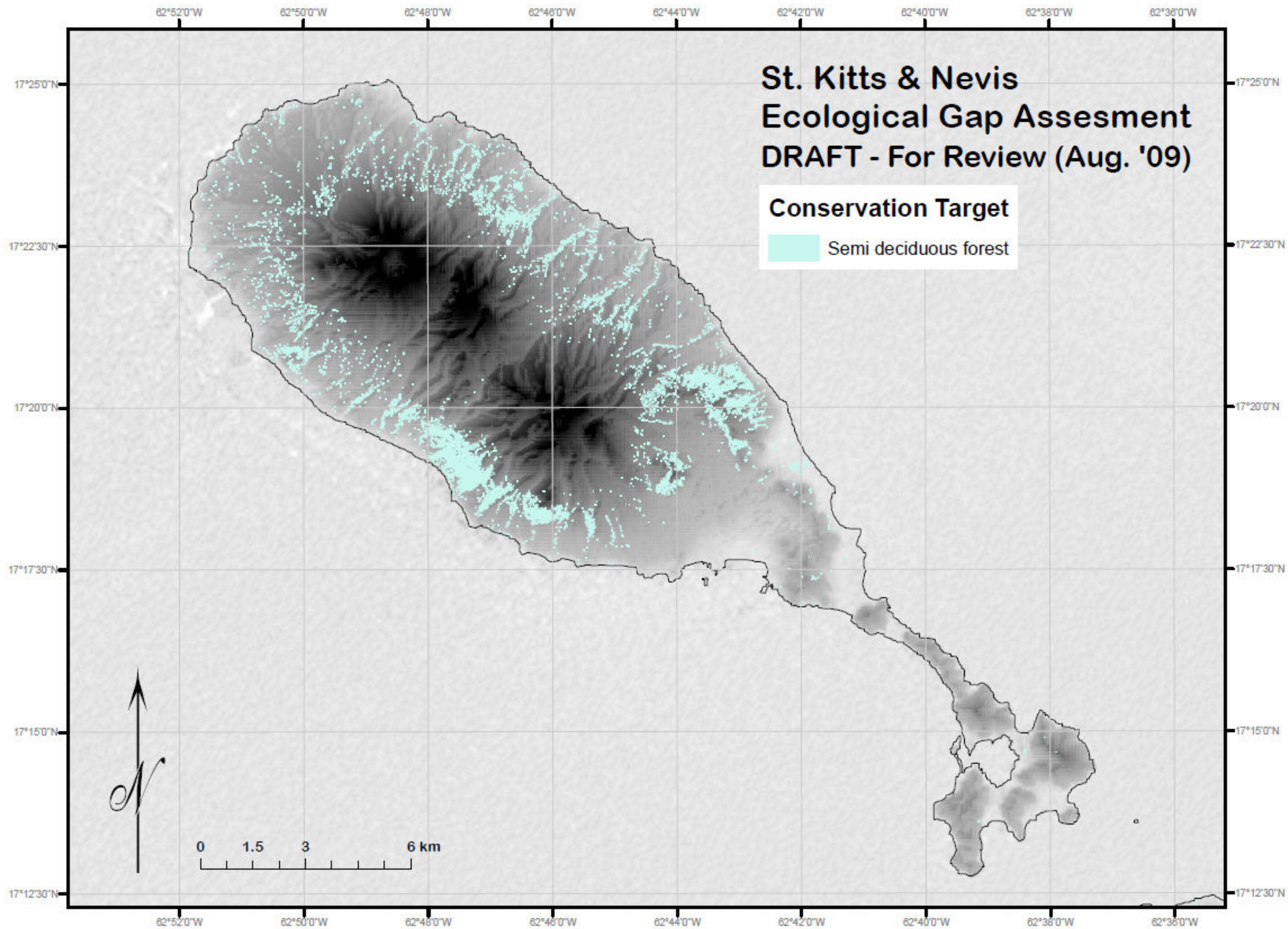

St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Rocky shore
0
1.5
3
6 km
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N

