Labrador – Island Transmission Link

Furbearers and Small Mammals Component Study
Supplementary Report #2

Marten Habitat Potential Mapping
Northern Peninsula of Newfoundland

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1.0 INTRODUCTION AND STUDY PURPOSE

Nalcor Energy is proposing to develop the *Labrador – Island Transmission Link* (the Project), a High Voltage Direct Current (HVdc) transmission system extending from Central Labrador to the Island of Newfoundland's Avalon Peninsula. The environmental assessment (EA) process for the Project was initiated in January 2009 and is in progress. An Environmental Impact Statement (EIS) is being prepared by Nalcor Energy, which will be submitted for review by governments, Aboriginal and stakeholder groups and the public. In preparation for and support of the Project's EA, a series of environmental studies have been completed, including a *Furbearers and Small Mammals Component Study*, of which this Supplementary Report comprises a part.

The American marten (*Martes americana atrata*), also known as the pine marten or Newfoundland marten, is a small tree-dwelling carnivore and member of the weasel family (NL DEC 2010). It is one of 14 marten subspecies in Canada and exists only in insular Newfoundland, primarily in areas of Western Newfoundland (Little Grand Lake, Red Indian Lake, Georges Lake / Pinchgut Lake), the Northern Peninsula (Main River area), and Eastern Newfoundland (Terra Nova National Park, northern portion of the Bay du Nord Wilderness area) (NMRT 2010, See identified core areas, Figure 1.1).

The Newfoundland population of American marten is currently listed as *Threatened* under the Newfoundland and Labrador *Endangered Species Act* (NL ESA) and the federal *Species at Risk Act* (SARA). A Recovery Plan for the Newfoundland marten was released in 2010 (NMRT 2010). That Plan states that (p. ii):

> *Similar to most other North American populations, American marten in Newfoundland are strongly associated with forested habitats. Forest structure provides critical resources required for survival including concealment and escape routes from predators, denning and resting sites, and access to prey. Recent studies have demonstrated that marten will use forests across a range of height and canopy closure conditions, including areas disturbed by forest insects and mid-successional forest.*
>
> *The Newfoundland and Labrador Endangered Species Act allows for the identification and protection of critical and recovery habitat for a species at risk. Critical habitat for the American marten in Newfoundland was determined by combining marten occurrence data and information on habitat quality. The area meeting the selected criteria was 6208 km^2; figures depicting the occurrence of critical habitat across the island are provided in this document.*

The Recovery Plan therefore identifies and illustrates area of proposed critical habitat for marten in areas of Western, Northern and Eastern Newfoundland (Figure 1.1). This includes an extensive area of proposed critical habitat in the south-central portion of the Island's of Newfoundland's Northern Peninsula (Figures 1.1 and 1.2).

The identified transmission corridor (2 km wide study area) for the proposed Labrador – Island Transmission Link crosses through this area. This was unavoidable, given the sheer geographic extent of these identified marten habitat polygons, and because these habitats, in combination with Gros Morne National Park to the west and the Main River Provincial Park to the east, cover the entire width of the Northern Peninsula in this region. The overlap between the proposed transmission corridor and identified marten core areas and proposed critical habitats is illustrated in Figure 1.1, with the specific area on the Northern Peninsula that is the subject of this study shown in further detail in Figure 1.2.

Figure 1.1 Marten Core Areas and Important (Proposed Critical) Habitats on the Island of Newfoundland

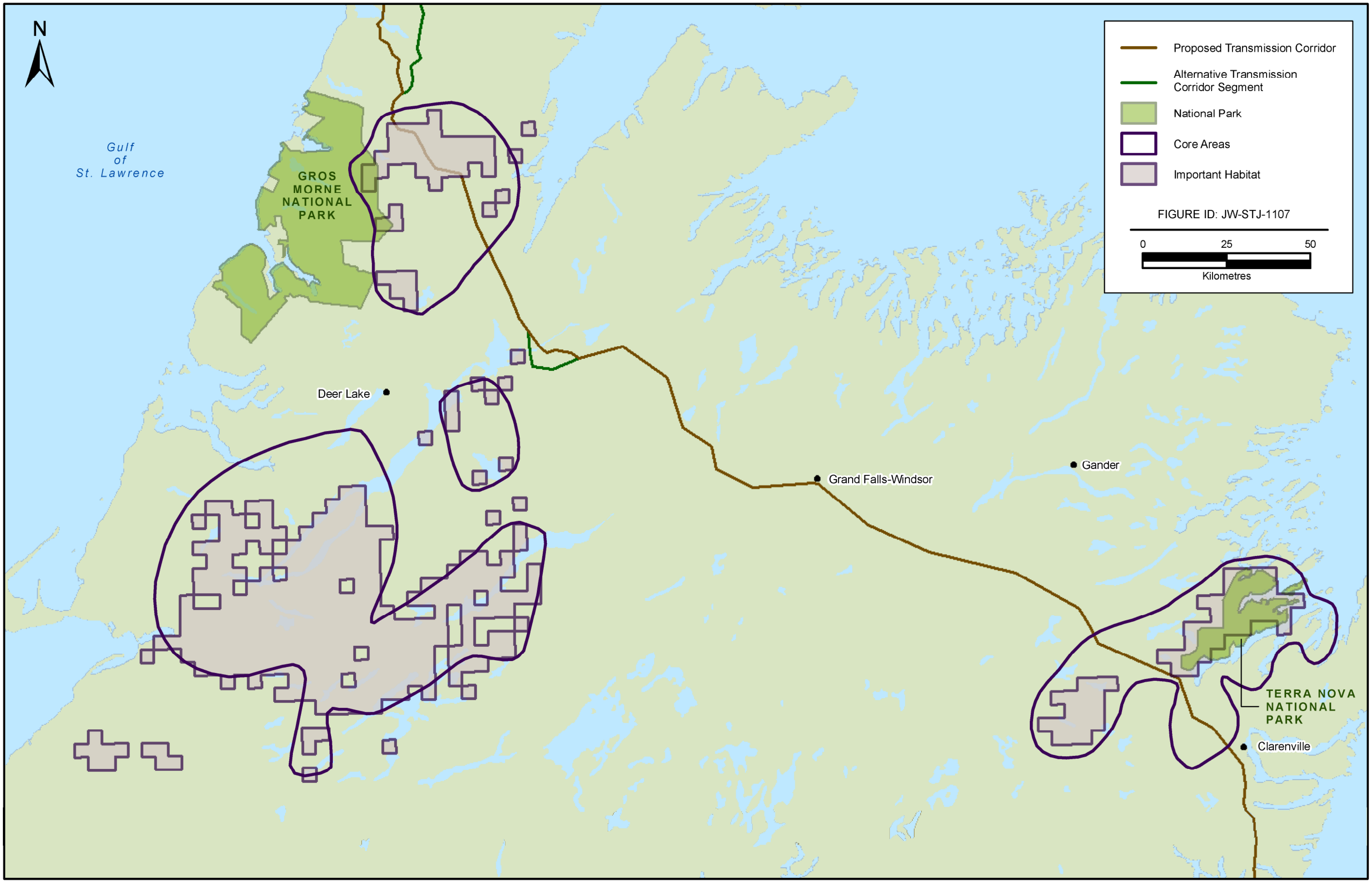
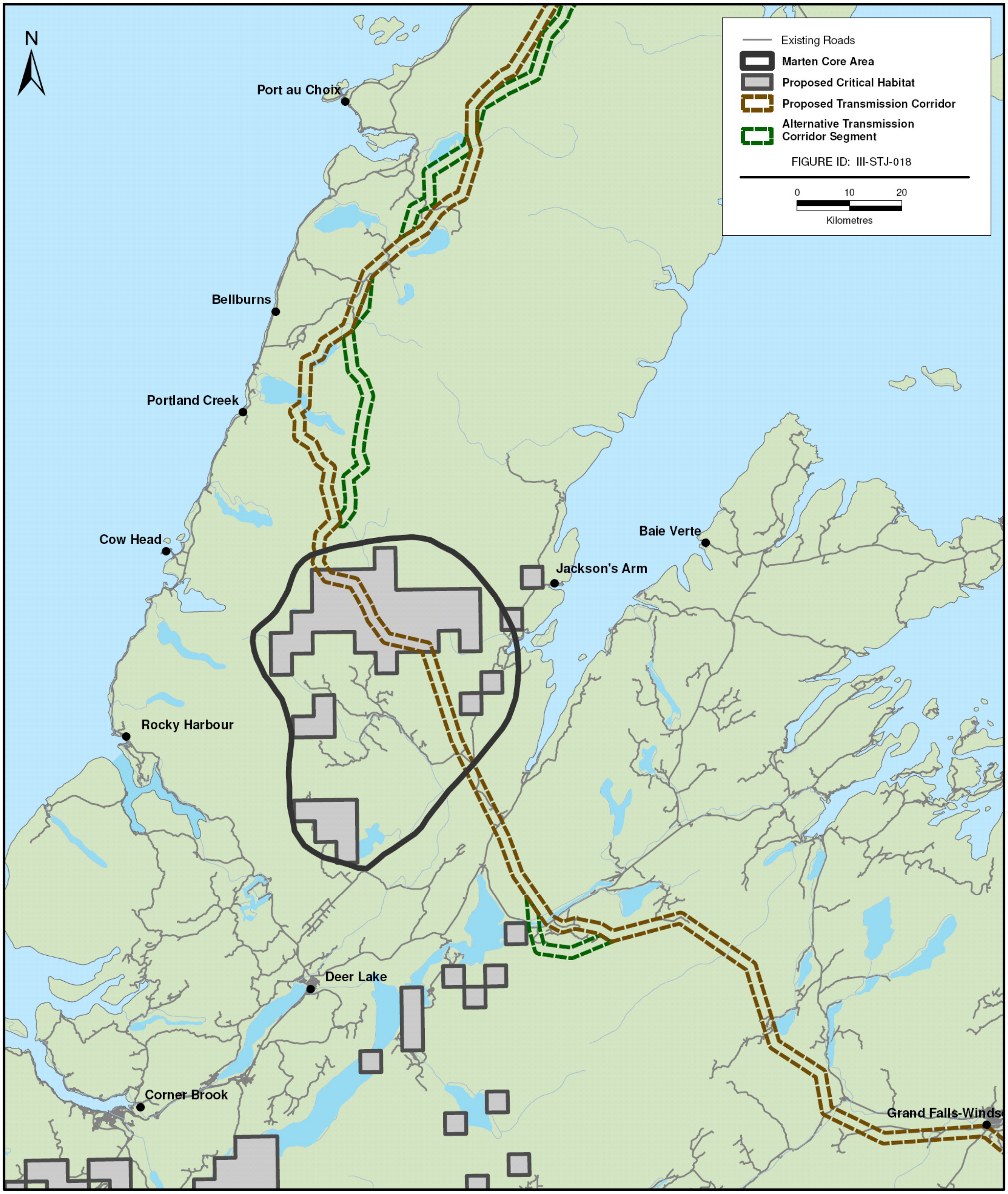


Figure 1.2 Marten Core Area and Proposed Critical Habitat on the Island of Newfoundland's Northern Peninsula



Clearly, the proposed critical habitat polygons illustrated in Figures 1.1 and 1.2 are comprised of a variety of forest types, tree cover and understory characteristics, types and levels of anthropogenic disturbance, and other characteristics, and therefore likely see varying degrees of use by, and potential importance for, marten.

Marten habitat use on the Island of Newfoundland was most recently examined by Hearn *et al.* (2010), who evaluated habitat selection by this species across landscapes composed of a range of habitat types. Their study found that at both the landscape and stand scales, adult resident marten utilized a broad range of habitat types, including recent cuts, regenerating forest, pre-commercially thinned stands, and mature and overmature forest, indicating that habitat selection by marten in Newfoundland is considerably more general than has traditionally been inferred. It is also important to recognize that while marten are willing to use several different habitat types, home range composition appears to require minimum amounts of high quality habitat (E. Herdmann, pers. comm.)

The objective of this study was therefore to use the detailed spatial imagery recently acquired by Nalcor Energy to map in detail the various forest habitat types and characteristics that occur within the transmission corridor segment that passes through the identified marten core area (55 km long corridor segment) and proposed critical habitat area (27.7 km long segment) on the southern end of the Island of Newfoundland's Northern Peninsula.

The various habitat types that were developed and used in this mapping exercise are based on those identified in the literature as being relevant to marten - either as potential or unlikely marten habitat - as well as the nature and resolution of the available spatial imagery.

It should be noted that this study does not assess or rate the potential relative importance of each forest habitat type for marten in this area. Rather it was intended to investigate and illustrate the presence and distribution of these forest habitat types across this portion of the proposed transmission corridor at a relatively fine scale and level of detail, as an information input into future Project design and planning - including the eventual selection of a specific cleared right-of-way for the proposed transmission line through this area.

2.0 STUDY METHODS AND HABITAT MAPPING RESULTS

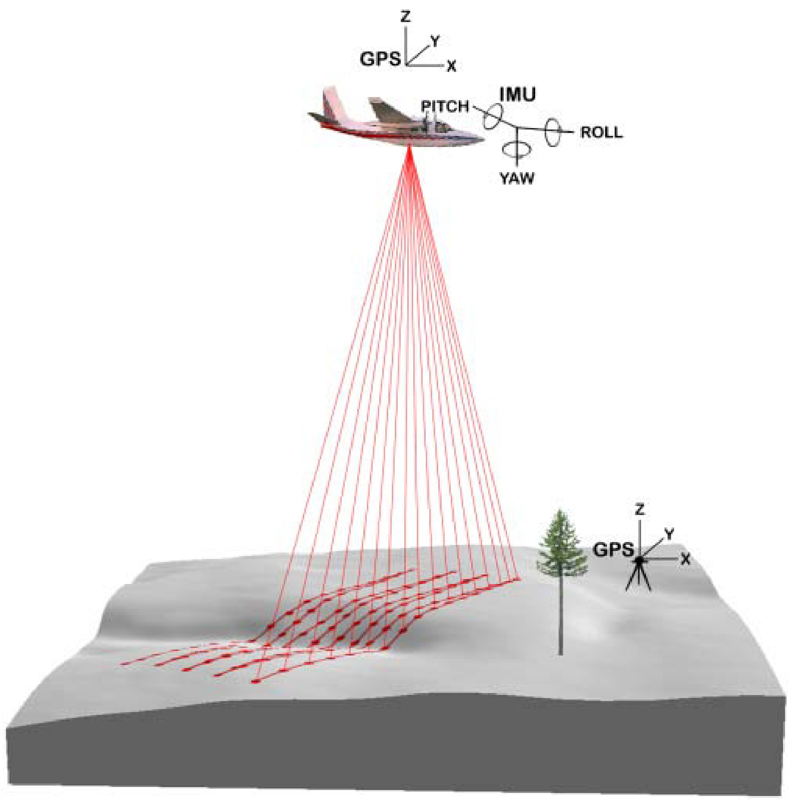
The following sections describe the spatial imagery and analytical and mapping methods that were used for this study, as well as presenting the marten habitat potential maps that resulted from this exercise. This study report was completed by **Steve Bonnell** and **Jackie Wells** of **Nalcor Energy**, with the mapping and associated methods write-up (Sections 2.1 – 2.4) completed by **Stephen Rowe** of **Integrated Informatics Inc**.

2.1 Spatial Imagery and Data Preparation

In 2010, Nalcor Energy contracted Terrapoint Inc. to acquire high resolution colour imagery and detailed light detection and ranging (LiDAR) data along the identified transmission corridor for the proposed Labrador – Island Transmission Link. The LiDAR data and digital imagery was obtained through an aerial survey of the proposed transmission corridor in the summer and early fall of 2010.

The LiDAR sensor on board the fixed wing aircraft sends out a dense swath of laser pulses along the study area, as shown below. The speed of the laser pulse is known and the time is measured for the pulse to hit a target and return to the sensor, and based on this information the distance from the sensor to the target for each return is calculated. The position of the aircraft was known at all times due to the presence of an inertial measurement unit that tracks the precise location and movement (roll, pitch and yaw) of the aircraft. Using this information the elevation of the ground surface and the height of features encountered by the returned laser pulses are calculated and are available as raw LiDAR point cloud data.

Simultaneous to the LiDAR data collection, colour digital imagery was also captured at a high resolution. The information collected by the inertial measurement unit was also used in the in the ortho-correction of the imagery. The imagery was delivered at a resolution of 0.2 m.



Schematic of Fixed Wing LiDAR Acquisition

Source: Fusion/LDV: Software for LiDAR Data Analysis and Visualization
Robert McGaughey; July 2010 – Fusion Version 2.90
United States Department of Agriculture – Forest Service

The raw LiDAR point cloud data were filtered and refined to a 1 m bare earth and full feature Digital Elevation Model (DEM) product. The data and imagery provided to Nalcor Energy were packaged into tiles to ensure that file sizes were manageable for use within a variety of software applications.

The bare earth and full feature DEM data were subsequently provided to Integrated Informatics Inc. for use in this study. The product was delivered in ASCII xyz format and converted to ESRI grid format using the ArcGIS Spatial Analyst extension. The 1 m point locations were translated to a 1 m grid resolution DEM. The data was delivered using 13 individual tiles. The tiles were combined into one seamless mosaic for the purpose of display and analysis.

The digital ortho-imagery was provided in an uncompressed GeoTIFF format. The imagery was delivered using 13 individual tiles. The tiles were combined into one seamless mosaic for the purpose of display and for use in the supervised land cover classification.

The raw point cloud data was useful in determining a range of vegetation characteristics. Metrics such as canopy closure estimates and tree density can be derived using LiDAR point data. For the purpose of this study canopy cover estimates were required. A software package called FUSION was used for visual interpretation of the raw LiDAR point cloud and for automated canopy closure calculations. FUSION is a product of the United States Department of Agriculture (USDA) Forest Service.

