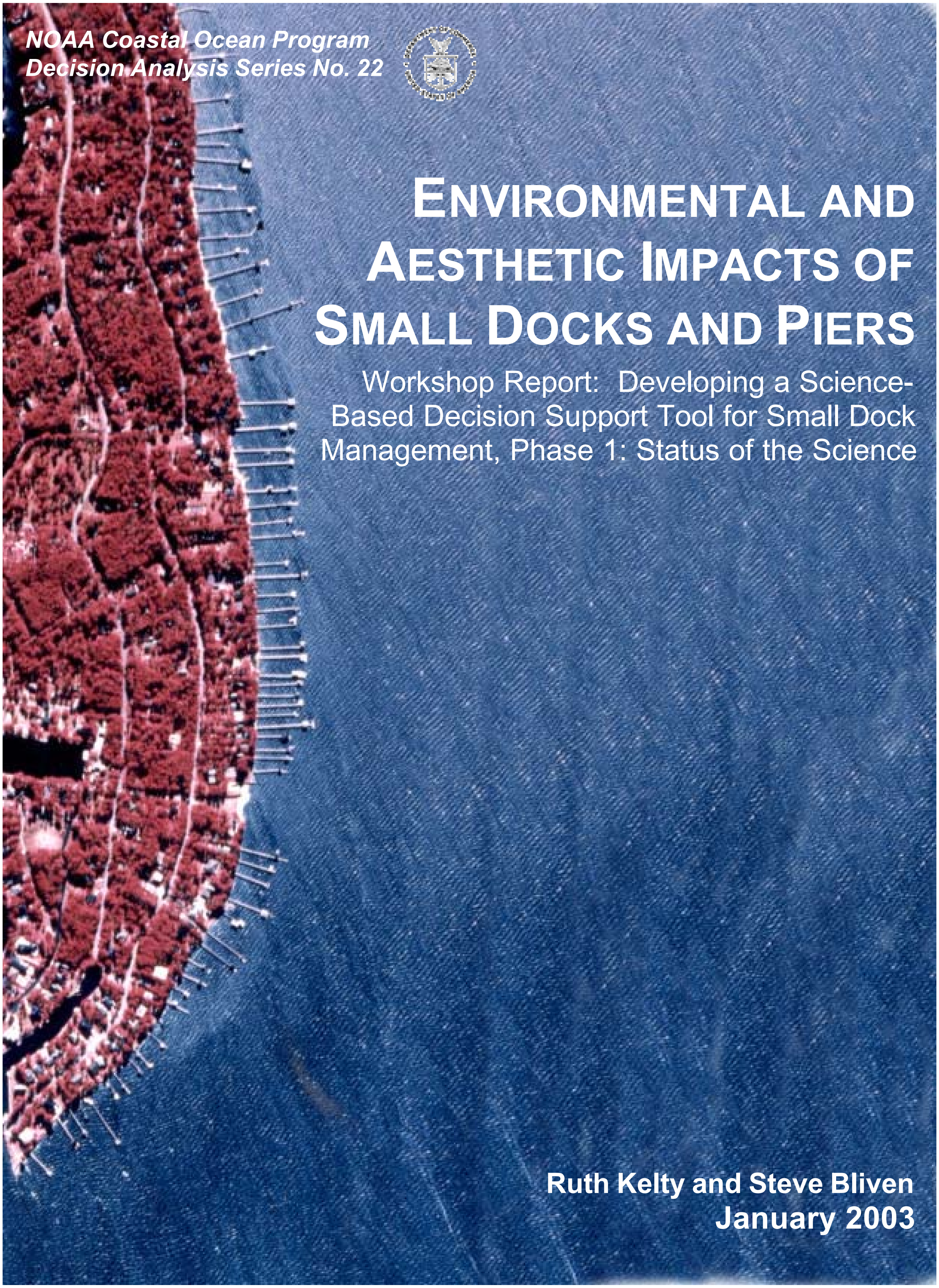

NOAA Coastal Ocean Program
Decision Analysis Series No. 22

Environmental and Aesthetic Impacts of Small Docks and Piers

Workshop Report: Developing a Science-Based Decision Support Tool for Small Dock Management, Phase 1: Status of the Science

Ruth Kelty and Steve Bliven

January 2003

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Science for Solutions

NOAA's COASTAL OCEAN PROGRAM
Decision Analysis Series Number 22

ENVIRONMENTAL AND AESTHETIC IMPACTS OF SMALL DOCKS AND PIERS

Workshop Report: Developing a Science-Based Decision Support Tool for Small Dock Management, Phase 1: Status of the Science

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January 2003

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Note to Readers

Environmental and Aesthetic Impacts of Small Docks and Piers is the proceedings from a January 2003 workshop sponsored by the National Centers for Coastal Ocean Science (NCCOS). The workshop, which focused on the status of the science, is the first of a series designed to support the development of a science-based decision support tool for small dock management. Future workshops will synthesize information on regulatory, non-regulatory, and construction tools available to improve the management, and reduce the environmental impacts, of small docks and piers.

The NCCOS provide a focal point through which NOAA, together with other organizations with responsibilities for the coastal environment and its resources, can make significant strides toward finding solutions to critical problems. By working together toward these solutions, we can ensure the sustainability of these coastal resources and allow for compatible economic development that will enhance the well-being of the Nation now and in future generations.

A specific objective of the NCCOS is to provide the highest quality of scientific information to coastal managers in time for critical decision-making and in formats useful for these decisions. To this end, the Decision Analysis Series was developed by the Coastal Ocean Program to synthesize information on issues of high priority to coastal managers. As a contribution to the Decision Analysis Series, this report provides a critical synthesis of the potential consequences of the construction, presence, and use of small docks and piers on the coastal environment. A list of other available documents in the Decision Analysis Series can be found on the last page of this report.

As with all of its products, the NCCOS is interested in ascertaining the utility of *Environmental and Aesthetic Impacts of Small Docks and Piers,* particularly in regard to its application to the management decision process. Therefore, we encourage you to write, fax, call or email us with your comments. Please be assured that we will appreciate these comments, either positive or negative, and that they will help us direct our future efforts. Our contact information is below.

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INTRODUCTION

Statement of Problem

Few issues confronting coastal resource managers are as divisive or difficult to manage as regulating the construction of private recreational docks and piers associated with residential development. State resource managers face a growing population intent on living on or near the coast, coupled with an increasing desire to have immediate access to the water by private docks or piers.

The numbers of requests for permits to construct docks, and the numbers of docks constructed and used throughout the nation's coastal areas, have increased in recent years (e.g. see Fig. 1). A strong economy, the associated increase in discretionary spending, increasing boat sales, and limited mooring and public docking facilities all contribute to the trend. These docks and the vessels using them impact:

- natural resources and their use,
- aesthetic values, including natural and development area characteristics, and
- public access and uses of shoreline and nearshore areas.

Coastal managers and others have indicated there is a need for better understanding of the individual and cumulative effects of residential docks and the uses associated with them. Ideally, this improved understanding would result in better aquatic management that ensures that additional docks: (1) do not harm the environment, (2) provide waterfront property owners reasonable access to the water if they choose to have it, and (3) do not adversely affect public access, navigation, or other uses of the aquatic environment.

The Coastal Zone Management Act of 1972 (CZMA) encourages states to "exercise their full authority over the lands and water in the coastal zone." In this broadly stated goal, the CZMA recognizes the need for each state to develop a coastal management program tailored to its unique needs and circumstances. Nearly all coastal states and territories have responded by developing programs that include various means of regulating and managing docks and piers.

Dock authorizations are now the single most frequently sought permit from coastal managers. Among a significant segment of the public, there is a perceived "right" to have a dock. For example, 90% of coastal South Carolina residents surveyed in 2001 want a dock, 86% felt docks increased their property value, and 73% thought they should be allowed to build one (Felts et al. 2001). Many people consider private residential docks a normal and characteristic part of the coastal landscape and often do not understand why they must undergo a long and arduous permit review process. Others, however, consider docks a

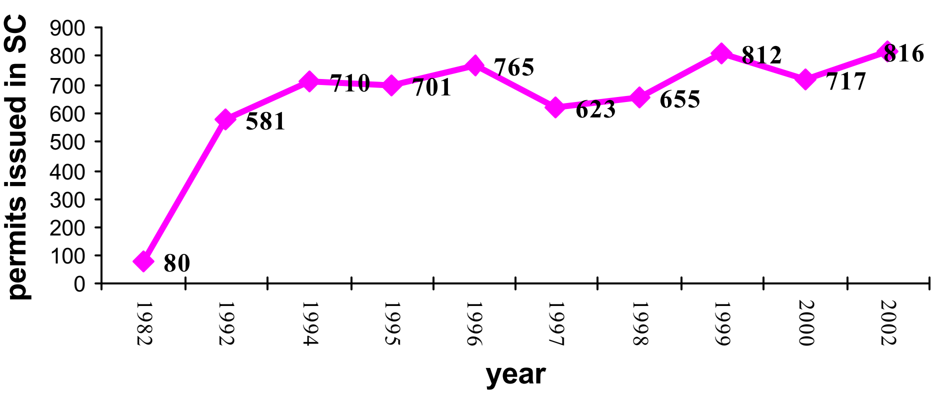

Figure 1. Increase in permits issued for dock construction in South Carolina.

threat to public values and the environment, and question why they are allowed at all. As coastal areas are developed and the number of permit requests increases, coastal managers are looking for a rational, science-based decision-making tool to guide their regulatory decisions.

As with other coastal activities, the construction and use of private residential docks can create a range of impacts—depending on both geographically site-specific factors and the perspective of the observer. There is considerable evidence that docks shade, alter patterns of water flow, introduce chemicals into the marine environment, and impact public access and navigation. The vessels using docks also affect resources and human uses to varying degrees. However, scientific investigations and resulting literature quantifying the biological effects associated with individual and cumulative impacts are limited. Furthermore, the existing literature is not well known or understood by the general public.

Background to the workshop

State and local governments in Alabama, Connecticut, Georgia, Massachusetts, New Hampshire, Rhode Island, and South Carolina are currently reviewing or revising the manner in which they manage docks and piers. In November 2000, a one-day workshop on dock and pier science and management was held as part of the Northeast Regional Coastal Zone Management Program Manager's Meeting. Southern and Caribbean managers expressed interest in a similar workshop at their 2001 regional meeting. In response, OCRM hosted a special session at the Coastal Zone '01 conference in Ohio on management of docks and piers. This was followed by a cover story in the fall issue of NOAA's Coastal Services magazine.

Feedback from these initial efforts indicates that state managers see a need for credible, relevant, and high quality scientific analysis of the issue. They have asked NOAA's National Ocean Service for further assistance in developing the proposed tools and expressed a willingness to help with the workshops and assessments.

The workshop described in this document is an initial step in this effort—an effort to assess the state of knowledge about the impacts of small docks on both the natural environment and human uses thereof.

Further efforts may explore various means currently available to minimize or alleviate the various impacts, as well as their economic and social costs. Finally, funding and support will be sought for a similar working session on the regulatory and non-regulatory tools available for management of docks.

NOAA's Coastal Services Center (CSC) is presently conducting an assessment of laws, regulations, and policies pertaining to dock management for the southeastern U.S. (the states of North Carolina, South Carolina, Georgia and Florida). Over time, it is hoped that this effort will be expanded to include many of the remaining 29 coastal states and territories and to compile the information into a searchable database. Such a system would facilitate state-to-state interaction and comparisons, allowing managers to see how similar regions have dealt with specific permitting issues.

THE WORKSHOP

On 22–23 January 2003, NOAA's National Centers for Coastal Ocean Science hosted a workshop at the University of Massachusetts Boston to review the available scientific knowledge about the impacts of small, recreational docks. Twenty-two scientists and eight managers representing the Southeast, Gulf Coast, Mid-Atlantic, Northeast, Great Lakes, and Pacific regions discussed what is known (and not known) about how docks and associated boating activities individually and collectively impact vegetation, sediments and sedimentation, contamination, navigation and public trust rights and interests, and aesthetics/quality of life.

The workshop focused on relatively small, recreational docks associated with residential use. These generally consist of a pile-supported walkway leading from the shore into the water and often have a float at the water end of the structure. Floats may be bottom anchored or held in place by piles. The structures may be used for boat landings, fishing, relaxing, or similar uses.

Workshop Objectives

- Synthesize existing scientific information on direct, cumulative, and secondary effects of small docks on the coastal environments and their users.
- Identify gaps in research results related to the impacts of small docks.
- Assess susceptibility of regions to the negative impacts associated with docks.

Desired Outcomes

- A summary of existing scientific knowledge that can help managers guide the implementation, development, or revision of federal, state, and local dock regulations.
- Identification of key elements needed by managers to effectively evaluate permit requests or develop area-wide plans.
- Identification of gaps in research on the environmental, social, and economic impacts of small docks.
- Development of a work plan to formulate assessment protocols needed to guide management actions, including a prioritized listing of research needs.

Workshop Products

The desired outcomes of the workshop were intended to be reflected in the following specific products discussed in this document:

- A report summarizing the state of existing scientific knowledge pertaining to the impacts from small docks,
- A bibliography of publications pertaining to the science and management of small docks, and
- A prioritized list of research needs.

Discussion Topics

Workshop discussions were designed to address the following topics:

- vegetation,
- contaminants,
- boating impacts,
- navigation, and
- aesthetics.

These discussions led to a series of recommendations for consideration by those involved in residential dock and pier regulation, construction, and use.

Background Paper

Developing a Science-Based Decision Support Tool for Small Dock Management:

Status of the Science

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Introduction

Purpose of the document:
The following document is intended to provide a general background for participants at the workshop on "Developing a Science-Based Decision Support Tool for Small Dock Management: Phase I: Status of the Science" to be held on 22–23 January 2003 at the University of Massachusetts Boston. It is not intended to be a comprehensive survey of the literature related to small docks and their impacts; only as an introduction to the various topics to be discussed.

Definition of small docks for the purpose of this paper and workshop:
The focus at the workshop will be on small, recreational docks designed for residential use. They generally consist of a pile-supported walkway leading from the shore into the water and often have a float at the water end of the structure. Floats may be bottom anchored or held in place by piles. The structures may be used for boat landings, fishing or similar uses.

Purposes of the Workshop

1. To synthesize existing scientific information on direct, cumulative, and secondary effects of small docks on the coastal environments and their users,
2. To identify gaps in research results related to the impacts of small docks, and
3. To assess susceptibility of regions to the negative impacts associated with docks.

Desired Outcomes:

- A summary of existing scientific knowledge that can help managers to guide the implementation, development, or revision of federal, state, and local dock permitting processes to include identification of key elements needed by managers to effectively evaluate a permit request or in the development of an area-wide plan.
- Identification of gaps in research on the environmental, social, and economic impacts of small docks. Development of a work plan to formulate assessment protocols needed to guide management actions, including a prioritized listing of research needs.

Workshop Products:

- A report summarizing the state of existing scientific knowledge pertaining to the impacts from small docks,
- A bibliography of publications pertaining to the science and management of small docks,
- A prioritized listing of research needs, and
- A check-list of known impacts from small docks.

Impacts on Vegetation

Vegetation is critical as a food source, habitat, and protection against erosion—both on the shore or marsh and submerged below the water line.

Impacts to plant productivity generally occur in one of two ways:

- Short-term construction impacts
- Chronic impacts from shading

Construction Impacts

Activities during construction can destroy plants either above the tide line (*e.g., Spartina* or *Distichlis*) or below (e.g., *Zostera* or *Halodule*) by pulling them from the substrate or destroying their root system. The peat beds underlying salt marshes can be compacted through the improper use of heavy equipment. Although these impacts are seemingly evident, limited research appears to have been done on the long-term impacts of these activities.

In sea grass beds, the installation of pilings may have immediate impacts as well as cause long-term changes. Installation through "jetting" with high-pressure hoses typically disturbs a surrounding area—depopulating grasses there prior to construction. Once areas are depopulated, the presence of pilings may lessen chances of regrowth. Beal, Schmit, and Williams (1999) suggest that changes in seagrass communities in the vicinity of pilings may be caused by the modification of currents, sediment deposition, attraction of bioturbators, and leaching from chemically treated wood. Shafer and Robinson (2001) tracked the regrowth of *Halodule wrightii* beneath docks in St. Andrew Bay, FL. They noted bare areas from 35–78 inches in diameter around pilings, even though the docks had been constructed at various times, suggesting that regrowth is affected by the presence of pilings. The authors found that where piles were installed using low-pressure jetting techniques there was, "little or no sand deposition around the pilings and the remaining seagrasses around the pilings looked healthy and had good growth around the piling."

Sanger and Holland (2002) noted a path along each side of one new dock where vegetation had been almost totally destroyed, presumably during construction. Resurveying the site 15 months later the researchers found that *S. alterniflora* had recolonized the area and substantial recovery had occurred.

<u>Chronic Shading Impacts</u>

Both marsh grasses and sea grasses have adapted to living in extended periods of sunlight. Their photosynthetic pathways vary from many terrestrial plants allowing them to be highly productive in their natural settings. Shading can have significant impacts on the health and productivity of these plants.

Shaefer and Robinson (2001) indicate that light levels of 13–14 percent of mean daily surface irradiance (SI) are necessary for survival of the seagrass *Halodule wrightii*. Shaefer (1999) also found that seagrass densities were 40–47 percent less in areas shaded at levels of 16–19 percent SI. The summary of a NMFS Technical Memorandum (Kenworthy and Haunert, 1991) noted that "the light requirements of temperate and tropical seagrasses are very similar" requiring "at least 15 to 25 % of the incident light just for maintenance." Research by Koch and Beer (1994) indicate that light levels of 300 to 500 _$Em^{-2}s^{-1}$ are necessary for *Zostera* survival in Long Island Sound and Narragansett Bay.