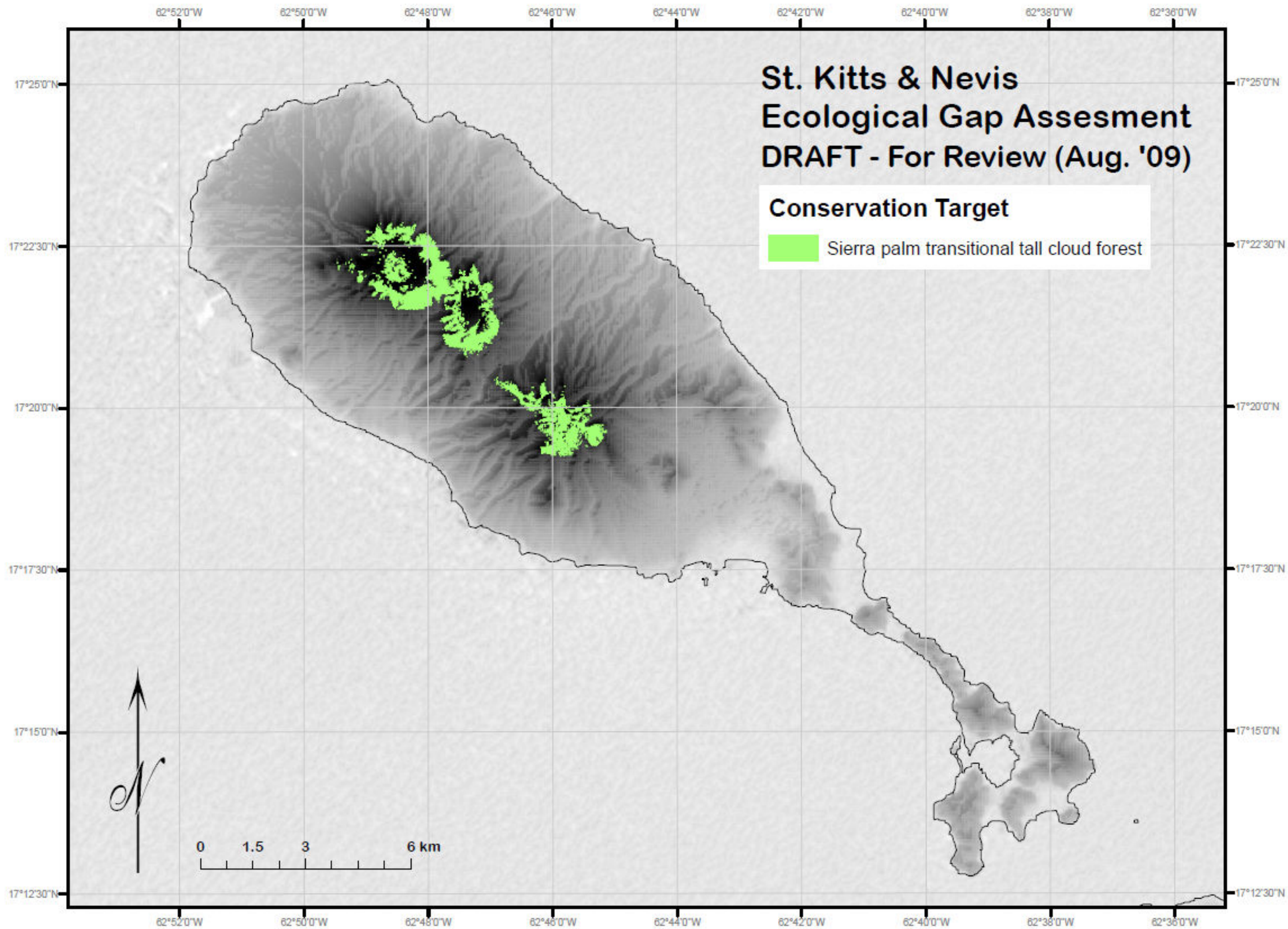


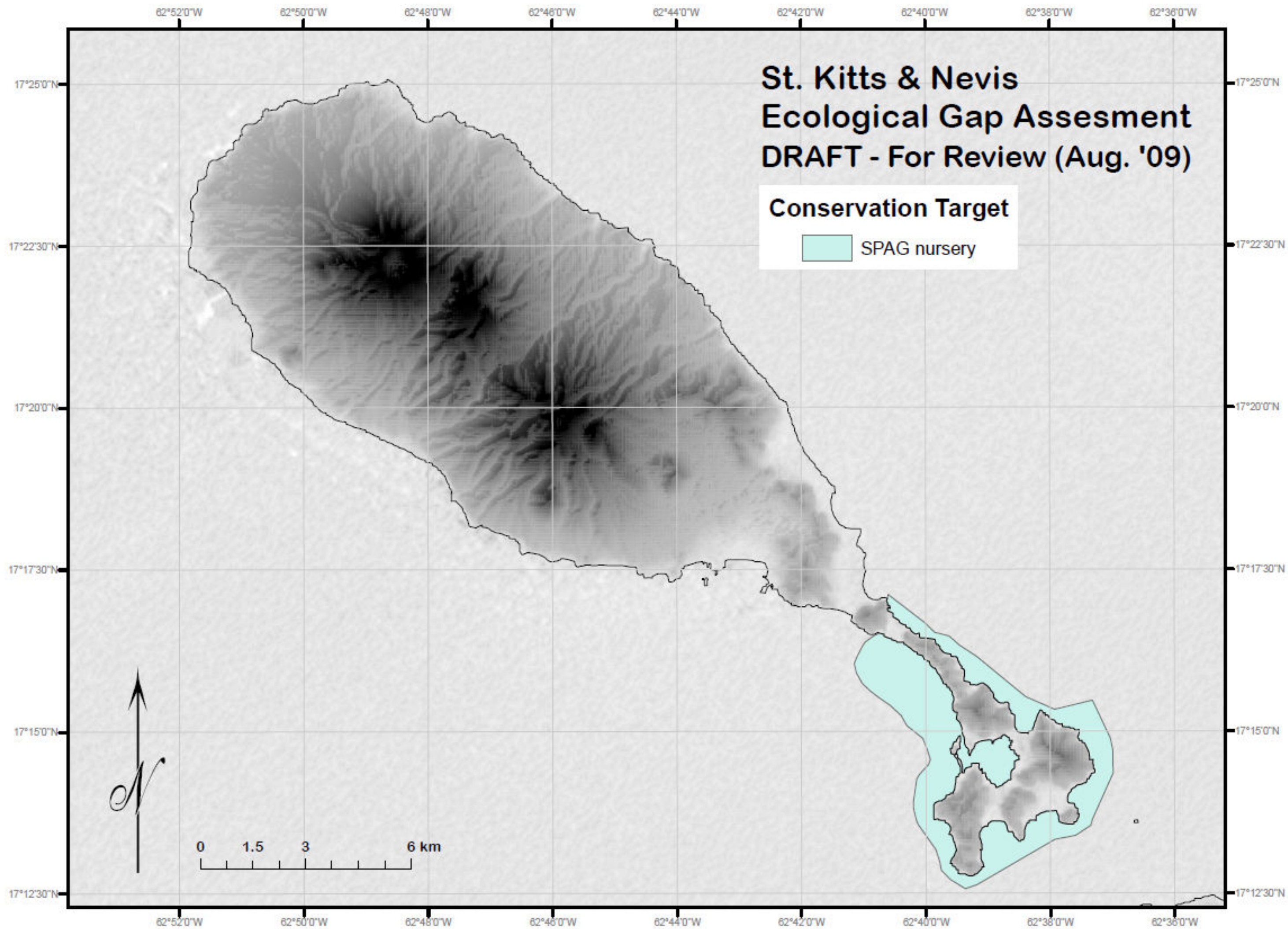
St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Salt water ponds
0
1.5
3
6 km
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Sea moss
0
1.5
3
6 km
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N
17°12'30"N


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Seasonal evergreen forest
0 1.5 3 6 km
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Semi deciduous forest
0
1.5
3
6 km
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N
17°12'30"N


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Sierra palm transitional tall cloud forest
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N
17°12'30"N
0
1.5
3
6 km


