LINKING LAND INPUTS TO ESTUARINE WATER QUALITY TRENDS

Joint Meeting:

Tidal Monitoring and Analysis Workgroup and
Nontidal Water Quality Workgroup
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USGS Baltimore Science Center

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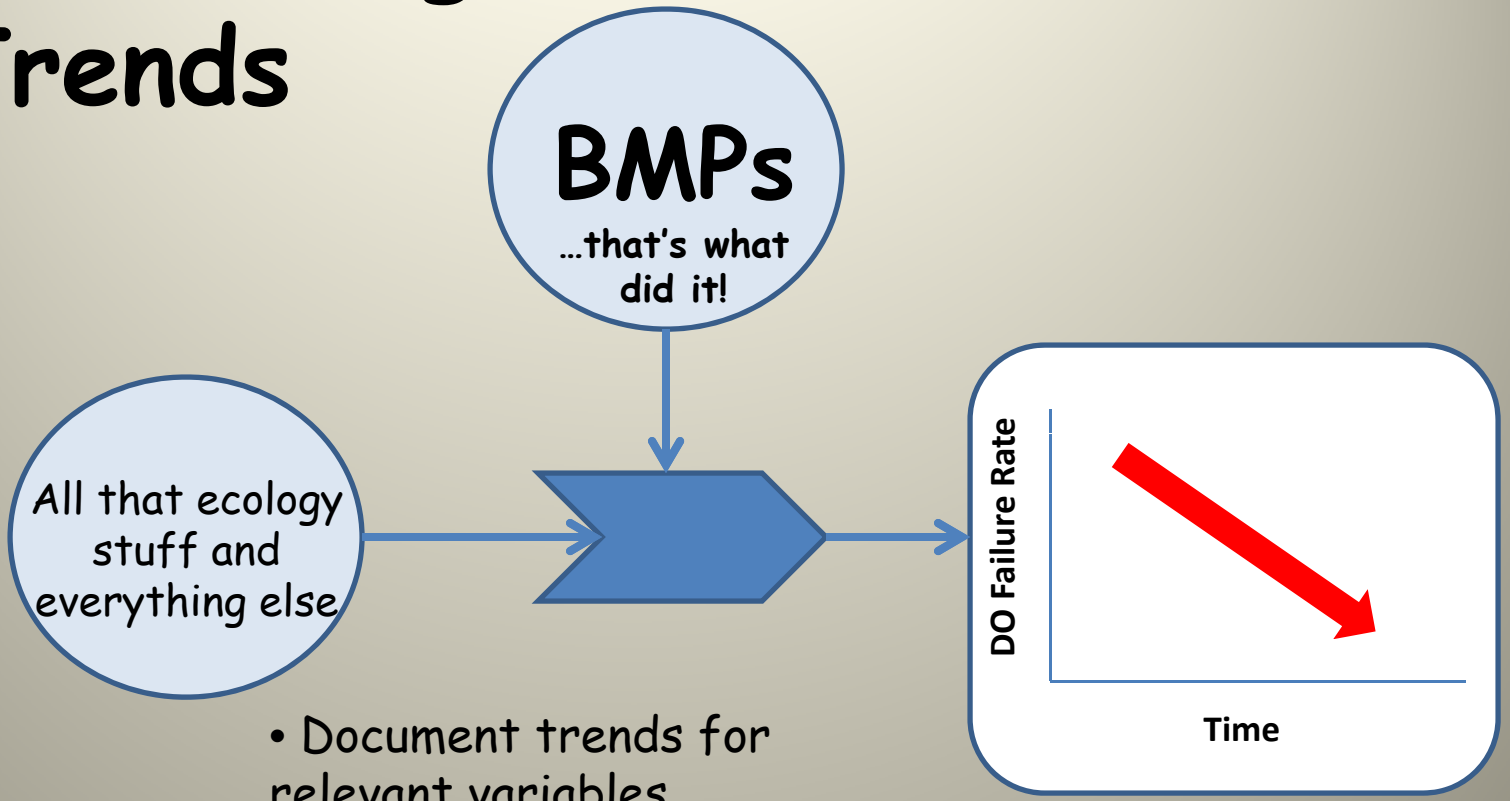
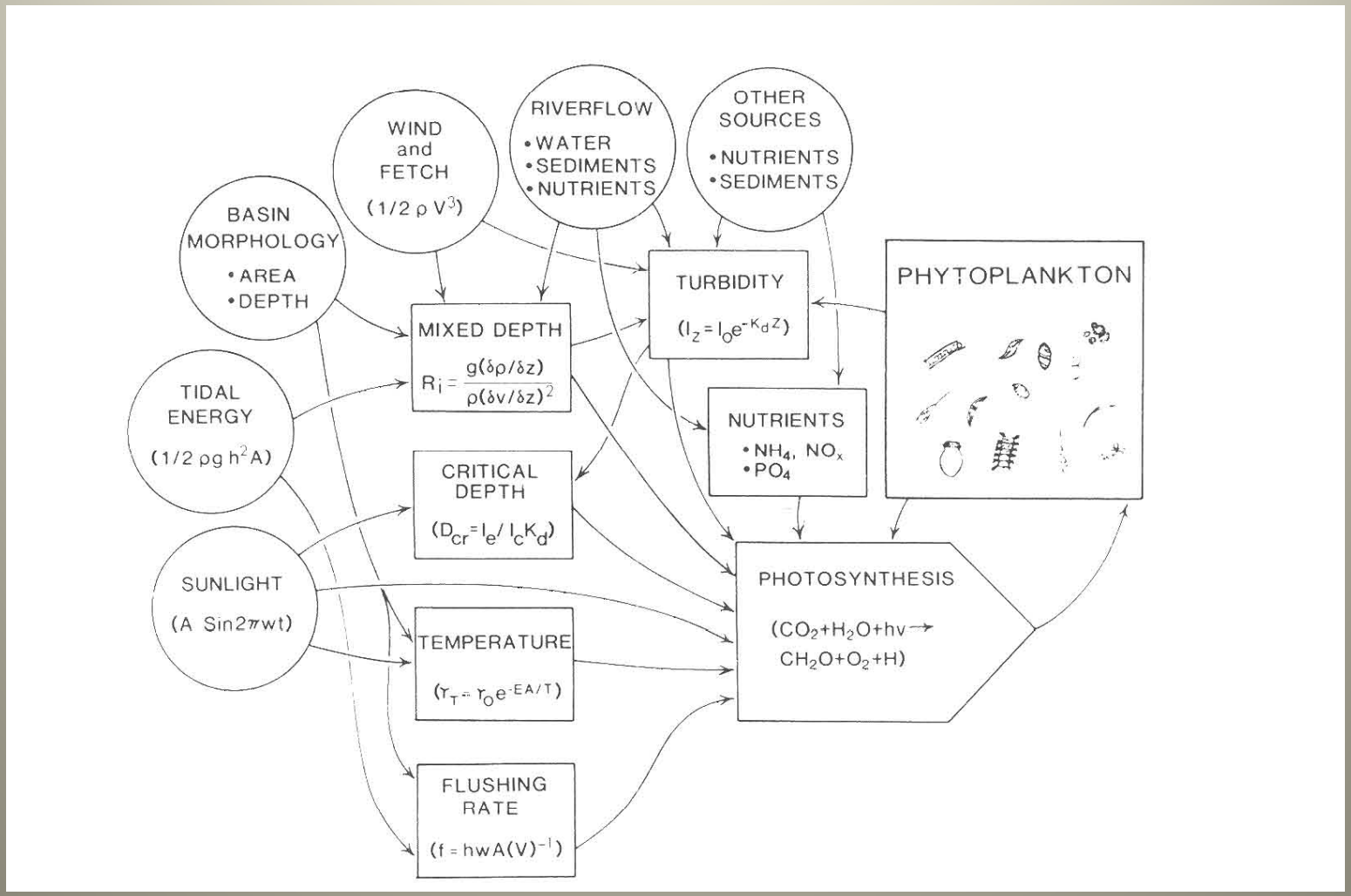
Understanding Trends



