Boat Hull Coating Selection and Hull Cleaning for Water Pollution Prevention

Water Quality Factsheet for Marina Operators and Boaters

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Water Quality Issue

Antifouling hull paints or coatings are typically applied to marine vessels to deter the attachment and growth of "fouling organisms" such as barnacles, oysters, mussels, shipworms, or algae that attach to boat hulls. These fouling organisms cause drag that can significantly slow the vessel, reduce its maneuverability, and increase fuel usage, and may also damage the hull. Boats that are kept in the water also require maintenance to remove fouling organisms.

Toxins released from the antifouling coating and pollutants generated during boat hull maintenance may impair water quality and threaten the health of aquatic habitats. Water quality impacts from antifouling hull coatings and boat hull maintenance can be minimized by selecting a less toxic or non-toxic hull coating or paint, using appropriate hull cleaning methods, and reducing the release of toxic chemicals from hull cleaning products.

This factsheet focuses on Best Management Practices (BMPs) for the selection of antifouling hull coatings, and for in-water boat hull cleaning. It does not address boat maintenance above the water line, minor maintenance conducted at on-shore areas of marinas, or maintenance conducted in commercial boat yards. Additional recommendations for minimizing impacts to water quality and aquatic habitats from recreational boating and marina activities are provided in the California Nonpoint Source Pollution Control Program's management measures.[1] These management measures were developed for facilities with 10 or more boats, public or commercial boat ramps, and boat maintenance or repair yards that are adjacent to the water, but they may also be appropriate for smaller facilities.

Types of Boat Hull Coatings

Antifouling hull paints and coatings work either by releasing a toxic chemical ("biocide"), or by presenting a hard or slippery surface that minimizes attachment by fouling organisms. Some antifouling paints are designed to slowly release biocide particles over time (i.e., "ablative coatings"), thus continually exposing fouling organisms to fresh releases of biocides.

[1] See California's management measures for marinas and recreational boating at http://www.swrcb.ca.gov/water_issues/programs/nps/encyclopedia/4_0marina.shtml.

Copper-Based Hull Paint

Copper has been a standard biocide in anti-fouling hull paints for many decades, and copper-based antifouling hull paints are currently the most commonly used antifouling coating. Copper in hull paint slowly leaches into the water column, and can also be released from the hull as particles that fall to the sediment. Copper discourages fouling organisms, but is highly toxic to a broad range of aquatic organisms (including fish, aquatic invertebrates, aquatic plants, and algae), and thus may also have adverse impacts on non-targeted aquatic species. For many aquatic species, the greatest risk of adverse impacts is from long-term accumulation of copper in sediments, elevating copper levels in benthic and epibenthic organisms and indirectly in other animals through the food web.

It has only been in the last decade that water quality sampling has shown that copper-based antifouling paint can, in some cases, cause copper levels in the water and underlying sediment to exceed water quality standards. In some southern California coastal waters, high densities of boats with copper-based hull paint in areas with a low water circulation rate have caused levels of copper to exceed water quality standards, and thus these waters have been included on the state's list of impaired water bodies.[2]

As no antifouling paints are completely effective, in-water hull cleaning is a standard maintenance practice for boats that are kept in the water. In the case of soft or ablative copper paints, this maintenance also releases some paint to the water column. Ideally, this should be paint that has already released its copper at a slow rate that does not cause an exceedance of water quality standards. However, if hull cleaning is too vigorous, or if the paint is not properly adhered to the hull, paint flakes with active copper can be released to the water. This significantly increases the likelihood that the copper concentration in the water will exceed water quality standards.

Alternative Hull Coatings

Alternatives to copper-based antifouling hull paints have been developed in response to water quality concerns about the aquatic toxicity of copper.[3] Alternative hull coatings can be classified into two categories: biocide and non-biocide hull coatings. Examples of alternative (i.e., non-copper) biocides used in hull coatings include zinc, fluorine, chlorine, and various organic biocides. However, switching from copper to an alternative biocide such as zinc may also potentially create water quality problems due to the aquatic toxicity of the alternative biocides. In addition, there is limited information available on the toxicity and long-term environmental impacts of new organic biocides being used in hull paint formulations, such as Econea.

Non-biocide coatings present a hard or slippery surface to deter attachment by fouling organisms. Non-biocide coatings can be classified as either soft or hard. Soft non-biocide coatings may contain silicon or fluoropolymers that result in a slick surface, making it difficult for fouling organisms to attach. Hard non-biocide coatings may be ceramic or epoxy, and are generally used on racing boats and boats stored out of water.

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[2] The Clean Water Act Section 303(d) requires states to list impaired water bodies (i.e., where there is an ongoing failure to meet water quality standards), and to develop a schedule for restoring water quality. Methods may include imposing a total maximum daily load (TMDL) limit on discharges, which can create restrictions on land uses. http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml.

[3] Copper-based hull paints are regulated as pesticides in California by the California Department of Pesticide Regulation. Not all alternative coatings have been registered, as non-toxic paints do not need to be registered.

