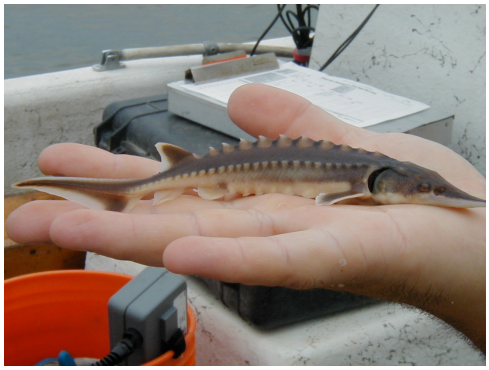
The Atlantic Sturgeon (Acipenser oxyrinchus) of the Delaware River – A Story of Plenty and Decline.



Juvenile Atlantic Sturgeon caught in the Delaware River 2009.
Photo: Matt Fisher, DNREC

On January 31, 2012 it was announced by the National Marine Fisheries Service that the Atlantic Sturgeon in the Delaware River, and other River systems, would be listed as an "endangered species" pursuant to the Federal Endangered Species Act effective April of the same year. The Delaware River population was listed along with the Hudson River Population in a Distinct Population Segment known as the New York Bight.

The Delaware River once supported the largest population of Atlantic Sturgeon known to exist. Today, there may be less than 100 according to some sources.

In the late 19th century Americans developed a taste for caviar. The Delaware River was so populated with sturgeon (both Atlantic and Shortnose) that it became the "caviar capital of North America." From 1890 to 1899 75% of the sturgeon harvested in the United States came from the Delaware River. At caviar's peak, more than 2,000 metric tons per year of female Atlantic sturgeon were harvested from the Delaware, this out of a total population of 180,000 individuals. Catching and canning sturgeon, and caviar production became a way of life for many in the region. But by 1900 the population and the catch of sturgeon was already severely depressed. In 1901, New Jersey landings were down to a mere 6% of the peak levels harvested just over a decade earlier in 1889.

While sturgeon harvesting continued it did so only at these very depressed levels. In the 1950s the reason for harvesting sturgeon shifted largely to obtaining the fish flesh as opposed to the caviar/eggs.

In an effort to protect the population from further decline moratoriums have been put in place on the commercial, recreational and tribal harvest of Atlantic Sturgeon in the

United States.[1] In 1998, after over 100 years of abuse and decline, the Atlantic Sturgeon fishery was closed by the Atlantic States Marine Fisheries Council (ASMFC) – the ASMFC put in place a coastwide fishing moratorium.

In addition to now being listed as an endangered species under federal law, the Atlantic Sturgeon of the Delaware River is also listed as endangered by the States of Delaware, Pennsylvania and New Jersey.

Despite these protections, Atlantic Sturgeon populations are not recovering. While Atlantic Sturgeon used to spawn in 26 river and estuarine systems, today they only spawn in 17 (2 of which are in Canada).[2]

When announcing its listing decision the National Marine Fisheries Service said that while there is no current estimate of spawning Atlantic Sturgeon in the Delaware River, there is believed to be less than 300. The 2008 Basin report describes the status of the Atlantic Sturgeon as "poor and getting worse" with numbers "probably less than 100 across the Estuary."

The Life, Habits and Habitats of the Delaware River Atlantic Sturgeon

Atlantic sturgeon have been known to live in the range of 60 years of age. Atlantic Sturgeon are anadromous, meaning that while they spend part of their life cycle in salt water (Atlantic Sturgeon actually spend most of their lives in the salt water) they come to fresh waters to spawn.

When spawning Atlantic sturgeon deposit their eggs highly adhesive eggs on rocky or hard bottom substrates where they can be fertilized by the male of the species. Every 3 to 5 years females can lay between 400,000 and 8 million eggs. Males spawn every 1 to 5 years. But, Atlantic Sturgeon are slow to mature: females only reach sexual maturity when 16 or older, males reach maturity after about 12 years.

Growing juveniles can spend months or years in estuary waters before entering the ocean for their next life stage. When Atlantic Sturgeon head out to sea they can migrate great distances – migrations of over 900 miles have been recorded.

When Atlantic sturgeon eventually return to the Delaware Estuary it is generally spring (April thru June).

Why Are Atlantic Sturgeon still at such Risk in the Delaware River? And What Actions Must we Take?

