

Estimating Historical Nitrogen Loads from the Great Bay Watershed

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Background

- *Evidence supports the assertion that the ecological condition of the Great Bay Estuary (and its sub-estuaries) has deteriorated over time.*
- *It is thought that one of the reasons for this decline is related to increasing watershed development.*
- *This watershed development driver (together with the larger-scale atmospheric driver) has likely increased ecological pressure on Great Bay due to nitrogen loading.*
- *Therefore, data on historical changes in nitrogen loading to the estuary are being sought.*



Overall Objective

*To estimate historical nitrogen load to the
Great Bay Watershed (GBW) and to the
Great Bay Estuary (GBE)*



Description of Nitrogen Loading Model (NLM)

General

- predicts total dissolved N loads
- shallow estuaries from rural - suburban watersheds
- watersheds underlain by unconsolidated sands
- groundwater flow is the dominant transport vehicle

Sources

- wastewater (via septic systems, using values for per capita contributions of N)
- fertilizer use on turf/residents
- fertilizer use in agriculture (determined from local data)
- atmospheric deposition (estimated from local data, expanded to SNE)

Sinks: Watershed Surface

- natural vegetation
- turf
- impervious surfaces

Sinks: Watershed Subsurface

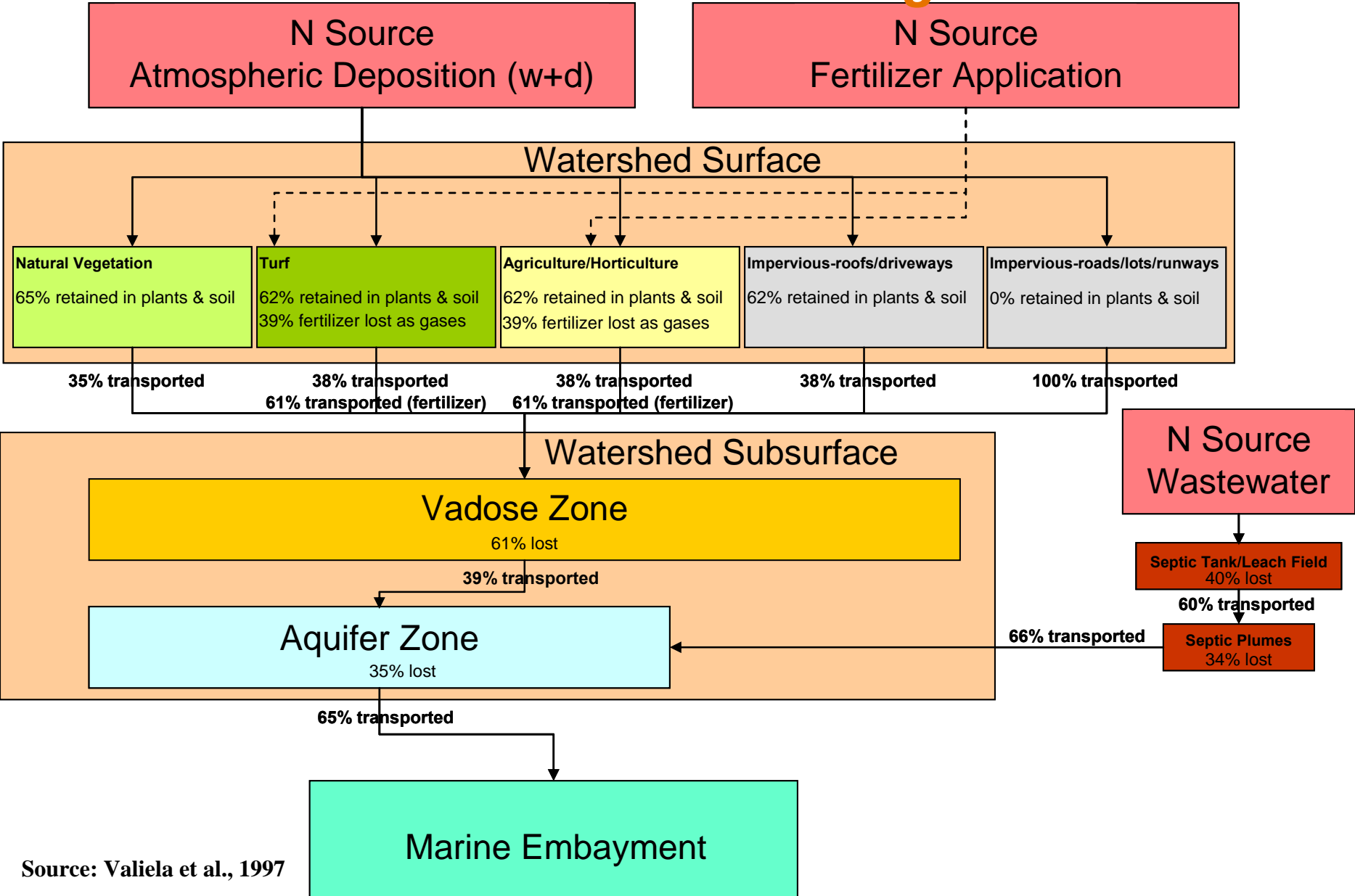
- soil
- vadose
- aquifer

Valiela, I., G. Collins, J. Kremer, K. Lajtha, M. Geist, B. Seely, J. Brawley, and C.H. Sham, 1997, Nitrogen loading from coastal watersheds to receiving estuaries: new method and application: *Ecological Applications*, v. 7, p. 358-380.

Valiela, I., M. Geist, J. McClland, and G. Tomasky, 2000, Nitrogen loading from watersheds to estuaries: verification of the Waquoit Bay nitrogen loading model: *Biogeochemistry*, v. 49, p. 277-293.



Estimation of N Load using the NLM



Source: Valiela et al., 1997



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Advantages/Disadvantages of NLM applied to GBW/E

Advantages

- Simple and consistent with conceptual understanding of N movement through watersheds
- Linked to watershed attributes and thus to watershed management options

Disadvantages

- Generally static, not dynamic (season/year)
- Model divergence:
 - GBE has significant surface water inputs
 - GBW is not underlain by unconsolidated sand
 - GBW is large and N from distant portions of the watershed is included
 - Watershed loss coefficients may not be appropriate to GBW

