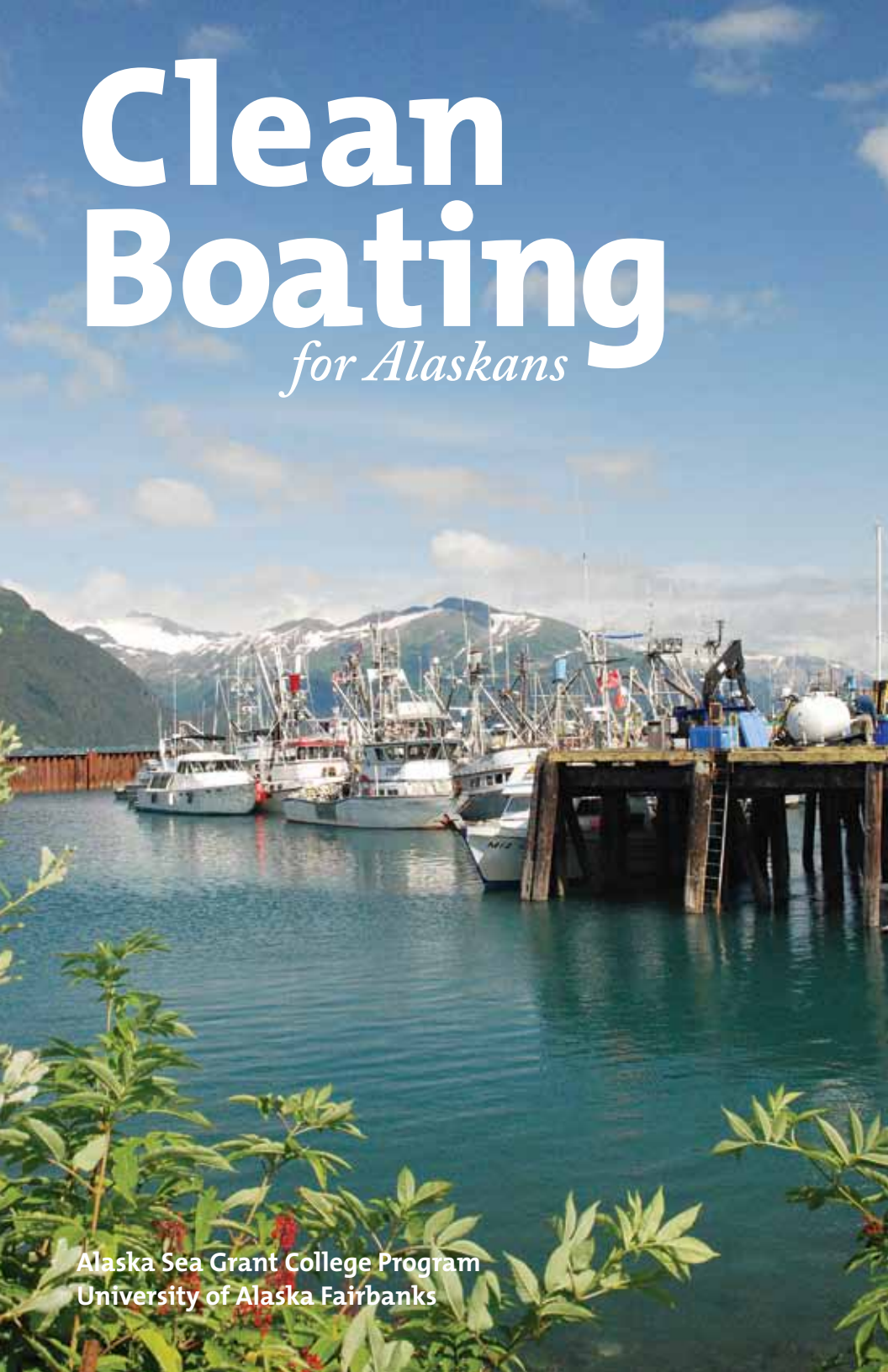
Clean Boating

for Alaskans



Alaska Sea Grant College Program
University of Alaska Fairbanks

Leave No Trace Boating

LNT is a popular concept nationally as a way to ensure that the qualities of wildlands and waters will be preserved for future generations. Though developed for land-based activities, the seven LNT principles also apply to boat operations.

1. Plan ahead and prepare.
2. Travel and camp (if hiking or camping on shore) on non-vegetated surfaces wherever possible.
3. Dispose of waste properly.
4. Leave natural and historical items, and Native artifacts, where you find them.
5. Minimize campfire impacts.
6. Respect wildlife.
7. Be considerate of other visitors.

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ALAN PARKS

As an Alaskan boater, taking steps to secure the quality of your marine environment can improve your operational efficiency and save money at the same time.

Contributors

Terry Johnson, marine recreation and tourism specialist for the Alaska Sea Grant Marine Advisory Program, wrote the text for most chapters. Alan Parks, Alaska Marine Conservation Council, wrote the Rethinking Boat Operations chapter and contributed some photographs. Alan Sorum, City of Skagway, made contributions to the Clean Boat Operations and Maintenance chapter. Staff of Cook Inletkeeper and the Marine Conservation Alliance Foundation contributed to the Marine Debris chapter. Marilyn Sigman, marine educator for Alaska Sea Grant Marine Advisory Program (formerly of the Center for Alaskan Coastal Studies), helped with the beach etiquette topic. Mary McBurney, Lake Clark National Park and Preserve, edited the book.

Introduction

As a boat operator in Alaska you enjoy pristine waters, stunning views, and abundant fish and wildlife. You can take steps to secure the quality of your marine environment. The good news is that, in many cases, doing so can improve your operational efficiency and save you money.

