Innovations in Coastal Management[1]

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INTRODUCTION

In recent years, our enhanced understanding of the important role played by coastal bays and estuarine regions in the maintenance of sport and commercial fisheries, as well as their aesthetic and recreational values, has led to greatly increased public and official desire to preserve these areas wherever possible. On the other hand, we are faced with a continual and ever-increasing public need for water-oriented activities, such as waterfront living, boating, swimming, fishing and generation of electric power. Pursuits of many of these activities impose stress on fragile estuarine environments.

It is probably safe to say that one single factor stands out above all others as a stress-producer – the requirement for housing, particularly waterfront communities. If we accept the premise that people will always wish to live near the water, and that more and more people will wish to work, retire or vacation near the seashore, then our coastal environments will continue to deteriorate. This cannot be allowed to happen.

What, then, are the alternatives facing us?

Perhaps the most appealing and obvious alternative is to acquire coastal lands with state or federal funds and thus prevent their development. This seems hardly practical. Funds are insufficient to buy all coastal areas, and even if this *could* be achieved there will still be an upland boundary to the acquired lands. Development would proceed unabated behind this boundary, and its effects would *still* be felt in the coastal zones. If a preserve the size of the 1.3-million-acre Everglades National Park is too small to prevent alteration of an ecosystem, we cannot expect smaller preserves to survive unchanged. Strict preservation is obviously not the complete answer. We must attempt to manage our coastal resources for multiple usage.

Of all multiple use components, human habitation is probably the least compatible with the others; but as it is also the most powerful single component, we must try to increase its compatibility (i.e. lessen its impact on other components). With current public opinion now tending to limit the loss of marshlands and submerged lands by dredge and fill operations, the emphasis shifts to the effects of development adjacent to the newly spared marshes and bays. When we look at these effects, two stand out particularly; *firstly,* damage resulting from nutrient-rich waters entering bay systems (via storm drains, sewage facilities or dead-end canals) and, *secondly,* the loss of valuable beaches

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(actual loss and aesthetic loss) as a result of building on or seaward of the dune line. The concepts we are about to briefly discuss seem to us to offer the possibility of alleviating certain aspects of these two problems.

THE INTERCEPTOR WATERWAY

Consider first the problem of runoff from urban developments adjacent to coastal marshes, bays and estuaries. In many cases this runoff, with its accumulated nutrient materials (including poorly treated sewage), enters narrow, box-cut canals so typical of Florida waterfront communities. Many of these canals, by virtue of their design characteristics, are unable to handle such nutrient loads and their water quality degenerates as a result of overenrichment. This low-quality water eventually enters the nearby bays and imposes undue stress on the environment.

We have chosen to call the water management concept, which we hope will protect natural systems from such stresses, the Interceptor or Perimeter Waterway. This concept was mentioned briefly by Bernard Yokel at the last Gulf and Caribbean Fisheries Institute meeting (Yokel and Tabb, 1971). Since then we have given the concept a great deal of attention and detailed thinking. As visualized, this management tool should perform best on an *extensive,* not *small,* scale.

The Perimeter Waterway can perform a number of functions, the primary one being the interception of, and nutrient removal from, runoff water before it reaches the bay. Water thus intercepted, spread laterally and "scrubbed" is then released seaward over the whole length of the canal rather than from the seaward end of single large canals dug directly to tide water as has been done in the recent past (Fig. 1).

For the waterway to function properly, sewage must be handled separately and treated to a very high level before disposal, preferably on an upland site where it helps in replenishment of ground water, or disposed of by deep well injection. If this is done, the waterway is capable of handling the "other" pollutants that originate from city areas. *Basic design criteria* to achieve this goal are: (1) the waterway must be wide (minimum 400 feet) to permit maximum wind effect for mixing and prevention of stratification, and it must be shallow (maximum 7 feet; mean <5 feet) to allow adequate sunlight penetration; (2) it must parallel natural contours on its seaward edge to conform with good land planning practices; (3) it should maintain itself under a given realistic nutrient-loading stress without significant aid from tidal exchange; and (4) it should be designed to develop a positive head within its confines – forcing excess water out over its seaward edge. This means control structures at either end and a uniform sill height where the waterway intercepts natural creeks. Locks for boat passage may be incorporated where the waterway approaches navigable tidal streams. (We specify this because in all probability developers will desire boat access to the Perimeter Waterway.)

