Use of Preservative-Treated Wood and Alternative Materials for Building Overwater and Waterfront Structures

Factsheet for the Marinas Interagency Coordinating Committee meeting, May 30, 2019

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This is a summary of information and recommendations compiled by Coastal Water Quality Program staff. It is not a finding by the Coastal Commission, and it may be superseded by site-specific information.

Overview

This factsheet summarizes ways to minimize the water quality impacts of materials used to build an overwater structure (such as a pier, wharf, dock, boat launch, or bridge) or waterfront structure (such as a bulkhead, esplanade, or boardwalk). These building materials have the potential to adversely impact water quality and aquatic species, especially in areas with a low water flow rate (such as harbors and marinas). Construction and maintenance practices used in or over coastal waters must also be carefully considered, in order to protect water quality.

When building an overwater or waterfront structure, it is important to ensure that the structure will be durable and has a long service life, because overhauling these structures is costly and can be disruptive to both the environment and the public. Wood used in aquatic environments is commonly pressure-treated with preservatives ("treated wood") to protect against decay, insects (including termites), and marine boring organisms. A coating (such as polyurea or epoxy) or wrapping (such as industrial-grade plastic or fiberglass) may also be applied to building materials to protect against damage from vessel impacts, corrosive saltwater, and marine borers.

However, the pesticides in wood preservatives – commonly copper – can adversely impact aquatic species, especially fish and invertebrates, and may accumulate in the underlying sediment. The use of treated wood in or over water is of particular concern in projects with one or more of these features: 1) installation of a large amount of treated wood; 2) a low water flow rate; and 3) where populations of especially copper-sensitive aquatic organisms may be present. A variety of building materials (such as concrete, metal, fiberglass, plastic, polymer composites, and naturally decay-resistant wood) are available as alternatives to treated wood for building most components of these structures, and may be the best option in many cases.

If treated wood is used, the preservative selected must be one that minimizes environmental risk; for example, some preservatives leach significantly less copper than others. It is also important that the wood be treated with the minimum preservative concentration ("retention level") appropriate for the use conditions for that component (such as saltwater splash vs. immersion). An inert coating or wrapping may also be applied to treated wood to reduce the leaching of preservative chemicals into coastal waters. Design features (such as bumpers and protective wear surfaces) should also be installed, where appropriate, to minimize releases of treated wood particles into the water through abrasion.

For all overwater and waterfront structures, all appropriate Best Management Practices (BMPs) should be implemented to protect coastal water quality both during construction and long-term. If treated wood is used to build the structure, both construction-phase and post-construction BMPs must specifically address the use of treated wood in aquatic environments.

Recommendations

The following list summarizes the Coastal Water Quality Program staff's recommendations for minimizing the water quality impacts of building materials used in overwater and waterfront structures:

Alternatives to Treated Wood

1. Piles installed in coastal waters (including wetlands) should be constructed of alternative materials instead of treated wood (such as reinforced concrete, steel, or fiber-reinforced polymer composites), unless there is a valid engineering reason to use treated wood (such as replacing a few piles in an existing treated wood structure).
2. For decking and other above-water components of the structure, prioritize the use of alternative materials instead of treated wood, such as concrete, fiberglass, metal, plastic (e.g., polyethylene, polypropylene, or PVC), wood-plastic composites (e.g., Trex or TimberTech), or naturally decay-resistant untreated wood (e.g., redwood, red cedar, ipe, greenheart, and perhaps Douglas fir), where feasible. Some of these alternative materials (e.g., composites) can be used for decking but may not provide suitable strength for the structural framework.

Wrappings and Coatings

3. Seal treated wood piles with an inert wrapping or coating (such as industrial-grade plastic wrapping, fiberglass wrapping, polyurea coating, or epoxy coating) to encapsulate the treated wood and minimize leaching of preservatives. The wrapping or coating should be made of inert materials that will not leach toxic chemicals into coastal waters, and should extend from below the waterline to above the high-water level. Wrappings and coatings should be periodically monitored during the life of the structure to ensure that the material maintains its structural integrity, and should be replaced if it begins to deteriorate.
4. If a wrapping or coating is applied to steel or concrete piles (or other submerged or splash-zone structural components) to protect them from corrosive saltwater and abrasion, the wrapping or coating should be made of inert materials that will not leach chemicals that could contribute to aquatic toxicity. Avoid the use of coal tar epoxy coatings, which leach polycyclic aromatic hydrocarbons (PAHs) that have high aquatic toxicity.
5. Consider applying a coating (such as a semitransparent penetrating stain or a durable epoxy sealer) to treated wood decking used in overwater structures, to reduce leaching and surface dislodgment of the preservative chemicals.[1] Maintenance and reapplication of the coating should follow BMPs to minimize the release of treated wood particles and leaching of preservatives into coastal waters.