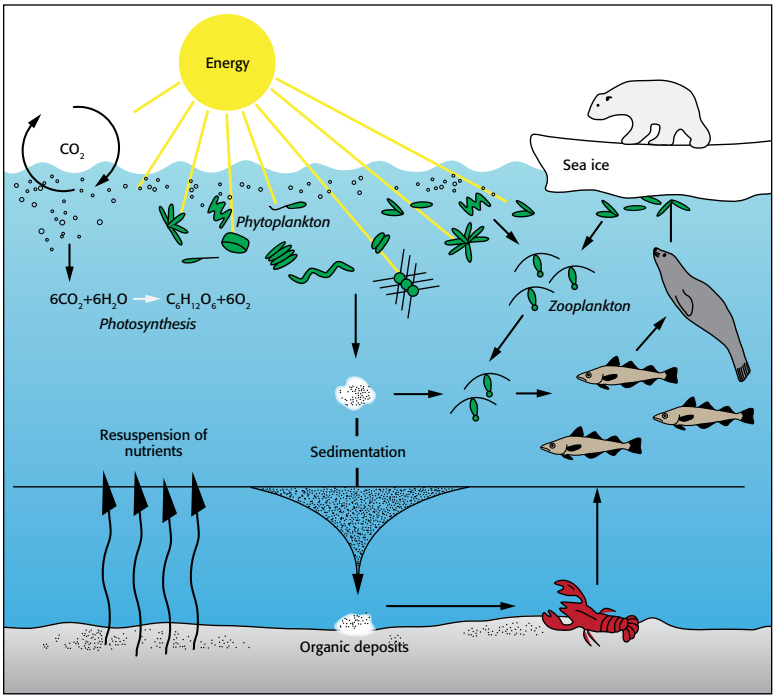
This booklet is intended to help you think about how using your boat affects the environment and how you can minimize your impact. It has ideas on how you can—immediately and in the future—operate your boat more efficiently, and more environmentally responsibly, on Alaska's waters.

The publication is a collaboration of the Alaska Marine Conservation Council, the National Park Service, and the Alaska Sea Grant Marine Advisory Program.

1
Rethinking Boat Operations

If you run a boat, you know that times are changing. First, the rapid rise in costs of fuel and other necessities is making it a lot more expensive to operate a vessel. Then there is the growing awareness of threats to the ocean environment—from trash and pollution to population growth in coastal areas and overuse of marine resources—that is changing our perceptions of the sea. Add to that the threats posed by global climate change and ocean acidification, and it is clear we all need to reevaluate the way we use the ocean.

The Intergovernmental Panel on Climate Change calculates that by the end of this century the earth's average temperature will have increased by more than 4°F, and by 5°F in the Arctic. This seemingly small change in temperature is enough to raise sea levels by 1.6 feet, open new arctic

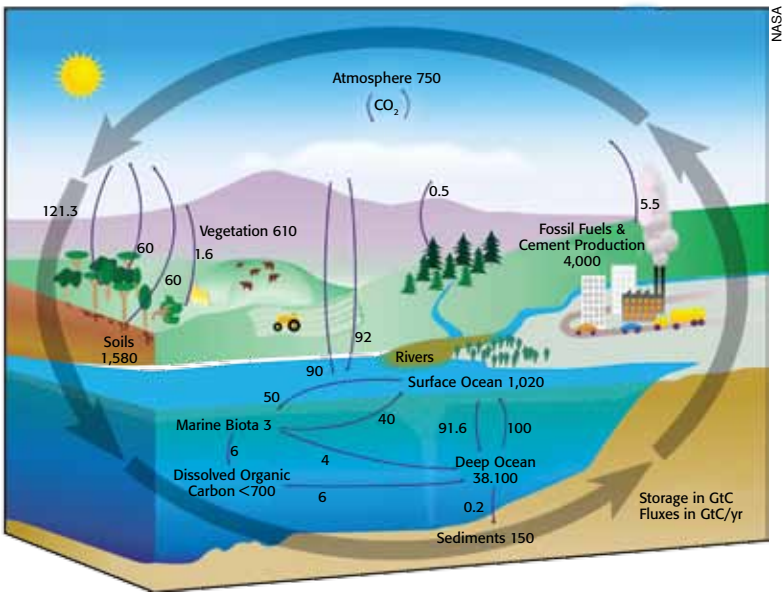


Global climate change may alter the fragile balance in the marine food web.

shipping routes, reduce populations of marine mammals that rely on sea ice, and change species compositions in important fisheries.

Changing ocean chemistry is another growing threat to the health and productivity of marine ecosystems. In the last 200 years, the acidity of the world's oceans has increased 30 percent due to growing levels of carbon dioxide in the atmosphere. Carbon dioxide reacts with seawater to form carbonic acid, which reduces the calcium carbonate available for many marine organisms—such as corals, crabs, oysters, scallops, and clams—to create and maintain their shells. More importantly, increased acidification threatens many kinds of zooplankton, which are the basis of the entire oceanic food chain that supports commercially valuable species such as salmon, herring, and cod. Many zooplankton organisms have calcium carbonate shells and cannot exist in a more acidic ocean. Gasoline and diesel engines constitute a major source of atmospheric carbon dioxide.

Slowing or reversing the effects of global climate change and ocean acidification is the greatest challenge of our time and Alaska boat owners can take steps to protect the quality of the ocean environment.



Ocean acidity is increasing due to rising levels of carbon dioxide in the atmosphere. This diagram shows annual exchange of carbon in gigatons (billions of tons).

2
Saving Fuel and Money, and Reducing Emissions

Every gallon of diesel fuel burned releases through exhaust about 22 pounds of carbon dioxide—the primary greenhouse gas responsible for ocean acidification—and a variety of particulates and compounds harmful to the environment. (Gasoline engines produce about 19 lbs of carbon dioxide per gallon.) If you reduce the amount of fuel consumed, you proportionally reduce the amount of exhaust produced. For vessel operators, it is important to find the right balance of productivity, efficiency, and environmental impact. The following suggestions can help lower your vessel fuel costs and emissions.