Selecting an Appropriate Boat Hull Coating

The purpose, frequency of use, and storage location of a boat will determine what type of hull coating is appropriate. An appropriate boat hull paint or coating should be selected that eliminates or minimizes the release of copper into coastal waters, taking into account the coating's cleaning needs, longevity, and availability. Hull paint choices are ranked from most environmentally-friendly to most toxic, in the following order:[4]

1. **Non-Biocide Paints –** Do not contain biocides (such as copper or zinc), and are the most environmentally-friendly choice.
2. **Non-Copper Biocide Paints –** Do not contain copper, but contain other toxic biocides (such as zinc or Econea) that may cause water quality impacts.
3. **Lower Leach Rate Copper Paints –** Contain copper that leaches at a rate at or below 9.5 μg/cm^2/day. The California Department of Pesticide Regulation lists brand names of copper-based hull paint products categorized by their copper leach rate.[5]
4. **Higher Leach Rate Copper Paints –** Contain copper that leaches at a rate above 9.5 μg/cm^2/day. Use of these higher leach rate copper paints increases the risk of aquatic toxicity, and is not recommended.

The performance, longevity, and cost of alternative copper-free coatings compared to copper-based hull paints were determined in an EPA-sponsored study conducted by the Port of San Diego and the Institute for Research and Technical Assistance.[6] Long-term cost differences among coatings took into account differences in hull cleaning frequency and longevity of the paint before reapplication. The most appropriate cost-effective application and cleaning methods were also identified for each type of coating.

The Port of San Diego study concluded that for recreational boaters, non-biocide coatings have many advantages over copper-based paints over the long run. The soft non-biocide coatings in particular were identified as the best alternative options tested in this study, as they are more environmentally-friendly, last longer, and can be cleaned at a similar frequency compared to copper-based hull paints. Alternative coatings currently cost more to purchase and initially apply than copper-based paints. However, because the longevity of non-biocide coatings may be double that of copper-based paints, and re-applying non-biocide coatings does not require that the boat hull be stripped, non-biocide coatings may be more cost-effective over time.

Converting a boat's copper-based hull paint to an alternative coating can be expensive, because alternative coatings often require stripping the copper paint off. In addition, the cost for spray application is higher than painting with a roller, due in part to the facilities needed to ensure that sprayed paint is not released to the environment.

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[4] Port of San Diego; County of Los Angeles, Department of Beaches and Harbors; California State Parks Division of Boating & Waterways; and the California Coastal Commission. (2016). *Boater's Guide to Using Hull Paint in California*. http://dbw.parks.ca.gov/pages/28702/files/Boaters-Guide-to-Using-Hull-Paint.pdf

[5] California Department of Pesticide Regulation. (2015). Memorandum: *List of Copper-Based Antifoulant Paints by Leach Rate Category*. http://www.cdpr.ca.gov/docs/registration/reevaluation/chemicals/final_copper_afp_leachrate_list.pdf

[6] Unified Port of San Diego and Institute for Research and Technical Assistance. (2011). U.S. Environmental Protection Agency Project NP00946501-4. *Safer Alternatives to Copper Antifouling Paints for Marine Vessels: Final Report*. http://www.boatus.com/gov/pdf/EPA-CopperPaint.pdf.

Boat Hull Cleaning

The cleaning schedule and appropriate methods for cleaning alternative hull paints may differ from that for copper-based paints. The Port of San Diego study recommends that hulls with alternative coatings be inspected regularly, and cleaned when a visual inspection determines the presence of fouling organisms. The study recommends that cleaning of hulls with biocide coatings be targeted only on areas of denser fouling; a slime layer may not require immediate cleaning. Soft non-biocide coatings should be hand-cleaned to prevent damage to the coating.

In addition, the release of toxic chemicals from hull cleaning products may be reduced by using non-toxic products, minimizing the use of toxic products, and implementing practices to prevent cleaning products from entering the water.

In response to water quality concerns, the California Professional Divers Association developed a manual of BMPs for in-water hull cleaning.[7] Research by the University of California Cooperative Extension concluded that the BMPs recommended in this manual, including frequent cleanings with the softest tool possible, provide cost-effective fouling control.[8]

Example BMPs for In-Water Boat Hull Maintenance

- Conduct regular hull inspections, and only clean the hull when the extent of fouling growth requires cleaning.
- Minimize cleaning of biocide coatings, in order to maintain the antifouling properties of the coating.
- Soft non-biocide coatings can be cleaned every three or four weeks, depending on the season and extent of fouling growth. Use soft cleaning tools, not power brushes.
- Clean boat hulls only by hand and using cloth, plastic scrapers, or soft scrubbers to remove fouling organisms. If the growth cannot be removed using hand tools, or requires metal scrapers, the boat should be hauled out for cleaning that uses methods to capture loosened paint and fouling organisms.
- Use the least abrasive cleaning method available.
- Refrain from cleaning any hull coating with wet sand paper.
- Do not create a visible plume of bottom paint during in-water hull cleaning.
- Suspend cleaning practices on newly painted hulls for at least 90 days.
- In-water hull scraping, or any other process that occurs underwater to remove paint from the boat hull, should be minimized, and Best Management Practices should be implemented to minimize the release of pollutants into the water.
- Boat hull maintenance areas should be designed to contain potential sources of pollution. Hull maintenance over land allows for the collection and proper disposal of debris, residues, solvents, spills, and polluted runoff. Use tarps to prevent paint overspray, sandblasting media, and debris from boat sanding and refinishing from polluting air and water resources.

