

There are approximately 9197 miles of shallow water shoreline (less than 6 feet deep at 40 feet from the shore) in Virginia, while there are approximately 1785 miles of deep water shoreline. As populations on the coastal plain of Virginia grow, more and more development is occurring on shallow tidal creeks. Property owners in these shallow areas frequently want to own similar size boats to those living on deep water. This means ever increasing requests for new dredging in shallow water to allow larger boats access to the main water bodies. In 2008, permits were requested for approximately 2,373,226 square feet of shallow water habitat dredging, including approximately 564,349 square feet of shallow water being converted to deep water.

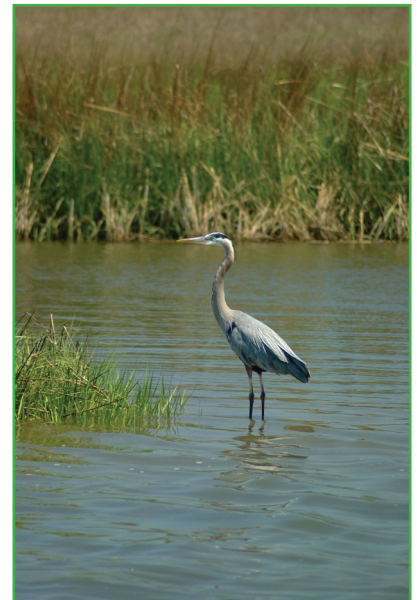


Shallow Water Dredging

Shallow water areas (defined as areas with less than 6 feet of water) are important components of the shoreline ecosystem providing food and shelter to many aquatic and fishery species. They are also hunting grounds for shore and marsh birds, such as great blue herons.

Property owners on shallow creeks frequently dredge to create deep water access to large creeks and rivers. After the initial impacts from the dredging the area may recover in time, depending on the shoreline condition and the magnitude of the impacts. However, access channels may need periodic maintenance dredging to prevent them from filling back in. Maintenance dredging converts a one-time event into a continual stressor, making it more difficult for the system to recover.

Disruptions to the function of these shallow water habitats and their connections to deeper areas may have both ecological and economic consequences. Ecological consequences include breaks in food web links, loss of bottom dwelling animals, and changes in available habitat. Alterations to any portion of the ecosystem, such as changes in the benthic (bottom dwelling) community or reductions in photosynthesis, have the potential to impact all levels of the food web. Economic consequences may include declines in fishery species populations and catch, impacts of increased turbidity or toxin release on aquaculture activities and increased shoreline erosion due to boat wakes in previously un-boatable areas. In this way activities in a confined area (e.g. shallow water) can affect both birds and deep water fish.



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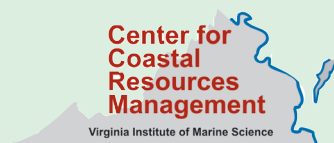
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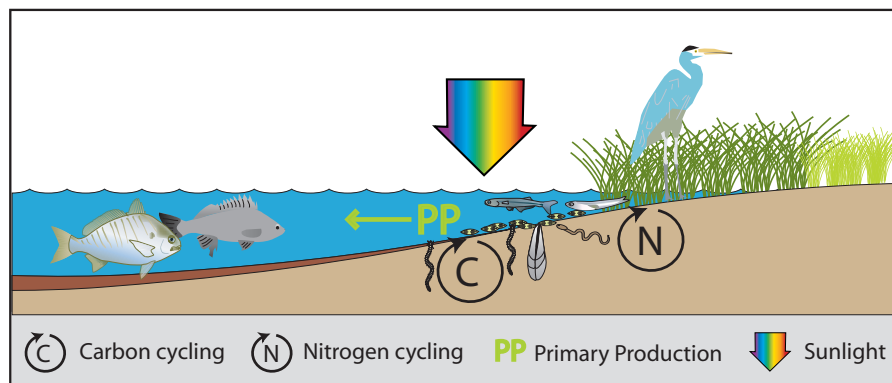
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Shallow Water Ecosystems

There are two unique characteristics of shallow water (less than 6 feet deep) ecosystems. One is that they are generally located adjacent to the shoreline, so they are coupled to food chains and nutrient processing of aquatic ecosystems, wetlands and uplands. The other is that, in clear water, sunlight can penetrate all the way to the bottom, allowing photosynthesis to occur throughout the water column and on the bottom.