Types of Treated Wood Preservatives

6. If using treated wood, a type of wood preservative should be selected that minimizes the risk of aquatic and sediment toxicity. Due to their high aquatic toxicity, avoid the use of wood treated with creosote, Pentachlorophenol, Micronized Alkaline Copper Quaternary (MCQ), and Micronized Copper Azole (MCA). The use of creosote-treated piles is acceptable when replacing a few wood piles in an existing structure located in a waterway impaired by a

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[1] Nejad, M. and P.A. Cooper. *Coatings to Reduce Wood Preservative Leaching*. Environ. Sci. Technol. 2010, 44, 6162–6166.

chemical in the other approved wood preservatives (e.g., copper or zinc); the creosote-treated piles must be wrapped or coated to minimize preservative leaching.

7. For treated wood piles and other in-water components of structures in saltwater, brackish water, or freshwater, the metal-arsenate preservatives Ammoniacal Copper Zinc Arsenate (ACZA) and Chromated Copper Arsenate (CCA) have the lowest aquatic toxicity and are thus the best choices of approved preservatives. In California, ACZA is mostly used because unlike CCA, ACZA effectively treats coastal Douglas fir. CCA is approved for certain uses in aquatic environments where little human contact will occur, but not for residential use.
8. For treated wood decking and other above-water components of structures over freshwater or saltwater, ACZA (and CCA if available and approved for the use) have the lowest aquatic toxicity, and are thus the best choices of preservatives approved for these uses, but only for components where frequent contact with humans or marine mammals is not expected.
9. For above-water components where frequent human or marine mammal contact will occur, avoid the use of wood preservatives and coatings containing chemicals that pose mammalian health concerns (such as the arsenic in ACZA and CCA). The arsenic-free preservatives Alkaline Copper Quaternary (ACQ), Copper Azole (CA), and Copper Naphthenate (CuN) are acceptable choices for treating above-water components over saltwater, brackish water, or freshwater. However, the arsenic-free preservatives leach substantially more copper (and thus have a higher risk of aquatic toxicity) than do the metal-arsenate preservatives ACZA and CCA, and so should only be used where frequent contact with humans or marine mammals is expected.

Preservative Retention Level

10. Select wood treated to the standards of the lowest appropriate Use Category for each component, as specified by the American Wood Protection Association, taking into account factors such as whether the component is subject to saltwater immersion vs. saltwater splash or freshwater, and whether or not the component is difficult to replace and critical to the structure. This will ensure that the treated wood does not exceed the minimum preservative retention level appropriate for that component.[2,3]

Treated Wood BMP-Certified for Aquatic Environments

11. Where available, only use treated wood that has been certified as produced for use in aquatic environments (as indicated by a BMP Quality Mark or Certificate of Compliance), in accordance with industry standards such as the *Best Management Practices for the Use of Treated Wood in Aquatic and Wetland Environments* by the Western Wood Preservers Institute, et al.[4]

[2] Western Wood Preservers Institute; Wood Preservation Canada; Southern Pressure Treaters' Association; and Southern Forest Products Association. (2012). *Treated Wood in Aquatic Environments: A Specification and Environmental Guide to Selecting, Installing and Managing Wood Preservation Systems in Aquatic and Wetland Environments.* http://preservedwood.org/portals/0/documents/TW_Aquatic_Guide.pdf

[3] Western Wood Preservers Institute. (2017). *Specifying with AWPA Use Categories for Construction.* https://preservedwood.org/portals/0/documents/PS_UC_Residential.pdf

[4] Western Wood Preservers Institute; Wood Preservation Canada; Southern Pressure Treaters' Association; and Southern Forest Products Association. (2011). *Best Management Practices for the Use of Treated Wood in Aquatic and Wetland Environments.* http://preservedwood.org/portals/0/documents/BMP.pdf

Design Features to Minimize Abrasion of Treated Wood

12. Install design features (such as bumpers or a protective wearing surface) to protect treated wood components, where appropriate, to minimize the release of treated wood particles through abrasion by vessels or vehicle traffic.

