

Investigating Atlantic Menhaden mortalities in New Jersey



NJ Water Monitoring Council Meeting (29-Sep-2021)

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NEW JERSEY DIVISION OF
Fish and Wildlife
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Atlantic Menhaden biology and annual mortality

- Found from Nova Scotia to Florida
 - Dense populations in Chesapeake, Delaware Bay (NJ/NY Bight)
- Highly migratory fish and managed by ASMFC as a single population
- Important in local ecology
- Largest landings by volume of any fishery in US Atlantic
 - Bait, animal feeds, fertilizer, supplements
- Mortality is reported annually
- Numerous causes, though mortality has been reported since at least the 1950's



Annual mortality of Atlantic Menhaden

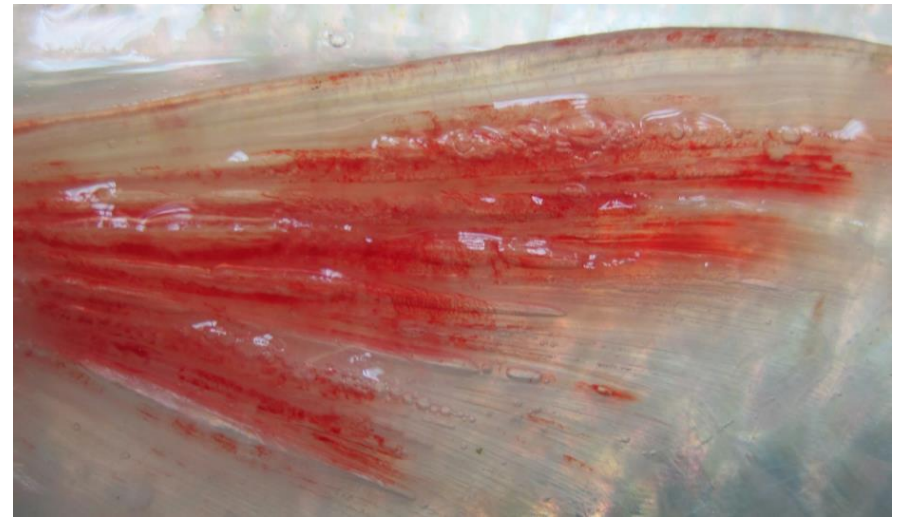
Hypoxia

- Most frequent in the mid-summer
- Dense schools become trapped in small low-flushing estuaries



Annual mortality of Atlantic Menhaden

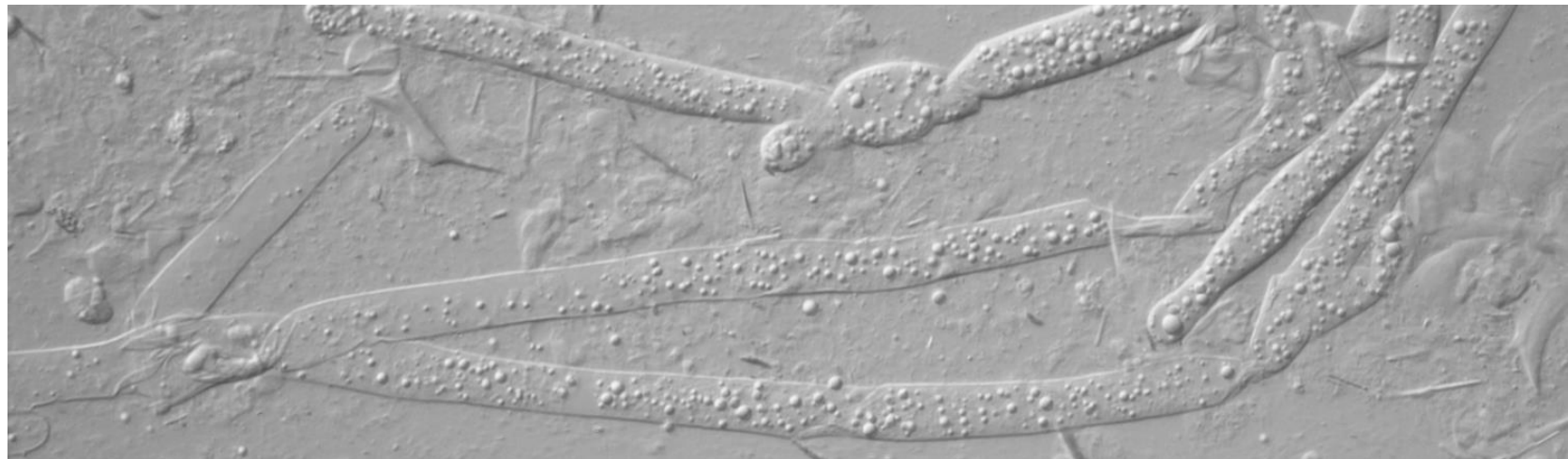
- Thermal discharge causing “gas bubble disease”
- Fast warming of water may cause supersaturation
- Most frequent in colder temperature months