Food webs in shallow waters can be complex. Small fish may feed on terrestrial insects, benthic (bottom dwelling) invertebrates, and benthic and mudflat algae. These small fish, in turn, serve as food for both larger fish (contributing to the aquatic food web) and shore or marsh birds (contributing to the upland food web). In addition, nutrients from groundwater, overlying estuarine water and exported marsh detritus are processed by benthic microbes and invertebrates.



Processes and interactions occurring in the shallow water zone. Symbols for diagrams courtesy of the Integration and Application Network (ian.umces.edu/symbols), University of Maryland Center for Environmental Science.

Figure 1. Shallow water function

Shallow water systems also provide aesthetic views and are enjoyed by many recreational boaters, generally in canoes or kayaks. Tranquil creek settings are less likely to have shoreline erosion, making them an (economical waterfront setting).



Taskinas Creek

Management Perspective

Coastal Dredging Effects

Dredging in shallow water areas are expected to have many of the same effects as general coastal dredging, and some additional effects specific to shallow water ecosystems. Effects of general coastal dredging and dredged material disposal include habitat removal, removal of existing benthic populations, burial of nearby benthos due to turbidity or sidecasting activities, temporary increased turbidity, and alterations to current patterns, sediment, water quality, salinity and tidal flushing.

Direct dredging effects to fish may include capture and killing by dredge equipment, disruption of normal foraging or spawning behaviors, and gill injury from

exposure to local increases in turbidity. Long-term and cumulative impacts on habitats, plants and animals which are likely to occur have yet to be measured. For example, elevated turbidity could reduce primary productivity and larval feeding, reducing the amount of food available to higher food web levels, and the conversion of habitats (e.g. shallow subtidal to deeper subtidal or sandy to muddy bottom) could result in a shift in ecosystem dynamics with unknown cumulative effects.

The specific effects of dredging on shallow water systems have not been well studied. However, the ecosystem links in shallow water systems allow for impacts to potentially resonate through the food webs.

Typically, shallow systems are dredged to provide boat access and maintenance dredging is required to address continued siltation. Instead of a one-time event (with a potentially short recovery time) the dredging cycle results in on-going stress. Dredging may alter local topography and bathymetry leading to changes in the accessibility of these systems (both by fish and boaters), subsequently influencing the interactions of all living organisms. Predators have improved access to the systems that previously served as prey refuge habitat. Food sources are also disrupted due to reductions in the primary and secondary productivity of macrobenthic, microalgal, oyster reef, and aquatic or marsh plant communities.

