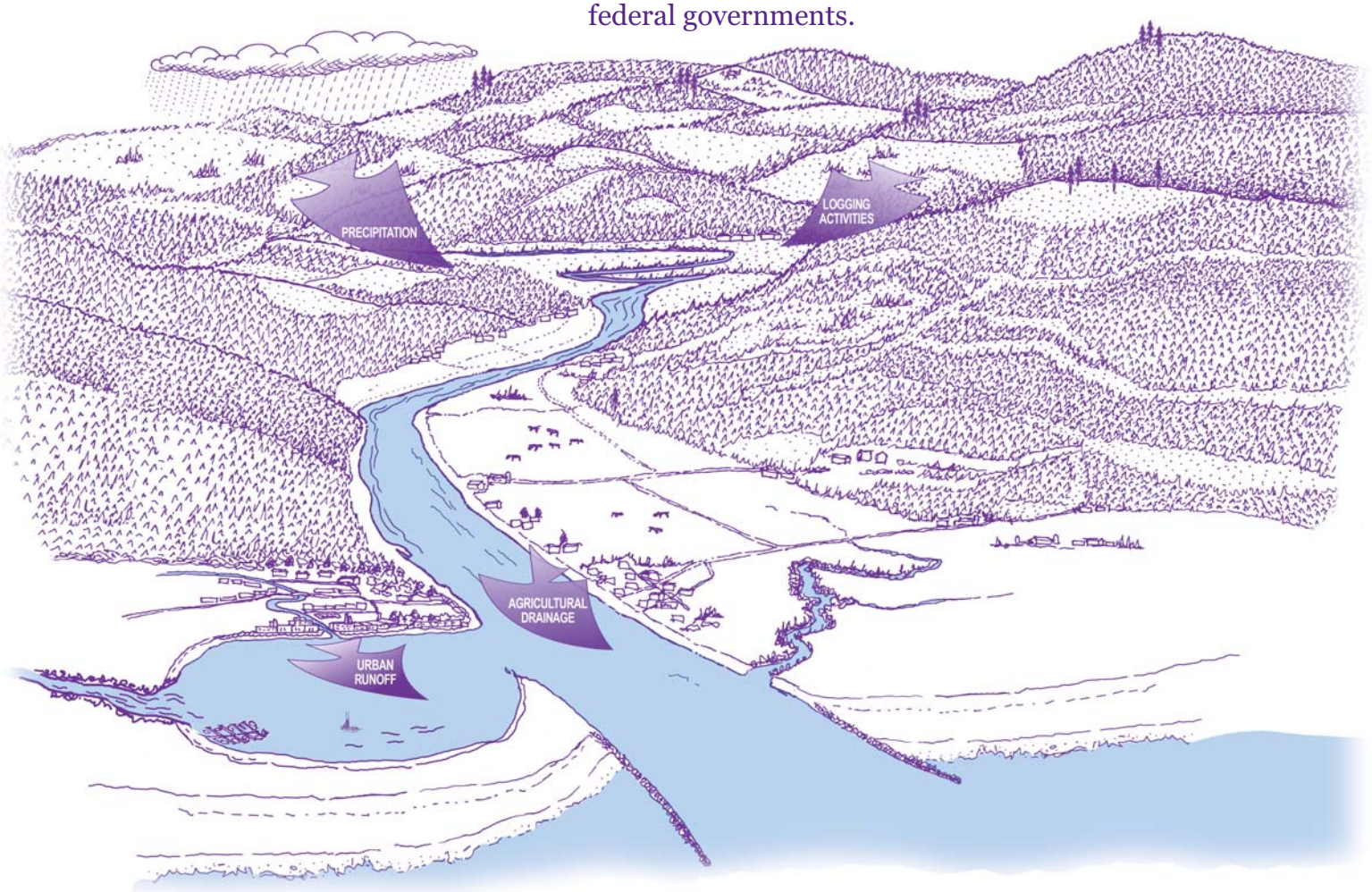
NONPOINT SOURCE POLLUTION
and Pacific Northwest Estuaries

"When impervious surfaces cover more than ten percent of a watershed, the rivers, creeks, and estuaries they surround become biologically degraded."