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
SPAG nursery
0
1.5
3
6 km
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
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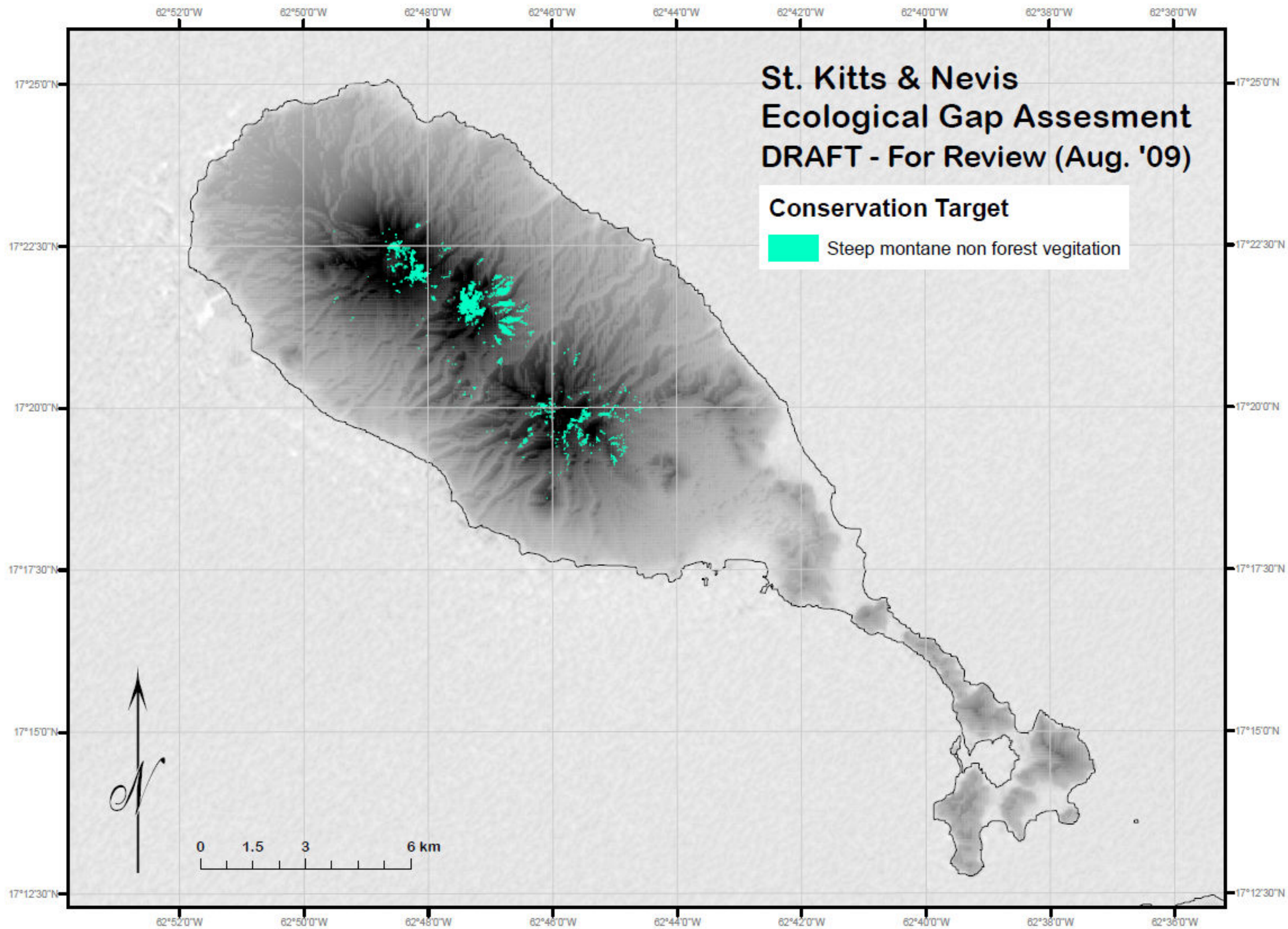
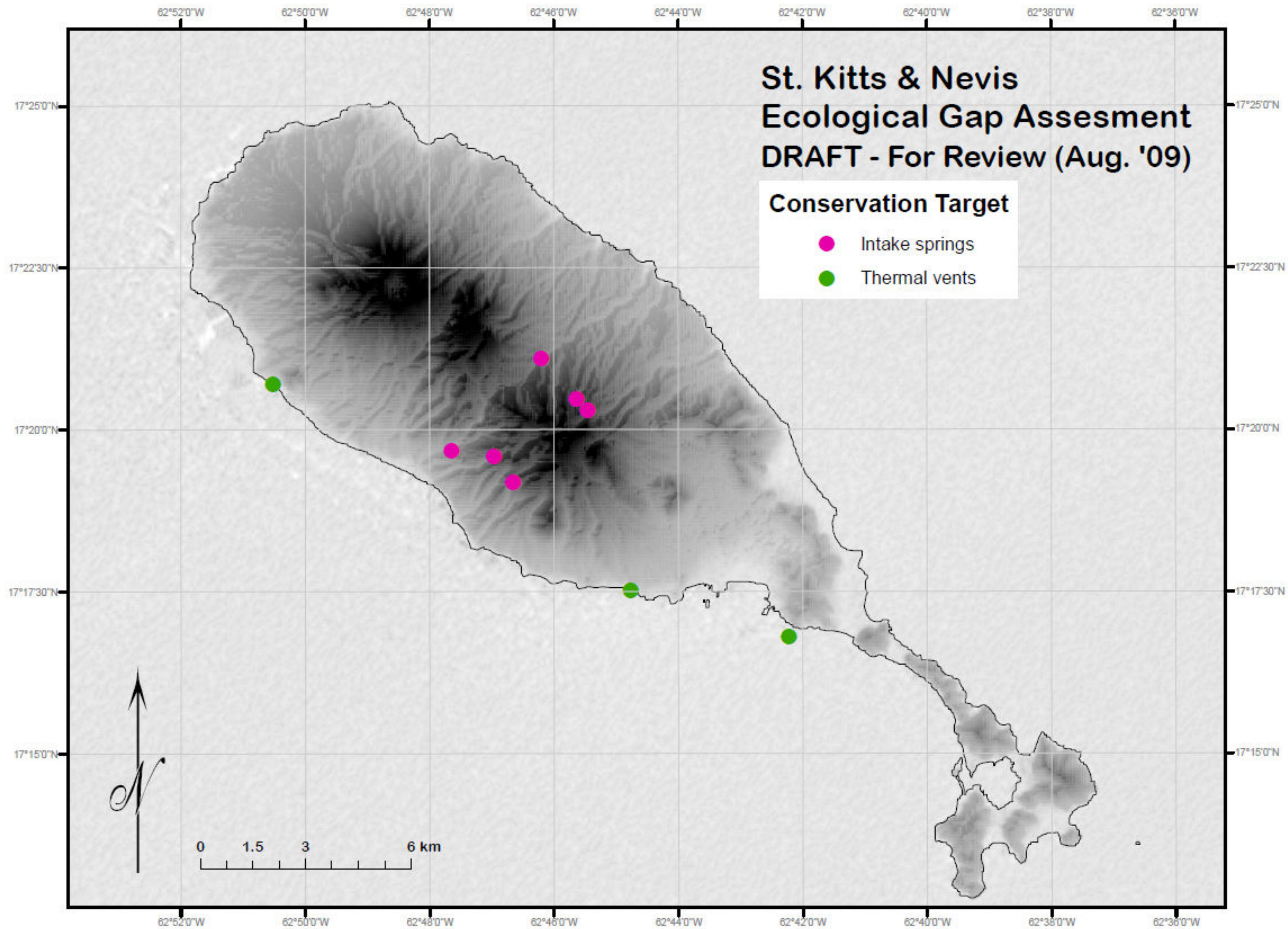
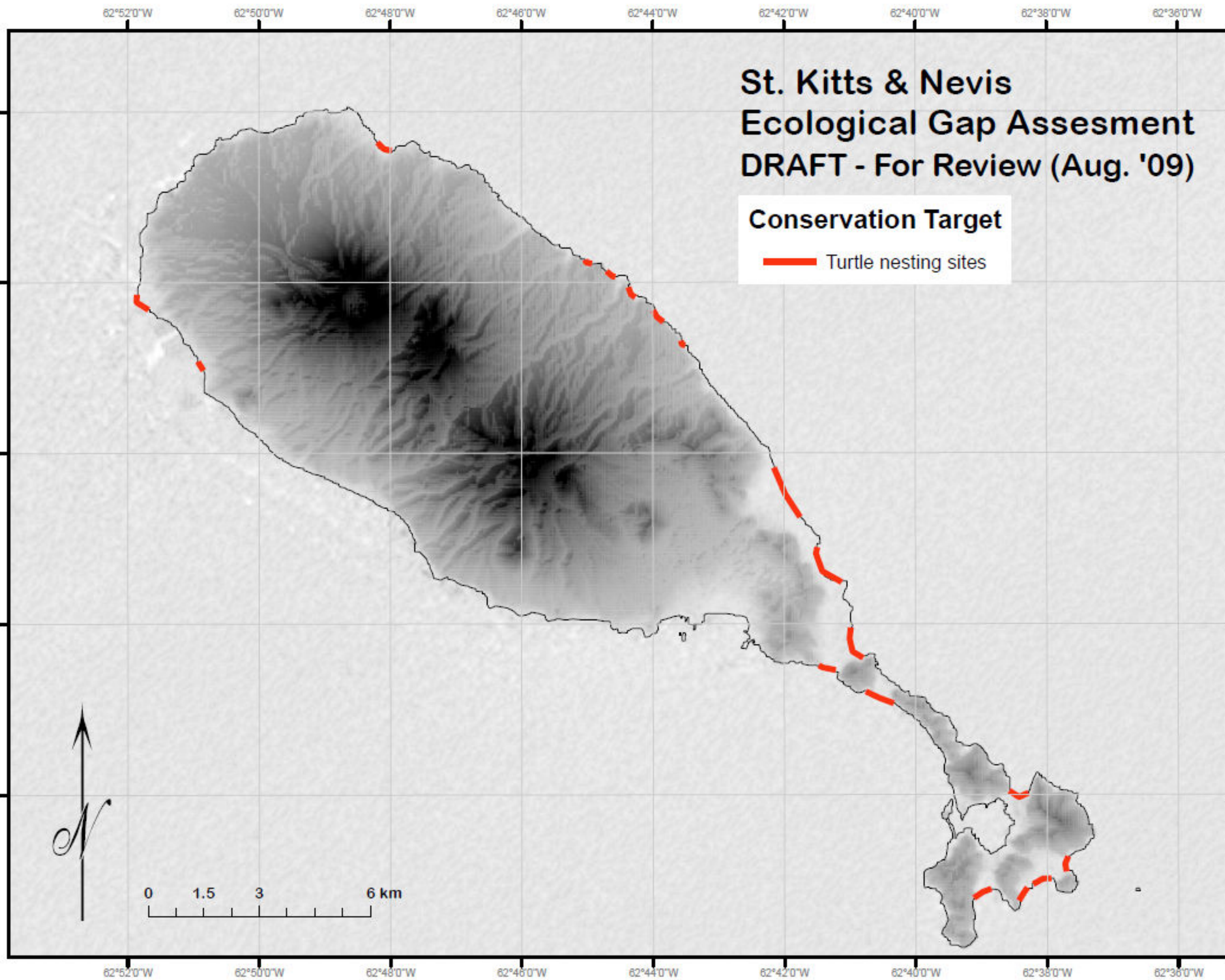
17°12'30"N


