Appendix D1:

Description of GIS Approach to Identifying the Best and Most Important Opportunities to Conserve Forest Ecosystems

A. Background

Forests are the dominant natural land cover in New Hampshire's coastal watersheds, occupying about 70% of the land area. Identifying and conserving the best remaining examples of our forest ecosystems is an important component of this plan because unfragmented forests provide essential plant and wildlife habitat, filter and purify water, offer extensive recreational opportunities, and provide timber and other products that support local economies and human needs.

In this region, forests are dominated by Appalachian oak-pine (white oak, black oak, hickories, white pine) and hemlock-beech-oak-pine communities. These dominant forest types, which scientists refer to as the "matrix forest," occur in a complex mosaic interspersed with smaller "patch" natural communities, a pattern driven by topography, landscape position, elevation, aspect, soils, hydrology, and other environmental factors.

We developed a GIS-based model and analysis for identifying optimal areas to conserve and restore functional core forest conditions in New Hampshire's coastal watersheds. By "functional core forest" we mean forest that has sufficient ecological integrity – as measured by size (in areal extent), condition (species composition, structure), and landscape context (buffer, connectivity) - to support interior forest habitat conditions, to be a source area for interior forest species, and to be resistant and resilient over time to expected natural disturbances. We emphasize unfragmented forest blocks, and especially those with significant area of "interior" forest. We intentionally use the term "forest ecosystem" to reflect that these unfragmented habitat blocks, while typically dominated by forest, also include wetlands and water features that comprise a healthy and productive ecosystem.

The model utilizes three data layers:
1) Unfragmented forest blocks
2) Aggregated forest blocks
3) High quality stream watersheds

We describe each of these data layers below, and explain the model weighting system.

B. Contributing Data Sets

1. Unfragmented Forest Blocks

We use the term "forest blocks" to include the range of natural habitats and naturally occurring land cover types such as forests, wetlands, streams, and ponds. **Unfragmented forest blocks** are defined as *forestland and embedded natural habitats and naturally occurring land cover types - such as forests, wetlands, streams, and ponds – that are not bisected or otherwise significantly fragmented by publicly accessible roads, powerlines, railroads, or other development.* The best and most important examples of these blocks are large enough to:

a) absorb and be resilient to infrequent, devastating natural disturbances such as fire, hurricane, or ice storm; and,
b) encompass and support a suite of characteristic forest interior species at abundance levels that ensure viable populations over time.

Model Weighting Considerations:
We highlight larger unfragmented forest blocks that are regionally significant, as well as smaller blocks with more localized significance.

Regionally significant forest block size classes:

>10,000 acres
- reasonable confidence in the ability to absorb and be resilient to large-scale fires in Oak-Pine forests and downbursts
- provides effective breeding habitat for most neotropical forest interior birds, and for 25 barred owl female territories

5,000 - 9,999 acres
- reasonable confidence in the ability to absorb and be resilient to hurricanes and medium-scale fires
- provides effective breeding habitat for some neotropical forest interior birds, and for 25 pileated woodpecker or broad-winged hawk female territories

1,000- 4,999 acres
- reasonable confidence in the ability to absorb and be resilient to smaller-scale natural disturbances such as wind-throw, blowdowns, and natural gap dynamics
- provides some core, interior forest with no edge effects

Locally significant forest block size classes:

500-999 acres
- may provide habitat for some interior forest species with smaller area requirements

250-499 acres
- provides minimal habitat for interior forest species, however blocks of this size are often locally important for recreational opportunities, neighborhood greenspace, or localized ground-water protection

2. Aggregated Blocks

Although all fragmenting features have *some* ecological impacts, not all fragmenting features have insurmountable fragmenting impacts. Therefore, we aggregate contiguous truly unfragmented forest blocks into *relatively unfragmented* blocks. TNC has used similar thinking as the basis for delineating matrix forest blocks in ecoregional planning efforts. Our aggregation process is intended to highlight relatively unfragmented groups of forest blocks that retain sufficient ecological cohesiveness and functionality for forest ecosystem viability (e.g., wildlife movement, seed dispersal, key ecological processes can occur). Many species of wildlife (especially birds and mammals) are able to move, without excessive mortality, across small roads and other fragmenting features if the feature width, adjoining development and traffic use patterns are not excessive. Similarly, many small fragmenting features do not serve as significant barriers to seed dispersal.