—Dana Beach, Pew Oceans Commission, 2002

Oregon's coastal rivers drain many square miles of forests, farms, ranches, suburbs, industrial areas, and cities before they reach the Pacific Ocean. Most of these rivers, which range from the mighty Columbia River in the north to the tiny Winchuck River near the California border, deliver their water to estuaries, biologically rich mixing zones located at the interface between the rivers and the sea. But on their way to the sea, the rivers gather sediments and pollutants that can contaminate the estuaries and damage the communities of plants and animals that thrive there. These include the effluents of pulp mills, factories, and other industrial outfalls, as well as discharges from municipal sewage-treatment plants. They also contain more troublesome nonpoint source (NPS) pollution. Nonpoint source contaminants have many diffuse origins, but the biggest causes of NPS pollution are stormwater runoff in cities and agricultural drainage in rural areas. Reducing nonpoint source pollution in estuaries can be accomplished in part through the individual efforts of coastal residents, with assistance from county, state, and federal governments.



NPS Pollution Threatens Estuarine Water Quality

The Clean Water Act of 1972 and the programs it has spawned have been tremendously successful in cleaning up America's lakes, streams, and estuaries. In recent decades, the United States Environmental Protection Agency (EPA) made great strides to reduce the amount of pollutants reaching our coastal waterways from industrial plants, municipal waste-water treatment facilities, and other identifiable sources. The EPA established limits on the discharge of these point-source pollutants through a regulatory permit system.

Nonpoint source (NPS) pollution has been more difficult to control. A variety of pollutants continue to evade effective control measures. Excessive sediments, animal wastes, fertilizers, pesticides, pathogens, heavy metals, toxic chemicals, oil, and other contaminants, issue from scattered and unidentifiable sources. These NPS pollutants find their ways overland and underground to our lakes, creeks, rivers, estuaries, and groundwater. They are carried by runoff from rainfall, snowmelt, irrigation, lawn watering, and from household tasks such as washing the car or cleaning the dog's kennel.

Among the varied sources of NPS pollution, the most significant on the West Coast are logging activities, agricultural drainage, malfunctioning septic systems, urban runoff, construction projects, and boating. The very nature of NPS pollution makes management difficult. Since regulatory agencies can't identify individual sources, they can't measure and monitor the effects of NPS pollution, issue permits, or enforce compliance.

Often, the effects of NPS pollution go unnoticed by the casual observer. From time to time, reports of major fish kills, or closures of shellfish beds due to contamination, appear in the headlines, but public interest quickly wanes once the story is over. Nevertheless, ecological damage occurs more often and at greater levels than most people might think. Chronic pollutant overloads degrade water quality and harm resident plants and animals. Some aquatic organisms may become restricted to less-polluted sites or disappear altogether, while others survive to pass toxic substances up the food chain to fish, birds, mammals, and humans.

Nonpoint source pollution remains a serious problem. In fact, the EPA estimates that at least 50 percent of all water-quality problems in the U.S. stem from nonpoint sources. The EPA considers NPS pollution to be the nation's greatest threat to clean water.

NPS Pollution Runs Downhill in the Watershed

As a coastal river descends from its headwaters and moves toward the estuary it gathers runoff from tributaries and adjacent lands. As the volume of water grows and the gradient of the stream decreases, its current slackens. Slower currents lack the energy to suspend larger, heavier sediments in the water column, so these particles drop out and settle to the bottom. By the time the river reaches the lowlands and broadens into the estuary, only the smallest sediments remain suspended in the water. Were it not for the saltwater input of tides and storm surges, most of these remaining sediments and pollutants would flow out to sea.

Twice daily, ocean tides, bearing sandy marine sediments and nutrients, flood into the estuary with sufficient force to slow, stop, and even reverse the river's current. Coinciding with the slowing of tidal and riverine currents, smaller and smaller particles rain out and settle in the estuary. In this manner, the estuary builds and maintains its own tidal flats and salt marshes. Estuarine vegetation contributes to sediment deposition, because water currents are further dampened as they flow through marshes, eelgrass beds, and algal mats.

Salt water itself directly influences how readily the sediments settle out. In fresh water, particles of sediment are negatively charged and tend to repulse one another. Salt water can neutralize the negative charges, allowing the particles to clump together and settle to the estuary bottom in a process called flocculation. As the clumps become larger they provide surface areas for food to accumulate and become available for estuarine animals.