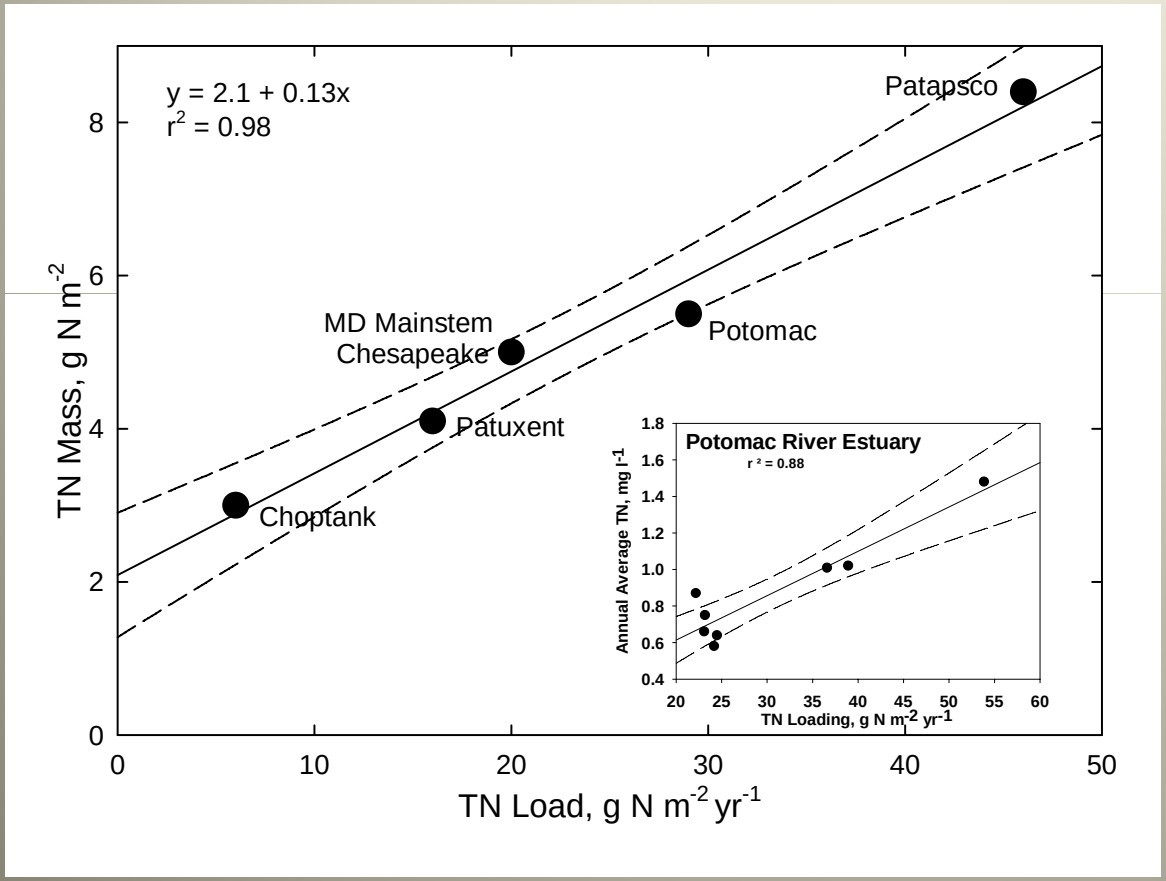
- Document trends for relevant variables
- UNDERSTAND the cause(s) of the trend(s)
- Relate trend(s) to BMPs…the effects of management…and everything else