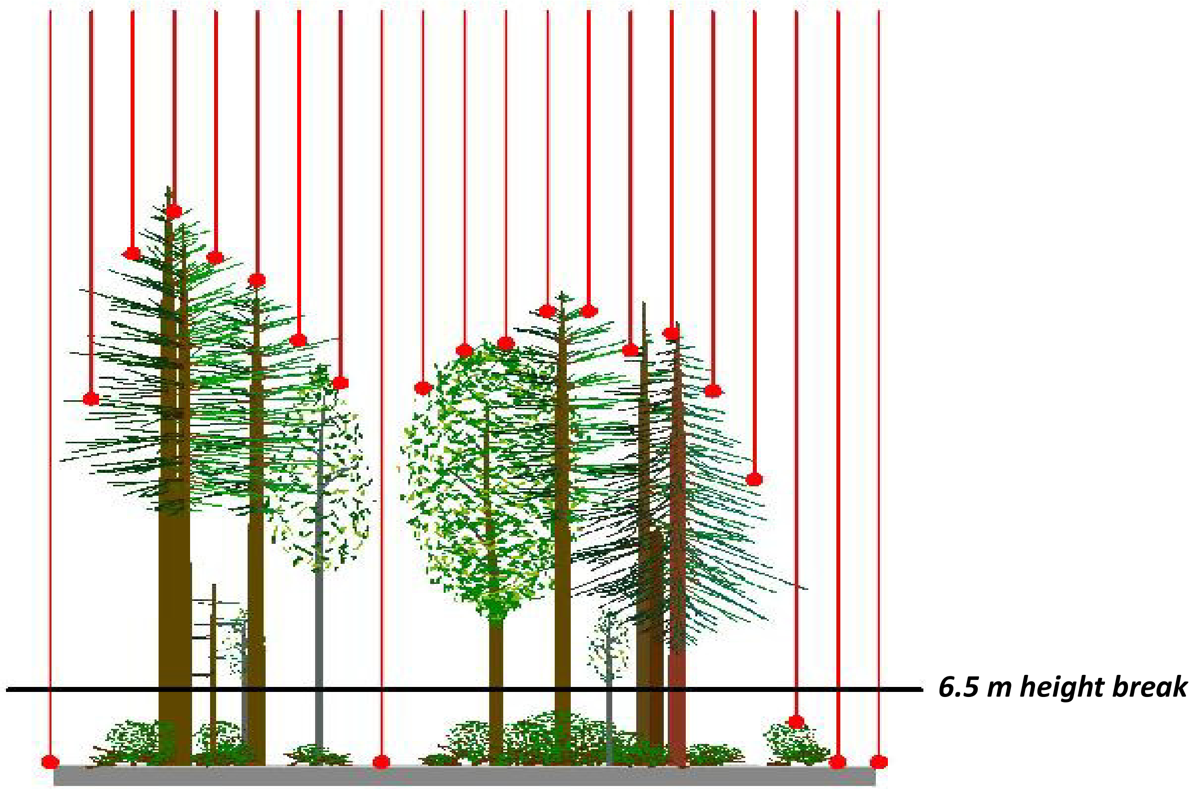
Using the full feature and bare earth DEM layers, vegetation height was determined. The vegetation height was calculated by subtracting the bare earth data from the full feature data using the ArcGIS subtract tool. The resultant layer contains values representing vegetation height ranging from 0 m up to 25 m.

Using FUSION software, overstory canopy closure estimates were calculated for the entire study area. The software required a bare earth DEM as well as the raw LiDAR point cloud in LAS format as input to calculate crown closure. To eliminate the presence of understory cover in the canopy closure calculation a height break must be specified as an input to the calculation. For this study a height break of 6.5 m was selected, based on a review of the vegetation height data and detailed analysis of the point cloud data throughout the study area. The chosen height break also relates to the Provincial Forestry height class divisions. All point cloud data points above this height break are considered as part of the overstory crown closure calculation while those points that fall below this line are removed as they are considered to be a part of the understory vegetation.

The schematic below is an aid to describe how this height break was used to determine canopy closure estimates. Overstory canopy is defined as any vegetation greater than the height break (6.5 m in this study) above the ground. Of the 21 LiDAR pulses that enter the canopy (as show in the schematic), 16 first returns are recorded above the 6.5 m threshold. Therefore, the overstory canopy cover estimate for the area depicted in the schematic would be computed as 16/21 or 76 % closure.

Although the LiDAR DEM data used in this study was provided using 1 m point spacing, it was necessary to use a coarser grid resolution for canopy closure calculations. If a smaller grid were used the analysis would be too focused on individual tree canopies and the breaks between them and the results would not be useful. In order to produce more meaningful results, the output cell size must be larger than the individual tree crowns. After an analysis of the point cloud data, a cell size of 10 m was chosen.

The canopy closure layer was calculated for the entire study area, and the values range between 0% canopy closure in open areas to 100 % closure in densely forested areas.



Source: Fusion/LDV: Software for LiDAR Data Analysis and Visualization
Robert McGaughey; July 2010 – Fusion Version 2.90
United States Department of Agriculture – Forest Service

Schematic Depicting How Canopy Closure is Calculated Using a Height Break

2.2 Interactive Supervised Classification

General land classes were derived through an interactive supervised classification approach using ArcGIS. Training areas were defined for the following land classes; bog / barren / exposed earth, scrub / regeneration forest, water, anthropogenic and low conifer. The input layers used in the supervised classification included the Red, Green and Blue visible bands from the colour imagery along with the vegetation height layer derived from the LiDAR data. The vegetation height data was normalised to match the 0 to 255 range of the colour imagery prior to running the classification. The vegetation height layer helped to differentiate between vegetation classes that shared similar spectral properties but differing height ranges.

Prior to running the classification, training areas were delineated by the GIS operator in the form of polygons that encompass areas that best represent the desired class with respect to the spectral properties and the vegetation height. The training areas were used by the GIS software to find associations or trends in the pixel values from the three visible bands and the LiDAR data for each of the desired classes and to apply those class properties over the entire study area. The result is a seamless land cover layer which is colour coded to represent the output classes.

2.3 Image Processing and Raster Math

For the purpose of this study, detailed marten habitat classes were derived (in addition to the general land cover classes) using LiDAR data derivatives including canopy closure and vegetation height.

As noted above, the various habitat categories that were developed and used in this mapping exercise were based strongly on those identified and evaluated by Hearn *et al* (2010), as well as the nature and resolution of the available imagery. Table 2.1 presents the habitat categories used and their respective characteristics.

Table 2.1: Habitat Classes Used in Marten Habitat Potential Mapping

Habitat Classification	Canopy Closure (%)	Vegetation Height (m)
Water		
Anthropogenic		
Bog / Barren / Exposed Earth		
Scrub / Regeneration Forest		< 6.5
Low Conifer		< 6.5
Medium Height, Open Canopy Conifer	< 50	6.6 – 12.5
Medium Height, Closed Canopy Conifer	> 50	6.6 – 12.5
Tall, Open Canopy Conifer	< 50	≥ 12.6
Tall, Closed Canopy Conifer	> 50	≥ 12.6
Insect Killed Stands	< 25	≥ 12.6
Pre-Commercially Thinned	> 50	
Hardwood / Mixed Wood		

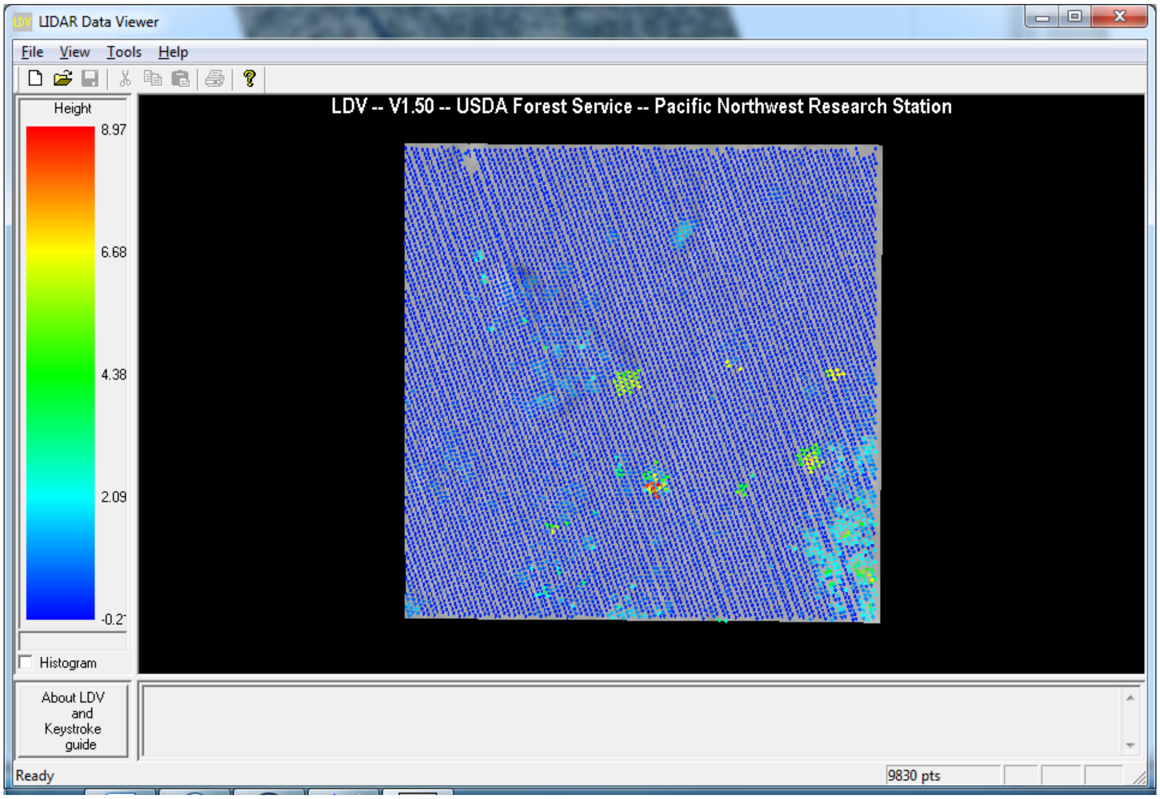
The ArcGIS raster calculator tool was used to perform all raster math (combining of layers satisfying the suggested criteria) and query operations. The resultant layers overlay the general land cover classes and are presented using the 10 m grid resolution due to the input canopy closure layers.

It should be noted that as no significant amounts of insect killed stands, pre-commercially thinned areas, or hardwood / mixed wood occurred in the study area, these were not included in the map products.

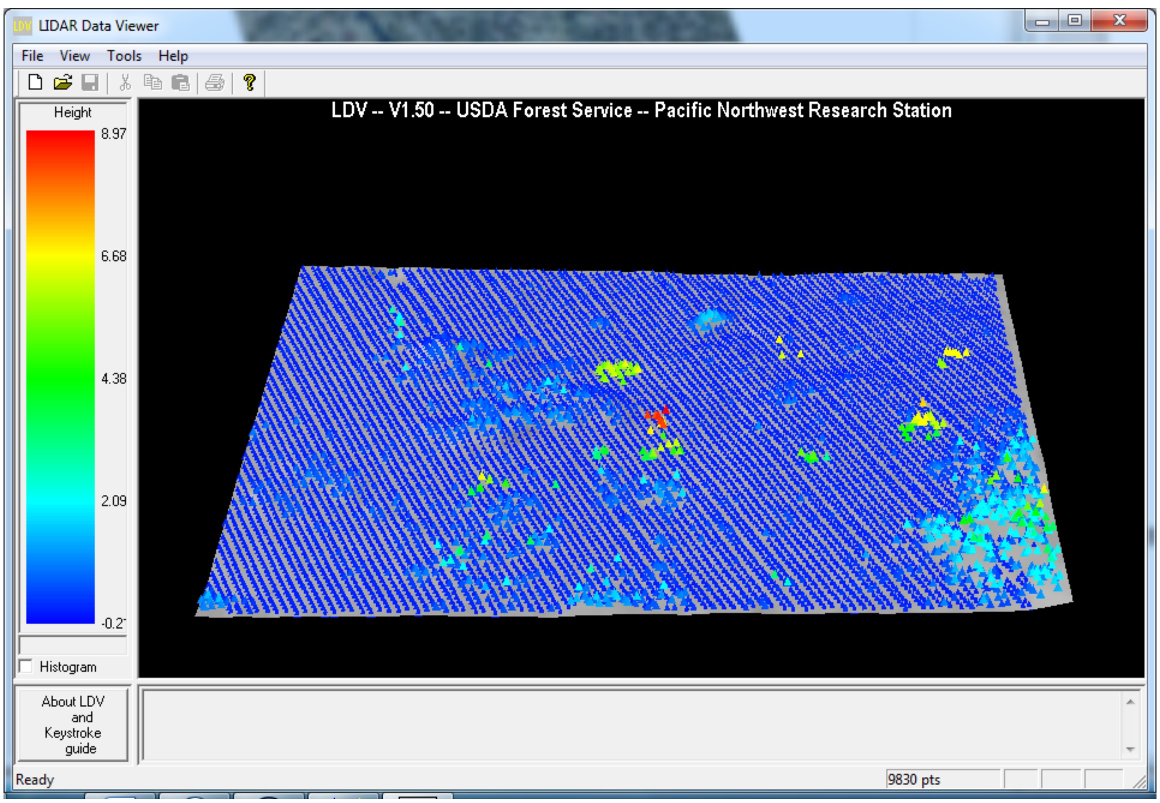
2.4 Habitat Class Assessment

To assist in understanding the point cloud distribution for each of the defined vegetation classes, the schematics that follow depict a 75 m by 75 m window of the raw LiDAR point cloud with an oblique and top down (Nadir) view.

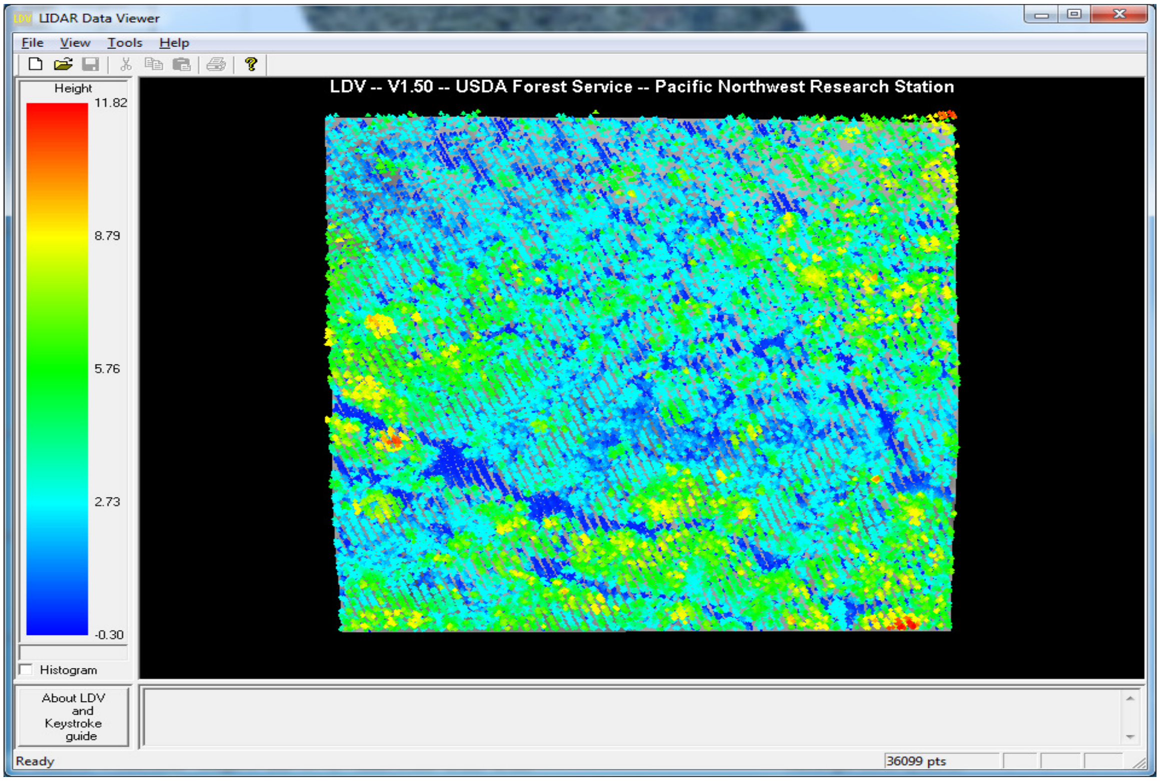
In each snap shot the height of the points can be determined by looking at the colour gradient to the left of the schematic.