St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Steep montane non forest vegitation
0
1.5
3
6 km
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N
17°12'30"N



St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Intake springs
Thermal vents
0
1.5
3
6 km
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N



St. Kitts & Nevis
Ecological Gap Assesment
DRAFT - For Review (Aug. '09)
Conservation Target
Turtle nesting sites
62°52'0"W
62°50'0"W
62°48'0"W
62°46'0"W
62°44'0"W
62°42'0"W
62°40'0"W
62°38'0"W
62°36'0"W
17°25'0"N
17°22'30"N
17°20'0"N
17°17'30"N
17°15'0"N
0
1.5
3
6 km

APPENDIX III

ENVIRONMENTAL RISK SURFACE

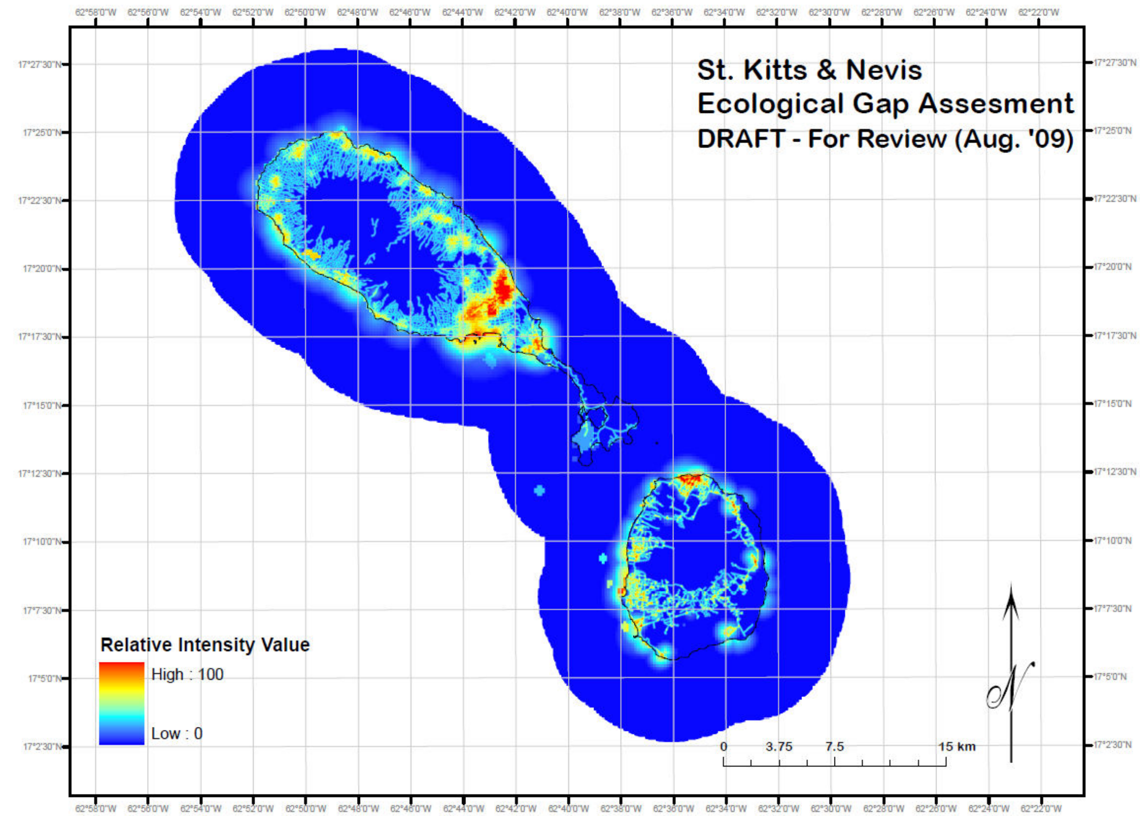
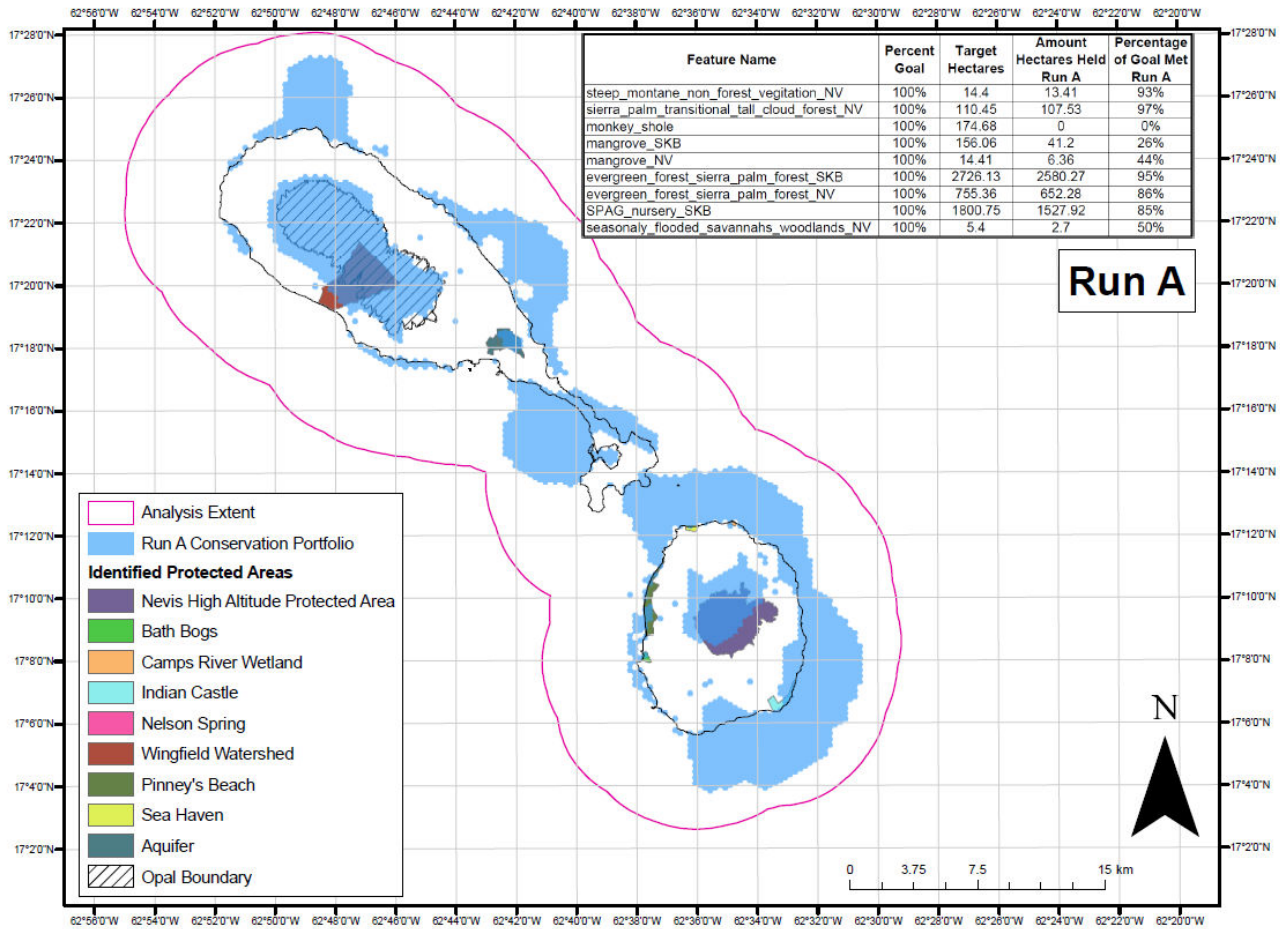


Figure 1. Environmental Risk Surface (ERS) model showing the "human footprint" of St. Kitts & Nevis. This model is the results of several GIS files that represent certain human activities that have been assigned intensity and influence distances (Table 2) and have been aggregated together. The darker red areas indicate higher levels of human activity.