These same processes can harm plant and animal populations when the water enters the es-

tuary bearing sediment and nutrient overloads, chemical residues, oil, and other pollutants. Consequently, finding ways to reduce the input of nonpoint source pollution is essential to the health of the estuary.

NPS Pollution Has Varied Sources and Consequences

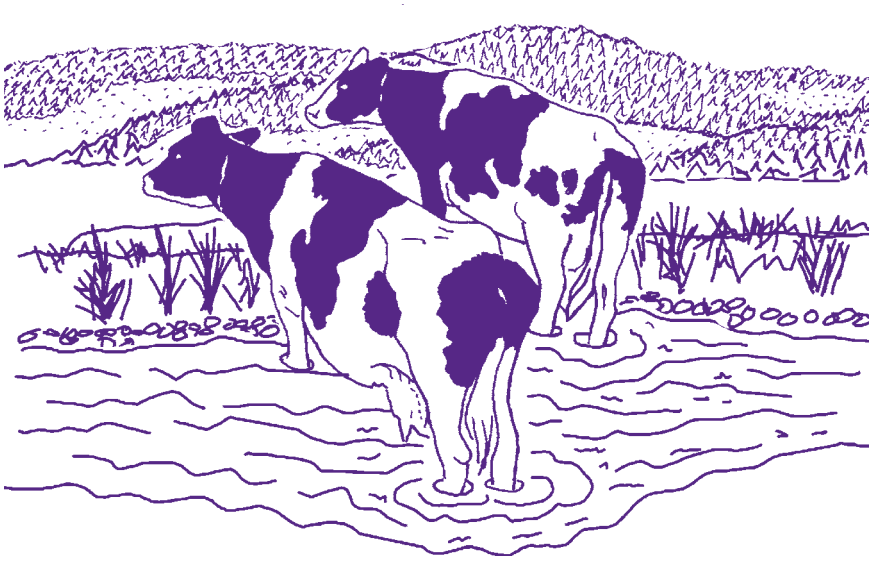
Nonpoint source pollution is widespread and can enter waterways from various sources throughout the watershed. It washes from upland forests and lowland farms, rural residential areas, city centers, golf courses, construction sites, and anywhere water moves freely over contaminated surfaces. Navigable waterways and marinas within the estuary itself are also susceptible.

Logging Activities

Several causes of nonpoint source pollution are associated with logging and forestry practices. They include timber harvesting in riparian areas, the removal of streamside vegetation, the use of heavy machinery to prepare for planting, and the use and construction of logging roads. These activities can lead to soil erosion and stream sedimentation. Poorly engineered roads account for up to 90 percent of sediment that erodes from forests. Logging in stream corridors reduces shading and increases water temperatures.

Agricultural Drainage

Nonpoint source pollution from agricultural operations is the leading cause of water-quality degradation in America's lakes and rivers. After urban runoff and municipal point-source pollution, it is also the third-largest threat to the nation's estuaries.



Contamination from livestock can be a major source of NPS pollution.

Livestock grazing along streams can trample and kill streamside vegetation, damage streambeds, and accelerate erosion. Wind and water can also transport topsoil from crop fields to any nearby lake or stream, resulting in excessive sedimentation, which harms aquatic plants and animals.

As water from rainfall and snowmelt flows across agricultural land it gathers pollutants—such as fertilizer residues, pesticides, and pathogens—and carries them to nearby drainage ditches, creeks, and rivers. This runoff can also seep underground and introduce pollutants into the groundwater, contaminating drinking water.

Not all irrigation water is taken up and used by crops. Some evaporates, while the rest runs over or into the ground, reaching drainage ditches or groundwater. During dry weather, when irrigation is most intensive, stream levels and flows are usually low. Polluted irrigation runoff can exacerbate the already stressful conditions of low water and high temperatures, with disastrous results for both adult and juvenile fishes and other animals and plants.

Nitrogen-based synthetic fertilizers can introduce excess nitrates to agricultural runoff. In the estuary, nutrient-rich runoff promotes the rapid growth and subsequent die-off of algae and other aquatic vegetation. In a process called eutrophication, life-giving oxygen is depleted by the microbes that thrive on the excess nutrients. Low oxygen conditions can asphyxiate fish and other aquatic animals.