In a field study conducted in Waquoit Bay, Falmouth/Mashpee and Nantucket Harbor, Burdick and Short (1999) found that the most significant factors affecting shading impacts on eelgrass from boat docks with plank decking are height of the structure above vegetation, orientation of the dock (north-south versus east-west) and dock width. The National Marine Fisheries Service suggests that spacing between decking planks on the order of an inch or two has little effect on shading impacts. (Michael Ludwig, NMFS, Personal Communication).

Kearney *et al*. (1983) studied impacts to marsh grasses from walkways/docks. They assessed the impacts from "all the structures" within Connecticut's major salt marsh regions, collecting data on vegetation density and height beneath and adjacent to the structures, and the physical dimensions of the docks (width, height, plank width and spacing between planking—they did not include orientation). They found that dock height was the only statistically significant variable. They further reported that the vegetation density of low marsh grasses (*Spartina alterniflora*) was affected less by shading than high marsh grasses (*S. patens and Distichlys spicata*). The opposite trend was noted in vegetation height—possibly due to etiolation. No measures of biomass were taken. Docks less than 30–40 cm (12–16 inches) above the marsh shaded out all vegetation in all of the study sites. A subsequent effect of the shading was reported to be accelerated soil erosion beneath structures passing over *S. alterniflora* at the edge of the marsh.

The NMFS (Colligan and Collins, 1995) assessed dock impacts on vegetation in Connecticut, Rhode Island, and Massachusetts with the results compiled in a "Pre-publication copy—not for distribution". This study cast some doubt on the methodology and statistical analyses of Kearney et al (1983) but, because it has not been released in a final form, it is difficult to evaluate the results.

Maguire (1990) measured the effects of shading by open pile structures on *S. alterniflora* density in a fringe marsh in the York River Estuary (VA). The docks ranged in length between 15–20 m (~50–65 feet) and .6 m–2.4 m (2–8 feet) wide. A computer program was developed to calculate the total number of hours of shading produced by each structure based on height, width and orientation of the structure. Based on the information from this program, correlation coefficients between shade duration and vegetation density were calculated These displayed a wide range (+ 0.03 to –0.93 with 60% falling between –0.70 and –0.93. The author attributes the wide range to a threshold phenomenon and that "a more refined measurement that can account for temporal differences in light intensities reaching vegetation as well as the response of the plant to the light that it receives may result in greater predictive powers." The computer program developed as part of this project appears to hold promise as a predictive tool. Unfortunately, no electronic copies of the program remain (the text of the program is available) and it is written in Pascal. To be effective the program would have to be rewritten in a contemporary, and more user-friendly format.

Sanger and Holland (2002) assessed impacts from 32 docks in the Charleston, SC area on *S. alterniflora.* The structures represented a range of lengths, orientations, and ages. The researchers noted that the plants under the docks were often taller than those adjacent to the dock. They suggested that this might be affected by fecal material from birds resting on the structures. Reviewing the data of Maguire (1990) the authors noted that the orientation of the docks did not seem to affect density.

Sanger and Holland (2002) then compared the area of marsh affected by docks to the total area within creek systems and across the state. Using the numbers of docks present in 1999, their findings resulted in an estimate of reduction in plant densities of between 0.03–0.72% of the total amount of *S. alterniflora wi*thin local creek settings. Projected to total possible build-out of similarly sized docks in the creeks, these figures increase to 0.18–5.45% decrease in marsh grass. Expanded to the area of *S. alterniflora* in the eight coastal counties in the state at projected year 2010 dock numbers at the maximum size presently allowable under regulation, an estimated density reduction of between 0.03–1.98% could be attributed to dock impacts.

As noted above, Maguire (1990) produced a program to predict the amount of shading over a season that would result from a dock of any given size. Burdick and Short (1998) prepared estimates of impacts to *Zostera* from docks of specific height, width, and orientation. They did not attempt to develop a process to assess the impacts from other sizes and orientation.

Questions for consideration:

1. Are the light level thresholds for maintenance or additional growth known for marsh grasses to a level of certainty to make defensible decisions?

2. Is it known which parameters of the dock structure are critical to predict impacts to vegetation—either marsh grasses or seagrasses?
3. Is there a tool available, or could one be developed to predict the impacts of specific structures, given the design parameters?
4. The existing studies of marsh grasses looked at vegetation density and/or height. No measures of biomass were recorded. To provide a prediction of energy source to the food web (as opposed to appropriate habitat or erosion control), is this an important factor? If so has any research been done on this topic?

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Impacts from Contaminants

Small docks and piers in coastal waters, either pile supported or floating, are not apt to have a measurable effect on levels of dissolved oxygen or temperature. Such structures are generally too small and, except in the most closed of lagoons or canals, the movement of coastal waters is sufficient to avoid such impacts.

The most common contaminant-related concern related to docks is leaching from preservatives applied to pilings or floats in locations that come into regular contact with water.

Oil based preservatives containing creosote (CRT) or pentachlorophenol (PCP), applied to the surface of wood materials, leach readily and have demonstrated toxic effects. Most states have banned their use in aquatic settings.

Wood pressure-treated with a chromated copper arsenate (CCA) is the most commonly used material for pilings and decking for small docks. The form of CCA most often seen is comprised of 47.5% hexavalent chromic oxide, 18.5% curpic oxide, and 34% arsenic pentoxide. Research has shown that in fact some leaching does occur in saline waters (Weis *et al.*, 1991,1992). There has been extensive study of the toxicity of these compounds in the marine environment that suggests that the degree of toxicity depends on the chemical form as it reaches the target organism. The forms will change over time and in response to sediment types, amounts of organic material present, oxygen levels and water movement (Luoma and Carter, 1991).

Laboratory studies by Weis *et al.* (1991, 1992) have shown that leachate from CCA-treated wood can be toxic to estuarine species. Leaching decreases by about 50% daily once the wood is immersed in seawater. Approximately 99% of the leaching occurs within the first 90 days (Cooper, 1990, Brooks 1990; in Sanger and Holland, 2002).

Elevated concentrations of metals from CCA-treated woods can be found in organisms living on treated pilings and in the areas near to the pilings (Wendt *et al.*, 1996; Weis and Weis, 1996) Field studies by Weis *et al.* (1998) found elevated concentrations of metals in fine sediments adjacent (within 1 meter) of bulkheads constructed of CCA-treated material. At a limited number of sites elevated concentrations could be seen at greater distances. In an unpublished "grey literature" study prepared for the New Jersey Department of Environmental Protection however, Weis and Weis (1998) did not observe "any evidence that CCA dock pilings are a source of metal contaminants in the Navesink/Shrewsbury Rivers." Pedrick Weis reported similar findings at a Massachusetts Coastal Zone Management workshop in 2000. Sanger and Holland (2002) report that, "it is unlikely that the bioaccumulation of dock lechates by marine biota is having or is likely to have an impact on living resources in South Carolina estuaries and tidal creeks." Reasons given are that the leaching generally occurs only when the dock is new, that the size of the area around the dock that might be affected is small, and high rates of tidal flushing will dilute and flush any accumulations in the water column.

Questions to consider:

1. Are there demonstrated impacts from preservatives used for the protection of wooden portions of small docks? If so, what are the impacts?
2. Are there other contaminants of concern can be linked to small docks (as opposed to impacts from associated boating which will be discussed later)?

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Boating Impacts

Most small docks are associated with boat traffic. Being situated at the interface between land and water, at least a portion of each dock is in the intertidal zone and extends through shallow areas. In many cases this leads to potential environmental impacts. In 1994, a workshop on the impacts of boating was held at the Woods Hole Oceanographic Institution. The results are summarized in Crawford *et al*. (1998). A number of potential boating-related impacts were discussed. While noting that there were adverse impacts, the presentations revealed that there were limited quantitative data available that could be used as the basis for management decisions—although it was agreed that sufficient data exist to “substantiate the inference that recreational … motor boat traffic is far from a benign influence on aquatic and marine environments.” No differentiation was made between general boating activities and that taking place in the vicinity of docks.

A second symposium on the topic, “Impacts of Small Motorized Watercraft on Shallow Aquatic Systems” was held in 2000 at Rutgers. The results of this symposium were published in Kennish (2002).

Both workshops identified several issues of concern regarding boating activity including:

- Impacts to submerged aquatic vegetation,
- Contamination from fuel discharges,
- Erosion on shorelines, and
- Resuspension of bottom sediments and turbidity.

<u>Impacts to submerged bottom vegetation.</u>
Boat propellers can directly damage submerged aquatic vegetation in shallow waters (Thayer *et al.,* 1975; Kruer, 1998; Burdick and Short, 1999); impacts that may take years to heal. *Thallasia sp.,* for example,

can take four to six years to recolonize a prop scar (Kruer, 1998). Damage to the plants and their rhizome system often leads to both reduced habitat and destabilized sediments.

Contamination from fuel discharges:
Outboard motors associated with boating have long been associated with contamination of waterways. Milliken and Lee (1990) provide a good summary of the early literature. Two-cycle engines release up to 20% unburned fuel along with exhaust gases (Moore, 1998). Moore (1998) compared the PAH output from a two-cycle outboard engine with that from a four-cycle engine. Discharge from the two-cycle contained five times as much PAH as from the four-cycle. Most of this difference was due to a reduction in discharge of 2- and 3-ring compounds—those that are generally considered acutely toxic—in the four-cycle. However, he found little difference between the levels of discharge of 4- and 5-ring compounds—those generally related to chronic toxicity. Albers (2002) notes that PAH concentrations in the water column are "usually several orders of magnitude below levels that are acutely toxic", but those in sediments may be much higher.

PAHs related to boating activities probably accumulate in bottom sediments (Sanger *et al.* 1999) where they may be stirred up by boat traffic (Albers, 2002). However, Sanger and Holland (2002) were not able to distinguish PAHs from dock-related activities from other anthropogenic sources.

Erosion on shorelines:
Many studies have related boat wakes with shore erosion (*e.g.,* Zabawa *et al.* 1980; Camfield *et al.* 1980; Hagerty *et al.*, 1981). Most of these relate to boats moving at or near hull speed through waterways. There was little found in the literature that pertained specifically to boats maneuvering near docks or landing areas.

Resuspension of bottom sediments and turbidity:
Running a motorized boat through shallow waters produces two distinct types of wake: 1) the surface bow wake that can lead to erosion of the shoreline as discussed above and 2) a pressure wave formed beneath the boat hull that can impact the bottom (Crawford, 1998). Crawford (1998) describes two components that make up the pressure wave; a low frequency wave caused by the motion of the hull through the water and higher frequency waves produced by the action of the propeller. The pressure wave does not fan out as does the surface wake and consequently has localized impacts. It is also a greater in slow-moving hulls, modern planning hulls have a far lesser impact on bottom sediments (Crawford, 1998; Hartge, 1998). Hartge (1998) also compared prop-driven boats with those that were water-jet propelled and noted no major differences between the amount of resuspension of sediments; he did note that slow-moving, heavy laden boats caused more turbidity than lighter, faster-moving boats.

Passage of slow-moving boats in shallow waters over fine sediments will produce turbidity, but Crawford (1998) found in Waquoit Bay, MA that this was a short-term phenomenon. Ambient light sufficient for maintenance of eelgrass was restored within 10 minutes of the passage of a vessel. The suspension of bottom sediments also appears to be related to the presence of the odor of hydrogen sulfide.

Investigating impacts of bow waves from personal watercraft, Anderson (2000) found a wide range of settling times of resuspended sediments. Depending on the nature of the sediments, settling times ranged from 7 seconds to approximately 10 minutes.

Boats operating in the vicinity of docks are generally moving slowly so such impacts may be particularly significant to these areas, although this does not appear to be demonstrated in the literature reviewed for this paper.

"Prop dredging" is a specialized form of sediment suspension in which the propeller or water jets of a vessel are used to move sediments out of a particular area; either as a purposeful action or as a by-product of boating use. This typically occurs where docks are of insufficient length to reach water depths appropriate to vessels being docked (Ziencina, 2002, pers. com.). This may lead to the loss of seagrasses in the vicinity of a dock (Burdick and Short, 1999) either through physical disruption of the vegetation or though burial by sediments.

Questions to consider:

1. What boating impacts have been sufficiently defined that they can form the basis of defensible management decisions?
2. What other impacts should be evaluated?
3. Are the impacts of boating as related to docks significantly different from those of general boating? If so, what are the differences and what is known about them?

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Impacts on Sediments and Sedimentation

It has been suggested that pile-supported docks may cause changes to sediments and habitats in the vicinity of the structure. This may occur through erosion, increased sedimentation, or resuspension and movement of specific particulate sizes or types. Three principal impacts from docks have been discussed in the literature or in review of proposed construction.

- Altering currents in the vicinity of the dock due to pilings disrupting flow or inducing scour in the immediate vicinity of the piling,
- Disrupting sediments during piling installation,
- Suspension of sediments as floats or boats attached to docks touch or approach bottom at low tides and lift sediments as they rise with the tide ("pumping").

Structures placed in moving water have the capability to disrupt the water's flow. Piles may cause increased flow rates immediately around the structure. These modifications in the flow of water may produce scour and erosion or increased deposition of sediments depending on the conditions and structure. Either of these may affect shellfish or wildlife habitats.

There appears to be very limited research results available on the impacts on sedimentation from small pile supported structures. What research has been reported was done in open ocean settings, not in embayments, and most focused on the morphological changes to adjacent shorelines and bottom topography—no information was located on the nature of sediment type change, if any, over time in the vicinity of pile-supported piers.

Noble (1978) assessed the impacts of 20 piers—all situated within the Southern California Bight. These piers ranged from 625–2,500 feet in length and 15–300 feet in width—far larger than the small recreational facilities under consideration here. All of the piers studied had pile spacing greater that 4 times the diameter of the piles. Noble found that these piers "had a negligible effect" on sedimentation and erosion of adjacent shorelines. He notes that his results support prior findings of Johnson (1973) and Evert and DeWall (1975).

Miller *et al.,* (1983), researching the impacts of a 1,840 foot long, 20 foot wide pier near Duck, NC on the Atlantic coast found that the pier produced a permanent trough under the pier reaching a maximum depth of 9.9 feet. Scour around individual pilings was noted to be on the order of 3.3 feet in depth. The pilings in this case are 30 and 36 inches in diameter spaced 15 feet on center across the pier and 40 feet on center along its length.

In an engineering study related to Lagoon Pond on Martha's Vineyard, MA (Poole, 1987) suggests that, "At a wind angle of 90º to a 50-foot pier with 5 pilings on each side [diameter of pilings not noted–SB.] can [sic] produce eddy currents and flow friction 2 times the diameter of the pilings—minimally. This means…a 30 percent reduction in flow. The area or parallel shoreline affected by the flow reduction would be a factor of 2 to 3 times the pier length. Properties within 100 feet to 150 feet of a 50–foot pier could be subjected to wrack algae accumulation, sand deposition and shellfish population changes." This evaluation cites no research results and is based on predictive engineering calculations.

Anecdotal evidence suggests that the method of piling installation has varying impacts on sediments in the vicinity of a dock (Ziencina, 2002 pers. com.) Jetting of pilings tends to cause greater disruption than driving. Jetting suspends sediments and disrupts vegetation producing bare areas around pilings that appear to be subject to scour. Shaefer (2001) found that using a low pressure pump to produce a starter hole and subsequent insertion of a sharpened pile with a drop hammer in a sandy area "reduces the physical removal and disturbance" of seagrasses in the area of the piling and results in little to no sand deposition around the pilings.

Observational evidence indicates that changes in sediments occur when floats settle on the bottom at low tide. As the floats rise they create a suction bring with it sediments. As wave action lifts and lowers the float, sediment is "pumped" into resuspension. Additionally wave refraction in a downward direction may also resuspend some sediments (Ludwig, 2003, pers. com.).

Questions for consideration:

1. What permanent impacts in sediment topography and type are produced by individual or collections of small, recreational, pile-supported docks—either on the open coast or in backwaters?
2. What are the impacts of various means of pile insertion in different settings?
3. What are the levels of impact from "pumping" due to floats settling on or near the bottom at low tides?

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Aesthetics/Quality of Life Impacts

From a manager's perspective, oftentimes the publicly-held concerns related to small docks are not really related to the environment. They may be aesthetic in nature, a sense of over-development of the shore, or simply change. It is not uncommon for managers to hear very vocal outcries from one segment of the population while the rest remains quiet—the manager generally has no idea whether this silence means acquiescence or simply no opinion.

In an attempt to get a better sense of public sentiment regarding docks in South Carolina, Felts *et al.* conducted surveys of the opinions of residents of coastal counties in the state (2001) and of dock owners (2002). Some of their major findings include:

- 75% of the residents of coastal counties feel that property owners should be able to construct a dock.
- 66% of the dock owners feel that docks should be regulated but only 50% of the residents feel the same way. The authors offer two possible interpretations for the stronger acceptance of regulation by dock owners: 1) they have their dock and would like future construction restricted or 2) they better understand the need to manage docks as they are closer to the issue.
- 75% of the dock owners feel that the length of docks should be restricted; nearly 80% feel that the size should be restricted. In contrast, only 50% of the general public feels length should be restricted.
- Approximately 20% of both the dock owners and the general public felt that docks are harmful to the aquatic environment.
- 20% of the owners and 25% of the general public felt that docks detracted from the view of the waterbody and shoreline.
- Approximately 75% of both dock owners and the general public feel that there are not too many docks.