Slow down

In displacement hull vessels, even a small decrease in boat speed will save fuel. Data show that reducing power by as little as 10 percent from full throttle reduces fuel consumption by 20 percent. The bow and stern waves produced by displacement hulls create drag that reduces efficiency. Backing off the throttle to the point where the bow and stern waves start to flatten out will result in greater fuel savings. Typically, cutting speed by one to two knots can cut consumption by 30 to 50 percent.

If you have a planing or semi-displacement hull, the matter is more complicated. Slowing too much can decrease fuel efficiency. Still, backing off from wide-open throttle is sure to lower consumption per mile traveled. Use a fuel flow meter, or keep accurate records of gallons burned divided by distance traveled at different engine rpms until you find the most efficient operating speed for your vessel.

Look at your exhaust

Exhaust from a well-maintained diesel engine is virtually invisible. If yours is black, the engine is overloaded, starved for air, or has worn injectors. If it is white, there may be an injector or valve timing problem, burnt valves, or bad gaskets allowing coolant into the cylinders. If exhaust is blue, there is oil in the combustion chambers from worn rings or valve guides or a turbo seal failure. These problems decrease engine efficiency and should be repaired.

AMCC

Boaters can take advantage of tides, currents, and predicted winds to reduce fuel consumption.

Check your prop

With your boat out of the water, check the prop for bent blades, dings, or eroded edges that create cavitation. Propellers with bent or worn blades can cause engine damage. While underway, check the propwash for excessive turbulence and bubbles that suggest a prop that is too small or has too little pitch. Check your exhaust stack for black smoke that would suggest overloading.

Use your tachometer and pyrometer to ensure you have the right prop. The engine should quickly reach rated rpms and the exhaust temperature should be within the manufacturer's specifications. If not, the prop is too big or has too much pitch. If the engine exceeds rated speed or the exhaust temperature is too low, the engine could be underloaded and you could be wasting fuel and causing long-term harm to the engine due to carbon buildup and cylinder glazing.

Maintain the bottom

Marine growth on your hull saps power and wastes fuel. Remove weeds and barnacles and keep them off with nontoxic antifouling paints or coatings.

Reevaluate your electrical system

A larger alternator on an underloaded main engine, and an inverter that converts battery power to AC, may produce electricity more efficiently than a stand-alone generator. Turn off power-consuming electrical devices when they are not needed. Consider adding a wind charger or solar panels to reduce the fuel cost of producing electricity.

Check your steering

If you're not going the shortest distance to your destination you're wasting fuel. If you have play in your steering, make adjustments to eliminate it as much as possible. Even if you have a great autopilot, watch your wake and see if you're zigzagging through the water. The pilot's control head probably has adjustments that can change steering parameters and allow you to minimize delayed or oversteering in calm conditions. Newer units even have a "no-drift mode" that compensates for wind and current.

Plan your route and timing

Take advantage of tides, currents, and predicted winds to reduce your fuel consumption. Tide and current tables and oceanographic current charts can indicate ways to get a boost from nature. Marine weather forecasts can help you avoid headwinds or delaying sea conditions and identify opportunities to take advantage of tailwinds.

Reduce vessel weight

More important on a planing or semi-displacement vessel, weight control reduces the amount of power needed to achieve a given speed. On short trips, it may not be necessary to run with full fuel and water tanks. Use trim tabs or shift passengers, gear, and ballast to achieve proper vessel trim.

On displacement boats, additional weight may actually improve seakeeping and fuel efficiency by helping the boat proceed more directly through the water. Still, it takes energy to push weight through the water so keep your boat as light as is prudent for your operating circumstances.

Keep good records

Keep records tracking fuel use, operating hours (from your hour meter or engine hour logbook), and distance traveled. Observations such as changes in coolant and exhaust temperatures, oil temperatures and pressures, and speed over the ground should also be logged.

3
Clean Boat Operations and Maintenance

Conserving fuel and reducing emissions can help save money and minimize your boat's impact on the environment, but there are additional steps you can take to be an environmentally responsible boat operator.

Taking care of the bilge

Preventive maintenance and proactive bilge care reduce the possible environmental impact that could be caused by **unintended oil discharge from bilge pumps**. Engine oil, hydraulic oil, and fuel often leak from loose or worn fittings, seals, and gaskets. A steady drip combined with an automatic bilge pump spell a pollution hazard and can draw a violation notice if a sheen is noted by a harbor officer or reported to the Coast Guard. Bilge spaces are often concealed under cowlings and hatch covers and are not easy to access, so spilled oil is likely to be ignored until a sheen is seen on the water.

Most inboard marine engines and their associated systems develop oil leaks as they age. Some leaks can be prevented or stopped by simply **tightening fittings or replacing gaskets**. Others require expensive replacement of engine or reduction gear seals, and may not be financially justifiable based on oil loss alone. Check all fuel, oil, and hydraulic lines and fittings regularly and look for cracked or chafed hoses, loose or corroded hose clamps and other fasteners, and other potential problems. Some older marine engines contaminate their own spaces with "blow-by," an oily mist emitted by the crankcase ventilation tube. This problem is easily fixed by installing a crankcase vent filter and recirculation kit.

Oil changes are a major source of bilge oil, so exercise care when changing oil and filters. Most inboard engines have a manual or electric oil change pump for removing used oil, but these pumps—or their associated hoses and fittings—tend to leak. Keep absorbent pads under the engine while changing the oil and oil filter. If possible, use an open heavy-duty garbage bag to catch oil and the filter unit itself in case it slips from your hands when it comes free of its bracket. It is a good practice to disable automatic bilge pumps when performing engine maintenance.

K. BYERS, ALASKA SEA GRANT

Boaters should dispose of their used oil, oily bilge water, oily absorbent pads, and old batteries at an environmental operations station such as this one in Whittier.

