Making Dollars and Sense of Nontoxic Antifouling Strategies for Boats

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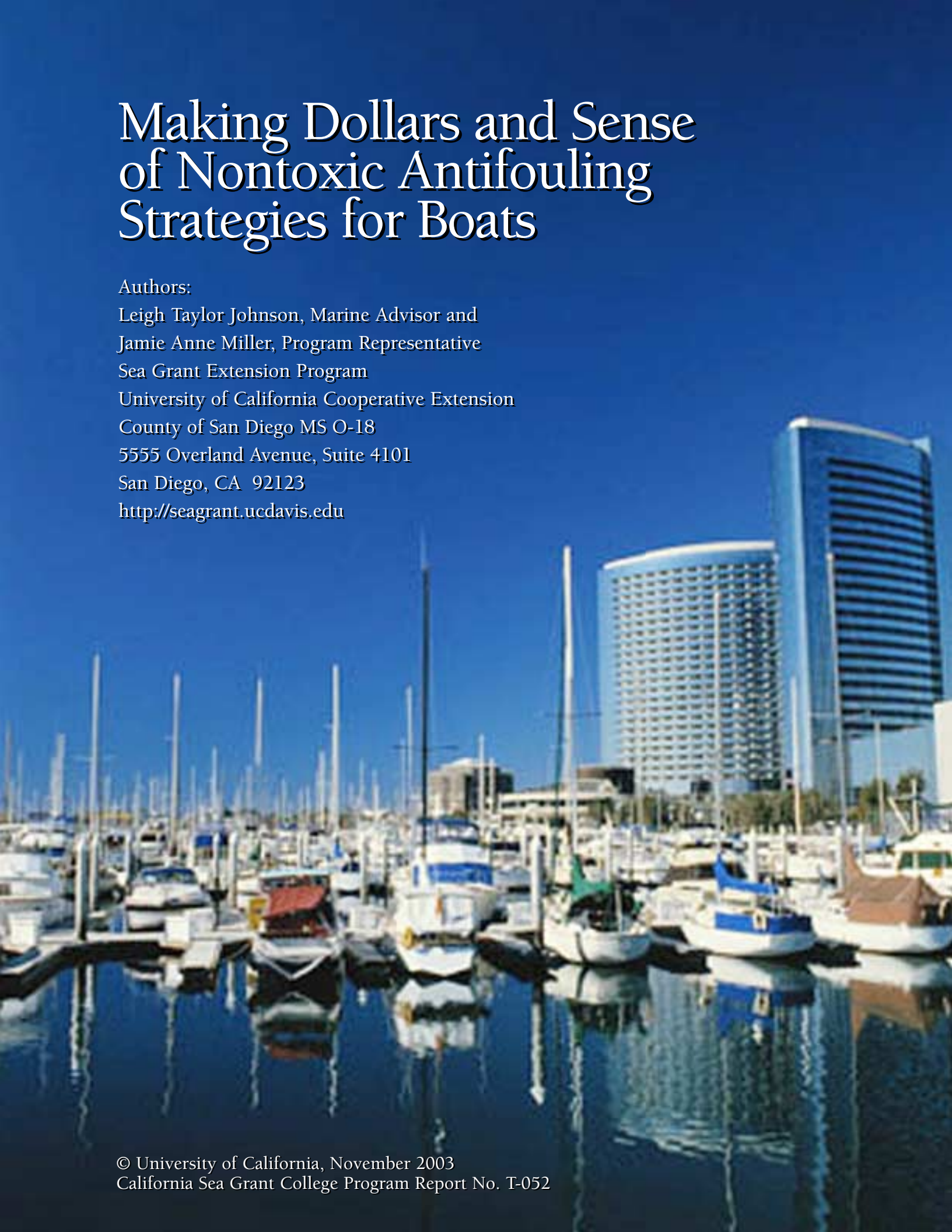

California Sea Grant College Program Report No. T-052

Acknowledgments

The authors gratefully acknowledge Dr. Richard Carson, Ms. Maria Damon and Mr. Robert Koga of the University of California at San Diego, Department of Economics. Dr. Carson provided leadership and all collaborated actively in conducting the research and preparing the study report on which this report is based. We especially want to thank California Senator Dede Alpert, former California Assemblymember Howard Wayne, and Raynor Tsuneyoshi (Director), Don Waltz and Dr. Reinhart (Ron) Flick of California Department of Boating and Waterways. This effort to assist California boaters and boating businesses to improve coastal water quality while maintaining our valuable boating industry would not have been possible without their vision and support.

We also wish to thank: the members of the San Diego Advisory Committee for Environmentally Superior Antifouling Paints; the many boat owners who participated anonymously in survey research; the boat repair yard operators; marina, yacht club, and harbor managers; underwater hull cleaners; paint, coating and other antifouling companies; scientists; agency, trade, and environmental organization staff who gave so generously of their time and expertise to provide the data, insights and review that made the study report and this report possible.

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Funding for this program has been provided in part by the U.S. Environmental Protection Agency (USEPA) pursuant to assistance Agreement No. C9-989697-00-0 and any amendments thereto which has been awarded to the State Water Resources Control Board (SWRCB) for the implementation of California's Nonpoint Source Pollution Control Program. The contents of this document do not necessarily reflect the views and policies of the USEPA or the SWRCB, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Funding for this program has been provided in part by the National Sea Grant College Program of the U.S. Department of Commerce's National Oceanic and Atmospheric Administration under NOAA Grant #NA06RG0142, project number A/EA-1, through the California Sea Grant College Program and in part by the California State Resources Agency, the California Department of Boating and Waterways, the University of California Agriculture and Natural Resources and Center for Pest Management, Research and Extension, the Renewable Resources Extension Act, and the County of San Diego. The views expressed herein do not necessarily reflect the views of any of these organizations.