It is not clear whether these findings are transferable to other settings along the coast—other states or regions within those states.

The aesthetic appeal of docks is an individual assessment. However, techniques have evolved that appear to provide a reproducible or predictive assessment of the aesthetic values of an area and how those might change with development. As seen in Felts *et al.* (2001, 2002), a survey will provide some sense as to the feelings of the public regarding docks, although these feelings may change when applied to specific sites.

An assessment method applied in Blakely Harbor, WA to develop a build-out of all potential docks in the harbor built to full length and size by existing regulation. Calculations were then made for several public viewing areas around the harbor of how much of the viewshed would be impinged on by dock construction. The "reductions" ranged from 27% to 78%. No suggestion was provided as to public acceptance of these values.

Smardon (1988, 1986) and Galliano *et al.* (2000) have utilized assessment techniques to measure scenic quality based on public aesthetic values. These have been utilized in planning and land use management activities on public lands but are only beginning to be investigated for use as a regulatory tool for docks. The State of Maine is in the process of preparing regulatory standards for dock aesthetics (Gates, 2002, pers. com.).

Questions for consideration:

1. How significant are aesthetic/quality of life issues in regards to small docks?
2. Are there reproducible techniques to measure the aesthetic issues relating to docks and piers?
3. Are there "quality of life" or social issues other than those relating to the environment or aesthetics that are measurable?

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WORKSHOP AGENDA

<u>22 January:</u>

Opening

- Welcome to the group
- Logistical information/housekeeping information
- Charge to the group—Workshop purposes, desired outcomes, agenda
- Connection between this Workshop and future activities
- Introductions of the participants

The Management Context: Introduction to management issues and needs related to small dock management.

- Susan Snow-Cotter, Massachusetts Office of Coastal Zone Management

Panel Presentations and Discussion

Panels consisted of 15-minute individual presentation, a 5-minute question period after each speaker, and a 20-minute discussion period following panel presentations.

Panel I: Impacts to vegetation from docks

- Dave Burdick, University of New Hampshire
- Ron Thom, Battelle Marine Sciences Laboratory, Sequim WA
- Deborah Shaefer, US ACOE, Waterways Experimental Station, Vicksburgh, MO
- Mike Ludwig, National Marine Fisheries Service, Milford (CT) Laboratory

Panel II: Impacts from contaminants related to docks

- Pedrick Weiss, New Jersey Medical School
- Denise Sanger, South Carolina Department of Natural Resources

Panel III: Impacts from associated boating use

- Rick Crawford, Nautilus Environmental Services, Cape Cod, MA
- Steve Ressler, New York Coastal Management Program

Panel IV: Impacts to navigation and riparian uses

- Dave Killoy, New England Division, US Army Corps of Engineers

Summary discussions from first day

<u>23 January:</u>

Panel V: Impacts to Aesthetics and Quality of Life Issues

- Judy Gates, Maine Department of Environmental Protection
- Richard Smardon, SUNY Syracuse
- Richard Chinnis, South Carolina Office of Coastal Resource Management

Managers respond to scientific status, develop research needs and recommendations based on existing information

Wrap-up: *General discussion of future steps*

Managers meet to begin planning future steps

MANAGEMENT CONTEXT

Susan Snow-Cotter
Massachusetts Coastal Zone Management Office

A review of the volume and status of dock and pier applications on Cape Cod, one segment of the Massachusetts coastal zone, showed that over the past five years there have been approximately 250 applications for dock construction. Of these 195 were approved and 63 denied. Of those 63 denials, only six (approximately 10%) were upheld in the courts (Fig. 2). This suggests that managers need better means to review dock proposals and make defensible decisions. For example, most of the denials were aimed at protecting shellfish and habitat but when challenged it was difficult to clearly demonstrate the impacts to these resources.

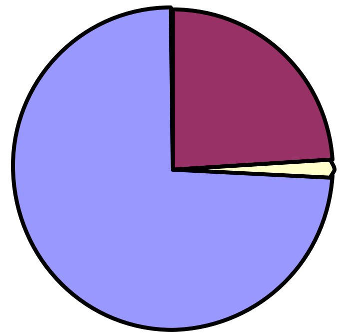


Figure 2. About 78% of applications for docks in Cape Cod were approved on the first review. After the appeal process, less than 1% of applications were denied.

Both scientists and managers recognize that there are significant regional differences in resources, dock design, and impacts. However, state and local regulators need a science-based framework and guidance in order to make reasonable decisions.

Docks affect coastal conditions and uses including:

- Navigation—docks can both promote and hinder navigation in waterways,
- Aesthetics—cumulative impacts are the significant issue,
- Public access to and along waterways—docks can promote public access to the waterway but may also impede lateral access,

Docks may impede public access along the coast (Photo credit: S. Snow-Cotter).

- Shellfish habitat,
- Water quality—impacts result from materials used in construction and scouring or resuspension of sediments around pilings and floats, and
- Vegetative cover—docks shade vegetation in salt marshes and below the water.

In addition to their physical structure, the boating associated with docks results in indirect or secondary effects such as prop dredging/scouring and the release of contaminants like oil, gas, detergents, anti-fouling paints, etc.

The types of information needed by managers to make defensible decisions include:

- A science-based understanding of the ecological impacts from construction and use over time,
- Techniques for practical approaches at a local and state level that will allow for a comprehensive harbor by harbor planning and regulatory approach,
- A better understanding of the benefits of Best Management Practices,
- Guidance on incorporating science into statutes, ordinances, regulations, and rules, and
- Techniques to factor cumulative impacts into the planning and permitting process.

Question & Answer Period

Q. Have you seen increased vessel size leading to proposals for larger family docks in Massachusetts?

A. Absolutely. Not only are the proposed docks larger, larger boats need larger "buffer zones" to navigate. It is important to ensure that the regulatory framework includes usage of the docks, not just construction.

Q. In Massachusetts, the environmental reviews are done at the local level with appeal to the state. Is that because there are significant local concerns? This not the case in Georgia where there is little concern at the local level and the feeling there is that there is no need for legislation. Must local governments apply for ability to regulate at that level?

A. The Massachusetts Wetlands Protection Act (a state law with regulations issued by the state) requires local municipalities to regulate impacts to wetland resources, including shellfish habitat, salt marshes, land under the ocean, etc. Public trust standards are regulated at the state level, but there is a provision for local boards to manage that aspect as well, although few have availed themselves of that opportunity. Delaware has developed BMPs for docks and piers at the state level that will be incorporated into state land regulations. We tapped into legislators interested in the waterfront to help move this forward.

Q. Were the issues involved in approving or denying pier permits mostly social/aesthetic or ecological?

A. Both. In many instances there are no defensible standards and consequently the local decisions may be unpredictable. This again shows the need for science-based guidance.

IMPACTS TO VEGETATION FROM DOCKS

Introduction

Submerged aquatic vegetation (SAV) and marsh grasses provide critical habitat, filter nutrients and sediments, provide nursery habitat for fish and shellfish, stabilize bottom sediments, and form the basis of the marine food web. Impacts to plant productivity generally occur in two ways: short-term construction impacts and chronic impacts from shading. Irradiance under docks falls well below the requirements for minimum maintenance (~3 M d^{-1}) and full growth (= 5 M d^{-1}) (Fig. 3). This results in reduced shoot density, biomass, growth, and increased height (probably due to etiolation), increased erosion, undercutting of vegetation (Burdick and Short 1999). Susceptibility varies by species—*Spartina patens* was most robust followed by *Distichlis spicata,* then *S. alterniflora* (Kearney et al. 1983).

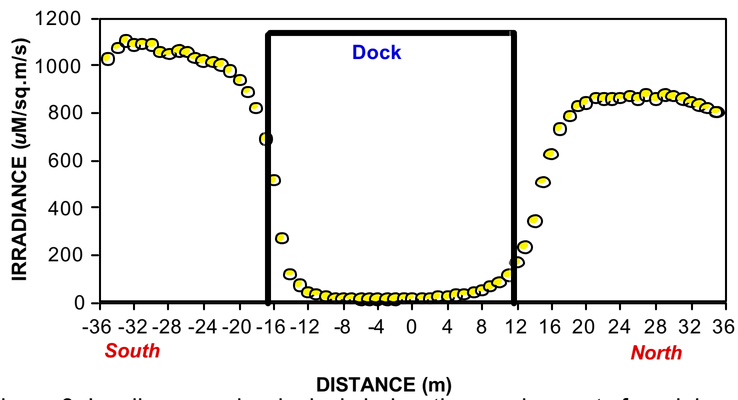


Figure 3. Irradiance under docks is below the requirements for minimum maintenance (~3 M d-1) and full growth (= 5 M d-1) (From Nightengale and Simenstad 2001, Ron Thom, pers. comm.)

The significance of these shading impacts to the coastal ecosystem as a whole varies by region. In South Carolina, docks existing in 1999 reduced *S. alterniflora* cover by 0.03–0.72%. Projected to a total possible build-out of similarly sized docks in these creeks, the decrease in marsh grass density was 0.18–5.45% (Sanger and Holland 2002). In New England and Florida, where coastal vegetation is already severely impacted and reduced, the existing and potential loss of vegetation associated with dock shading is greater.

Dave Burdick

Jackson Laboratory, University of New Hampshire

In conjunction with Fred Short, Dave Burdick investigated the impacts of docks on eelgrass (*Zostera marina*) in Waquoit Bay, Falmouth/Mashpee, Massachusetts. They found that the presence of small docks leads to fragmentation of eelgrass beds—primarily through shading of the grasses (Fig. 4). They next examined physical and biological parameters to better understand how docks impact eelgrass and, ultimately, how to minimize those impacts. Specifically, Burdick and Short quantified dock characteristics (length, width, height, construction materials, age, orientation, and design), light reduction under the dock, and eelgrass characteristics (shoot density, canopy height, and bed quality under the docks). They observed which docks allowed the best eelgrass survival, and which dock characteristics are the most important predictors of eelgrass bed quality. This allowed them to develop dock specifications designed to allow eelgrass to thrive under docks.

Figure 4. The obvious impact of docks is through shading of vegetation (Photo credit: D. Burdick).

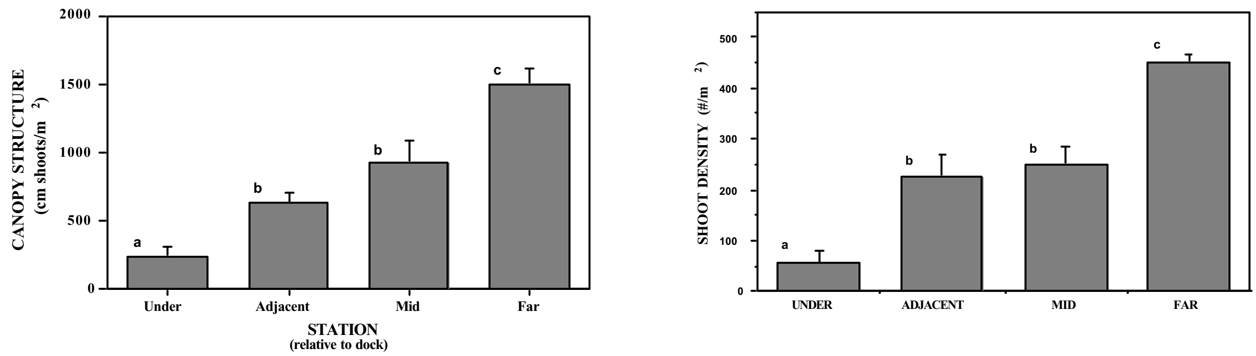


Figure 5. Eelgrass density (A) and canopy structure (B) were significantly lower under and near docks than at reference sites (From Burdick and Short 1999).

Burdick and Short found lower eelgrass density and greater shoot height under docks (Fig. 5). Canopy structure (cm shoots/m^2) was lower under the docks. They concluded that light levels of 15% of surface irradiance are the minimum necessary for *Zosters.* Levels of approximately 50–60% are necessary for health beds.

Dock orientation (north/south, east/west) is a critical predictor of eelgrass bed quality. They calculated the light levels under various docks using the factors of height of dock, width of dock, and orientation and found they could predict impacts. Using this information Burdick and Short produced "Dock Design with the Environment in Mind: Minimizing dock impacts to eelgrass beds," an informational CD that allows the user to see how different dock designs will affect an eelgrass bed and the associated coastal species (Fig. 6). In this CD they provided calculations for a limited number of scenarios; ideally they would like to produce a model that predicts impacts from a larger combination of design factors.

They noted that the presence of docks in Waquoit Bay is not the only factor contributing to loss of eelgrass. Nutrient enrichment impacts eelgrass by promoting epiphytes that live on and shade the grass blades. It is not clear whether this situation made grasses more susceptible to impacts from docks.

This study did not address the cumulative impacts from eelgrass bed fragmentation. It is not clear whether these impacts are simply additive, or whether synergistic factors are at work.

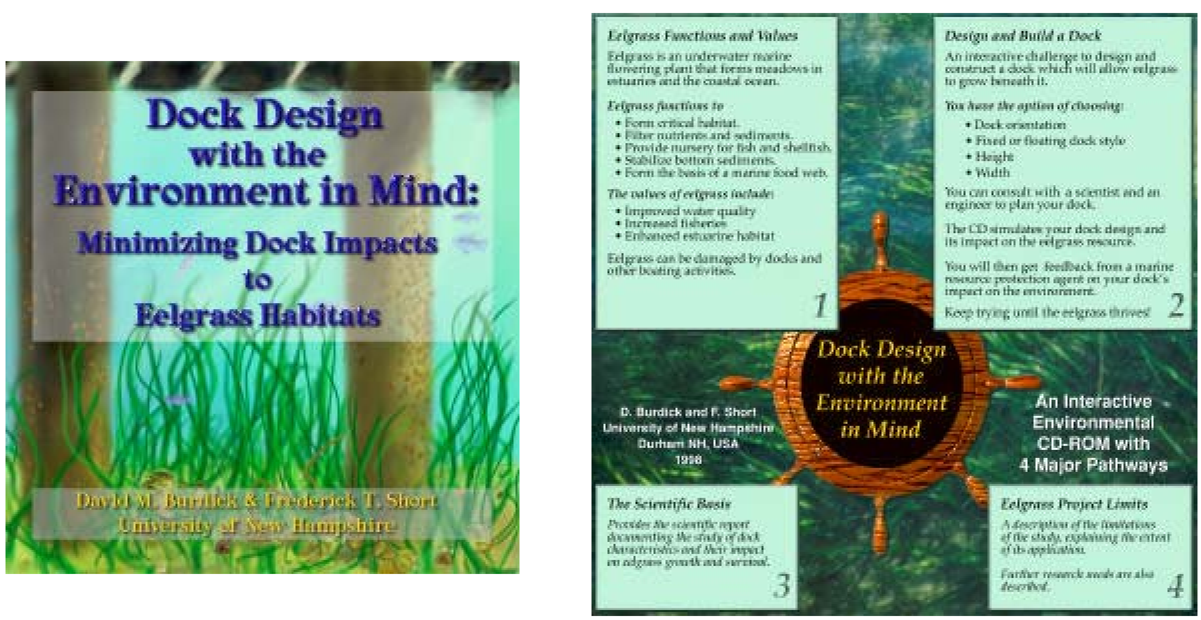


Figure 6. Burdick and Short's CD shows how dock design affects seagrasses and associated aquatic species and allows users to see how impacts vary with design.

Question & Answer Period

Q. What is the management goal articulated for eelgrass?

A. Informally, the goal is no net loss. Submerged aquatic vegetation, including eelgrass, has been designated as a Habitat Area of Particular Concern by several of the Fishery Management Councils—in part because it provides Essential Fish Habitat.

Q. What is the correlation between the age of a dock and its height?

A. They tend to cancel one another out. Older docks mean better eelgrass because they are thinner and more rickety. Also, regulations for docks now require larger dimensions (i.e. wheelchair access) and materials that are less indestructible. The best way to calculate success is if you base everything on light reaching the eelgrass. This may be more direct than dealing with complex biological indicators.

Q. Many owners argue their docks only cover a small area and, therefore, don't cause a problem. How would your research address that contention.

A. To this point fragmentation and cumulative effects have not been adequately considered so it is difficult to tell how valid that contention is.

Ron Thom

Battelle Marine Sciences Laboratory, Sequim, WA

Ron Thom's work was done in conjunction with the renovation and expansion of ferry terminal docks in the Pacific Northwest. Thom assessed the potential impacts of the planned expansion and worked with the company to minimize environmental impacts during and after construction. While commercial ferry structures are considerably larger than private recreational docks, many of the issues remain the same.

In addition to shading, impacts on eelgrass bed health were predicted from:

- Initial construction impacts and maintenance efforts
- Propeller wash (turbidity from boat traffic that decreased light levels), and
- Biological impacts from crabs and starfish eating the recovering shoots and drift algae smothering the plants.

Thom quantified the light requirements for eelgrass (*Zostera*) in the Northwest by charting light attenuation over depth (the area has a 4–5 meter tidal range) and comparing *Zostera* shoot density against depth. They found the highest density at 350 micromoles PAR.

Vegetation near this commercial ferry in Washington State is impacted by shading and propeller wash associated with the dock.