Many products on the marine market are designed to address bilge problems. Every boat should **carry a stack of oil absorbent pads and absorbent pillows**. These are good for keeping bilge water free of small amounts of oil. Used absorbent pads and materials should not go into the garbage but be properly disposed at the harbor's waste oil station. If your harbor does not have a waste oil station, contact the harbormaster for recommendations.

Several companies make **in-line filters** that are connected to installed bilge pumps. They are designed to remove oil from bilge water before it is pumped overboard.

Some boat harbors offer **pump-out services for oily bilge water** at a nominal fee. Marine service providers can steam-clean engines and engine rooms. However, it is only a short-term gain to clean the bilge or entire engine compartment before the source of the leaks has been addressed.

Oil spill response and reporting

Any oil or fuel spill, no matter how small, must be contained, cleaned up, and reported. A boat operator who causes or witnesses a spill is required to **report it to the Coast Guard**. Call the U.S. Coast Guard on VHF channel 16 or the National Response Center at 1-800-424-8802. Citations are rarely issued for minor, unintentional spills, especially when vessel operators have taken immediate action to control, clean up, and report them.

If your vessel causes an oil or fuel spill, **take immediate action**. Locate the source of the problem, stop or slow the leak, and prevent the oil or fuel from leaving your boat. Contain an oil spill on the deck by blocking the scuppers or deck drains. Pick up spilled fuel or oil in the water or on the boat with oil absorbent pads, sweeps, or pillows.

Do not use soap or detergent to clean up an oil spill on the water. Fuel is less harmful to the environment when it is allowed to evaporate. Using soap to break up a sheen will sink the fuel or oil to the bottom where it can harm marine life. The Clean Water Act specifically prohibits the use of soap or detergent on oil in the water.

Safe boat fueling

Improper fueling can cause a fuel spill, fire, or explosion. Here are some tips for safe fueling:

- Try to fuel up in calm water conditions. If there is boat traffic, wait until wakes have passed to prevent your boat from rocking excessively. Ensure that all sources of flame are extinguished before taking the fuel hose nozzle. Ask passengers to disembark, and close all doors and hatches to prevent vapors from settling in spaces below decks.
- Know the capacity of your tank and approximately how much fuel you have used since last filling. If you don't have an accurate gauge or flow meter, keep a log of engine hours and rate of consumption.
- Use a filler nozzle smaller than your fuel fill fitting, to allow air to escape from the tank and prevent pressure buildup. Don't hesitate to ask the dealer for a smaller nozzle, and also ask him to reduce pump pressure if it is too great for your tank and filler.
- Place absorbent pads around the filler, or put an absorbent collar on the nozzle. Consider installing a vent whistle to let you know when your tank is nearly full, or an air-fuel separator to prevent fuel from belching out of the tank vent.
- During filling maintain contact between nozzle and fill pipe to prevent static electricity buildup. Never leave the nozzle

K. BYERS, ALASKA SEA GRANT

Improper fueling can cause a fuel spill, fire, or explosion.

unattended. Catch any drips or vent mist with a rag or bilge diaper. Stop filling when fuel level approaches the top of the tank, not the top of the filler pipe. Learn to recognize the sound made by the vent when the tank is nearly full.

- Return the hose to the attendant with the nozzle pointed up to prevent drips.
- Fill portable tanks on the fuel float or at an upland location. Set plastic gasoline tanks on the ground before filling to prevent static discharge that could cause an explosion.

Bottom painting

Good hull preparation can reduce bottom painting costs and impacts to the environment. Many bottom paints contain highly toxic lead or copper, so the scraping and sanding of vessel hulls generates hazardous waste that must be disposed of properly. The following tips can help reduce environmental problems associated with scraping and sanding vessel hulls.

- Use dustless or vacuum sanders to remove paint, and retain the sanding material.
- Place tarps or filter cloth under the vessel to collect paint and scraping chips.
- Paint removal should be done in an enclosed or sheltered structure or in a tarped enclosure to contain airborne debris and dust.

- Avoid paint removal on windy days if an enclosed shelter is not available.
- Use minimal abrasion when cleaning antifouling paints.
- Collect all resulting trash, debris, paint chips, fiberglass, blast grit, and residue from paint removal. Dispose of properly.
- Paint residue and blast grit must not be dumped in the trash, or construction materials dumpsters, unless certified as not containing lead.
- Avoid in-water bottom cleaning, hull scraping, or other process that could remove antifouling paint and introduce it into the water.

Using antifouling bottom paints

Environmentally responsible boat owners are concerned with the antifouling bottom paint used on their vessels. Copper is the most common antifouling agent in bottom paint. Some nontoxic alternatives produce very smooth surfaces to prevent marine organisms from attaching to the hull.

You can alleviate the environmental impacts of antifouling paint by employing the following suggestions for your next haulout:

- Use antifouling paints that contain the minimum amount of toxin necessary for expected conditions, or better yet, none at all. Look for self-polishing "slick" paints that contain no toxins.
- Avoid the use of soft paints that wear away, and use water-based paints when possible.
- Use brushes and rollers rather than paint sprayers whenever possible.
- Tarp or shroud vessels to avoid overspray or runoff of paint onto the ground or water.
- Use a designated area to mix paints, solvents, and reducers.
- Purchase only enough paint to complete the job.
- Allow empty paint cans to dry out completely prior to disposal.

Batteries

Proper care and storage of starting and house batteries will greatly extend their life and will minimize the volume of hazardous waste generated. **Keep batteries fully charged**, and never leave partially discharged batteries in subfreezing conditions where they can crack and spill acid.

If batteries are left on board for extended layup periods, **disconnect them** from the boat's circuitry to minimize drain. Use a marine battery

charger or solar panels to maintain a charge over the winter. Better yet, remove them and store in a cool, dry location. Batteries should rest on a nonconductive surface that is off the floor. Scraps of 2 × 6 inch lumber resting on a couple of concrete blocks work well for this purpose.