[7] California Professional Divers Association. (2008). *Divers Hull Cleaning Best Management Practices Certification Manual.* http://50.87.139.198/prodivers/wp-content/uploads/2012/09/2011-CPDA-BMP-Manual-Rev5a.pdf

[8] University of California Cooperative Extension and California Sea Grant. (2011). *To Clean or Not to Clean: Managing Fouling on Boat Hulls.* http://ucanr.edu/sites/coast/files/77136.pdf.

- Hull maintenance areas should be cleaned regularly to remove trash, sanding dust, paint chips, and other debris.
- Do not sand or strip hull paint underwater.
- Use vacuum sanders to remove paint from hulls and to collect debris during sanding. Vacuum sanding should not occur over water.
- Painting or abrasive blasting should be performed within spray booths or plastic tarp enclosures to prevent residue from being carried into surface waters. If tarp enclosures are used, blasting should not be done on windy days.
- Detergents and cleaning products used for washing boats should be phosphate-free and biodegradable, and the amounts used should be kept to a minimum.
- Detergents containing ammonia, sodium hypochlorite, chlorinated solvents, petroleum distillates, or lye should not be used.
- Report all coating problems (e.g., chips, flaking, or cracks,) to the supervisor or boat owner.
- Report observations of paint in the water, or heavy fouling, to the dock master.

Additional Information

- **Boater's Guide to Using Hull Paint in California (2016).** This brochure by the Port of San Diego, in collaboration with the County of Los Angeles, Department of Beaches and Harbors, the California State Parks Division of Boating & Waterways, and the California Coastal Commission, guides the selection of hull paint that eliminates or reduces the release of copper into coastal waters. http://dbw.parks.ca.gov/pages/28702/files/Boaters-Guide-to-Using-Hull-Paint.pdf

- **List of Copper-Based Antifoulant Paints by Leach Rate Category (2015).** This memorandum by the California Department of Pesticide Regulation lists brand name copper-based hull paint products categorized by their copper leach rate, in three categories. http://www.cdpr.ca.gov/docs/registration/reevaluation/chemicals/final_copper_afp_leachrate_list.pdf

- **Nontoxic Antifouling Strategies.** This webpage by the University of California Cooperative Extension's Coastal Resources program provides information and research results on nontoxic antifouling coatings. http://ucanr.edu/sites/coast/Nontoxic_Antifouling_Strategies/

- **Alternative Hull Paint Testing and Research.** This webpage by the Unified Port of San Diego provides an online tool for boaters to estimate the cost to replace their copper hull paint with an eco-friendly option. Information on alternative boat hull paints and ways to reduce copper pollution in marinas are also available on the webpage. https://www.portofsandiego.org/environment/alternative-hull-paints.html

- **Marine Vessel Service and Repair factsheets.** These factsheets by the Dept. of Toxic Substances Control, California Division of Boating and Waterways, and the California Coastal Commission address techniques proven effective in reducing pollution from marine vessel maintenance operations. http://www.dtsc.ca.gov/PollutionPrevention/Marine.cfm

- **California's Marinas & Recreational Boating Workgroup, and Antifouling Strategy Sub-Workgroup.** These workgroups, coordinated by the California Coastal Commission, the State Water Resources Control Board, and the California Department of Pesticide Regulation, provide an informative forum for agencies (state, federal, and local), marinas, and other organizations to address pollution related to marinas and recreational boating. Informational materials and an archive of meeting presentations are available on the Marinas & Recreational Boating Workgroup webpage https://www.coastal.ca.gov/water-quality/marina-boating/

- **The Boating Clean & Green Program.** This education and outreach program conducted by the California Division of Boating and Waterways and the California Coastal Commission promotes environmentally sound boating practices to marine businesses and boaters in California. http://dbw.parks.ca.gov/?page_id=28767

- **The California Clean Marina Toolkit (2004).** This document prepared by the California Coastal Commission's Boating Clean and Green Campaign is a resource for environmentally-sound marina management and operation. http://dbw.parks.ca.gov/pages/28702/files/marina-toolkit%5b1%5d.pdf

- **California's Clean Marinas Program.** This marina facility stewardship and certification program was developed by marine industry volunteers to protect California's waters from pollution. http://www.cleanmarina.org/

- **EPA's Marinas and Recreational Boating Program.** This program of the U.S Environmental Protection Agency provides factsheets, reports, and guidance documents on the control of pollution from marinas and recreational boating. https://www.epa.gov/polluted-runoff-nonpoint-source-pollution/nonpoint-source-marinas-and-boating