

Coastal Ecosystem Assessment of Chesapeake Bay Watersheds: Land Use Patterns and River Conditions

NOAA/NCCOS

Cooperative Oxford Lab

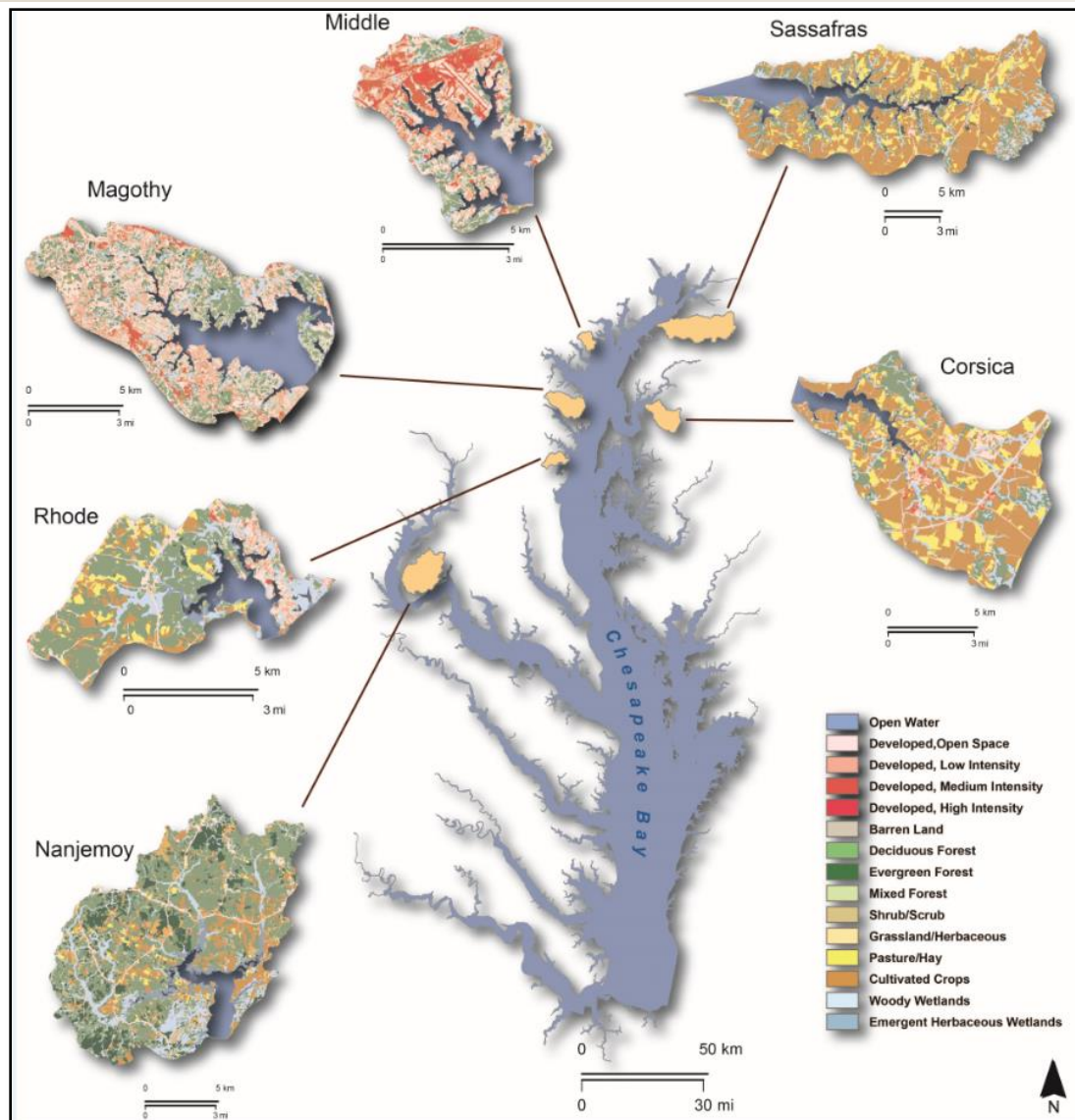
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Assessment of Six Chesapeake Bay Rivers



	Years Studied	
Dominant Land Use Type	2007-2011	2010-2012
Agricultural	Corsica	Sassafras
Developed	Magothy	Middle
Forested	Rhode	Nanjemoy

Goal:
Provide insights on the linkages between human activities, environmental condition and coastal community resilience



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Watershed Characteristics

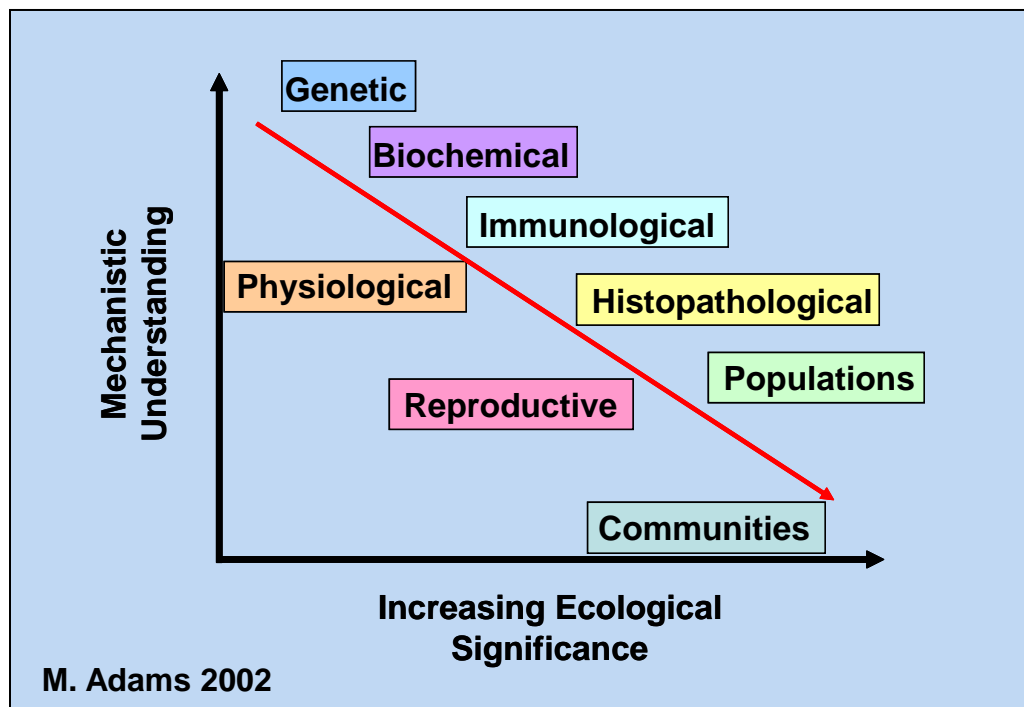
		Watersheds					
River		Corsica	Sassafras	Magothy	Middle	Rhode	Nanjemoy
Primary Land Use		Agriculture		Developed		Forested/Mixed Use	
303d Listings	PCBs	X	X	X	X		
	Nutrients	X	X	X	X	X	X
	Suspended Solids	X	X	X	X		X
	Benthic IBI			X			X
	Fecal Coliforms	X	X	X		X	
Hardened Shoreline %		15	9	60	51	25	4
River:Watershed Ratio		1:17	1:6	1:4	1:3	1:7	1:17

