Appendix D2:

Description of GIS Approach to Identifying the Best and Most Important Opportunities to Conserve Freshwater Resources

A. Background

Freshwater resources in conservation planning studies typically embrace a wide range of natural resource features, including not only surface water features such as lakes, ponds, rivers and streams, but also wetlands and groundwater resources such as stratified drift aquifers. The water quality and habitat goals of this plan emphasize surface water resources over groundwater; however, aquifers and public water supplies are mapped as part of this study and are included in the published materials for use as reference datasets. Rivers and streams are given emphasis over lakes and ponds in this study because they have a greater overall impact on coastal water quality and living resources, provide important habitat for many species of conservation concern, and serve as important regional connectivity zones.

Aside from floodplain forests, freshwater wetlands are not included in this data composite. Note that coastal and estuarine water resources are also addressed in a separate section.

The integrity and health of our freshwater ecosystems are important not only to overall water quality within the coastal watersheds and the marine environment, but also because they directly relate to the critical habitat structure, function and processes necessary to maintain biodiversity unique to aquatic and marine environments. Although many conservation plans recognize freshwater resources, we sought to go a step further by identifying a subset of these resources with special significance for living resources and water quality.

We utilized three key datalayers for the freshwater systems analysis:
1) High quality stream watersheds
2) Riparian zones on streams and rivers
3) Important stream reaches with special ecological value

These datalayers are described below, including brief conceptual information and assumptions made in processing each datalayer.

B. Contributing Datasets

1. High Quality Stream Watersheds

These watersheds are comprised of small stream catchment areas defined by USGS in the SPARROW water quality model.[1] This research was originally designed to identify nitrogen and phosphorus load and yield for management and mitigation, but by reverse engineering the datasets, watersheds with high water quality can also be identified. Rather than the large, regional-scale river system delineations typically used in conservation planning, the SPARROW catchments each relate to individual stream reaches, and are generally only a few square miles in extent (the mean catchment size in the coastal study area is 590 acres). This relatively fine

[1] Moore, R.B., C.M. Johnston, K.W. Robinson, and J.R. Deacon. Estimation of total nitrogen and phosphorous in New England streams using spatially referenced regression models. Scientific Investigations Report 2004-5012. U.S. Geological Survey, New Hampshire.

spatial resolution allows water quality profiling within relatively small land areas and serves as a valuable index of environmental integrity in the natural landscape.

For the purposes of this study, there are three parameters related to water quality for each SPARROW catchment: population density, percent land cover developed, and percent land cover in agricultural use. More information is available in the SPARROW publication cited above. To improve accuracy, the original 1990s SPARROW datasets were updated using the 1998 Land Use (for Rockingham and Strafford counties), 2001 NH Land Cover Assessment Dataset, and U.S. Census 2000 population density data.

For this analysis, 193 SPARROW catchments were selected from a total of 888 catchments across the study area, representing those watersheds with highest water quality and landscape integrity. The selected catchments total about 86,000 acres in area, or about 16% of the study area. This subset, in turn, is stratified into three tiers using breaks in population density that span typical geographic definitions of "rural" landscape, and by slight increases in percent developed land cover. Note that agricultural land cover percentages remain the same throughout the tiers; 5% is the threshold value in the SPARROW model criteria for the highest ambient water quality.

- Tier 1 is the most pristine of the full range of all watersheds in the coastal watershed region, and meets the EPA definition of a "reference" catchment, that is a near-pristine, undeveloped watershed where anthropogenic nutrient inputs are minimal and against which the impacts of land use can be evaluated over time. The defining criteria are for Tier 1 are: <20 persons per square mile, <1% developed land cover, and <5% agricultural land use.
- Tier 2 is close to Tier 1 in quality, but allows for up to 36 people per square mile (the upper limit of rural population density according to conservation geographers) and up to 2% developed land cover.
- Tiers 3 and 4 move up the population density scale to the median value definition of "exurban density" – up 64 and 90 persons per square mile, respectively. The percent of developed land cover also increases to 3% and 5%, respectively.

