Reviewers Report on;
Treated Wood in Aquatic Environments: Technical Review and Use Recommendations
&
Creosote-Treated Wood in Aquatic Environments: Technical Review and Use Recommendations

By

Jason M Weeks
(Appointed by CIE)

Cefas
Pakefield Road
Lowestoft
Suffolk, NR33 0HT
United Kingdom
www.cefas.co.uk

Tel. +44-1502-527759
e-mail j.m.weeks@cefas.co.uk

Contents of the Report

Objectives of the CIE Review

This review considers the information presented by a consulting firm working under contract to NOAA Fisheries. The consultants report was intended to be a complete and thorough review of the best available science concerning effects of treated wood in aquatic environments, providing both a technical review and use recommendations for wood treated with products other than creosote (see second review). The key focus of this work is to assess the likelihood of negative effects of the most likely contaminants coming from such treated wood on protected habitats and species. The documents focus on copper treated wood, primarily ammoniacal copper zinc arsenate (ACZA), as this is the most prominent material used on the west coast of the United States and in Alaska.

These products are being examined by NOAA's National Marine Fisheries Service (NOAA Fisheries) to determine the risks generated by their usage to the living marine resources, which NOAA is responsible for managing, referred to as NOAA's Trust Resources. These include anadromous salmonids managed under the Endangered Species Act (ESA) and Essential Fish Habitat (EFH) as designated by the Magnuson-Stevens Fishery Management and Conservation Act. The use of treated wood in or near aquatic environments commonly requires a permit issued by the U.S. Army Corps of Engineers under section 404 of the Clean Water Act. Under the ESA, federal agencies are to consult with NOAA Fisheries to ensure that any action authorized, funded or carried out by the federal agency does not jeopardize the continued existence of any threatened or endangered anadromous salmonids or result in the destruction or adverse modification of designated critical habitat.

This review also considers the information presented by a consulting firm working under contract to NOAA Fisheries. The consultants report was intended to be a complete and thorough review of the best available science concerning effects of creosote treated wood and the effects of the most likely contaminants coming from such treated wood.

Executive Summary

This document comprises a critical review of the reports "Treated Wood in Aquatic Environments: Technical Review and Use Recommendations" and "Creosote-Treated Wood in Aquatic environments: Technical Review and Use Recommendations". It reports on key areas addressed by the Terms of Reference and attempts to provide a holistic overview of the value of the report in terms of meeting its intentions. Several areas are highlighted where the reviewer believes the report fails to provide adequate guidance or make clear its judgements. The reviewer believes there are changes to the reporting style that would accelerate learning by the reader and provide greater assistance in providing use recommendations.

Key Recommendations

The following key recommendations are made; other suggestions are presented in the full text below.

- The structure of the report requires modification to include additional sections and commentaries on a series of issues not currently addressed by the consultants report.

- More recommendations are required, and key statements addressing the issues should be given, i.e. much evidence is presented, but few firm conclusions are extracted and made.

- The modelling sections do not fully highlight their associated uncertainty – the message requires more purpose in its reporting; what are the key recommendations from this report and where is the evidence for these decisions?

- The risk assessment section is weak and requires context and specific recommendations to be given.

- The report suffers from inadequate linking to the final protection goal, i.e. the species and habitats of concern.

- It further suffers from excluding international literature which could often strengthen ones point of view. Although the brief was clearly to use local examples for direct relevance much of the background information could be provided from other sources. This is also highlighted by the lack of consideration of global issues pertaining by way of example, say CCA and how policy makers are dealing with similar issues.

Creosote

- The structure of the report requires modification to include additional sections and commentaries on a series of issues not currently addressed by the consultants report.

- More recommendations are required and statements addressing the issues should be given, i.e. much evidence is presented but no firm conclusions are extracted and made

- The modelling sections are consistently ambivalent – the message is confused and requires more purpose in its reporting, what are the key recommendations from this report and where is the evidence for these decisions?

- The risk assessment section is weak and requires context and specific recommendations to be given.

- The report suffers from inadequate linking to the final protection goal, i.e. the species and habitats of concern

- It further suffers from excluding international literature which could often strengthen ones point of view. Although the brief was clearly to use local examples for direct relevance much of the background information could be provided from other sources.

Introduction

Wood preservation products based on a mixture of copper sulphate, sodium dichromate and arsenic pentoxide have been used for decades for the industrial pre-treatment of timber using pressure impregnation. The chemicals bind with constituents in the wood and are essentially 'fixed' to the wood in a form that is resistant to leaching out by water. The treated timber is used in areas where long term protection is needed and this resistance to leaching is particularly important in e.g. telegraph poles, motorway fencing and timber in cooling towers. Some treated timber is used in outdoor playground equipment.