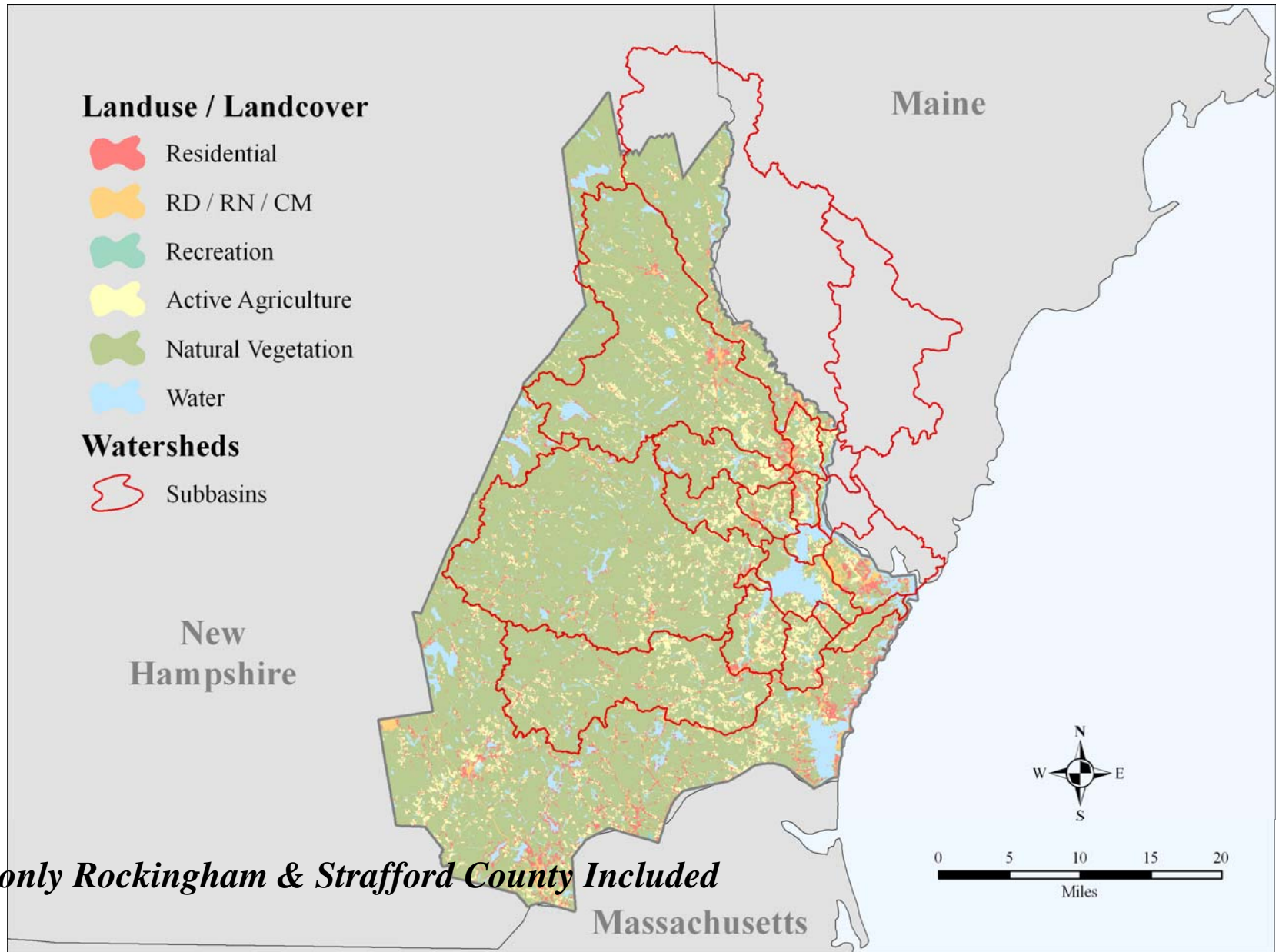


Steps (Status)

- Obtain Historical Land use/Land Cover data
(completed for 1962, 1974, 1998 – 2001, 2005 (pending))
- Aggregate LULC data into AED-NLM LU types
(just completed, needs QA check)
- Obtain Historical Wet and Dry Atmospheric Deposition Rates of N species
(pending – need data/references)