- All rivers have some impairments – compared to EPA criteria (303d Listings)
- Developed watersheds have extensive shoreline hardening
- Corsica and Nanjemoy have very large watersheds compared to river size



Indicator Selection

- Study design included endpoints at several different biological scales
- May provide better understanding of impacts on organisms



Study Variables

Water Quality

- Random, stratified design
- Mainstem (3 segments) and 4 tribs

Fish

- Collected from three mainstem segments

Blue Crabs

- Collections throughout mainstem

Benthic Habitat and Community

- Only in Corsica, Magothy and Rhode

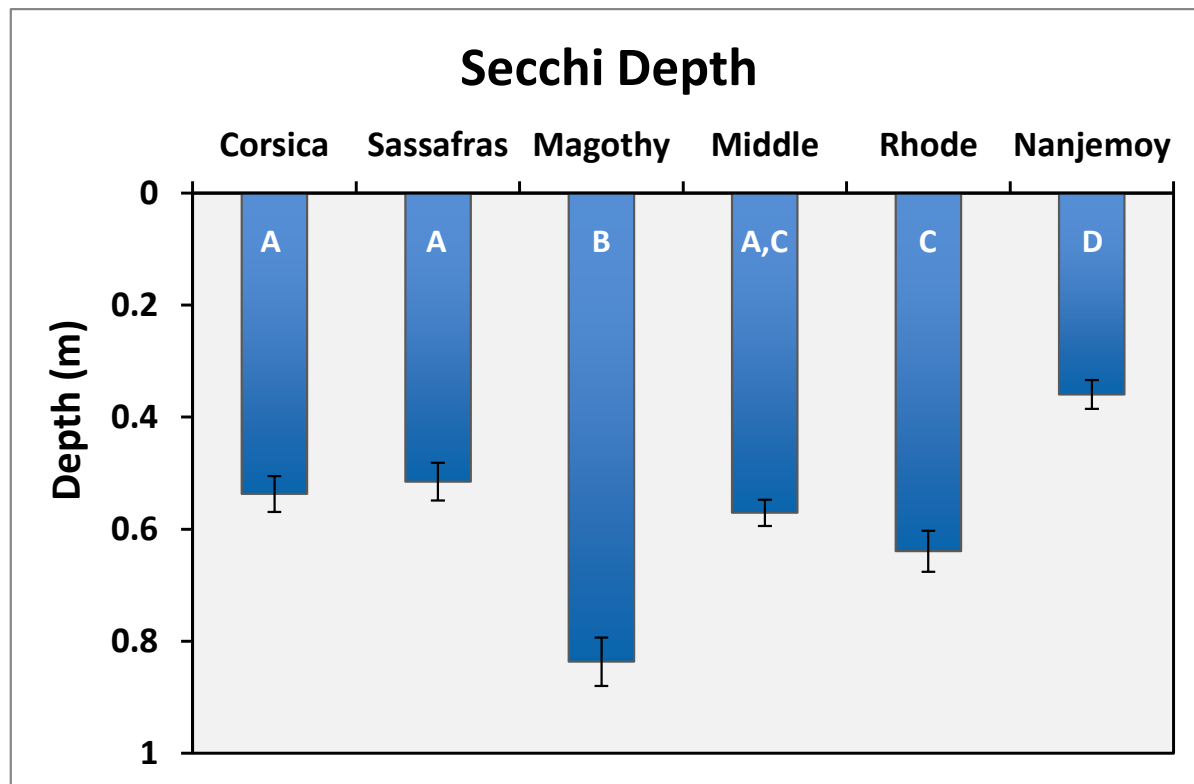
Aquatic Vegetation

- VIMS surveys



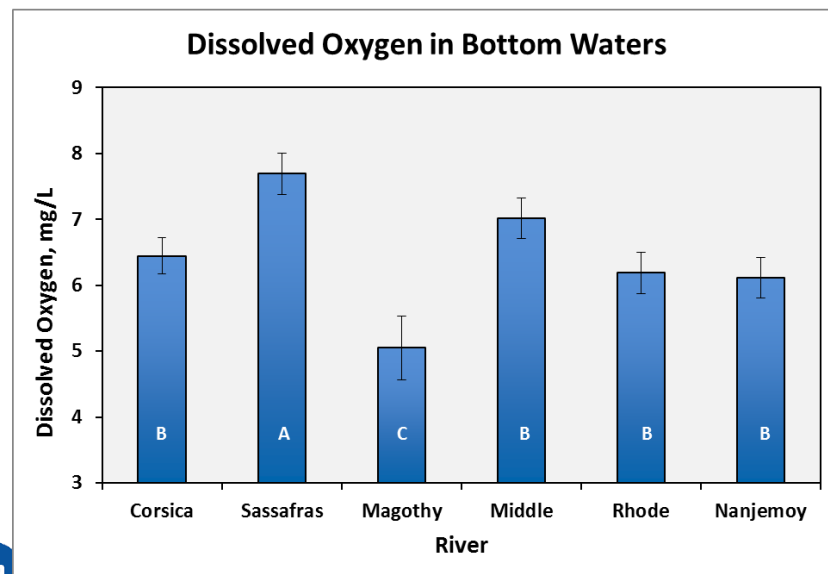
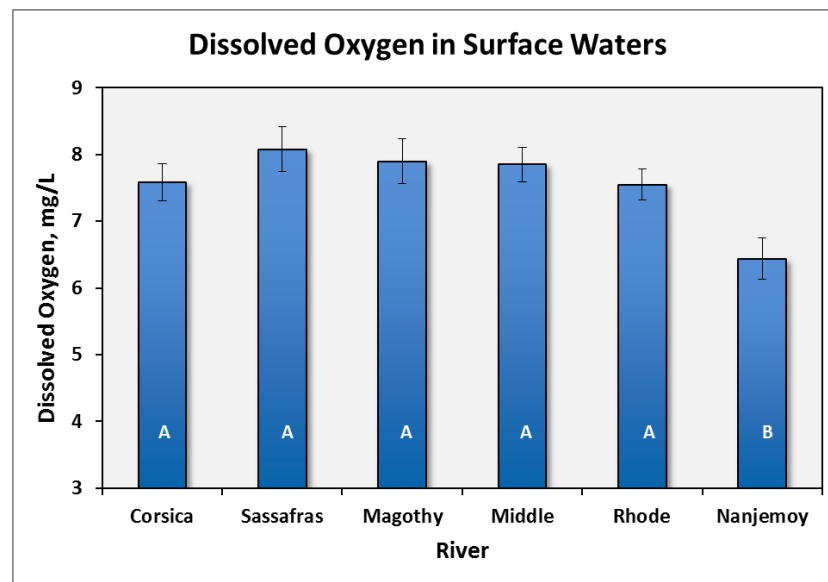
Water Clarity

- Letters on bars indicate significant differences ($p < 0.05$)
- Clearest water in Magothy, most turbid in Nanjemoy
- Findings contrary to expectations, possibly related to river depth