Annual mortality of Atlantic Menhaden

Ulcerative mycosis in juvenile fish

- Frequently no obvious mortality is noticed
- In lower salinity estuaries, more prevalent in high rain events
- We have noted it in later summer in juvenile fish



Spring mortality events

- Chronic mortality with a highly seasonal nature has been occurring in the Raritan Bay and Navesink / Shrewsbury Rivers
- Previous literature has identified an IPN-like virus causing “spinning disease” causing annual spring epizootics in Chesapeake Bay (Stephens et al. 1980; J Fish Diseases 3, 387-398)
- Collaboration- Our lab, Dr. Getchell, and Dr. Iwanowicz have been screening for this virus since 2015 using cell culture
 - Suspect CPE has been checked for viruses by NGS



Fall 2020 mortality event

- First report of significant mortality in the fall (November-December) around Liberty State Park
- We collected 30 moribund fish for necropsy and histopathologic evaluation



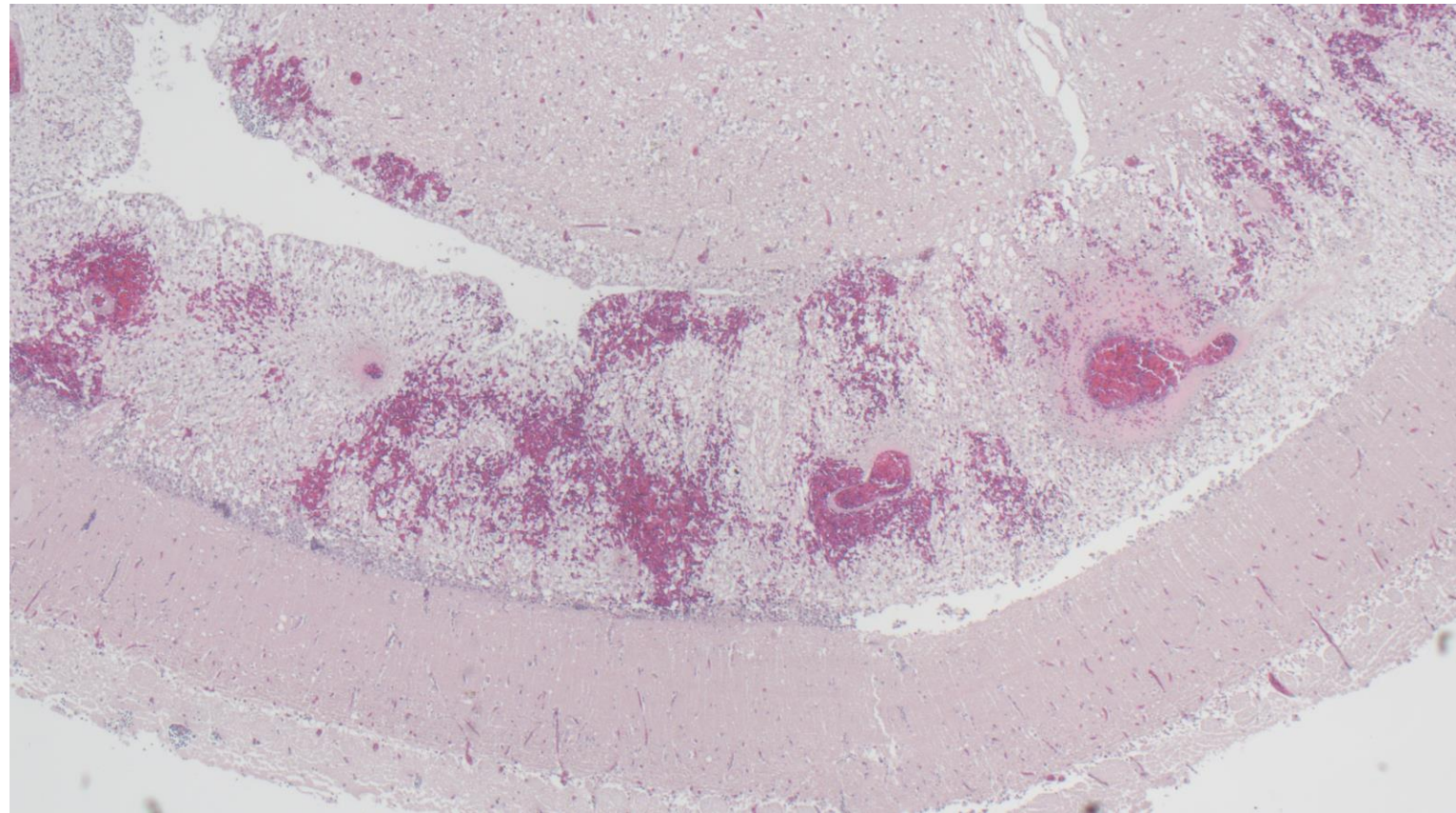
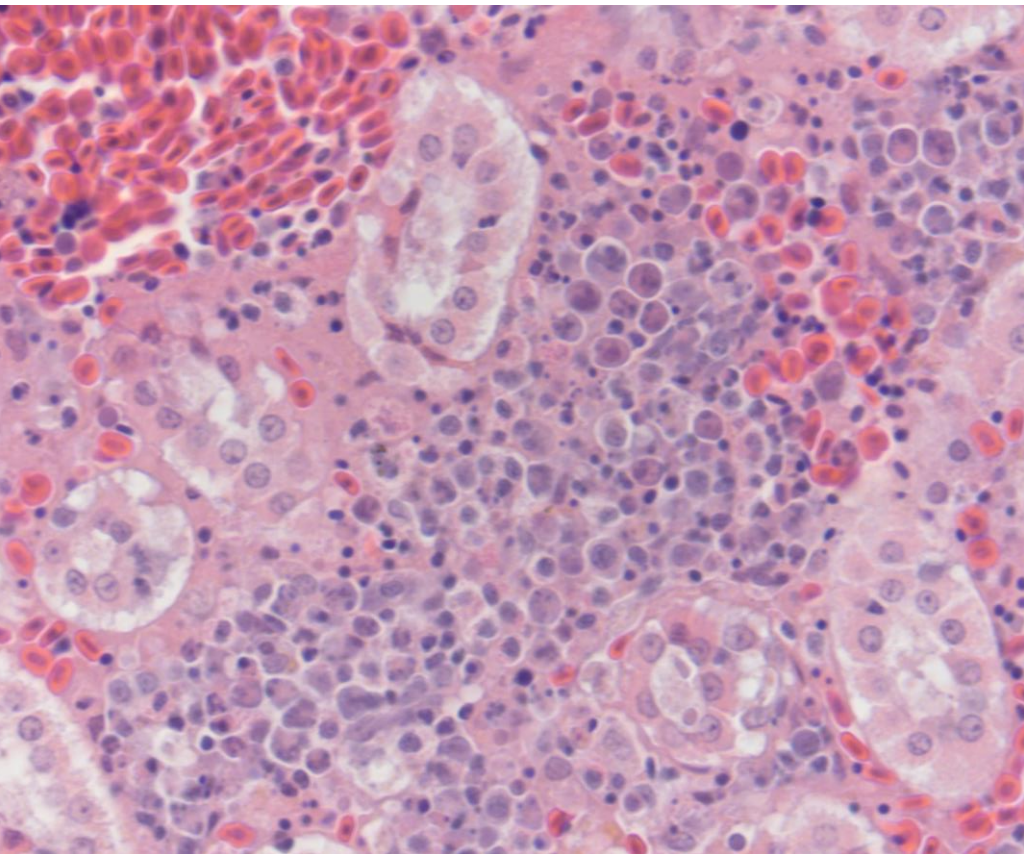
Fall 2020 mortality event- gross findings