San Diego Bay Marina

Photo by Jamie Anne Miller

Why Should You Consider a Nontoxic Antifouling Strategy?

The level of dissolved copper found in crowded boat basins with low circulation of San Diego Bay, Newport Bay, and Marina Del Rey is harmful to marine life such as mussels, oysters, scallops, crustaceans and sea urchins. According to scientific studies, it affects the growth, development, reproduction, ability to swim, and survival of various life stages. In fact, the dissolved copper in these boat basins exceeds federal and state standards that were established to protect marine life. In Shelter Island Yacht Basin of San Diego Bay, most of the dissolved copper comes from slow, constant leaching by the antifouling paint on boat bottoms, according to the California Regional Water Quality Control Board, San Diego Region and the Southern California Coastal Water Research Project. Copper pollution is also a concern in other parts of San Diego Bay and in Oceanside Harbor.

As a result, California Regional Water Quality Control Boards are studying the problem and considering how they can protect water quality. Copper-based bottom paints have been banned in recent years for recreational boats in the Netherlands, Denmark and along the east coast of Sweden; some European regulations are under review. Nontoxic antifouling strategies can help boaters to reduce copper levels in boat basins and protect the marine life that provides food for fish and birds.

Boat bottoms need some type of coating that can be cleaned efficiently and that will prevent water penetration. Several types of nontoxic bottom coatings for recreational boats are on the market, for example, durable epoxy and ceramic-epoxy, easy-clean silicone and siloxane, fiber-epoxy, polymer, water-based urethane, and bottom wax. Scientists are studying innovative materials that they hope will have less environmental impact, such as erodable polymers and additives including enzymes, pharmaceuticals and short-lived organic compounds. Independent, long-term testing of new bottom coatings is needed to determine their performance, longevity and lifetime costs in various geographic locations and under various operating conditions and cleaning schedules.

▶ Independent, long-term testing of new boat bottom coatings is needed.

For more detailed information on regulatory programs, environmental effects of dissolved copper and a variety of nontoxic antifouling strategies, please see our 2002 report, "What You Need to Know about Nontoxic Antifouling Strategies for Boats," and the Bibliography at the end of this report. A third report will be published in 2004 on the results of our field demonstration of epoxy, ceramic-epoxy and silicone boat bottom coatings. You are also welcome to visit http://seagrant.ucdavis.edu for more information.

The purpose of this report is to provide information that will assist boat owners; boat repair and maintenance businesses; marina, yacht club, harbor and port managers; paint and coating companies; government agency staff; environmental organizations; and policy makers in making sound, economic decisions on ways to reduce pollution from copper-based and other toxic antifouling paints. Much of it is based on research conducted during 2002 in the San Diego Bay area of southern California and on an extensive report of this study (see Bibliography), that was submitted to the California Department of Boating and Waterways.

Copper-Based Versus Nontoxic Antifouling Strategies - Technical Factors

How Does Each Strategy Work?

Traditional, copper-based boat bottom paints contain between 40% and 70% cuprous oxide. The cuprous oxide is designed to leach out of the paint to slow the growth of fouling organisms such as algae, barnacles and tubeworms. Despite the presence of copper, over time fouling growth can attach to a boat's hull. Boat owners in southern California generally hire a diving service to remove early stages of fouling growth before they harden and become difficult to remove.

A nontoxic antifouling strategy combines a nontoxic boat bottom coating with a companion strategy, such as mechanical cleaning. Because a nontoxic bottom coating will not slow fouling growth, it must be cleaned more often than a copper-based paint if the boat is stored in the water. For example, in San Diego copper-based paints may need to be cleaned once every three to four weeks, but nontoxic coatings may need to be cleaned once every two to two-and-a-half weeks. Regardless of the coating type, bottoms of racing boats are often cleaned shortly before a race to minimize "drag" from fouling growth. Drag is friction created when a boat moves through the water; it increases fuel consumption for powerboats and slows sailboats.

Sailboats Racing in San Diego Bay

Photo by Jamie Anne Miller

Divers who follow best management practices clean copper-based boat bottom paints with a hand-held cloth, piece of carpet, pad or brush. Nontoxic coatings may need to be cleaned with powered scrub brushes, because fouling growth accumulates more quickly. If it is not removed frequently, the fouling growth may harden and very aggressive cleaning may be needed to remove it. Silicone coatings are more delicate and may need to be cleaned by hand. These points will be covered in more detail in a 2004 report on our field demonstration of nontoxic bottom coatings.

Other, typical companion strategies rely on keeping the boat where it will not be exposed to fouling growth. Some boats are stored in racks or on a hoist or trailer. Slip liners are used to surround the boat's hull so that fresh water may be added to lower the salinity and deter marine fouling growth.

How Long Will Copper-Based and Nontoxic Coatings Last?

The lifespan of the coating depends partly on its effectiveness and durability. According to our research, most boat owners in the San Diego, California area replace their boat's copper bottom paint every two or three years, because the cuprous oxide has been depleted. According to paint and coating manufacturers, some nontoxic coatings may last up to twelve years, because they are durable and do not depend on the leach rate of cuprous oxide. One boat in the San Diego area has a five-year old, nontoxic epoxy bottom coating that is still in good condition. Coating lifespan also may vary among geographic areas and according to how the boat is used and maintained. Very aggressive cleaning may wear or damage the paint or coating and shorten its service life.