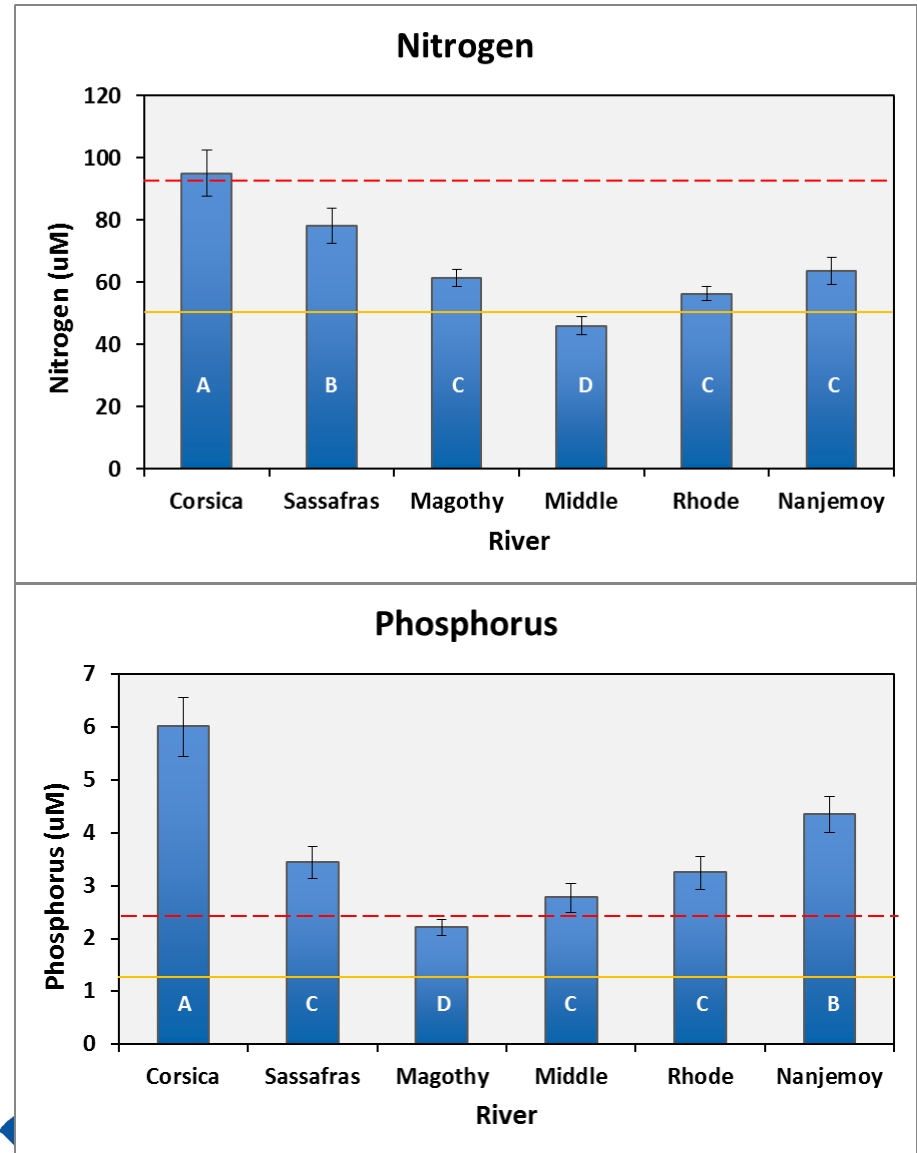
Dissolved Oxygen

- Compared to EPA criteria
- Surface waters meet standard to support healthy populations
- Significant periods of hypoxia in bottom waters of Magothy River



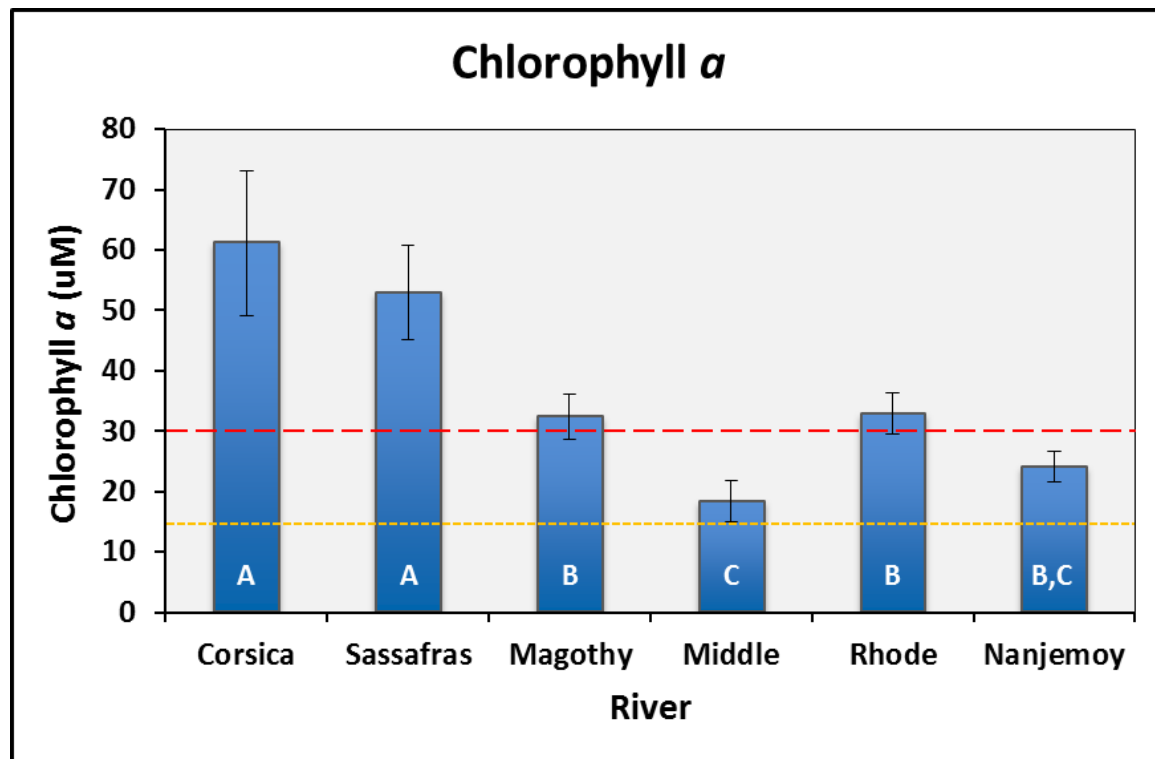
Excessive Nutrients - Especially in Agricultural Watersheds

- Compared to published criteria (Wazniak et al, 2007)
- Orange/solid line = criteria
- Red/dashed line = twice the criteria
- Agricultural rivers highest values
- Nanjemoy very high in phosphorous – perhaps related to high suspended solids



