Balancing Management of Marina Water Quality and Invasive Hull-Fouling Species: Pertinent Scientific Findings

ALTERNATIVE HULL COATINGS

SERVICE LIFE

- Our 2008 survey[1] of California boatyards found average hull coating service lives:
  - Copper = 2.4 years
  - Zinc = 1.8 years
  - Nontoxic Epoxy = 3.0 years
  - Nontoxic Slick = 5.0 years
- Follow-up contacts with 4 boat owners who participated in our 2002-2003 field demonstration found that nontoxic epoxy coatings lasted 5-8 years in San Diego Bay.[2]
- The longer service life of nontoxic coatings can make them cost effective, despite increased costs for application and more frequent hull cleaning.[3]

BOATING INDUSTRY CAPACITY FOR ALTERNATIVE COATINGS NEEDS TO BE DEVELOPED[4]

- Our 2008 survey of 60 California (CA) and Baja California peninsula (BCP) boatyards and hull cleaners found much capacity to apply and maintain copper antifouling paint.
- Zinc coatings were 1% and nontoxic coatings were 3% of CA boatyards' business. Only 1 BCP boatyard had applied zinc coatings and none had applied nontoxic coatings.
- Zinc coatings were 7% and nontoxic coatings were 5% of CA hull cleaners' business. No BCP hull cleaners worked on alternative coatings.

NONTOXIC COATINGS FOR BOATS THAT STAY HOME[5]

- Our 2008 survey of CA and BCP marinas found that half of boats rarely leave home.
- Much recreational boat traffic occurs along the coast, especially to and from San Francisco Bay and between Southern CA and the BCP.
- Copper risks are higher for boats that stay home; lower for active boats.
- Invasive species risks are lower for boats that stay home; higher for active boats.
- Nontoxic hull coatings + more frequent cleaning may be better for boats that rarely travel.
- Pesticidal hull coatings may be better for boats that travel often.

COPPER TOLERANCE OF HULL-FOULING SPECIES

SCIENTIFIC EVIDENCE

- There is plentiful scientific evidence that hull fouling species, and especially the invasive species, are becoming tolerant of copper. Work in the lab and the field has shown that some species can attach directly on copper coatings, and thrive in copper polluted environments.
  - One study showed that, of surfaces covered in copper antifouling paints, 64% were covered in an invasive bryozoan (*Watersipora subtorquata*).[6]
  - Many other studies repeatedly showed that invasive species were able to grow on copper surfaces[7, 8] and reduce native diversity in polluted environments.[9, 10, 11, 12]
  - Evidence is beginning to appear for copper tolerance of some native species.[13, 14]

OTHER SPECIES "PIGGY-BACK" ON COPPER-TOLERANT ONES

- Copper-tolerant species not only pose a threat of invasion themselves, they also provide an opportunity for other, less-tolerant native and invasive fouling species to "piggy-back" into new environments, by creating a barrier that protects them from the copper paint.
  - Scientists observed that other fouling species were 248 times more abundant on the invasive *Watersipora subtorquata*, than were directly on the copper coated surfaces. The *Watersipora* subtorquata also allowed 22 species to grow on it, which did not grow directly on the antifouling surfaces.[15]

COPPER-POLLUTED WATER FAVORS TOLERANT SPECIES

- Invasive species thrive, and natives falter in polluted environments. A clean environment can help buffer against invasions: science shows that copper tolerant invasive species did not exhibit an advantage in clean harbors.[16]

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