Conceptual Models Used to Organize the Analysis:
An example…one of many



From: Boynton et al 1982

SIMPLE RELATIONSHIP LINKING LAND AND ESTUARY

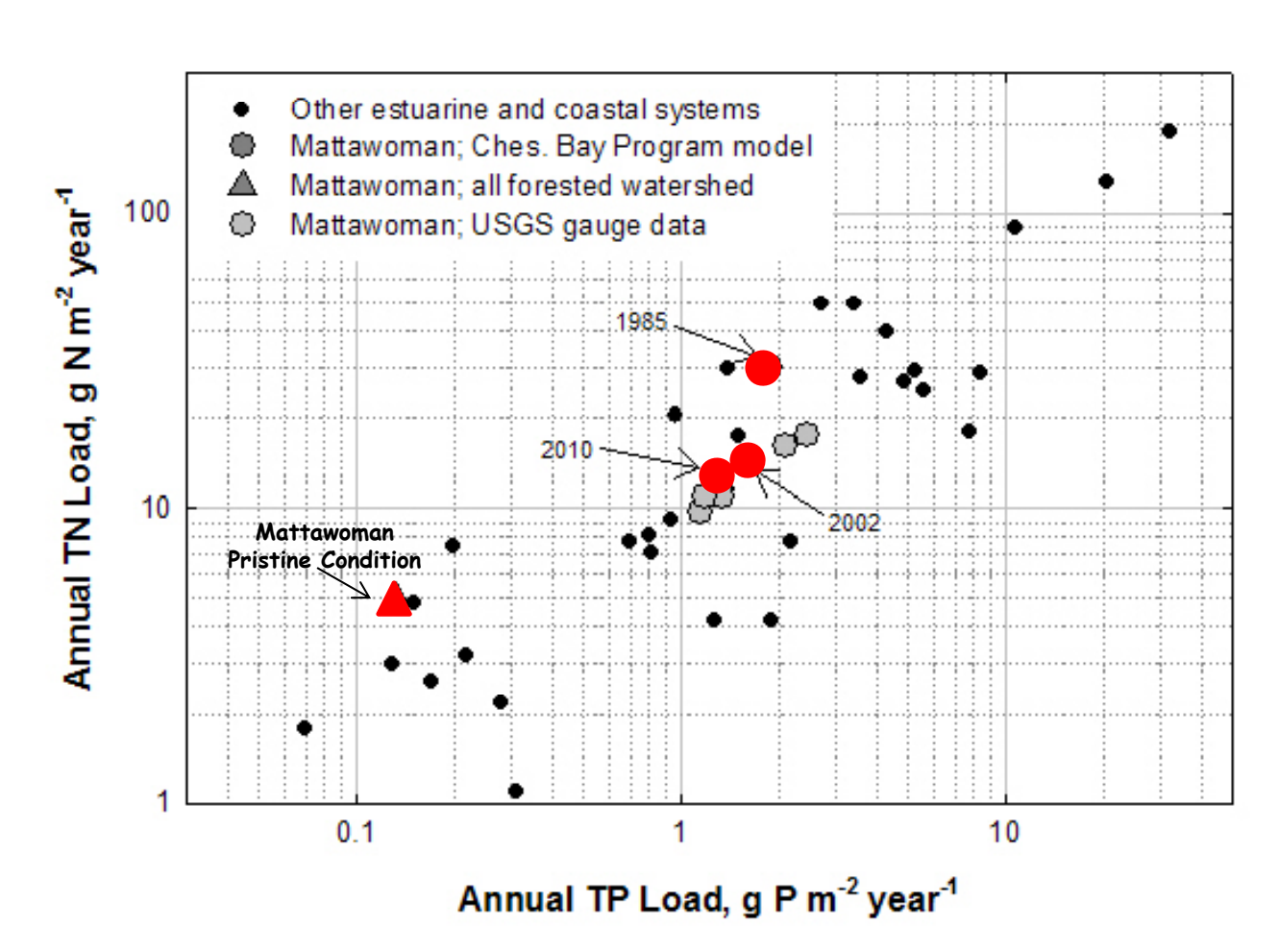


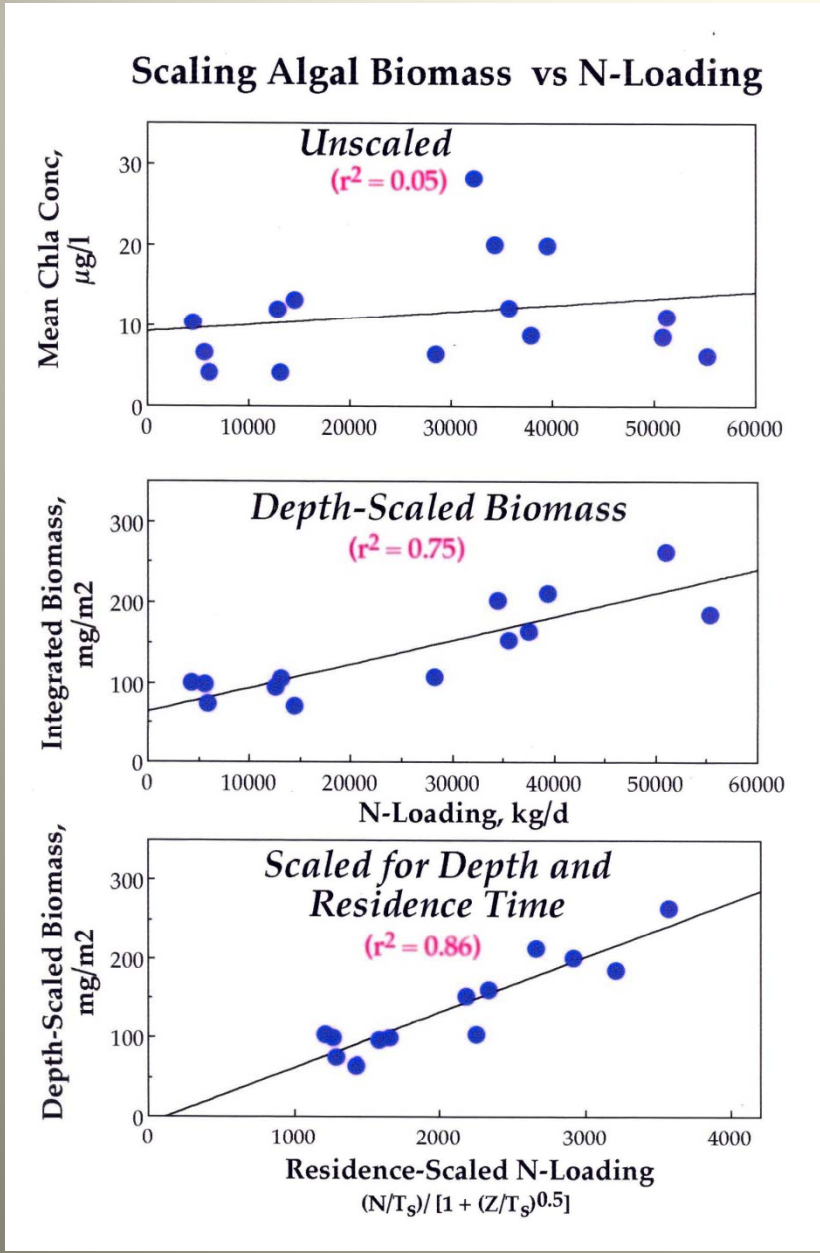
Mass of N in mesohaline regions proportional to loading rate

- Data from multiple sub-systems of the Bay
- Analysis done on annual time-scale

N and P loading rates and Changes in Loading Rates:

Several from Chesapeake Bay systems and we many more CB sites can be added





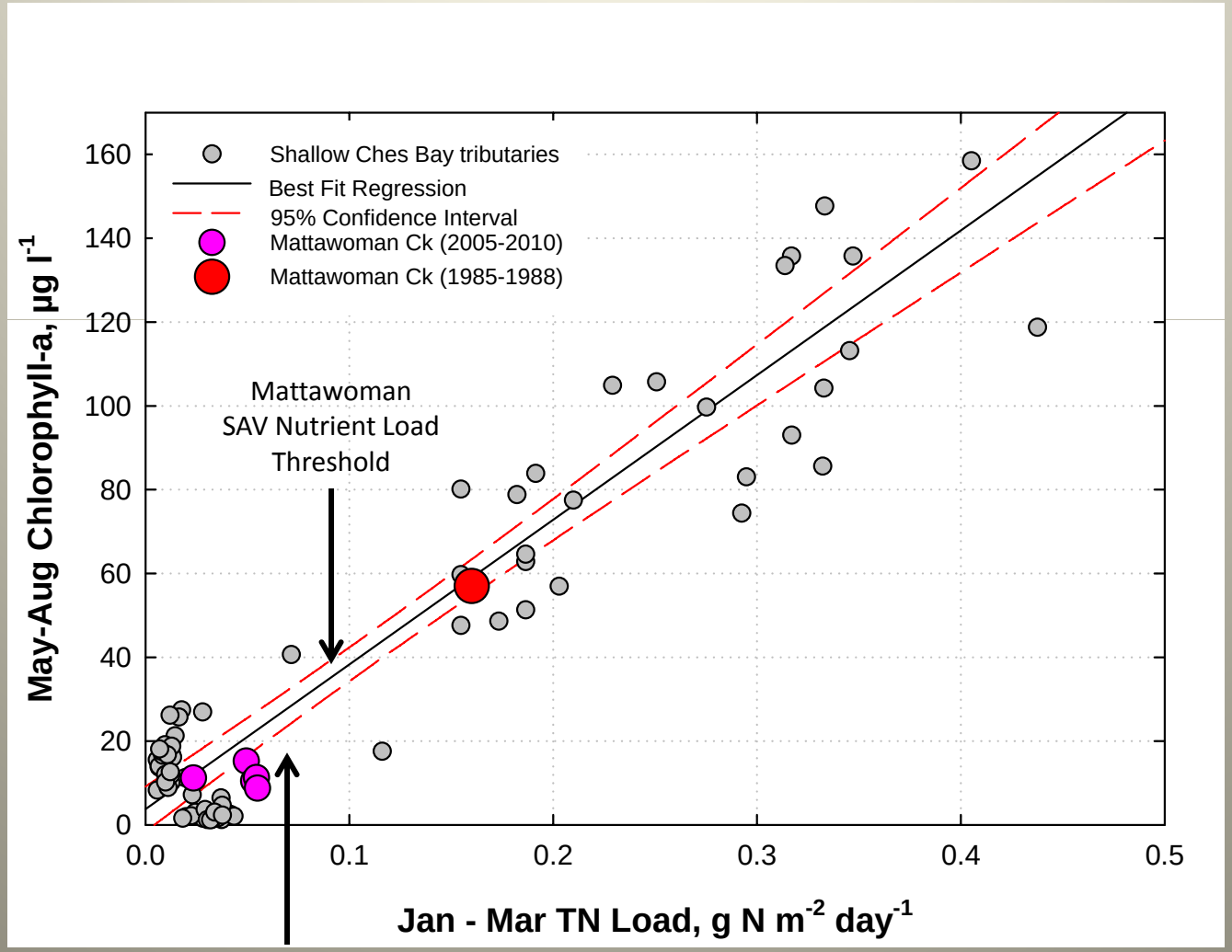
The Scaling Process

- Assemble data sets
- Using conceptual model as a guide to explore data for chlorophyll-a relationships
- Examine "residuals" from initial analyses and add variables as needed to improve relationship
- In an on-going analysis we are conducting 20 different CB estuaries are included, each with a time-series of 19 years

Boynton and Kemp 2000

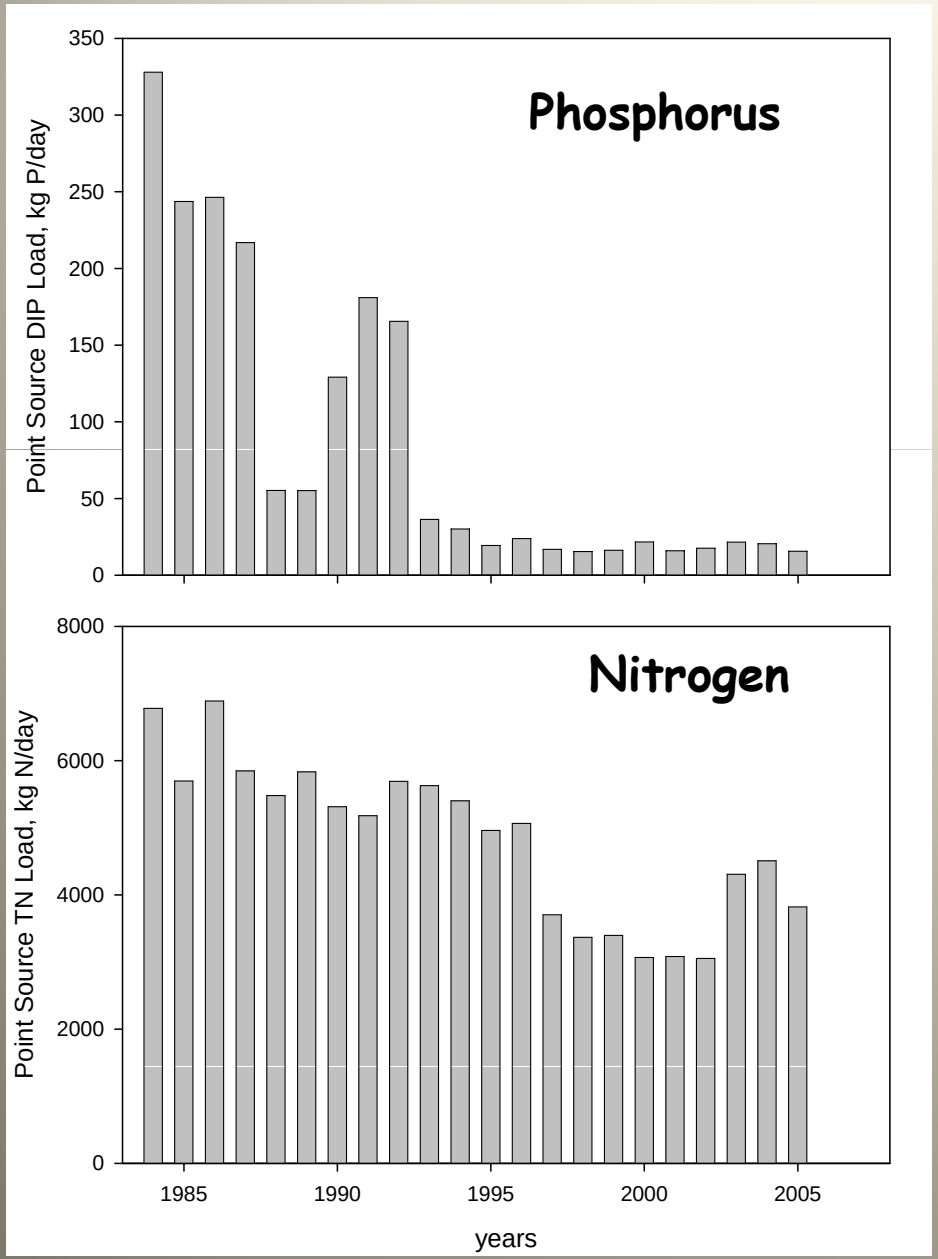
Preliminary Product:

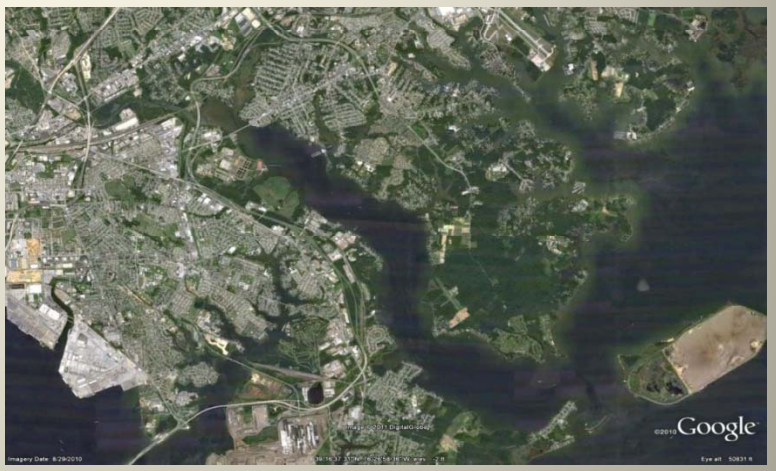
A simple "scaled" nitrogen load vs chlorophyll-a relationship