- External lesions ranged from absent to some fish with eye hemorrhage, hemorrhage at the base of fins, and brain congestion / hemorrhage
- Virology was negative (CHSE-214, BF-2, and EPC at 15 degrees)



Fall 2020 mortality event- histopathology

- Evidence of disease in the internal organs of fish
- Hematopoietic cell necrosis in kidney and spleen (28/30 fish)
- Hemorrhagic lesions in the brain of 23/30 fish; bacteria present in some lesions



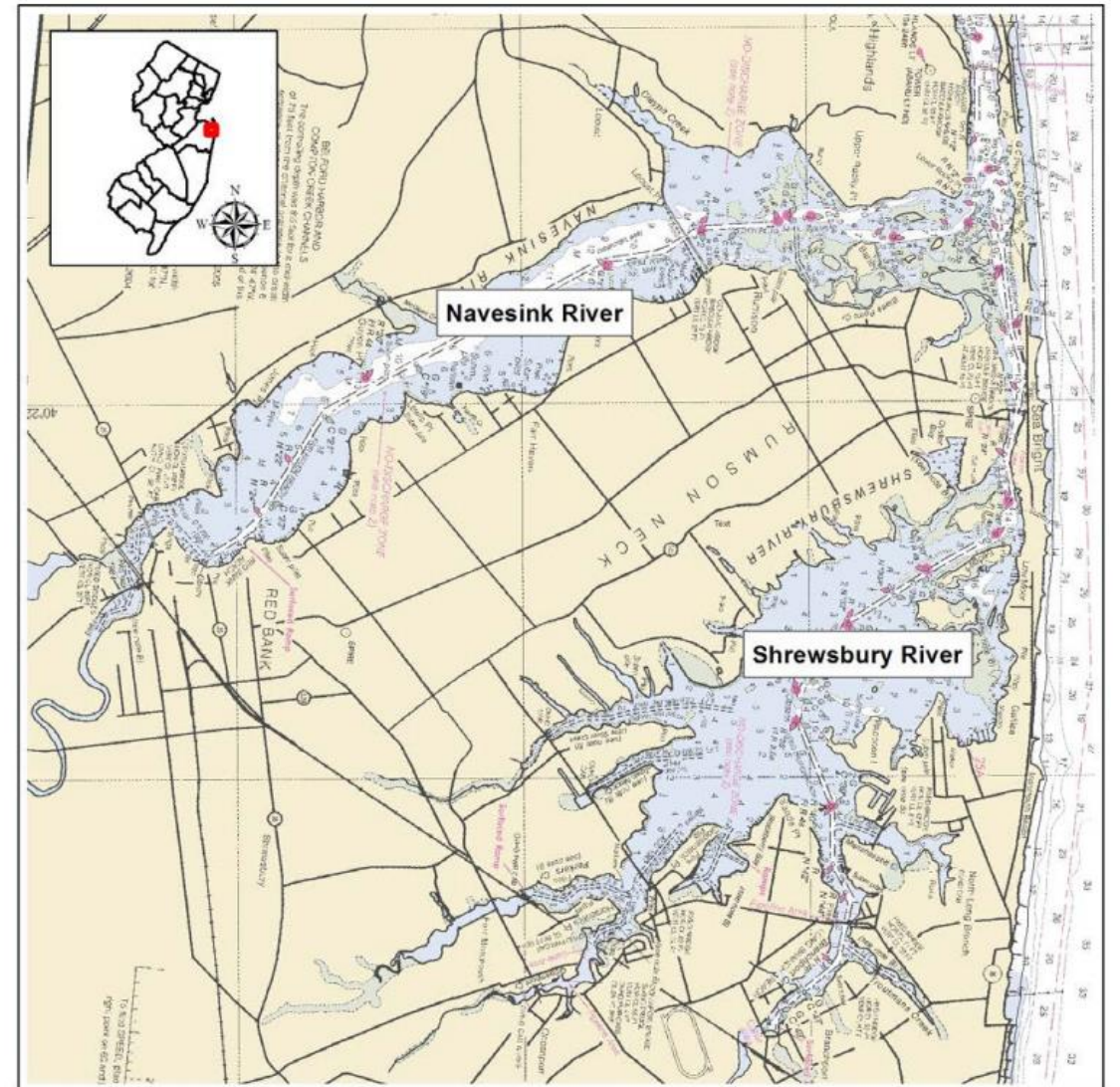
Fall 2020 mortality event- metagenomics

- Finding of bacteria in histology associated with brain lesions led us to use metagenomics to examine 16S rDNA libraries
- Sequencing of V3 and V4 (hypervariable regions) of the 16S rDNA