The catchment statistics of the four tiers are as follows:

Tier	Number Catchments	Total Acreage	% of Total Coastal Watersheds Area	Mean size	Maximum Size
1	58	11,760	2.3%	213 Ac	1,316 Ac
2	44	18,190	3.5%	421 Ac	1,684 Ac
3	37	19,010	3.8%	648 Ac	6,156 Ac
4	54	34,160	6.7%	693 Ac	2,519 Ac

We also considered the effects of active dams on high quality stream watersheds. Dams have significant effects on freshwater habitats and biotic communities by acting as barriers to fish passage and other aquatic organisms, disrupting stream flow and sediment transport regimes, and destroying stream and floodplain habitat. On our maps, we display dams by their height and impoundment size; generally speaking, taller dams are more likely to be a barrier, and loss of stream habitat is proportional to impoundment size.

2. Riparian Zones: Streams & Rivers

Riparian zones comprise the natural spatial corridor along streams and rivers, formed by hydrological processes over time and defined largely by topography, but also characterized by

special plant and animal communities adapted to life on floodplains or in close proximity to watercourses. Riparian zones are frequently highlighted in conservation planning because of their singular importance for biodiversity and water quality.

These corridors may be wide or narrow depending upon the physical characteristics of the terrain and the size of the watercourse. They filter upland runoff, absorbing nutrients and helping to prevent siltation and pollutants from affecting waterbodies. Unique natural communities, such as silver maple floodplain forests, exist only in the alluvial soils along some riparian corridors. Riparian forests regulate water temperature by providing needed shade, provide organic inputs that drive the food web in small streams, and contribute coarse woody debris for aquatic habitat structure. They provide important connectivity zones and habitat areas for many species of wildlife. And, riparian zones are important for regulating and storing flood waters.

To delineate a broadly meaningful riparian corridor, we applied a buffer zone of 500' on either side of a watercourse. This distance is sufficient to maintain water quality and aquatic habitat function close to the water's edge and within a distance of 100' where most stormwater drainage is cleaned and filtered naturally; it also allows space and cover for other wildlife corridor/habitat functions of species ranging throughout the corridor, such as river otter and many turtles. This buffer zone has been placed uniformly along all streams in the study area, ranging from 1st order tributary streams high in the watershed to 6th order mainstem rivers draining to the coast.

We further highlight **Floodplain Forests,** riparian areas where the physical landscape periodically floods during high water discharge events. Floodplain forests were derived from a predictive model in the New Hampshire Fish and Game Department's Wildlife Action Plan. They differ from our delineation of riparian zones in that they are based on landform and hydrologic modeling as opposed to simple buffering.

3. Important Stream Reaches

A limited number of stream or river reaches (and one lake) and their associated floodplain and riparian zones in the study area are known to have special significance for living resources, including fish species of conservation concern and globally rare species such as the brook floater mussel. The 500' buffer zone along those segments has been given special recognition.

These watercourse segments were identified by aquatic ecologists with the New Hampshire Fish & Game Department, and from records of the NH Natural Heritage Bureau. Freshwater fish species of conservation concern that occur in the coastal watersheds include: American eel, bridle shiner, banded sunfish, swamp darter, redfin pickerel, Eastern brook trout, lake trout, and brook lamprey. The table below provides information on the Important Stream Reaches and associated species of concern.

Water Body	Species of Concern	Additional Comments
Cocheco River	bridle shiner	High bridle shiner abundance, possibly an isolated population (impassable barrier)
Exeter River	brook floater mussel	-
Great East Lake	lake trout	Only water body located within this conservation plan containing lake trout (an indicator species of a cold, clear, clean, and deep lake)
Isinglass River	American eel, banded sunfish, bridle shiner	-

Jones Brook	bridle shiner	Jones Brook contains bridle shiners, which appear to be declining in NH and their entire range
Lamprey River	American eel, banded sunfish, bridle shiner, brook floater mussel, redfin pickerel, and swamp darter	-
Little River	American eel, banded sunfish, redfin pickerel	-
Mallego Brook	Eastern brook trout	-
North River	American eel, banded sunfish, bridle shiner	-
Oyster River/Chelsey Brook	American brook lamprey	Important American Brook Lamprey rearing habitat