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[1] Shortnose Sturgeon too have been the subject of needed regulation – their populations once so decimated that they were entered onto the Federal Endangered Species list. But while Shortnose have received this higher level of population and habitat protection, the

[2] Different sources have slightly different figures, for example the National Marine Fisheries Service places the count at 35 rivers for historical spawning and 20 present day. Either way, the decline is significant and a concern.

Atlantic Sturgeon have suffered from a wide array of harms that are individually and collectively responsible for the decline and ongoing risk to the species.

- Habitat loss (primarily due to deepening and dredging),
- saltwater intrusion,
- water quality degradation,
- siltation of the River substrate (spawning habitat) by the coal industry,
- boat strikes,
- propellor strikes, and
- bycatch mortality (both in the Estuary and off the nearby continental shelf)

have all contributed to the Atlantic Sturgeon's continuing decline and inability to recover.

<u>Dredging</u>

Dredging of river systems significantly impact aquatic ecosystems in a way that is harmful to Atlantic sturgeon.

Dredging activities remove, disturb, dispose of and resuspend river sediments, modifying the river bottom substrate and impacting the community of benthic microfauna.

Dredging operations can remove or bury organisms and destroy benthic feeding areas,

Dredging operations can create noise and disburbance, and can disrupt spawning migrations,

Dredging activities can resuspend contaminants, affect turbidity and siltation, and deposit fine sediments in spawning habitats.

Dredging activities alter the hydrodynamic regime, alter physical habitats, and create the loss of riparian habitat.

The disturbance of benthic fauna, elimination of deep holes and alteration of rock substrates have been identified as of particular concern for Atlantic sturgeon. Atlantic sturgeon are substrate-dependent and as such have been shown to avoid soil dumping grounds.

Study has shown that Atlantic sturgeon avoid areas where dredging operations are taking place.

In addition, hydraulic dredging can entrain Atlantic sturgeon, taking them up into the dredge drag-arms and impeller pumps resulting in death. A review of sturgeon takings from dredging activities by the Army Corps showed that from 1990 to 2005 the largest take was on the Delaware River at 6 sturgeon.

Deepening of the Delaware River main channel and its maintenance dredging has increased the tidal range of the Delaware Estuary. Consumptive use and water diversions up river have reduced freshwater flows. The combination of increased tidal fluctuation and reduced freshwater flows has caused saltwater to intrude into the freshwater-tidal reach of the estuary, depriving the Atlantic Sturgeon of freshwater

habitat important for spawning. Ongoing dredging continues to change salinity and bottom habitats in a way that affect the Atlantic Sturgeon and their habits. The proposal to deepen the Delaware River's main channel from 40 to 45 feet will exacerbate these conditions – moving the salt line even further up river and so further shrinking the available spawning grounds for the Atlantic Sturgeon.

When announcing its listing decision, NMFS said: "The Delaware River Main Channel Deepening Project was discussed in detail in the proposed rule, because … the location and scope of the project in the Delaware River, coupled with the lack of information on the precise location of spawning and other important habitat in the Delaware River, indicate that the project could be very harmful to the Delaware River riverine population of Atlantic sturgeon."

Pollution of the River:
Atlantic sturgeon are vulnerable to situations of high temperature and low oxygen. Reduced oxygen levels have been found to reduce growth rates, respiration rates and survival in Atlantic sturgeon. Science has shown a correlation between decreasing sturgeon populations and decreasing water quality due to increased nutrient loadings and an increase in hypoxic (low oxygen) conditions and locations.

Because Atlantic Sturgeon forage for and eat food that lives on the bottom of the River, because they have long life spans, and because they are subjected to contaminants in all of the habitats they use throughout their life cycle, they are believed to be particularly susceptible to environmental contamination. Toxic metals, PAHs (Polychlorinated aromatic hydrocarbons), organophosphate and organochlorine pesticides, PCBs (polychlorinated biphenyls and other chlorinated hydrocarbon compounds have been found to harm fish by causing production of acute lesions, growth retardation, reproductive impairment, reduced egg viability, reduced survival of larval fish, delayed maturity and posterior malformations. Exposure to pesticides harms fish anti-predator and homing behavior, as well as harming reproductive function, physiological development, swimming speed, and swimming distances. It is believed that deformities and ulcerations found in Atlantic sturgeon in the Brunswick River may be due to poor water quality and boat propellor injuries.