GENEWIZ NGS 16S-EZ ANALYSIS REPORT									
OTU_ID	Kidney- 1A	Kidney-3A	Kidney-6A	Kidney-7A	Brain-1B	Brain-6B	Brain-7B	Brain-8B	taxonomy
OTU1	76	99	13	249	37,470	39,144	40,198	33,437	99.78% <i>Vibrio anguillarum</i>
OTU10	0	0	0	0	17	0	24	0	Unclassified
OTU100	1	2	1	0	0	0	0	1	k__Bacteria
OTU1002	0	0	0	0	0	1	0	0	k__Bacteria
OTU1003	0	0	0	0	0	1	0	0	k__Bacteria
OTU101	1	8	1	3	0	4	0	0	k__Bacteria;p__Proteobact eria
OTU1015	0	0	0	0	0	1	0	0	k__Bacteria
OTU1017	0	0	0	0	0	1	0	0	k__Bacteria

Spring 2021 mortality event

- Over two-month long mortality in the Raritan Bay / Long Island area
 - Two rivers were heavily impacted
 - Natco Lake
 - Long Island Sound
 - Delaware Bay during later stages
- First reports in NJ in the end of March, extending to mid-June
- Collected fish from three time periods in the mortality (early, mid, late)



Spring 2021 mortality event- sampling

- Collected a total of 57 fish for examination
 - Only menhaden, and no other species, were impacted by the mortality
- Water temp ranged between 9°C and 13°C, with normal DO
- External lesions (absent to severe)
 - Hemorrhage around head and body
 - Hemorrhagic exophthalmia
 - Enlarged spleen, occasional petechial



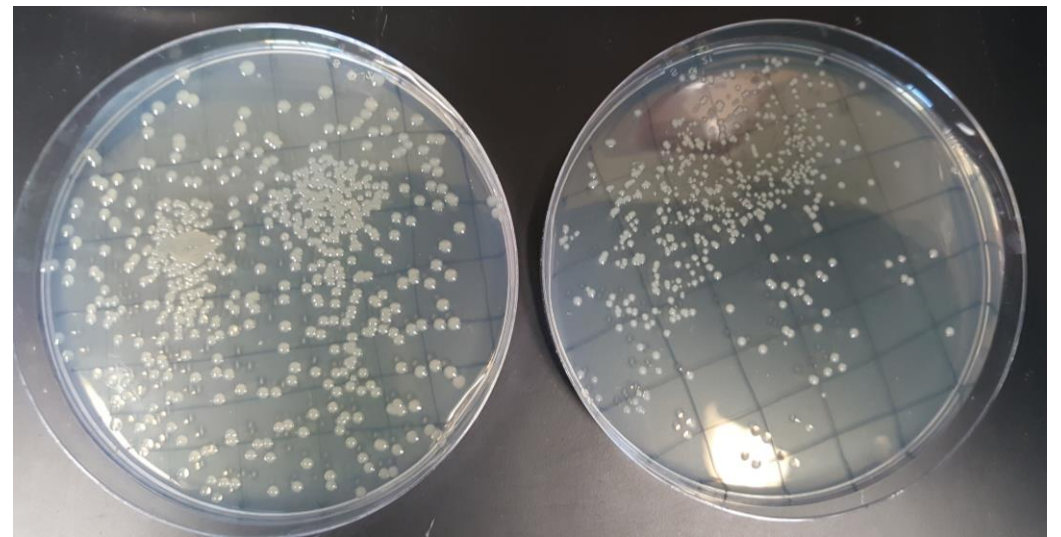
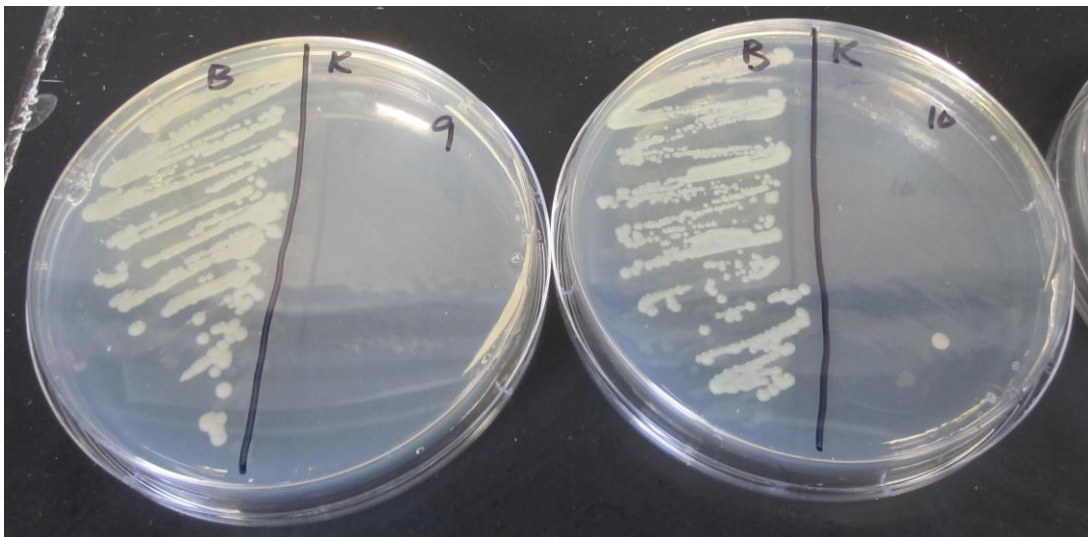
Spring 2021 mortality sampling results