There are a number of techniques available to reduce shading and increase light under docks, including grating, glass blocks, sun tunnels, and applying reflective material on the underside of docks (Fig. 7). These have been shown to be effective in the large ferry docks in Puget Sound.

As part of this effort they developed a multiple stressor model—a conceptual model with mitigation as an end point (Fig. 8). Thom recommended that the ferry company modify the design of the dock to lessen the impacts to the *Zostera* bed. By building a longer, narrower dock, the engineers were able to extend the bulk of the structure and associated shading impacts past the eelgrass beds. Shading impacts were further reduced by incorporating light transmission techniques. Additionally, they removed all of the eelgrass that would have been destroyed and maintained the shoots for restoration projects.

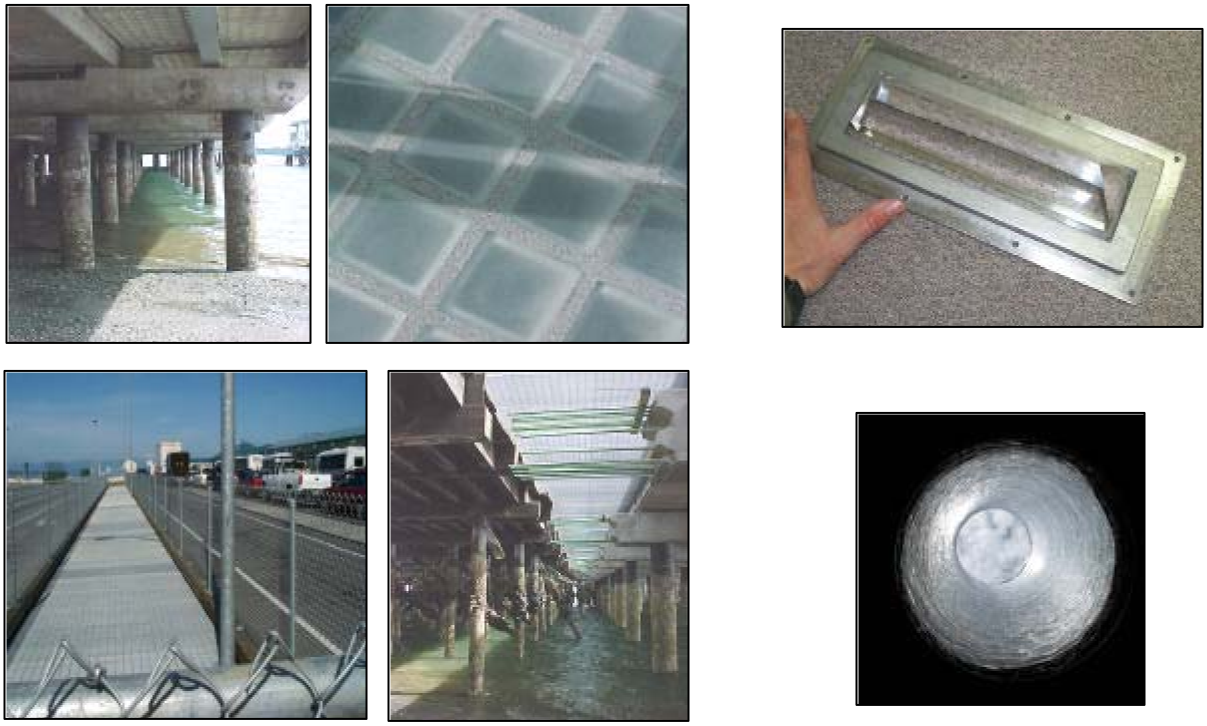


Figure 7. New materials used in ferry construction in Washington State. Top left: light under glass blocks. Top center: Glass blocks used instead of traditional wooden planking. Top right: A sun prism. Bottom left and center: Metal grating on a dock and light penetration below that dock. Bottom right: A sun tunnel. (Photo credit: R. Thom).

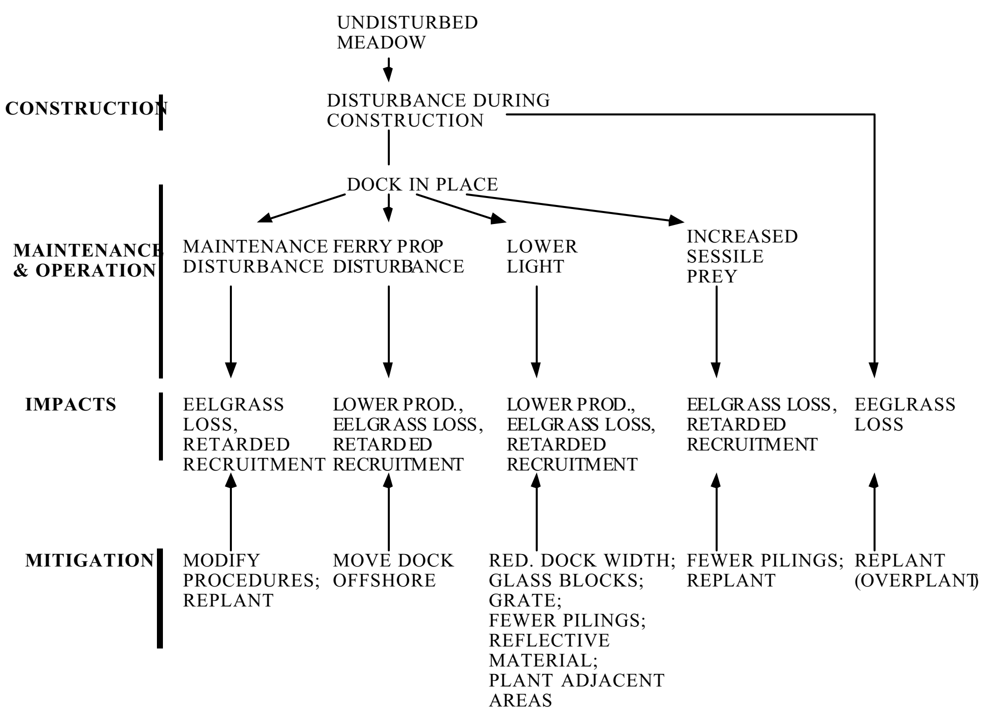


Figure 8. Conceptual model showing how mitigation can be used to minimize construction impacts (From R. Thom).

Question & Answer Period

Q. Does eelgrass senesce (age) in the winter?
A. It continues to grow during winter but adapts to be shorter, thicker, and greener.

Q. Is the 5 mols figure for growth time dependent?
A. To be sure it would be necessary to do a carbon balance study, but generally this assumes summer months. Otherwise the 5 mols is based on average daily sunlight.

Q. Were the eelgrass restoration projects successful?
A. Yes, they have been successful in the Pacific NW. This type of project needs the right conditions. We've found that the best way to proceed is to do environmental assessments and then establish plantings.

Q. Has the architectural shading model been used to predict impacts over the seasons? Could this be adapted as a useful tool?
A. It's not the ultimate answer. We need an overall eelgrass model.

Q. In the course of the survey throughout Puget Sound was drift algae a problem?
A. Yes. It gets caught up under the docks and was a problem.

Q. Are eelgrass beds and their growth patterns comparable between the east and west coasts?
A. Yes, when water clarity is comparable.

Deborah Shaefer

US Army Corps of Engineers, Waterways Experimental Station

Dock construction has had negative impacts on seagrass beds in the panhandle area of Florida and Alabama. Up to 50 acres of seagrass were destroyed in the early 1990s, and it was felt that there was the potential for significant cumulative impacts. As a result, the US Army Corps of Engineers wanted to develop construction guidelines and regulations. However, there was a lack of data supporting such guidelines. Shaefer and Lundin therefore started by studying the effects of docks on the seagrass *Halodule wrightii* in Perdido Bay, Alabama.

Docks along an Alabama coastline (Photo: D. Shaefer).

The principal sources of dock impacts were identified as:

- impacts from shading,
- destruction of seagrasses during construction,
- prop scarring and hull grounding,
- alteration of bottom topography and sediment characteristics, and
- contaminants leaching from treated wood materials and from fuel spills.

Shaefer and Lundin examined shading and construction impacts and experimented with ways to minimize them. They selected docks with a standard set of characteristics and then quantified seagrass loss for those docks. To minimize variability, all of the docks in the study were:

- oriented north to south,
- four feet wide,
- four feet above mean sea level,
- four to nine years old,
- located in an area of continuous seagrass meadows, and
- located within a one-mile stretch of shoreline.

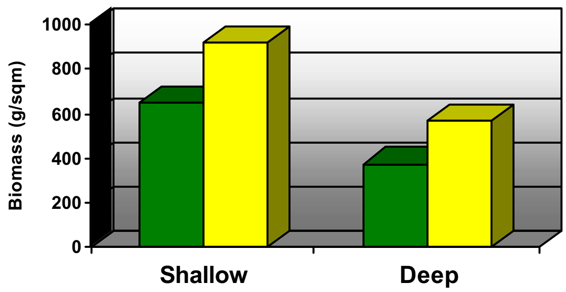
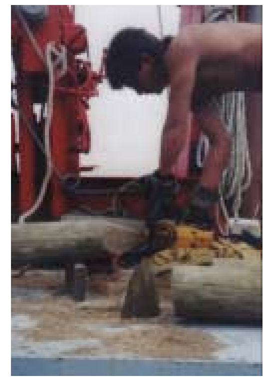


Figure 9. Biomass of the seagrass *Halodule wrightii* growing under docks (green) was 1/3rd lower than biomass in adjacent unshaded (yellow) areas.

Shaefer and Ludin observed that light (PAR) under the docks was below the saturation rate between 10 am and 2:30 pm, for a total of 4.5 hours each day. Shoot densities were 40% and 47% lower in shaded plots at shallow and deep locations, respectively. Biomass was reduced 30% and 33% in the same locations (Fig. 9). As in other studies of shading impacts on seagrass, Shaefer and Lundin found that shade-stressed plants grow to greater heights, perhaps due to etiolation. This suggests that seagrasses posses mechanisms to compensate for light reduction. They concluded that seagrasses under docks can be maintained and bed fragmentation eliminated, although density and biomass are reduced.

A second part of the study was designed to evaluate the effectiveness of grated decking material as a means of transmitting light and to demonstrate the possibility of low-impact construction techniques. A series of docks were built with varying the heights (4' vs. 5') and surface materials (traditional wood planking vs. 1" thick reinforced fiberglass grating with 1x2" openings). On a dock five feet above mean sea level, the light levels never dropped below saturation. On a four-foot high dock they dropped below saturation only briefly during the day. Light levels were much higher and seagrass grew better under docks with grating rather than solid wood plank decking (Fig. 10).



The State of Florida has prohibited roofs on terminal structures in an effort to further reduce seagrass loss resulting from dock shading.

In an investigation of impacts associated with dock construction techniques, Shaefer noted that the high pressure jet pump normally used to install dock pilings produced a six to seven foot hole around each piling. The resultant "halo" might remain for 10 years without seagrass regrowth. By sharpening the piling ends, using a low pressure jet to start the pilings, and a drop hammer to do the final installation, the size of the "halo" was reduced. The smaller scar size will make it faster and easier for seagrass to regrow. Another way to minimize construction impacts is to bring construction equipment in from the water on a barge rather than driving heavy equipment through the marsh.

The Corps has adopted these techniques as guidelines for the Southeast. Despite these being only guidelines, they are often followed by permit applicants as a way of speeding the application review process.

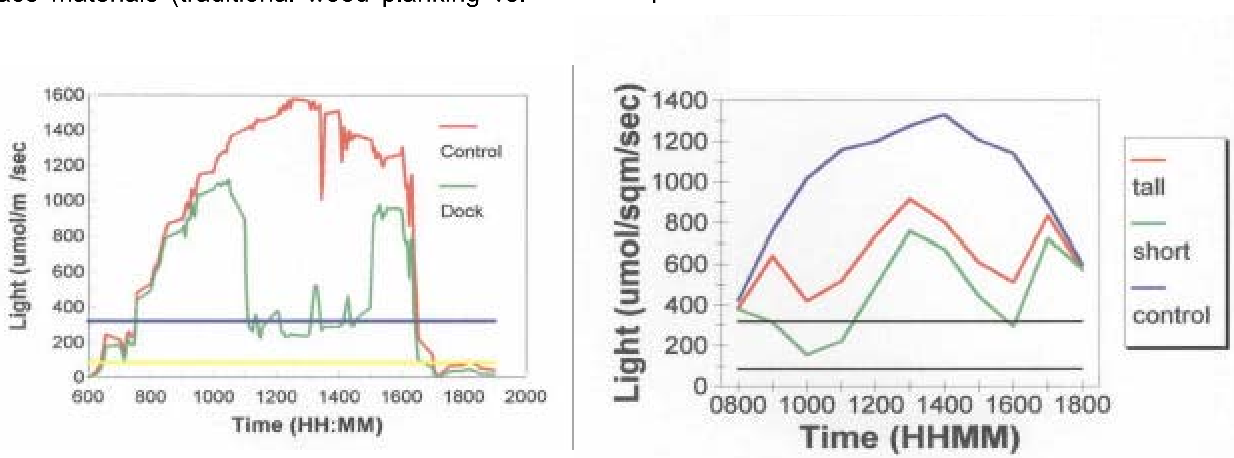


Figure 10. While light levels under traditional wooden plank docks (left) fell dramatically during the day, grated decking (right) significantly reduced the shading impact of the dock.

Question & Answer Period

Q. On your grid analysis – were any of the existing docks roofed?
A. No, regulatory guidelines currently prohibit construction of roofed docks.

Q. How many roofed structures might you find in a stretch?
A. This area had approximately 15 roofed structures in a one mile stretch of coast.

Q. Does grating come in different sizes?
A. Yes. It comes in different sized grates and varying thickness.

Q. Is grating acceptable for a broad range of uses (*e.g.,* does it preclude sunbathing, high heels, is it hot underfoot, etc.)?
A. There have been some complaints, but it is generally well accepted.

Q. Is it an aluminum product or plastic?
A. We use fiberglass. It is the amount of light passing through that is important, not the materials utilized.

Q. What's the cost of grating materials?
A. A 4' by 8' panel is about $500. This is approximately 20% more than wood planking for initial cost (not including labor) but it tends to last longer, thereby minimizing the cost differential.

Q. Have these regulatory guidelines been taken to court yet?
A. They have been out for 3–4 years and have been tested in court. Remember that these are USACE guidelines. USACE can't require, but can guide people toward this end. All of these guidelines are specific to North Florida.

Mike Ludwig
National Marine Fisheries Service, NE Fisheries Science Center

Mike Ludwig presented a discussion of experiments conducted by Mary Colligan and Cori Collins to quantify the impacts of docks on the coastal environment. The study was undertaken after the authors observed that:

- Permits for dock approval are the most common permit requests received by regulators.
- There is a perceived "right" to dock construction.
- There is little in the way of defensible management policy.
- There is no uniformity of design.
- There is little literature available about dock impacts to marsh grasses.
- Consequently there is little justification to deny permits.

Ludwig argued that the ongoing workshop was necessary because of our failure as managers. While there is a Constitutional right to *riparian access,* we've extended that to include putting in docks to increase property value and gain access to deeper water. There is no absolute right to a dock!

Colligan and Collins collected data on marsh grass density and height directly under and adjacent to each of 125 docks in Connecticut, Rhode Island, and Massachusetts. As noted previously, height of the grasses was greater under the pier, but the densities were lower. Impacts varied by species with *Spartina alterniflora* being the most affected followed by *Distichlis spicata* and *S. patens*.

Colligan and Collins also experimented with reducing impacts by shifting orientation and replacing solid planks with grid material. Orientation seemed to have an impact but it was not significant. Nor did use of grid material reduce shading - light reduction under the grid was almost the same as that measured under traditional planks. This may be because in the northern latitudes the sun did not get high enough in the sky to shine through the grid (as it had in the Florida experiments).

Figure 11. Undercutting of the vegetative mat near a dock (left) can lead to marsh slump (right) and the death of marsh grass (Photo credit: M. Ludwig).

Erosion to areas adjacent to the dock was increased—this was attributed to prop wash—and there was an undercutting of the mat in the sub-tidal range (Fig. 11). When this happens the surface of the marsh slumps, falls out of its growing zone, and dies. These would have the additional benefit of providing habitat for *Spartina* and would be an improvement over bulkheads.

Figure 12. Installation of wire mesh baskets filled with small stone can alleviate the undercutting associated with many docks. It has the additional benefit of providing habitat for *Spartina* and is an improvement over bulkheads.

The conclusions of the study include:

- There are two principal impacts to plants, 1) density—generally lowered, and 2) height—generally increased.
- A north-south alignment seems to particularly affect *S. alterniflora*.
- The height of docks affects different species differently.
- Spacing between planks appears to have no effect on plants.
- A grid deck may not be beneficial in higher latitudes.
- Docks segment wetlands and may inhibit wetland functions and values.
- Dock impacts include increased erosion.

Ludwig noted that the impacts of pier alignment merits further investigation. Regulations on pier height to width ratios may prove useful, but second order impacts on motile species such as birds need to be investigated before these are adopted. In conclusion, Ludwig suggested that a little “intestinal fortitude” and the increased use of shared public docks as an alternative to constructing more private docks might better protect public resources.

Question & Answer Period

Q. It is misleading to suggest we, as regulators, can deny riparian property rights in the interest of the public trust because our laws are simply not there at this point. We may have failed as a society, but not as regulators.