Metals including mercury, cadmium, selenium and lead (also referred to as inorganic contaminants) may cause death or sub-lethal effects in fish. Loss of the ability to reproduce, body malformation, the inability to avoid predation, and increased susceptibility to infectious organisms may result from the chronic toxicity of some metals. Heavy metal exposure, depending on the metal and the fish, can cause brain lesions, altered behavior, degraded vertebrae, and reduced survival and abundance of larvae. Heavy metals and organochlorine compounds accumulate in sturgeon tissue.

It has been reported that fish exposure to PCBs causes a higher incidence of fin erosion, epidermal lesions, blood anemia and altered immune response. PCB exposure in fish has also been found to cause reproductive failure and mortality. The Delaware River suffers from high levels of PCBs, so much so that it is the subject of an extensive sampling program and increasing regulations under the Clean Water Act. It is believed

that the Delaware River could not meet PCB water quality standards for many decades into the future, despite strong regulatory action, because levels are so very high.

While there has not been much research on the implications of these toxins for Atlantic sturgeon specifically, it has been found that pesticides, heavy metals, and other contaminants have been found in other sturgeon species at high enough levels to cause concern and or to cause harm.

Delaware River Shortnose sturgeon have been shown to have a variety of toxins in their tissues, including PCBs, PCDDs, PCDFs, DDE, and a variety of heavy metals (including aluminum, cadmium, copper) above adverse effect concentration levels.

Dioxin, mercury, PCBs and chlorinated pesticides are considered to be contaminants of particular concern for Atlantic sturgeon populations in the Delaware River.

Early life stages of Atlantic sturgeon have been found to be more susceptible to some contaminants than a variety of other threatened and endangered fish species, and more susceptible than fish species that are more typically used to test for the aquatic toxicity of contaminants (i.e. fathead minnow, sheepshead minnow, rainbow trout).

Atlantic sturgeon in one study exposed to oxygen levels of 3 mg/l at a temperature of 26C, when unable to otherwise access air, all died. The DO criteria currently held by the DRBC for the Delaware Estuary is 3.5 mg/l. In the Philadelphia reach of the River even this low oxygen level is not always achieved. Other fish also need and thrive on higher dissolved oxygen levels, those higher than 3.5

<u>Ongoing Harvest, Take and Bycatch:</u>
While direct harvest of Atlantic sturgeon is currently prohibited, poaching occurs and is believed to be a significant threat, although the magnitude taking place is known. There is a known black market for Atlantic sturgeon and therefore an ongoing incentive for poaching.

Bycatch of Atlantic sturgeon is reported as a part of a variety of other fisheries. Coastal locations in New Jersey and Delaware are among the areas of particular bycatch concern. The greatest of bycatch were in the weakfish-striped bass fishery. American shad and white perch fisheries was among the others with high bycatch rates for Atlantic sturgeon. Sink-net fisheries were the highest for bycatch losses with trawl fisheries also likely to be having high bycatch losses. Because the Delaware River has such a small population, bycatch may have a relatively significant impact on Atlantic sturgeon recovery rates.

Both Juvenile and Adult Atlantic Sturgeon often inhabit main channel habitats, increasing their vulnerability to boat strikes. In 2004, at a time when surveys were not being methodically undertaken, 10 adult Atlantic sturgeon were found to have been struck by ship, most likely ocean going vessels; 6 were found in 2005 and 6 in 2006. With so few Atlantic sturgeon surviving in the River, these are significant figures – 10% and 6% respectively of the possible entire population.

Take by Industry:
Every day powerplants and other facilities intake millions to billions of gallons of water from the Delaware River for cooling purposes. When these plants intake water they also draw in billions of aquatic organisms, including plankton, eggs, larvae, fish and any other animal or organism that lives in the water. The water, and attendant aquatic organisms, are drawn into the plant by cooling water intake structures (also referred to as "CWIS"). When these aquatic organisms are drawn into the cooling water intake structures they are usually given a death sentence.