- Predominant bacterium isolated was *Vibrio anguillarum*
 - Isolated from 45/57 fish examined and 35 fish had pure cultures of *V. anguillarum*
- Secondary bacteria isolated included *Yersinia ruckeri* (6 fish) and *Aeromonas salmonicida* (1 fish)
- Predominant agent is *V. anguillarum* and at times secondary infections with other fish pathogenic bacteria



Vibrio anguillarum tissue tropism

- Based on bacterial plating, brain was consistently the organ with most bacterial growth, though kidney was also frequently infected
- Bacterial counts as high as 4.87×10^7 / gram of tissue were documented in brain tissue
- Explains the neurologic behavior (circling and erratic swimming)



Vibrio anguillarum

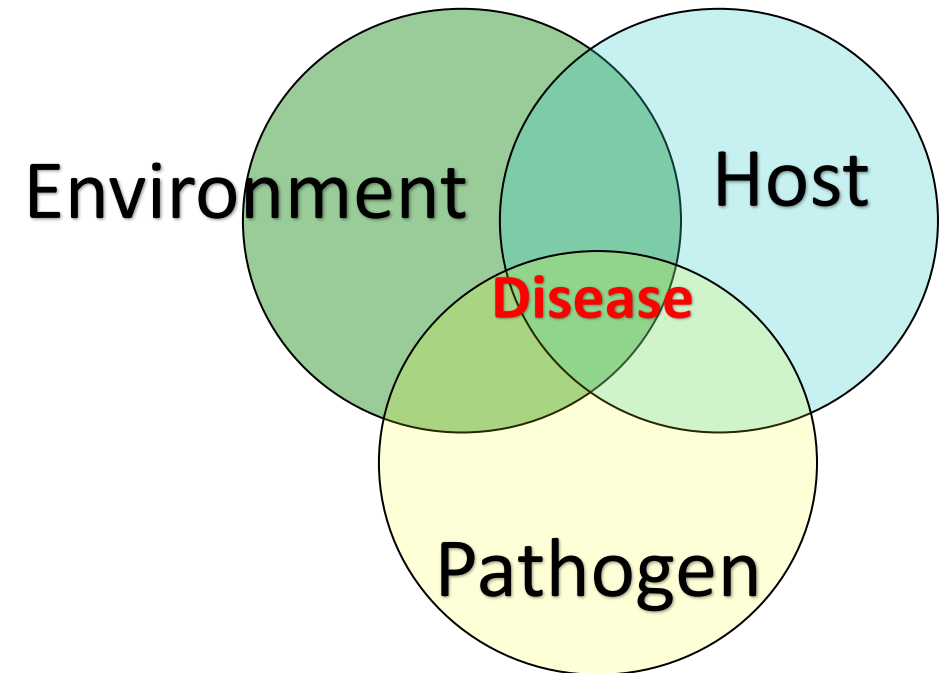
- Causes a hemorrhagic septicemia in a variety of marine finfish, crustaceans, and mollusks
 - Originally described as “red-pest” in eels
 - Highly problematic in salmonid aquaculture
 - Striped bass, turbot, etc.
- Causes disease in warmer temperature months
 - Herein we see disease outbreaks occurring in early spring and late fall (lower temperatures around 9 - 13°C)
- Reported to cause systemic infection, though generally not neurotropic
 - Herein there is a clear tropism in brain of fish