One of the most harmful pollutants transported to waterways by agricultural drainage is ammonia, a by-product of fertilizer that is toxic to fish and other organisms. Ammonia is also abundant in animal wastes, along with fecal coliform bacteria and other

contaminants. These can be carried in the runoff from dairy farms and cattle feedlots, making the proper management of animal wastes an important undertaking in agricultural areas.

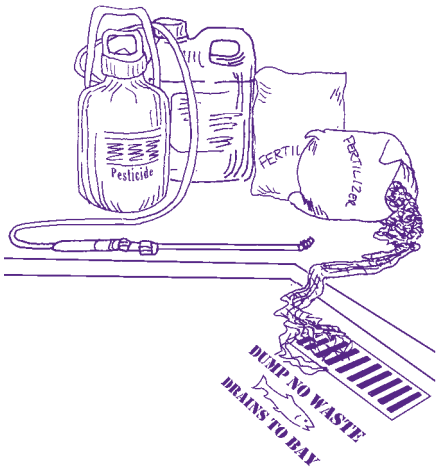
Urban Runoff

Since prehistoric times, people have been attracted to banks of coastal rivers and the shores of estuaries, drawn by abundant food sources, ease of transportation, readily available building materials, and the moderate coastal climate. Presently, more than two thirds of all Americans live on or within 50 miles of the coast.

Development and dense population of coastal areas has made urban runoff the main source of pollution in estuaries. Impervious surfaces dominate the urban landscape. Streets, highways, bridges, parking lots, driveways, sidewalks, patios, and roofs concentrate runoff and speed it toward drainage ditches, creeks, and storm drains, carrying a multitude of contaminants.

The problem is compounded when wetlands are filled for the construction of houses, businesses, municipal and industrial complexes, and parking lots. These developments displace fields, meadows, and woodlands, often spreading right up to the edges of estuaries. Although construction projects are relatively short-lived, their effects on the environment can be long-lasting and detrimental. Soils eroded from construction sites can find their way to lakes, creeks, rivers, and estuaries, where they damage or displace aquatic organisms and modify habitat. Often during construction, builders unknowingly pave over or eliminate important vegetated natural areas, unpaved swales, and protective berms, which can reduce NPS pollutions by trapping runoff and filtering out pollutants.

When water tainted with cleaning fluids, detergents or petroleum enters a storm sewer, it carries those pollutants directly to the bay or river.



Rainfall in the typical urban landscape accumulates on impervious surfaces and quickly runs off in large amounts to nearby drainage systems, instead of slowly percolating into the ground, as in grassy fields and woodlots. When it enters a stream, the fast-flowing runoff can damage streamside vegetation, erode stream banks, and alter channels. High levels of runoff can also destroy fish habitat and increase sediment loads bound for the estuary. Moreover, rain draining from roofs and paved areas warms quickly and can raise water temperatures in urban streams, threatening the survival of native fish, especially salmon.

Paved surfaces are contaminated by pollutants emitted from vehicle tailpipes and the liquids that ooze and drip from engines, radiators, transmissions, and crankcases. Motor oil, grease, antifreeze, brake fluid, and other toxic substances collect on urban streets,

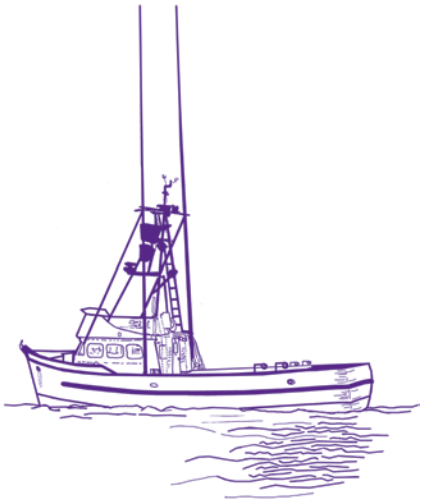
bridges, and parking lots, forming tarry residues that lie waiting for the next rainfall to carry them into the estuary.

Residential areas add lawn-care products, household chemicals, and other pollutants to the mix. Many homeowners reason that if small amounts of fertilizer and pesticides are good for the lawn, then large amounts must be better, so they apply excess chemicals, leaving residues to run off when it rains. Some pour all manner of poisons—cleaners, solvents, thinners, and other toxic substances—down storm drains. Weekend mechanics similarly discard old motor oil and antifreeze. All of this eventually makes its way to the estuary, where it spreads over vast areas and degrades aquatic life. One quart of motor oil, for example, can pollute 250,000 gallons of estuary water; the discard from a single oil change can pollute more than a million gallons.

