M E M O R A N D U M

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SUBJECT: DETERMINATION OF MAXIMUM ALLOWABLE LEACH RATE AND MITIGATION RECOMMENDATIONS FOR COPPER ANTIFOULING PAINTS PER AB 425

The Department of Pesticide Regulation (DPR) placed copper-based antifouling paint (AFP) products into reevaluation in June 2010 to address elevated copper concentrations in salt water marinas that are primarily a result of extensive use of copper AFPs on recreational boat hulls.

To date, affected pesticide registrants have complied with the reevaluation data requirements, including disclosure of product copper leach rate, paint types, and potential mitigation strategies that have been valuable to the Environmental Monitoring Branch (EMB) as our staff evaluate mitigation approaches to address the issue. The registrants also funded a passive leaching and hull cleaning study (Earley *et al.*, 2013) to provide DPR with data on copper loading and the water quality impacts of in-water hull cleaning. Reevaluation continues as DPR works toward implementing solutions that will reduce copper concentrations in California marinas.

In October 2013, the Governor signed Assembly Bill (AB) 425 (Atkins) into law. AB 425 states, "No later than February 1, 2014, the Department of Pesticide Regulation shall determine a leach rate for copper-based antifouling paint used on recreational vessels and make recommendations for appropriate mitigation measures that may be implemented to address the protection of aquatic environments from the effects of exposure to that paint if it is registered as a pesticide."

The purpose of this memorandum is to present: 1) DPR's modeling approach and rationale for decision making; 2) DPR's recommendations for mitigation; and 3) the selected maximum allowable leach rate.

Modeling Approach and Rationale for Decision Making

EMB utilized the Marine Antifoulant Model to Predict Environmental Concentrations (MAM-PEC) as a reliable modeling tool to simulate the fate of copper in typical California marinas. Scientists and regulators worldwide (including the U.S. Environmental Protection Agency and the European Union) commonly utilize MAM-PEC to predict environmental concentrations of AFP biocides in a variety of marine environments. In our case, we used MAM-PEC in a manner that ultimately generated a maximum allowable copper leach rate for boats painted with copper AFPs.

DPR selected the California Toxics Rule (CTR) chronic criterion of 3.1 µg/l or parts per billion (ppb) dissolved copper as the statewide target for the reduction of copper loading from AFPs in California marinas. The CTR acute and chronic criteria are currently being enforced by the State Water Resources Control Board and the nine Regional Water Quality Control Boards (collectively referred to as the Water Boards).

With the CTR reduction target in mind, EMB relied on data for 20 California salt water marinas to accurately construct marina scenarios that reflected various levels of copper loading (for detailed modeling analysis see Appendix 1). Five scenarios were subsequently established to define distinct risk management levels. The lowest marina scenario (i.e., #1) represents marinas with 733 boats, which is the median size among the 20 sampled marinas. Scenario 2 represents marinas with 1,270 boats (75^{th} percentile in size); scenario 3 represents marinas with 1,833 boats (90^{th} percentile in size); scenario 4 represents marinas with 2,263 boats (95^{th} percentile in size). Scenario 5 represents marinas with 4,754 boats (largest in size among the sampled marinas), which is comparable to Marina del Rey in Los Angeles County.

As an initial step in determining the maximum allowable leach rate for the five scenarios, EMB modeled the leach rates produced under the condition that the average predicted concentration of dissolved copper within a marina is below the CTR of 3.1 µg/l. This modeling procedure produced the maximum allowable leach rates for each of the five scenarios that range from 1.12 to 24.60 $\mu g/cm^2/day$ (Appendix 1, Table 6, "LR_0" column).

Since in-water hull cleaning commonly occurs in California marina waters, we must adjust these leach rates appropriately to account for the impacts of this activity on passive leaching. Note that cleaning produces particulate copper as well as dissolved copper; however, for the purpose of our analysis, we focused only on dissolved copper.

Although Earley *et al.* (2013) showed that the in-water hull cleaning event itself represents only about 1–3% of dissolved copper loading to the 3-year life span of the AFP, their data also showed that the refreshment of the painted hull surface ultimately causes a spike in passive leaching that gradually declines to the baseline or steady state leach rate within about four weeks.

Therefore, as a direct result of this activity, the regular refreshment of the painted hull can contribute to 59% (average for epoxy and ablative AFPs) of the dissolved copper loading over the 3-year life span of the paint if a relatively abrasive 3M™ pad is used for scrubbing. Note that the use of this material is not considered to be a best management practice (BMP) and therefore we consider this to be a worst case cleaning scenario. For the purpose of determining a maximum allowable leach rate, EMB conservatively assumed that this non-BMP practice is used by all in-water hull cleaners on all boats in every marina. Adjustments for non-BMP in-water hull cleaning lower the initial leach rates to a range of 0.46 to 10.09 µg/cm^2/day (Appendix 1, Table 6, "LR_2" column).