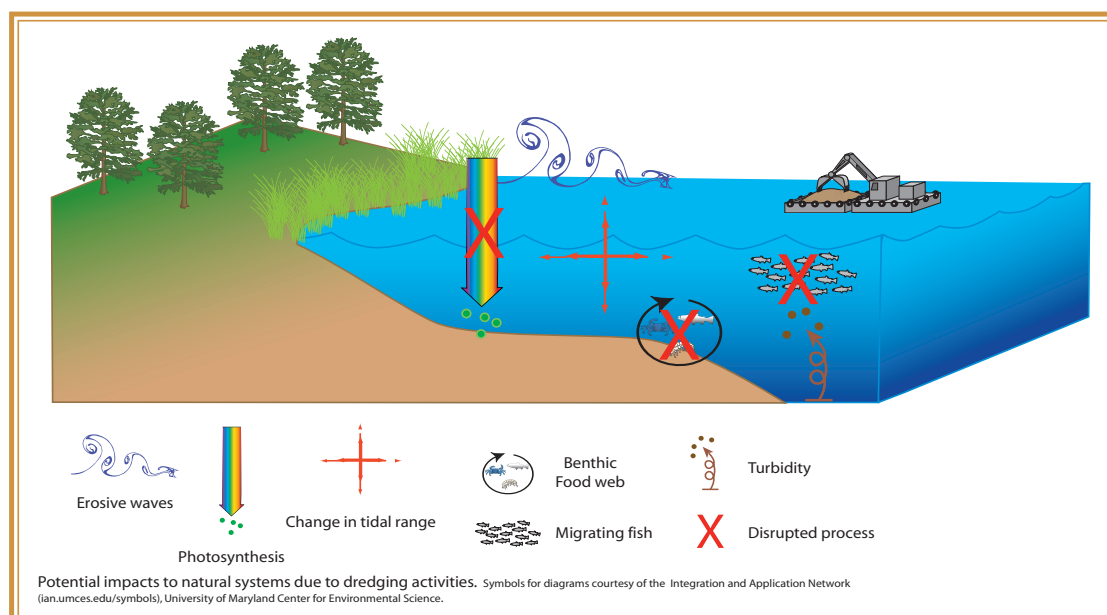


Figure 2. Some potential impacts of dredging

Shallow Water Impacts

Increased depth

Photosynthetic alterations

In shallow waters, the light necessary for photosynthesis (known as “photosynthetically active radiation” or PAR) penetrates to the bottom of the water column. This supports the growth of seagrass (“submerged aquatic vegetation” or SAV) and algae. SAV provides shelter and food for young fish and helps reduce turbidity by slowing water to allow sediment to settle out. Benthic algae is a food source for some fish species. When the water gets too deep (below ~6 feet), the available light decreases and plants can no longer photosynthesize (see figure 3). The loss of the plants and algae results in a reduction in food availability and in the case of SAV loss, refuge.

Tidal alterations

Dredging can lead to alterations to tidal range and wave action. Changes in channel profile caused by dredging can increase tidal area, wave height and water velocity, resulting in bank erosion.

Change in bottom type

Dredging, even relatively small amounts can radically change the sediment type. This has implications for the benthic community living in it. Infilling may further change the community, frequently to one dominated by fines (very small particles of mud, which are easily suspended in the water column). Muddy and sandy bottoms support different algal and invertebrate communities. The different algal and invertebrate communities support different fish communities. In areas where both types of bottom are present,

a change in bottom type can lead to a loss of environmental diversity.

Temporary sediment suspension and release of toxins

Suspended sediment in the water column blocks available light for photosynthesis, reducing benthic primary productivity and inhibiting the ability of benthic plants to recover from dredging impacts (see figure 4). Different species have different tolerances for low light. The magnitude of the impact depends somewhat on length of disturbance. SAV are also affected by burial, with variable recovery rates. If dredging is below the photosynthetic depth (see figure 3), SAV cannot recover.

High suspended sediment loads can bury adjacent bottom communities or oyster reefs and cause fish gill injury, smothering of fish eggs/early larvae, and hinder larval feeding.

Dredging exposes anaerobic layers of sediment, potentially disturbing and remobilizing toxic sediments and releasing contaminants. This has implications for water quality and aquatic animal health.

Enhanced availability, dispersion and concentration of nutrients and carbon can result from the dredging and resuspension of sediments. Enhanced nutrient and particulate organic matter bioavailability to plankton and bacteria could provide conditions conducive for proliferation of