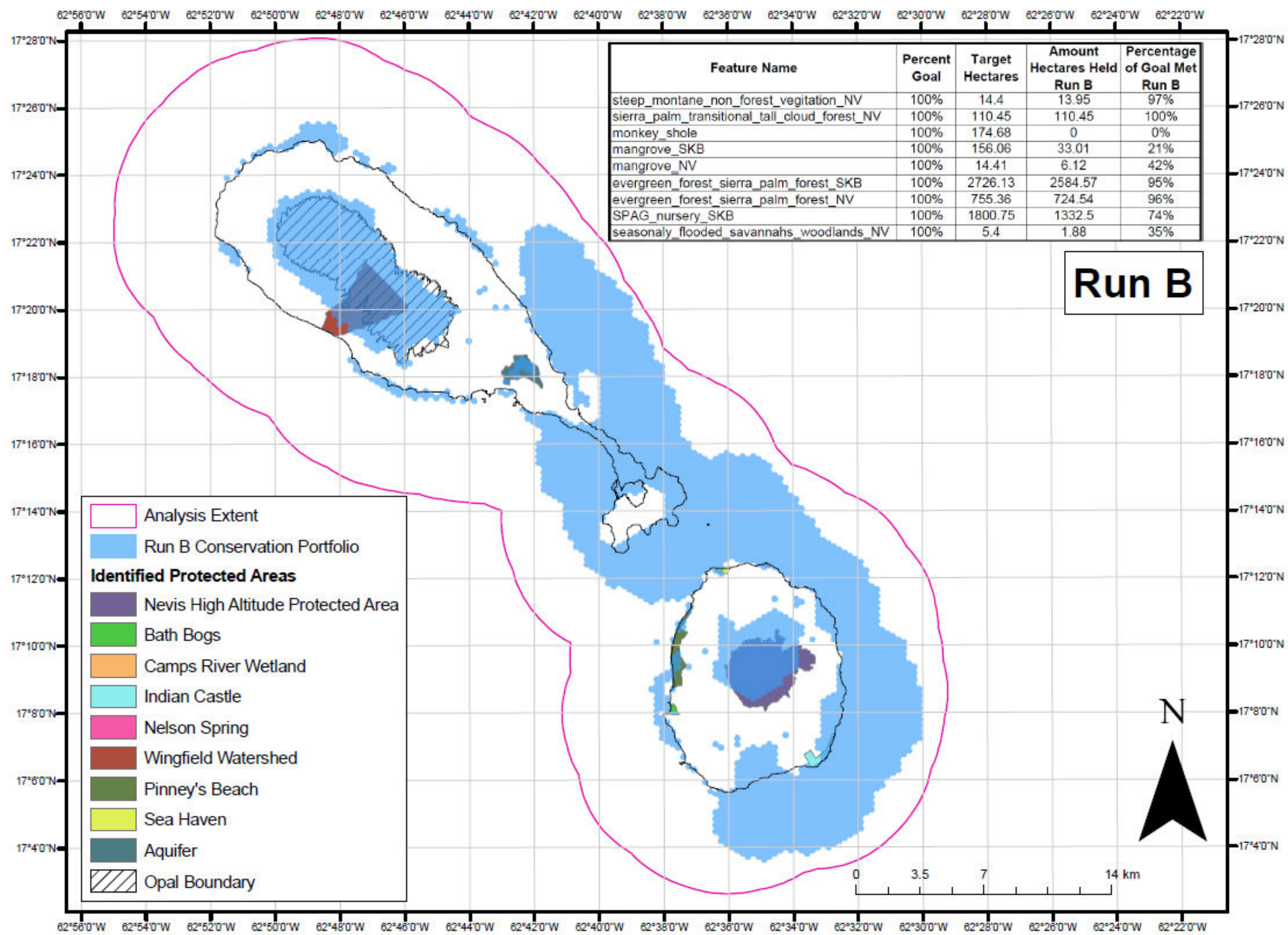
APPENDIX IV

MARXAN RESULTS



Feature Name	Percent Goal	Target Hectares	Amount Hectares Held Run A	Percentage of Goal Met Run A
steep_montane_non_forest_vegitation_NV	100%	14.4	13.41	93%
sierra_palm_transitional_tall_cloud_forest_NV	100%	110.45	107.53	97%
monkey_shole	100%	174.68	0	0%
mangrove_SKB	100%	156.06	41.2	26%
mangrove_NV	100%	14.41	6.36	44%
evergreen_forest_sierra_palm_forest_SKB	100%	2726.13	2580.27	95%
evergreen_forest_sierra_palm_forest_NV	100%	755.36	652.28	86%
SPAG_nursery_SKB	100%	1800.75	1527.92	85%
seasonaly_flooded_savannahs_woodlands_NV	100%	5.4	2.7	50%

Figure 1. Marxan output showing a solution performed relative to the set goals (Table 1). Inset table shows the target goals that were not met with this solution. Feature Name: Name of the target for which a goal is set; Goal: The desired level of representation for that conservation feature; Amount Held: The amount of that target captured in the reserve system; Percentage Goal Met: Percentage of the goal met.



Feature Name	Percent Goal	Target Hectares	Amount Hectares Held Run B	Percentage of Goal Met Run B
steep_montane_non_forest_vegitation_NV	100%	14.4	13.95	97%
sierra_palm_transitional_tall_cloud_forest_NV	100%	110.45	110.45	100%
monkey_shole	100%	174.68	0	0%
mangrove_SKB	100%	156.06	33.01	21%
mangrove_NV	100%	14.41	6.12	42%
evergreen_forest_sierra_palm_forest_SKB	100%	2726.13	2584.57	95%
evergreen_forest_sierra_palm_forest_NV	100%	755.36	724.54	96%
SPAG_nursery_SKB	100%	1800.75	1332.5	74%
seasonaly_flooded_savannahs_woodlands_NV	100%	5.4	1.88	35%

Figure 2 Marxan output showing a solution performed relative to the set goals (Table 1). Inset table shows the target goals that were not met with this solution. Feature Name: Name of the target for which a goal is set; Goal: The desired level of representation for that conservation feature; Amount Held: The amount of that target captured in the reserve system; Percentage Goal Met: Percentage of the goal met.

