Action Plan

Managing Nitrogen-Sensitive Embayments

Problem

In Buzzards Bay, as in most coastal waters, nitrogen, which is an essential nutrient, typically limits the growth of algae. Algae, which includes macroalgae or "seaweeds" and microalgae such as phytoplankton, form the base of many marine food webs. Excessive inputs of nitrogen from human activities threaten many embayments within Buzzards Bay by stimulating excessive growth of both types of algae. This increased production and accumulation of micro- and macroalgae can result in many adverse changes to coastal ecosystems, and is often referred to as "coastal eutrophication" or "nutrient enrichment". For example, increased abundance of algae can limit the transmission of light reaching eelgrass leaves, resulting in loss of eelgrass beds that provide habitat for shellfish and other animals. Dense layers of macroalgae accumulate on the bottom of some shallow bays and exclude shellfish and other invertebrates, destroying valuable habitat. In addition, decay of macroalgae depletes oxygen in the water and causes unpleasant odors. Severe oxygen depletion can kill fish and shellfish. There is also evidence that excess nitrogen loading promotes, directly and indirectly, the survival of coliform bacteria, which contributes to closures of shellfish areas. Algae blooms and accumulation of macroalgae may also cause aesthetic problems and inhibit typical recreational uses of the water such as swimming and boating. Overall, the excess addition of nitrogen is one of the most serious long-term problems threatening many embayments around Buzzards Bay.

Sources of anthropogenic nitrogen reaching coastal waters (also defined here as "nitrogen loading") include sewage treatment facilities, septic systems, acid rain, and fertilizer used on lawns, golf courses, and agricultural land. The nitrogen from these sources enters the Bay via streams, groundwater, direct deposition, and direct effluent discharge. Most of the nitrogen entering Buzzards Bay comes from sewage treatment discharges; the next highest amount is from home septic systems (refer to Table 4.1). In general, the effects of nitrogen inputs are localized near the sites of input. This is true even of large sewage treatment facility discharges such as New Bedford's, whose nitrogen inputs mostly affect waters within several miles of the outfall. Although such discharges are important and must be managed for nitrogen loading, Buzzards Bay has a large volume of water relative to nitrogen inputs and is flushed well enough that nitrogen from human activity does not affect the central portion of the Bay to the same degree that small embayments are affected. In Buzzards Bay, shallow, poorly flushed embayments are most sensitive to new nitrogen additions and are most likely to exhibit the symptoms and impacts described above; these are called "Nitrogen-Sensitive Embayments."

The relative importance of the various nitrogen sources in any embayment depends largely on the land use in the drainage basin that surrounds that embayment. Septic systems are the major source of nitrogen in most moderately developed embayments around Buzzard Bay. All septic systems, both properly operating and failing, release

large amounts of nitrogen as ammonia that is rapidly converted to nitrate. Nitrate in groundwater flows great distances without attenuation and with little chance of uptake by plants. For example, in Buttermilk Bay, septic systems account for more than 74% of the nitrogen entering this coastal embayment (Table 4.1). In some rural agricultural areas like Westport, fertilizers and wastes from livestock may be significant contributors of anthropogenic nitrogen. In an urban area like New Bedford, the sewage treatment facility and combined sewer overflows are the principal sources of nitrogen to surrounding coastal waters.

As noted above, it is important to realize that nitrogen inputs from a sizable discharge like the New Bedford sewage outfall do not contribute appreciable amounts of nitrogen to embayments more than a few miles from the discharge and thus does not affect most embayments in Buzzards Bay. Instead, each embayment is affected most by waterborne nitrogen conveyed through groundwater and stream discharges within that embayment. Consequently, any strategy to manage nitrogen inputs to an embayment or estuary must be directed toward those identified sources and land uses.

This action plan principally targets management of point and nonpoint sources of nitrogen at an embayment level, rather than baywide. Nitrogen loading from sewer outfalls is addressed in more detail in the action plan on Sewage Treatment Facilities.

Background

Impacts from excessive nitrogen-loading are mostly a localized phenomenon in the network of shallow embayments that line the shores of Buzzards Bay. Consequently, the Buzzards Bay Project has targeted these embayments for management action.