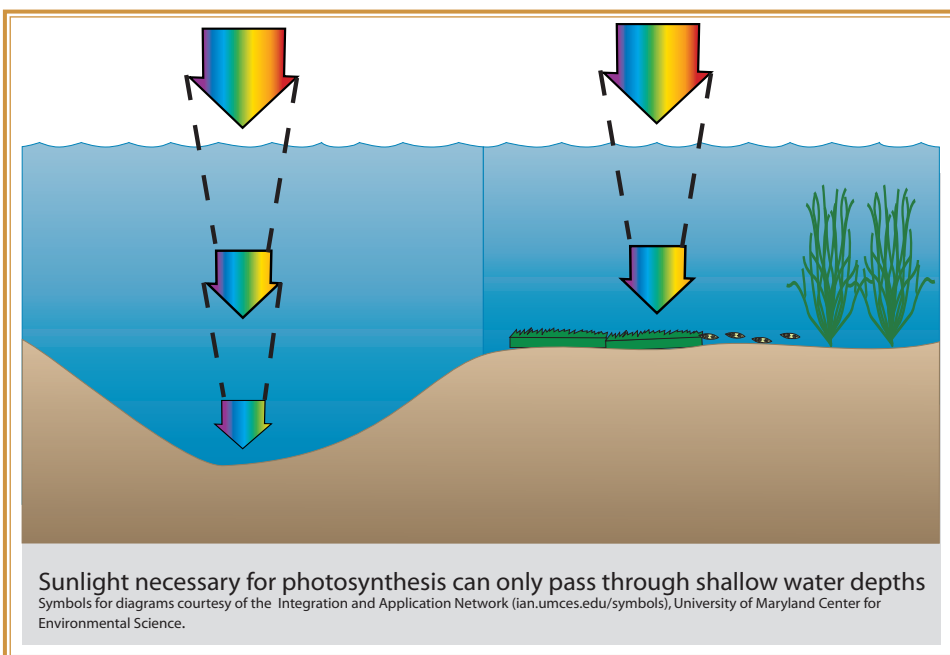


Figure 3. Light reduction in deep versus shallow water

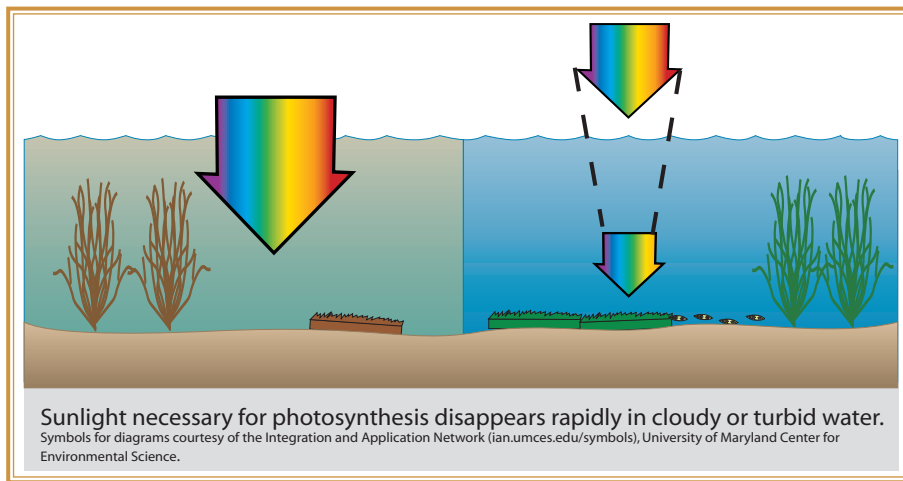


Figure 4. Light attenuation in turbid water

algal blooms. “Overall, changes in sediment organic content, nutrients and granulometry, as the result of anthropogenic activities such as dredging, have been reported to have an adverse affect on the resident community structure of the environment” (Nayer et al 2007).

Removal of benthic community

Dredging activity removes the existing benthic community which is important in nutrient cycling and as a source of food. The rate of recovery for the benthic community is highly variable and depends on the type of sediment, system size, the composition of nearby communities, the amount of sediment removed, and salinity. For instance, recovery is reported as faster for benthic communities in low versus high salinity habitats, and those associated with fine-grained sediments versus coarse-grained sediments (Newell et al. 1998).

Recurring physical disturbances (such as maintenance dredging) can alter the sediment chemistry and

reduce recruitment of new benthic animals. Over time, a decrease in benthic community abundance and diversity is likely.

Loss of the benthic community may have ramifications for the local fish population. The fish population is directly impacted by dredging activity through entrainment, elevated suspended sediments and noise level. Fish that recover from these direct impacts can also be indirectly impacted by a lack of food availability. Fish distribution may track the re-colonization of food sources and decreases in food source due to repeated dredging could mean fewer fish.