Southern New England SAV
Nutrient Load Threshold

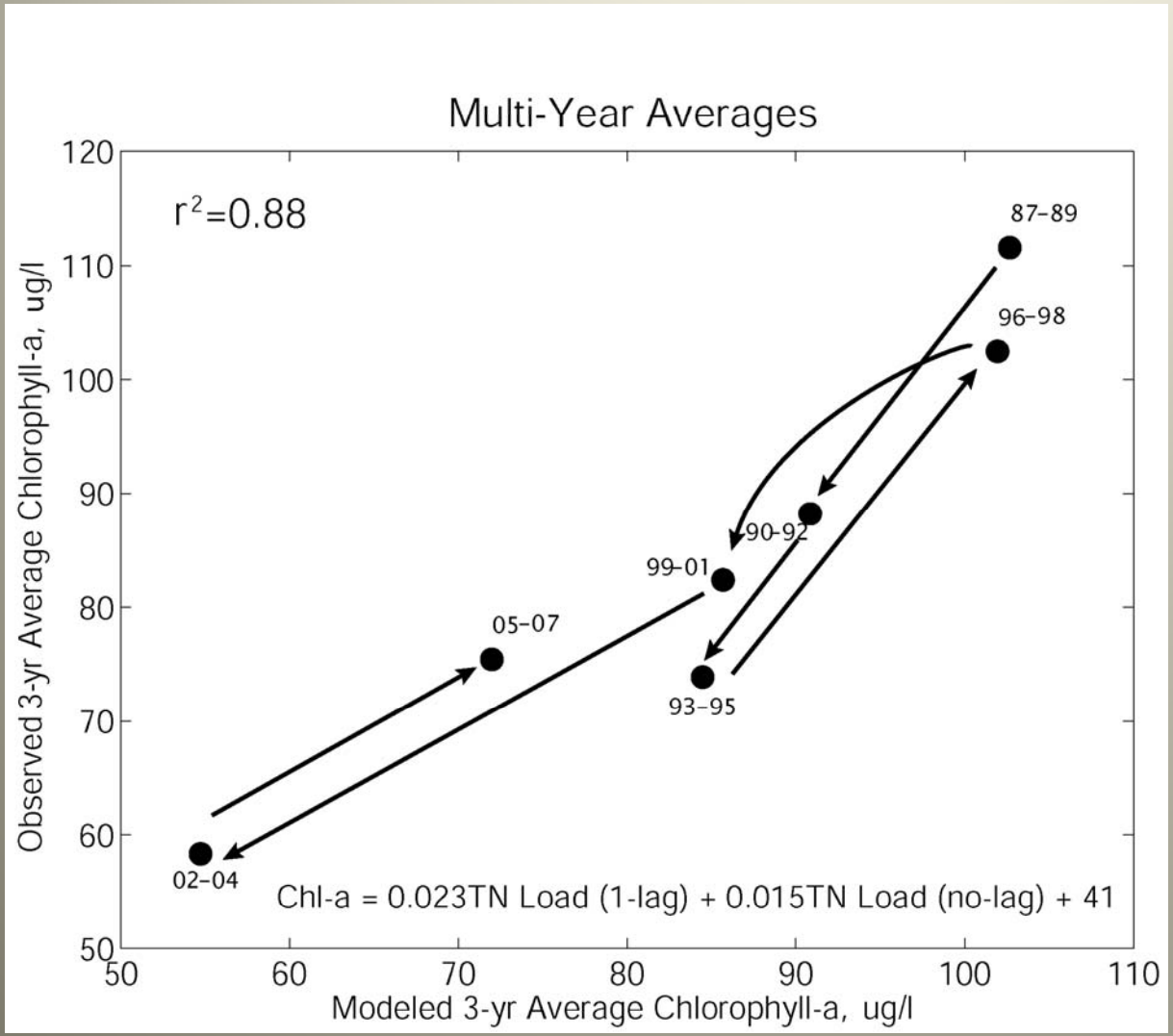
Examples of WWTP Load Reductions: Back River





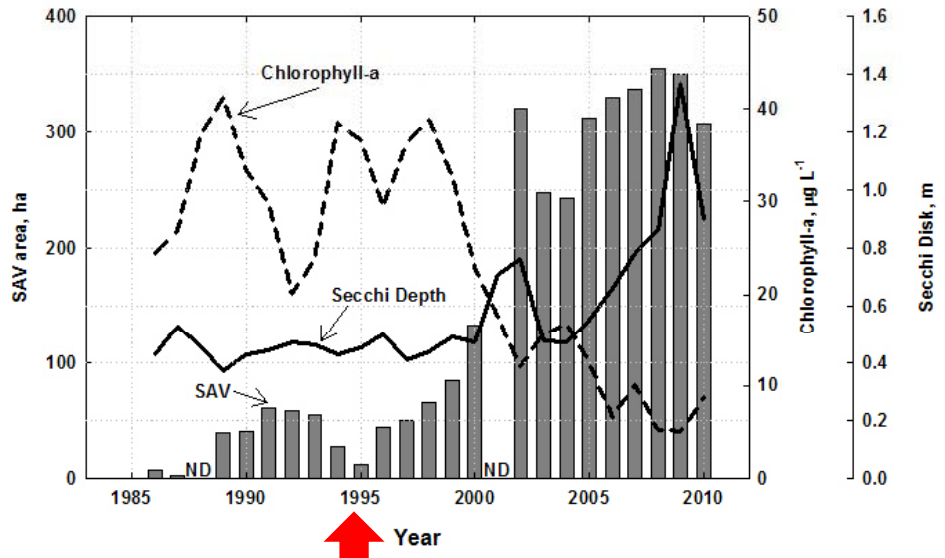
- Good engineering works!
- P loads very reduced.
- N loads also reduced.
- TSS and BOD_5 also greatly reduced

Chlorophyll – Nutrient Load Relationship

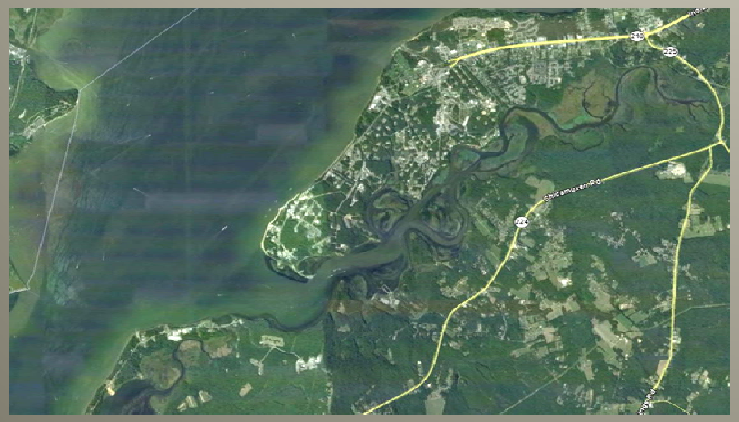


- Strongest relationship between nutrients and Chl-a was with NITROGEN
- All strong relationships involved multi-year averaging (2-3 yrs)
- Time lags between load changes and response were important…there is a nutrient memory
- Significant Chl-a reduction was achieved (~50%)

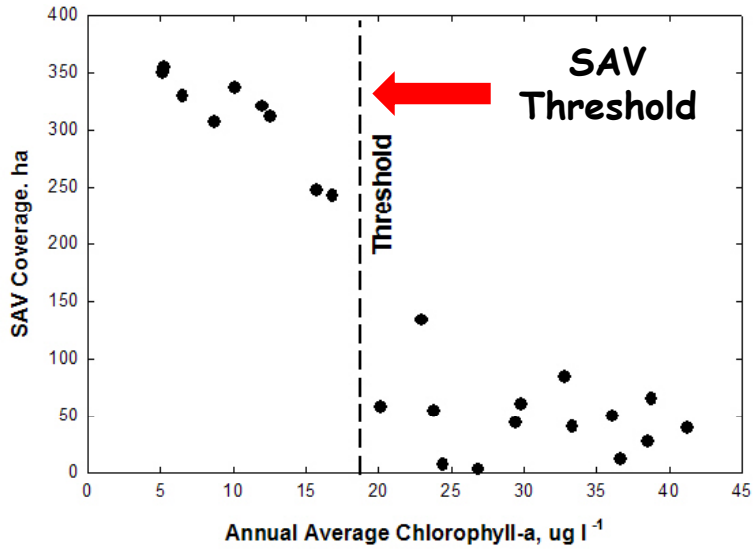
Trends and Analysis: Mattawoman Creek Case Study