EMB compiled a list of leach rates for 169 copper AFP products that were actively registered as of December 2013, using data submitted by registrants. Leach rates ranged from 1.0 to 29.6 µg/cm^2/day with a mean of 11.1 µg/cm^2/day. With this list, EMB determined that for scenarios 1, 2, 3, 4 and 5, the percentage of currently registered copper AFP products that exceed each scenario's associated leach rate were 50, 85, 91, 97 and 100, respectively. Note that the calculated maximum allowable leach rates could change if other actions that impact copper leaching from boat hulls are taken.

Recommendations for Mitigation

EMB assumes that the AB 425 requirement for the "determination of a leach rate" means a maximum allowable leach rate that will serve as a limit for California registered copper AFP products. As noted above, this would mean some percentage of currently registered products would be required to reformulate. EMB has determined that reformulation to AFP products to reduce copper leach rates will dramatically decrease copper loading in marinas. This impact will be pronounced in any of the five scenarios we have defined. However, if product reformulation is to play a key part in the mitigation of copper in marinas, other critical activities need to also be implemented to ensure the overall success of this endeavor. Appendix 2 contains a list of mitigation recommendations from EMB and includes the identification of the parties likely to be involved and a short rationale for the recommendation. Besides reformulation of copper AFP products, these recommendations also include:

- Require in-water hull cleaners to implement BMPs for in-water hull cleaning.
- Reduce in-water hull cleaning frequency to no more than once per month.
- Include painted-hull maintenance information as part of product labels.
- Develop for distribution hull maintenance brochures to be provided to boaters via boatyards at the time of painting.
- Increase boater awareness and acceptance of copper AFP alternatives.
- Foster new incentive programs and continue support for existing programs to convert copper-painted boat hulls to those painted with alternatives.

- Consider site-specific objectives (SSOs) for copper for certain marinas or harbors.

In Appendix 1, EMB further quantitatively explored the impacts that the implementation of many of these recommendations could have on bringing California salt water marinas to compliance with the CTR chronic criterion. Two of these quantitative evaluations that relate to in-water hull cleaning are summarized below.

Earley *et al.* (2013) tested an in-water hull cleaning BMP that employed soft pile carpet as the scrubbing material. This BMP came directly out of the California Professional Divers Association's (CPDA's) hull cleaning BMP certification manual (CPDA, 2008). The BMP material was tested against a more abrasive non-BMP 3M™ pad. Data showed that the BMP cleaning only contributed to 43% (average for epoxy and ablative AFPs) of the copper loading over the 3-year lifespan of the paint compared to 59% from the non-BMP cleaning.

EMB staff also observed that by limiting the frequency of cleaning to monthly during the entire year, up to five less passive leaching spikes are eliminated over the 3-year lifespan of the paint. The cleaning schedule used by Earley *et al.* (2013) was once every three weeks in the summer (June, July, August) and once every four weeks the rest of the year. Loading comparisons showed that a monthly frequency of cleaning lowers copper loading from 43% to 29% over the 3-year lifespan of the paint. Implementation of an even lower frequency of cleaning (e.g., every five weeks, bimonthly) could further reduce copper loading; however, reduction in frequency should be carefully weighted with the benefits of cleaning.

Implementation of these two proposed actions to decrease the magnitude of passive leaching of copper allows DPR to work with a higher range of leach rates that provides greater flexibility in maintaining sufficient product efficacy in reformulated products. Efficacy is critical for the effective control of native fouling species as well as non-native aquatic invasive species. If monthly, soft-pile carpet BMP becomes the accepted industry norm for a cleaning regime, this will allow DPR to work with scenarios with maximum allowable leach rates that range from 0.79 to 17.47 $\mu g/cm^2/day$ (Appendix 1, Table 6, "LR_3" column).

<u>Selected Maximum Allowable Copper Leach Rate</u>

Based on our modeling analysis, DPR recommends the establishment of the maximum allowable copper leach rate for AFP products at 9.5 $\mu g/cm^2/day$ under the condition that in-water hull cleaners follow CPDA's BMP method with soft-pile carpet and that cleaning cannot be performed more frequently than once per month.

For copper AFP products that do not require in-water cleaning, DPR recommends the establishment of the maximum allowable copper leach rate at 13.4 $\mu g/cm^2/day$ under the condition that in-water hull cleaning of any type is prohibited. Registrants will need to prove this

specific product claim to DPR via studies that are conducted in appropriate California marine settings.