The location of this waterway should be upland of tidal marshes and mangroves, and it should not broach the heads of tidal creeks unless unavoidable. Where creeks must be crossed, the waterway sill must be built up to *control*

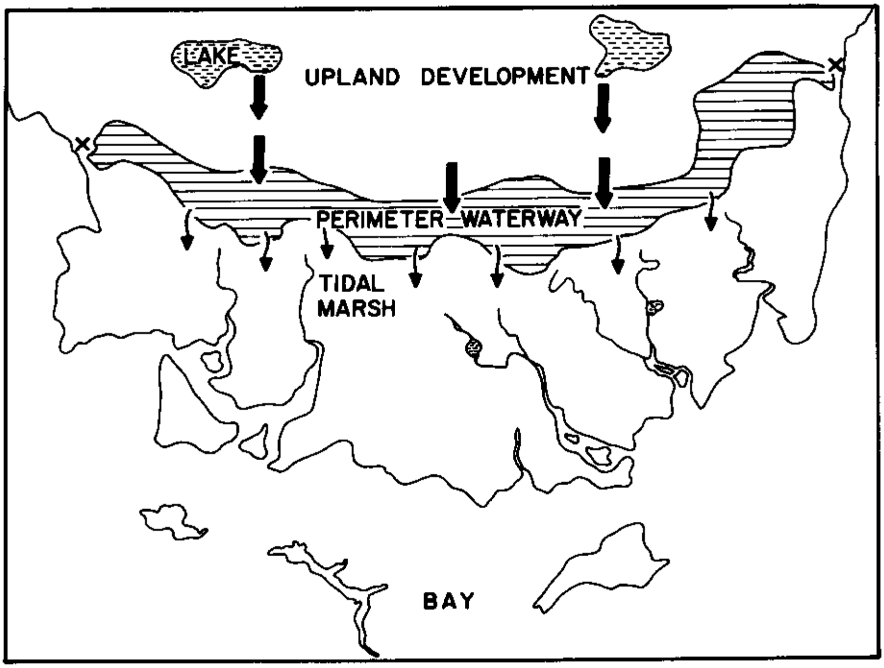

Fig. 1. The lateral distribution of runoff water by a perimeter waterway. Points of controlled boat access to the waterway are marked X.

elevation. Exact placement of the seaward edge of the waterway (i.e. on what contour) must be determined on the basis of careful land survey and observed tidal conditions in closely adjacent natural waterways.

The *operational principle* underlying the ability of this waterway to remove nutrients is that the biota associated with a given volume of impounded water can consume and convert given amounts of dissolved nutrients into food chain components, providing that the configuration of the waterway permits good sunlight penetration and wind-induced circulation. Drawing on mariculture experience, primarily our shrimp culture experiments, we have made tentative estimates of the "loading" capacity of a wide, shallow, non-tidal body of brackish to saline water. It must be stressed that the surface to depth ratio is critical: wind induced turnover is the single most important factor in maintenance of adequate oxygen levels and hence high nutrient assimilation levels in an enclosed water body. We know that a seawater body of 1 acre extent, with a maximum depth of 5 feet and a mean depth of 4 feet, is capable of assimilating considerable nutrients. At temperatures between 23 and 32C it can withstand the addition of 7 pounds of inorganic nitrogen and 10 pounds of inorganic phosphorus in a single "application," as might happen during a heavy runoff from an urban area. In addition, it can withstand the steady daily input of about 0.75 pound of protein nitrogen (for instance, in the form of leaf litter and street

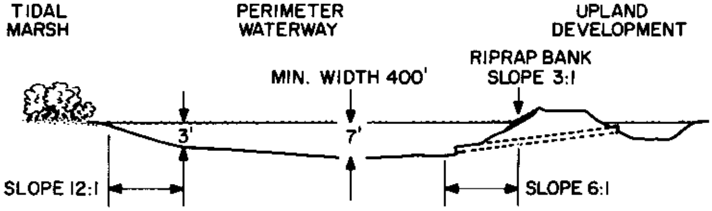

Fig. 2. Cross-section of the perimeter waterway.

washings) without becoming deoxygenated, provided that winds of 5-10 mph are fairly persistent.

Under these loading conditions, some degree of enrichment is to be expected, but the system will not become anaerobic. Ideally, such a system should have periodic net removal of accumulated organics. This can be effected by harvesting fish, shrimp, oysters and other organisms, and by allowing migratory access of native organisms across the seaward sill from the adjacent natural bays on the flood and ebb of certain tides. As visualized, the controlled elevation of the seaward edge of the waterway should be placed on a land contour that permits limited tidal flow across the entire marsh front *into* and *out* of the waterway on monthly spring tides for about 6 days each month. Such tidal conditions would permit entry and exit of organisms and consequent removal of organic production in the form of plankton, organic detritus, fish and crustaceans to adjacent natural bays. Since some waterways being planned are of very large size (about 1,000 surface acres), they can contribute significantly to the total productivity of the estuarine system.

A typical waterway cross section is depicted in Figure 2.