A. Look at Common Law and the Constitution for the basis of these types of laws.

Q. In some instances, in an attempt to minimize fragmentation of wetlands, long walkways to tidal creek have been requested, but the applicants have been denied and told to walk. Is it better to allow them to trample the wetland?

A. The sense is yes. It is better to allow a foot path than a walkway. In 2002 there was a case that was denied on this basis. Most of plant growth is done by the end of June before the major summer boating season. Therefore, people are probably not walking. If they do walk they should be encouraged to use the same path repeatedly because this flora is so delicate.

Comment: Based on our work in NC, *Spartina* can recolonize after being trampled, but it is a slow process. Orientation didn't appear to be a factor there. A reduction of light of 71% was found with both tall and short docks.

Q. Did you vary grid height in your investigations? Height is a major factor.

A. We had a limited number of investigations with all structures being between three–four feet high. Our grid material is thicker than some. It is Morton* safety grip planking that is designed to allow significant light passage. It is produced by Central Steel & Wire Company. They carry the Morton Open-Grip Grating, Standard Planks that I showed in the presentation. You can see the specifications and decking at www.centralsteel.com .

Q. Shoreline erosion in one of your slides appears to be attributed to a dock – did you look at orientations, etc.?

A. No. It seemed that shoreline erosion depended more on boat use and type (*i.e.*, prop dredge/wash, etc.). In other words, human behavior is related to erosion impacts. Wave focusing could also be responsible for some erosion.

General Discussion on Impacts to Vegetation

Question to the group: Are the impacts on vegetation sufficiently well known to develop a management assessment tool? If so, what sort of tools would be appropriate?

Comment: Managers must determine what level of impairment is acceptable and then develop a mechanism to determine whether the impacts of a dock or series of docks will go beyond that acceptability.

Comment: In making a regulatory decision it is important to consider all of the pertinent factors—impacts on vegetation, on navigation, on erosion/sedimentation, etc. While it is not necessary to be technically "perfect" it is important to show that all of the factors have been assessed. This is best done through the use of a checklist.

Comment: The use of a conceptual model would be useful to promote understanding between factors, structure, and function. This has been done for specific projects in the Pacific NW (Columbia Model). This model could be linked to impacts on specific types of vegetative communities—submerged marsh, submerged aquatic vegetation—and could incorporate regional differences. A level could then be added stating possible management options. This could be augmented by a list of management options and associated impacts.

Comment: A useful method is to establish guidelines that show applicants that if they build a dock that meets a defined set of criteria, that they will get a dock. New York has established such guidelines and they have successfully been defended in court. If you design your regulation around legitimate objectives and take a rational approach, the courts will back you.

Comment: Although we suspect that there are cumulative impacts, we really don't have any research on the topic. It's not really clear whether the problem is docks or development in general.

Summary and Recommendations

Shading under docks and piers is clearly documented, and associated biological impacts on aquatic vegetation have been quantified for some SAV and grass species. However, these impacts are species specific and vary with latitude. Further studies are needed to understand the impacts of dock shading on more species and in other geographic regions. There is also a need to identify and better quantify secondary effects of docks on vegetation. These include impacts to SAV beyond the footprint of approved docks such as the halo effect around a dock, or unpermitted "add-ons" like floating docks, roofs, observation decks, etc.

A conceptual model explaining the factors controlling the types and magnitude of potential impacts should be further developed. It will be important to define types and accuracy of information that would feed into this conceptual model and to identify information gaps. This led to the following recommendations:

- Develop a conceptual model.
- Prepare a synthesis paper that draws together all of the existing data.
- Develop a searchable database/website that could be a repository for relevant data.
- Develop checklists of parameters that managers should consider in the permitting process (tailored to localities).

IMPACTS FROM CONTAMINANTS RELATED TO DOCKS

Summary

The most common contaminant-related concern associated with docks is leaching from preservatives applied to pilings or floats in locations that come into regular contact with water. Many states have banned the residential use of creosote or pentachlorophenol in aquatic settings (they leach readily and have demonstrated toxic effects); and consequently wood pressure-treated with a chromated copper arsenate (CCA) is the most commonly used material for pilings and decking for residential docks. CCA also leaches in saline waters (Weis *et al.* 1991, 1992). The degree of toxicity depends on both the concentration and the chemical form as it reaches the target organism and can change over time and in response to sediment types, amounts of organic material present, oxygen levels and water movement (Luoma and Carter 1991). Ninety-nine percent of the leaching occurs within the first 90 days (Cooper 1990, Brooks 1990).

In areas of low water flow, elevated concentrations of chromium (Cr), copper (Cu), and arsenic (As) can be found in fine sediments adjacent to bulkheads constructed of CCA-treated wood and in organisms living on and around treated pilings (Weis and Weis 1996, Weis et al. 1998). Dilution appears to reduce these impacts; the bioaccumulation of dock leachates by marine biota did not impact survival of mummichogs, juvenile red drum, white shrimp, or mud snails in South Carolina estuaries characterized by higher flow rates (Wendt et al. 1996). However, tidal flushing thresholds for contaminant impacts have not been identified, and data does not exist to evaluate the dilution capacity of an area.

(Photo credit: P. Weis)

Peddrick Weis[1] and Judith S. Weis[2]

[1]Aquatic Toxicology Laboratory, Dept. of Radiology, UMDNJ, NJ Medical School
[2]Dept. of Biological Sciences, Rutgers University

When CCA-treated wood products are used in estuaries—for dock pilings, floats, or bulkheads—contaminants leach out of the wood. These contaminants may be taken up by organisms living on the wood, transferred to consumers, enter sediments and the benthic organisms that live there, and/or wash away with the tides or currents. (Fig. 13).

Weis and Weis observed elevated levels of copper and arsenic in algae growing on open water docks in Pensacola Beach, Florida (Weis and Weis 1994, Fig. 14). A subsequent laboratory experiment showed that snails fed algae grown on CCA-treated wood became inactive in 3-4 weeks and eventually curled up inside their shells and died (Weis and Weis 1992). This was supported by a field study showing that oysters living on bulkheads made of CCA-treated wood had taken up measurable concentrations of copper and were smaller than control populations (Weis et. al 1993). When CCA concentrations are high enough, oyster digestive glands shrink.

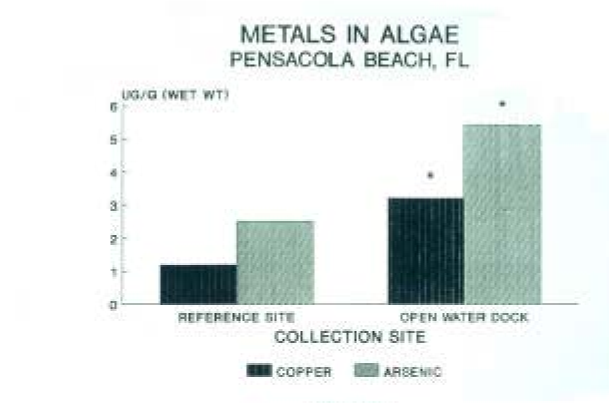


Figure 14. Copper and arsenic were elevated in algae growing on docks (From Weis, J.S., & P. Weis. 1994. Arch. Environ. Contam. Toxicol. 26: 103-109

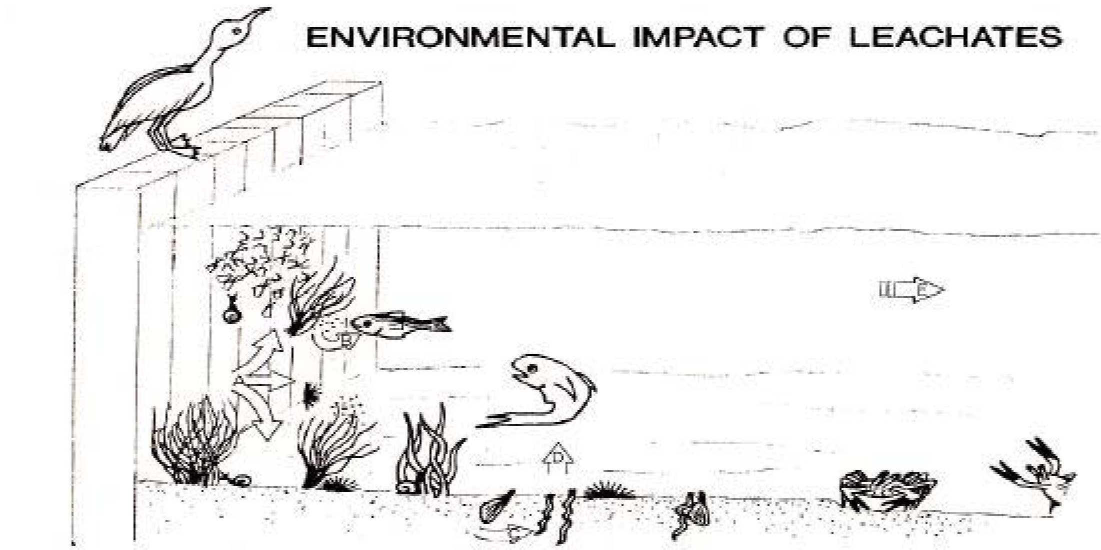


Figure 13. Some of the contaminants leaching out of wood is taken up by organisms living on the wood, some is transferred to consumers, some may enter sediments and the benthic organisms that live there, and some is washed away by the tides or currents. (From Weis, J.S., and P. Weis 1992. J. Exp. Mar. Biol. Ecol. 161: 189-199.)

Contaminants have been measured in sediments adjacent to CCA-treated wood, and these contaminants accumulate in animals living in and feeding on those sediments (Weis and Weis 1994, Fig. 15). In areas bulkheaded with CCA materials, fine sediments, and low water flows (*e.g.,* canal communities in NJ), contamination may extend up to 10 meters, although the highest levels are found within the first meter. Newer wood leaches more rapidly than weathered material and most leaching occurs in the first few months.

There has been no evidence of trophic transfer from amphipods to fish or higher vertebrates, but species richness was depressed in areas with higher contaminant levels.

As almost all of the research work presented by Weis is with bulkheaded areas, it is unclear what impacts there will be from a limited number of pilings for docks. Issues to consider include the area of exposed surface of CCA-treated materials, the newness of the materials used, the types of sediments in the area, and the flow of water through the system.

Alternatives to CCA-treated materials include recycled plastics, untreated woods, steel or concrete.

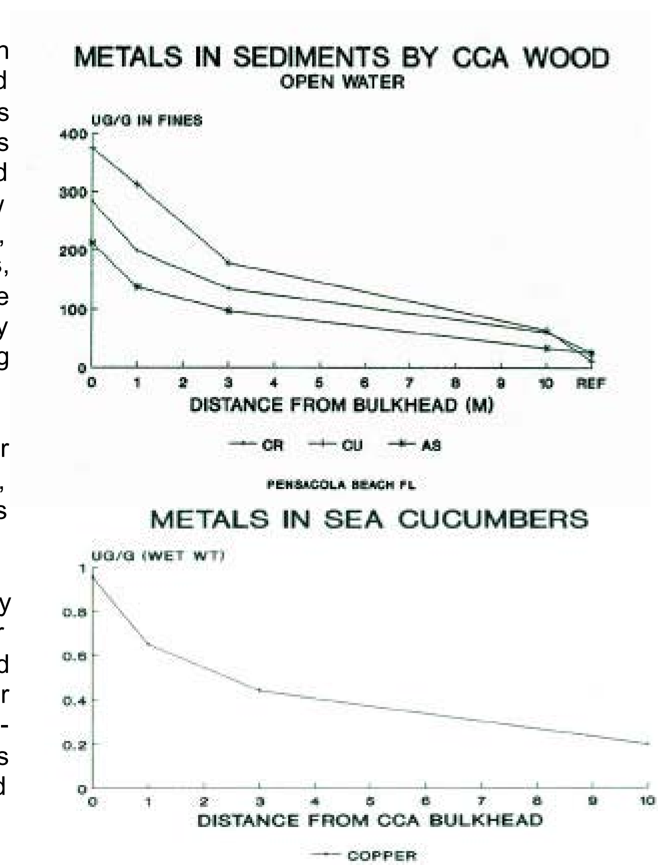


Figure 15. Contaminants are found in sediments and sediment feeders near CCA-treated woods. (From Weis, J.S., & P. Weis. 1994. Arch. Environ. Contam. Toxicol. 26: 103-109).

Question & Answer Period

Q. You mentioned different findings in Delaware and Pensacola Bay, Florida. Was there a significant difference in the tidal range between the two sites?
A. The tidal range is substantially greater in Delaware than Florida. This is key as the amount of water flow greatly impacts levels of copper and other contaminants concentrated in the area.

Q. Can recycled plastics be used for pilings as well as decking?
A. They can be used for both, but they can't be driven in with a drop hammer. There is a version that can be screwed in that is much less disturbing to the sediments and protects the pilings.

Q. Did you look at toxic impacts in copepods?
A. No, but we did look at trophic transfer and conduct some impact studies.

Q. Has any of your information been presented to EPA to apprise them of these environmental contaminants?
A. Yes, but I don't know what their response is.

Denise Sanger

South Carolina Division of Natural Resources, Marine Resources Division, Marine Resources Research Institute

Denise Sanger presented research results from two studies: (1) a study undertaken by Priscilla Wendt and Robert Van Dolah, and (2) a study undertaken by Denise Sanger and Fred Holland. The Wendt and Van Dolah study was published in Archives of Environmental Contamination and Toxicology in 1996. The study was designed to evaluate the effects of wood preservative leachates from dock structures in South Carolina and was conducted in two phases. Phase one of the project was designed to compare creeks with docks to reference creeks without docks. Three conditions were surveyed:

- The concentration of copper, chromium, and arsenic in sediments and oysters;
- The acute toxicity of sediments to a marine bacterium (i.e., Microtox) and a micro-invertebrate (i.e., Rotifer); and
- The physiological condition of the sampled oysters.

One composite sediment sample and one composite oyster sample were taken in each creek at varying distances from the docks (<1m and >10m) and in reference creeks.

Concentrations of copper in oyster tissue from animals attached to pilings were significantly higher than those in oysters collected away from the pilings and from reference sites. However, Wendt and Van Dolah did not find physiological differences between the sampled groups. Sediment copper, chromium and arsenic concentrations were not different among the sediments collected near docks, greater than 10m away from docks and in reference areas. Furthermore, no acute toxicity was observed.

Photo credit: D. Sanger.

The second phase of the Wendt and Van Dolah study focused on recently constructed docks. *In situ* bioassays measured mortality in white shrimp, red drum, mud snails, and mummichog placed adjacent to five 4–12 month old docks after a 96 hour period. These results were compared to mortality in animals placed in reference areas. A six-week study of oyster bioaccumulation of metal and its relationship to growth was also conducted. There was no decrease in survival of the four species in the 96-hour assays. In addition, there were no differences in the deployed oyster tissue metal concentrations or in their growth.

The second study, conducted by Sanger and Holland and published in a 2002 SCDNR/MRD technical report, examined cumulative impacts of docks. *Spartina* shading, sediment contamination, and impacts on nursery habitat were examined in an effort to address as wide a range of impacts as possible within a limited budget. Only the sediment contamination and nursery habitat research in both small and large tidal creeks was presented at this workshop.

No new data was collected for this portion of the study as pre-existing data from two projects performed at SCDNR were used. The small tidal creek data set was pulled from the Tidal Creek Project (TCP) which defined small tidal creeks as <20m wide. The large tidal creek data set utilized data from the South Carolina Estuarine and Coastal Assessment Program (SCECAP). Large tidal creeks were defined as creeks between 20m and 100m wide. The small tidal creek data set compared creeks with no development (reference) to creeks with suburban development and no docks (suburban-no docks) to creeks with suburban development and docks (suburban-dock) (Fig. 16). The large tidal creek data set compared creeks with no docks (no docks) to creeks with low numbers of docks (low docks) to creeks with high numbers of docks (high docks).

In general, both the small and large tidal creek data sets showed:

- CCA contaminants did not increase with increasing numbers of docks.
- Higher levels of PAHs were measured in creeks with suburban development and docks, but the higher levels were probably due to the suburban development and not the docks;

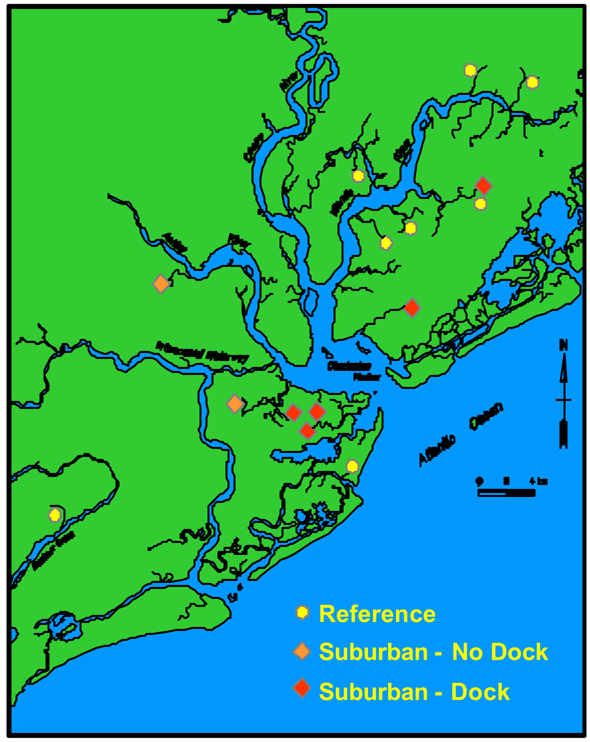


Figure 16. Sites selected for the cumulative impact study compared reference areas in South Carolina to suburban areas with and without docks (from D. Sanger).