Where to Avoid Use of Treated Wood

13. Avoid the use of treated wood in locations with a low water circulation or flow rate (typically 0.3 ft./sec. or less, measured at slack tide or low flow conditions). Only use treated wood where water circulation is strong and will provide dilution of any leached chemicals, such as in the surf zone or where tidal flushing occurs.
14. Avoid the use of treated wood in locations where especially copper-sensitive aquatic organisms (such as salmon, trout, herring, Dungeness crab, blue mussels, abalone, oysters, sea urchins, and certain zooplankton) may be present.[5] Dissolved copper is highly toxic to a broad range of aquatic species, and juvenile and larval stages of fish and invertebrates are especially sensitive to copper. Also take into consideration that the adverse impact of copper on aquatic life is more pronounced in freshwater than in saltwater.
15. Avoid the use of wood preservatives and coatings containing chemicals that may contribute to any listed water quality impairment of the waterway by that chemical (such as copper or zinc).[6] Copper pollution may already be an issue for many marinas or harbors, due to copper leaching into the water from copper-based antifouling paints commonly used on boat hulls.

Preservative Risk Assessment

16. Assess the risk of adverse impacts to the site's aquatic environment from treated wood, taking into consideration the amount of treated wood to be installed (both in-water and above-water), the type(s) of preservative, whether the site is saltwater or freshwater, and the water flow or circulation rate (measured at slack tide or low flow conditions). The Western Wood Preservers Institute (WWPI) Level One Screening Assessment tables may be used as a starting point.[7,8] These tables indicate the amount of treated wood (both piles and decking) that, at various flow rates, is predicted to not exceed EPA's Acute Water Quality Criteria for copper (and other pollutants). If a project passes this screening level assessment, a more detailed site-specific risk assessment may not be required.

    Nonetheless, additional site-specific factors should be taken into account for projects in coastal waters, including the presence of especially copper-sensitive aquatic species, any impairment of the waterway by chemicals in the preservative, and whether the project is less

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[5] U.S. EPA. (2016). *Draft Aquatic Life Ambient Estuarine/Marine Water Quality Criteria for Copper – 2016*. EPA-822-P-16-001. https://www.epa.gov/wqc/aquatic-life-criteria-copper

[6] Clean Water Act section 303(d) list of impaired water bodies. https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2012.shtml

[7] See *Level One Screening Assessment tables*, pg.12-16 *in:* Western Wood Preservers Institute, et al. (2012). *Treated Wood in Aquatic Environments: A Specification and Environmental Guide to Selecting, Installing and Managing Wood Preservation Systems in Aquatic and Wetland Environments.* http://preservedwood.org/portals/0/documents/TW_Aquatic_Guide.pdf

[8] See additional resources on preservative risk screening assessments in aquatic environments on the Western Wood Preservers Institute's webpage *Preserved Wood in Aquatic Environments.* https://preservedwood.org/Uses/Aquatics.aspx

than 50 feet from another structure with more than 20 piles treated with a similar preservative (e.g., copper-based). Note that the screening assessment tables do not reflect the Coastal Water Quality staff's recommendation to avoid the use of creosote, Pentachlorophenol, and the micronized preservatives MCQ and MCA, due to their high aquatic toxicity.