Shallow, poorly flushed embayments that have large land areas (and hence a potential for sizeable nitrogen inputs from development) with respect to the size of the receiving waters are most susceptible to adverse effects from nitrogen loading. The Project has developed embayment nitrogen loading limits based on embayment volume, flushing time, bathymetry, and water quality classification. Embayments will likely be critically impacted by nitrogen inputs as their drainage basins are fully developed.

DEFINITIONS

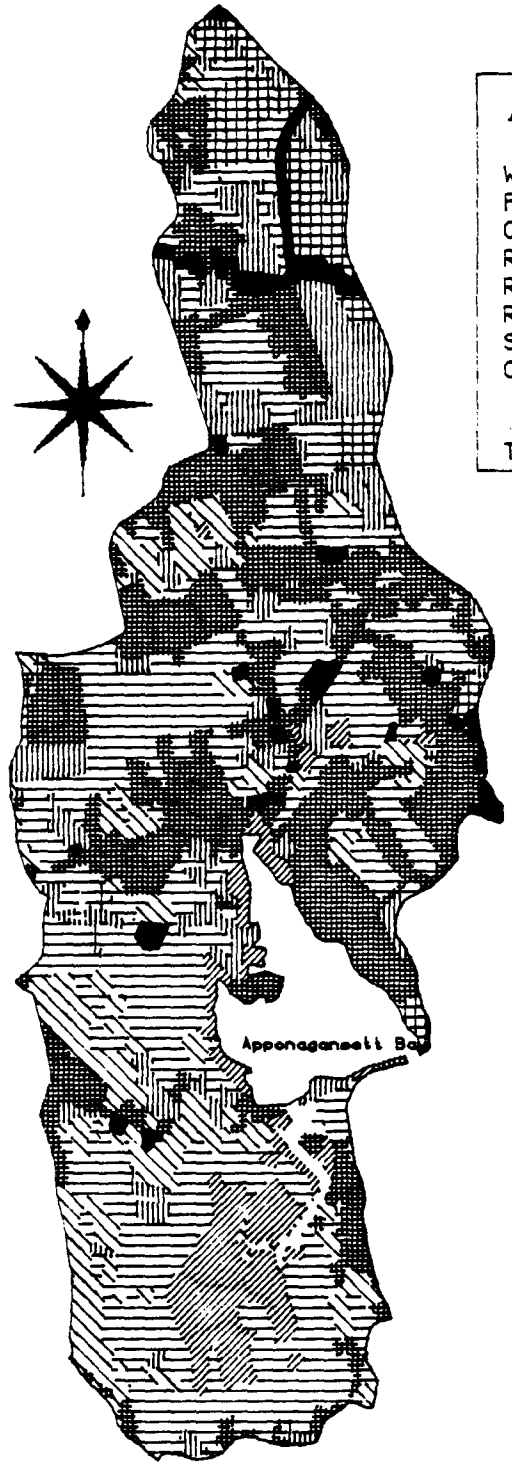
Nitrogen loading: inputs of nitrogen to receiving waters from anthropogenic sources. Excessive nitrogen loading leads to environmental degradation.

Nitrogen-sensitive embayment: any embayment that has the potential of being critically impacted by nitrogen loading from existing land use or future development. In general, shallow, poorly flushed embayments tend to be most sensitive to nitrogen loading.

Nitrogen impacted embayment: Any embayment whose resources and ecosystem have been adversely impacted by nitrogen loading.

Some embayments are already significantly impacted by excess nitrogen loading, either from existing land use, or from sources external to the drainage basin, such as sewage treatment facilities that collect waste streams from outside the embayment's drainage basin. These bays are defined here as "nitrogen-impacted embayments."

Nitrogen-sensitive embayments can be protected through a combined strategy of managing growth, reducing fertilizer use, and promoting treatment technologies capable of reducing nitrogen through a denitrification process. This



ACREAGE BY LAND USE GROUPINGS

Water	3.9
Forest	1753.2
Cropland/Pasture/Other Agric.	530.0
Recreational Uses/Open Land	557.2
Residential Lots < 1/4 Acre	258.4
Residential Lots > 1/4 Acre	1357.3
Salt Marsh/Non-Forested Wetland	316.6
Commerc'l/Industr'l/Transport'n Mining/Waste Disposal	137.9
TOTAL	4914.5