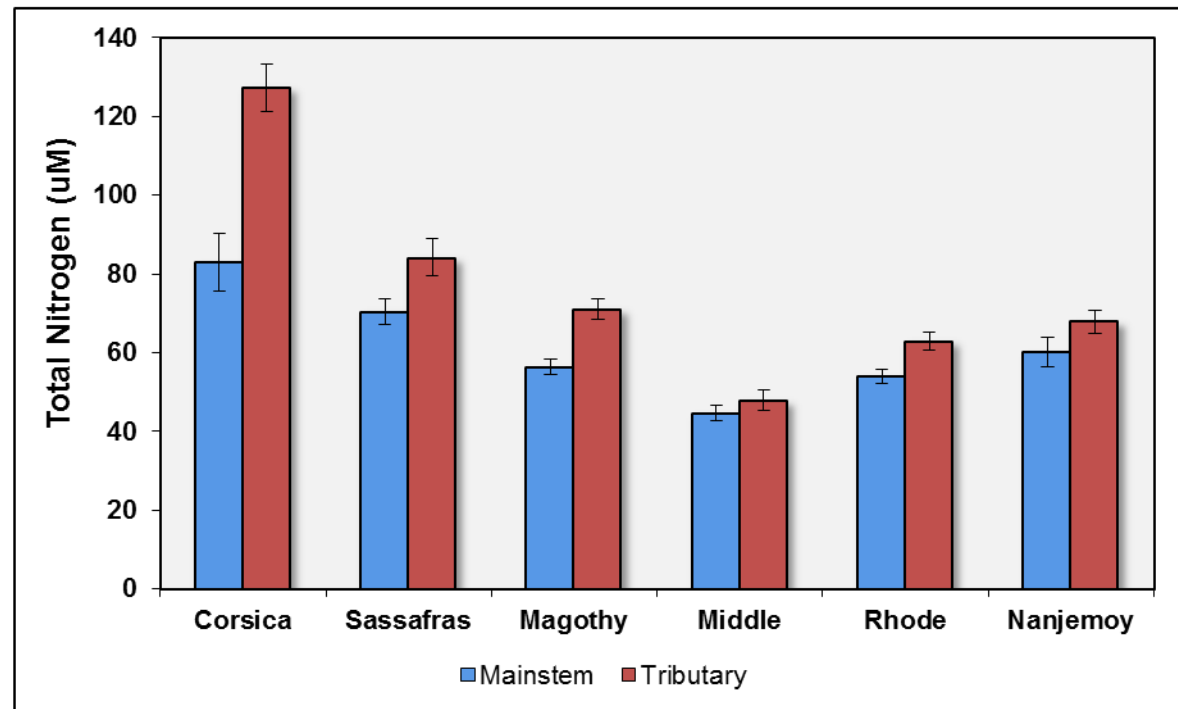
Chlorophyll *a*

- Compared to published criteria (Wazniak et al, 2007)
- Orange/solid line = criteria
- Red/dashed line = twice the criteria
- All rivers exceed criteria
- Agricultural rivers highest values



Water Quality in Tributaries versus River Mainstem

- Conditions in tributaries often worse than mainstem
- Closer to sources (point and diffuse)



Fish Sampling Design

Fish Community Composition:

May through September

Sampling every two weeks

Mid-water trawls

Beach seines

Three mainstem segments

Fish Health Indicators:

September/October each year

Throughout mainstem



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Fish Response

- Abundance – nearshore (seine) and mid-river (trawls)
- Disease Condition (indication of mycobacteriosis)
- Body Fat Index
- Parasites
- Macrophage Aggregates



Fish Abundance

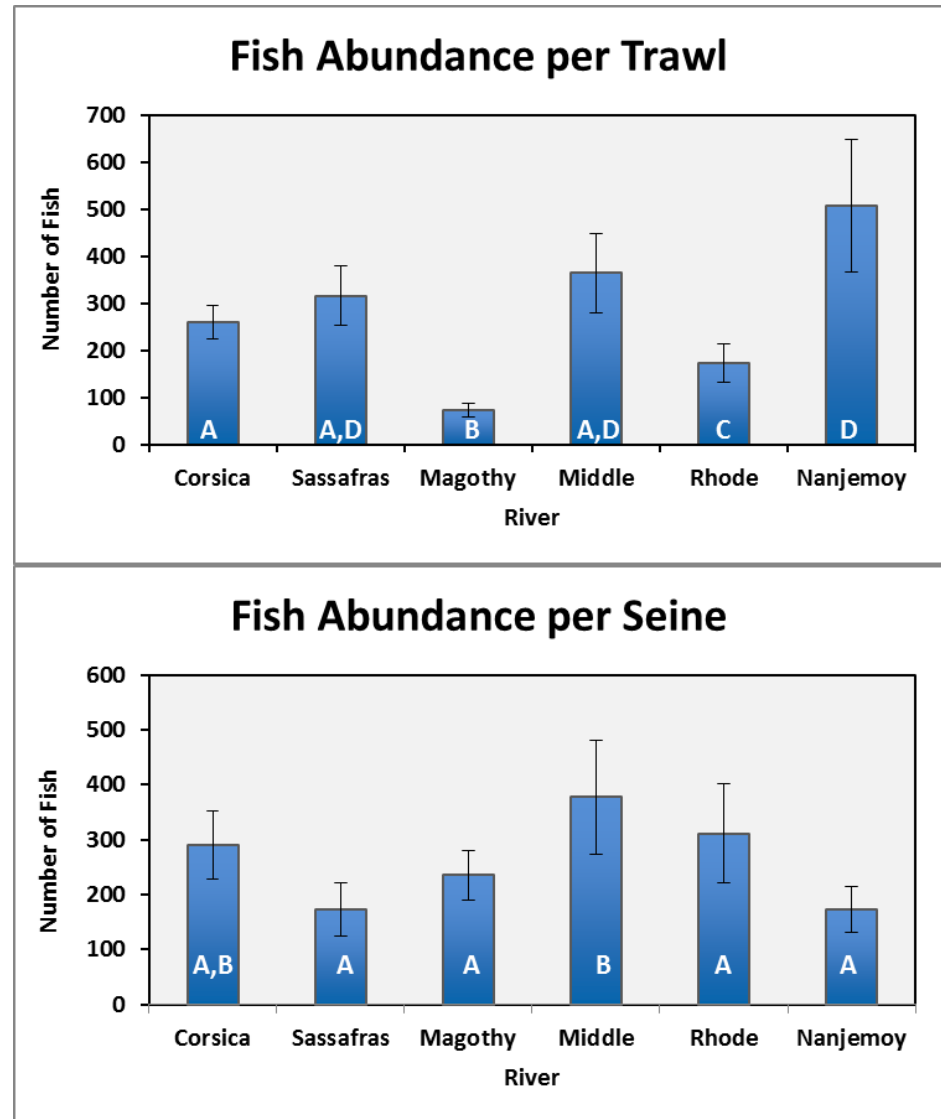
Trawl and seine samples – different indications

Trawls:

- Higher densities in oligohaline rivers
- Lowest densities in Magothy

Seines:

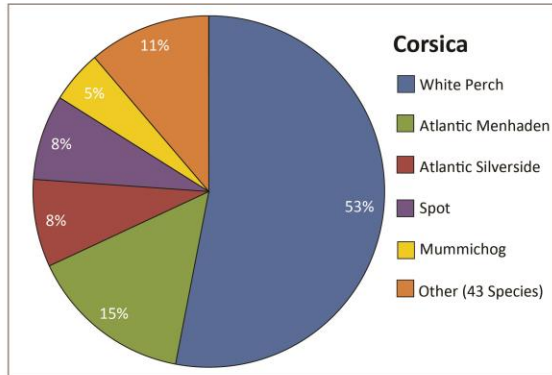
- Densities adjusted for seine distance
- Highest densities in Middle River
- Seines conducted at 'beaches' – did not target armored shorelines