Never discard batteries anywhere except at a location at the harbor or boatyard designated for that purpose, where they will be collected and recycled. You can probably return your tired batteries to the dealer for a small credit toward purchase of a new set, thereby eliminating the possibility of a hazardous waste spill while at the same time saving money.

K. BYERS, ALASKA SEA GRANT

Toss your trash in port, not at sea. It is illegal to discard plastic items in any waters, and to dispose of even ground up paper, rags, glass, and food waste within three miles of shore.

Garbage management and disposal

Common sense, as well as federal and international law, dictate that you handle garbage and trash correctly. Trash is not only unsightly—it can poison or strangle marine wildlife.

If your boat is 26 feet or longer it is **required to display a MARPOL trash placard** that specifies what can and cannot be dumped at sea. It is illegal, for example, to discard any plastic items in any waters. Even ground up paper, rags, glass, and food wastes are prohibited within three miles of shore. Study your MARPOL placard to reacquaint yourself with its contents.

Furthermore, commercial vessels 40 feet or longer that have galley and berthing are required to have a **posted waste management plan** and to keep records of garbage disposals. Significant fines and imprisonment are prescribed for violators.

Use sturdy trash containers on board, lined with heavy-duty removable trash bags. Secure the partially filled and tightly closed bags inside a tote, locker, or other safe location on an aft deck (to keep the smell out of living spaces) so they can easily be transferred to dumpsters in port. Keep recyclables in separate containers.

Heads, pump-outs, and sewage management

Dumping raw sewage overboard is unsightly, can contaminate shellfish beds, and is prohibited in state waters (within three miles of shore). Federal law requires any installed head (marine toilet) to be plumbed to an approved Type I, II, or III marine sanitation device (MSD).

- Type I treats sewage with chemicals or other prescribed methods before overboard discharge.
- Type II is a larger, more sophisticated treatment system, generally suitable for vessels greater than 65 feet in length.
- Type III is a holding tank, designed to allow overboard discharge outside state waters, to a pump-out system at a receiving station, or both.

Even approved Type I or II MSDs shouldn't be discharged into boat harbors, anchorages, or intensely used fishing hot spots. In remote areas avoid pumping in constricted bays with little tidal flushing.

Most portable toilets ("porta-potties") are not approved MSDs, but may be used aboard vessels and should be taken ashore and emptied in appropriate facilities. An alternative is the new generation of field toilet systems that use a sealable plastic bag containing a powdered chemical that dries, deodorizes, and breaks down waste so that it can be safely dumped in any trash can.

Note that **it is illegal to discharge raw sewage within state waters** from any installed head—one that is affixed to the boat. The legal prohibition does not apply to a bucket or other portable toilet. However, courtesy and common sense dictate that sewage never is dumped from deck buckets around other boaters or close to shorelines or sensitive marine habitat.

Top ten hints for clean boating

1. **Reduce engine pollution.** Keep engines in good condition, stop or control leaks, drive conservatively, and take steps to minimize fuel consumption.
2. **Keep the bilge clean.** Good routine maintenance and some absorbent pads or pillows will help keep bilge oil out of the water.
3. **Exercise caution in fueling.** Prevent overfilling, use proper nozzle size and pressure, keep absorbent pads handy, and fuel portable tanks off the boat.
4. If you have a choice, **choose a "clean marina."** Pick a well-planned facility that provides pump-out services, proper solid waste disposal, and good maintenance facilities.
5. **Reduce wastewater discharges.** Use upland restrooms, showers, laundry facilities, and vessel washdown pads to reduce the amount of gray water going into the sea.
6. **Avoid in-water exterior maintenance.** Do hull maintenance at an upland boatyard with correct facilities and materials. Use dustless sanders and proper screening.
7. **Be careful with bottom paint.** Select the proper paint for your location and use best management practices for applying it.
8. **Use pump-out facilities** where available. If none are available where you operate, dispose of sewage legally and with consideration to the environment.
9. **Avoid use of soaps and detergents** for vessel maintenance. Don't use them to break up an oil sheen. Detergents are pollutants so minimize use, especially in areas of little water exchange.
10. **Pack it in/pack it out.** Keep solid wastes and trash on board and take them home for disposal. Use approved waste disposal facilities. Abide by the MARPOL trash placard.

4
Marine Debris

Marine debris is a growing crisis in Alaska and around the world. It is not only unsightly—it can pose a serious threat to seabirds, fish, marine mammals, and even terrestrial animals that frequent beaches, through entanglement, choking, and poisoning. Wildlife can mistake small items of debris for food and can subsequently die of starvation or impacted digestive tracts from eating indigestible debris. Some plastics act like a sponge and soak up toxic chemicals, poisoning animals that swallow them.

Discarded gillnet, seine/trawl web, fishing line, and plastic packing bands are particularly deadly to fish, birds, and other wildlife, and rope and buoy lines can entangle and kill marine mammals.

- Ensure that none of your trash gets into the water.
- Recycle used web, lines, and other gear. If your port doesn't have a used gear-recycling program, dispose of these materials in the proper trash receptacles at the boat harbor or fish plant dock.
- Set a good example and make a point of letting your crew and other operators know you are responsible with your trash.
- Buy consumer products that use a minimum of plastic packing materials and reduce your personal use of plastics.
- Encourage local harbors and marinas to provide convenient solid waste collection facilities and bins for recyclable materials.
- Support and participate in scheduled beach cleanup activities.
- Report concentrations of marine debris to the Marine Conservation Alliance Foundation at 907-523-0731 or marinedebris@ak.net. MCAF is compiling reports to build a database of debris accumulations to plan cleanup projects. Reports that include GPS coordinates and photos are especially useful.
- Pick up and take back to port all marine debris items you can comfortably remove and carry aboard your boat.

KARIN HOLSER

Marine debris poses a serious threat to marine mammals, seabirds, and fish. This northern fur seal, trapped in net debris, was photographed on St. George Island, Alaska.