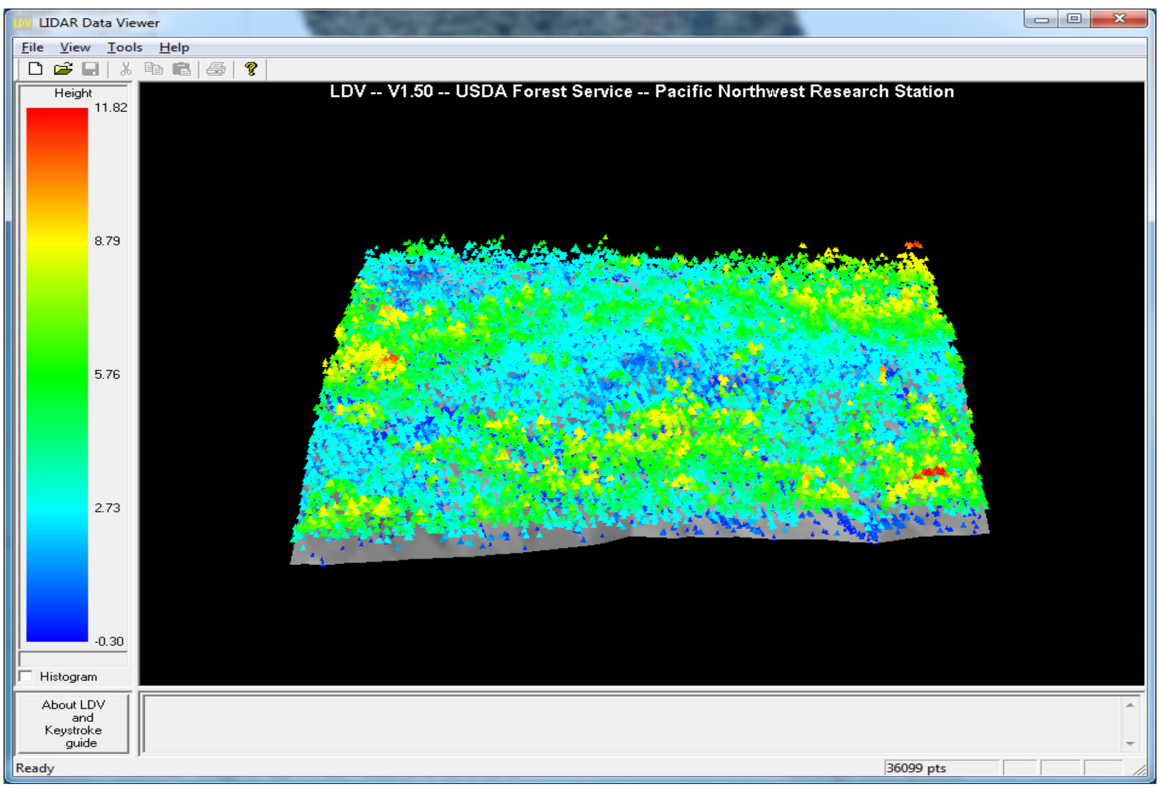
Bog / Barren / Exposed Earth – Nadir



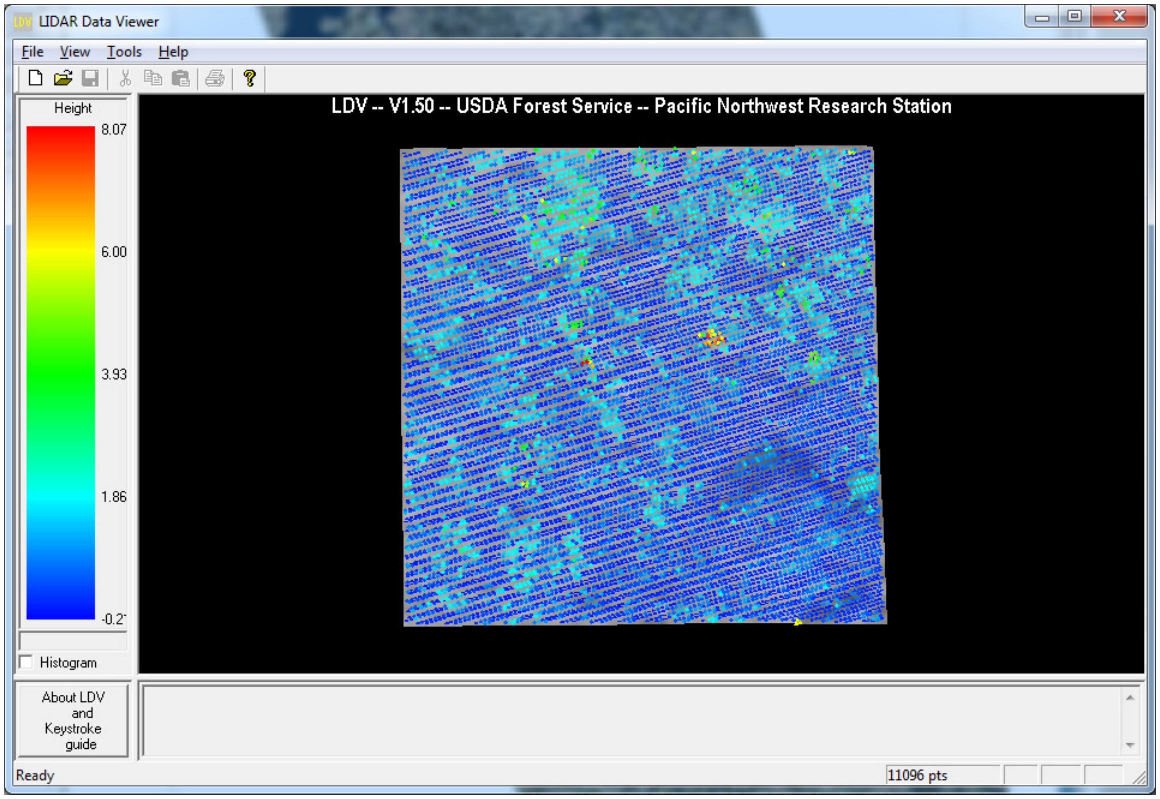
Bog / Barren / Exposed Earth - Oblique



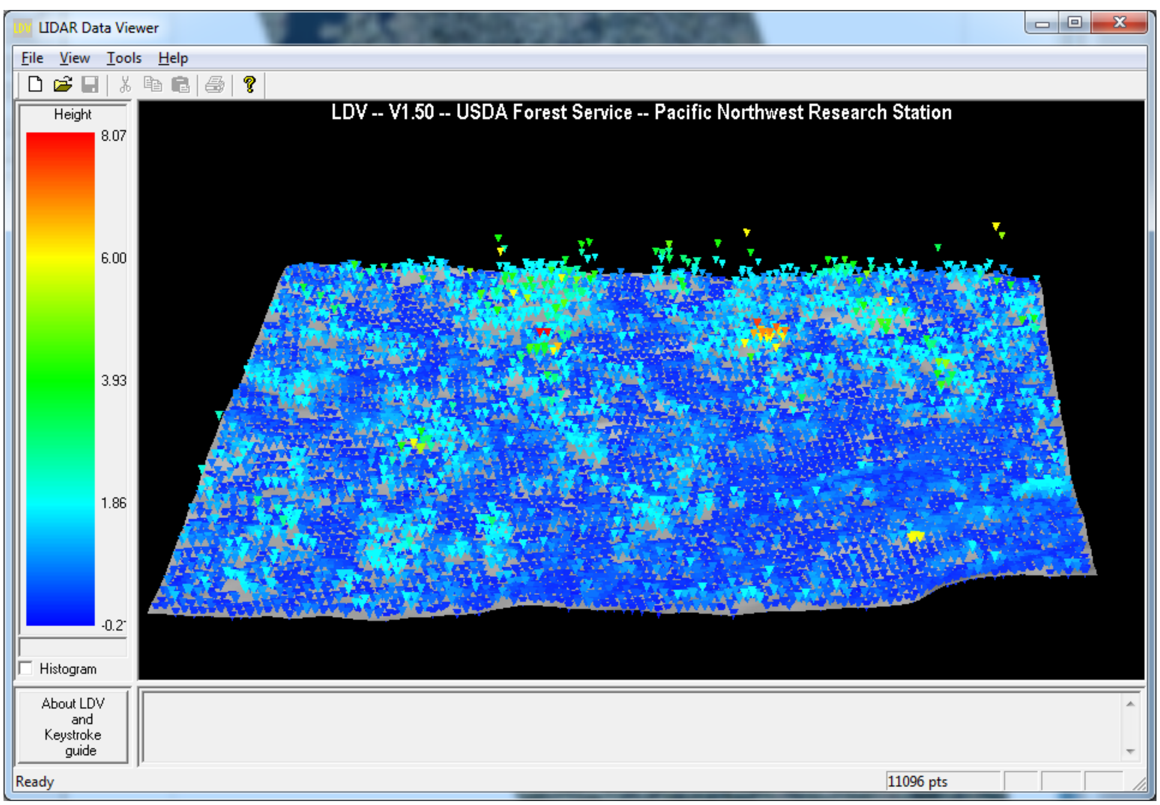
Low Conifer – Nadir



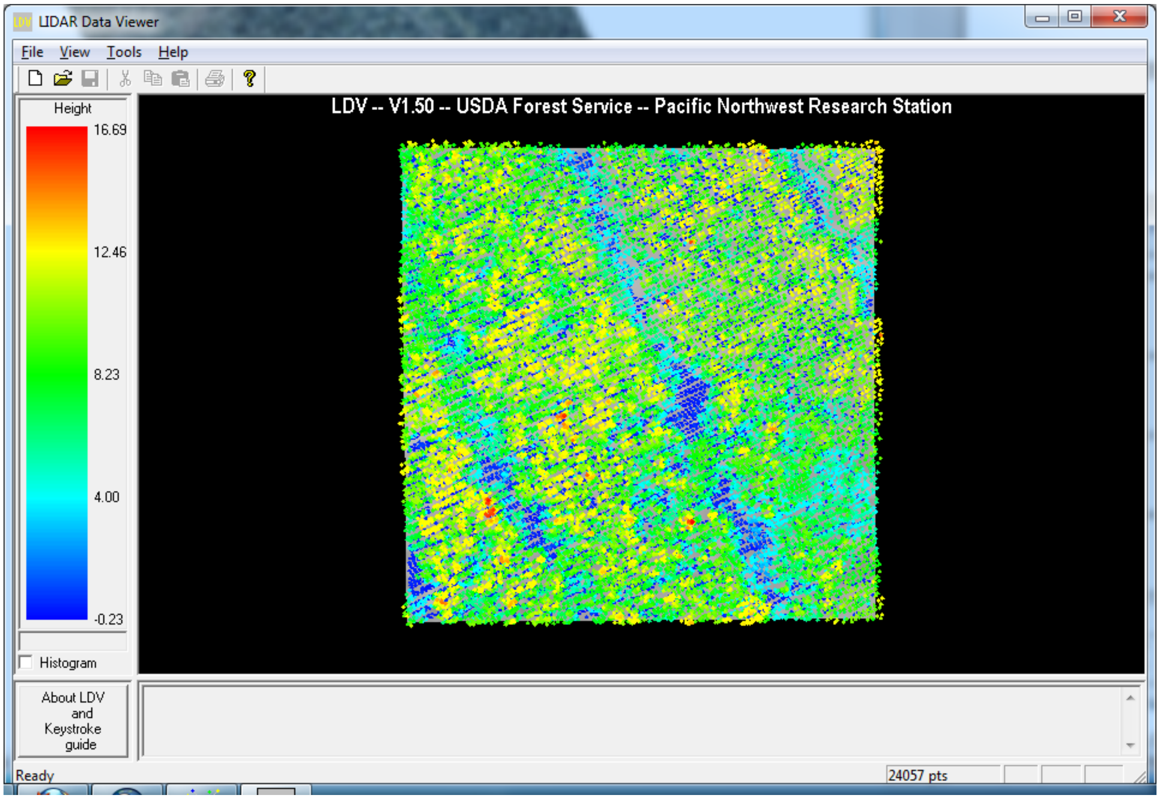
Low Conifer - Oblique



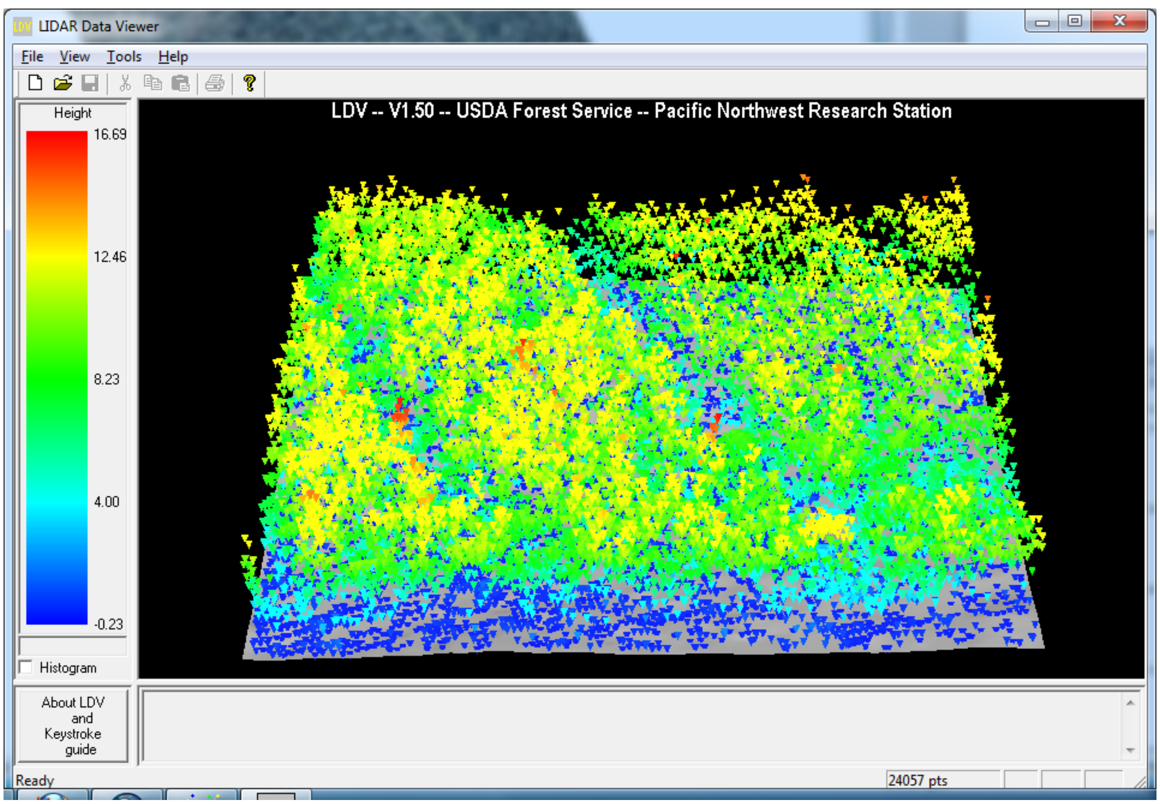
Scrub / Regenerating Forest – Nadir



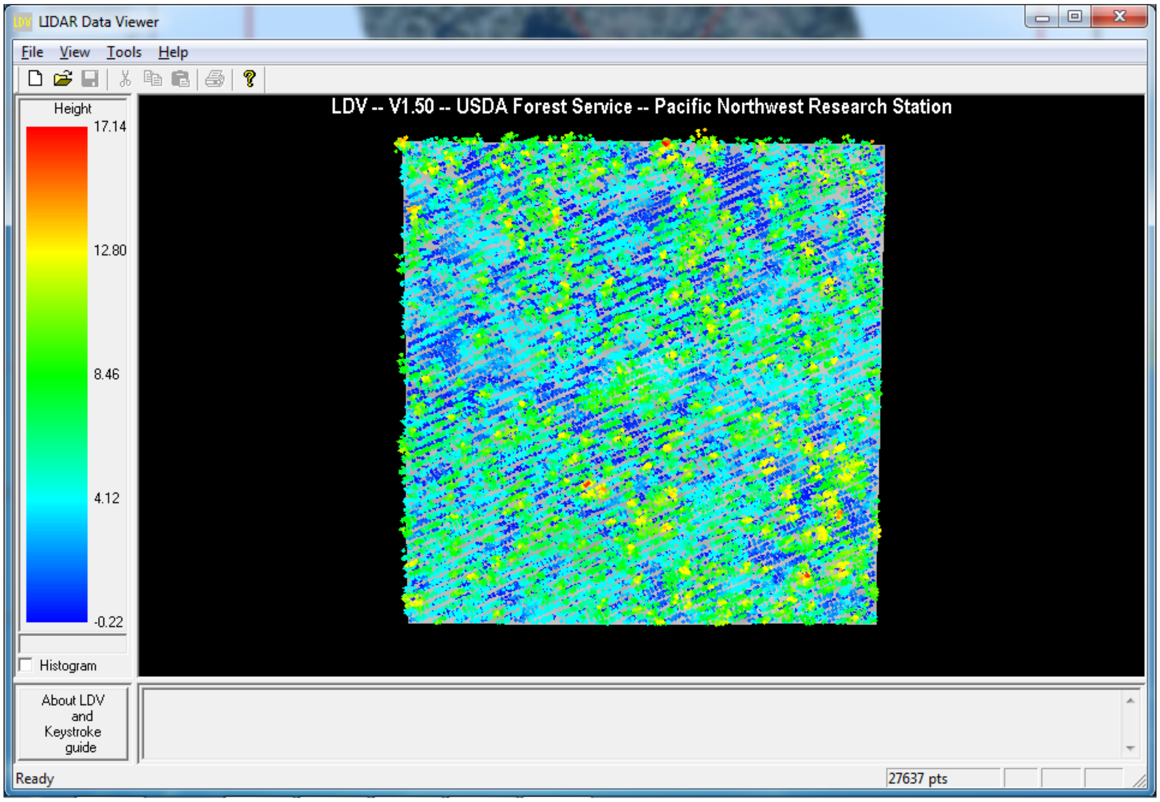
Scrub / Regenerating Forest – Oblique



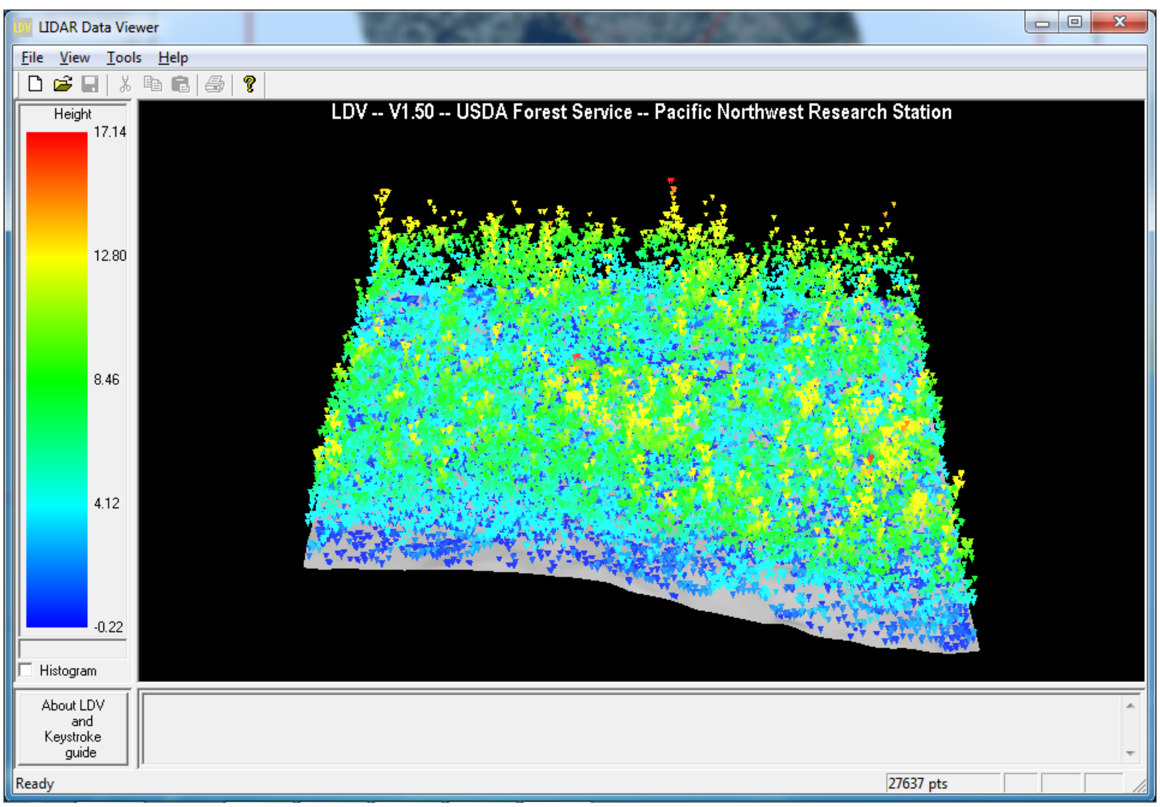
Medium, Closed Canopy Conifer – Nadir



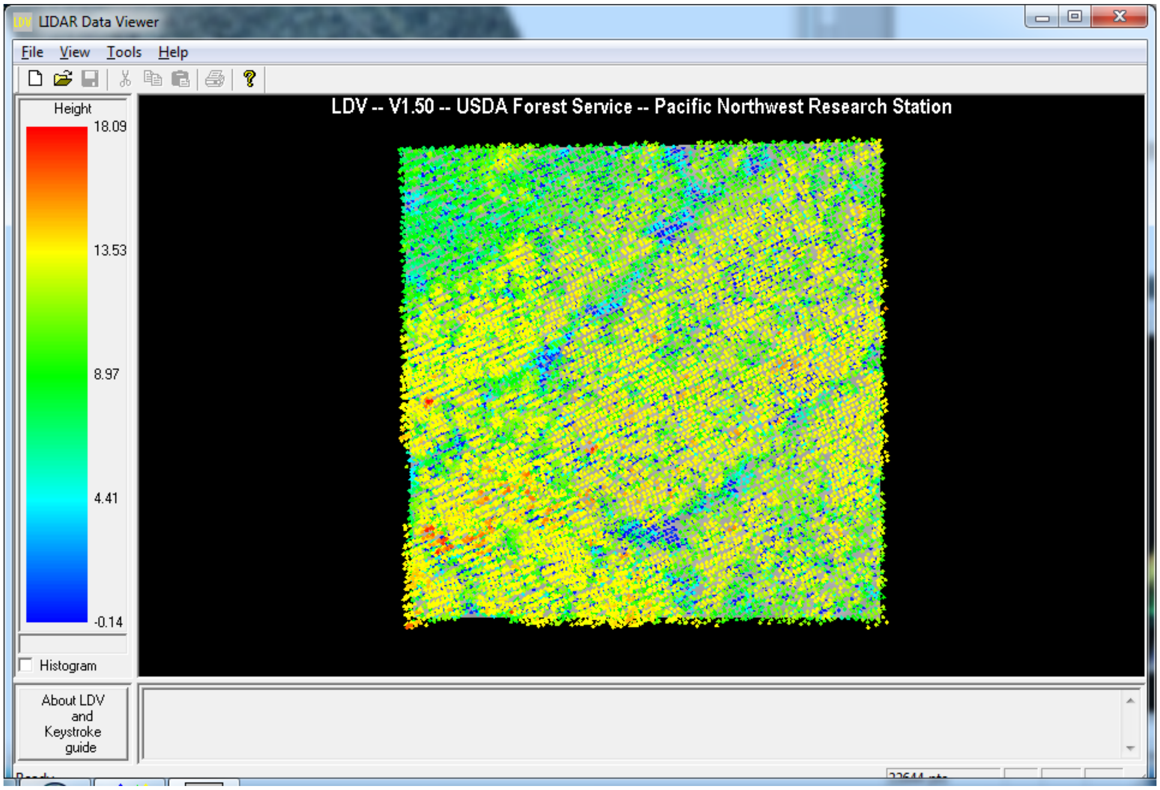
Medium, Closed Canopy Conifer - Oblique



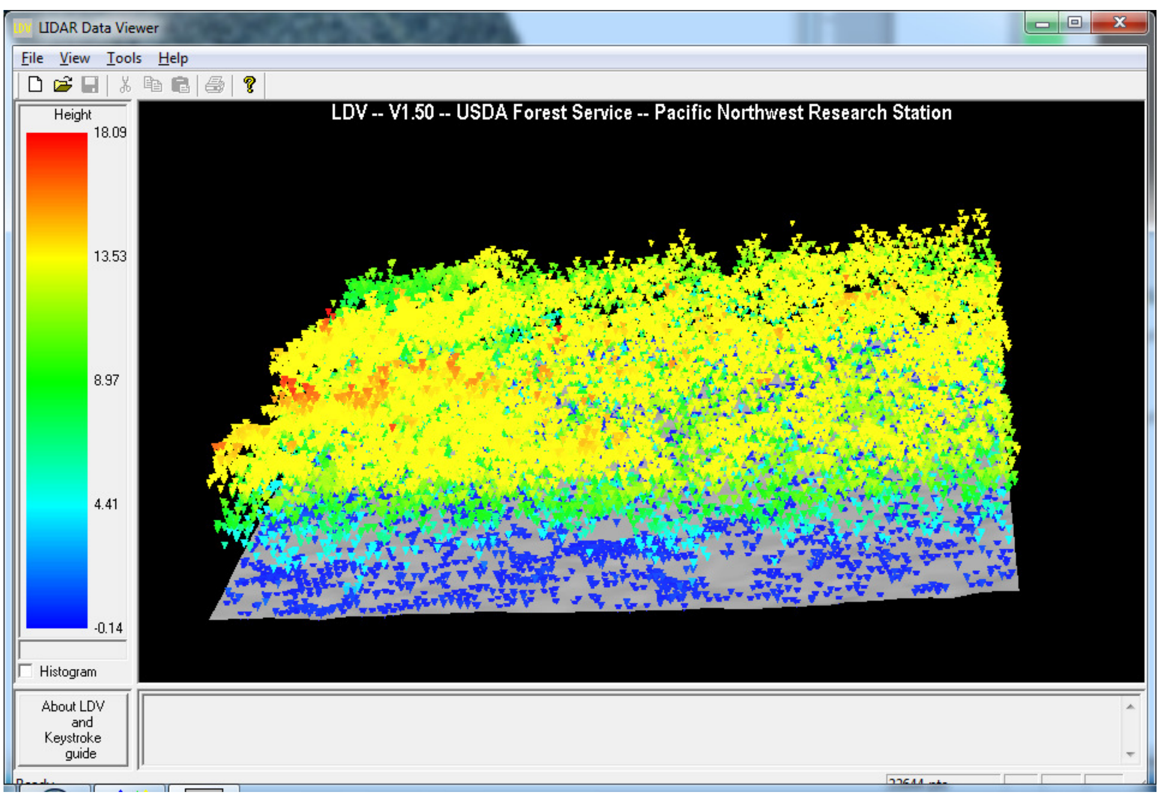
Medium, Open Canopy Conifer – Nadir



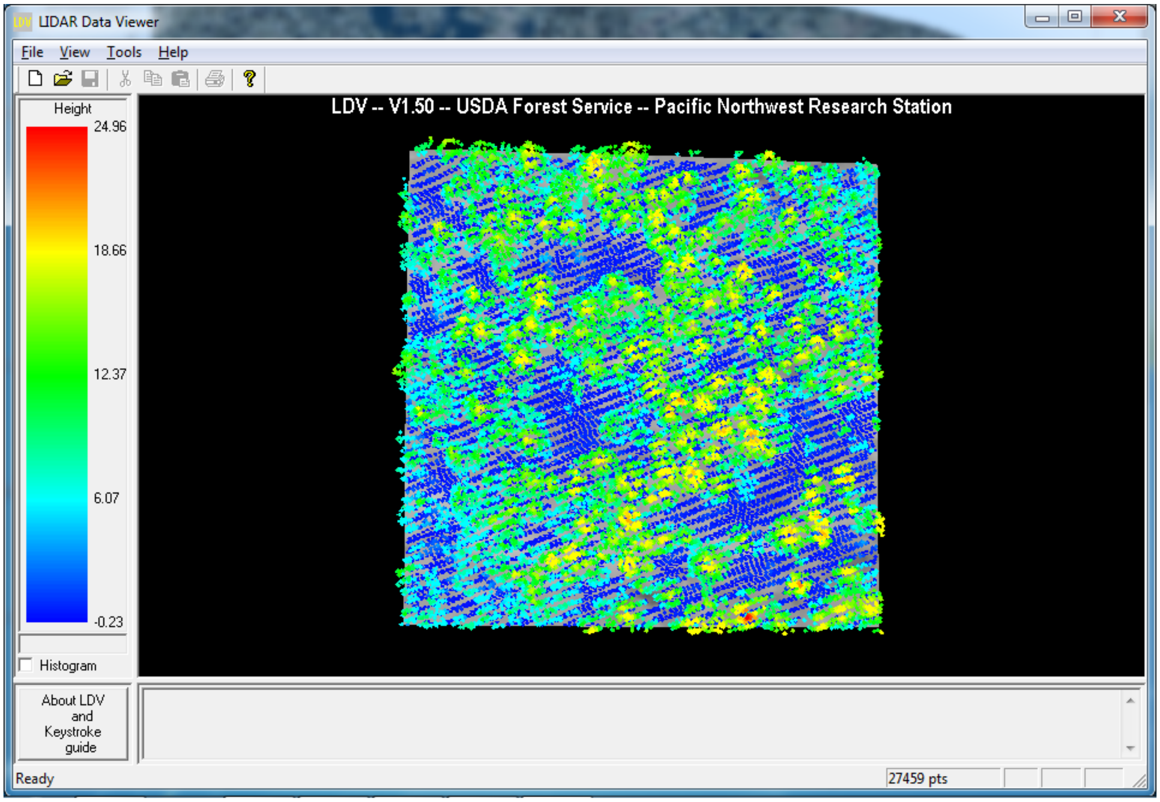