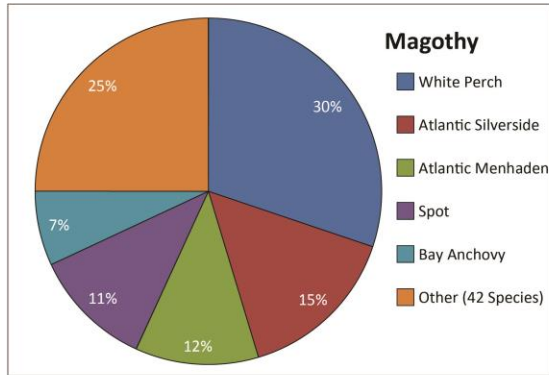
Fish Species Evenness

**Meso-
haline**

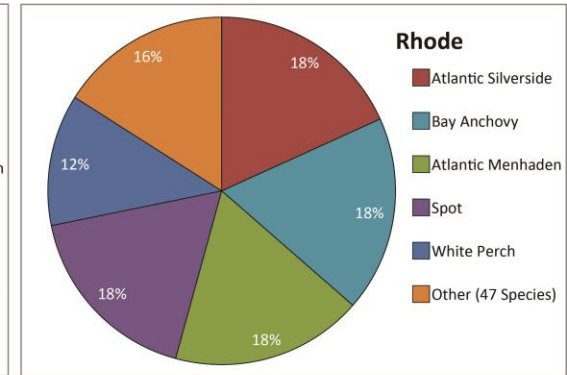
Agricultural



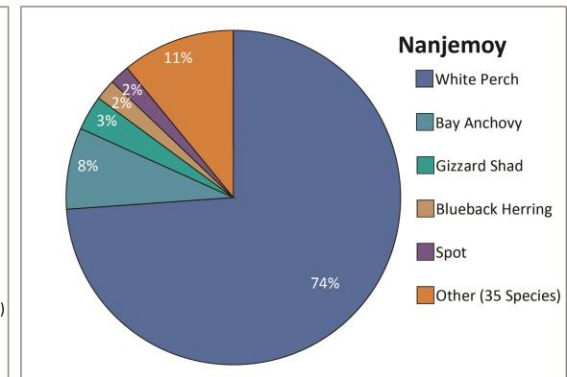
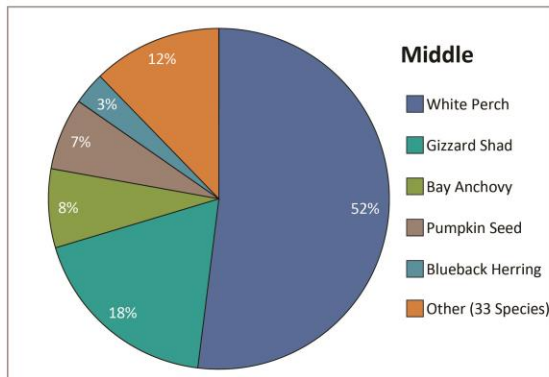
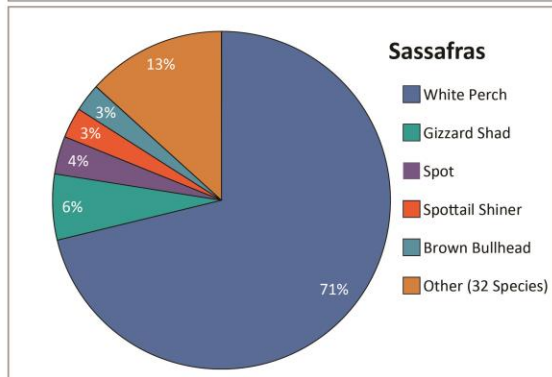
Developed



Forested/Mixed-Use

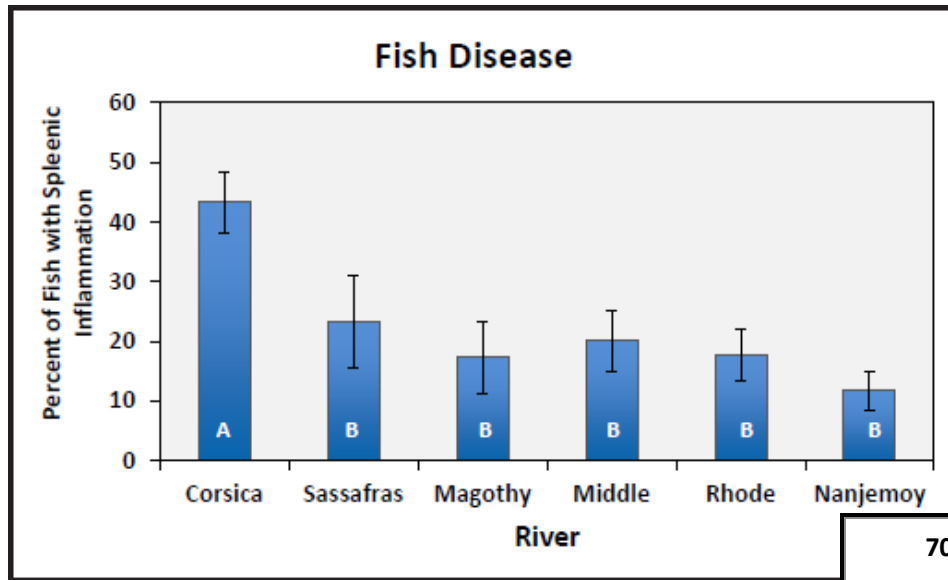


**Oligo-
haline**



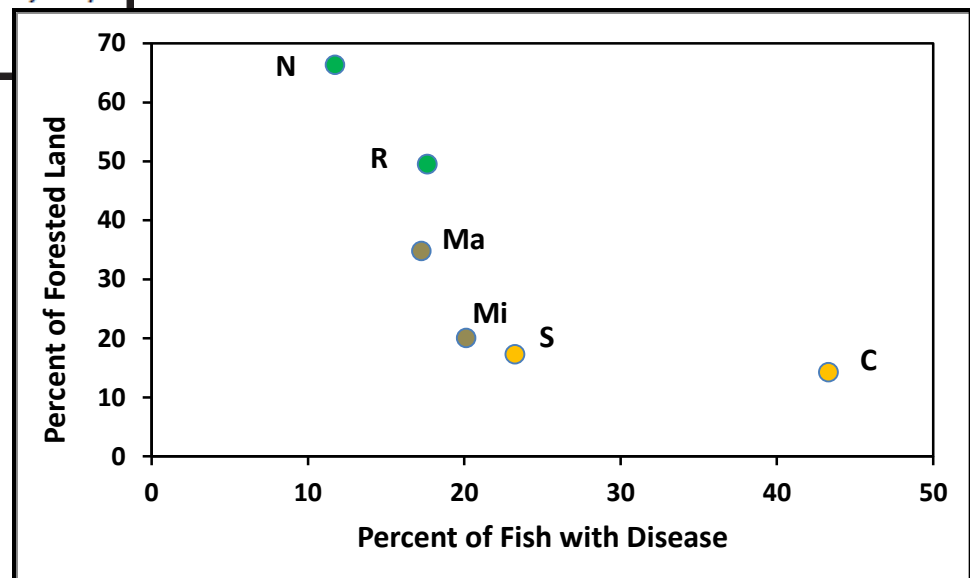
- Dominance of white perch in all but Rhode and Magothy
- More even abundance of fish species in mesohaline rivers
- Recruitment to oligohaline rivers likely higher for several species, such as white perch