What Preparation Is Necessary to Apply Copper-Based and Nontoxic Coatings?

If a coating is to be applied by spraying, the work area must be surrounded by tarps to protect structures and other boats from overspray. Because silicone coatings are slippery, special lifting and blocking techniques must be used to prevent the boat from slipping and falling. The boat repair yard should be informed if your boat has a silicone or other, slippery bottom coating.

Reapplying copper-based paint requires at least that the old paint be hydro-washed. One boat repair yard in San Diego recommends hydro-washing followed by

▶ Be sure to tell the boat repair yard if your boat has a silicone or other, slippery bottom coating!

light sanding before repainting. Another finds that good, high-pressure hydro-washing will take care of all except rough spots which need to be sanded, feathered and touched up with an extra coat of paint. A third recommends sanding around the waterline and touching up bad spots with epoxy.

Nontoxic coatings may be applied to the gel coat on new boats or to a similar type of old, nontoxic coating, depending on the product. However, they will not adhere to old, copper-based paints. Thus, old, copper-based paint must be stripped from the hull before a nontoxic bottom coating can be applied.

▶ Old, copper-based paint must be stripped from the hull before a nontoxic bottom coating can be applied.

Dr. Richard Carson of the University of California, San Diego's Department of Economics reports that, during interviews in 2002, boat repair yard owners and hull cleaners estimated that boats generally need to be stripped every 12 to 20 years and 15 years is about average. The authors of this report polled 10 boat repair yards in San Diego and Orange Counties in 2003 who reported boats need to be stripped after 8 to 20 years (one mentioned an outside limit of 30 years). The middle of the range of 8-20 years is about 15 years. Thus, Table 1 uses 15 years as the average stripping frequency for copper-based bottom paints.

Boat repair yard operators explained that the time before stripping is needed can be extended if fouling growth is removed often and carefully and if the surface is cleaned well each time before it is repainted. For example, if remnants of old fouling growth, rough spots, etc. are not removed, the build-up of material may cause the paint to crack and chip when the boat is hauled.

Stripping may also be needed, for example: if there are adhesion problems; if it is an old, wooden boat; if "blisters" must be repaired; or if an "unlike" type of paint will be applied, such as applying a harder paint over a softer paint, or applying a nontoxic coating over a copper-based paint. Some boat repair yards prefer sandblasting, instead of stripping, to remove old paint. Boat owners should talk with several boat repair yards if they are considering a change that may require removing old paint.

How Are Copper-Based and Nontoxic Coatings Applied?

Copper-based paints may be applied with a brush, roller or sprayer. Some nontoxic coatings are applied with a roller, others with a sprayer or special equipment, and some must first be heated. A special "tie" coat may need to be applied to the hull before some silicone coatings are applied.

Blister Repair

Photo by Jamie Anne Miller

Roller Application of Nontoxic Bottom Coating

Photo by Jamie Anne Miller

Copper-Based Versus Nontoxic Antifouling Strategies - Economic Factors

Why Compare Total Lifetime Costs for Bottom Coatings?

Because longevity, application and maintenance profiles differ for copper-based and nontoxic coatings, an economic comparison must consider **total lifetime costs**. The analysis below is based on our survey of paint and coating companies and of San Diego, California boat owners, boat repair yard operators and underwater hull cleaners during 2002 (Carson et al. 2002). It is for a "stylized," 40-foot long boat with an 11-foot beam and 375 square feet of "wet" hull. Table 1 shows cost factors used in the analysis and Figure 1 shows how costs compare over the 30-year life of a new boat for various combinations of paint/coating longevity and application costs.

This stylized boat is painted with either a "typical," copper-based bottom paint containing cuprous oxide or with a "typical," hard and smooth, nontoxic epoxy (or ceramic-epoxy) bottom coating. Epoxy was selected as the typical, nontoxic coating for three reasons. First, because some boat repair yards and underwater hull cleaning companies in the San Diego area have extensive experience with it. Second, because a nontoxic epoxy coating is still in good condition after five years on a local boat. Finally, although silicone coatings are attractive for their easy-clean qualities and a possible increase in boat speed, they require special handling, are more easily damaged, and some are much more expensive than epoxy coatings.

Figure 1 shows the importance of the nontoxic coating's longevity and of considering coating application and maintenance costs over the entire life of the boat. Over 15 to 20 years a long-lasting, reasonably priced, nontoxic, epoxy bottom coating (blue, gold and red, broken lines) can make up for its higher initial costs compared to copper-based paint (black, solid line). Over 30 years the cost of the long-lasting epoxy will be less than that of a copper-based paint. (Note: the cost for both types of paint will be higher, if the boat is repainted and sold at 30 years.)