- Obtain Historical Fertilizer Application Rates
(pending – need data/references)
- Obtain Historical Wastewater Inputs (derivable from LULC and assumptions)
(pending – need data on housing density per LU)



Example of LU for GBW (1962 only)



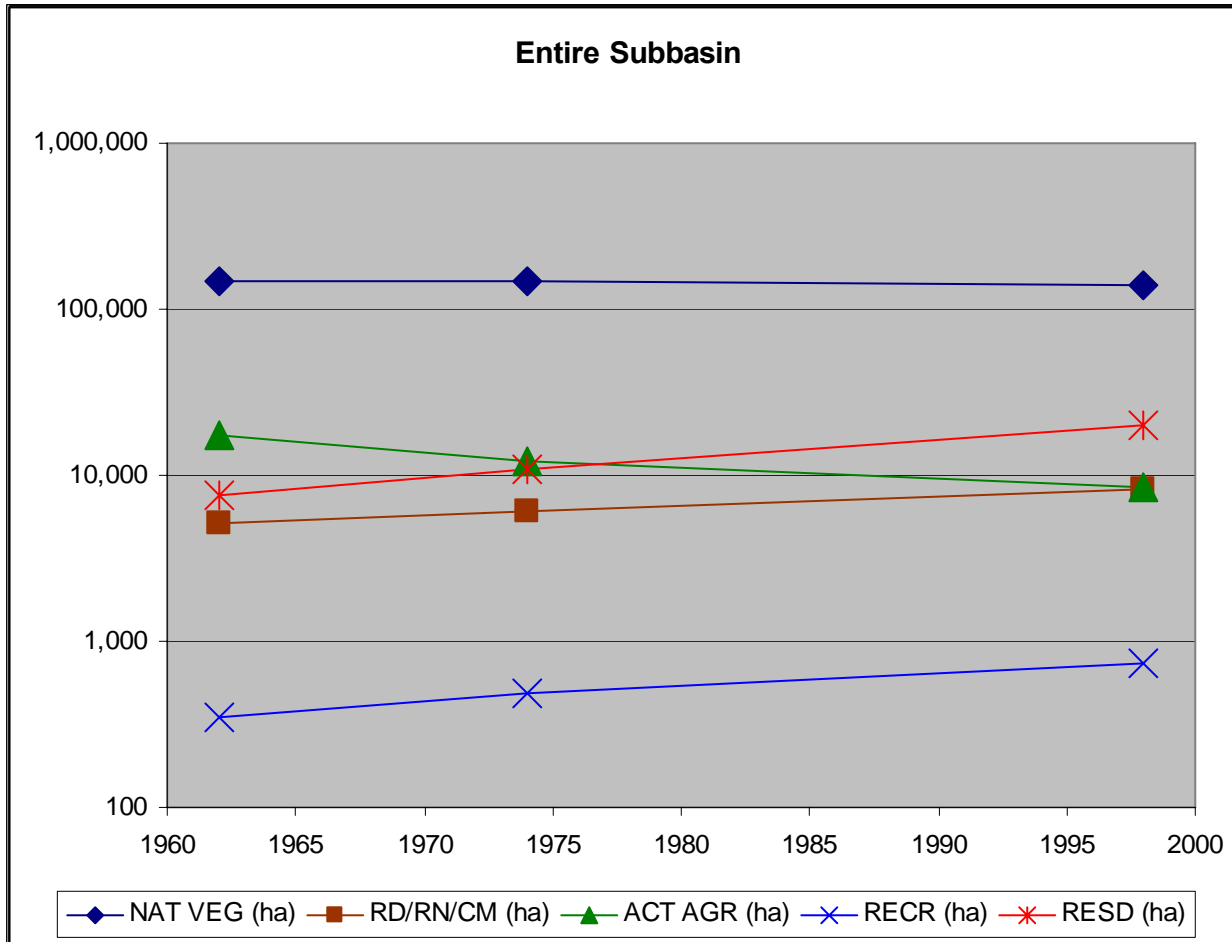
(note only Rockingham & Strafford County Included)