Percent of Diseased Fish Higher in Agricultural Watersheds



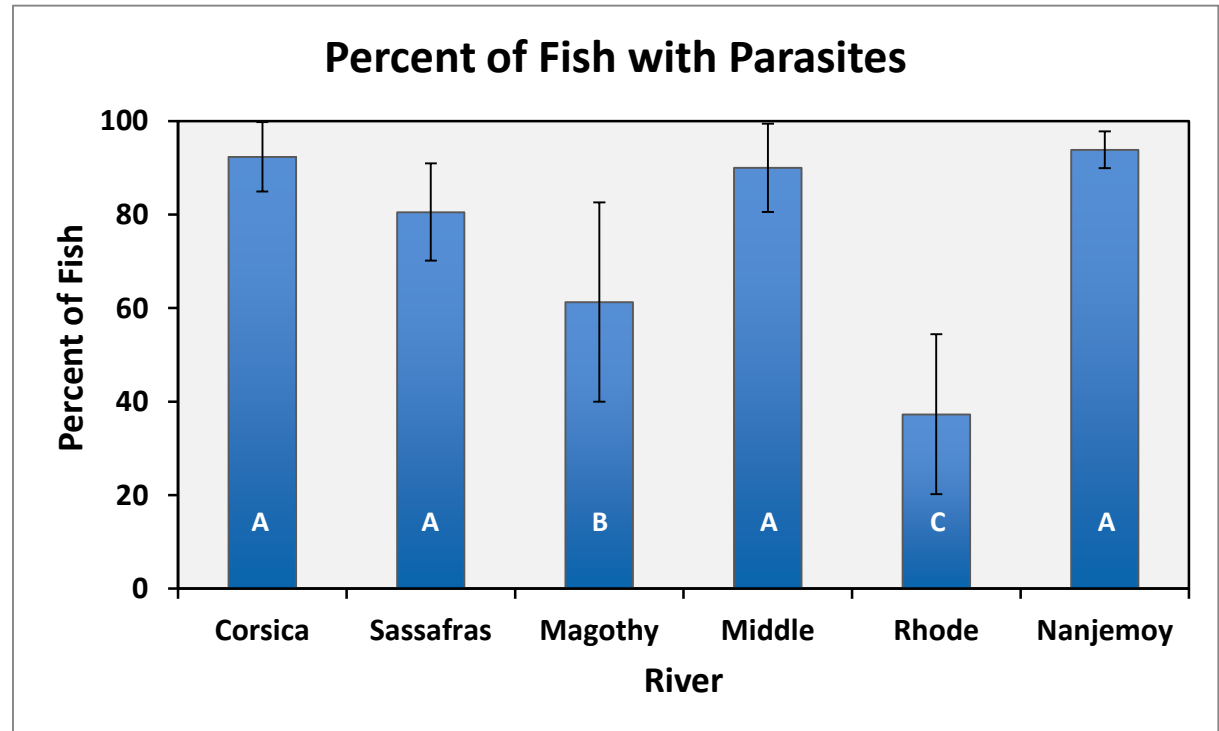
- Disease - inflammation of spleen and presence of acid-fast bacteria
- Slight trend of higher percentages of diseased fish in agricultural rivers (Corsica and Sassafras)

Percent of diseased fish inversely related to percent of forested land in watershed



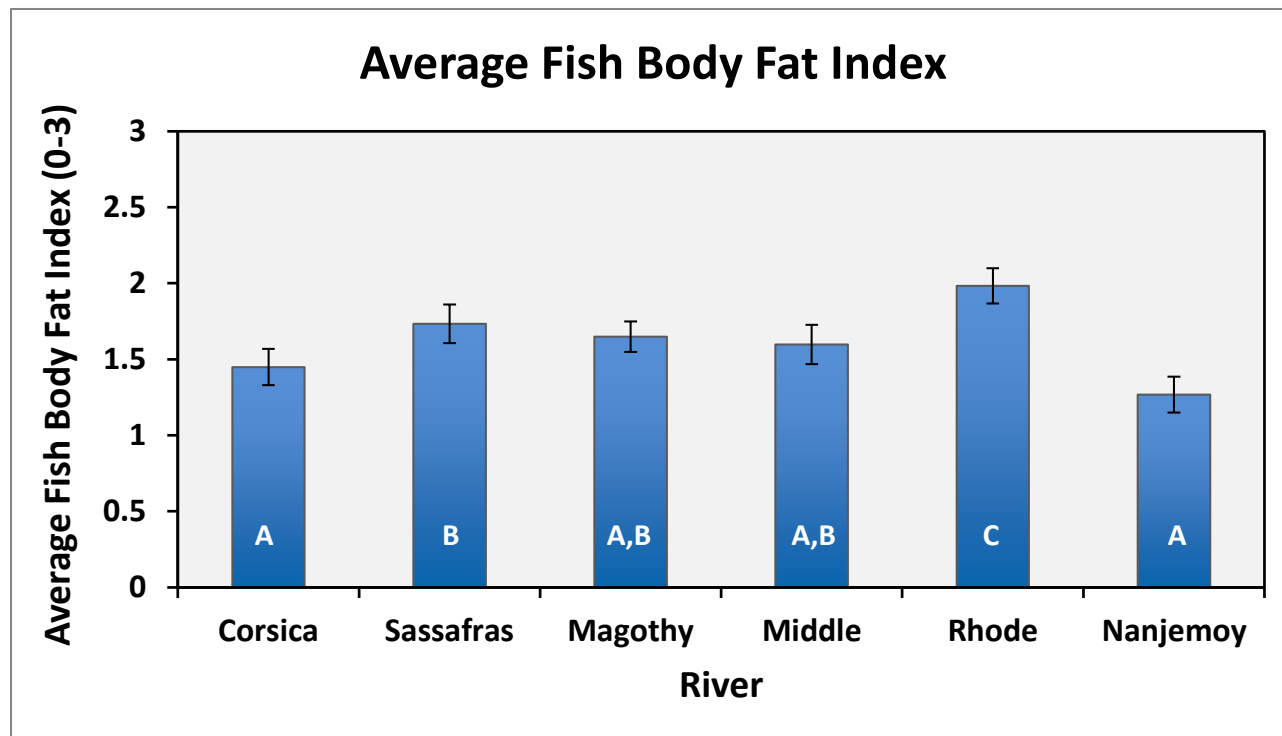
Fish Parasites

- High percent of fish with external parasites in most rivers
- Lowest in Rhode
- Mesohaline rivers show trend with agricultural
Corsica River highest – no trend in oligohaline rivers