5
Operating Around Wildlife

Global climate change, ocean acidification, and changing human use patterns will have profound effects on Alaska's marine ecosystems and wildlife. They may cause increased marine wildlife strandings, the introduction of invasive species, and periodic die-offs of various animals due to starvation, disease, and habitat loss. Take steps to ensure that you don't cause more problems for wildlife—react correctly to strandings, and learn to operate in such a way as to minimize disturbance of marine wildlife.

Marine wildlife strandings

It is illegal to touch, pick up, or harass any marine mammal (dead or alive) unless you have a permit from the U.S. Fish and Wildlife Service or National Marine Fisheries Service. Stranded animals may be dead, obviously sick or injured, or simply resting on or near the shore. Avoid the temptation to try to help an apparently abandoned young animal, because in most cases the mother is foraging nearby and touching or moving the little one might cause her to abandon it.

- Do not approach, touch, or feed stranded animals. Some diseases can be transmitted between wild animals and pets, and even humans.
- Do not remove any part of a dead bird, Steller sea lion, or endangered whale.
- Keep other people and domestic animals away.
- Take detailed notes with the time and location of the observed stranding, physical characteristics and behaviors of the animal, and other relevant information.
- Report a mammal stranding via the Stranded Marine Mammal Hotline by calling 1-888-774-7325 and follow instructions provided on the line.
- Report dead sea otters to the U.S. Fish and Wildlife Service at 1-800-362-5148.
- To report dead marine mammals (other than sea otter, walrus, or polar bear) or to register marine mammal hard parts, call the National Marine Fisheries Service Protected Resources Division at 907-271-5006.

- If you observe anyone harassing marine mammals call the National Marine Fisheries Service Office of Law Enforcement at 1-800-853-1964.

Minimize disturbance of marine wildlife

Watching marine wildlife is enjoyable and supports a vibrant tourism industry, but it's not always good for the animals. Marine mammals and seabirds can become stressed and can be displaced from important feeding, resting, and nesting sites if pressed too closely or too frequently by people and their boats.

How close is too close? That varies by species and situation. You have come too close if an animal appears alert, agitated, or focused on your approaching boat, or attempts to escape or takes evasive action. Cliff and ground-nesting seabirds and shorebirds are especially vulnerable to disturbance by approach, and may lose their eggs or chicks to exposure or to predators if the adults are flushed from the nest.

Furthermore, state and federal laws prohibit disturbance of marine mammals and birds, and penalties are severe for violations.

The best way to be a responsible marine wildlife viewer is to become a good naturalist. Learn about the needs and behaviors of the animals you encounter, look for signs of disturbance, and then give them space.

The Alaska Sea Grant Marine Advisory Program (University of Alaska Fairbanks), in cooperation with the National Marine Fisheries

K. HARRELL, AMCC

Learn about the needs and behaviors of the animals you are watching, such as these tufted puffins. Look for signs of disturbance and give them space.

Service, U.S. Fish and Wildlife Service, National Park Service, and Alaska Department of Fish and Game, has developed a voluntary code of conduct that provides guidelines for approaching and operating a vessel around marine wildlife. See the back of this booklet for your copy of the guidelines.

Anchoring

Most boaters who operate on remote Alaska waters are experienced at anchoring and know how to allow adequate swinging room and how to avoid fetching up on the beach, coming down on a rock, or crowding other boats. You should, however, consider how to minimize the effect of anchoring on the bottom. Kelps and many kinds of invertebrates such as anemones, sea stars, crabs, clams, and even bottom-dwelling fish, are vulnerable to anchor, chain, and cable damage.

Be aware of the bottom characteristics of potential anchor sites. Estuary bottoms, for example, are high-productivity rearing habitat for many fish and crustacean species. A place that the chart indicates kelp or a "foul" bottom is likely to be a living substrate that can be damaged by anchoring. Furthermore, foul bottoms tend not to hold well, or can grab an anchor so that it can't be retrieved.

Beach etiquette

Beaches are home to a great variety of marine plants and animals, most of which are delicate. Walking on them can crush and kill them, and handling can damage them or expose them to predators. Furthermore, it is against Alaska state law to remove live beach plants and animals except with a scientific collecting permit or under the provisions of legal sport or subsistence harvesting. Consider the effects of visiting beaches and take steps to minimize your impact.

- Walk, don't run.
- Step on bare rock rather than on a living organism wherever possible.
- Explore from the exposed beach rather than wading into the water, and from the edge of the tide pool rather than in it.
- Turn over only small rocks, and do so gently and carefully.
- Wet your hand with beach water before touching or holding an animal. Minimize handling, especially at low tide.
- Always replace a rock carefully so as not to crush the life below, and replace seaweed or other cover.

6
The Future of Boats—New Technologies

If you are thinking about renovating, repowering, or building an entirely new boat, there are new technologies worth considering. Some are still in the early stages of development and others are already on the showroom floor or in widespread use.

Four-stoke and DFI outboards

These outboard motor types have been around for a few years and are gradually replacing older carbureted two-stroke engines. Manufacturers of both four-stroke and DFI (direct fuel injection) engines claim the emissions are much lower than those produced by older model outboards.

Compared to carbureted two-strokes, four-strokes and DFIs are smooth, quiet, clean-burning, and fuel efficient. Direct comparison tests show that a comparably rated four-stroke outboard will propel a boat at comparable cruising speed on about 20 percent less fuel than a carbureted two-stroke—and without burning oil. The difference in efficiency is greater at trolling speeds because when running slowly the two-stroke runs rough, misfires, and pumps a lot of unburned fuel and oil out the exhaust. By some measures, as much as half of the fuel and oil consumed by a carbureted two-stroke at idle and low speeds is pumped out the exhaust unburned or partially burned.

A DFI motor burns its own lubrication oil, which is metered and injected with the fuel, but in lesser quantity than the premix used in carbureted motors. Compared with four-stroke engines, DFI outboards are marginally lighter weight, have faster acceleration, and operate at lower rpms at comparable power output.