LEGEND

- Water
- Forest
- Cropland/Pasture/Other Agric.
- Recreational Uses/Open Land
- Resid'l - lots up to 1/4 acre
- Resid'l - lots more than 1/4 acre
- Salt Marsh/Non-Forested Wetland
- Commerc'l/Industr'l/Transportat'n/ Mining/Waste Disposal

Land use data compiled by U. Mass. - Amherst Resources Mapping Group from 1:25000 scale aerial photography; data supplied to Buzzards Bay Project (BBP) by MassGIS. Drainage basin boundary delineated by BBP with assistance and review from USGS staff. Map prepared by Buzzards Bay Project using ARC/INFO software.

Scale is approximately 1 inch = 1 mile.

Figure 5.1. Apponagansett Bay, Dartmouth, drainage basin and land use

strategy can similarly be applied to nitrogen-impacted embayments, but more dramatic solutions such as sewering portions of the drainage basin may be required to adequately lower inputs of nitrogen. Some communities have gone so far as to dredge harbor entrances to increase flushing rates, but this strategy is controversial because enlarging channels may increase tidal ranges, change salinities, limit light penetration, or result in significant changes in sediments deposition; these changes could have significant impacts on the distribution and abundance of many species.

To address problems caused by nitrogen-loading, some municipalities have already adopted bylaws and health regulations. One strategy has been to establish total nitrogen "critical concentrations" that should not be exceeded in embayments. These critical concentrations are often set to reflect existing development and existing total nitrogen concentrations so that embayments not yet impacted can be protected with more stringent standards, and polluted embayments do not worsen. The basis of this strategy is to determine whether nitrogen from a proposed development will raise the existing total nitrogen concentration above critical limits. One problem with this approach, however, is that total nitrogen is not always an adequate measure of existing nitrogen contributions to the watershed and receiving waters. For example, nitrogen entering groundwater from septic systems may not reach coastal receiving waters for many years or even decades because groundwater typically travels 1-3 feet per day in the region, and inland portions of some watersheds may be miles from shore. Hence total nitrogen concentrations in seawater may not be representative of existing land loadings. Furthermore, there is debate about the adequacy of certain methods currently used for measuring total nitrogen in seawater, as well as about the location and number of sampling stations required, and the frequency at which they must be sampled. Finally, not all nitrogen that enters the Bay remains in the water column. Shallow bays may accumulate dense layers of drift algae, which would maintain low nitrogen concentrations in the water, thereby failing to reflect the increased loading.

For these reasons, the Buzzards Bay Project is recommending an alternate approach similar to that used to protect large well-recharge areas. That is, decisions on development should not be based on projected elevations of existing concentrations of nitrogen in coastal waters. Instead, the nitrogen contributions allowed from the watershed in the future would be determined by comparing the mass loading rates from existing development with the critical mass loading limits set for each embayment. The critical mass loading limit chosen would be set to prevent critical impacts to the health of that embayment and based upon the volume and flushing time of water specific to each embayment. These limits can then be reflected in zoning bylaws and health regulations. In other words, these nitrogen mass loading limits would be the basis for a nitrogen "carrying capacity" specific to each bay and used for setting lot size, loading rates per acre, or other management strategies.

Technical basis of the proposed strategy

The response of coastal ecosystems to excessive anthropogenic contributions of nitrogen is complex and varied but is most pronounced in embayments with restricted water exchange or where the amount of nitrogen added is large compared to the volume of the receiving water. Perhaps the most overriding feature that defines the response of coastal ecosystems to nitrogen loading is the bathymetry of the receiving waters, particularly the area of bottom within the photic zone.

In the Project's approach, anthropogenic nitrogen mass loading limits are established for embayments to minimize the risk of critical environmental degradation. These limits were chosen based on the best available scientific information from experimental mesocosm manipulations, as well as ecosystem scale case histories where adverse impacts have been documented and nitrogen loadings estimated. Because nitrogen loading rates can be meaningfully characterized as either annual loadings per unit area or loadings per unit volume during the water turnover time, both methods are used to establish nitrogen loading limits. The proposed loading rate limits are tiered to reflect existing water quality classifications as well as bathymetric and hydrographic features of the embayment.