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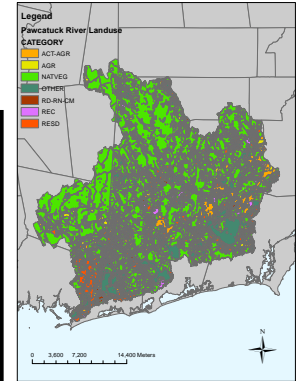
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Historic Land Use Change



Within Watershed Losses (surface and subsurface)

Atmospheric Deposition to Watershed



Input	Natural Vegetation		Turf		Agriculture/ Horticulture		Impervious Roofs/Driveways		Impervious Roads/Lots/Runways	
	% retained or transported	mass/time	% retained or transported	mass/time	% retained or transported	mass/time	% retained or transported	mass/time	% retained or transported	mass/time
Atmospheric Deposition (w+d)	100									
Retained on watershed surface	65%	65	62%	62	62%	62	62%	62	0%	0
Transported to Vadose zone	35%	35	38%	38	38%	38	38%	38	100%	100
Watershed Sub - Surface										
Loss in Vadose Zone	61%	21	61%	23	61%	23	61%	23	61%	61
Transported to Aquifer	39%	14	39%	15	39%	15	39%	15	39%	39
Loss in Aquifer	35%	5	35%	5	35%	5	35%	5	35%	14
Marine Embayment										
Transport to Marine Embayment	65%	9	65%	10	65%	10	65%	10	65%	25

Natural Vegetation includes: forests, wetlands and other natural lands

Turf includes: lawns and golf courses

Agriculture/Horticulture includes: croplands

Impervious Roofs/Driveways include: roofs and driveways adjoined by turf

Impervious Roads/Lots/Runways include: roads, runways and parking lots that discharge into catch basins

Wastewater Inputs to Watershed

Input	mg/L	% retained or transported	ISDS Wastewater into Watershed Sub-Surface	
			mg/L	mg/L
ISDS Wastewater	100		Lost	Transported
Lost in septic tank/leach field		40%	40	
Transported to septic plume		60%		60
Lost in septic plume		34%	20	
Transported to Vadose zone		66%		40
Loss in Aquifer		35%	14	
Transport to Marine Embayment		65%		26