Medium, Open Canopy Conifer – Oblique



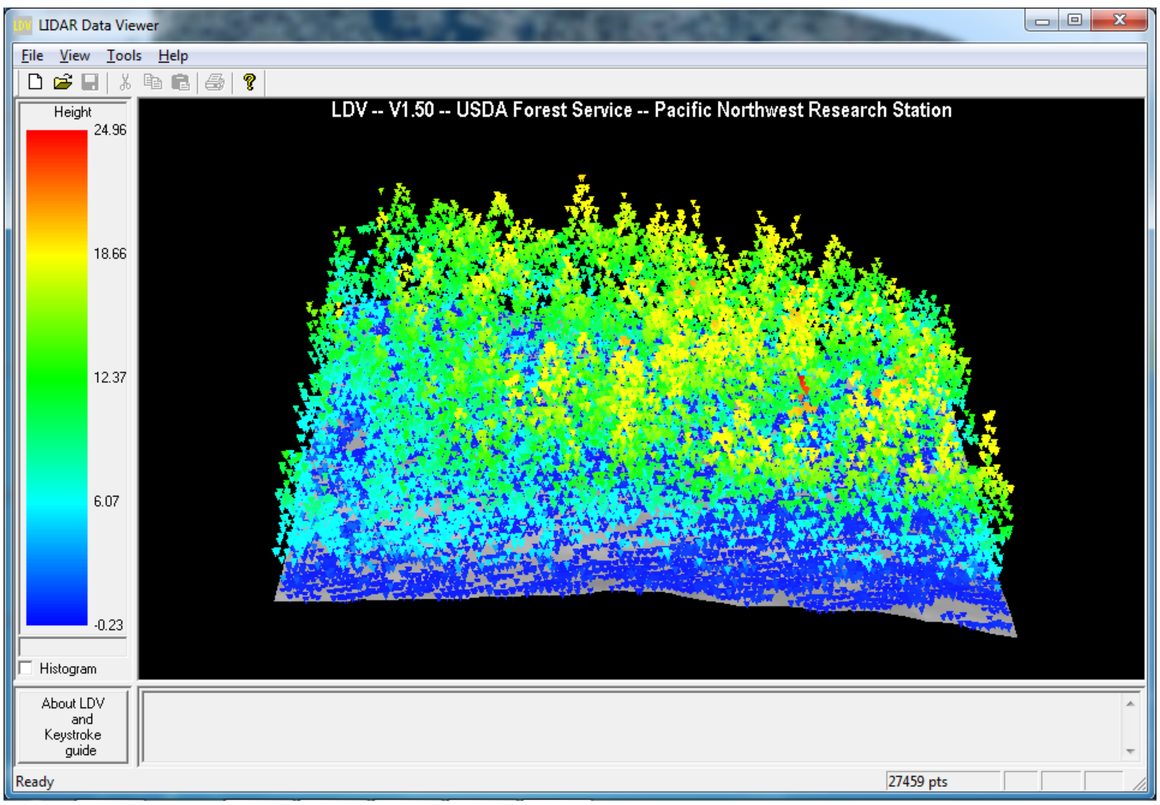
Tall, Closed Canopy Conifer – Nadir



Tall, Closed Canopy Conifer - Oblique



Tall, Open Canopy Conifer – Nadir

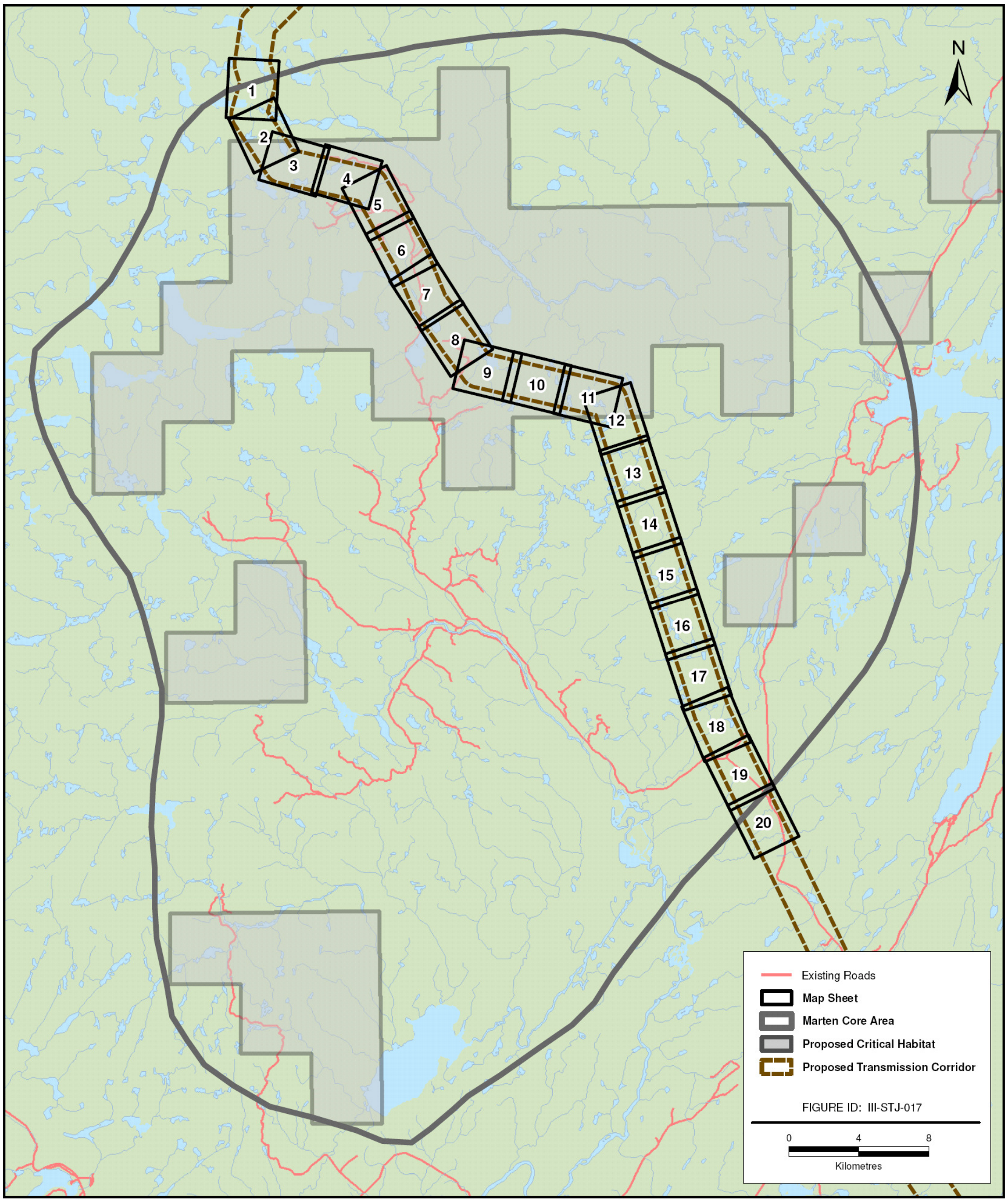


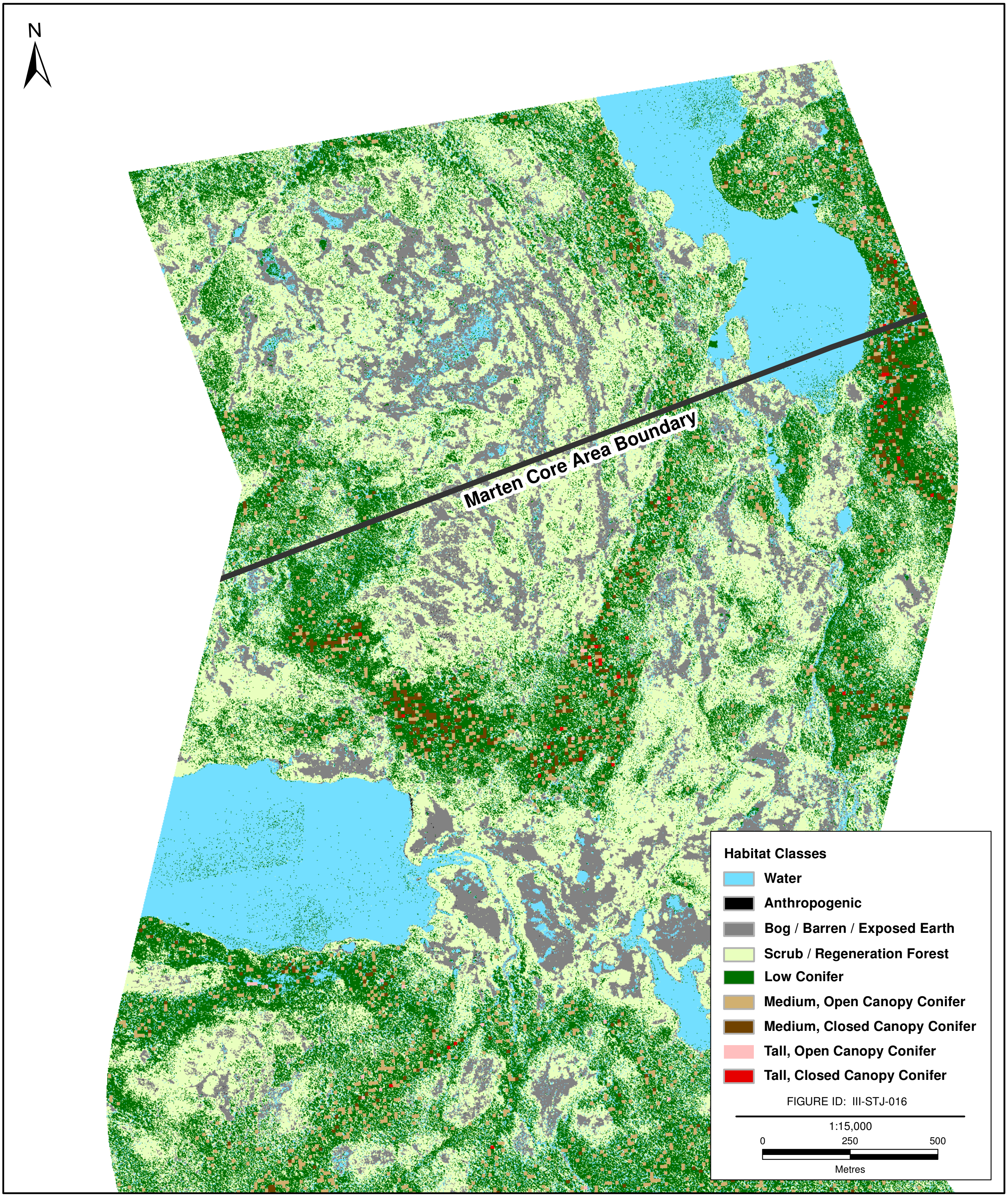
Tall, Open Canopy Conifer - Oblique

2.5 Marten Habitat Potential Mapping Outcomes

Figure 2.1 provides an index for the individual habitat potential maps that were produced through the above exercise. This is followed by the twenty (20) detailed habitat potential maps that cover the approximately 55 km long segment of the proposed transmission corridor that crosses through the identified marten core area on the southern portion of the Northern Peninsula.