In order to reinforce product-specific requirements for in-water hull maintenance for both categories of AFPs to boat owners, brochures or other forms of outreach materials need to also be provided to them. The most logical strategy for product-specific outreach is probably to have boatyards provide brochures to boat owners at the time of painting. More general outreach is important as well in the overall mitigation effort. Other points of distribution (e.g., marinas, AFP retailers, and boating events) will need to be explored.

Setting a maximum allowable leach rate at 9.5 $\mu g/cm^2$/day should result in about 58% of the currently registered copper AFP products or approximately 100 products having to be reformulated. The highest leaching product currently available has the leach rate of 29.6 $\mu g/cm^2$/day. This is equivalent to a maximum of 68% reduction in leaching rate.

The selection of these two leach rates is protective of marinas in scenario 2 where EMB expects waters in marinas that contain as many as 1,270 boats to be in complete compliance with the chronic CTR criterion of 3.1 ppb. Nearly all California salt water marinas are addressed in scenario 2. EMB expects to also observe a significant reduction in dissolved copper concentrations in the larger marinas of scenarios 3, 4, and 5. Although dissolved copper concentrations in these marinas may still at times exceed the CTR criterion, the eventual reduction in copper loading will increase protection of aquatic organisms in all of California's marinas.

EMB expects to see increased adoption of non-copper alternatives (i.e., coatings or technologies) in the future considering the amount of research, development, testing, and demonstration of alternatives that has taken place in recent years. Using our model, we estimated that a 12% adoption rate of non-copper alternatives will bring the marinas belonging in scenario 3 (those with 1,833 boats or less) into compliance with the CTR criterion. A larger adoption rate will bring even larger marinas into compliance. EMB will continue to work with stakeholders groups to facilitate greater adoption of AFP alternatives, including biocide-free products that are a growing presence in the marketplace.

Interested parties may also pursue development of SSOs for consideration by the Water Boards. Before undertaking this effort, parties should discuss the various approaches available to them with a representative of the Water Boards. The Water Effects Ratio approach already exists as option. The Biotic Ligand Model (BLM), which represents a reliable and economical way to calculate site-specific standards in fresh water, is being evaluated by U.S. EPA for use in the salt water environment. Note that in a letter from its Executive Director to the San Diego Port Tenants Association dated September 13, 2013, the State Water Resources Control Board (State Water Board) stated its support of the U.S. EPA in pursuing and making it a priority to complete

development of salt water copper criteria using the BLM. In that letter, the State Water Board also stated that if a BLM for salt water copper criteria was completed, then it would provide another tool that could be used by the Water Boards in developing SSOs for copper.

It is important to stress that reformulation alone based on the selection of any of the five scenarios we developed represents a significant reduction of copper loading to all salt water marinas in California. Reductions should also benefit brackish and fresh water marinas that harbor boats with copper AFPs. The full water quality impact of the this mitigation effort may not be realized for many years due to the timeframes involved with reformulation, relabeling, registration approval, and market distribution. Moreover, the rate at which boatyards can convert boat hulls (i.e., strip existing AFP and apply a new one) is limited. Therefore, the eventual transition to reformulated AFP products will also be dependent on this factor. We would, however, expect to see more immediate improvements in water quality from changes to in-water hull cleaning practices.

As a part of the copper AFP reevaluation, DPR will begin immediate discussions with copper AFP registrants and U.S. EPA regarding reformulation, data requirements (e.g., efficacy), label restrictions and outreach for boaters, boatyards, and marinas. DPR will additionally engage with the Water Boards, registrants and key stakeholder groups to further refine and implement the overall mitigation effort.

We request your approval of this determination. If you or your staff have any questions or require additional information, please contact Nan Singhasemanon, of my staff, at 916-324-4122 or <nsinghasemanon@cdpr.ca.gov>.

APPROVED: *Original Approved By* DATE: 01/30/14
Brain R. Leahy, Director

Attachments

cc: Victoria Whitney, SWRCB, Deputy Director (w/Attachments)
Chris Reardon, DPR, Chief Deputy Director (w/Attachments)
Nan Singhasemanon, DPR, Sr. Environmental Scientist (w/Attachments)

References

Patrick J. Earley, Brandon L. Swope, Katherine Barbeau, Randelle Bundy, Janessa A. McDonald & Ignacio Rivera-Duarte, Biofouling (2013): Life cycle contributions of copper from vessel painting and maintenance activities, *Biofouling: The Journal of Bioadhesion and Biofilm Research*, DOI: 10.1080/08927014.2013.841891

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