Major WWTP
Load Reduction

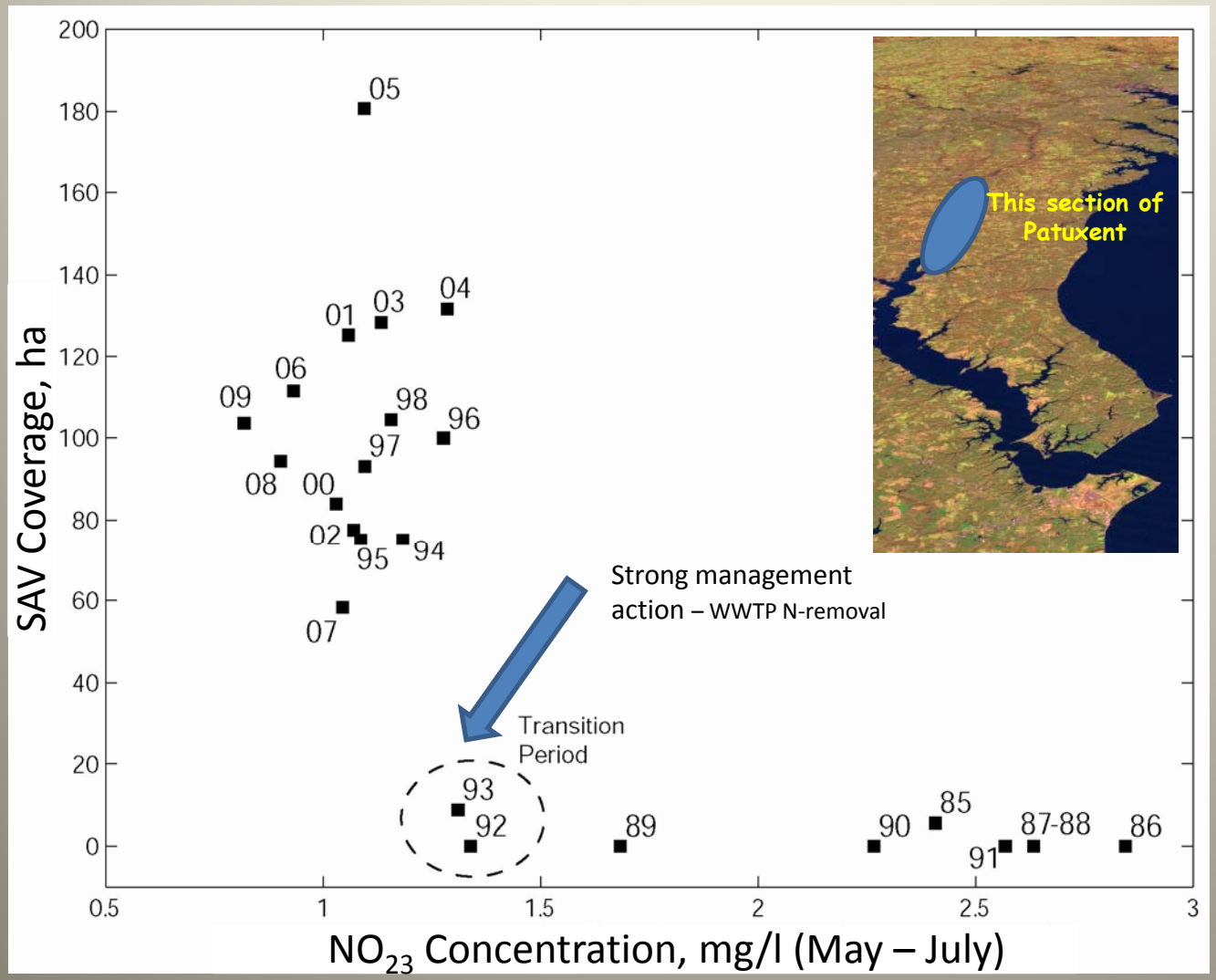


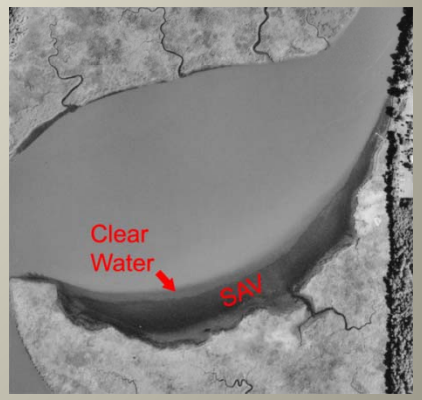
- Major reduction in N and P loads
- Several year delay in responses
- Chlorophyll declined (4X), clarity improved (2.5X) and SAV exploded
- Appeared to be a threshold response for SAV (< 18 ug/l chlorophyll)



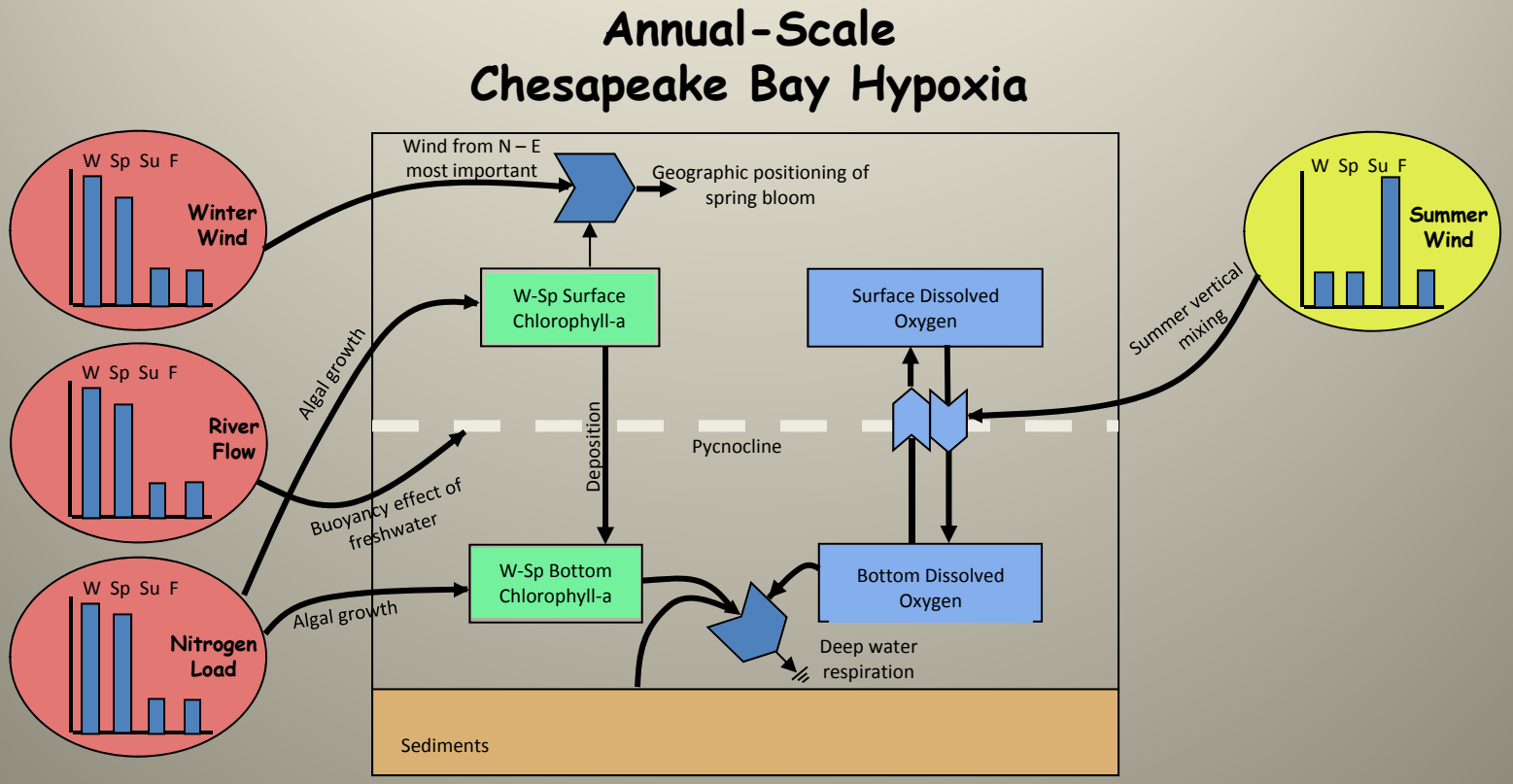
Another Threshold Example:

SAV recovery in upper Patuxent River

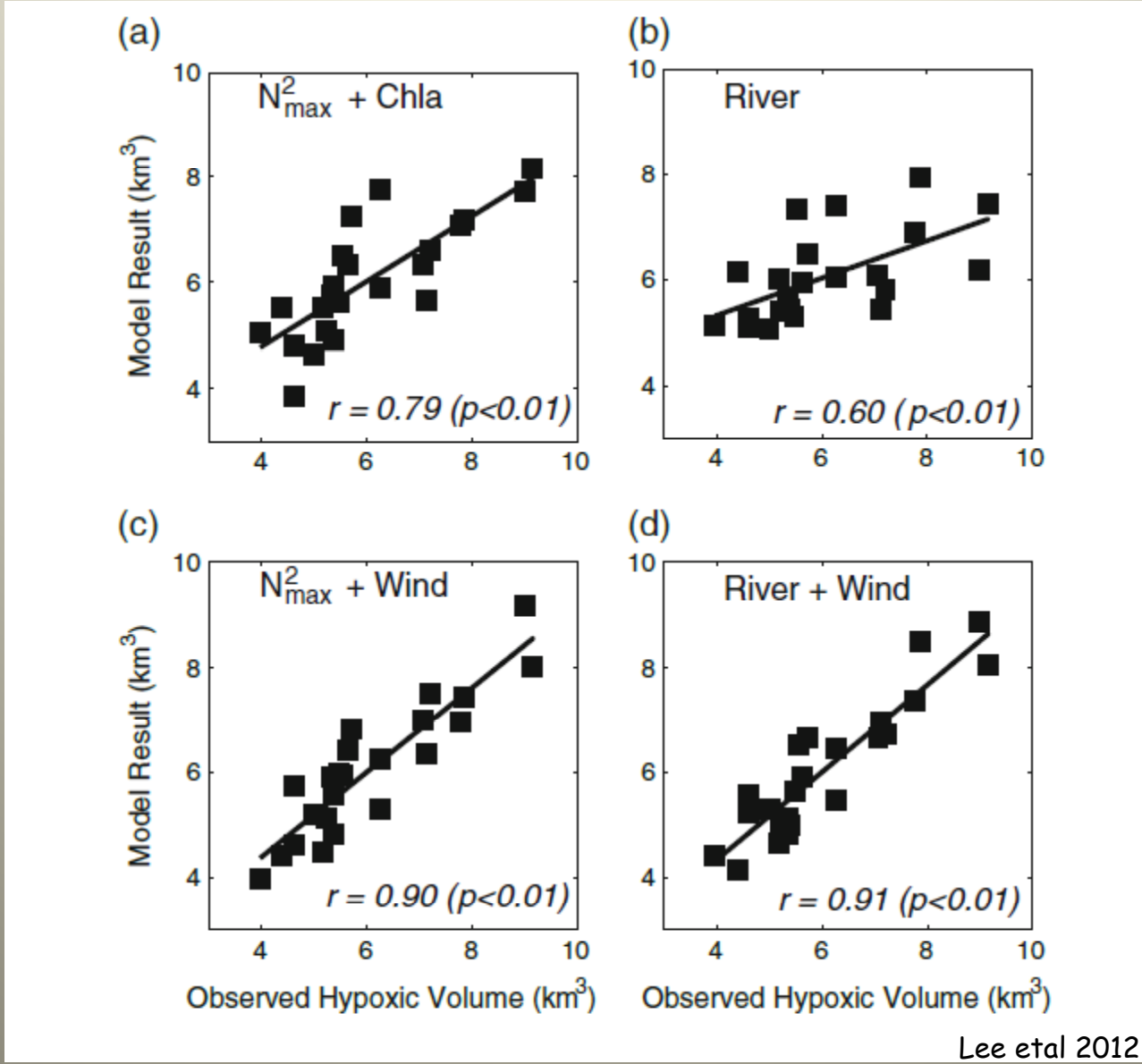




Here's another conceptual model: **Winter factors** of wind, flow and nutrient loads play a key role in determining the extent of summer hypoxia….summer winds tend to reduce the duration and intensity of hypoxia