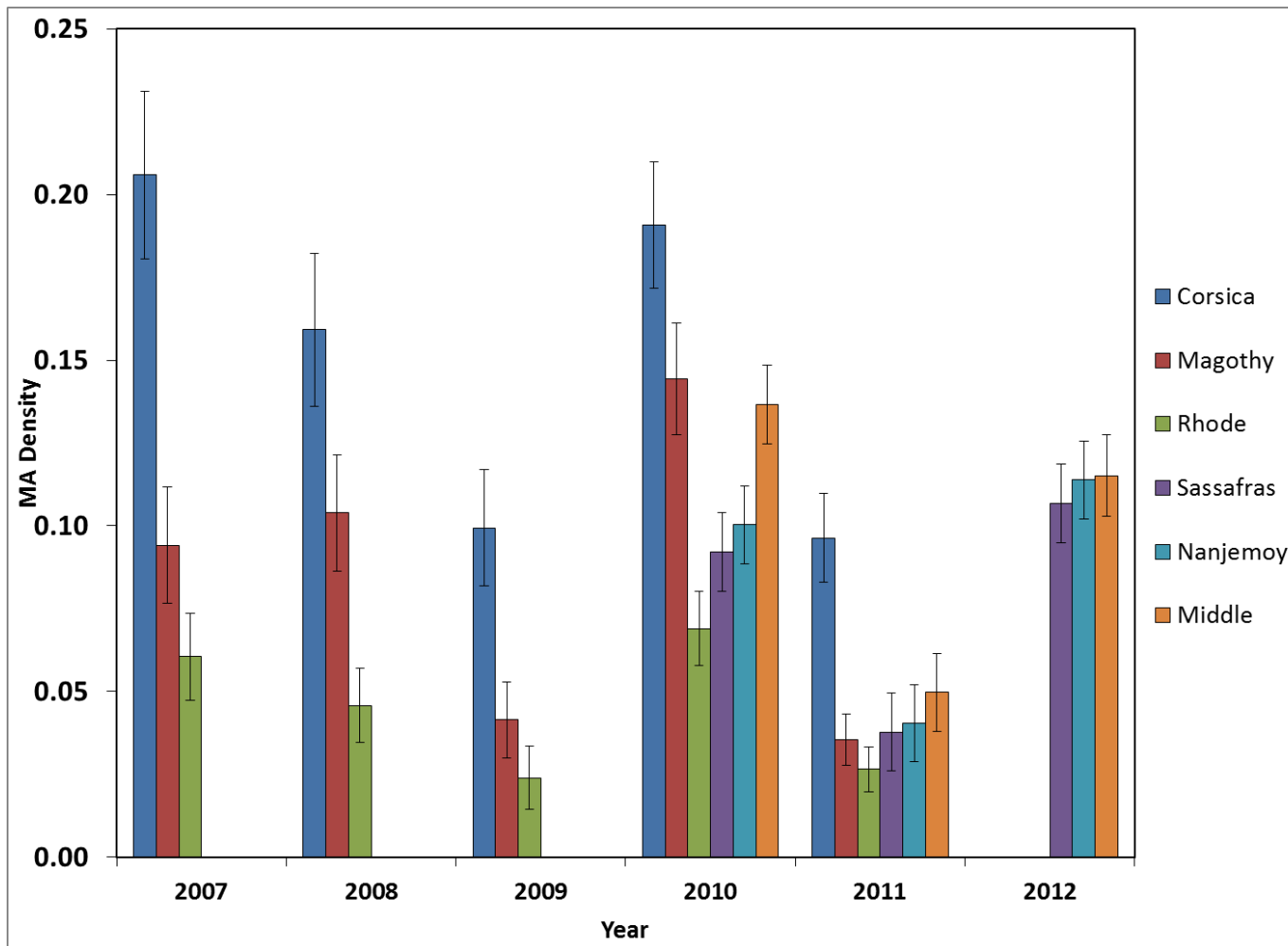


Fish Body Fat Index

- Rhode River fish had significantly higher fat stores
- Body fat levels did not clearly differentiate other rivers



Macrophage Aggregates



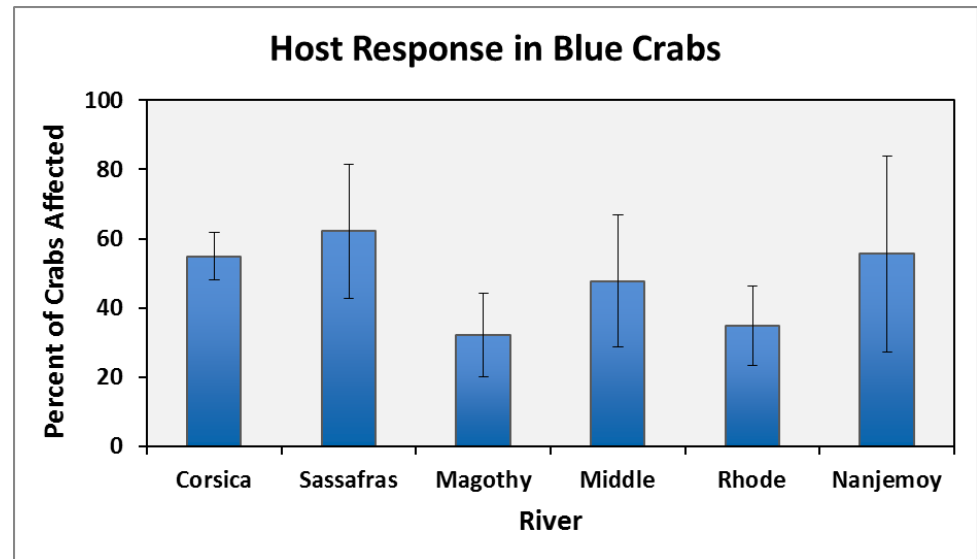
- Order of rivers same between years despite interannual variability
- Corsica always highest
- Rhode always lowest
- Landuse trends apparent for mesohaline rivers, but not for oligohaline rivers



Crab Health

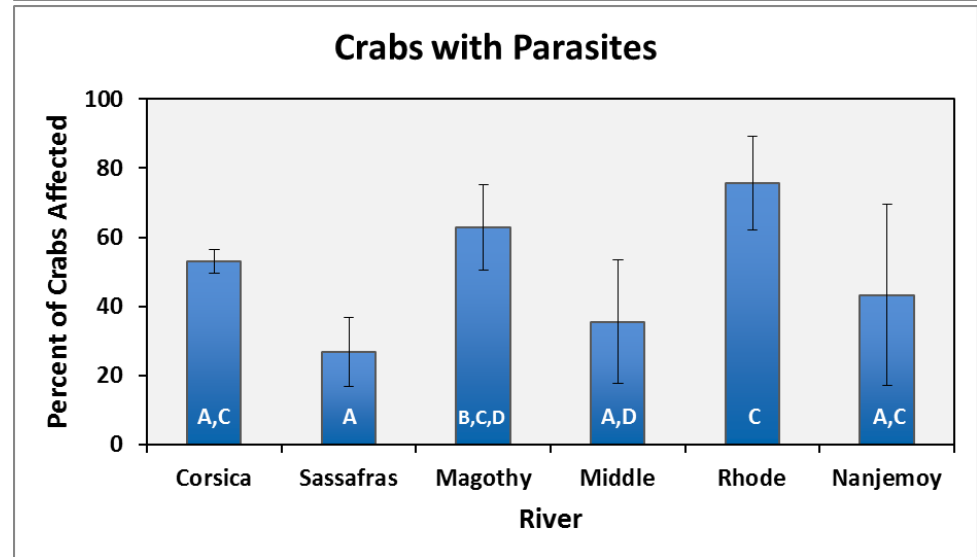
Host Response

- Histological method
- Includes inflammation, nodules, tissue necrosis
- Not statistically different between rivers – trend toward higher percentages in agricultural rivers