Larger organisms drawn into the powerplant by the CWISs are trapped ("impinged") against screens, designed to filter out debris that would interfere with the operation of the plant. Organisms impinged on intake screens often die as the result of starvation, asphyxiation or physical damage that is beyond repair. While powerplants frequently have systems for retrieving fish and organisms impinged on the intake screens and returning them to their water-home, these systems are frequently not effective in rescuing the impinged life before it dies. If an organism or fish impinged against an intake screen is lucky enough to be removed from the screen while it is alive, it still has little chance of survival; these fish may suffocate if the return system keeps them out of the water too long, often their impingement has resulted in damage which causes the fish to die soon after return to the water, and frequently the fish return system itself damages the organisms to such an extent, during its attempts to rescue them, that the organisms die upon return to the water.

Aquatic organisms who are not so unlucky as to get impinged on intake screens are subject to their own perils and tortures. These organisms are taken into the powerplant's gut, where they impact with the inner-workings of the plant, where the water they are carried in is heated to extreme temperatures thereby killing the organisms, or the organisms come into contact with deadly chemicals. If entrained organisms are lucky, if they survive any physical impacts with the cooling system's inner-workings, if they can withstand the high temperatures and/or chemicals they are subject to while passing through the cooling system, and they make it through the cooling system alive, frequently their survival is short-lived and they die after the cooling water has been discharged back into the source waterbody.

Impingement and entrainment by water withdrawal intakes is a significant concern for Atlantic sturgeon, including in the Delaware River where there are a significant number of withdrawals for commercial and other uses. For example, the Salem Nuclear Generating station withdrawals up to 3.024 billion gallons per day of Delaware River water for cooling purposes. From 1991 to 1999 a total of 8 sturgeon were reported impinged at Salem – with populations of Shortnose and Atlantic sturgeon so low this is a significant number.

In Pennsylvania there are 2 intakes on the Delaware River and 3 on the Schuylkill. The Exelon Eddystone facility that operates on the Delawre River in PA takes in 858.4 million gallons per day, Reliant Portland also in PA 286.6 million gallons per day. They do not take the volume of water or fish that Salem does, but they have their impacts.

Delaware too has a number of cooling water intakes that have an affect on fish populations. The Premcor Delaware City facility intakes 374.3 million gallons a day, Conectiv Edgmoor 276.8 (units 1-4 and 5 together) million gallons per day. While these facilities don't rival in intake the 3.024 billion gallons per day of Salem, they too kill their fair share of fish, and when all the facilities are added together the cumulative impact is clearly significant.

LNG:
The Crown Landing near Logan, New Jersey is believed to have been a historic spawning ground for Atlantic Sturgeon. This reach of the River was approved by the Federal Energy Regulatory Commission for construction and operation of a Liquefied Natural Gas import terminal. Construction of an LNG facility is likely to threaten the viability of the Delaware River population of Atlantic sturgeon. Dredging for construction and maintenance will be required for this facility. In addition, it is believed the facility will receive up to 150 shipments per year. LNG carriers take on ballast water as they offload in order to maintain stability – an estimated 8 million gallons will be pumped from the River over a 10 hour period while at the berth with an additional 5 to 11 million gallons being taken on after undocking downstream of the berth area. If still used by Atlantic sturgeon, entrainment and impingement of Atlantic sturgeon larvae is foreseeable.

Non-native invasives:
It is believed that predation could also be an important part of the recovery picture for Atlantic Sturgeon. The introduction of the non-native flathead catfish could adversely affect fish conservation efforts in the Delaware River, although there is no reason to believe that flathead catfish have a greater impact on Atlantic sturgeon than other species.

Delaware River's distinct genetic line:
There is genetic evidence that there exists a specific Delaware River haplotype, i.e. a Delaware River-specific genetic line of Atlantic Sturgeon. Haplotype A5 is private to the Atlantic sturgeon of the Delaware River. Although, many of the juveniles found in the Delaware River are likely not from this genetic stock -- Atlantic Sturgeon spawned in other river systems are using the Delaware as nursery habitat -- study has demonstrated that this genetic line is a distinct population of Atlantic Sturgeon that is unique only to the Delaware River.

While the Hudson River population of Atlantic sturgeon is growing, the Delaware River population is shrinking. The Hudson has been characterized by the National Marine Fisheries Service as one of two rivers nationwide that are believed to have the healthiest Atlantic sturgeon populations today – all other rivers are predicted to have less than 300, in the case of the Delaware it is believed that there may be less than 100.