Figure 2.1 Labrador - Island Transmission Link: Marten Habitat Potential Mapping Index





Map 1 of 20

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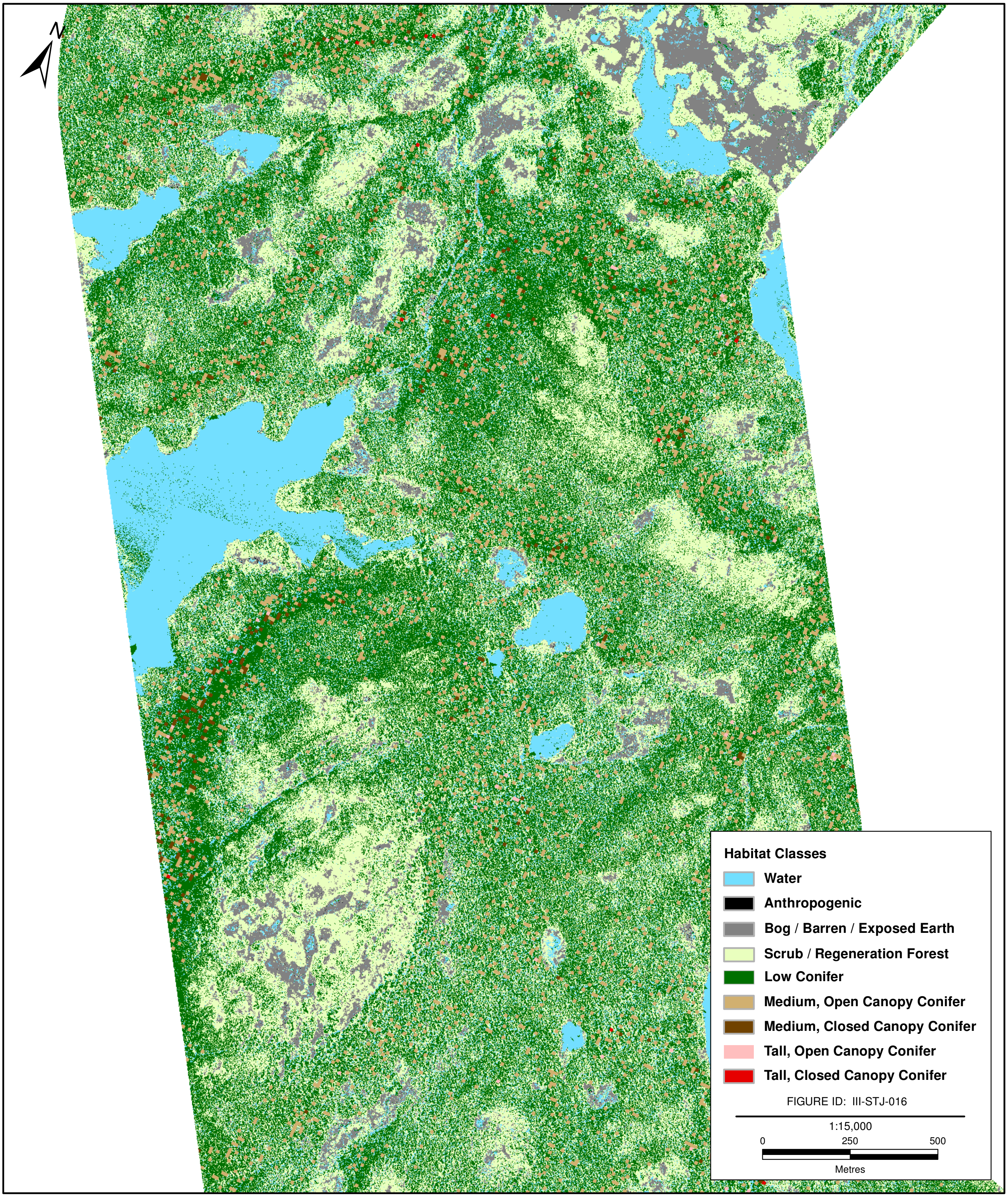
Labrador - Island Transmission Link: Marten Habitat Potential Mapping



Map 2 of 20

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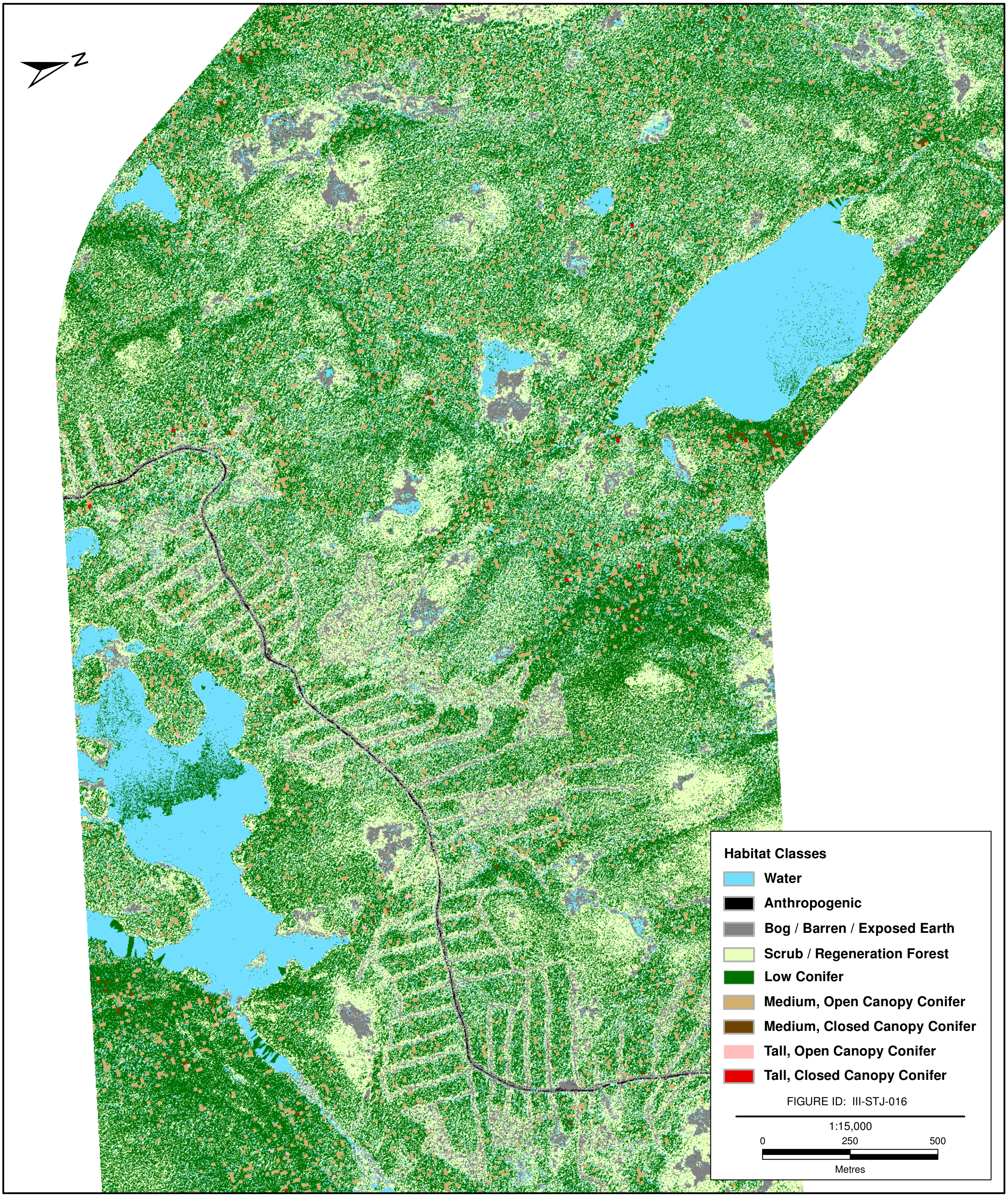
Labrador - Island Transmission Link: Marten Habitat Potential Mapping



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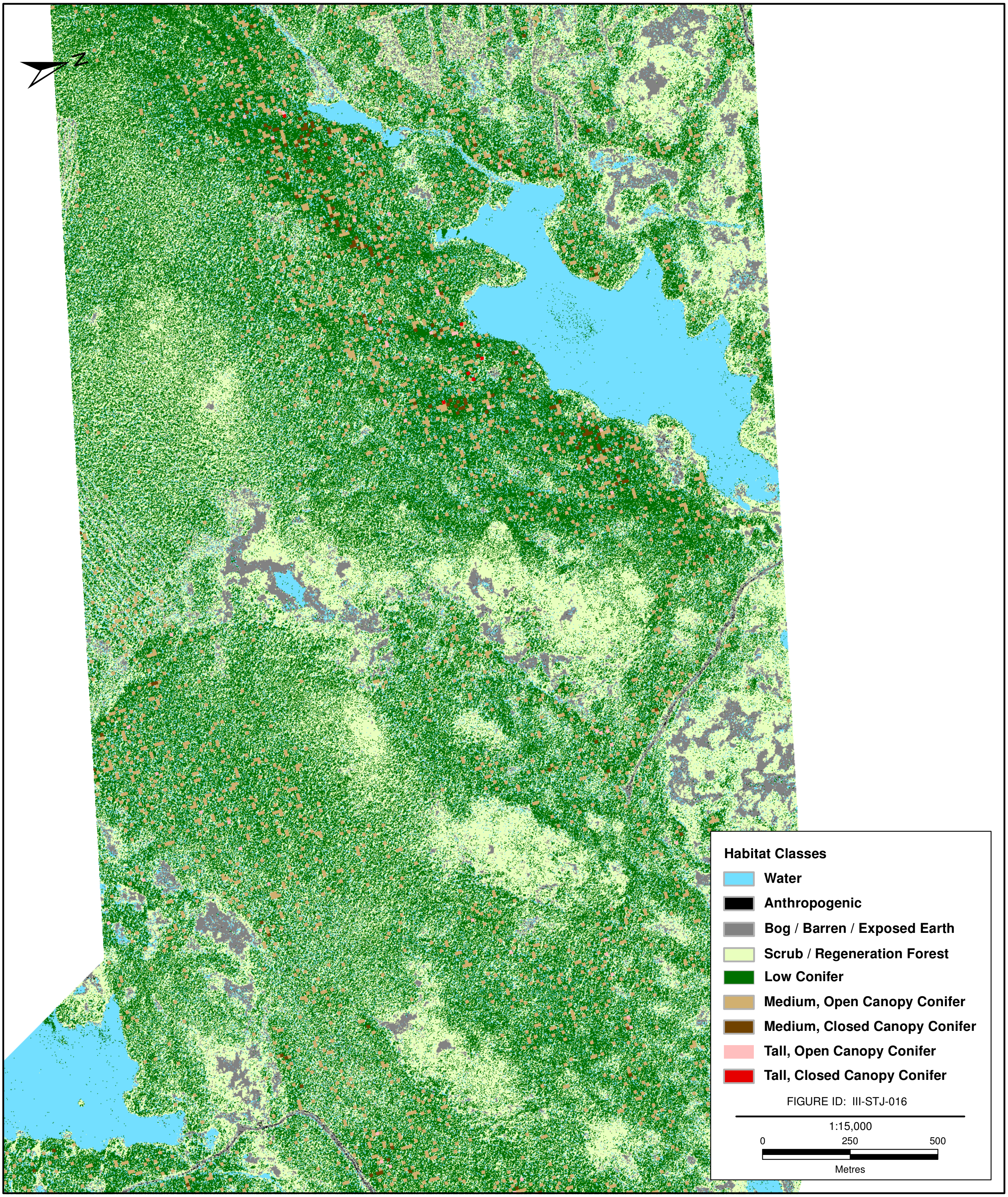
Map 3 of 20

Labrador - Island Transmission Link: Marten Habitat Potential Mapping



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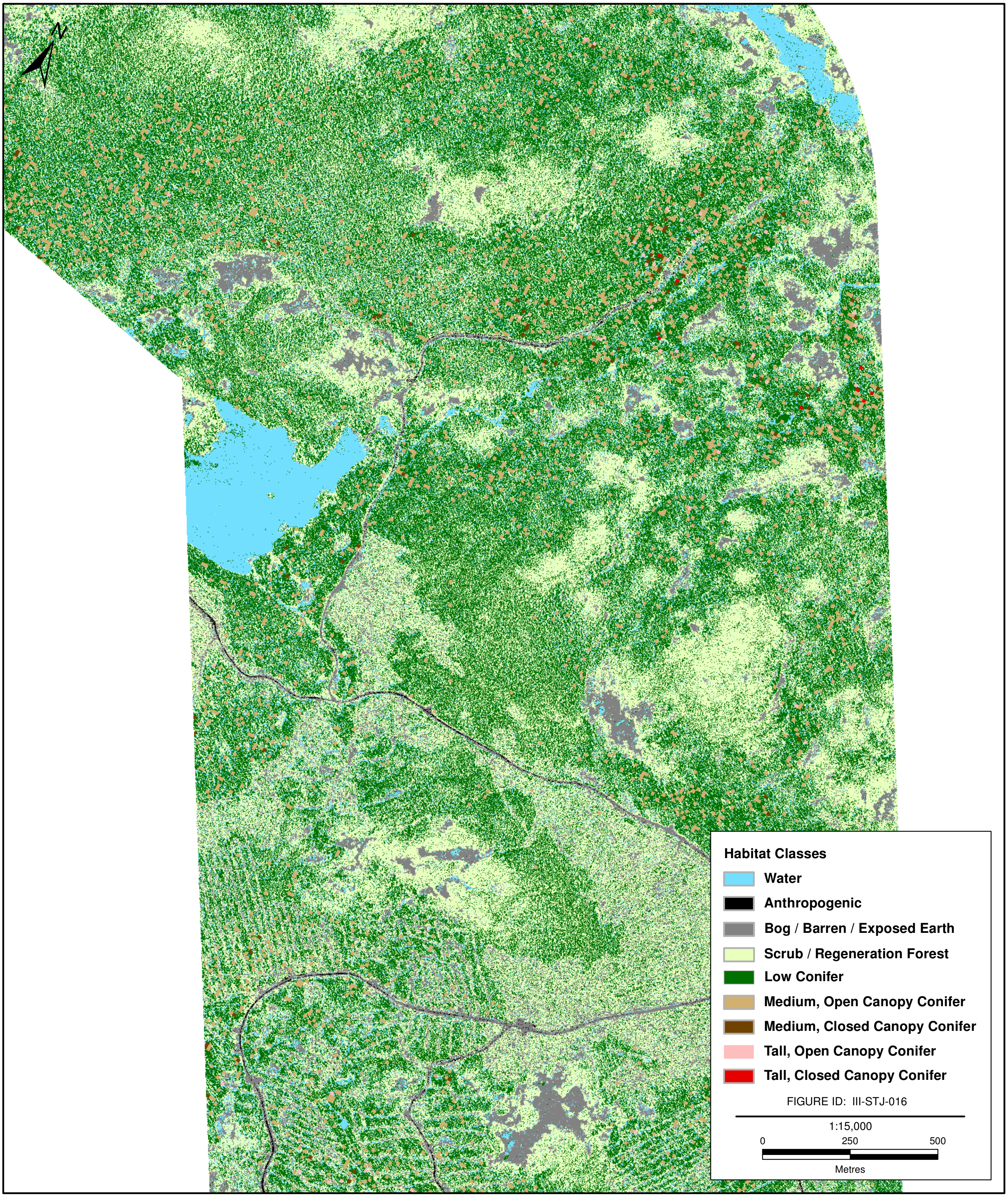
Map 4 of 20

Labrador - Island Transmission Link: Marten Habitat Potential Mapping



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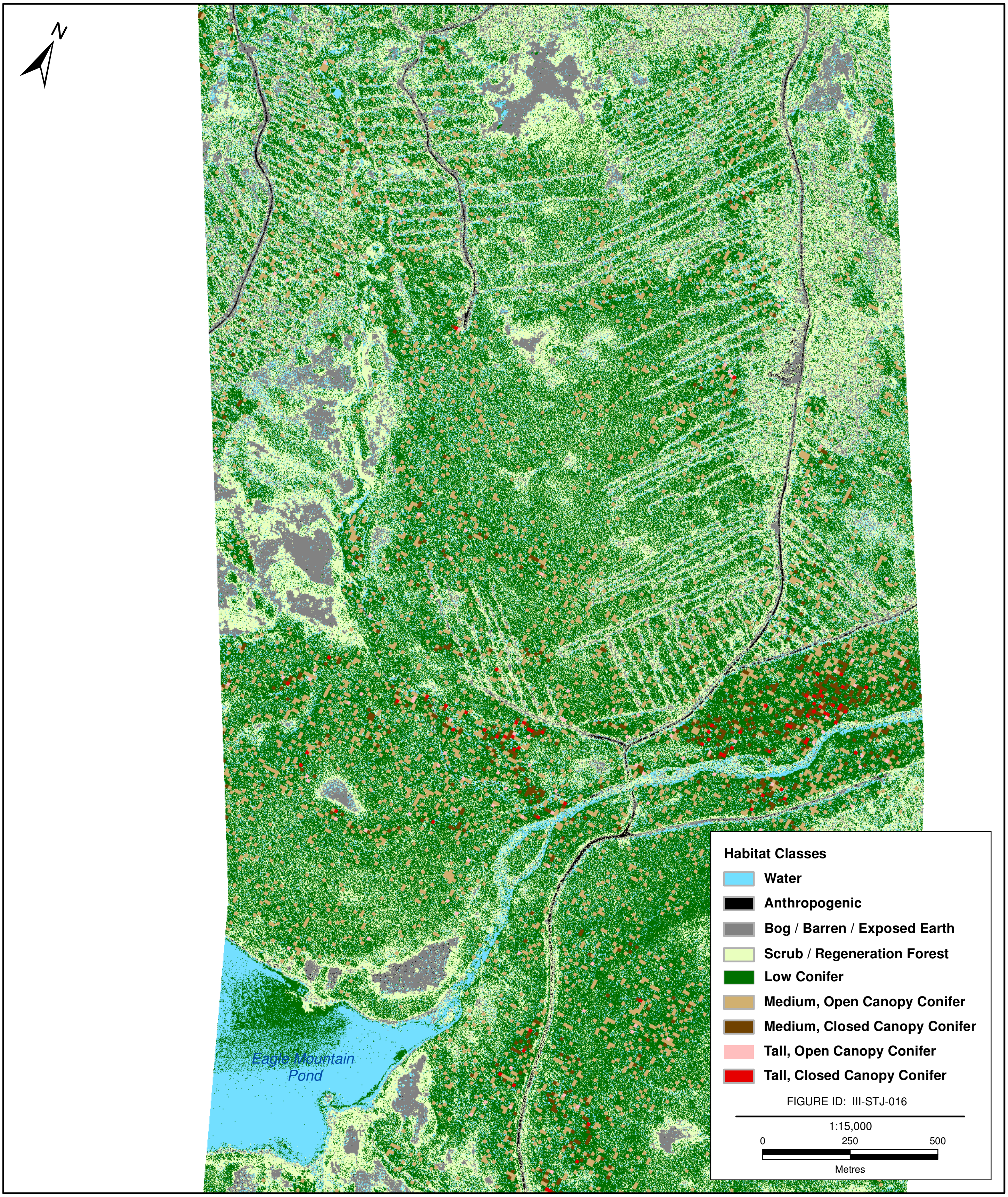
Labrador - Island Transmission Link: Marten Habitat Potential Mapping