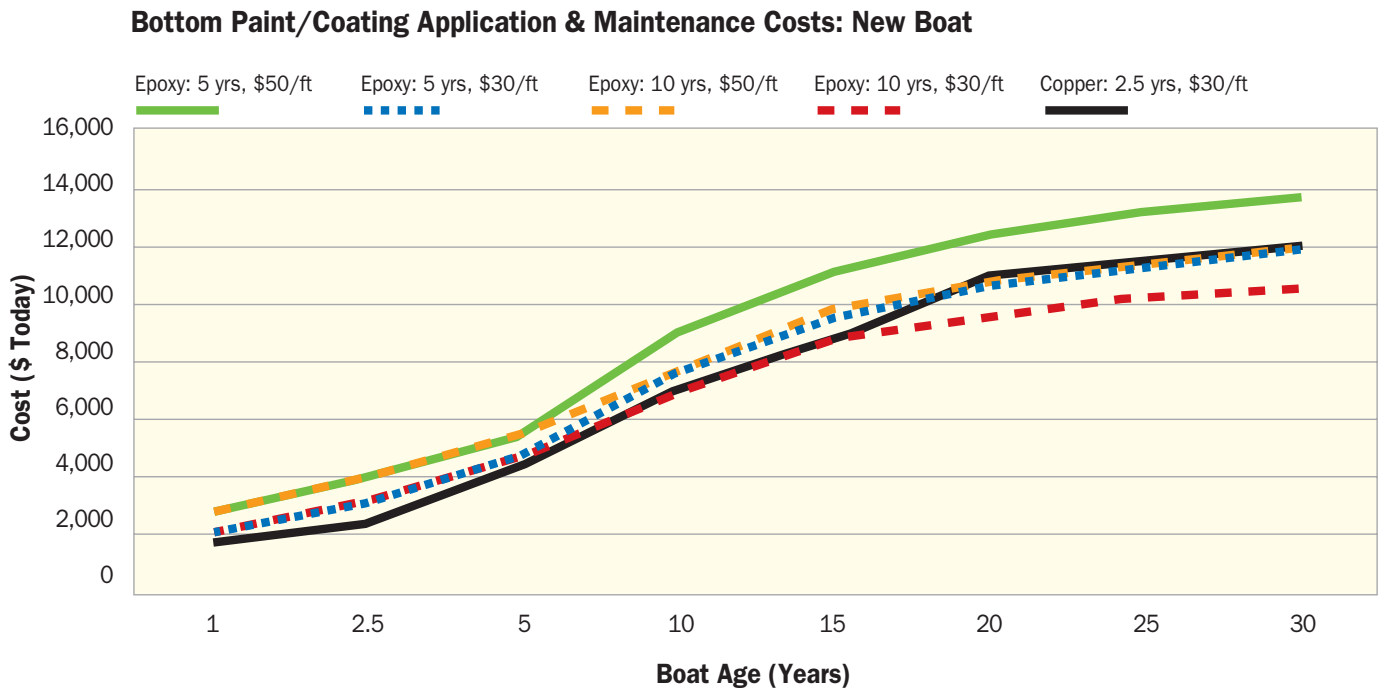
Table 1.

Bottom Paint Application and Maintenance Factors for Lifetime Cost Analysis of New, 40-Foot Long Boat with 11-Foot Beam and 375 Feet of "Wet" Hull (Summer 2002 San Diego Data)

Cost Factor	Copper-based Paint	Nontoxic Epoxy Coating
Haulout, Preparation & Paint Application Cost	$30/foot (typical)	$30/foot or $50/foot
Initial Application	Time "0"	Time "0"
Reapplication Frequency	Every 2.5 years (average)	Every 5 years or every 10 years
Stripping Cost (in addition to above haulout/repaint cost)	$120/foot	$120/foot
Stripping Decision	If hull has "blisters," build-up of paint, etc.	If convert from copper-based or other "unlike" paint
Stripping Frequency (On average at 15 years = every 6th time if reapply paint every 2.5 years)	Every 15 years (on average) See discussion of stripping frequencies under "What Preparation is Necessary..."	If strip every 6th time, then: Every 30 years (if reapply coating every 5 years) Every 60 years (if reapply coating every 10 years)
Hull Cleaning Cost	$1/foot	$1/foot
Hull Cleaning Frequency	14 times/year	22 times/year

Figure 1.

Comparison of 30-Year, Lifetime Costs for a New Boat with Various Combinations of Bottom Paint/Coating Longevity and Application Costs Using Maintenance Factors from Table 1[1,2]



[1] Specifically, Figure 1 shows that:
a. The copper-based paint costs $30 per foot of boat length to apply. It must be reapplied every 2.5 years and stripped after 15 years (black, solid line).
b. The other four lines represent nontoxic, epoxy coatings that must be reapplied either every 5 or 10 years and that may cost either $30 or $50 per foot of boat length to apply. The epoxy coatings will not need to be stripped, because the boat will be retired before it is needed.
c. The epoxy coating that must be reapplied every 5 years and costs $50 per foot of boat length to apply is the only condition in which the epoxy coating costs more over the 30-year life of the boat (green, solid line).
d. The epoxy coating that lasts 10 years before it must be reapplied at $30 per foot costs about the same as copper-based paint after approximately 10 years, costs less than copper-based paint after 15 years, and costs several hundred dollars less than the copper-based paint after 30 years (red, dash-dot-dash line).
e. The other two epoxies cost more than copper-based paint until about 20 years after which they cost a little less than the copper-based paint (blue, dot line = 5 years; $30 per foot; gold, dash line = 10 years; $50 per foot).

[2] "Costs" in Figure 1 are based on a discount rate of 5%. Discount rates allow us to take the time value of money into account and they are chosen to represent what you could reasonably expect if you invested in something else. Generally, discounting makes current costs worth more than future costs. In Figure 1 the 30-year cost for a new boat with copper-based paint is $11,922 with a 5% discount rate. If the discount rate were 0% (time value of money is ignored), then the cost would be $36,000. Figure 1 is taken from Carson et al. (2002).

How Can You Decide Whether to Switch to a Nontoxic Bottom Coating?

In deciding whether to switch to a nontoxic coating, boat owners should consider:

- Whether a nontoxic coating is required where the boat is kept;
- The cost of switching to the nontoxic coating;
- The cost of maintaining the nontoxic coating;
- Whether it may be more cost effective to sell or move the boat to an area where copper pollution from antifouling paint is not a problem; and
- The environmental benefits of reducing copper pollution.