Scientific research is showing that the Delaware River has its own distinct population of Atlantic Sturgeon. The Endangered Species Act encourages listing of distinct population segments (DPS) of species in order to ensure conservation of genetic diversity. DPS is based on population discreteness and their significance to the species. Right now only 5 DPS populations of Atlantic

Research is showing that Rivers south of the Hudson have high genetic diversity, while rivers north of the Hudson have low genetic diversity. As such, preservation of the Delaware River population takes on increased significance.

A 2007 status review of Atlantic sturgeon that considered the Delaware population as part of the larger Hudson population, predicted that they had a greater than 50% chance (moderately high chance) of becoming extinct within the next 20 years, and recommended they be listed as threatened. If the Delaware River population is given its own distinct designation/recognition it becomes clear in our eyes that endangered designation is critical. The status review also determined that the Delaware population had a moderately high risk, greater than 50% chance, of becoming endangered in the next 20 years due to the loss from ship strikes with the threat of dredging, water quality and commercial bycatch creating a moderate risk.

While the Delaware River has been shown to have a level of genetic difference that some argue should have entitled it to be listed as endangered in its own right, as its own DPS, in the final listing analysis the Delaware population was deemed by NMFS to be most appropriately grouped with the Hudson River population in a DPS known as the NY Bight.

Protecting spawning grounds:
The current spawning areas for the Atlantic Sturgeon in the Delaware Estuary remain little unknown, although the existence of a remnant spawning population coupled with recent discoveries of young seem to demonstrate that spawning is occurring. Atlantic Sturgeon in general are believed to spawn in the flow water that is between the salt front and the fall line of the major river systems they spawn in. But it should be noted that because Atlantic sturgeon are so long-lived a population can persist in a waterway with only a low level of individuals and limited reproduction for a long-period of time. This, coupled with the difficulty in capturing sturgeon who often spend time in the deeper waters makes a full picture of their spawning and population success difficult.

During the summer months juveniles concentrate in three main areas, it is believed, Artificial Island (RM 89), Cherry Island Flats (RM 110) and the Marcus Hook Anchorage (RM 125).

Spawning does require freshwater and a hardbottom substrate. Research is indicating that suitable spawning habitat exists between Marcus Hook (rkm 125) and Tinicum Island, between Tinicum Island (rkm 136) and the mouth of the Schuylkill River (rkm 148); and, because of the availability of freshwater and hard-bottom substrates, spawning habitat is also believed to exist all the way up to Trenton (rkm 211)

The majority of zones with hard-bottom substrate are within or adjacent to the shipping channel. Of course spawning within the shipping channel may have disasterous results for an Atlantic Sturgeon attempting to spawn, subjecting them to boatstrikes that could result in death. Because of the availability of freshwater and an hard-bottom substrates, potential spawning habitat is also believed to exist between Marcus Hook and Trenton.

One study indicated that spawning of Atlantic Sturgeon in the Delaware may be occurring between mid and late June in the freshwater tidal reaches between north Philadelphia (RM 176) and Trenton, NJ (RM 211). These reaches are higher than reported spawning areas of the past. It is believed that there may be a move up river as the result of increased saltwater intrusion. The increased saltwater intrusion resulting from deepening the river would continue to reduce the amount of habitat available to the Atlantic Sturgeon.

In 2008, Marcus Hook was found to be a favored spot of summering juveniles. According to the NJ Division of Fish & Wildlife "The spawning area for Atlantic sturgeon remains unknown at this time. It may well be the rock outcropping at Marcus Hook that will have to be blasted" as part of the deepening project. *(NJDEP Briefing, Delaware River Main Channel Deepening Project, Supplemental Environmental Impact Statement (SEIS) Information, January 2007.)* In addition, science continues to emerge about the use of this reach of the River for spawning, young of year and other life stages.

Dredging in the upper portions of the River near Philadelphia is considered detrimental to the successful spawning of the Atlantic sturgeon in the Delaware – this is not just because of the act of dredging but because of the degradation of spawning habitat. It is believed that this dredging and the habitat impact could lead to the population endangerment in the foreseeable future.

The Delaware deepening project being proposed and pursued by the Army Corps and Philadelphia will move the salt line further up River, further reducing available spawning grounds for the Atlantic Sturgeon. This project also requires blasting of the rock ledge that exists at Marcus Hook. Because so little is known about the habits of Atlantic Sturgeon, but what information does exists demonstrates that Marcus Hook is utilized by the population, blasting could have devastating short term and long term affects.