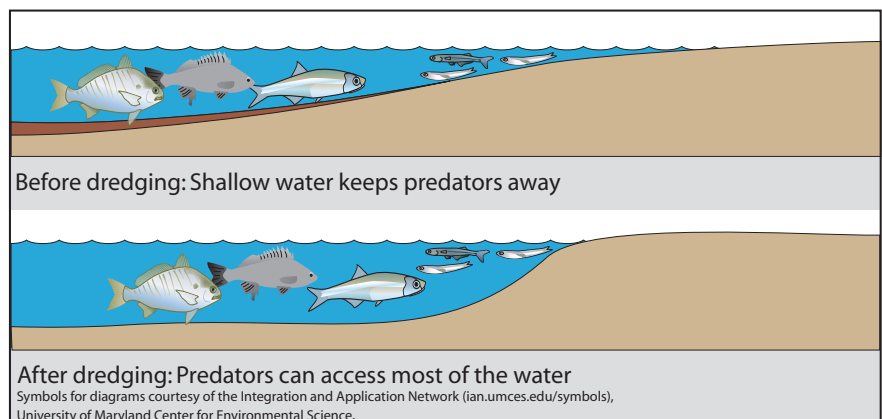


Figure 5. Loss of refuge for small fish following dredging

Loss of refuge habitat

Studies looking at changes in predation risk with depth (Clark et al. 2003, Manderson et al. 2004 and Ruiz et al. 1993) show that a number of species are less likely to be eaten in shallower water. Specific species include: grass shrimp, which survive better in 1 foot of water than 2 feet of water; winter flounder, which survive better in depths of less than 3 feet; and mummichugs and small blue crabs, which survive best in depths less than 1 foot.

The difference in survival is simply due to the size of their predators, which keeps them out of the shallower water depths. Some species may use the shallow waters for their entire life cycles, while other species use them as nursery habitat, moving into deeper water as they grow.

Dredging narrows the shallow water area and decreases the number of small fish that can take refuge there. It allows the larger fish to come much closer to the shoreline to feed. Relatively small increases in depth (around 1 foot) can impact small fish survival (see figure 5).

Best Management Practices for Reducing Dredge Impacts

Precautionary principle

There is much still unknown about the impacts of dredging on shallow water systems. Predicting the exact response of a particular system to dredging activity is difficult because the response depends on

the species present, the sediment type, the time frame of disturbance and the surrounding setting. When making decisions about whether to dredge in shallow water systems, we advocate taking a precautionary (conservative) approach.

The Precautionary Principle

“When an activity raises threats of harm to human health or the environment, precautionary measures should be taken, even if some cause and effect relationships are not fully established scientifically.”
Wingspread Conference, January 1998 (reported in deFur and Kaszuba, 2002)

The precautionary principle (see the box) articulates a basis for decision making in cases with insufficient scientific understanding and/or highly complex systems. This principle is especially important when outcomes are irreversible and/or widespread. The following considerations are Best Management Practices for implementing the precautionary principle for shallow water areas.

1. Appropriate water access

Although waterfront property owners in Virginia have the right to access the water from their shoreline, the type of access has not been defined. Liberal access policies have generally allowed property owners to modify their water depth to match the boats they own. To reduce the need for shallow water dredging, boat access should match the existing depth of the creek. In very shallow areas, only canoe and kayak access may be appropriate.



A dredged shallow water creek in the Lynnhaven River

2. Pier out or use boat ramps

Boat owners with boats requiring deeper water than is available along their shoreline have the option of either building piers out to appropriate water depth (when it does not impede navigation) or using public boat ramps to launch their boats.

Time to Recovery

Recovery of the seabed and bottom organisms following dredging depends on a variety of factors, such as the intensity of dredging, and the species of organisms present

- In shallow waters, dredging below the photic zone (the zone in which plants can grow) or altering the bottom material (e.g. converting a sandy area to a muddy area) could result in a permanently changed community*
- Sites that have been dredged repeatedly over several years may take longer to recover*