Menhaden mortalities seasonality and location

- Mortality has been most common in the spring (highly seasonal), though this past year it was noted in the fall
 - Documented a smaller scale mortality in the end of August during higher water temperatures (25°C)
 - Confirmed it was attributed to *V. anguillarum* and isolated *Photobacterium damsela* as secondary
- In May, we documented a smaller mortality in the Delaware Bay (also caused by *V. anguillarum*)
- Mortality was reported in Massachusetts and Maine as the menhaden school migrated northward

Factors that may contribute to these mortalities

- Likely that environmental stressors contribute to these mortalities
 - Temperature fluctuations in spring and fall
 - Spawning/migration stressors
 - Changes in migration patterns of menhaden
 - Population density
 - Water quality
- *Vibrio anguillarum* and other bacteria isolated are known fish-pathogenic bacteria that are common in marine environments and are likely amplified by these fish bacterial epizootics
 - *Y. ruckeri* is a known salmonid pathogen, not previously known in menhaden. Serotyping indicated this is identical to the salmonid bacterium
 - *Photobacterium damsela* is a pathogenic bacterium to various species of marine finfish



Public attention and response

News

N.J. investigating bacteria blamed for dead fish found in rivers, bays for months

Updated Apr 07, 2021; Posted Apr 07, 2021



This April 2, 2021 photo shows dead menhaden fish on a bank of the Navesink River in Red Bank, N.J. New Jersey's Department of Environmental Protection said on April 6, that they believe a species of the *Vibrio* bacteria is responsible for this and other recent fish kills in the state since November. (AP Photo/Wayne Parry) AP

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Bacterium Probable Cause of Local Massive Fish Kills

April 9, 2021

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Dead Fish Could Signal Problems for NJ Waterways

April 1, 2021

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Numerous dead menhaden, a feeder fish that is a foundation of the marine ecosystem, have washed up on the banks of local waterways. Elizabeth Wulforst

By Elizabeth Wulforst

Clean Ocean Action

Making Waves to Save our Seas, One Blog Post at a Time

Home COA Website

WEDNESDAY, APRIL 21, 2021

Fish Die-Off Update: COA meets with NJDEP officials

Background information on the ongoing menhaden die-off in the sink and Shrewsbury Rivers, see COA's blog post from April 2, 2021.



COA responded to a letter sent to Commissioners of the New Jersey Department of Environmental Protection (NJDEP) and NJ Department of Environmental Protection (NJDOH) on April 16, 2021.

COA responded the next day to set up a meeting on April 19, 2021. COA assembled all the key program top level directors and lead staff for discussion. Here are some updates from the meeting:

NJDEP confirmed fish bacteria *Vibrio anguillarum* as the cause for this menhaden (aka bunker) die-off.

NJDEP has been monitoring these die-offs for years, but this is the most severe mortality event in recent memory. This on-going event is also particularly notable because it is caused by a

Continued research and collaboration



Dr. Luke Iwanowicz



Dr. Tim Welch

- Multilocus sequence analysis to characterize isolates

- Whole genome sequence to determine sequence diversity- clones?

- Experimental infection trials in salmonids

- Maybe menhaden infection trials in the future

- Obtaining samples from New York waters



Dr. Bassem Allem