Application of this nitrogen loading management strategy requires that several features of the embayment and its drainage basin be accurately determined including, embayment volume, bathymetry, turnover times, delineation of the surrounding drainage basin, and quantification of existing and potential future nitrogen load from point and non-point sources. The methods for determining each of these parameters are described in Costa et al. (1991). To calculate anthropogenic nitrogen loads, a parcel level land-use analysis is required using a well defined set of nitrogen loading assumptions. These are given in Appendix D.

Tiered loading rate limit

The Buzzards Bay Project is recommending that environmental regulators adopt the following nitrogen loading rate limits as the basis of their strategy to manage nitrogen inputs to coastal waters. These rate limits are embayment specific because they account for the volume and flushing rate of the receiving waters, and they are also tiered to reflect state water quality standards, bathymetry and other special designations. Special designations include ACECs and Outstanding Resource Areas under the Anti-degradation Provision of the Clean Water Act. Shallow embayments are defined as those with 40% or more of their area less than 1 m MLW or having a mean depth at half-tide no greater than 2 m.

Table 5.1. Recommended nitrogen loading limits for coastal embayments

Embayment	Waters classified SB	Waters classified SA	SA waters desig. Outstanding Resource Waters
Shallow			
-flushing: 4.5 days or less	350 $mg/m^3/Vr$	200 $mg/m^3/Vr$	100 $mg/m^3/Vr$
-flushing: greater than 4.5 days	30 $g/m^2/y$	15 $g/m^2/y$	5 $g/m^2/y$
Deep			
-select rate resulting in lesser annual loading	500 $mg/m^3/Vr$ or 45 $g/m^2/y$	260 $mg/m^3/Vr$ or 20 $g/m^2/y$	130 $mg/m^3/Vr$ or 10 $g/m^2/y$

Note: Vr= Vollenweider flushing term, defined by the equation $Vr=r/(1+sqrt(r))$. When used above, should be read as loading during the "Vollenweider-term adjusted flushing period." Shallow is defined as 40% or more of area less than 1 m or having a mean depth of 2m or less.