Economically, one of the key issues in switching to nontoxic bottom coatings is that they must be applied to a new or to a stripped hull. However, stripping old paint is expensive. Based on Table 1, the following is a general comparison of copper-based and nontoxic coatings:

Copper-based bottom paints	Nontoxic epoxy bottom coatings
Initially less expensive to apply	Initially more expensive to apply
Do not need to be cleaned as often	Need to be cleaned more often
Need to be reapplied more often	Do not need to be reapplied very often
Need to be stripped on average after 15 years	May not need to be stripped in first 30 years

Hull Paint Stripping

Photo by Jamie Anne Miller

New Boat Construction

Photo by Knight & Carver Yacht Center

The greater longevity of nontoxic, epoxy boat bottom coatings may create cost savings to balance the extra stripping, application and hull cleaning costs. As Figure 1 illustrates, this may result in overall savings in the long term. In other words, **over the short term copper-based bottom paints have a cost advantage but nontoxic epoxy bottom coatings may be the lower cost alternative over the entire lifespan of a boat.** Therefore, based on typical prices in the San Diego region, it would be most reasonable, economically, for boat owners to switch to a nontoxic, epoxy bottom coating if one or more of the following applies:

- The boat is ready to be stripped;
- They are ready to purchase a new boat;
- They expect to keep the boat long enough to amortize the stripping cost; and/or
- A ban on copper-based bottom paints is expected.

Cost Calculation Worksheet

Use the worksheet included in this report to compare costs of using copper-based antifouling paints versus various nontoxic bottom coatings. We suggest you make a copy for each type of paint you want to consider, run the calculations and compare sheets to determine relative costs for each type of paint. Consult your boat repair yard and in-water hull cleaner for cost factors to use in the calculations.

Boater Survey of Economic Incentives

A random sample of 200 San Diego Bay boat owners was surveyed in 2002. The purpose was to determine factors that would be useful to policy makers in creating incentives for boat owners to switch to nontoxic boat bottom coatings. Detailed results can be found in Carson et al. (2002).

The survey first asked about boaters' background knowledge of the copper antifouling paint pollution issue. Most survey participants (63%) knew that there was a pollution problem involving copper in San Diego Bay. Of these, 69% were not aware that recreational boats were the primary source of the copper problem. Less than half knew that the California Regional Water Quality Control Board, San Diego Region is legally required to reduce copper pollution to comply with water quality standards. Overall, 80% of the boaters surveyed were not familiar with any specific nontoxic bottom coatings. Clearly, if copper-based antifouling paints are regulated, educational outreach to the boating community will be necessary to improve water quality in boat basins.

▶ If copper-based antifouling paints are regulated, educational outreach to the boating community will be necessary.

Boat owners were also asked their opinions about the importance of different factors in deciding whether to switch to a nontoxic bottom coating. They answered on a five-point scale from extremely important to not important.

The top three factors that were rated extremely or very important by the following percentages of boaters were:

- The greater longevity of nontoxic coatings (77%)
- A law requiring nontoxic coatings (76%)
- That San Diego Bay would be cleaner if boaters used nontoxic boat bottom coatings (71%)

The other four factors that were rated extremely or very important by the following percentages of boaters were:

- Marina or mooring requires nontoxic boat bottom coatings (62%)
- Hull must be cleaned more often with nontoxic coating (57%)
- Boat would be easier to resell with nontoxic coating (45%)
- Cost to remove old copper paint (39%)

▶ The longevity of nontoxic coatings and a law requiring their use would be paramount to most boaters in making a decision to switch. Almost as many felt strongly that a clean bay would be a critical factor.

Clearly, the longevity of nontoxic bottom coatings and a law requiring their use would be paramount to most boaters in making a decision to switch. However, almost as many boaters felt strongly that a clean bay would be a critical factor in their decision. Nearly two-thirds would be strongly influenced in switching to nontoxic coatings, if their marina or mooring required them to, and more than half indicated that hull cleaning costs would be a critical factor. Interestingly, almost half were concerned about the influence of a nontoxic coating on their ability to sell their boat and more than one-third were concerned about the cost to remove old copper paint.

Boaters were asked to choose their most and least favorite among various combinations of paint types, one-time hull conversion or preparation costs, paint application costs, how often the paint needed to be reapplied, and how often it needed to be cleaned. Results indicated that some boaters were willing to switch to nontoxic coatings, even if they were substantially more expensive than copper paint. This suggests that an educational campaign on nontoxic coatings may persuade some boaters to switch. The largest group of boaters, however, was roughly indifferent between nontoxic and copper coatings with similar prices and performance characteristics. The last group favored copper paint even if it cost more than a nontoxic coating. This suggests that voluntary measures, alone, would not succeed in phasing out copper paints, even if boaters knew that nontoxic coatings have some advantages.

Surveying Recreational Boat Owner

Photo by Jamie Anne Miller

Some of the boat owners were asked to choose among paints after they were told that copper-based paints would likely be banned ten years later. These boaters were 33% more likely to choose nontoxic bottom coatings than those who were not told that a ban was likely.