Parasites

- Histological method
- Included ciliates, worms and microsporidians
- Comparing rivers of similar salinity – higher percent of crabs with parasites in forested/mixed-use rivers



Findings



Developed watershed



Agricultural watershed



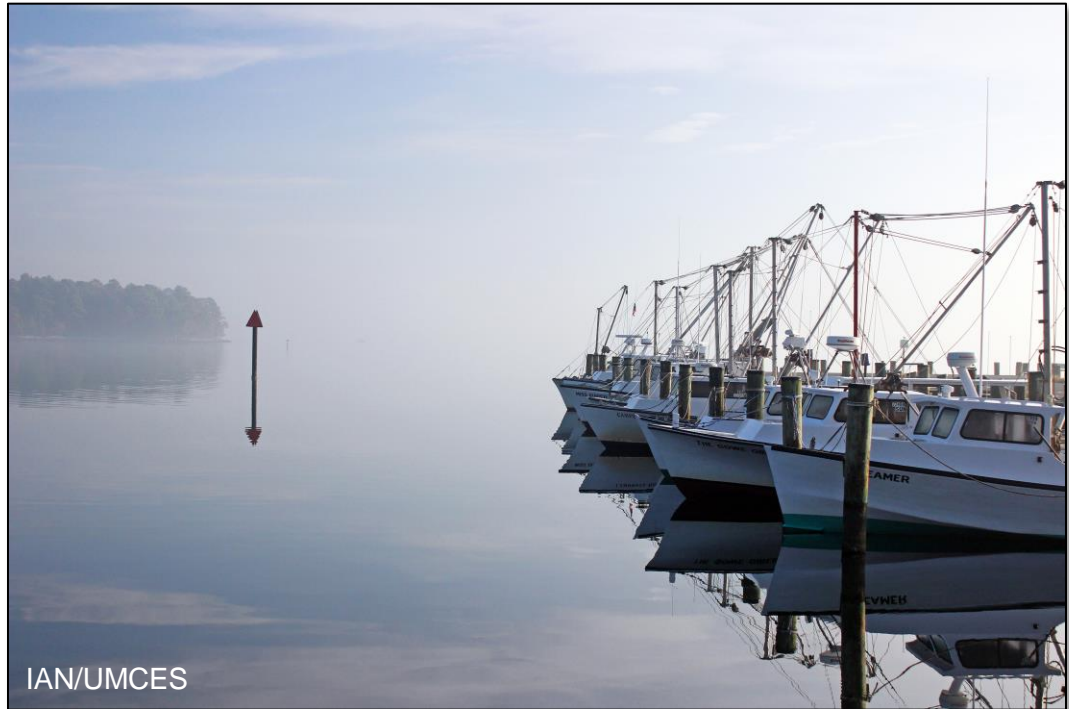
Mixed reference watershed

Variable	Notes
Dissolved Oxygen	Generally sufficient – Very low (hypoxic) in bottom waters of developed Magothy
Nutrients	P and N high in all rivers; very high in agricultural rivers, lowest in developed rivers
Chlorophyll a	Agricultural rivers very high
Secchi Depth	Poor scores for most rivers, especially for Nanjemoy
Fish Abundance	No correlation to land use or water quality, most rivers similar
Fish Disease	High prevalence in agricultural rivers, especially Corsica, low in forested
Macrophage Aggregates	Rivers poorly differentiated; high levels in 2010 and low in 2011
Parasites in Fish	Higher crab host response in agricultural rivers and crab parasites in higher salinity rivers
Crab Health	Mixed results



Some Management Implications

- Need for continued efforts to reduce nutrient and sediment inputs to Bay
- Need to preserve habitat for diverse and healthy fish populations
- Need to better identify/understand crab health as indicator of habitat conditions



Choptank Habitat Focus Area



NCCOS Activities:

- Tred Avon Watershed Assessment
- Oyster Bioextraction Project
- Remote Sensing Wetlands Assessment
- Baseline Assessment of Historic Conditions



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Ecological Assessment in Tred Avon River

- Assessment of conditions in tributaries of Tred Avon River
- Refined list of variables from 6-River Assessment
- Collaboration with MD-DNR Fish Health Program on fish health assessment and index development



Fish Health Assessment and Index Development

Target species: White perch

Health Indicators

1) Health Assessment Index (HAI)

a. Semi-quantitative:

- i. Gross appearance of organs
(eye, skin, gills, heart, liver, spleen, intestine, kidney)
- ii. Presence of internal and external parasites
- iii. Select blood values - compared to reference intervals

b. Lesions, abnormal blood values and parasites

2) Organ indices: spleen (index and volume), liver, gonad, body fat

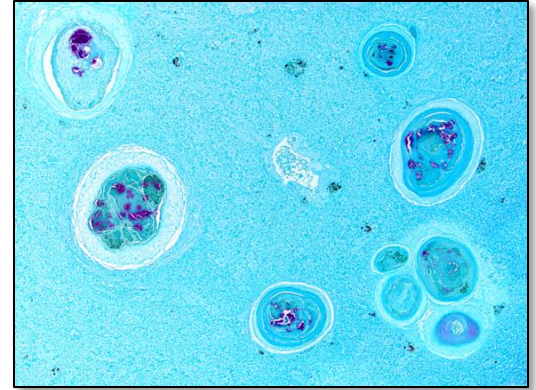


Fish Health Assessment and Index Development

Health indicators

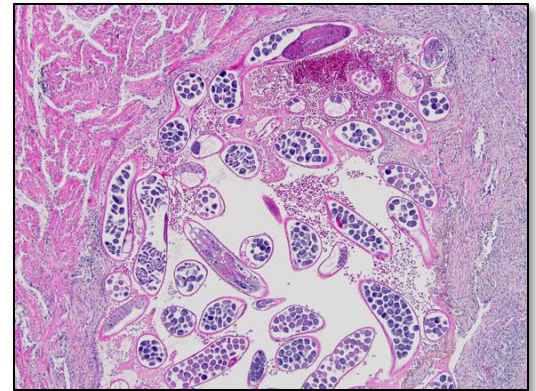
3) Histological indicators

- a) Macrophage aggregates (MA)
- b) Granulomas - lesion induced by mycobacteria (bacterial disease)
- c) Encysted larval parasites - metacercariae of digenetic trematodes



4) Bacterial infection

- a) Isolates identified from posterior kidney and liver
- b) Pathogenic and environmental species



Questions and Discussion



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