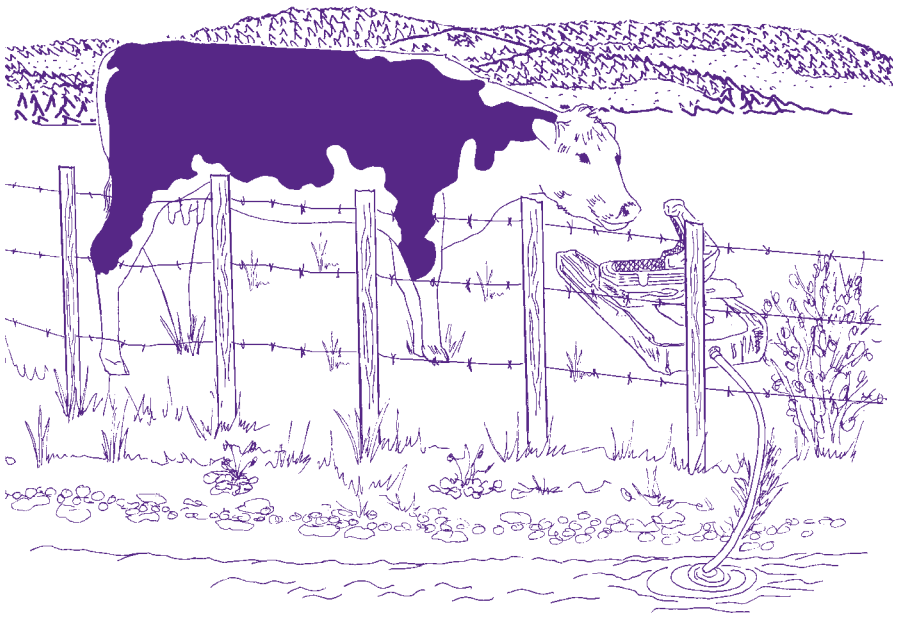
Marinas and Boating

Navigable estuaries are naturally attractive to recreational boaters and provide safe harbors for commercial fishermen. Marinas, fuel docks, and boatyards are built right on the water, and adjacent shoreline offers a convenient location for buildings, maintenance and repair facilities, boat launches, and parking lots. Marinas are usually located in populated areas and are vulnerable to the same kinds of nonpoint source pollution associated with urban runoff. Additionally, these waterfront facilities have the potential for creating pollution problems that are unique to boating activities.

Most marinas and boatyards are either situated in the quiet backwaters of estuaries, or they are well protected from wind and waves by substantial breakwaters. Such poorly flushed areas are easily damaged by pollution, including sewage discharge from boats, oil and fuel leakage or spills, and runoff from adjacent impervious surfaces. Boat repair, maintenance, cleaning, and painting can introduce oil, grease, solvents, paint, and other toxic substances to the estuarine environment.



Boaters bear even greater responsibilities for reducing NPS pollution in estuaries and waterways.



By building streamside fences and providing off-channel watering sites for their cattle, livestock managers can protect their streambanks from erosion and reduce NPS pollution.

POLLUTION SOLUTIONS: A Watershed Approach

For a variety of reasons, it's important to take a watershed-management approach to dealing with nonpoint source pollution. The overall health of the watershed is only as good as the well-being of its many components. Protecting water quality in the estuary below will be a futile effort if the sources of pollution in the watershed up above are not addressed.

Rural Areas

Small-farm operators and other rural residents bear special re-

Total Maximum Daily Load

Section 303(d) of the Clean Water Act directs each state to determine which lakes, streams, and estuaries do not meet clean-water standards. The state then prepares a list of water quality-impaired streams for the US Environmental Protection Agency (EPA) and submits an updated list every two years. These lists identify water quality problems, but not their causes.

The EPA uses Total Maximum Daily Loads, or TMDLs, to regulate these streams. A TMDL specifies the maximum daily amount of a particular pollutant a stream can absorb without violating state water quality standards. Once a TMDL is established, the state apportions responsibility for reducing the pollution to the various sources, point, non-point and natural, that contribute to it.