The Waterway obviously has a finite scrubbing capability and therefore should be used in conjunction with upland lakes where some preliminary scrubbing of runoff water occurs before discharging to the waterway. Then the waterway can perform its designed functions of second stage clean-up and distribution of runoff in a sheet-flow configuration over a broad front into the seaward marsh. The marsh itself then acts as a trickle filter; delivering water of acceptable quality to inshore bays.

THE "9 AND 3 RULE"

To ameliorate the problem of beach abuse, typified by high-rise buildings on the dune crest, or even seaward of it, we put forth the "9 and 3 rule" for management consideration. This concept apparently originated in Australia in an attempt to keep tall buildings from being built in areas where they would cast shadows on the public beach. Simply stated, the concept stipulates that no building shall be built near enough to the beach so that its shadow falls on that beach between the hours of 9:00 a.m. and 3:00 p.m. The concept recognizes that where beaches are public property and where sunlight is a prime tourist

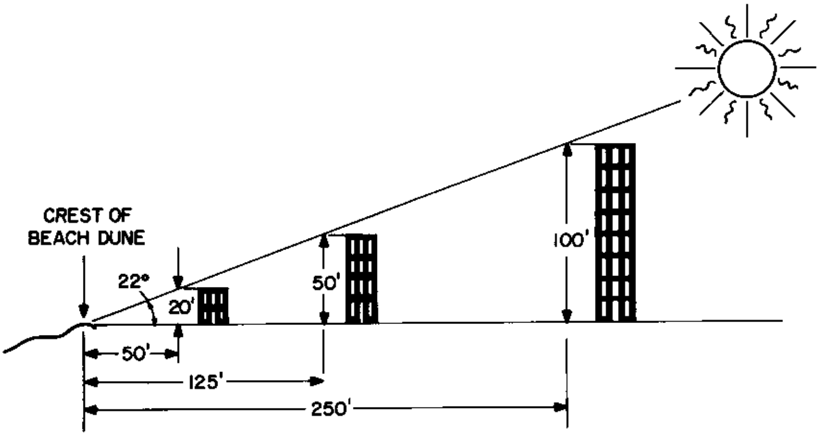

Fig. 3. Operational concept of the "9 and 3 rule".

attraction, adjacent property owners have a responsibility not to interfere with the resource. These aspects of the problem apply in Florida, and other U.S. coastal states as well, where tourism is important.

We find the concept attractive, and perhaps useful, to planners coping with decisions related to coastal set-back regulations. Part of the attractive character of the concept lies in the fact that there is a valid ecological basis for it as well as its legal-social aspects.

In examining the effect of the sun angle on light penetration of water surfaces we find that the angle must exceed 22° before 90% of available light penetrates the water surface. Below this angle light penetration drops off very rapidly (Schenck & Kendall, 1954). The ecological significance lies in the relationship between sunlight penetration and the photosynthesis of aquatic plants.

Understanding the physical and ecological basis for the concept makes it possible to compute, on any given date, the time of day when the sun angle reaches 22° above the horizon for any north-south trending coastal area. According to calculations made by Raoul Reher from solar altitude tables, this angle is reached in the Miami area at about 7:00 a.m. and again, as the sun descends at 5:00 p.m. on June 21st. On December 21st the times are 8:45 a.m. and 3:15 p.m. If it is decided that maximum sun exposure is most desirable during winter, and the winter hours for the 22° angle are chosen, it would be logical to name the concept the "9 and 3 rule" in south Florida as in Australia.

We know of no previously published rule for locating the apex of the angle from which to "shoot" the all important horizontal baseline, so propose the following: (1) that survey towers be set up a suitable distance off shore from undeveloped beaches so that the average elevation of the dune crest along its entire length can be surveyed relative to mean sea level datum; and (2) having the average elevation of the dune crest, we then propose that aerial photography be employed to give the precise chart location of the dune crest as indicated by dune vegetation and that this line with its elevation relative to mean sea level become the basic reference point from which to shoot the 22° angle. Figure 3 shows how the angle then becomes a height and set-back regulating device. For example, no building taller than 20 feet or about two stories should be built closer than 50 feet inland from the reference line on the dune crest.

The answer to questions as to how the rule applies to east-west trending beaches would be that the elevation of 22° be applied around the compass always using the dune crest as elevation control. It then could become a "universal" tool for regulating set-back lines. When applied to islands, lake shores or other waterfronts having no dune crest, it might be appropriate to select the mean high water mark as the angle apex.

The effect of the "9 and 3 rule" would be to reverse the profile of coastal development and put the highest buildings inland where their superior height could take maximum advantage of the overview of green and blue of water and vegetation. This is in accord with good land planning where visual pollution is also being considered.

In summary, we have described two new management techniques for coastal areas that we believe have merit. Neither have been fully tried or perfected, but both are being considered seriously by many people, including county commissioners, land planners and developers, in Florida.

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