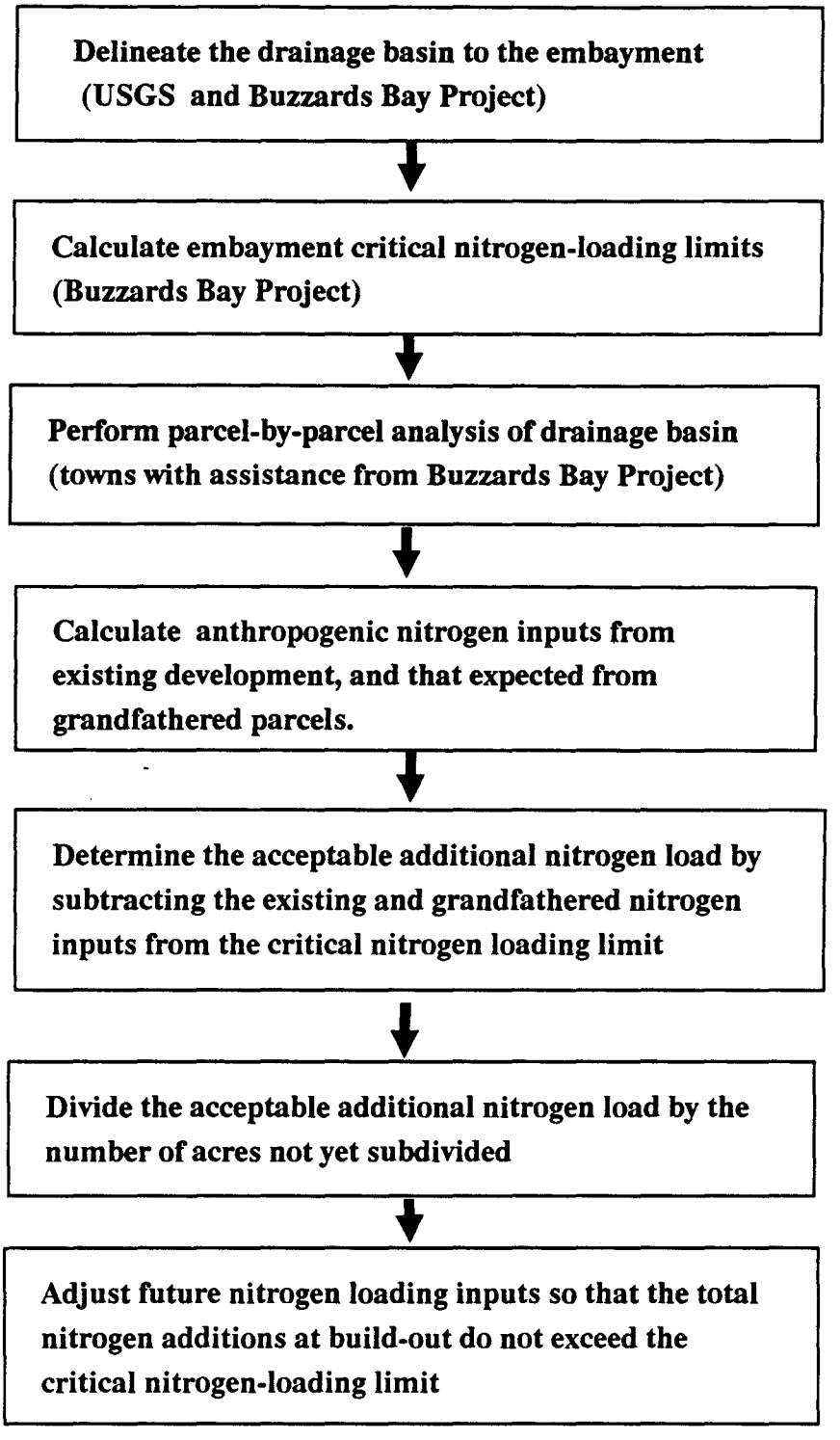


Figure 5.2. Nitrogen loading program for sensitive embayments not yet critically impacted

The Buzzards Bay Project has conducted a preliminary assessment of Buzzards Bay embayments to determine whether management action is likely to be required to meet proposed nitrogen loading limits (Table 5.2). Based on this information, a town can decide whether it wishes to select an embayment and its drainage basin for more detailed assessment and possibly management action. Once an embayment is selected for a more detailed assessment, the community or communities must assess existing nitrogen contributions from the existing land use and identify the ecological, economic, and aesthetic values of embayment resources. Figure 5.1 shows the delineated drainage basin and land use around Apponagansett Bay, an embayment being evaluated by the Buzzards Bay Project and the town of Dartmouth.

The Project is recommending that towns select appropriate bays for this management strategy to prevent anthropogenic nitrogen inputs from reaching the recommended loading limits (see flow diagram in Figure 5.2 and worksheet in Appendix D, Part 1). In practical terms, the drainage basin around each embayment would have a specific limit (# pounds of nitrogen per year) that could not be exceeded (Table 5.2).

This strategy has several advantages. Growth would be managed through more effective planning and zoning; less reliance would be placed on individual residential permit review. The permit-review process could instead be used to focus on subdivisions and large commercial projects and determine whether the proposed development would exceed the designated nitrogen contributions permissible per unit land area (refer to Appendix D, Part 4). If exceeded, developers would then need to devise innovative solutions to limit nitrogen — such as reducing lawn sizes and fertilizer use, purchasing or setting aside open spaces, or installing private treatment plants that remove nitrogen.

The first step in this management strategy is to estimate existing nitrogen loading to the embayment from development within the surrounding drainage basin. A nitrogen loading worksheet is used for this purpose (see Appendix D). The estimate is adjusted for flushing and volume of the embayment and is compared to the embayment's designated nitrogen-loading limit. The next step is to conduct a developable lot, or "buildout," analysis. This will determine the number of additional residential and commercial units that are expected to be constructed under current zoning in undeveloped parts of the basin. This analysis can be conducted for an entire municipality as well as for any geographic subset. The Buzzards Bay Project completed such a buildout and nitrogen-loading analysis of the drainage basin to Buttermilk Bay. The Project then worked with the towns of Plymouth, Wareham, and Bourne to change zoning in a way that would limit excess nitrogen additions and prevent over-enrichment of the embayment. This effort resulted in a prototype nitrogen management district for other nitrogen-sensitive embayments in Buzzards Bay.