17. A large installation of treated wood in or over coastal waters (exceeding 30 piles and/or 3,000 ft^2 of above-water treated wood), or a project that otherwise raises a concern during the screening level assessment, should be evaluated with a site-specific Level Two Intermediate Risk Assessment. This assessment can be conducted using an online modeling tool, which takes into account additional factors such as the preservative retention level, and expanded environmental parameters.[9]

Construction-Phase and Post-Construction BMPs

18. Employ all appropriate construction-phase BMPs to minimize the discharge of construction debris and pollutants to coastal waters. If treated wood is used, construction-phase BMPs should specifically address the use of treated wood in aquatic environments, including materials selection, materials storage, cutting or drilling treated wood, preservative field-treatment, and coating application.[10] For example:
    a. Keep treated wood sawdust and debris out of the water. Because of their large surface to volume area, small treated wood particles (such as sawdust) entering the water contribute a disproportionately large amount to the leaching of preservatives from the structure.
    b. Apply field-treatment of Copper Naphthenate preservative sparingly to cut ends and drilled holes in treated wood, because it does not bond as strongly to wood compared to pressure-treatments. Also avoid drips or spills of Copper Naphthenate into the water.[11]
19. Employ all appropriate post-construction BMPs, addressing long-term use, repair, monitoring, and maintenance of the structure. If treated wood is used, post-construction BMPs should specifically address the use of treated wood in aquatic environments. For example:
    a. Avoid sanding, scraping, or pressure-washing treated wood decking, to the extent feasible, as this may increase the leaching of wood preservatives and the discharge of treated wood particles into the water.
    b. Deck cleaners and brighteners, especially those containing acid-based or highly oxidizing chemicals (such as bleach, sodium hydroxide, sodium percarbonate, oxalic acid, and citric acid) should not be used on treated wood, as they may increase the leaching of wood preservatives, and contain ingredients that may directly harm aquatic life.[12,13]

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[9] Oregon State University. *Environmental Assessment Modeling Tool* (online). http://wwpi.forestry.oregonstate.edu/

[10] Western Wood Preservers Institute, et al. (2012). *Treated Wood in Aquatic Environments: A Specification and Environmental Guide to Selecting, Installing and Managing Wood Preservation Systems in Aquatic and Wetland Environments.* http://preservedwood.org/portals/0/documents/TW_Aquatic_Guide.pdf

[11] Lelow, S.T. and M. Tippie. (2001). *Guide for Minimizing the Effect of Preservative-Treated Wood on Sensitive Environments*. Gen. Tech. Rep. FPL–GTR–122. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. https://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr122.pdf

[12] U.S. Consumer Product Safety Commission, U.S. EPA, and USDA Forest Products Laboratory. *CCA-Pressure Treated Wood: Chromated Copper Arsenate Guidance for Outdoor Wooden Structures.* Interagency Consumer Awareness Brochure. CPSC Publication 270 062011. http://cdn2.hubspot.net/hub/75190/file-17419606-pdf/docs/interagency_guide_-_cca-pressure_treated_wood-june-2011.pdf?t=1465307251137

Treated Wood Preservatives Approved for Aquatic Uses

Wood preservatives are registered as pesticides by the U.S. EPA. To meet building code compliance, a preservative formulation for treating wood can be "standardized" (i.e., evaluated and approved) for certain uses by the American Wood Protection Association (AWPA) – the principal standards-setting organization for treated wood in the U.S. Alternatively, a preservative formulation can be approved by the International Code Council-Evaluation Service (ICCES).[14] For use in aquatic environments, seven commonly available wood preservatives are approved by the AWPA, and two micronized formulations are approved by ICC-ES (see Table 1).

Saltwater or Brackish Water Immersion

Only a few wood preservatives protect against marine borers, and can therefore be used to treat wood (such as marine piles) immersed in saltwater or brackish water.

Creosote

For well over a century, marine piles were traditionally made from timber treated with creosote, which is a mixture of hydrocarbon compounds, to protect the wood from decay, wood-attacking insects, and marine borers. However, in recent years, the Coastal Commission and the California Department of Fish and Wildlife have no longer approved the installation of creosote-treated wood piles in new structures in aquatic environments. This is due to concerns about the high toxicity of polycyclic aromatic hydrocarbons (PAHs) that leach from creosote and accumulate in the sediment, adversely impacting fish and aquatic invertebrates. But the Coastal Commission has continued to approve the use of creosote-treated piles when replacing a few wood piles in an existing structure, if there is a valid engineering reason to use wood piles and the waterway is impaired by a chemical (e.g., copper or zinc) in the other available wood preservatives. Also, the creosote-treated piles are required to be wrapped or coated to minimize preservative leaching.