In Oregon the Department of Environmental Quality sets limits for nonpoint sources identified in locally-developed water quality management plans. These management plans are developed for agricultural lands in cooperation with private landowners. State forest practices rules protect water quality on private forest land. Federal agencies, such as the Bureau of Land Management and Forest Service, are responsible for developing watershed-management plans for federal lands. Cities and counties, working with local watershed councils, develop management plans for urban and rural areas that aren't under the jurisdiction of other government agencies.

The DEQ plans to develop TMDLs for all water bodies on Oregon's 303(d) list and submit them to the EPA for approval by 2007.

sponsibilities as stewards of the landscape. They also enjoy opportunities to make positive contributions to water quality, both on their own land and beyond their property lines.

Those who keep livestock can fence off ditches and streams to prevent livestock from trampling stream banks and destroying adjacent vegetation. Overgrazing can be prevented by proper pasture maintenance, rotation, and soil renovation techniques. Healthy pastures enhance the land's ability to absorb runoff. Careful application of fertilizers, pesticides, and manure to pastures, crops, gardens, and lawns prevents excess amounts of chemicals from accumulating in runoff.

Seepage from malfunctioning septic systems is another contributor of NPS pollution in rural areas. Upgrading a failing or improperly designed system, or installing a new one, requires a permit and the services of a licensed designer. Proper use and care, scheduled inspections, and periodic pumping can eliminate the need for costly repairs and prevent the contamination of groundwater and nearby streams.

Urban Homes and Businesses

Urban homeowners and small-business operators can do much to reduce the pollutants reaching creeks, rivers, and estuaries in urban runoff. Individual efforts are important, because the threat of NPS pollution lies in the cumulative effects of all its many sources. Each of us is an actual or potential contributor.

Property owners can improve runoff absorption by substituting attractive walkways for concrete sidewalks. Alternative materials—such as gravel, bricks, flagstones, pavers, and duckboards — allow rainwater to seep into the ground between cracks and spaces. A wood deck is a good substitute for a concrete patio. A carefully designed and engineered gravel pad for parking a boat or recreational vehicle is kinder to the environment—and cheaper—than pouring concrete or laying asphalt. Businesses can install gravel parking lots to similar advantage.

Homeowners can use native shrubs and trees wherever possible, or plant hardy shrubs and ground covers that are pest-resistant and require minimal watering and fertilizing. A layer of mulch, spread two to four inches deep over bare ground, between plants, or along walkways, will help to reduce runoff and erosion.

Home and business owners commonly use and store many toxic chemicals and automotive products that can degrade water quality if they are disposed of improperly. Paints, thinners, cleaners, solvents, detergents, fertilizers, pesticides, motor oil, antifreeze, and other potentially harmful substances require careful use and disposal. Consumers can reduce the impact of pollutants from these products by following manu-

facturers' instructions for use, or by buying less-toxic products when possible.

Toxic household substances discarded on the ground can pollute runoff and groundwater. They are also harmful if they're poured down storm drains, which usually carry runoff directly to the estuary. If they're dumped down household drains or toilets, they can interfere with the treatment of municipal wastes.

Some cities and counties sponsor periodic pick-up days for toxic household chemicals and automotive products. Some communities have recycling centers that accept toxic substances. Local service stations may also accept discarded motor oil for recycling.

Boating Activities

Boaters, fishermen, and operators of marinas, boatyards, and other waterfront facilities can do their part to improve the water quality of navigable estuaries by taking the same precautions as home and business owners in disposing of toxic chemicals, fuel, and used oil.

In addition, boaters can avoid discharging sewage and waste into coastal waters by using approved sanitation devices and properly discarding their contents when they return to port or shore. Most marinas and boat basins along the Oregon coast provide facilities for emptying portable toilets and pumping out holding tanks. Coastal marinas also provide fish-cleaning stations, where anglers can conveniently clean their catches and properly discard wastes.

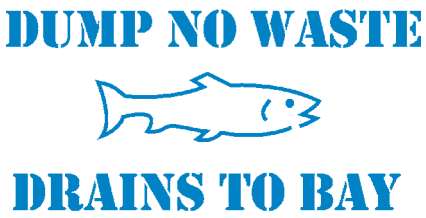
Boaters can help prevent NPS pollution by immediately repairing fuel and lubricant leaks, performing repairs and maintenance away from the water, and using drop cloths and vacuum cleaners to catch and dispose of paint chips and debris from cleaning that might otherwise end up in the bay.