Major Issues

The methods for calculating present and future nitrogen loadings have been developed. Although initial outlays of manpower and funding are required to obtain these data, as well as to characterize hydrologic features, this nitrogen loading management approach establishes an objective process for state and local managers to manage nitrogen inputs from both point and non-point sources in coastal embayments.

Table 5.2. Preliminary assessment of nitrogen loading to some Buzzards Bay embayments[1]

BUZZARDS BAY EMBAYMENT	Existing N Load (kg/y)	Future N Load (kg/y)	Classif. Goal	Recommended Load limit (kg/y)	Preliminary Recommended action
Acushnet River New Bedford inner	333,000	360,000	SB	256,000	Manage Growth & Remediation
Apponagansett Bay, inner	52,000	63,000	SA	35,700	Manage Growth & Remediation
Buttermilk Bay	41,300	57,600	SA	55,200	Manage future growth
Hen Cove	9,100	10,500	SA	5,600	Manage Growth & Remediation
Marks Cove	6,100	7,500	ORA	21,800	no action
Mattapoisett upper+lower	49,000	106,000	SA	86,000	Manage future growth
Inner Nasketucket Bay	44,300	51,100	ORA	107,000	no action
Onset Bay	29,400	40,000	ORA	37,000	Manage future growth
Phinneys Harbor	17,700	25,900	ORA	127,000	no action
Pocasset River	12,700	32,700	ORA	21,500	Manage future growth
Quisset Harbor	1,500	1,900	ORA	40,000	no action
Red Brook Harbor	3,000	6,000	ORA	18,600	no action
Sippican Harbor upper harbor	12,600	15,600	SA	25,500	no action
Slocums River	97,000	178,000	SA	29,600	Manage Growth & Remediation
Squeteague Harbor	8,500	16,200	SA	31,000	no action
Wareham River	94,200	222,000	SA	37,400	Manage Growth & Remediation
West Falmouth Harbor	24,000	31,000	SA	37,200	no action
Westport River, East Branch	123,000	219,000	SA	120,300	Manage Growth & Remediation
Westport River, West Branch	27,900	56,000	ORA	26,600	Manage Growth & Remediation
Weweantic River	144,000	291,000	SA	47,600	Manage Growth & Remediation
Widows Cove	200	800	ORA	28,000	no action
Wild Harbor	8,000	9,400	ORA	30,400	no action
Wings Cove	2,001	3,700	ORA	28,000	no action

[1]This table is a preliminary assessment of nitrogen loading based on the limits recommended in Table 5.1 and embayment hydrologic features and estimated loadings calculated from landuse reported in Costa et al., 1991 and based on MassGIS landuse statistics and other sources. Because these are preliminary estimates, it is recommended that environmental managers consider more detailed assessments before implementing any specific actions or determining that no action is required, particularly where predicted loads are near recommended limits. Water quality classifications are recommended goals, not actual existing classifications. SA = high water quality areas that have excellent habitat and ecological and aesthetic values, SB =areas that have good habitat and ecological and aesthetic values, shellfish areas are restricted and require depuration, ORA = Outstanding resource areas with exceptional habitat, aesthetic, and ecological values.

Future nitrogen management strategies may be based on embayment-specific nitrogen limits determined from computer models based on a large number of variables. This approach has not yet been developed and the proposed tiered approach is the most practical strategy based upon existing scientific understanding of coastal ecosystem response to nitrogen loading. Nonetheless, the proposed loading rates in table 5.1 should not be used if it can be well documented that a more appropriate limit be selected. For example, if it has been documented that an embayment showed catastrophic decline of eelgrass habitat or shellfish abundance at a certain time in its recent history – and that it has been demonstrated that this loss was due to nitrogen loading, then an appropriate loading limit goal for remediation activities should be set for nitrogen impact rates before the catastrophic degradation.

The major responsibility for implementation will be at the town level, where a shortage of expertise may present a problem. This situation can be alleviated if the Project and state, federal, and regional agencies provide the municipalities with the information and tools necessary to carry out nitrogen-management programs. The towns are still responsible for conducting buildout analyses, but this cost in most cases is nominal ($5,000-$8,000). The cost of administering a nitrogen-management program, a bylaw, or both is also nominal.