Metal-arsenate preservatives ACZA and CCA

The other two wood preservatives approved for saltwater or brackish water immersion are the metal-arsenate preservatives Ammoniacal Copper Zinc Arsenate (ACZA) and Chromated Copper Arsenate (CCA); both contain copper as the main biocide. Copper is highly toxic to a broad range of aquatic species, but nonetheless poses less environmental risk than the PAHs that leach from creosote.[15] The arsenic, chromium, and zinc in the metal-arsenate preservatives are less toxic than copper to aquatic organisms, and the U.S. EPA has determined that they are unlikely to result in significant water or sediment contamination.[16]

However, ACZA and CCA contain arsenic, which has high mammalian toxicity and is a known human carcinogen, and thus raises human health concerns where frequent human contact is

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[13] Lelow, S.T. and M. Tippie. (2001). https://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr122.pdf

[14] *ICC-ES Evaluation Reports for Preservative Wood Treatments.* International Code Council-Evaluation Service. http://www.icc-es.org/Reports/index.cfm?csi_id=273&view_details

[15] NOAA Fisheries, Southwest Region. (2009). *The Use of Treated Wood Products in Aquatic Environments: Guidelines to West Coast NOAA Fisheries Staff for Endangered Species Act and Essential Fish Habitat Consultations in the Alaska, Northwest and Southwest Regions*. https://preservedwood.org/portals/0/documents/NOAA_guidelines.pdf

[16] U.S. EPA. (2008). *Reregistration Eligibility Decision (RED) Document for Chromated Arsenicals*. EPA 739-R-08-006. http://www3.epa.gov/pesticides/chem_search/reg_actions/reregistration/red_G-22_1-Sep-08.pdf. Note that chromated arsenicals include both CCA and ACZA; however, copper and zinc were not addressed in this document.

expected. CCA was phased out for residential uses in 2004 due to human health concerns about its arsenic content, but it is approved for certain commercial and industrial uses in aquatic environments where little human contact occurs (such as marine and freshwater pilings, and the framework for a marine dock). In California, ACZA is mainly used rather than CCA to treat marine piles, because unlike CCA, it effectively treats coastal Douglas fir, a west coast wood commonly used for building materials.

Freshwater or Above Saltwater

In addition to ACZA and CCA, a few other wood preservatives are approved for components of structures that are in or over freshwater, or where the wood is subject to splashing from saltwater or brackish water, but not immersion (and therefore does not need protection from marine borers). These include the arsenic-free preservatives Alkaline Copper Quaternary (ACQ) and Copper Azole (CA); the micronized versions of ACQ and CA, which are Micronized Alkaline Copper Quaternary (MCQ) and Micronized Copper Azole (MCA); Copper Naphthenate (CuN); and Pentachlorophenol (Penta). All but Penta rely on copper as the main biocide.

Metal-arsenate preservatives ACZA and CCA

Of the preservatives approved for freshwater and above-saltwater use, ACZA (and CCA if available and approved for the particular use) have the lowest aquatic toxicity, and are thus the best choice of preservative for these uses. However, because these two preservatives contain arsenic, which has high mammalian toxicity, they are not appropriate to treat components of the structure where frequent contact by humans (such as a dock railing) or by marine mammals (such as dock decking where sea lions commonly haul out) is expected. ACZA-treated lumber may need to be special-ordered in some locations where the lumber has to be shipped to a treatment facility.

Arsenic-free preservatives ACQ and CA

The arsenic-free preservatives ACQ and CA are appropriate choices for components where frequent human or marine mammal contact is expected. However, they leach significantly more copper into the water, and thus have a greater degree of aquatic toxicity, than do the metal-arsenate preservatives ACZA and CCA. Therefore, ACQ and CA should only be used for components where an arsenic-free preservative is required. ACQ leaches less copper than does CA, and is therefore the preferable choice of the two.