The combination of late maturity, a relatively low frequency of when spawning happens, and maximum egg production only happening at later ages, has contributed to the Atlantic sturgeon's inability to rebound from the historic and ongoing harms of overharvesting, damaged habitat, and direct hits they have suffered.

The Delaware River and Estuary play an important role in the life cycle of the Atlantic Sturgeon and so harms within our River ecosystems are significant for the fish.

Action to be taken:

<u>Identify the Entire Delaware Estuary as Critical Habitat for Atlantic Sturgeon.</u>
Now that the Delaware River population of Atlantic Sturgeon has been identified as endangered under the federal Endangered Species Act, NMFS has to identify what is believed to be critical habitat for the species and therefore entitled to a higher level of protection.

Scientific study on the Delaware River population of Atlantic sturgeon show that the entire Delaware Estuary provides important habitat, with the upper reaches of the estuary providing important spawning grounds and lower reaches important habitat for a mix of life stages. Thus, in order to ensure protection of the Atlantic sturgeon the Delaware River, the entire Estuary should be designated as critical habitat, only opening the door to a reduction in this designation if new information becomes available justifying it.

Raise oxygen levels.
In order to provide favorable and nurturing habitat for the struggling Atlantic sturgeon, as well as other fish and aquatic species in the Delaware Estuary, it is important that the DRBC raise its DO criteria, significantly, targeting in the first instance the more optimal level of 6 mg/l. And in the second instance, DRBC must take swift and strong action to ensure upgrades and activities that will ensure this new DO level is actually achieved throughout the Estuary waters.

Stop the unnecessary fish kills at cooling water intakes.
The Clean Water Act Section 316(b) requires that "...the location, design, construction, and capacity of cooling water intake structures reflect the best technology available ["BTA"] for minimizing adverse environmental impact." There has been, and continues to be, litigation regarding this section of the law. But at this point it is clear, to comply with section 316(b) facilities must implement technology solutions on their intake structures that address their fish kills, they cannot undertake mitigation measures that seek to in some other way benefit or enhance fish populations. It is critical that New Jersey, Pennsylvania and Delaware all put in place permit requirements that mandate existing facilities like Salem come into compliance with this requirement as soon as possible, for most facilities, this will likely mean putting in place closed cycle cooling systems. While closed cycle cooling may require upfront investment and cost, the long-term benefits to our fish populations and all who depend upon those fish will be worth it. Because Delaware and New Jersey have the largest number of facilities with the greatest volume of intake in the estuary where there are so many life stages of such a wide variety of fish those are the two states that need to act first and fastest with the greatest level of effectiveness and stringency.

No LNG at Crown Landing.
The Crown Landing LNG facility cannot be permitted at this location proposed. Instead, action needs to be taken by New Jersey to ensure permanent protection of this area of the River to ensure its continued viability for protecting and enhancing Atlantic Sturgeon populations of the River. While at this moment the project is not being pursued, there is not reason to believe that it won't again be raised at some point in the future.

Do not deepen.

Maintenance dredging of the Delaware River's main channel has already taken its toll on the Atlantic Sturgeon of the Delaware River. Deepening the channel from 40 to 45 feet will make things worse. Destroying important habitat and feeding grounds, reducing spawning grounds, and threatening the species with direct hits.

Both the dredging and the blasting elements of the deepening project must be stopped. In light of the fact that Atlantic Sturgeon is listed in two states, that information indicates they are present during the time and location of proposed blasting, that the rock outcrop that will be blasted is used by various life stages of the species, that it is recognized that the species uses main channel habitats and that dredging may be changing salinity and bottom habitats in a way that impacts their habitats and spawning, it is clear that Atlantic Sturgeon need to become a focal point for additional review and protection from this project proposal. Deepening of the Delaware River from 40 to 45 feet must not happen – the project needs to be stopped.

No more open water spoil disposal in estuary waters.
Spoil disposal that takes place in open bay waters, such as has taken place at buoy 10 in association with channel maintenance and at one point was associated with channel deepening are avoided by Atlantic sturgeon. And no longer should open water spoil disposal be allowed in estuary waters.

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