The boaters' paint choices also suggested that:

- They were willing to pay about $700 in order to wait one more year to paint their boat. This is very close to what they would pay anyway (in average cost per year) for copper-based bottom paint. (San Diego Bay boaters generally paint their boats about every 2 to 3 years and pay between $1500 and $2000. So, waiting to paint their boats every 3 years, instead of every 2 years, should be worth about $700). This result does not say anything in particular about copper versus nontoxic coatings. However, since nontoxic coatings will generally last longer, it says that boaters will be willing to pay more for them.
- They did not care whether a particular paint had a high or a low copper content. This suggests they did not see much value in marginal reductions in copper losses. Further, the research suggested that most low-copper paints require more frequent repainting or more coats of paint. Hence, the total amount of copper leached from the hull over long time periods may be quite similar to regular copper paints.
- They were willing to pay about $500 more to have a nontoxic coating applied to their boat, instead of a copper-based paint.
- They distinguished between one-time conversion costs and paint application costs.

How Can We Make a More Economical Transition to Nontoxic Boat Bottom Coatings?

Policy Instruments

The 2002 economic study was mandated by the California Legislature to identify incentives necessary for ensuring that nontoxic alternatives to metal-based antifouling hull coatings are used for recreational vessels. The manner in which a transition from copper-based to nontoxic coatings is structured can create incentives and reduce costs to boat owners. The following policy instruments, which are based on study results, may be useful for policy makers to consider in resolving the problem of copper pollution in boat basins while maintaining the economic viability of boating. The California boating industry was worth $16.5 billion, or 1.2% of the total Gross State Product, in 2000 according to a study by California State University, Sacramento Foundation. It supported over 284 thousand jobs and generated $1.6 billion in state and local taxes.

Hauling Sailboat

Photo by Jamie Anne Miller

- The most important single policy instrument would be to require that new boats use only nontoxic coatings. This would begin the phase-out of copper and save boat owners money in the long run.
- The second most important policy instrument would be to announce a future ban on the use of copper paint. This would raise the value of boats with nontoxic coatings and strongly influence decisions to repaint with a copper or nontoxic coating when old paint is being stripped from a boat's hull.
- Any plans to phase out copper paint should consider boat repair yard capacity and the stripping schedule for old bottom paint. For example, phasing out copper paint for all 7,342 recreational boats that were kept in San Diego Bay in summer, 2002 would cost $20 million above and beyond usual maintenance costs, if it occurred over 7 years, which is the shortest possible time given local boat repair yard capacity. However, if it occurred over 15 years, it would cost only $1 million extra. This is because it would allow boats to be converted to nontoxic bottom coatings when they are 15 years old and are typically ready to be stripped. Further, this would allow time for new and improved nontoxic coatings to be developed and evaluated.

Education

Two types of educational programs are needed for a successful and sustainable phase-in of nontoxic antifouling strategies:

- A two-year, educational effort is needed for boat owners and boating industries on the copper pollution problem, nontoxic antifouling strategies, and short- versus long-term costs of nontoxic coatings relative to copper-based paints
- A two-year, commercial demonstration is needed for boat repair yards and underwater hull cleaning companies to acquire special equipment and to develop expertise needed for applying and maintaining nontoxic boat bottom coatings.

Parting Thoughts

Regulatory agencies are concerned about high levels of dissolved copper in southern California boat basins. They are required to regulate pollution sources to restore water quality to legal standards. Scientific research has found that passive leaching by antifouling paints on recreational boats is the primary cause of copper pollution in several, southern California boat basins. As a result, agencies are likely to require changes in antifouling strategies in order to reduce copper discharges from antifouling paints.

The University of California Cooperative Extension – Sea Grant Extension Program's goal is to provide information that will be useful to boat owners, boating businesses, harbor and port district managers, policy makers, regulators and environmental organizations for improving water quality while sustaining California's valuable boating industry. Nontoxic antifouling strategies offer a means for controlling fouling growth and reducing copper pollution in boat basins. The study on which this report is based used data on coatings, prices and conditions that applied in San Diego during 2002. Readers should adapt the information in this report to suit current coatings, prices and conditions that apply in their local areas.

▶ Adapt the information in this report to suit current coatings, prices and conditions that apply in your local area.

Boat owners reported that clean water was important to them and some were willing to pay a little more in order to have a nontoxic boat bottom coating. According to our research results, boat owners are not likely to face a significant price increase for maintaining the hulls of their boats, when considered over the lifetime of the boat and if a long-lasting, nontoxic coating is selected. It is most cost effective to switch to a nontoxic coating when a boat is new and unpainted or when it is ready to have old layers of copper-based paint stripped. If a ban on copper-based paint were announced, a boat with a nontoxic coating would become more valuable. This would help the owner to recover costs of conversion if the boat were sold before costs have been amortized.

"The University of California Cooperative Extension – Sea Grant Extension Program's goal is to provide information that will be useful to boat owners, boating businesses, harbor and port district managers, policy makers, regulators and environmental organizations for improving water quality while sustaining California's valuable boating industry."

Boat owners and boating industries need to be educated about copper pollution problems and solutions. Boat repair and maintenance companies need to acquire special equipment and develop expertise for handling nontoxic boat bottom coatings.

The demand for a variety of nontoxic antifouling strategies is likely to increase, if concern over copper pollution in boat basins becomes widespread. For example, wooden boats may need a flexible, nontoxic coating. Paint and coating companies are already developing new products in anticipation of this demand. Independent, long-term testing of the longevity and performance of new coatings is needed in different geographic areas and under different operating and maintenance conditions. As demand increases, nontoxic coating prices are likely to fall due to competition between manufacturers and economies achieved by producing larger quantities. Coatings that are easier to maintain, enhance speed and have lower hull preparation and application costs will further enhance the desirability of nontoxic antifouling strategies.