Electronic diesels

The diesel engine has always been a miracle of efficiency. Even older engines produce 60-80 percent more power from a gallon of fuel than gasoline engines, and although the fuel is often dirty and the exhaust sometimes smoky, diesels produce less carbon monoxide and other pollutants than gas engines due to their higher compression, which burns fuel more completely. Driven by demands of the commercial trucking

industry, manufacturers now build electronically controlled diesels that are cleaner burning and even more fuel-efficient. They also have onboard computers that perform their own diagnostics to identify engine problems.

The popular "common rail" design has unit injectors that can produce a quick series of mini-injections during a single compression stroke to eliminate noisy "diesel clatter" and promote cleaner, more complete combustion. Published data show electronic diesels to have 5 to 15 percent better fuel efficiency than mechanically controlled engines.

New fuels

New fuels, not yet available in Alaska, won't necessarily make your engines more efficient or economical, but they might help to improve air and water quality.

Ultra low sulfur (ULS) diesel fuel is being phased in nationwide as required by federal law, and will soon be standard at marine fuel dealers. Sulfur is a lubricant in diesel fuel but is also a pollutant. Refiners add lubricating agents to ULS diesel fuel to prevent engine damage, but the energy content, gel point, and other characteristics are essentially the same as for low-sulfur diesel, which has been the primary fuel for many years.

Ethanol is alcohol made from agricultural products such as corn, and when added to gasoline is supposed to make it burn cleaner and produce less smog. E-10 is gasoline made with 10 percent ethanol. If E-10 does become available in Alaska, boaters should be aware that it can cause deterioration of certain kinds of fuel system seals and gaskets, and can attack the resins used in the manufacture of some fiberglass fuel tanks.

Bio-diesel refers to any of several different fuels made entirely or in part from agricultural products such as soybeans, fish oil, or recycled vegetable cooking oil. Bio-diesel can be straight vegetable oil (SVO)—known as B-100 or "neat"—or a blend of vegetable oil and petroleum such as B-5 or B-20, in which 95 percent or 80 percent of the fuel is petroleum-based diesel oil. Proponents claim that vegetable oil has greater lubricity than petroleum diesel, and has a higher flashpoint so it is a little safer and generally burns cleaner.

Bio-diesel has marginally lower energy content so it produces slightly less power per gallon of fuel, and is also associated with deterioration of certain kinds of hoses and seals, so older fuel systems may require modification. Vegetable oil gels at 32°F, so machines that run on SVO may need a heating tank in the fuel system. In the past bio-diesel has been more expensive than petroleum diesel fuel, but price ratios may be changing.

Most engine manufacturers do not endorse the use of B-100 in their products and will invalidate their warranties if it is used, but most do extend warranty coverage to include use of either B-5 or B-20. Coverage is specific to make and model, so owners should check with their engine's manufacturer before using any bio-diesel.

New boat designs

The boat of the future may look very different from that of the past. Since most of the energy produced by a marine engine is consumed in making bow and stern waves, modern vessel design is directed at creating hulls that minimize waves and wakes. Boat builders are also experimenting with high-tech lightweight materials like carbon fiber and Kevlar to minimize overall vessel weight. Here are some approaches marine architects are applying to achieve greater efficiency:

Bulbous bows are gaining wider acceptance. A bulbous bow creates a smaller bow wave that cancels the stern wave and reduces wave resistance. It also diminishes pitching for a smoother ride. Bulbs are most effective on larger vessels, but boats as small as 32 feet can be retrofitted, and some owners claim a 15 percent reduction in fuel consumption.

DAVE KUBIAK

A bulbous bow creates a smaller bow wave that cancels the stern wave and reduces wave resistance.

K. BYERS, ALASKA SEA GRANT

Catamarans have a pair of long, extremely narrow hulls designed to lower wave resistance, and they can achieve greater speeds with less power.

Catamarans also are increasing in popularity. They have a pair of long, extremely narrow hulls designed to lower wave resistance. Planing cats and cats with hydrofoil lift (see below) can achieve greater speeds with less power, while experiencing less roll and pounding in choppy water.

Hydrofoil designs include monohulls or catamarans fitted with fins below the surface that create lift to raise the boat clear of the water. At planing speeds they have negligible wave resistance and minimal roll and pounding in seas.

Small waterplane area twin hull (SWATH) boats sit on legs above submerged bulbous tubes. With most of their displacement submerged, they produce minimal wave drag and require relatively little power; at the same time they are more stable and less prone to roll and pitch than other designs.

Rigid inflatable boats (RIBs) and foam collar hulls have much of their buoyancy in extremely lightweight foam or air tubes. Their relatively narrow hulls have lower water friction and cut through chop more smoothly than conventional hulls of comparable capacity.

New drive systems

Jet drive, surface piercing, and other drive systems eliminate the drag associated with shafts, struts, skegs, rudders, and propeller blades, and increase propulsion efficiency, particularly at higher speeds. Duo-prop systems, forward-facing props, and other developments are aimed at overcoming some of the inefficiencies of the conventional screw prop,

and new propeller designs may make modest improvements even in conventional propulsion.

Azimuth, Z, and other alternative drive systems that use large diameter, large area propellers may or may not be more efficient, but they increase maneuverability thus reducing idle and low-speed maneuver time and increasing safety. These systems can be connected to a variety of motor types, electric as well as internal combustion.

Alternative power systems

Most of these technologies are still at the research and development stage, although a few are currently driving a small number of demonstration vessels. Some are stand-alone technologies while others are combined in hybrid propulsion systems similar to those appearing in automobiles.

Diesel-electric has a long history in railroad locomotives and ships and is being adapted to smaller vessels. A high-torque DC electric motor energized by a high-capacity battery bank turns the propeller shaft, and the diesel serves essentially as a battery charger. This allows the electric motor to run for limited periods without the engine, provides for recharging from shore power, and permits flexible boat layouts where the engine can be placed in a convenient location rather than right in front of the shaft, with no reverse-reduction gear required. The DC motor has full torque at any speed, and the diesel generator engine runs only at its most efficient speed rather than ranging from idle to full-bore, as with conventional engine propulsion.