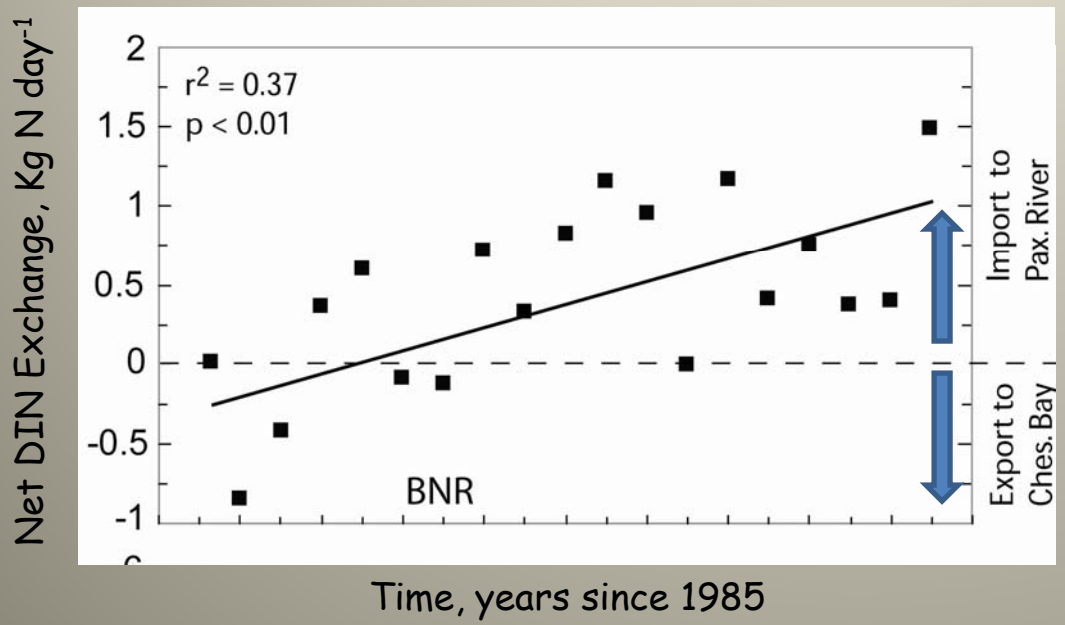


CB Hypoxia (June-Sept) and Controlling Features:
1985 - 2007



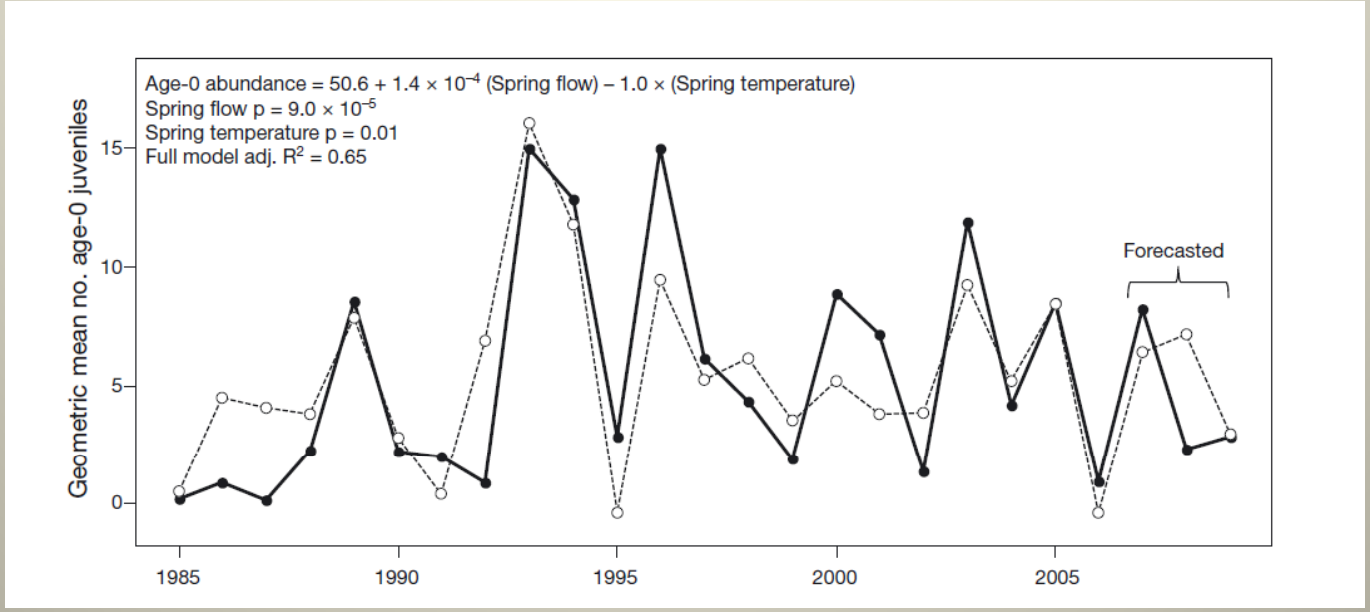
Lee etal 2012

The Chesapeake Bay appears to have become a SOURCE rather than a SINK for DIN…nutrients are now entering the Patuxent from both ends. A New TREND

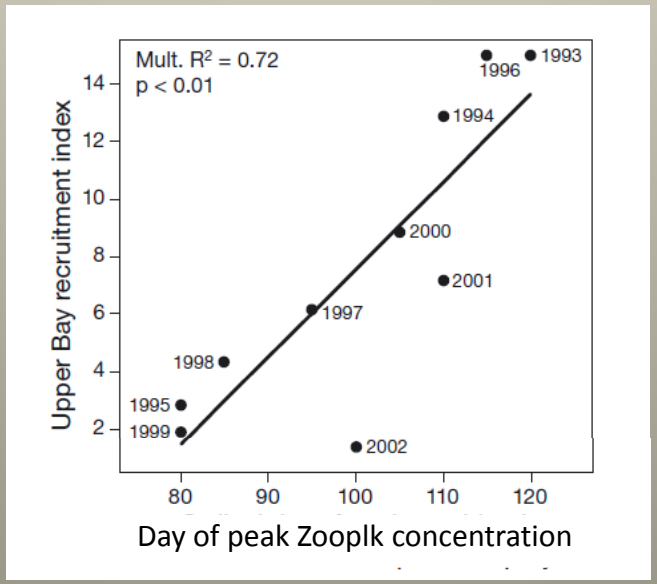


(From Testa et al 2008)

Understanding and Forecasting: Rockfish example



The Beginning



The End

Martino and Houde 2010

Next Steps

- Continue data assembly and analysis of trends, mainly N, P, flow and sediment loading from the basins

- Continue statistical (and simulation) modeling using conceptual models as guides

- Add variables to the models as needed but keep models as simple as possible for tractability and explainability

- Look for examples other than those related to WWTP load reductions (e.g., Murphy et al).

Physical characteristics of basins and estuaries:

arranged from smallest to largest basins

Estuary	Basin Area	Estuary Volume	Estuary Surface Area	Average Depth	Max Depth	max depth: average depth	mouth length	shoreline length	shoreline: mouth	Basin Area: Estuary Area	Basin Area: Estuary Volume
	m^2*10^6	m^3*10^6	m^2*10^6	m	m		m	m			1/m
Middle	33	16	10	2	3	2	6091	59763	10	3	2
WestRhode	66	24	15	2	4	3	4243	34110	8	4	3
Magothy	94	60	20	3	11	4	3998	35175	9	5	2
Corsica	97	10	5	2	5	3	1501	22458	15	18	9
Bohemia	131	28	14	2	6	3	1854	35793	19	9	5
Back	144	57	29	2	5	2	1443	32878	23	5	3
South	148	78	24	3	9	3	2936	48513	17	6	2
Piscataway	176	4	4	1	1	1	1199	10963	9	48	47
Severn	177	154	40	4	8	2	3319	49876	15	4	1
Northeast	184	19	16	1	4	3	2294	20503	9	11	10
Sassafras	217	155	36	4	10	2	5541	51045	9	6	1
Mattawoman	245	26	22	1	5	4	1607	29572	18	11	9
Bush	336	53	27	2	6	3	2513	46909	19	13	6
Wicomico	561	49	21	2	8	3	2757	53491	19	27	11
Gunpowder	1181	66	36	2	11	6	3392	50842	15	33	18
Patapsco	1518	469	101	5	11	2	8026	97541	12	15	3
Pocomoke	1672	19	7	3	8	3	14214	91697	6	243	90
Choptank	1951	1348	361	4	25	7	20554	239797	12	5	1
Patuxent	2343	652	137	5	36	8	2033	160597	79	17	4
Rappahannock	6918	1753	393	4	23	5	5899	275006	47	18	4

Hypoxia Duration Linked to Summer Algae