Our aggregate blocks were delineated by major highways and roads, including interstates, state highways and turnpikes, and other large and high-traffic roads. Once we had identified an

Aggregated Block boundary, we determined the *functional core forest acreage* of the aggregated block by summing the total acres of each Unfragmented Forest Block ≥ 500 acres within the Aggregated Block. For example, the total acreage within an Aggregated Block polygon could equal 60,000 acres, but the acreage within the Aggregated Block comprised of internal blocks ≥500 acres might only total 45,000 acres. We used the latter figure, which we consider to be the functional core forest acreage of the Aggregated Block.

Model Weighting Considerations:
Aggregated Blocks were grouped and weighted according to the following six size classes:
2,500 - 5,000 acres
5,000 – 9,999 acres
10,000 – 19,999 acres
20,000 – 39,999 acres
>40,000 acres

3. High Quality Stream Watersheds

These small stream catchment watersheds were generated as part of the U.S. Geological Survey SPARROW water quality model. We identified four top Tiers representing small watersheds with the highest landscape integrity and water quality. Tiers were stratified by breaks in population density, developed land cover, and agricultural land cover that span what might be understood as a "rural" landscape. For additional information, refer to write-up under "Best Opportunities to Conserve Freshwater Systems."

Model Weighting Considerations:
We adapted the SPARROW model to identify four tiers of high quality watersheds, with Tier 1 being the highest quality and meeting EPA standards as a "reference" catchment.

Tier 1- Reference Catchments
- Population density <20 persons/sq. mile
- % developed landcover <1%,
- % agricultural landcover <5%

Tier 2
- Population density <36 persons/sq. mile
- % developed landcover <2%,
- % agricultural landcover <5%

Tier 3
- Population density <64 persons/sq. mile
- % developed landcover <3%,
- % agricultural landcover <5%

Tier 4
- Population density <90 persons/sq. mile
- % developed landcover <5%,
- % agricultural landcover <5%

C. Co-Occurrence Model Weighting

The three data layers (or key variables) described above were overlaid to create a co-occurrence model. We gave primacy to the Unfragmented Forest Block Size data layer because this feature is linked tightly with potential core forest values. We derived a composite model score by summing the score assigned to each polygon for each of the five key model variables (see Table D1-1 below).

Table D1-1. Forest Ecosystem Co-Occurrence Model Scoring System.

Model Data Layer (Key Variable)	Scoring Class	Score
Unfragmented Forest Blocks	*Area in Acres*	
	250-499	5
	500-999	8
	1,000 – 4,999	14
	5,000 – 9,999	18
	>10,000	20
Aggregated Blocks	*Area in Acres*	
	2,500 – 4,999	4
	5,000-9,999	6
	10,000-19,999	8
	20,000-39,999	9
	≥ 40,000	10
High Quality Small Watersheds	*Aggregate of land cover and population density metrics*	
	Tier 4	5
	Tier 3	7
	Tier 2	9
	Tier 1	10

D. Identification of Best Remaining Opportunities to Conserve Forest Ecosystems

We identified the highest value areas through a statistical analysis of the forest ecosystem model results. The forest blocks remaining in the coastal and southern portion of the watershed, located east of Route 125 and south of Route 101, are substantially smaller and more disjunct as compared to those in the upper watershed located west of Route 125 and north of Route 101. Because of this disparity, we were concerned that from a watershed scale analysis, very few coastal forest areas would emerge as important for conservation. It is very important to identify and conserve remnant forest blocks in close proximity to the coast for the benefit of wildlife, native plant communities, and coastal water quality. Therefore, we decided to do parallel but independent statistical analyses of the upper and lower watershed forest ecosystems.

Co-occurrence model values ranged from 0-31. The model values were averaged over a 3,723 foot radius (encompassing a 1,000 acre area). For each half of the coastal watershed planning area (upper and lower), we then identified zones representing the top 20% of model values (by area). We then overlaid these zones, represented by contour lines, on top of the raw co-occurrence model results to determine the best remaining opportunities to conserve forest ecosystems. The vast majority of these "best opportunities" are reflected in the Conservation Focus Areas.