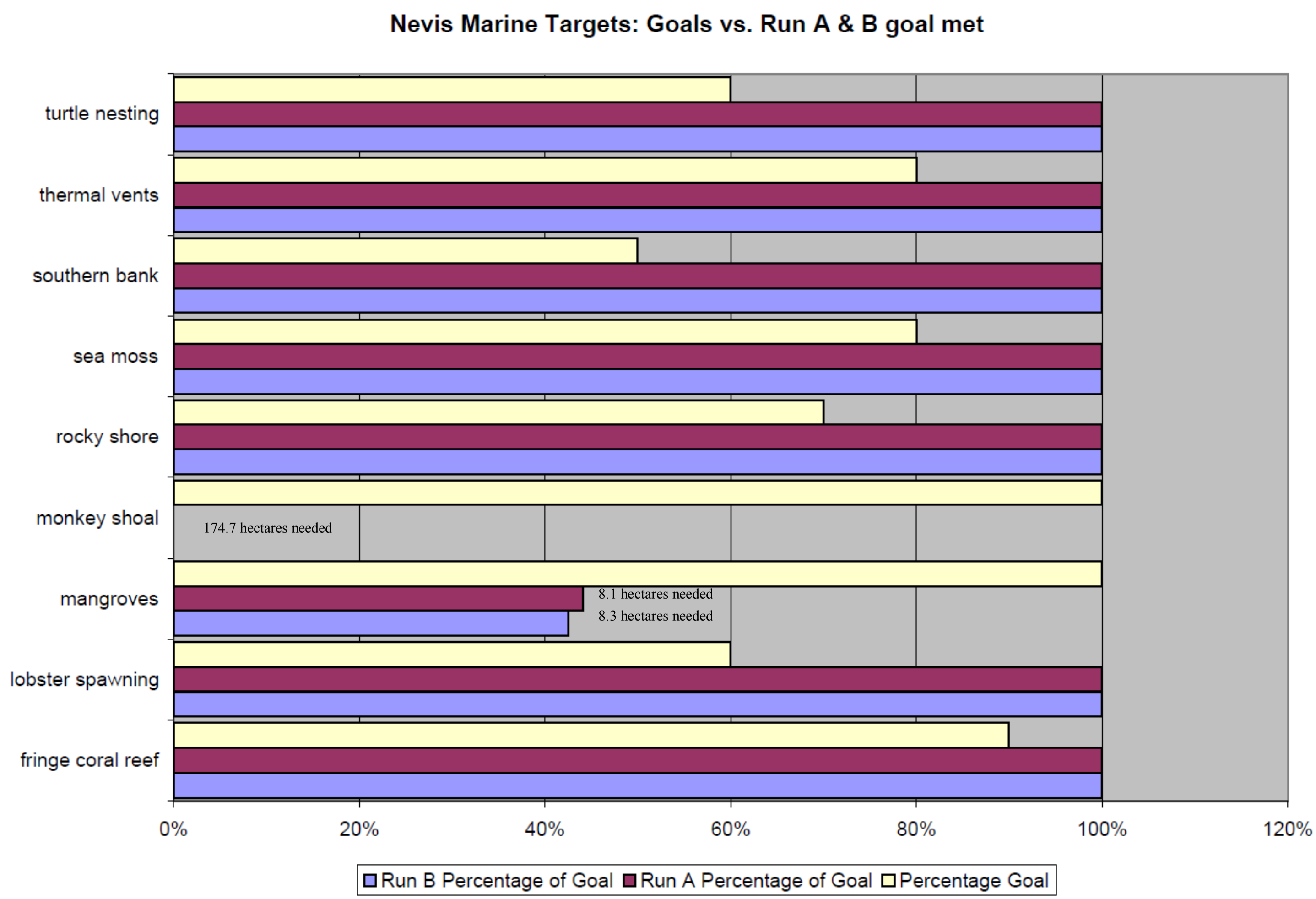


Figure 3. Graph indicating the target goal and the percentage of goal met for Run A and B for each marine target for Nevis. Where target goal was not met the number of hectares needed to reach goal is indicated.

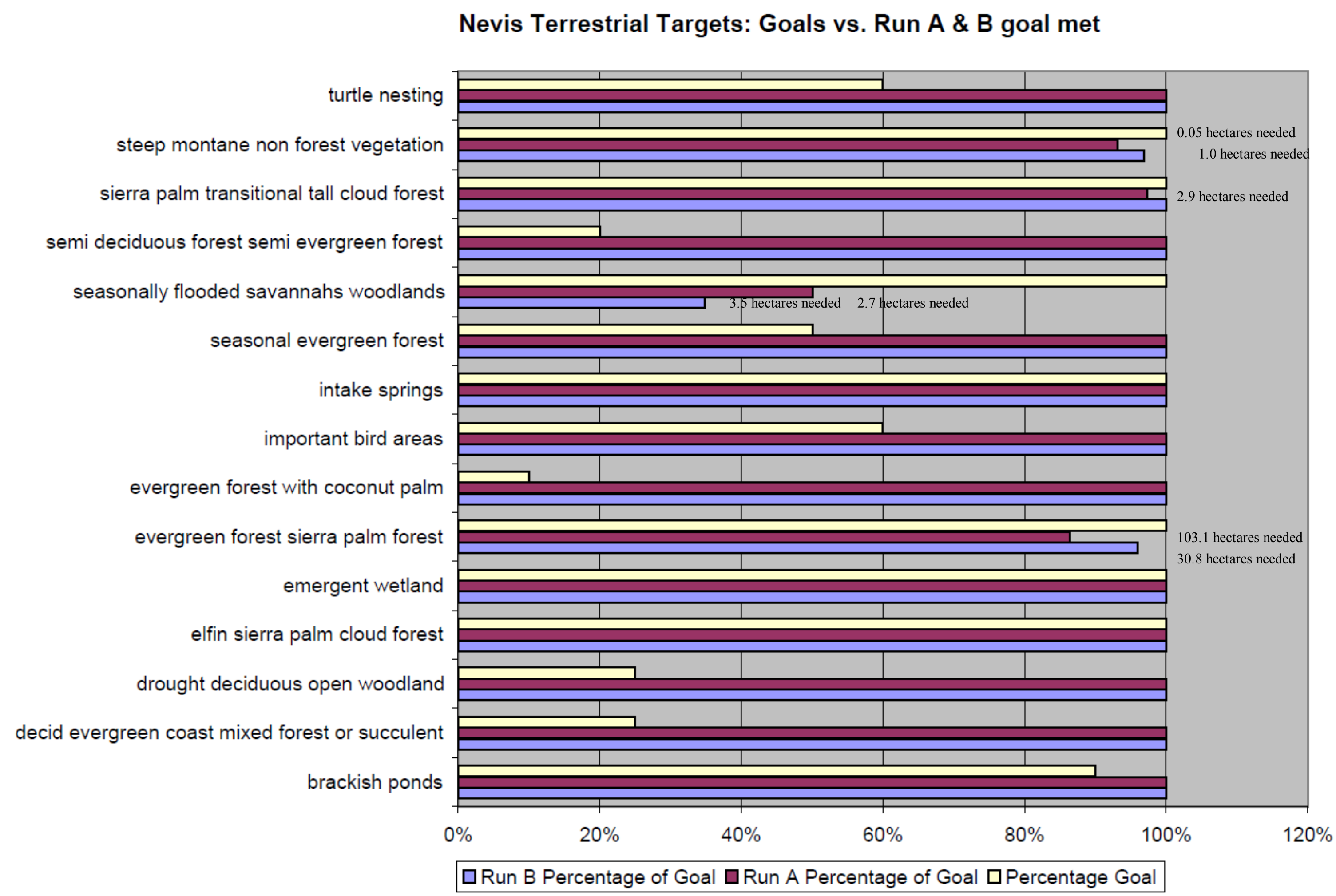


Figure 4. Graph indicating the target goal and the percentage of goal met for Run A and B for each terrestrial target for Nevis. Where target goal was not met the number of hectares needed to reach goal is indicated.