Cruising Past Coronado

Photo by Knight & Carver YachtCenter

Legislative and Research Foundations of Report

California Senator Dede Alpert and former Assemblyman Howard Wayne introduced Senate Bill 315 that was passed by the Legislature in 2001. It mandated a study to identify incentives for boaters to use nontoxic alternatives to metal-based antifouling hull coatings, and appropriated $50,000 from the Harbors and Watercraft Revolving Fund to the California Department of Boating and Waterways to provide funds for the study. This Legislation also established the San Diego Advisory Committee for Environmentally Superior Antifouling Paints to make recommendations and advise on the preparation of the study report. The committee included representatives of the following organizations:

Voting members: San Diego Association of Yacht Clubs, San Diego Port Tenants Association, San Diego Unified Port District, San Diego boatyard, marina, and recreational boater representatives, California Professional Divers Association, Environmental Health Coalition, San Diego Regional Water Quality Control Board, Department of Boating and Waterways, University of California Sea Grant Extension Program. Non-voting members: The United States Navy and Department of Pesticide Regulation.

The California Department of Boating and Waterways contracted with the University of California Sea Grant Extension Program and the University of California at San Diego, Department of Economics to conduct the research and prepare the study report, "Transitioning to Non-Metal Antifouling Paints on Marine Recreational Boats in San Diego Bay" in 2002. The study report incorporated data from scientific and other literature and from surveys of 200 boat owners and numerous boat repair yard operators, marina and yacht club managers, underwater hull cleaning companies, paint and coating companies, government agencies and environmental organizations. Many funding sources contributed to the study and to this report and they are recognized in the Acknowledgments. This report is based on the 130-page study report that was submitted to the Department. Neither report necessarily reflects the views of the California Department of Boating and Waterways or other funding sources.

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Calculate Your Cost to Use Copper-Based Paint vs. Nontoxic Bottom Coating!

Paying the Boatyard Bill

Photo by Jamie Anne Miller

Application and maintenance costs for copper-based boat bottom paints and nontoxic boat bottom coatings depend on costs to: prepare the hull; buy, apply, reapply and strip the paint/coating; and perform in-water hull cleaning. San Diego research found that nontoxic coatings do not slow fouling growth, so in-water cleaning must be performed about twice as often as for copper-based paints. Further, nontoxic coatings do not adhere to copper-based paint and stripping paint is expensive. So, the best time to switch to a nontoxic coating is when a boat is new and unpainted or when it is ready to be stripped of old paint layers (on average after 15 years). A durable nontoxic coating might last longer than a copper-based paint. If so, it might have equal or lower lifetime application and maintenance costs.

To compare costs for copper-based and nontoxic coatings, consider: the expected remaining life of the boat, how long you plan to own it, and whether copper-based paints are likely to be regulated where you or a prospective buyer will keep it. If so, a boat with a nontoxic coating might be more valuable.

Use the worksheet to calculate and compare total costs for various combinations of: paint or coating type; how long you plan to keep the boat or its remaining expected life; and in-water hull cleaning schedule. **Make a copy of this worksheet for each combination you want to evaluate. Ask your local boat repair yard and in-water hull cleaner for figures to use in the table.** This method does not account for the time value of money (discount rate; explained in footnote 2 of Figure 1).

Worksheet results are sensitive to how often you strip, repaint and perform in-water hull cleaning as well as to paint stripping and application costs. You may wish to get estimates from different companies and try various combinations of figures to get a clearer idea of how they might affect total costs before you make a decision.

To convert to a nontoxic coating you will need to strip old copper paint. Use this year as a baseline to calculate future reapplication and stripping costs and use figures for a nontoxic coating. Otherwise, use figures for the type of paint or coating you plan to apply or reapply. Include this year in the number of times you will coat the boat's bottom. Consider that you may not want to strip and repaint the bottom if the boat is near the end of its expected life or if you plan to sell it. Note that Lines 2 and 4 adjust for boat repair yard practice of quoting for entire job, instead of quoting stripping cost separately.

Hauling Out for Refinishing

Photo by Jamie Anne Miller

Lifetime Bottom Coating Cost Calculation Worksheet

Boat Type: _____ Old Paint/Coating Type: _____ New Paint/Coating Type: _____

1. Length of Boat in feet	feet
2. Standard Paint/Coating Application Cost per foot (haul, prepare hull, buy/apply paint/coating)	$
3. Reapplication Frequency (number of years between each repainting/recoating)	years
4. Paint/Coating Stripping Cost per foot (haul, strip, prepare hull, buy/apply paint/coating – Line 2)	$
5. How many years ago boat was last stripped (or was new)	years
6. Hull Cleanings per year	times/year
7. Cost of Hull Cleaning per foot	$
8. Expected Years in Boat's Lifetime or That You Plan to Own Your Boat	years

PAINT/COATING APPLICATION:

Expected Life of Boat **(Line 8)** _____ **years** ÷ Reapplication Frequency **(Line 3)** _____ **years** = _____ **(A)**
Note: Round (A) down to nearest whole number.

Boat Length **(Line 1)** _____ **feet** x Standard Paint/Coating Application Cost **(Line 2)** _____ **per foot** = $ _____ **(B)**

Multiply (A) _____ **X (B)** _____ **= $** _____ **(C) to find the application cost for the remaining life of your boat.**

PAINT/COATING STRIPPING:

Boat Length **(Line 1)** _____ **feet** x Paint Stripping Cost **(Line 4)** _____ **per foot = $** _____ **(F)**

Number of applications before paint is stripped (usually after 6th application) _____ applications
x Reapplication frequency **(Line 3)** _____ **years = _____ (J)**

Paint Stripping Frequency **(Answer J)** _____ **years –** Boat was stripped or new **(Line 5)** _____ **years** ago
= _____ (D) *Note: Round D down to nearest whole number and see below for help in using (D).*

Expected Life of Boat **(Line 8)** _____ **years ÷ Answer (D)** _____ **= _____ (E)** See below for help in using **(E)**.