DEP can adopt these loading limits by including them in the Massachusetts Surface Water Quality Standards. In this way, permitted discharges can be required to comply with these limits. The standards proposed here are meant as minimum standards of protection, and municipalities or state agencies may choose more stringent standards. In determining which embayments should be designated for special protection, the regulatory authorities must assess both existing nitrogen inputs and identify the ecological, economic, and aesthetic values it wishes to protect.

If nitrogen inputs to an embayment already exceed critical limits and that embayment has ecological or economic resources and values a community wishes to protect, the problems faced by a community trying to reduce nitrogen impacts are more difficult, but there are still solutions. Both short term and long term goals must be established with the eventual result that nitrogen inputs from future growth must be limited, and existing inputs must be reduced. Thus, impacted embayments must be protected and restored through a combined strategy of managing growth, reducing fertilizer use, promoting advanced onsite sewage treatment technologies capable of reducing nitrogen, and more dramatic long-term solutions such as sewering portions of the drainage basin, and where appropriate upgrading some public wastewater treatment facilities to include nitrogen removal.

For example, stringent growth-management strategies and new nitrogen controls must be put in place to ensure that nitrogen export from any future growth is consistent with long term goals for remediation. To reduce existing nitrogen inputs, sewering of homes in the embayments drainage basin is the approach most likely to result in reduced future loadings, but this strategy must include safeguards to prevent the sewering of areas in which growth should be discouraged such as near wetlands, critical areas, and beach areas that receive wave action during storms (the velocity zone). The sewering solution is most suitable when the existing facility provides denitrification (convert dissolved inorganic nitrogen to its harmless atmospheric form) or some other capacity to remove nitrogen (e.g., spray irrigation

and assimilation of N in biomass as in Falmouth), and is not being merely disposed in another sensitive estuary or waterway. Another option to reduce inputs is to require that septic systems be upgraded with denitrifying systems when these are approved for permits, or to connect homes in sensitive areas to small, advanced sewage treatment facilities. The costs of sewering or replacing septic systems within a drainage basin is very high and costs will vary among embayments. Strategies such as implementing best management practices in agricultural areas and reducing fertilizer use on lawns and golf courses, particularly in coastal areas, will help as well.

It is true that the costs associated with the traditional methods of wastewater denitrification and other nitrogen removal techniques are still exorbitant. As state and federal funding for large public treatment facilities continues to decrease, towns must not rely solely on typical large-scale structural remedies for controlling excess nitrogen loading to sensitive embayments. Alternative technologies such as denitrifying septic systems, biological uptake, and small-scale tertiary treatment facilities must be fully researched through state and federal programs and accepted as viable approaches for reducing nitrogen. Of course, some experimental denitrifying systems constructed in the state cost more than $15,000 per unit, more than double the cost of a standard Title 5 system but these costs are expected to drop considerably if these systems were granted permits for general use and more were manufactured and installed.

Goals

1. Ensure that no beneficial water uses[1] will be lost, nor will ecosystems be adversely affected by excessive contributions of nitrogen to any embayment within Buzzards Bay.

2. Restore any beneficial water uses and ecosystems lost or impacted by the excessive contribution of nitrogen to any embayment within Buzzards Bay.

Objectives

1. To control the amount of nitrogen entering Buzzards Bay as a whole.

2. To limit new additions of nitrogen entering nitrogen-sensitive embayments.

3. To reduce the amount of nitrogen entering nitrogen-impacted embayments.

4. To develop and support the use of alternative technologies that achieve denitrification of wastewater.

[1] Beneficial uses are those listed in Massachusetts Water Quality Standards, see entry in Glossary.

5. To develop a monitoring program that can assess the effectiveness of management actions taken and determine changes in water quality and health of coastal ecosystems (A description of this monitoring strategy is included in Volume III).

CCMP Commitments

Department of Environmental Protection (DEP)

1. DEP will adopt regulatory standards for nitrogen inputs to coastal embayments in its 1993 revision to State Water Quality Standards.

Target date: 6/93.