- Changes were found in the small tidal creek benthic community, but again this was probably more related to the suburban development of the upland; and
- Suburban development may reduce fish and crustacean abundances, but dock structures may also provide structure that attracts them.

The overall conclusions of these two portions of this study were: (1) chemical and biological effects were observed with increasing impervious cover and increasing dock numbers; and (2) docks are not the problem, they are a symptom of the much bigger problem which is development of the uplands.

Question & Answer Period

Q. What is the role of outboard motors and PAH? It seems that it could be a big issue.

A. Yes, outboards probably are a source of PAH. We did find some elevated levels of PAHs in small creeks with docks but the upland development masked any effect that may be due to docks. Unfortunately, it would be hard to design a study to evaluate this question due to teasing out recreational boat use unassociated with docks compared to recreational boat use associated with docks would be difficult.

Q. Is it safe to say that CCA-treated wood has no impacts in areas of flushing, but does in areas of low flow?

A. That is generally what our research, combined with that of Dr. Weis, indicates. Impacts are greatest directly after the wood is put into the water. It should also be noted that the contaminants don't just disappear. They may flow out of the system but we don't know where they go and whether they are having impacts elsewhere.

Comment: Delaware has dealt with impacts of bulkheads by not allowing them anymore. There is almost always a better way to deal with erosion. You can replace existing ones, but in the process applicants are required to dig out the old one.

Q. You noted that species richness of fish and crustaceans increased in creeks with suburban development and docks compared to suburban creeks with no docks and reference creeks - did you consider species composition?

A. We did evaluate individual species in our analyses but did not look at a true shift in the fish and crustacean species composition which is something that could be considered in the future.

Q. Given that most of the contaminants leach out in the initial 90 days, if a permit requires that the CCA-treated wood be seasoned before building would this a be a useful precaution?

A. Only if the wood is in contact with water (e.g., rain). Once again, however, those chemicals must go somewhere.

IMPACTS FROM ASSOCIATED BOATING USE

Summary

Most docks are for private recreational boating accessory to private residential uses of upland areas. Issues of concern include impacts to submerged aquatic vegetation, contamination from fuel discharges, increased use of vessels in shallow nearshore areas, erosion of shoreline and flats, turbidity and resuspension of bottom sediments, noise, and disturbance of wildlife (Crawford et al. 1998, Kennish 2002) and interference with other uses of nearshore areas. However, these impacts are difficult to quantify. Based on the limited quantitative data available, scientists agreed that, motor boat traffic is far from a benign influence on the aquatic and marine environments, and identified quantification of boating impacts as a research need.

Rick Crawford

Nautilus Environmental Services, Falmouth, MA

The general topic of impacts from boating usage in shallow estuaries has been of interest to managers and researchers for over three decades. Recently there have been two significant workshops (1994 and 2000) to review the state of knowledge on the subject.

Concerns commonly associated with boating use include:

- Damage to submerged aquatic vegetation;
- Water quality contamination associated with discharges of PAH and other petroleum by-products;
- Erosion of banks, marsh edge and tidal flats;
- Resuspension of sediments and resulting turbidity;
- Impacts from noise; and
- Disturbance of wildlife.

Because docks are in the most shallow areas of an embayment and are the location where refueling may take place and engines are started and stopped, impacts are apt to be particularly significant there. Propeller scarring of vegetation and "prop dredging" of sediments are perhaps the most obvious impacts in the shallow waters adjacent to docks (Fig. 17).

As a boat moves through the water there are two principal forces produced (also see Figure XX):

- The primary wake (or bow wake) that is related to water displacement by the boat that moves out to the side and can cause bank erosion; and
- The secondary wake (or prop wash) related to engine and propeller effects that moves behind the boat and down and causes sediment resuspension and damage to submerged aquatic vegetation.

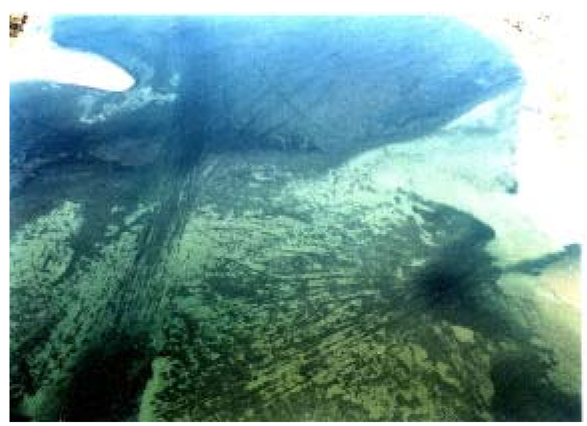


Figure17. Propeller and mooring chain scour marks near docks (left) and propeller wash scour marks in Waquoit Bay (right). (Photo credit: R. Crawford).

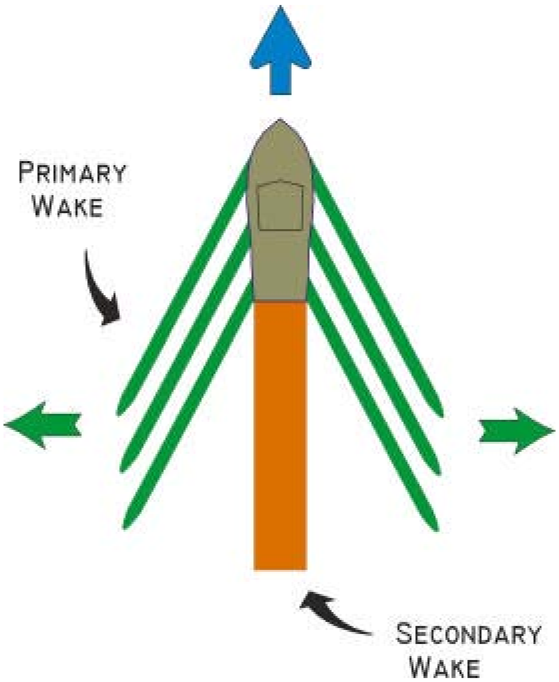


Figure 18. Primary wake travels away in widening path; effects add to naturally occurring disturbances (waves). Secondary wake disturbance area remains narrow and limited; it is an unnatural disturbance (From R. Crawford).

At slow speeds, such as those near a dock, it is the secondary wake and physical contact between the hull and/or prop that is apt to have the most significant impacts. However, these secondary wake impacts are difficult to quantify accurately because they vary widely from boat to boat and are based on environmental conditions. Propeller thrust characteristics are also highly variable, and depend on propeller size, thrust angle, clearance over bottom, engine power, hull shape, operating conditions (*e.g,* speed, state of the tide, weather, number of passengers), and operator choices.

Although environmental damage caused by boat operation in shallow waters can be quite obvious, despite the ongoing research, there has been limited progress in finding quantifiable, predictable impacts from boating uses.

Conclusions:

- Using sediment resuspension to assess impacts is not recommended.
- Small-scale measurements are too variable, the broader the scale the better.
- Parameters like light attenuation can be easily measured but the greatest impacts can be short-term phenomena that are better monitored with a recording device (an expensive device).
- It is difficult to ascribe generic impacts resulting from a boating activity.
- More research is needed—however the research is expensive and very time consuming.

Question & Answer Period

Q. Considering the photographs showing clear prop scarring in vegetative beds, why do you draw such negative conclusions about being able to predict boating impacts?
A. Despite having visual evidence of obvious damage, it's very hard to quantify what caused it.

Q. What kind of impacts were you trying to assess through the use of a light meter?
A. We were trying to determine how much sediment is disturbed by various boat propellers.

Q. Acoustic doppler current profilers have been used successfully in studying prop wash effects behind ferries. Have you tried them?
A. This kind of equipment doesn't work well in the shallow water situations being considered here.

Q. Researchers at Texas A&M have developed a model on propeller energy and disturbance.
A. I'm not familiar with that specific model, but the problem with models is that the conditions are constantly changing once you're out in the field.

Steve Resler
New York Department of State, Coastal Management Program

The management of docks and their associated uses, including recreational boating, involves consideration of human uses and values - and that has been used to drive approaches to managing them in New York. Generally, the primary purpose of private docks, from privately owned upland, accessory to the private residential use of the upland, is to gain private access to the water for a range of private purposes. These uses may include pedestrian access across vegetated and other intertidal areas to the water and vessels moored to the dock, launching of small vessels such as canoes or kayaks, and mooring larger vessels, whether powered by sailor motor).

(Photo credit: S. Snow-Cotter)

It is not always necessary to conduct detailed individual site-by-site assessments of docks or vessels using them. Likewise a detailed understanding of the specific types and degrees of impacts associated with a dock is not always prerequisite to developing and making regulatory decisions. A valid and much easier approach, based on generally understood resource and human use values, is through the designation of areas that have special or high value wetland or other natural resource or character values based on physical or other characteristics.

(Photo credit: S. Snow-Cotter)

Based on experience, mangers understand that docks and the uses of vessels associated with them have various types and levels or degrees of physical effects on resources and uses of them. If the overall objective in high value habitat or other areas with desired characteristics that should be protected is to protect, maintain, or restore the viability of an area as a habitat, or for other purposes, and the value of the habitat or other characteristics is recognized and considered in decision-making standards, the effects of docks and vessels using them can be regulated and in certain instances prohibited to prevent or minimize impairments to important characteristics, functions and values of important habitats and other areas.

New York has worked with municipalities to develop understandings of varying circumstances and needs relating to protection and uses of differing coastal areas, and to determine municipal needs and desires regarding docks and their uses. Public outreach efforts are included in assessing areas and considering the generally understood effects of docks and vessels, and involve community consensus-building regarding the protection of resources and areas and appropriate uses of them. This consensus-building involves consideration of human values regarding docks and their associated uses, including the effects of vessels and other uses and values associated with them and with other use and values.

This consensus-building results in the development of regulatory decision-making regulatory standards for docks and, in certain cases, the uses of vessels in special management areas. If a goal is developed to allow or encourage docks and vessels associated with them, or to limit them, the State Coastal Management Program provides recommendations, suggestions, and technical assistance in developing the regulatory and other means for doing so,

(Photo credit: S. Snow-Cotter).

including the means of minimizing adverse effects in certain areas where there is a need to minimize those effects. This is usually done through area-wide or water-body based planning, based on the unique circumstances of specific water bodies and resources and human use values associated with them.

Richard Crawford summarized some of the adverse effects of vessels, including those using docks. Richard Smardon will address aesthetic considerations regarding docks and vessels using them. Those and other affects discussed at this and other workshops are generally understood. We do not know absolutely all of the many and varying types and degrees of effects resulting from docks and vessels, and it is extremely difficult if not impossible in many circumstances to quantify those effects absolutely. However, we can and do develop standards and base regulatory and other decisions on our general understandings in order to achieve legitimate governmental objectives, using a wide range of available authorities.

Private docks on publicly owned underwater lands and in public waters, accessory to the private residential use of privately owned uplands, affect public resources and areas and uses of them. They do not advance legislative public purposes or state or national coastal management objectives. They serve only the personal private use of the upland property owner, whether for general private pedestrian access to the water or for the mooring of private recreational vessels, impairing publicly owned natural resources and legitimate public uses of nearshore areas to varying degrees. Vessels using or associated with docks, and the uses of vessels for a wide range of activities (i.e. water skiing in nearshore areas) also have a wide range of effects, including the suspension of sediments in shallow nearshore areas, erosion and scour of shoreline areas and wetlands from vessel wakes and prop wash, the introduction of certain pollutants in the water column, noise, and conflicts between other legitimate public uses of nearshore areas.

Government allows the owners of upland property abutting the water some types and degrees of impairments to, and interference with, resources and public uses associated with docks and vessels associated with and using them. Government has considerable latitude in deciding the types and levels of allowable private access to and uses of publicly owned lands, waters, and resources, and interference with legitimate public uses and values associated with public resources and uses of them.

While private upland property owners generally have rights to construct docks for access to the water for navigation, this right is limited to the minimum necessary for access to the water for navigation. Furthermore, this right does not always include the right to construct a dock and moor a vessel to it. The decision to allow greater encroachments into (and impairments to) publicly owned resources and legitimate public uses of in-water areas and resources through the construction and use of docks and vessels associated with them, is at the discretion of the states or other levels of government entrusted with the management of public resources, and the legitimate rights of the public to appropriate access to and use of those resources.

Boat lifts are increasingly common in small tidal creeks in South Carolina (Photo credit: R. Chinnis).

It has been our experience in New York that courts do not second guess managers when their regulatory standards and decisions are based on legitimate governmental authorities and objectives, are well documented, and are based on logical, rational decision-making and understandings.

The range of legitimate governmental objectives related to the regulation of docks and vessels associated with them include:

- protecting or providing for general public access along the shoreline and water for legitimate public purposes (such as strolling, wading, swimming, shellfishing, fishing, surfcasting, etc);
- protecting or providing for general public navigation, whether by canoe or kayak, sail, or motorized vessels;
- protecting or providing for important public or other water-dependent uses and the protection of natural resources;
- protecting or providing for certain development or other characteristics, including the maintenance or protection of aesthetic or cultural characteristics and values; and
- general public safety.

(Photo credit: S. Snow-Cotter)

In summary, we generally understand the effects of docks, vessels, and their uses on coastal resources, areas, and other human uses. We do not know absolutely the degree of all of their effects. However, the available information regarding, and our understandings of, those effects and available governmental authorities, have been and are sufficient to develop regulatory decision-making standards and make defensible regulatory decisions.

Question & Answer period

Comment: It seems quite important to make sure the public understands the differences between private amenities and public values and rights. This is the basis for determining what is and is not legal and allowable usage.

Q. How does New York regulate different uses of docks and waterways?

A. Through established authorities and principles of "traditional" land use planning and regulation, applying those principles to the water-side (i.e., "zoning" for different uses based on circumstances and desired characteristics and uses of areas).

Q. Would aesthetics always trump an individual's desire to build a dock?

A. Not necessarily. We need information on a wide range of effects to help us make rational decisions. And we have available a range of regulatory authorizations and factors to consider in making decisions.

Q. How do you determine the public's will?

A. We involve the public in understanding the effects of docks and their uses, defining what is desired, and asking whether the desired standards make sense in particular cases.

IMPACTS TO NAVIGATION AND RIPARIAN USES

Dave Killoy
US Army Corps of Engineers, New England District

Increased development has led to increased conflict between coastal resource users. The clear difference between access to water (riparian rights) and permission to extend a structure into the water is not always clear to property owners. In most cases, the land under the water is held in public trust by the states. Because navigation is a public trust rights, any structure that encroaches into the water must be reviewed for navigational impacts.

In 1991, in an effort to preempt potential user conflicts and streamline the review process, the New England District of the Army Corps of Engineers developed guidelines to minimize dock impacts to navigation. These guidelines were revised in 1996 and copies are available from the District.

The guidelines limit the impact of docks on navigation by:

- Prohibiting structures that extend into Federal Navigation Projects or traditional navigation ways.
- Allowing a new structure where a similar adjacent one already exists. The new structure should not extend beyond the length of the existing one. Exceptions are for structures that improve and are available for public use (*i.e.,* municipal or communal docks).
- Limiting the length of structures to less than 25% of the width of a waterway. Where structures extend from both sides of the waterway, at least 50% of the waterway should be navigable. Where there is no physical width constriction (because the waterway is wide), dock length should be limited to 600 ft.
- Discouraging the placement of a structure within 25 feet of riparian lines (extensions of property lines). This establishes a minimum of 50 feet between docks, a distance designed to allow for navigation by most vessels.
- Recommending that moorings be located close to applicant's property. When mooring area is far from the property, the location should be justified and the applicant should list potential impacts to public use of the area.

While the guidelines were developed as a basis for design, and not as a regulatory policy, they have been adopted into local ordinances by several municipalities in New England.

(Photo credit: J. Brashier)

IMPACTS TO AESTHETICS & QUALITY OF LIFE

Summary

From a manager's perspective, oftentimes the publicly-held concerns related to small docks are not really related to the environment. They may be aesthetic in nature, a sense of over-development of the shore, or simply change. It is not uncommon for managers to hear very vocal outcries from one segment of the population while the rest remains quiet.

In an attempt to get a better sense of public sentiment regarding docks in South Carolina, Felts *et al.* conducted telephone surveys of the opinions of residents of coastal counties in the state (2001, n=384) and of dock owners (2002, n= 423).

- 75% of the residents of coastal counties felt that property owners should be able to construct a dock.
- 66% of the dock owners and 50% of residents felt that docks should be regulated.
- 75% of the dock owners felt that the length of docks should be restricted; nearly 80% felt that the size should be restricted. In contrast, only 50% of the general public felt length should be restricted.
- <25% of dock owners and the general public felt that docks are harmful to the aquatic environment or detracted from the view of the water body and shoreline.
- ~75% of dock owners and the general public feel that there are not too many docks.

It is not clear whether these findings are transferable to other states or regions within those states.

While the aesthetic appeal of docks is an individual assessment, techniques have evolved that appear to provide a reproducible or predictive assessment of the aesthetic values of an area and how those might change with development. Visual impacts assessments (VIAs) developed by Smardon (1986, 1988) consider landscape compatibility, scale contrast, and spatial dominance.