Users of prototype diesel-electric systems claim exceptional fuel economy, especially on day trips where batteries can be recharged from shore power and no diesel is required. Some purists power the diesel generator unit with bio-diesel.

Electric and solar-electric systems rely on batteries charged by shore power or solar panels. With current technology, battery-only propulsion is only capable of producing relatively slow speeds for only a few hours, although one builder of small lightweight speedboats claims 18 to 20 knots on battery power.

Adding a high-capacity solar charging array greatly increases the potential for battery operated electrical systems. At least one experimental boat has made ocean crossings on solar power alone and a yacht builder is marketing a solar-powered catamaran reported to do 6 to 8 knots for up to four hours daily using only sunlight to charge the batteries. Passenger ferry companies in New York and Australia are building solar/wind/

diesel-electric vessels using giant "sails" covered with solar panels to power electric drive motors with zero emissions at low speeds.

Liquid propane gas (LPG) already fuels spark-ignition engines used in forklifts and some automobiles and trucks, and is adaptable to marine gasoline-type engines. LPG and compressed natural gas (CNG) are relatively clean burning and readily available, although they still produce carbon dioxide and are more expensive than gasoline or diesel. LPG and CNG have two significant disadvantages when it comes to marine propulsion—they're highly flammable, so the smallest leak could be catastrophic in the confined hull of a boat, and they are less energy-dense than gasoline or diesel, so a relatively large pressure tank is needed to provide a useful range.

Hydrogen and the hydrogen fuel cell are currently powering everything from motorcycles and cars to small boats and submarines, as well as providing electricity in remote locations. Hydrogen can be used as a fuel in specially designed internal combustion engines. It emits water and carbon dioxide, which contribute to global carbon emissions, but it does not emit other major air pollutants.

The fuel cell is a contained electrochemical reaction that uses hydrogen or other substances as fuel to produce electricity that can propel vessels with electric motors. By putting cells in series and in parallel, any voltage and amperage can be achieved. The cells themselves are made from expensive, exotic materials, which make them impractical for many applications at current market prices, but costs are expected to become more competitive in the future.

Hydrogen is described as an energy carrier, not an energy source, because it must be "made" or separated from other compounds, such as water, through energy-intensive processes such as electrolysis. Where hydro, geothermal, or other sources of electricity are relatively cheap, producing hydrogen for use in fuel cells can be a cost-effective way of making electricity "portable" to vehicles, vessels, or locations that cannot be connected to the grid by wire. However, if the electricity is generated from coal, gas, or nuclear power, hydrogen production has environmentally serious implications.

Return to sail, or more correctly, "**advance to sail**" involves the development of new sail and rigging materials and technologies. Three-dimensional sails, parafoil sails, and rotary sails are changing the ways wind can be harnessed to propel boats. Certain rotary sail designs actually generate electricity to power electric drive systems.

Share your tips on green boating

If you have comments, criticisms, or tips of your own for clean boating, please pass them along to

Terry Johnson, Alaska Sea Grant Marine Advisory Program
907-274-9695 or terry.johnson@alaska.edu

Alaska Marine Wildlife Viewing Voluntary Code of Conduct

To minimize disturbance of marine wildlife, the operator of this vessel pledges the following:

- No trash or pollution are allowed into the water, including fuel, oil, discarded fishing tackle, plastics, or sewage.
- No feeding, touching, or swimming with marine wildlife are allowed.
- Camera flash units and noisemakers are discouraged when near wildlife. Use of binoculars and telephoto lenses are encouraged.

We have learned to recognize indicators of disturbance in the local species and will take necessary steps to prevent or minimize negative effects of viewing.

Around Whales, Porpoises, and Dolphins we will

- Slow to no-wake speed when within a quarter mile of whales and will approach no closer than 100 yards, or greater distance if necessary to prevent them from changing behavior due to our presence. We allow the whales to control contact.
- Avoid abrupt speed and course changes.
- Not chase porpoises to induce "bow riding."
- Not pursue, herd, encircle, or separate whales from a group, and will not repeatedly "leapfrog" ahead. We approach only from behind or the side, and travel only parallel to whales.
- Minimize noise when near whales, and will limit observation to 30 minutes.

Around Seals, Sea Lions, and Sea Otters we will

- Slow to no-wake speed when approaching sea lions, seals, and sea otters in the water, or divert around them if we are transiting and not attempting to view them.
- Not pursue animals and will maintain enough distance to minimize disturbance and will give an extra margin of space to females with young.
- Maintain at least 100 yards from hauled-out seals and sea lions and more if needed to prevent behavior change.

Around Seabirds, Shorebirds, and Raptors (Eagles, Ospreys, Hawks, and Falcons) we will

- Remain at least 50 yards from nesting seabirds or more if necessary to prevent them from flushing from nests or perches.
- Divert around groups of seabirds on the water and give a wider margin to feeding birds. If viewing or photographing we approach slowly and quietly so as not to cause them to take evasive actions.
- Avoid walking on beach areas where seabird or shorebird behaviors indicate that they have concealed nests.
- Approach no closer than 50 yards to raptors, and 100 yards to raptor nests, or more if needed to avoid causing bother or agitation.

On Beaches we will

- Minimize walking on barnacles, mussels, anemones, and other intertidal creatures.
- Be aware of the effects of moving stones and other objects, and will return any that are moved to their original locations.
- Handle gently any intertidal creatures we touch, and keep such handling to a minimum.
- Refrain from removing live beach creatures and seaweeds, which is a violation of state law.
- Help our guests to understand the delicate and vulnerable condition of invertebrates so they will minimize their impact on the beach creatures they come to see.

Operator signature_____ Date_____

Sea Grant Alaska