Interim Actions: By 12/92 DEP will adopt a regulatory policy on nitrogen loading to coastal waters and field test it. DEP will work with the town of Marion and the Buzzards Bay Project to evaluate nitrogen inputs from point and non-point sources to Aucoot Cove. Based on these results, the findings and recommendations of the Buzzards Bay Project, and related research activities at the Waquoit Bay National Estuary Research Reserve, DEP will adopt appropriate nitrogen discharge limits for Marion's sewage treatment facility. DEP's Antidegradation Task Force will use this information to adopt an interim policy on nitrogen control and will develop a nutrient water quality standard. EPA and the Buzzards Bay Project will develop a list of nitrogen-sensitive embayments in Buzzards Bay (using embayment flushing rates and other criteria developed by the Project) to help DEP determine where to apply the state standard.

2. DEP will actively promote the development and acceptance of cost-effective alternative technologies for wastewater denitrification by assigning additional personnel to overview pilot projects.

Target date: 12/91

Environmental Protection Agency (EPA)

1. EPA, through its Near Coastal Waters Program, will construct and evaluate approximately four experimental denitrifying onsite wastewater disposal systems in Buzzards Bay municipalities.

2. EPA will contribute a water quality specialist's skills in working on nitrogen issues within the context of DEP's Anti-Degradation Task Force.

Target date: Beginning 1991

Buzzards Bay Municipalities

Per Project recommendations, Bourne, Plymouth and Wareham have adopted an intermunicipal overlay district around Buttermilk Bay to manage future nitrogen inputs in the surrounding drainage basin. These towns have amended their zoning bylaws so that future development will not exceed proposed nitrogen loading limits. They will also adopt, where appropriate, other bylaws and regulations to meet nitrogen loading goals. Dartmouth will pursue development of a nitrogen loading strategy for the Apponagansett Bay Watershed. Westport will pursue a nitrogen loading strategy for the Westport Rivers.

Target date: 9/91-9/92.

Other Recommended CCMP Actions

1. Municipalities should adopt nitrogen-loading bylaws, subdivision regulations, or health regulations to implement nitrogen-management programs around appropriate embayments.

Target dates: technical basis, 9/92; community action, as appropriate.

The Buzzards Bay Project (BBP) will coordinate with the scientific community and with state, federal, and regional agencies to provide municipalities with all the tools and building blocks to implement local nitrogen-management strategies. The BBP, with the assistance of the U.S. Geological Survey, has delineated preliminary drainage areas for nitrogen-sensitive embayments and incorporated these boundaries into the MassGIS system. The BBP has also worked with the scientific community to define flushing rates for all major embayments in Buzzards Bay. The BBP will develop criteria for identifying nitrogen-sensitive embayments and present this information to the communities. The BBP will work with planners and scientists to develop generally accepted methods for determining nitrogen loading through a "build-out" analysis. The BBP will work with the scientific community to establish theoretical critical loading rates for each nitrogen-sensitive embayment.

Using this information, the communities in Buzzards Bay must then decide which embayments they wish to restore or protect from future degradation. These communities would then adopt nitrogen-loading bylaws, subdivision regulations, or health regulations to implement nitrogen-management programs. Technical assistance on bylaw development and implementation will be provided by the BBP and the Southeastern Regional Planning and Economic Development District (SRPEDD). The U.S. Soil Conservation Service (SCS) will advise the communities on best management practices to reduce nitrogen from agricultural sources and on helping growers to implement these best management practices.

2. The Cape Cod Cranberry Growers' Association (CCCGA) in cooperation with the Plymouth County Conservation District should be encouraged to continue implementation of its Water Quality Protection Initiative.

Although not considered a significant wide-spread problem, continuing efforts to reduce fertilizer and pesticide discharges from cranberry bogs should be encouraged and supported. The primary initiative related to this goal is the implementation of the CCCGA Surface Water Protection Strategy. This initiative involves conducting on-site evaluations of water management systems and providing growers with specific recommendations, in accordance with Soil Conservation Service standards for decreasing the potential for nutrient and pesticide discharges. Other components of the strategy include comprehensive grower education and research related to new technology and Integrated Pest Management.

3. State and federal agricultural programs should coordinate efforts to assist farmers in implementing best management practices to control nitrogen release from agricultural land.

To the extent possible, the USDA Hydrologic Unit Plan for Buzzards Bay should coordinate its activities to implement Best Management Practices with similar efforts

of the CCCGA, the Plymouth County Conservation District and the Buzzards Bay Project to avoid duplication of efforts and assure that maximum benefit is derived from these efforts.