If Answer **(D)** is negative, the boat is overdue for stripping and Answer **(E)** will be at least 1. If the remaining life of the boat is also less than the stripping frequency, you might not need to strip it a second time. If so, then **(E)** = 1.

If **(E)** is more than 1, round down to nearest whole number. Below, multiply **(E)** by Answer **(F)** to find stripping cost.

If you are converting to a nontoxic coating, **(E)** will be at least 1 and you should use this year as a baseline for future reapplication and stripping costs.

Otherwise, if **(E)** is less than 1, then you might not need to strip the paint/coating from your boat because it is new, close to its life expectancy or has recently been stripped. If this is the case, then paint stripping cost **(G)** = 0.

Multiply (E) _____ **X (F)** _____ **= $** _____ **(G) to get the stripping cost for the remaining life of your boat.**

IN-WATER HULL CLEANING

Boat Length **(Line 1)** _____ **feet** x Hull Cleanings per year **(Line 6)** _____
x Hull Cleaning Cost/foot **(Line 7) $** _____
x Remaining life expectancy or ownership of boat **(Line 8)** _____ **years**
= $ _____ **(H) hull cleaning cost for the remaining life of your boat.**

Add answers C, G, and H for total cost of paint application, stripping, and hull cleaning for the remaining life of your boat:

C = $ _____ **+ G = $** _____ **+ H = $** _____ **= Total Cost $** _____


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EVALUATION: MAKING DOLLARS AND SENSE OF NONTOXIC ANTIFOULING STRATEGIES

Would you please help us to evaluate the effectiveness of our booklet by completing and returning the evaluation form? Thank you!

Please put an X by all of the groups to which you belong:

_____ Recreational Boat Owner
_____ Boating Association
_____ Marina or Yacht Club Manager
_____ Trade Association Manager
_____ Boat Repair Yard Company
_____ Environmental Organization
_____ Paint/Coating Company
_____ Underwater Hull Cleaning Company
_____ Port or Harbor Authority Commissioner
_____ Port or Harbor Authority Staff
_____ Other Elected/Appointed Official
_____ Other Government Agency Staff
_____ University Researcher
_____ Consultant
_____ Other:_____

Please circle the number that indicates how much you agree with the following statements, using this rating system:
1 = Do not agree, 2 = Agree slightly, 3 = Agree somewhat, 4 = Agree very much, 5 = Agree extremely

1 2 3 4 5 The information in the brochure will be USEFUL TO ME in understanding and making decisions about antifouling STRATEGIES for recreational boats.

1 2 3 4 5 The information in the brochure will be USEFUL TO ME in understanding and making decisions about antifouling POLICIES for recreational boats.

1 2 3 4 5 The Cost Calculation Worksheet will be USEFUL TO ME in making decisions about switching to a nontoxic coating.

Please place an <u>X</u> beside each topic in the booklet that provided you with NEW information:

_____Copper-based antifouling paints can create a problem for marine life in boat basins.

_____Nontoxic antifouling strategies include a nontoxic coating and a companion strategy.

_____ Nontoxic bottom paints will not adhere to existing, copper-based paints.

_____ As a result, unpainted hulls and those that need to have old paint layers stripped are the most cost effective candidates for nontoxic paint.

_____ Nontoxic coatings must be cleaned about twice as often as copper-based antifouling paints.

_____ Silicone coatings release fouling growth with boat speed of 20 knots or with gentle wiping, may increase boat speed, require special handling, and have a shorter life than epoxy coatings.

_____Total lifetime costs (application, longevity, maintenance) for a boat are important in choosing bottom coatings.

Please continue on next page……

_____ The greater longevity of nontoxic, epoxy coatings may create cost savings to balance the extra stripping, application , and hull cleaning costs which may result in overall savings in the long term.

_____15 years is the average time before built-up copper-based paint must be stripped in the San Diego area.

_____ Replacing copper antifouling paints with nontoxic, epoxy coatings on recreational boats in San Diego Bay over 7 years could cost $20 million, but only $1 million if they were phased out over 15 years.

_____To begin phasing out copper paints, the most important policy instrument would be to require that new boats use only nontoxic coatings.

_____Announcing a future ban on copper antifouling paints would increase the value of boats with a nontoxic coating.

Please place an X beside the components of the booklet that were clear and understandable and explain why or why not? If not, please let us know how they could be improved:

_____Was "Table 1: Bottom Paint Application and Maintenance Factors for Lifetime Cost Analysis of New, 40-Foot Long Boat with 11-Foot Beam and 375 Feet of 'Wet' Hull" clear and understandable? Why/Why not?

_____Was "Figure 1: Comparison of 30-Year, Lifetime Costs for a New Boat with Various Combinations of Bottom Paint/Coating Longevity and Application Costs" clear and understandable? Why/Why not?

_____Were "Lifetime Bottom Coating Cost Calculation Worksheet Instructions" clear and understandable? Why/Why not?

_____Was "Lifetime Bottom Coating Cost Calculation Worksheet" clear and understandable? Why/Why not?

Please comment or suggest other antifouling related information that would be useful to you:

Thank you for helping us to evaluate the effectiveness of our research and education programs!!

Please fax or mail the completed evaluation to:

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