In contrast to the social survey method discussed above, in which respondents are asked to express their perception of an abstract issue over the phone, VIAs present respondents with a concrete image that shows how the visual landscape would be affected by a proposed change. With computer technology, these "post-construction" images are realistic and easy to make. VIAs indicate that, when shown two images of a shoreline, the vast majority of people select the same image as being aesthetically preferable, and results from these assessments are reliable and repeatable.

In general, aesthetic preferences are for open/distance water views, enhanced water access, historic or generic coastal development, water related development, and diverse, well maintained vegetation. People disliked development in undeveloped coastal landscapes and tourist-like commercial development (Banerjee 1987, Knutson et al 1993, Shannon et al. 1990, Smardon 1987, Steinitz 1990).

(Photo credit: R. Smardon)

(Photo credit: J. Gates)

Aesthetic or visual impacts have been used as a basis for denying permit applications in Maine and New York. Maine's Natural Resources Protection Act (Title 38 §§ 480-A through Z), Standard 1 specifically requires an applicant to demonstrate that a proposed activity will not unreasonably interfere with existing scenic and aesthetic uses. Chapter 315, which is currently in review by the State of Maine, explains regulatory concerns (including visual impacts), establishes a standardized procedure for evaluating visual impacts, and explains options to mitigate adverse impacts to existing scenic and aesthetic uses.

Broad scale socio-economic assessments are necessary to determine:

- public awareness and opinion of environmental and socioeconomic costs and benefits of the increase in private, residential docks and piers,
- which coastal uses the public values and how residential docks and piers relate to those uses, and
- the human use patterns for existing docks including which dock owners use their docks and which have them as "porch furniture."

These assessments probably need to be a combination of a VIA and traditional public opinion survey. Results from these assessments will tell researchers and managers where to put emphasis in education and outreach efforts, and are critical to the development of regional scale dock policies.

Richard Smardon

State University of New York, Syracuse

Richard Smardon's presentation focused on the aesthetic impacts of fixed and floating docks and piers and associated boating activities (boardwalks and promenades have their own impacts). For example, views from the shore can be open, have a panoramic edge, or be filtered. Generally the public dislikes views being filtered through structures (e.g. docks).

Figure 19. Computer simulation of a dock build out in Massachusetts. (Photo credit: MA Coastal Zone Management Office).

Visual impact analyses (VIAs) grow from comparisons between existing settings and proposed changes. This allows members of the public to evaluate how much change a landscape can absorb. For example, simulations of views may be set up to show what build-out will look like (Fig. 19, 20, 21). For this process it is important to:

- document angle of the lens used,
- note the distance to the object,
- provide the aspect or angle of the viewer, and
- provide the location of the viewpoint where the picture was taken.

Sea Grant has set up a web site at www.coastal.lic.lisc.edu/bluelake.htm that allows the viewer to view Great Lakes landscapes with different levels of home build out and docks.

Visual Perception Studies of Coastal Settings

There is no visual assessment process specifically designed for small docks and piers, but assessments

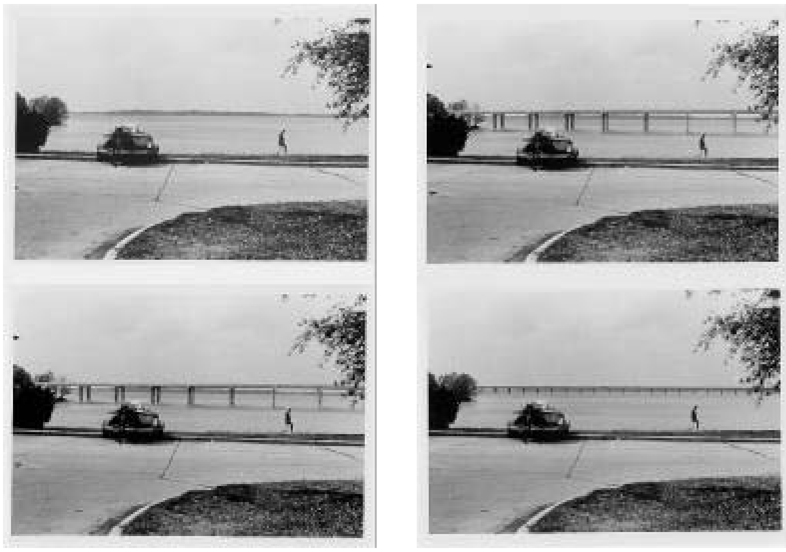


Figure 20. Side by side comparison yields different impacts. From Smardon & Karp 1992)

of coastal activities on aesthetics and visual impact conducted by Mann (1979) and Smardon and Hunter (1983) come close. The Visual Resources Assessment Process (VRAP) designed by Smardon et al. (1988) for the US Army Corps of Engineers to assess visual and aesthetic impacts for all water resource type projects is also useful.

Smardon presented an overview of visual perception studies that include coastal structures. Interestingly, docks are listed as both positive and negative attributes. Critical characteristics of docks in these cases are the condition of the dock (well maintained vs. deteriorating) and the number and array of docks compared to the visual quality and diversity of the shoreline landscape. Methods and results from individual studies are presented in Table 1 (facing page). These assessments indicate that the public likes: coastal development that is “generic” or historical (i.e., “fits with the context”), open/distance water views, and diverse but well maintained vegetation. Structures perceived as marine or water related are preferred, as are those that enhance water access. “Tourist-like” development and development in an undeveloped coastal landscape are disliked.

Two studies indicate that resident’s perceptions of what fits with the coastal landscape is distinctly different from visitors: Wohlwill’s 1983 study assessed visual perception of simulated levels of development on the Santa Barbara, CA coastline; and Zube and McLaughlin (1978) assessed perceptions of visitors and residents to photos of the Virgin Islands coastline in St. Johns. In both studies, residents were more tolerant of coastal development if economic income is generated to benefit the community.

Other factors that affect visual perception include the level of existing development in an area, the use of proposed development, and age of the respondent. In working or mixed-use coastal areas, judgments are not clear-cut, but visitors and residents tend to be more critical of coastal aesthetics in parks and undeveloped settings than in developed areas. Finally, older residents are generally more tolerant of coastal commercial development.

The only study that specially assesses visual impact of docks on the coastal landscape was by Felts et al (2001) in South Carolina. This was not a visual perception study that asked respondents to react to images or photos, but was a multi-item questionnaire asking South Carolina residents a number of questions about docks. The results of this study are discussed later in this panel.

In summary, the major aesthetic impacts of docks and piers are due to lack of upkeep. In addition to

Figure 21. Cross Lake "before" image (left) vs. Cross Lake: Simulation. Note **light/shadow + water texture (From Smardon & Karp 1992).**

Table 1. Review of coastal perception studies.			
Methodology	**Positive Attributes**	**Negative Attributes**	**Source**
Urban Los Angles respondents were shown panoramic images and video clips.	water, activities, beach area	inappropriate structures, high level of development	Banerjee and Gollub 1976
Photos of water resource development projects in varying stages were sorted into piles according to scenic quality.	beaver ponds, lakes, wildlife	uncompleted projects, pollution, oil tanks, eroded banks, excavation	Gauger and Wycoff 1973
Scenic river boaters in Wisconsin were given cameras and told to photograph both positive and negative aspects of the river visual experience.	river scenes, trees, houses set in the woods, rapids, developed recreation areas	metal pipes, powerlines, bridges, abutments	Cherem and Traweek 1977
Preference ratings of mounted photos were used visual attributes of islands and shoals within the Thousand Island area on the St. Lawrence River between US and Canada.	visually contrasting rocks and trees, island form variation, varied color and texture, clear edges	lower relief, lower variety, presence of buildings and development on the islands and shoals	Knutsen, Leopold, and Smardon 1996
In this study of landscape perception in Dennis Massachusetts on Cape Cod, ~60 photos taken by town residents were sorted by the town's people into piles according to landscape type and scenic quality.	void of humans, habitat	degradation, private exploitation	Palmer 1978, 1983
Photos of representative coastal areas were used to assess perception of coastal areas throughout NY.	lack of development	litter and debris, erosion, water appearance, presence of shoreline structures	Neiman 1987
For this study of views to the St. Lawrence River from Cape Vincent to Hammond, NY, North Country residents and students rated photos of views.	views or access to water, vegetation, natural landscape, rural image, water features, views to opposite shore, uniqueness, edge variety, superior or elevated views, fences, dirt roads	utilities, trailer parks, screening or blocking views, signage, excessive vegetation, flat topography, general clutter, boats and docks, poorly maintained areas	Smardon et al. 1987
Photos and video were taken of views to the St. Lawrence River from the road and from the water from Massena to Ogdensburg, NY were shown to student subjects.	islands with vegetation, marsh and emergent vegetation along the shoreline, vegetation rising in steps, dense vegetation down to the water, unique tree forms, golf course, grass area with grazing livestock, boat launch, grassy knoll with little vegetation, stone breakwater.	oil tanks, rocky dike and industrial plant, industrial plant, power lines, shipping lock, dam, steep rocky shoreline w/little vegetation, causeway, power authority dam	Shannon and Smardon 1990, 1996
Visual perception of views taken from the loop road in Arcadia National Park in Maine was measured by asking for positive and negative characteristics.	sense of mystery (they wish to be further drawn into the scene), coastal development that is generic to the Maine landscape or with a distinctly " historical" character, water views, long distance views, "folded" or multi-layered landscape (typically mountains and islands), diverse and well maintained vegetation distribution in the foreground and middle ground of the view.	developed or urbanized landscape, evidence of crowed use, tourist-oriented commercial development	Steinitz 1990

deteriorated structures, water quality considerations, wildlife disturbances, and the spacing or density of docks were important. These impacts can be mitigated by:

- Contrast reduction,
- Reduction in height and size,
- Using “natural” or “traditional” materials,
- Increasing the distance between docks,
- Enhancing public access,
- Providing interpretive sites (historic or heritage uses), and
- Establishing setbacks along the shoreline for other structures.

Historic water structures are generally considered scenic, tourist-like commercial structures are disliked. (Photo credit: J. Gates)

Recreation User Perception Studies

Beaches: Beach aesthetic preference studies indicate a divergence in beach preference. Higher educated older residents prefer natural beaches with low intensity of uses with attractive trees, whereas younger users prefer city beaches with facilities and do not mind crowds (Cutter 1979, Peterson and Neuman 1969). In general, cleanliness, convenience and aesthetics are desirable (Cutter 1979). Carls (1974) found that greater numbers and development reduces preference on Massachusetts’s beaches on Cape Cod.

Boating: Tolerance to crowds and user patterns depends on the type of boater and whether the boater is a resident or visitor. Power boaters are most tolerant of other uses, sailing boaters are less tolerant, and fishing and non-motorized boaters are least tolerant of multiple uses (Lime 1970). Permanent residents are more concerned about displacement, safety, litter and marine waste then visitors (Droggin et al. 2000).

Water Quality: Literature on perceptions of water quality by recreational users indicates concern for impacts of boating activity associated with docks. Water quality problems commonly mentioned by recreational users are: films of gas and oil, solid waste (bottles and cans), use of pesticides and herbicides, sedimentation/ turbidity, beach pollution. Boaters are most sensitive to water quality and are the first to notice muddy or foamy, unusual colors and objects, green scum and algae, sewage, and solids. Fisherman notice films and dead fish, and cottage owners notice strange odors, algae, and skin irritations.

Coastal development can impact views. (Photo credit: R. Smardon)

Shoreline Planning

Guidance material for coastal planning purposes and docks is part of the Wisconsin Sea Grant Coastal GIS Applications Project (Hart and Sutphin, undated and http://www.coastal.lic.wisc.edu/bluelake.htm). This site includes alternate layouts for coastal planning with an interactive GIS/3D animated software that allows one to envision different coastal development futures under different zoning and setback requirements. In terms of prescriptive planning and design guidance – the most detailed for coastal development is the Victoria Coastal Council’s (1988) Siting and design principles on web site http://www.vcc.vic.gov.au/siting/guidelines.htm

Shoreline regulations

Many states have regulations governing coastal zone land use (Smardon and Karp 1992) and marina siting and operation. Shoreline and water area zoning has been proposed, but is rarely implemented. Only two water body areas (to authors knowledge) have restrictions on the number of docks, or dock length and design: Lake Tahoe, (Smardon 1992, 1997) and lakes in the Adirondack Park in New York State (Smardon 1992). Because of the Lucas case in South Carolina (see Nolan 1997) and the threat of takings of private property rights via regulation of allowed coastal uses and development – one needs to be extremely careful in this area.

Aesthetic Coastal Regulation: State-by-State Breakdown

California Coastal Act of 1976, Cal. Res. Code, Div. 20, Art. 6 upheld by Candlestick Properties vs. San Francisco Bay Con. & Devel. Com. 89 Cal. Rpt. 897 (1970)

Connecticut Ch. 440 s. 22a-28

Maine Shoreline and Subdivision Control Act, Samorock LLC Rockland, Knox County Samoset Yaught Club L-14246-4F - permit denied on ecological & aesthetics at http://www.penday.org/nosamook

Maryland Title 9 s9-102 & Maryland Coastal Bays program: Ocean City Fishing Center in West Ocean City - ultra clean marina at http://www.mdcoastalbays.org/news/weekly14.html

Michigan Inland Lakes & Streams Act of 1972, s. 281.957

Minnesota Rules for Chapter 6105:0410 Marinas - limits locations http://www.reviser.leg.state.ms.us/

Mississippi Title 49, Ch. 27

New Hampshire Ch. 483As.1-b

New Jersey Title 13 Ch. 19

New York Tidal Wetlands Act art. 483 Ch. 25 s.010 (h)

North Carolina Ch. 13A-102

Oregon Land Conservation and Development Law, Goal 16: Estuarine Resources -regulates marinas in estuarine areas - http://utopia.uoregon.edu/projects/landuse/goal16.html

Rhode Island Title 2-1.13

Texas Ch. 33, ss001

Question & Answer Period

Q. How do you know that, if you follow the process and get public input, that the result (change in visual impact) arises from the process rather than from getting people to simply communicate?
A. The process is good for getting an iterative discussion started.

Comment: In our experience in Maine, it doesn't matter whether it is the process or not—you get same result.

Q. How many view points do you use – only one?
A. No, six or seven is the magic number.

Q. Do these analyses actually lead to design changes?

A. Yes, often when we recommended that project proponents "soften" the structures, they do as a means of gaining public acceptance. In many instances aesthetics became a huge issue with the public and were fundamental to getting these projects done.

Q. Could you do it backwards? Take developed shoreline and restore it?
A. Probably not, but that's an interesting idea. Reactions vary. People are attached to things in the landscape.

Judy Gates
Maine Department of Environmental Protection, Division of Land Resource Regulation

In recent years there has been a growth in permit applications for docks and with it an increased expectation for all-tide access which means that structures must have heavier construction and be larger in size and length.

Undeveloped coastline in Maine. (Photo credit: J. Gates).

The Maine Natural Resources Protection Act (NRPA) (Title 38 § 480, A–Z) specifically requires an applicant for a dock or other coastal structure to "demonstrate that a proposed activity will not unreasonably interfere with existing scenic and aesthetic uses." The supporting regulation, Chapter 315, has been developed over the past year to provide a tool for assessing and mitigating impacts to existing scenic and aesthetic uses.

Maine's DEP has found that to get the highest level of protection, it needs to get involved with the first structure in a newly developing area. In the past 5 years they have denied permits for docks proposed in places were there was no previous development.

There have been several court cases that tested decisions under these rules, including:

- Kolsaka vs. ME—in this case a permit denial was overturned because it was "too vague"; and
- Anne Hannum vs. ME Board of Environmental Protection—in this instance the proposed pier interfered with aesthetics and boat traffic. Additionally, there was potential for interference with seal pupping and endangered terns that are about a quarter of a mile away. The ruling was based on the use of the structure, not the structure itself.

In response to a concern that future cases will be lost because the NRPA standard concerning existing scenic and aesthetic uses is unconstitutionally vague, Maine's Department of Environmental Protection developed Chapter 315. This chapter codifies and standardizes aesthetic concepts by

- Specifying state regulatory concerns,
- Defining visual impacts,
- Establishing a procedure for evaluating visual impacts,
- Establishing when a visual assessment may be necessary,
- Explaining the components of a visual assessment, and
- Describing avoidance, mitigation, and offset measures that may eliminate or reduce adverse impacts to existing scenic and aesthetic uses.

Under Chapter 315 visual impacts will be determined by considering:

- Landscape compatibility of the proposed structure;
- Scale contrast; and
- Spatial dominance.

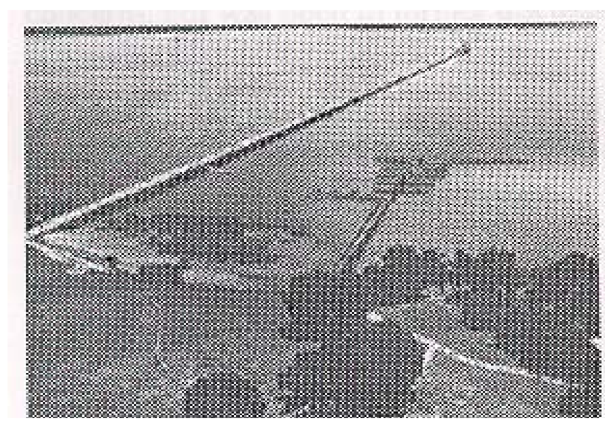
This process has played out in a series of decisions illustrated in Figures 22 - 24. In Case 1, a large coastal resort proposed a marina for its users that would have blocked a public view of a historic breakwater and lighthouse. This application was withdrawn after the DEP issued a draft denial based on the projects impact on existing scenic uses. In Case 2 the proposed dock was allowed because it did not interfere with scenic values of the viewshed. In Case 3, DEP found that the proposed dock would interfere with significant public scenic views and asked the proponent to consider other locations. This case is particularly interesting in that there were no direct resource impacts from this individual dock. However, the dock would have been located in the only natural fjord on the East coast and would have been the only dock visible for users of Acadia National Park viewing the fjord from a popular hiking trail. Consequently the project was denied, but at this date is still within the timeframe for appeal. In this instance, the denial was partly based on existing alternatives for coastal access available to the applicant that would preclude construction of the proposed pier.