Fertilizer Application to Watershed

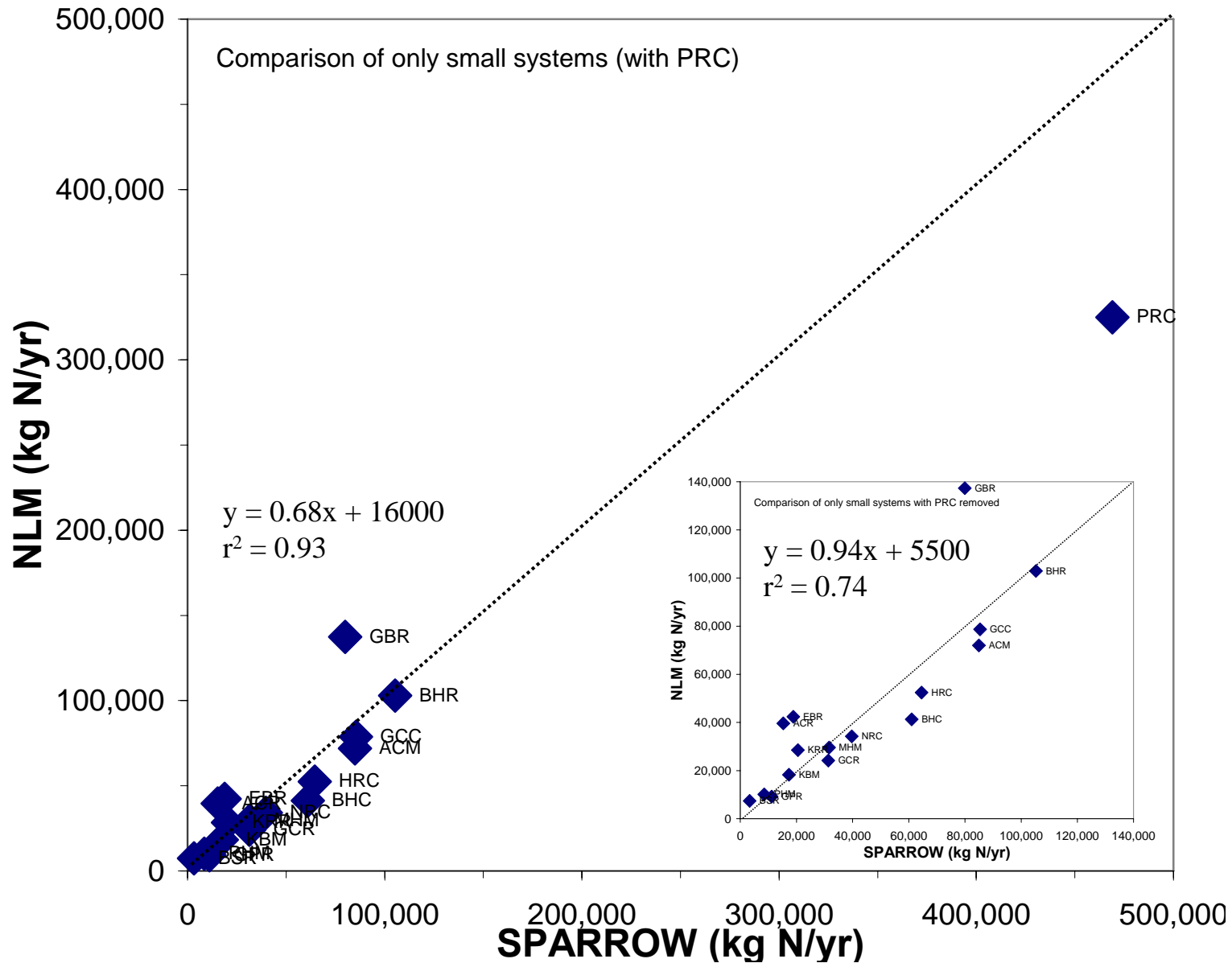
Input	Turf		Agriculture/ Horticulture	
	% retained or transported	kg/ha/yr	% retained or transported	kg/ha/yr
Fertilizer	100			
Retained on watershed surface	39%	39	39%	39
Transported to Vadose zone	61%	61	61%	61
Watershed Sub - Surface				
Loss in Vadose Zone	61%	37	61%	37
Transported to Aquifer	39%	24	39%	24
Loss in Aquifer	35%	8	35%	8
Marine Embayment				
Transport to Marine Embayment	65%	15	65%	15

Turf includes: lawns and golf courses

Agriculture/Horticulture includes: croplands



Comparison of AED-NLM to SPARROW



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