Micronized preservatives MCQ and MCA

The micronized preservatives MCQ and MCA leach about half as much copper as their non-micronized counterparts ACQ and CA. However, there are serious concerns about the environmental and human health impacts of micronized copper nanoparticles. As copper particle size decreases, toxicity increases; studies have shown a 15- to 65-fold increase in toxicity to aquatic organisms when copper nanoparticles are used. This is attributed in part to an increase in solubility, and consequently bioavailability.[17] Coastal Water Quality staff therefore recommends

[17] Kiaune, L., and N. Singhasemanon. (2011). *Pesticidal Copper (I) Oxide: Environmental Fate and Aquatic Toxicity. In:* D.M. Whitacre (ed.). *Reviews of Environmental Contamination and Toxicology, 213.* Springer Science+Business Media, LLC.
https://pdfs.semanticscholar.org/ddaf/bc2afc3175f3686b6009620dba05bd1dd99e.pdf

avoiding the use of the micronized preservatives MCQ and MCA in the aquatic environment. Furthermore, MCQ and MCA do not effectively treat coastal Douglas fir, and may therefore not be locally available.

Oil-based preservative Copper Naphthenate

Copper Naphthenate (CuN) is used primarily for above-water components, but also to treat freshwater piles. CuN leaches significantly more copper than does ACZA, and therefore should only be used for components where frequent contact with humans or marine mammals is expected, and an arsenic-free preservative is thus required. Among the arsenic-free preservatives, CuN may be the preferable choice for some uses, as it leaches less copper than do the arsenic-free preservatives ACQ and CA. However, the odor of the oil may be objectionable in some uses. A waterborne formula of CuN is available to the public as a topical field-treatment of cuts and borings in treated wood.

Oil-based preservative Pentachlorophenol

Pentachlorophenol (Penta) contains environmentally-persistent contaminants (such as dioxins) that are highly toxic to mammals, birds, and aquatic organisms, and it is therefore restricted by the U.S. EPA to commercial and industrial uses (such as freshwater pier pilings and bridges). Due to Penta's high environmental risk, the Coastal Commission has not approved the use of Penta-treated wood in coastal waters in recent decades. Coastal Water Quality staff therefore recommends avoiding the use of Penta in the aquatic environment.

Table 1: Summary of Commonly Available Treated Wood Preservatives Approved for Aquatic Uses, with Coastal Commission's Water Quality Staff Recommendations		
Waterborne Copper-Based Preservatives	**Approved Uses**	**Coastal Water Quality Staff Recommendations**
Metal-arsenate preservatives: **ACZA** Ammoniacal Copper Zinc Arsenate **CCA** Chromated Copper Arsenate	✓ Freshwater ✓ Saltwater splash ✓ Saltwater / brackish water immersion	**ACZA = BEST CHOICE IF NOT IN HUMAN OR MARINE MAMMAL CONTACT** • ACZA & CCA have lowest aquatic toxicity • ACZA more common on west coast, as it treats Douglas fir, unlike CCA • CCA only approved for certain commercial & industrial uses
Arsenic-free copper-based preservatives: **ACQ** Alkaline Copper Quaternary **CA** Copper Azole	✓ Freshwater ✓ Saltwater splash	**ACQ & CA = USE ONLY IF IN HUMAN OR MARINE MAMMAL CONTACT** • ACQ & CA are arsenic-free, so pose less risk to mammalian health • ACQ & CA leach more copper than ACZA, so have higher aquatic toxicity • ACQ leaches less copper than CA
Micronized arsenic-free copper-based: **MCQ** Micronized Alkaline Copper Quaternary **MCA** Micronized Copper Azole	✓ Freshwater ✓ Saltwater splash	**MCQ & MCA = NOT RECOMMENDED** • Leach less copper than ACZA, but may have very high aquatic toxicity
Oil-Based Preservatives		
Creosote	✓ Freshwater ✓ Saltwater splash ✓ Saltwater / brackish water immersion	**CREOSOTE = NOT RECOMMENDED IN NEW STRUCTURES** • Leaches toxic PAHs that accumulate in sediment **CREOSOTE = USE ONLY IN PARTIAL REPLACEMENT PROJECTS WITH VALID ENGINEERING REASON** • Where waters are impaired by chemicals in other available preservatives
Penta Pentachlorophenol	✓ Freshwater ✓ Saltwater splash	**PENTA = NOT RECOMMENDED** • Leaches highly toxic contaminants (dioxins, etc.)
CuN Copper Naphthenate	✓ Freshwater ✓ Saltwater splash	**CuN = USE ONLY IF IN HUMAN OR MARINE MAMMAL CONTACT** • Leaches more copper than ACZA & CCA, but less than ACQ & CA