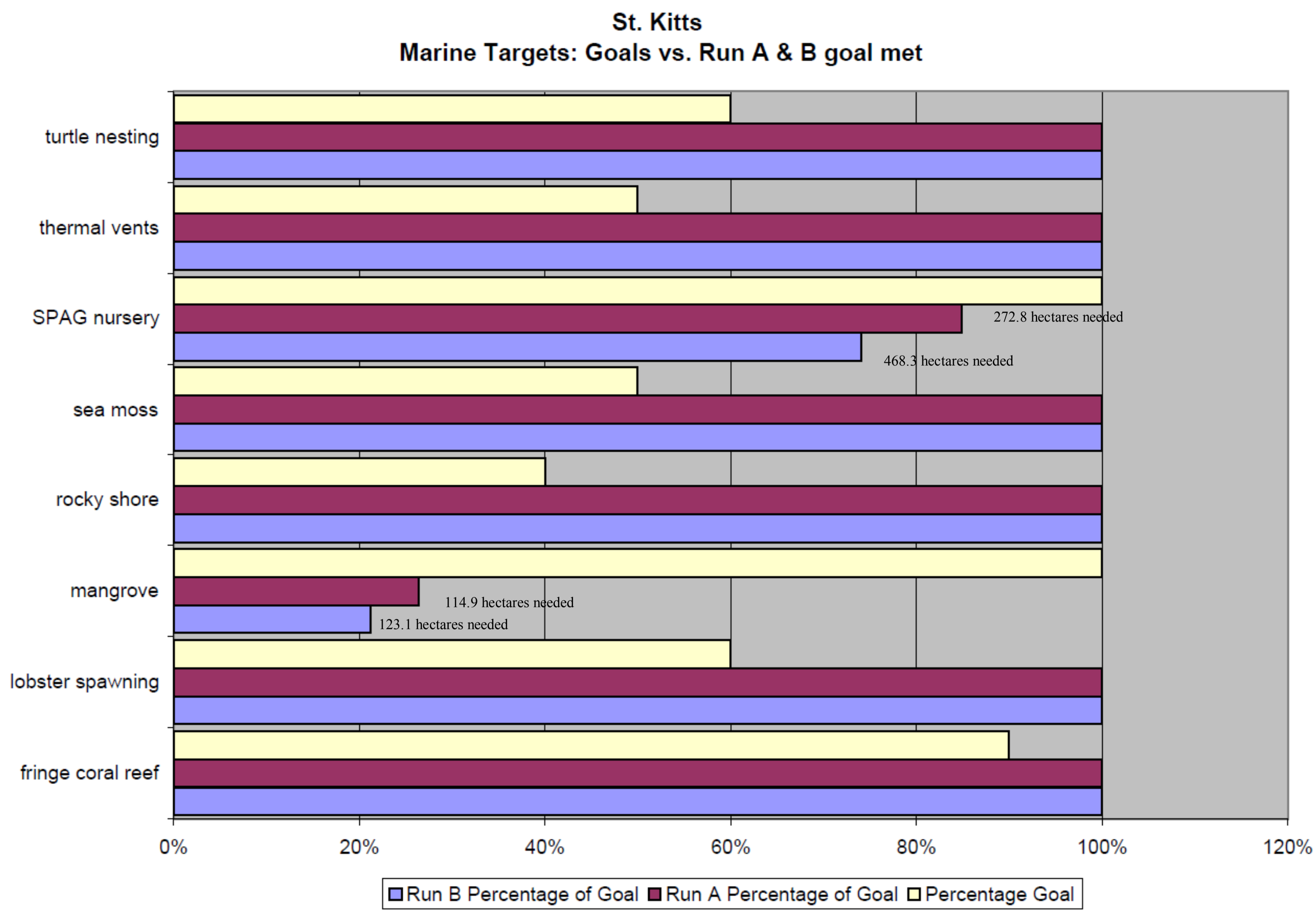


Figure 5. Graph indicating the target goal and the percentage of goal met for Run A and B for each marine target for St. Kitts. Where target goal was not met the number of hectares needed to reach goal is indicated.

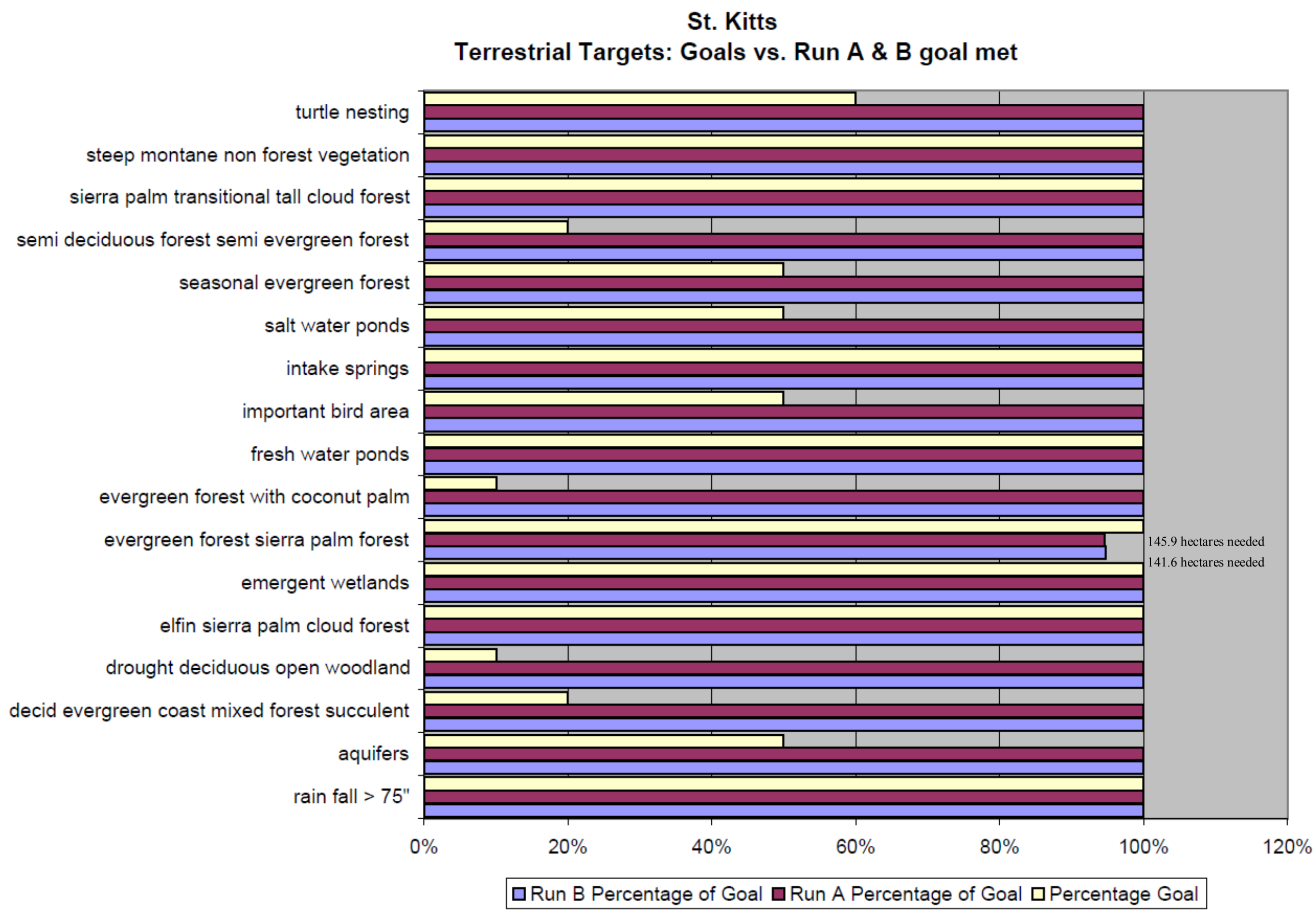


Figure 6. Graph indicating the target goal and the percentage of goal met for Run A and B for each terrestrial target for St. Kitts. Where target goal was not met the number of hectares needed to reach goal is indicated.