Figure 22. Case 1: The application for this dock was withdrawn after visual impact assessment revealed that it interfered with public scenic views.

The Samoset resort is adjacent to the 100 y.o. Rockland Breakwater. The Resort itself has already changed the character of the shoreline, so looking solely at the view from the water and considering the developed nature of Rockland Harbor, visual quality **might not be at issue.**

The resort has historically allowed the public to cross from a neighboring park, across the intertidal and subratidal to access the breakwater. This is the only access point to the breakwater.

From the park and beach, the public has an unobstructed view of the mile long breakwater and the lighthouse at the end, as well as a view of Owls Head across the bay.



A modified photo showing the proposed marina's proximity to the Rockalnd breakwater. The proposal placed the pier directly next to the park. Because the pier would have been higher than the breakwater, the public's view of and access to the breakwater **would have been impeded. Faced with a draft denial, the applicant withdrew.**

Figure 23. Case 2: The ME DEP determined that this pier (left), which had the dubious benefit of being permitted after it was built, did not interfere with the reason that the view was found to be scenic. As is not unusual, the party declaring a scenic impact was a neighbor, whose grandfathered lot potentially constituted a larger impact to the visual quality of the north side of the island (right). This project caused the DEP to think carefully about whose view they are charged with protecting, and reinforced the concept that it is the public's view that the legislature was concerned with when it adopted the NRPA.

Figure 24. Case 3: Looking toward the shore where the pier was proposed, it was easy to determine that the dock would not interfere with the visual quality of the shoreline any more than the existing development (top right). This was not the first pier proposed in the area, and in fact there are several along the adjacent shoreline (bottom left). Cumulative impact may have been an issue, but in this case there is a good distance between the piers and the additional direct impacts from this pier were unlikely. However, the coastal resource of concern is Somes Sound, the only natural fjord on the east coast. The view in this photo (bottom right) is from the top of Flying Mountain, one of the most popular hikes in Acadia National Park. **The proposed dock would be clearly visible from the trail and summit of Flying Mountain, while the existing docks are not.**

The DEP initiated development of the guidelines in April 2001 and held an internal review in October 2002. The draft rule has been posted and a public hearing will be held April 3, 2003, with public comments due by April 14.

As part of the process, a Standard Operating Procedure (SOP) for visual assessments was developed to provide consistency in decision-making among staff and improve the decision-makers' ability to document decisions. Under the new process, it is predicted that less than one percent of applications will have any additional requirements beyond what the law and the DEP already require.

Question & Answer Period

Q. Have any local governments adopted this process?
A. Not yet, local governments seem to be waiting until the rules pass all of the legal hurdles.

Q. What alternatives to building a dock are considered (*i.e.*, marina slips, moorings, etc.)?
A. We consider what applicants already hold as well as what's available.

Q. Do you consider the objections of neighbors with scenic issues?
A. Yes, but not exclusively. We are much more concerned with the public's view as specified in the preamble of the NRPA. We primarily look at the viewshed from publicly accessible viewpoints.

Q. How sensitive do you have to be to comments from self-interested commentators (realtors, developers) on the new rule?
A. We have spoken with them throughout this process. They'd like to see more consistency as well. Chapter 315 is simply further guidance – the existing regulations already require applicants to show that their project will meet all of the NRPA standards.

Q. How does this proposed rule on visual effects work with other rules regarding ecology, etc.? Are the processes the same?
A. The same department considers water quality and the other factors.

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In South Carolina permit applications have increased ten-fold over the past 20 years, from 80 in 1982 to over 800 in 2002. In addition, many docks are now designed with lifts to bring boats out of the water. This has had the benefit of keeping boats off the mud bottom but it has the adverse effect of allowing larger boats to dock in small tidal creeks (Fig. 25).

Existing regulations in South Carolina set the maximum length of docks at 1000 feet. State managers have attempted to have this shortened to 500 feet, but legislative support is lacking.

Figure 25. The use of boatlifts means that now you see not only the dock, but the entire profile of the raised boat as well. (Photo credit: R. Chinnis).

Figure 26. Proposed docks across from the historic Magnolia Gardens were denied because they would interfere with scenic views from the garden. (Photo credit: R. Chinnis).

Managers in South Carolina have the authority to review docks for visual impacts. To date, they have had a 100% success rate in denying permits on these grounds in areas designated for special protection such as the Ashley River. In one instance a project proponent subdivided her property and proposed to build a dock on each of seven lots. Her property was across the river from a Historic garden (Fig. 26). After testimony to the effect that the docks would degrade the visual enjoyment of visitors to the public garden, the permits were denied.

Last year, there were 42 appeals of dock permits. In most cases, the appellants were annoyed that too many docks are being permitted without consideration of cumulative or aesthetic impacts.

To find out more about public perceptions of docks, the DHEC sponsored two public attitude surveys that were conducted by Felts et al.

One sought opinions from coastal residents, the second from dock owners. Generally, people feel that docks add to property values. A court assessor claimed that a permit alone can enhance property value by $300–600K. Furthermore, the majority (~75%) of residents of coastal counties felt that:

- property owners should be allowed to build a dock,
- docks are not harmful to the aquatic environment,
- docks do not take away from views, and
- there are not too many docks.

However, 66% of dock owners and 50% of residents agreed that docks should be regulated and their size restricted. Half of those surveyed thought that boating uses are harmful, and 59-76% felt that there are places where docks should not be built.

If they have to be regulated, most residents felt that regulation by local, rather than state government is more appropriate. However, local governments do not want to do the regulation—they have neither the budget nor expertise.

Presently, docks are limited to three feet above mean high tide and four feet in width and can only be built on lots 75 ft wide or wider. Despite resistance to restrictions on roofs or coverings (as indicated in the survey), present regulations do not allow roofs if no one else near by has one. Where they are allowed the maximum is 12 ft above the deck level including peak of roof, weather vane, etc.

Question & Answer Period

Q. Do you consider other structures in the area?
A. No, because we use dated (1986) aerial photos.

Q. In Loyd Harbor, NY, they had two assessors look at values of properties with and without docks. The potential to have a dock (or having one) didn't affect property value. The value of the waterfront lot was similar to inland lots, development pattern and services were more important. So were the increases in property value real or perceived?
A. Analyses have not been conducted, but our opinions regarding these sorts of property value impact issues are based on the testimony of appraisers in court.

Q. Can you argue that a neighbor's dock devalues surrounding property values?
A. That question was asked in the survey. The public does not think this is the case.

Q. Is there a correlation between dredging requests and proliferation in docks?
A. Not really. We do not permit dredging in natural creeks along which most of these docks are built.

Q. Do you have a sense of the demographics of people interviewed for survey?
A. It was weighted toward white-collar college graduates. For more information take a look at the website. It can be downloaded from the Hot Topics section of the South Carolina Department of Health and Environmental Control website: http://www.scdhec.net/ocrm/.

Q. How do you deal with shading?
A. We deal with shading by requiring dock master plans that show alignment. We have some flexibility, but other than specific regulations we can't do much about height and width.

Q. What are dock master plans?
A. They are part of our newer process. Any project that requires another permit (*i.e.*, wastewater) from the state or federal government must provide a dock master plan according to specific guidelines. Applications are posted for the public on the website every week (see http://www.scdhec.net/ocrm/).

Q. Are dock master plans required in previously developed areas?
A. No, only since 1993 have dock master plans been required.

Q. No pictures were shown during the survey to participants? It is somewhat scary to have that survey out there.
A. That is correct, the survey was conducted on the telephone. We had no role in designing the survey—showing participants some pictures might have resulted in a different response.

Management Response

Following the presentations, the managers were asked to respond, either commenting on how the material presented met their needs or to make recommendations for best use of the material. The following are drawn from that discussion.

Comment: This sort of workshop is taking us in the right direction. There is a strong need for research that will quantify impacts and help managers explain why they are approving or denying docks. Managers need to know what species and habitats will be affected and whether there is the possibility of mitigating the impacts.

The idea of a conceptual model is very welcome. Based on such a model, managers could generate an overall plan, policy, or guidelines to avoid site-by-site analyses. Scientifically backed, broad policies add to predictability and understanding by legislators—whose support is critical—and the regulated community.

Comment: Matrices have been used in some instances with a fair degree of success. In a proposed sub-division in Delaware the developer promised a dock for each of some 40+ lots. Rather than reviewing this many individual permits over time, state managers developed a general plan that assessed the cumulative impacts and determined that the system could handle 20 docks without unacceptable impacts. Under appeal, it was found that this was a reasonable approach and the 20-dock limit was upheld.

Comment: Managers realize that it is difficult if not impossible to establish specific thresholds or standards for all impacts. However, the best available information on the various impacts will help managers make more informed decisions on approvable designs and on when a proposed project should be denied.

Comment: There is little information on the topic of cumulative impacts. While managers have some sense of the impacts of individual docks, it is not known whether cumulative impacts are additive, exponential or otherwise. Additional research on systems where there are multiple docks is necessary.

Comment: It is important to put proposed docks in their environmental context. In South Carolina, where there is a considerable amount of salt marsh, shading impacts may be minimal when compared with the amount of the resources. In other states, or even in particular creeks in South Carolina, full build-out may not be appropriate.

Comment: There needs to be an assessment of the impacts of the "no build option" as well as from dock construction and use. If a dock is not permitted, the result may be additional foot traffic across a marsh or tidal flat or boat storage on the shore. We have little solid data on the impacts of this sort of use as compared with a dock to meet the same needs.

Comment: It was very useful to get a better understanding of the validity of viewshed analyses. This information needs to be incorporated in project assessment and the techniques need to be more widely disseminated.

Comment: There has been little peer-reviewed information published on the topic of shading impacts to salt marsh vegetation. It is important to have better information on this topic and perhaps more research. There presently is no tool available to managers to predict shading impacts.

Comment: Better outreach to the affected community and their legislators and elected officials is critical. Providing defensible science-based information can help frame policy and regulatory decisions and lead to acceptance. It is often difficult to clearly explain and justify changes in regulatory or assessment processes and consequently there is a need for clear scientific data. Along with any guidelines should be a clear rationale of what the intended goal is and on what information decisions will be based.

Comment: There is a need for flexibility in the review process. By identifying and clearly stating social and environmental goals and putting each project into its context decisions will be more understandable. This requires the development of critical decision points for these goals.

Comment: All of this underscores the need for the development of a conceptual model or matrix to be utilized in decision-making.

RECOMMENDATIONS

Coastal Planning and Regulation

- **Base** licensing decisions on small docks on impacts to habitats, water quality, and existing uses, which include navigation, recreation, and scenic and aesthetic values.
- **Mandate** that the purpose and use of a dock be water dependent.
- **Educate** that public trust and riparian rights only allow waterside property owners access to the water—the use of public waterways for a dock is a privilege, not a right of ownership. There is no absolute right to a dock for a large boat.
- **Charge** responsible application fees for the use of public trust lands where managers rely on permitting to regulate docks. Fees should reflect the property value increase the dock owner will receive and a portion of the fees should be applied to mitigating for lost or damaged resources associated with the permitted structure.
- **Incorporate** results from environmental and socioeconomic assessments to develop regional scale dock policies that (1) provide incentives for home owners who elect not to have docks or groups of homeowners that chose a shared dock strategy (e.g. reduced property taxes for short-term and permanent easements against a dock), and (2) include a dock mitigation strategy and plan that can be supported at the local, state, and national level.

Environmental Mitigation Strategies

- **Minimize** shading impacts on vegetation by limiting the following parameters:
  - Height: maintain a four-foot minimum elevation over the marsh face or mean high water (In New England that height may need to be greater.)
  - Width: limit the width to a maximum of four feet (with exceptions for handicap access and American Disabilities Act issues)
  - Orientation: orient as close as possible to North–South.
  - Length: limit length to the minimum needed to reach water navigable at mean low water.
- **Consider** alternatives to CCA-treated lumber in areas of low flushing.

- **Reduce** shading impacts by using grated material as decking (especially in Southern US).
- **Increase** illumination under docks by incorporating light tunnels or reflective deck bottoms.
- **Keep** heavy equipment off the marsh face unless it is especially designed to avoid peat compaction. Float construction materials in from the water side, and work as much as possible from the water or existing structures.
- **Avoid** high pressure jetting for piling installation—sharpen piling tips and make initial insertion with low pressure jetting or by utilizing a drop hammer.

Accounting for Visual Impacts

- **Consider** aesthetics in the permitting process.
- **Predict** aesthetic impacts reliably by incorporating Visual Impact Assessment techniques into the permitting process.
- **Conduct** public opinion surveys to establish general values and levels of awareness; they are greatly improved when preceded by a visual characterization. (The surveys do not provide aesthetic valuations.)

Minimizing Impacts to Navigation

- **Discourage** structures that extend >25% across a waterway
- **Redirect** structures extending into Federal Navigation Projects or traditional navigation paths.

RESEARCH NEEDS

Subsequent to the presentations, the managers in attendance met to discuss research needs from their perspective. These are summarized in the following list. No priorities were applied to the items on the list.

- The cumulative impacts from docks and their associated uses and how they can be avoided, minimized or mitigated.
- The relationship between the presence, construction, and/or use of docks and vegetative habitat fragmentation.
- The regional differences, if any, between impacts from docks.
- Light requirements for marsh and submerged aquatic vegetation by region.
- A method or model to predict shading impacts from proposed docks.
- Better understanding of impacts to shellfish and fisheries, habitat for shellfish and fisheries, and on shellfishing and fishing.
- Monitoring protocols to measure impacts from docks over time.
- Impacts of docks on sediments, sedimentation, and hydrodynamics.
- Public perceptions and understanding of the benefits and detriments of docks.
- The impacts of a no-build scenario (*i.e.,* foot traffic, dingy storage, etc. on inter-tidal and supra-tidal resources.
- Better understanding of the overall effects of docks and their associated uses on: resource functions, characteristics, and values; development and aesthetic characteristics and values; and human uses of coastal areas and resources.

Non-research needs identified by the managers included:

- Additional information on the technical aspects and capabilities of dock design and construction in order to minimize impacts.
- Establishment of an outreach or education plan and materials to inform the general public and those seeking to construct docks about potential impacts, purposes and nature of regulatory programs, and techniques of dock construction.

(Photo credit: D. Shafer)

Bibliography Resulting from the Workshop

During the course of preparing for and presenting this workshop an extensive bibliography was developed. This will be supplemented and posted on the NOAA National Centers for Coastal Ocean Science website: http://www.coastalscience.noaa.gov. Full references for literature cited in this report are included in the online bibliography.

The bibliography is searchable for the following keywords: vegetation, shading, contaminants, sediments, boating, recreational uses, navigation, planning, public access, recreation, and aesthetics, as well as by author, and title.

FUTURE STEPS

Prepare a peer-reviewed synthesis document on the impacts of small docks.

It was strongly suggested that there is a need for a thorough, peer-reviewed synthesis report on the state of the scientific knowledge related to the impacts of small docks. The background paper included in this proceedings provides a starting point but a much more thorough review is needed.

In addition to expanding on the material in the background paper prepared prior to the workshop, the synthesis document should:

- Address regional differences in affected environment, dock design and impacts
- Provide a clearer description of the nature of the problem(s)—real or perceived
- Characterize the various designs and construction of docks (*i.e.,* the range of structures) as well as the activities related to dock use
- Determine impacts for each element of dock structure (*e.g.* pylons, etc.)
- Address both project-specific and cumulative impacts.

Develop bibliography related to the science of dock impacts.
As part of the preparation and presentation of this workshop, an initial bibliography related to docks was prepared. Several of the presenters submitted additional bibliographic material. This should be expanded and made available—possibly through a web site—for researchers and managers. Plans should be made to maintain the bibliography with current research.

Host additional workshops on:

- Available technologies for dock design and construction
  This workshop would bring together managers, representatives of the dock design and construction industry, and those familiar with new and innovative techniques and materials to help managers better understand the options available in dock design and construction.
- Available management techniques: regulatory and non-regulatory
  A workshop providing information on the management techniques and tools available at the local, state, and federal level would provide a basis for refining planning and regulatory programs. This should include a review of the legal parameters that apply to docks and case studies of successful (and perhaps unsuccessful) programs.

Prepare a state-by-state checklist of regulatory tools and programs used to manage docks and precedent-setting court decisions.

Present workshop findings. The following presentations are scheduled:

- Emerging Technologies, Tools, & Techniques – January 2003, Coco Beach, FL
- Southeast Coastal Program Managers' Meeting – February 2003, Wrightsville Beach, NC
- Coastal Zone '03 – July 2003, Baltimore, MD
- Society for Conservation Biology Annual Meeting – June 2003, in Duluth, Minnesota

Establish a dedicated web site for dock impacts and management discussion.

Develop a checklist of known and potential/implicated impacts from small docks.

Develop a conceptual model that will allow managers to assess the impacts of single dock proposals or develop a regional dock management plan.

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