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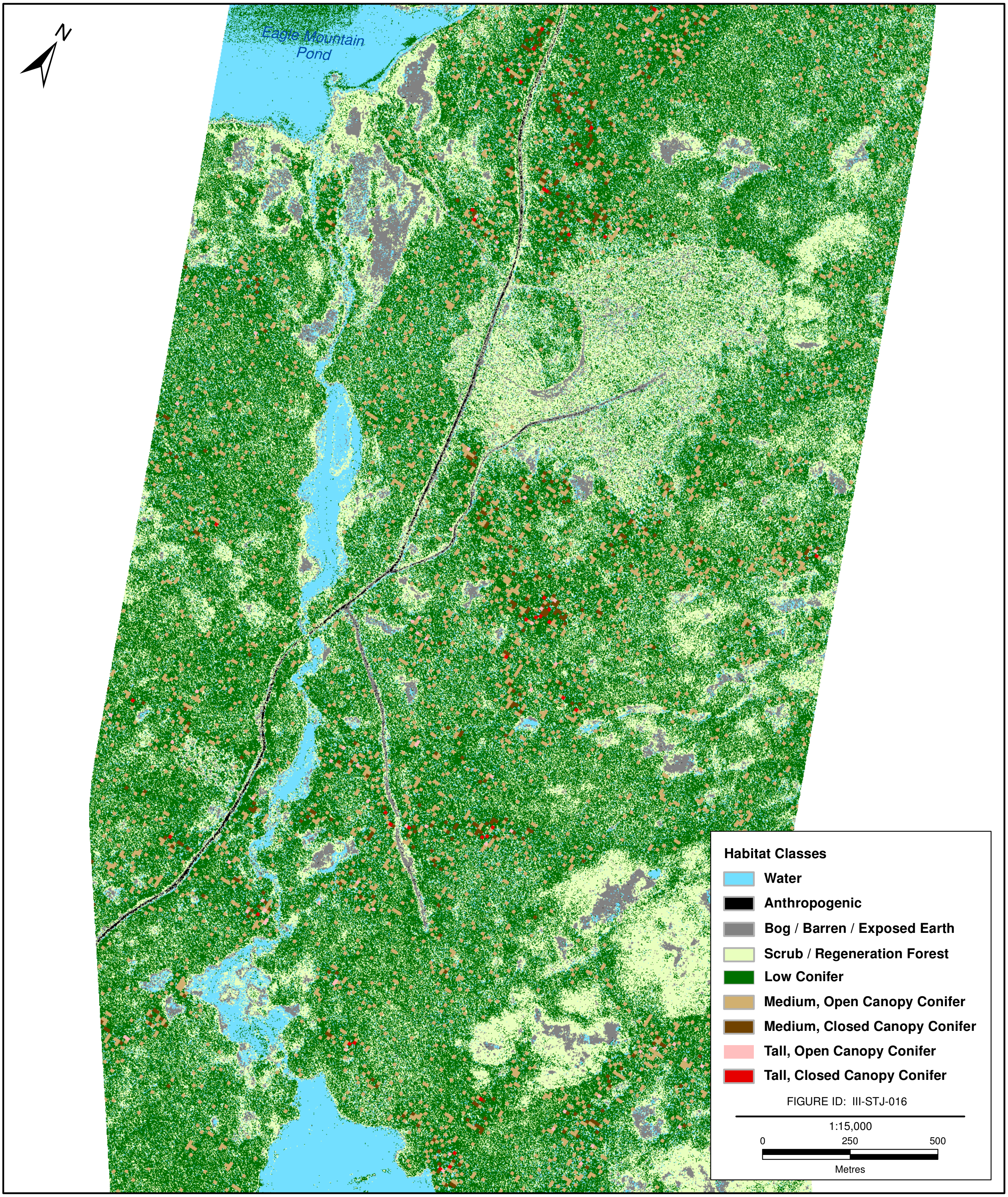
Map 6 of 20

Labrador - Island Transmission Link: Marten Habitat Potential Mapping



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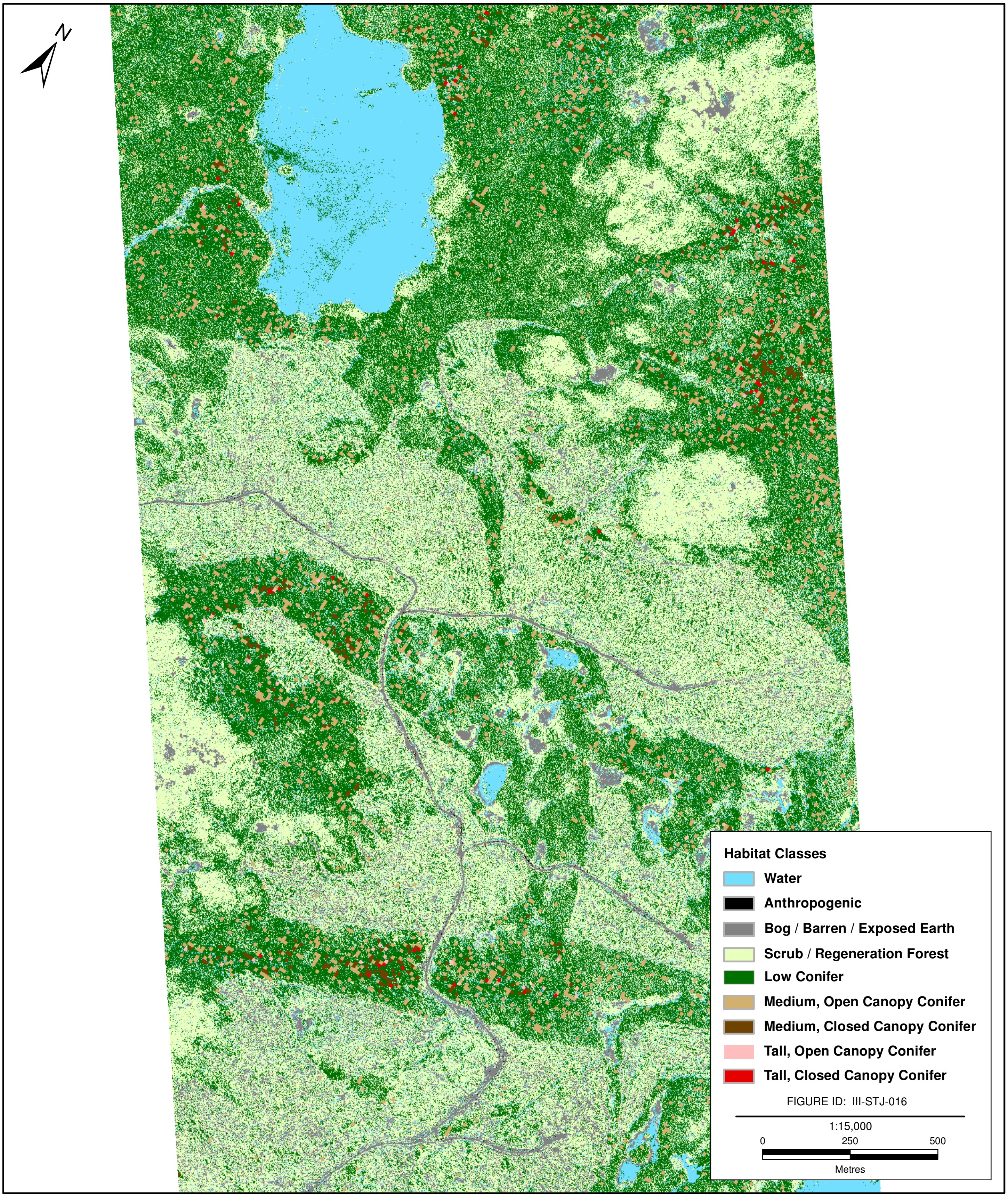
Labrador - Island Transmission Link: Marten Habitat Potential Mapping



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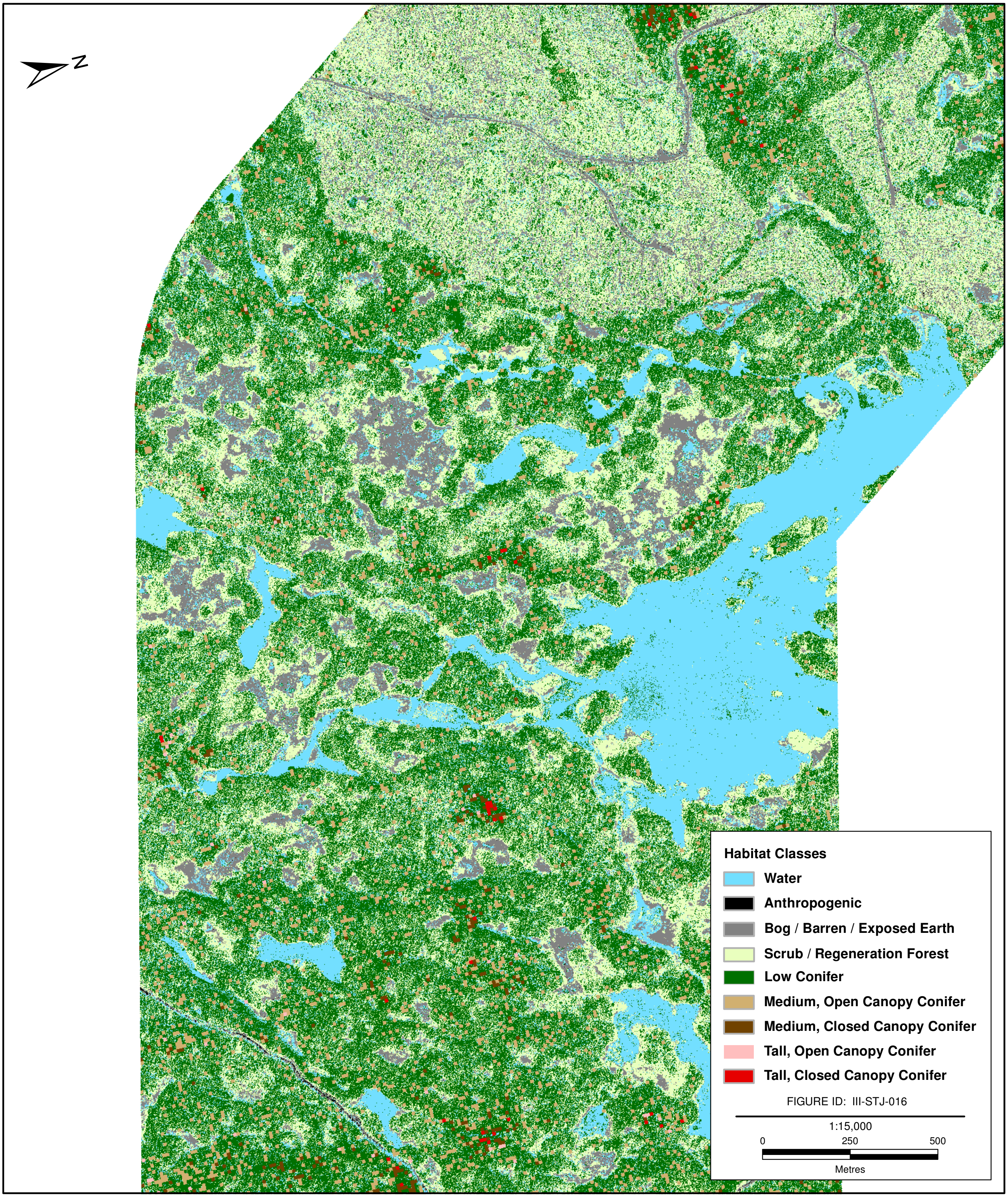
Labrador - Island Transmission Link: Marten Habitat Potential Mapping



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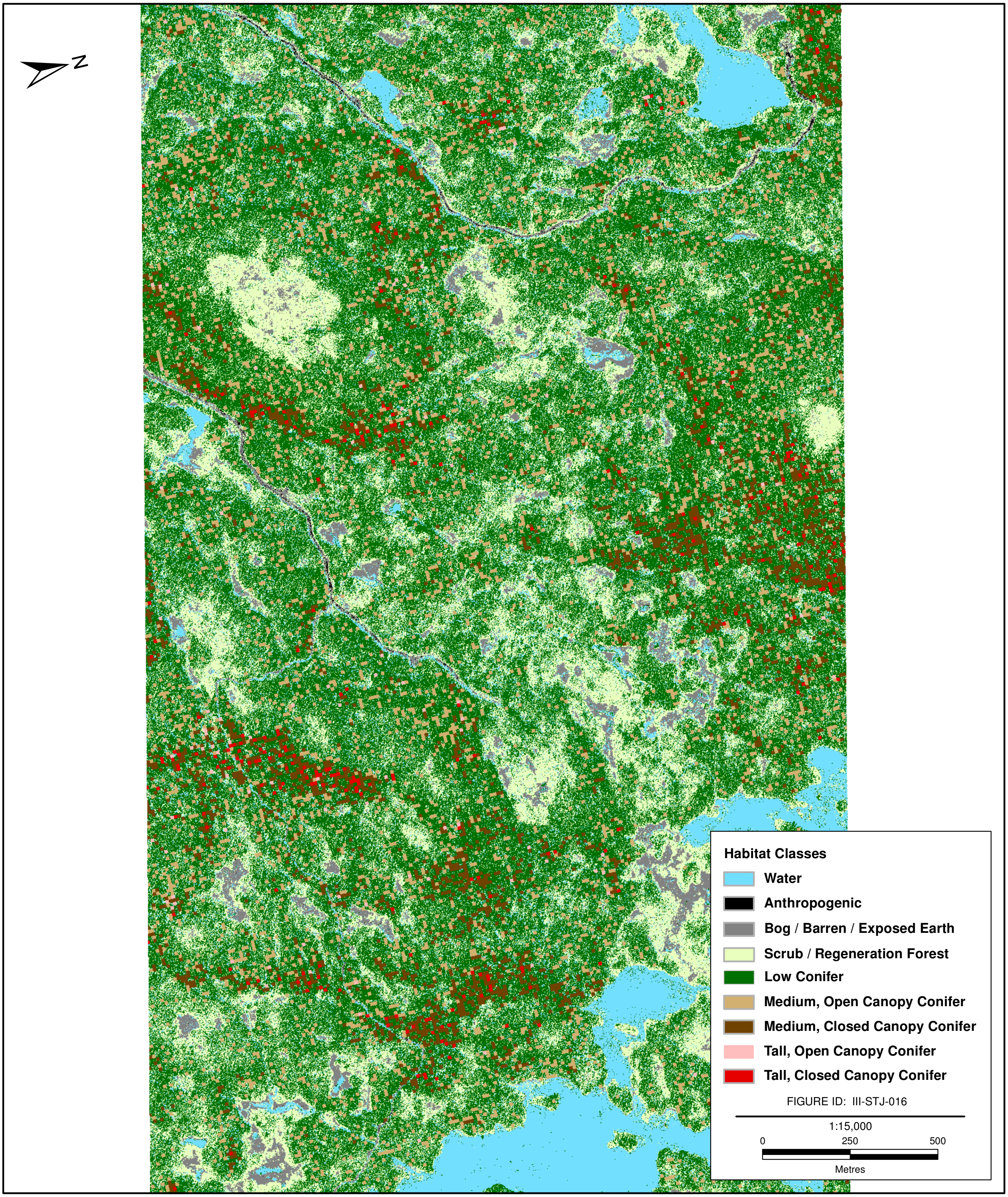
Labrador - Island Transmission Link: Marten Habitat Potential Mapping