Community Action and Public Involvement

While federal and state agencies have done much to clean up American waterways, stemming the flow of nonpoint source pollution also requires community-level measures and local public involvement.

People who live, work, and play on or near an estuary can help their communities find ways to reduce NPS pollution. Many coastal streams now have watershed councils working to protect them. Often they are in need of volunteers for administrative duties, public education, and to provide labor during streamside restoration projects. Local government councils or committees formed to address nonpoint source pollution and other coastal issues likewise need volunteer assistance.

These groups provide ways for local chapters of national associations, clubs, citizens' groups, and other organizations to get involved in preserving, protecting, and restoring wetlands and urban green spaces. Youth



When stenciled near a storm drain, this pollution-prevention warning provides a reminder about the damage caused by NPS runoff.

groups, schools, and churches can get involved. In one project, students from Coos Bay and North Bend schools stenciled signs next to storm-sewer drains to warn people that toxic substances discarded there can harm fish and wildlife. Variations of the sign, which included a picture of a fish and the message, "Drains to Bay," have appeared above storm drains in several other Oregon communities, too, to remind people of the connection between urban runoff and our bays or streams.

Community involvement, public-education programs, and volunteer participation in pollution-control projects are cost-effective. What's more, they turn coastal residents into watershed stewards who have a personal stake in protecting their estuaries.

Upstream pollution is always a downstream problem. The quality of coastal life and the vigor of coastal economies depend in part on a clean and safe environment. Community action and public involvement can help ensure that estuaries and coastal waterways remain as healthy and vital places to live.

Glossary

brackish *adj.* – slightly salty, as some estuarine water, with salt content usually ranging from 0.5 to 1.7 percent.

eutrophication *n.* – the abundant accumulation of nutrients leading to the rapid and dense growth of algae and other organisms, the decay of which depletes oxygen in the water.

food chain *n.* – the interdependent arrangement of organisms within an ecological community, in which those of the lowest order are fed upon by larger organisms, which in turn become food for still larger animals.

pathogen *n.* – any bacterium, virus, or other microorganism that produces disease.

riparian *adj.* – of or pertaining to the bank of a river or shoreline of a body of water.

salt marsh *n.* – a brackish wetland created by sediments of riverine and marine sources, which is periodically inundated by high tides, and where specially adapted plant and animal communities thrive.

storm surge *n.* – an abnormal rise in sea level caused by strong onshore winds, usually associated with a severe storm.

turbidity *n.* – the state of being unclear or cloudy because of stirred-up sediments, algal blooms, and the like.

watershed *n.* – the drainage area of a river or other stream.

wetland *n.* – land that has wet, spongy soil, as a bog, marsh, swamp, or wet meadow.

Further Reading

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Fundamentals of Urban Runoff Management. Washington, DC: Terrene Institute, 1994.

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Urbanization and Water Quality. Washington, DC: Terrene Institute, 1994.

Wolf, Michael J., ed. *Water Quality Protection Guide.* Salem, Oregon: Oregon Department of Agriculture, 1993.

Web Sites

National Estuarine Research Reserves:
www.ocrm.nos.noaa.gov/nerr/welcome.html

National Estuary Program:
www.epa.gov/nep/nep.html

South Slough National Estuarine Research Reserve: www.southsloughestuary.com

Tillamook Bay National Estuary Project:
www.co.tillamook.or.us/gov/estuary/tbnep/nephome.html

The Oregon Estuary Plan Book:
www.inforain.org/mapsatwork/oregonestuary

Oregon Department of Agriculture:
www.oda.state.or.us

Oregon Department of Environmental Quality:
www.deq.state.or.us

Oregon Department of Fish and Wildlife:
www.dfw.state.or.us

Oregon Department of Forestry:
www.odf.state.or.us

National Oceanic and Atmospheric Administration:
www.noaa.gov

Ofice of Wetlands, Oceans, and Watersheds:
www.epa.gov/owow

US Commission on Ocean Policy:
www.oceancommission.gov

US Department of Agriculture:
www.usda.gov

USDA Forest Service:
www.fs.fed.us

US Environmental Protection Agency:
www.epa.gov

Bioregional Rainforest Information System:
www.inforain.org

Coastnet Links to Other Sites:
secchi.hmsc.orst.edu/coastnet/links.html

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