3. Time of Year restrictions

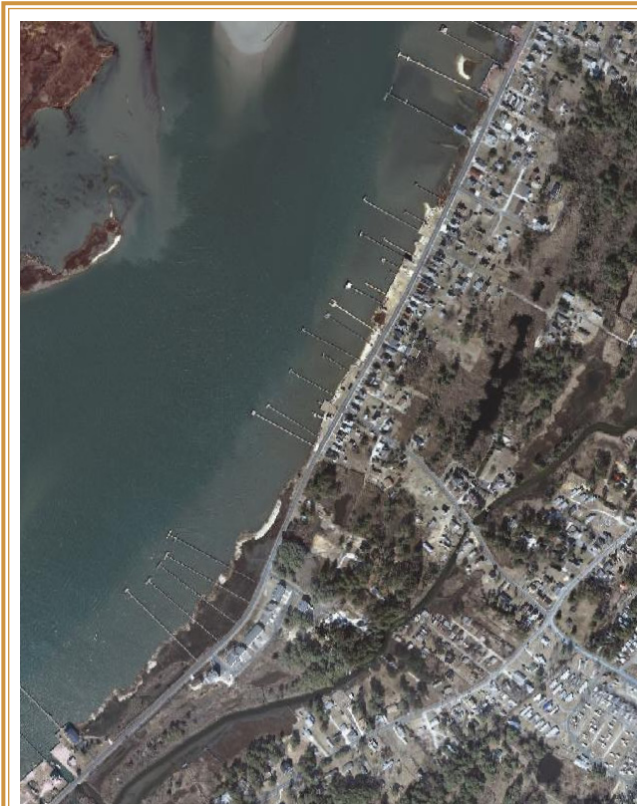
When shallow water dredge projects are deemed appropriate due to an overwhelming public benefit, time of year restrictions can help mitigate the impacts. These are seasonal restrictions on dredging activities that may minimize direct physical impacts to fish species with sensitive early

life stages (often Spring-Summer when migration, peak spawning, and nursery use occurs), native and cultured shellfish, and other species of importance. This provides some measure of protection for these species; however, they may still experience direct losses from sedimentation effects, entrapment by dredge equipment, smothering, and reduced feeding during dredging at other times of the year.

Examples of Time of Year Restrictions												
	J	F	M	A	M	J	J	A	S	O	N	D
Shellfish	X	X	X			X	X	X	X			
Anadromous Figh		X	X	X	X							
Summer Flounder			X	X	X	X	X	X	X			
Loggerhead Sea Turtle					X	X	X	X	X	X	X	

4. Wetland and SAV buffers to maintain nursery habitat

When shallow water dredge projects are deemed appropriate due to an overwhelming public benefit, maintaining wide buffers from wetlands and SAV beds can prevent the loss of these resources from slumping sides of the dredge cut, burial and reduced photosynthesis from excess turbidity and loss of suitable habitat through deepening.



On Chesapeake Bay, residents extend their piers out to deep water

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Legislative Perspective

What do we know about the impacts of shallow water dredging?

- ❖ At least temporarily, dredging in shallow waters changes:
 - Chemical and physical properties of the bottom
 - Algal and faunal benthic (bottom) populations
 - Fish population composition
- ❖ The magnitude and duration of these effects is difficult to predict and may be site specific
- ❖ There are potential ramifications for entire food web/ecosystem processes from these impacts

Therefore, impacts from shallow water dredging should be taken very seriously and should be carefully considered prior to project approval.

Historically, Virginia has taken a very liberal interpretation of the rights of waterfront property owners to access the water. This has allowed the manipulation of natural systems for inappropriately sized boat access, which has potential environmental and economic consequences for this public resource. Powered boat access should be reserved for deepwater shorelines. Property owners on shallow water creeks should enjoy their water access with small crafts such as kayaks and canoes.

When shallow water dredge projects are deemed appropriate due to an overwhelming public benefit, all precautions (such as time of year restrictions) should be taken to protect these vital resources.

Sources of potential dredging impacts:

- ❖ *Exposure to elevated suspended sediment concentrations and turbidity (disrupts primary production, filter feeders, and fish spawning)*
- ❖ *Disrupted fish migrations*
- ❖ *Physical disturbance of habitat by increased sedimentation*
- ❖ *Hydraulic entrainment (entrapment by dredge equipment) of animals during dredging including: young oysters, striped bass, blue crabs, juvenile sturgeon, and sea turtles among others*