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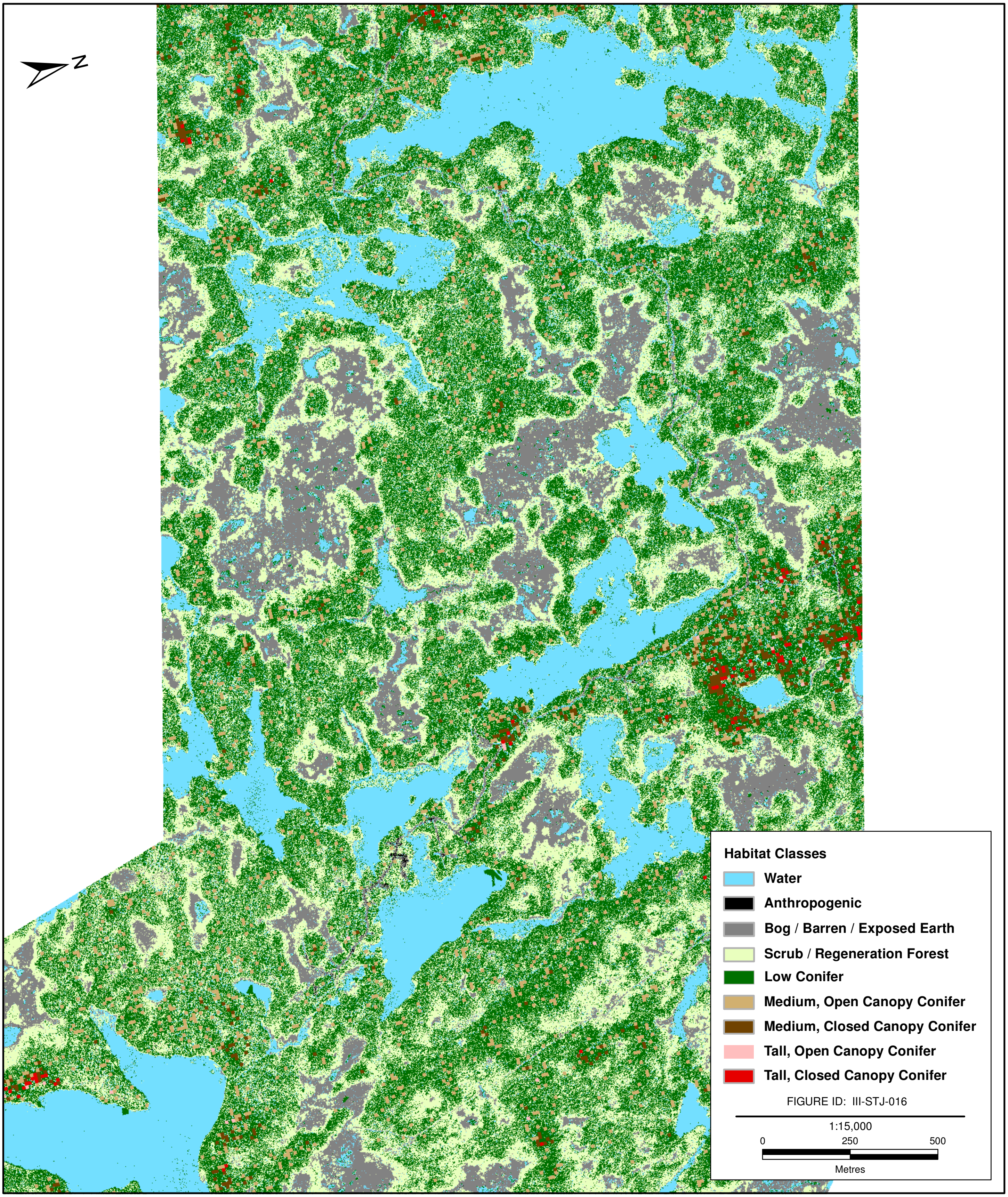
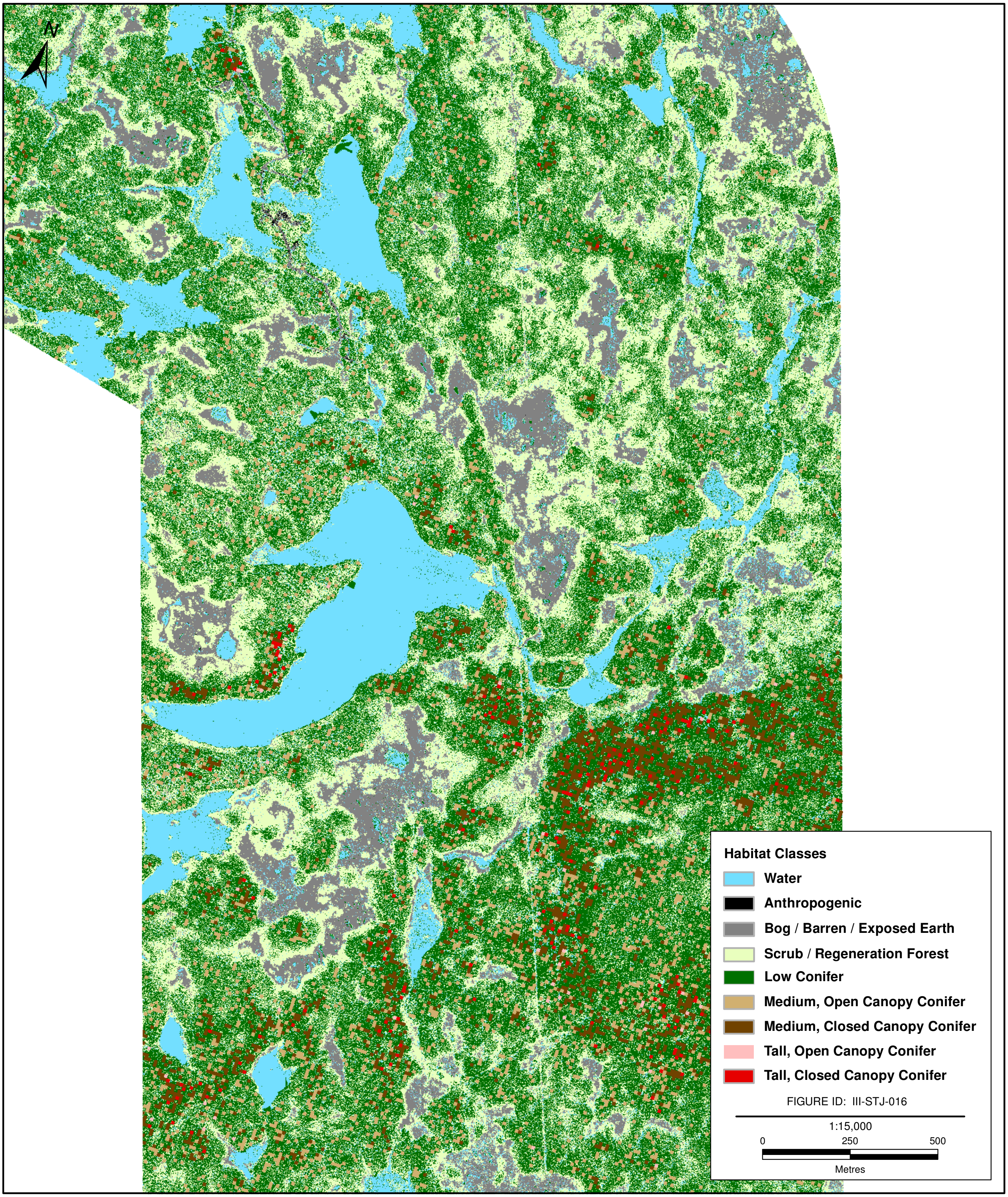
Labrador - Island Transmission Link: Marten Habitat Potential Mapping



Labrador - Island Transmission Link: Marten Habitat Potential Mapping



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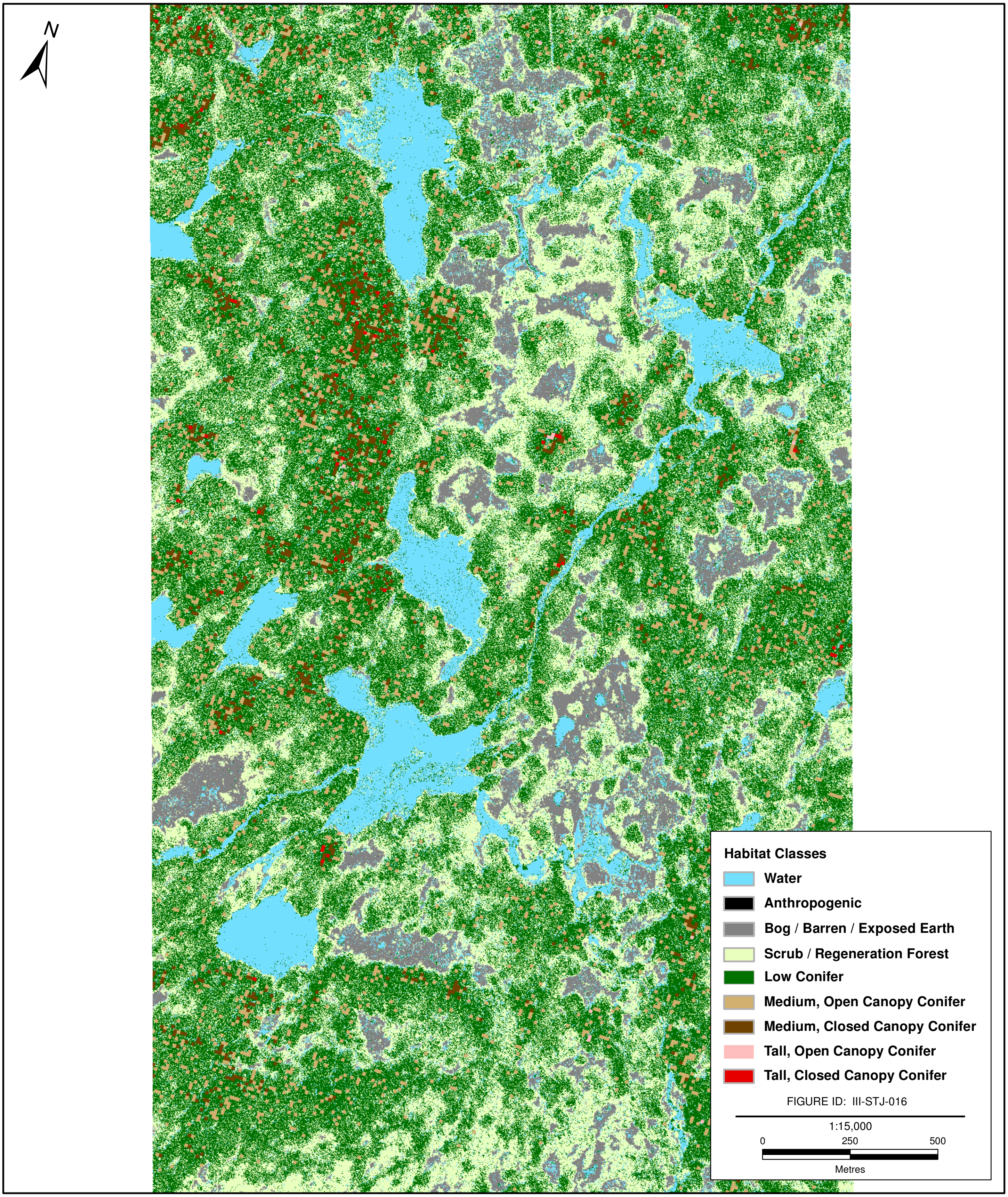
Labrador - Island Transmission Link: Marten Habitat Potential Mapping



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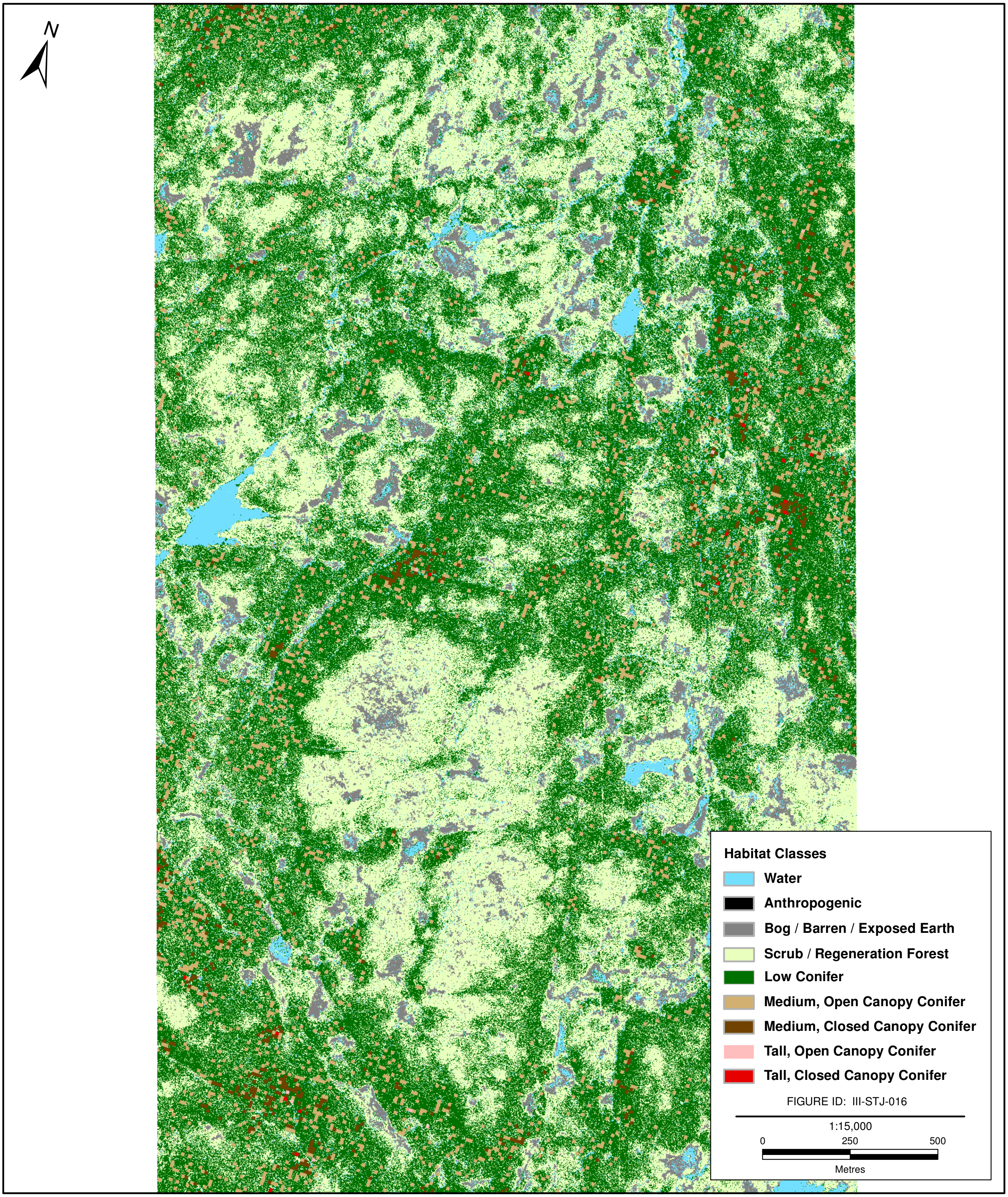
nalcor energy

Labrador - Island Transmission Link: Marten Habitat Potential Mapping



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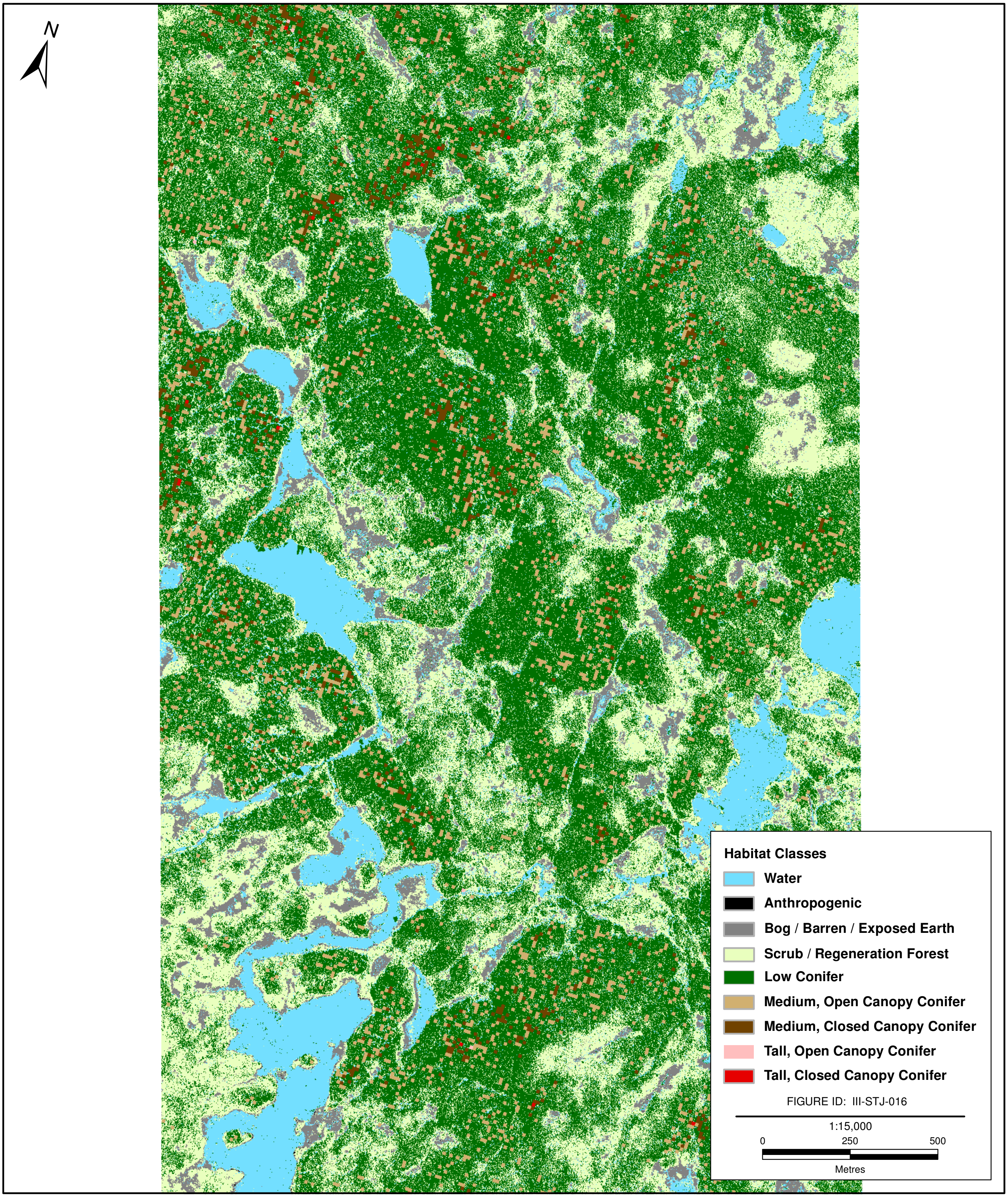
Labrador - Island Transmission Link: Marten Habitat Potential Mapping



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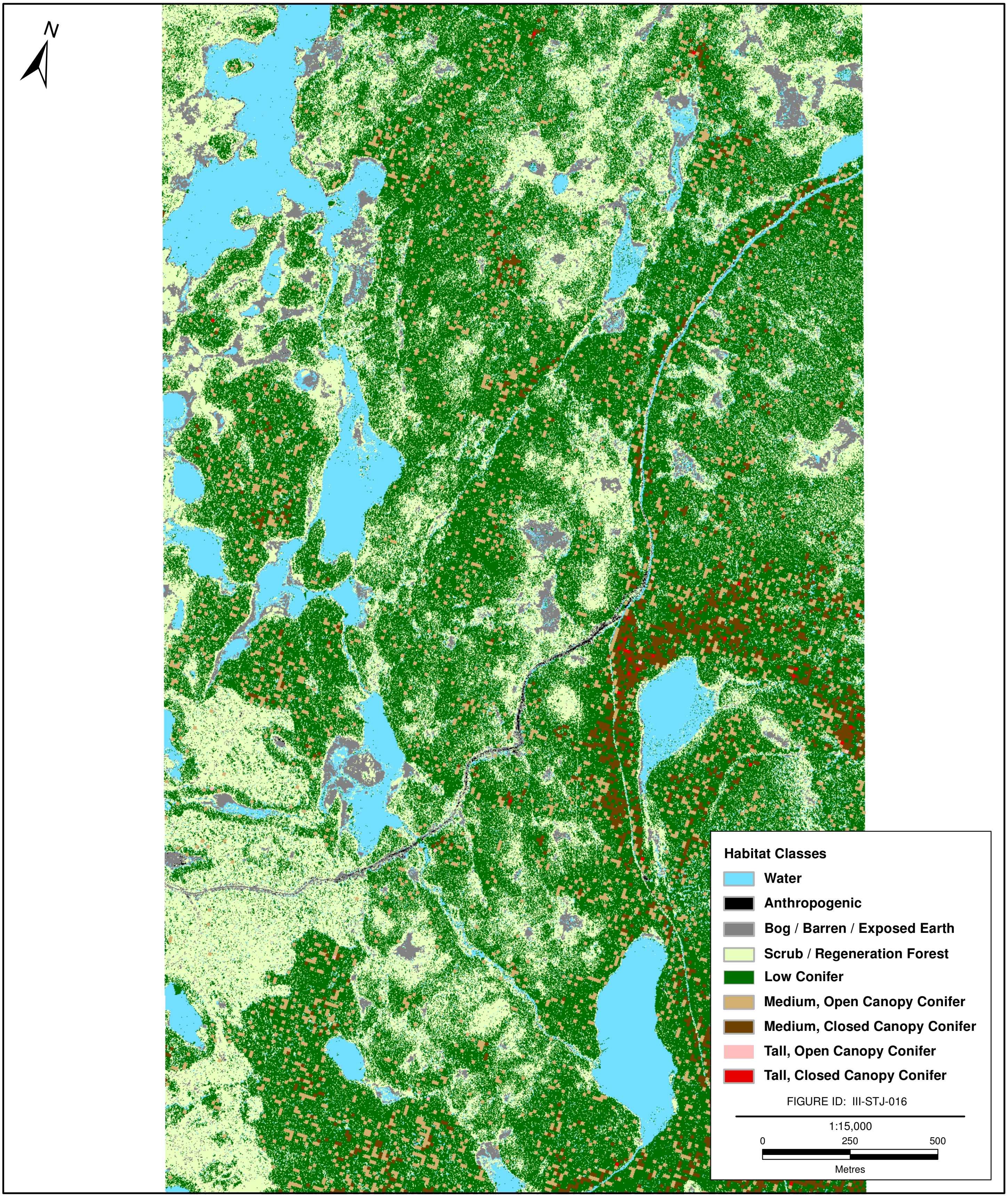
Labrador - Island Transmission Link: Marten Habitat Potential Mapping



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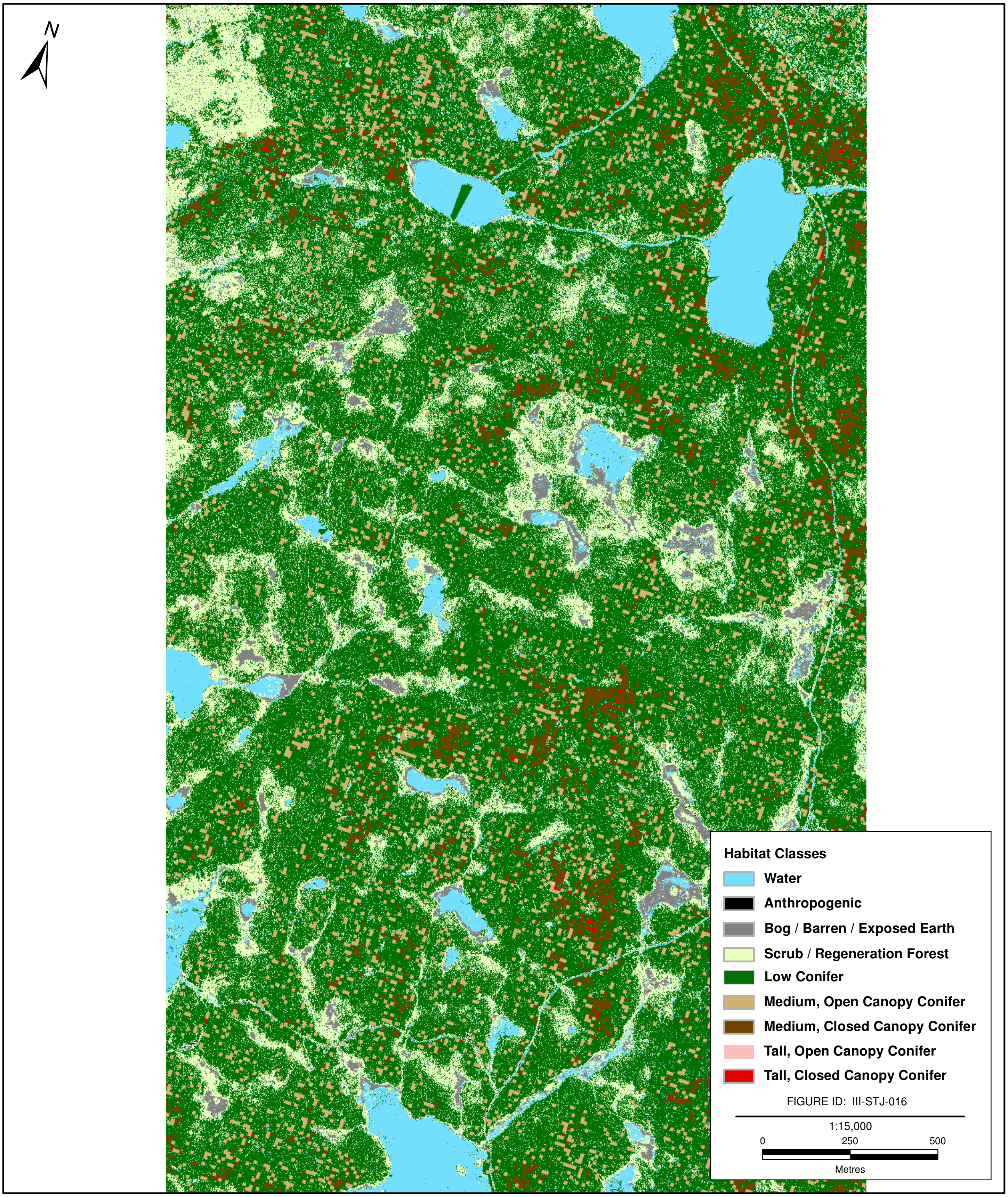
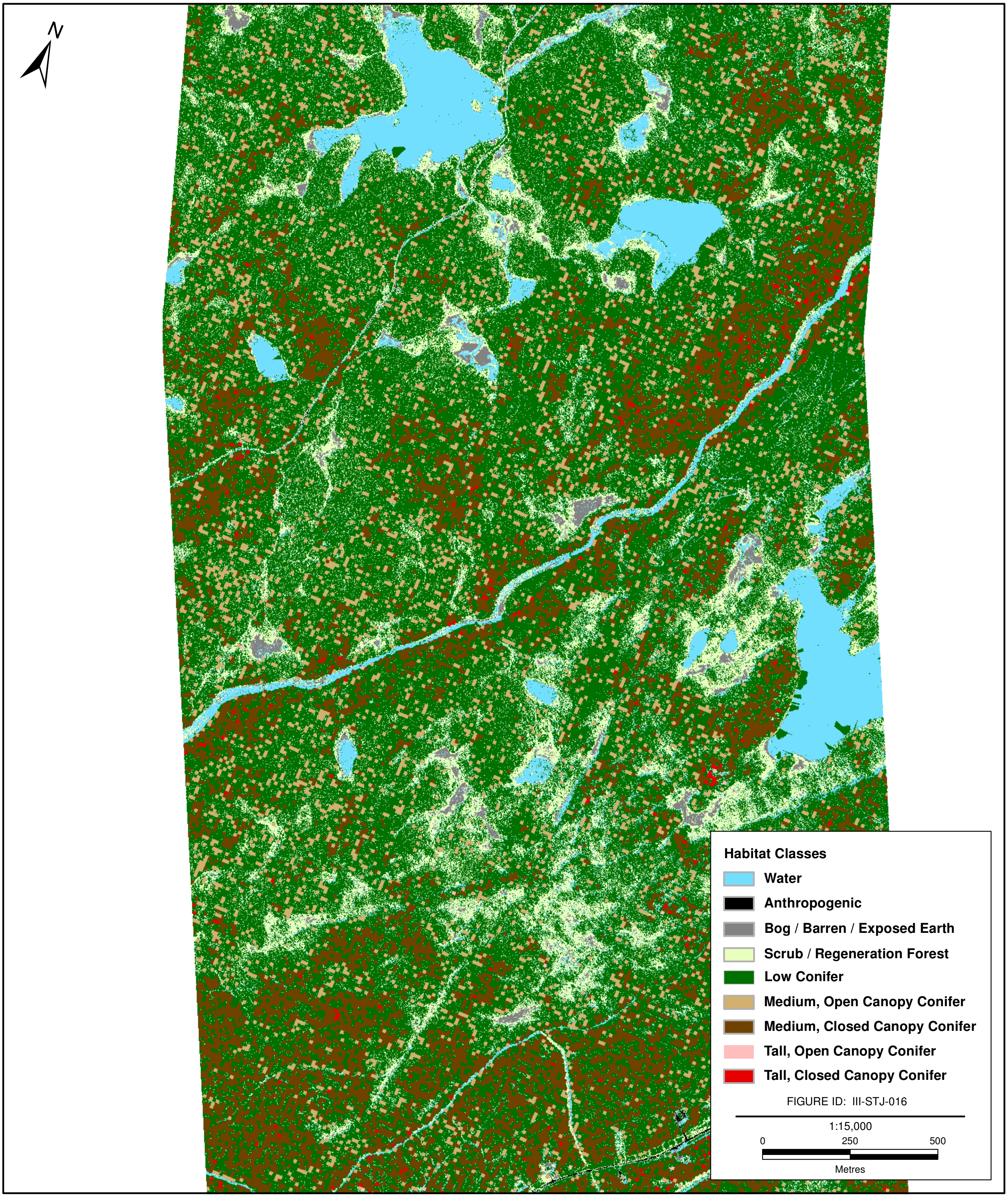
Labrador - Island Transmission Link: Marten Habitat Potential Mapping



Map 17 of 20

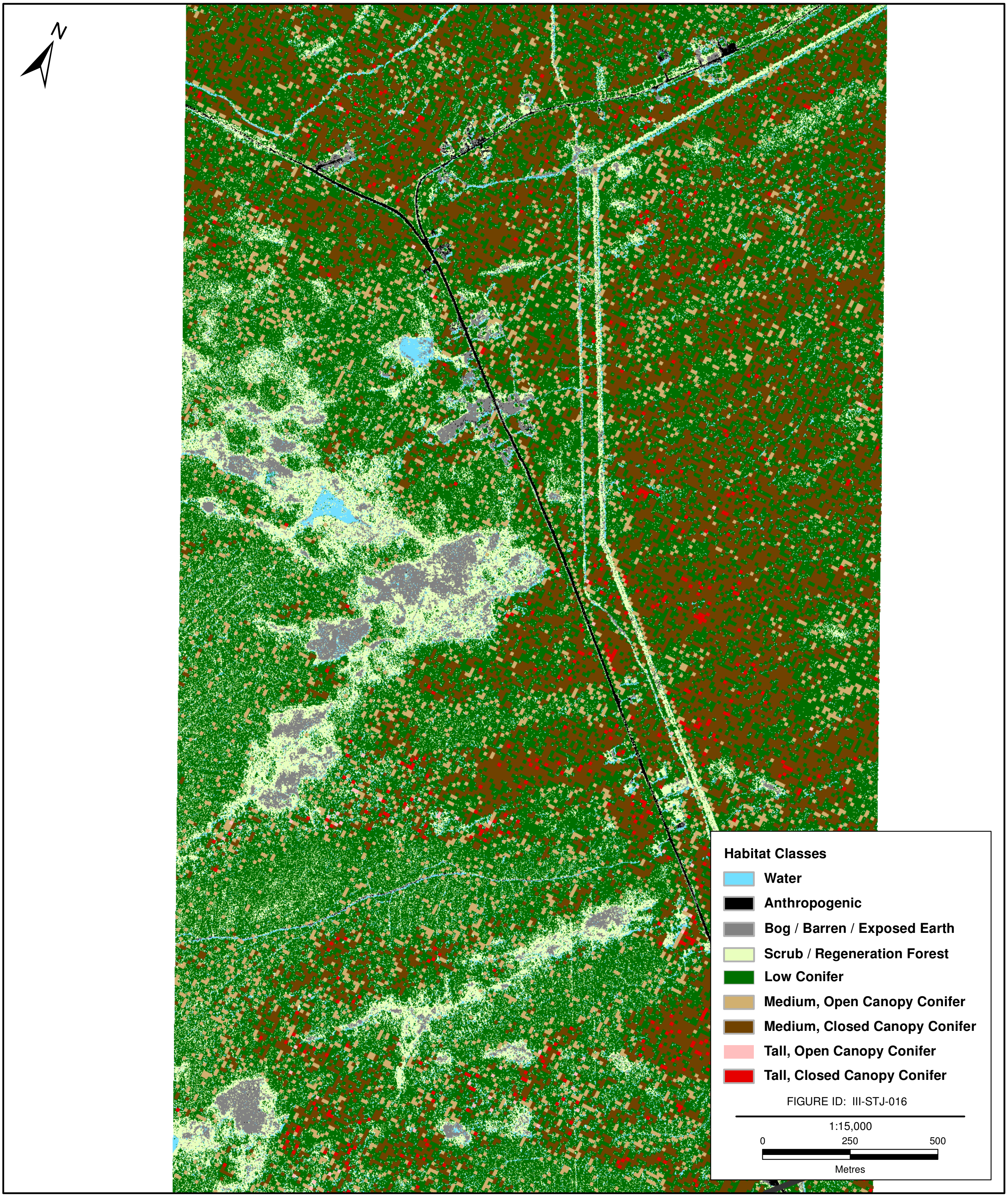
Labrador - Island Transmission Link: Marten Habitat Potential Mapping



Map 18 of 20

nalcor energy

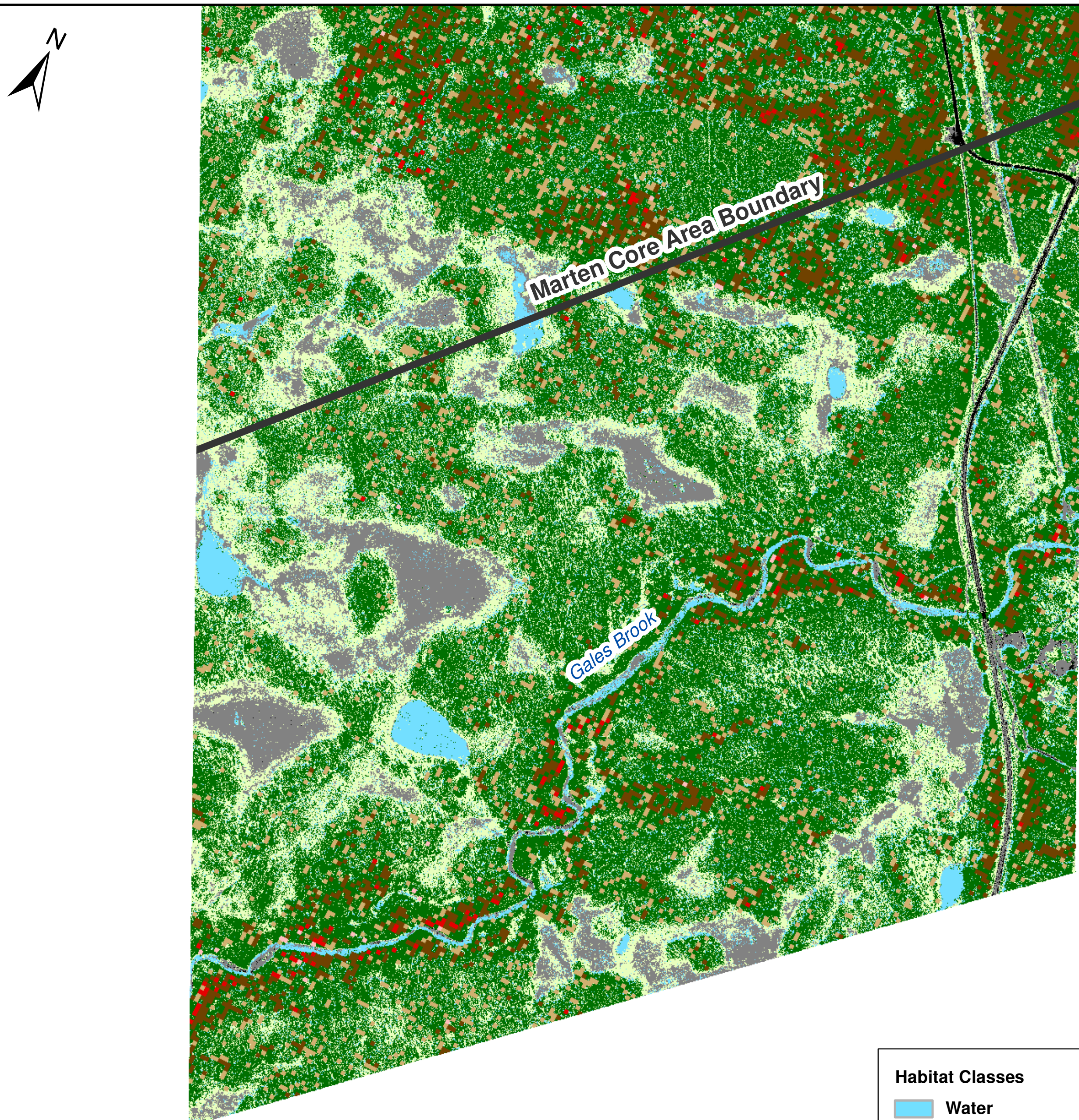
Labrador - Island Transmission Link: Marten Habitat Potential Mapping



nalcor energy

Map 19 of 20

Labrador - Island Transmission Link: Marten Habitat Potential Mapping



Habitat Classes

- Water
- Anthropogenic
- Bog / Barren / Exposed Earth
- Scrub / Regeneration Forest
- Low Conifer
- Medium, Open Canopy Conifer
- Medium, Closed Canopy Conifer
- Tall, Open Canopy Conifer
- Tall, Closed Canopy Conifer

FIGURE ID: III-STJ-016

1:15,000

0 250 500

Metres

nalcor energy

Labrador - Island Transmission Link: Marten Habitat Potential Mapping

3.0 SUMMARY

The objective of this study was to identify and map the various forest habitat types and other characteristics that occur within a portion of the Project's proposed transmission corridor that passes through an identified marten core area (55 km long corridor segment) and proposed critical habitat area (27.7 km long segment) on the southern end of the Island of Newfoundland's Northern Peninsula.

A total of nine habitat types were identified and used in this mapping exercise, including those referenced in the recent literature as being relevant to marten - either as potential or unlikely habitat - as well as the nature and resolution of the spatial imagery.

This current study does not evaluate or rate the potential and relative importance of each forest habitat type for marten in this area. Rather it was intended to investigate and illustrate the presence and distribution of these forest habitat types across this portion of the proposed transmission corridor at a relatively fine scale and level of detail. This analysis and mapping exercise provides information for general use in the Project's EA, as well as for future Project design and planning, including as input to the eventual selection of a specific right-of-way for the proposed transmission line through this area.

This report is intended to provide an initial overview of the mapping process and outputs, for consideration in the EA. This information and mapping is contained in a GIS system, and can therefore be updated and refined as required – including in assessing the likely importance of each habitat type for marten, in consultation with the NL Wildlife Division and/or other relevant parties - to help facilitate that planning process.

4.0 REFERENCES AND PERSONAL COMMUNICATION

Hearn, Brian J., Daniel J. Harrison, Angela K. Fuller, Cyril G. Lundrigan, and William J. Curran. (2010). Paradigm Shifts in Habitat Ecology of Threatened Newfoundland Martens. *Journal of Wildlife Management* 74(4):719–728

Herdman, Emily PhD. Ecosystem Management Ecologist, Endangered Species and Biodiversity, Wildlife Division Department of Environment and Conservation, Government of Newfoundland and Labrador, Corner Brook, NL. Email correspondence, May 6, 2011.

NL DEC (Department of Environment and Conservation, Wildlife Division). (2010). Species at Risk. Last Updated: December 9, 2010 *http://www.env.gov.nl.ca/env/wildlife/endangeredspecies/index.html*

NMRT (Newfoundland Marten Recovery Team). (2010). Recovery Plan for the Threatened Newfoundland Population of American marten (*Martes americana atrata*). Wildlife Division, Department of Environment and Conservation, Government of Newfoundland and Labrador, Corner Brook, NL.