It is well established that both inorganic arsenic compounds (such as arsenic pentoxide) and sodium dichromate can produce serious adverse health effects, in particular cancer, and both are regarded as human carcinogens. The concerns with arsenic specifically relate to skin and lung cancer, and in the case of dichromate, lung cancer when exposure is via inhalation.

There is no doubt that the components of CCA are hazardous. They are only used at industrial sites under strictly controlled conditions. The treatment process is in enclosed systems and any exposure to operators is minimal.

With regard to the treated wood, again normal handling and use does not result in any significant exposure because of the fixation of the compounds in a form which does not result in any exposure to the compounds of concern.

However, the application of such timbers in situations such as marine pilings may give rise to concern. This report undertaken by the consultants sets out to address this issue and report a series of recommendations and best use practise.

The objective of the technical review and use recommendations development was to establish a solid scientific basis from which guidance development and implementation could proceed, particularly concerning potential direct and indirect effects of treated timbers.

Creosote is a wood preservative used for commercial purposes only; it has no registered residential uses. Creosote is obtained from high temperature distillation of coal tar (itself a mixture of hundreds of organic substances), and over 100 components in creosote have been identified. It is used as a fungicide, insecticide, miticide, and sporicide to protect wood and is applied by pressure methods to wood products, primarily utility poles and railroad ties. The US EPA is currently reassessing creosote as part of its ongoing re-registration program for older pesticides. Federal law directs EPA to periodically re-evaluate older pesticides to ensure that they continue to meet current safety standards. Due to the smell (diesel-like) and feel (often sticky) creosote-treated timber is not generally used for residential or contact uses, but because of creosote's efficacy in protecting wood, creosote-treated timber is used in industrial applications in Australia and North America.

Creosote as a ``heavy duty wood preservative," was first registered in the United States in 1948 as a coal tar creosote active ingredient. Presently, 16 products are registered for use as industrial wood preservatives for above and below ground wood protection treatments, as well as treating wood in marine environments. Creosote wood preservatives are used primarily in the pressure treatment of railroad ties/crossties (about 70% of all creosote use) and utility poles/cross-arms (about 15-20% of all creosote use). Assorted creosote-treated lumber products (e.g., timbers, poles, posts and ground-line support structures) account for the remaining uses of this wood preservative in the US. The consultants report addressed the use of such creosote treated wood in aquatic environments through a report detailing technical and use recommendations.

Structure of the Report

The report provided for review follows a logical framework and is similar in structure to the report on Creosote Treated Wood in Aquatic Environments: Technical Review and Use Recommendations.

The report is based on a series of naturally linked chapters, with Chapter 1 providing a general introduction to the issue and a background to the types of wood treatment. Chapter 2 moves immediately to an examination of metal leaching potential from treated wood and the potential for environmental exposure, and is based around a series of 5 subsections examining metal leaching rates; Models of leaching rates; application of laboratory derived leaching results to field conditions, field trials; and attempts at Predicting Environmental Concentrations (PEC) of metals from leaching models. This is followed by a series of conclusions. Chapter 3 goes on to look at the toxicity of wood treatment chemicals to aquatic organisms and consists of 3 subsections: 1) examining water column exposure, 2) looking at sediment concentrations, and 3) dietary exposure. Chapter 4 undertakes a risk evaluation containing three subsections: 1) looking at predictive risk assessments, 2) laboratory and field studies, and 3) factors to be considered in aquatic risk assessments. Chapter 5, with 5 subsections examines the use of alternative materials or treatments to that of using wood and covers in section 1) material

types; 2) toxicity considerations; 3) economic considerations of these alternatives and 4) a summary of costs for alternative piling treatments with section 5) presenting annualized costs for a hypothetical fender piling project. Chapter 6 examines in 4 sections current regulations and Best Management Practices (BMP) and looks at 1) the production and treatment of treated wood, 2) construction specifications, 3) when to use treated wood and 4) a set of conclusions of their use. Chapter 7 provides a section covering general conclusions and recommendations, followed by a set of references and appendices detailing information referred to in the preceding chapters.

Generic Comments on the overall report

The report is fairly well written and follows a useful framework. However, I would like to see the following additions;

1) An executive summary

2) A bulleted list of recommendations

3) Greater numeration of sections for ease of reference

4) A critical re-evaluation and set of conclusion(s) at the end of each section/ chapter or statement clearly identifiable from the remainder of the report and showing how chapter 7 was complied from such recommendations within the report – better road mapping

5) It would be useful to have a chapter providing an overview of the current legislative status of treated wood in an international context (see section below on other comments), comparing policy and guidance from e.g. US EPA with other sources such as Canada and Europe. This could be included possibly as part of chapter 6.

6) A summary at the end of each chapter addressing the key aspects.

7) A section detailing site specific risk assessment and the processes involved would be useful

Overall the report is written in a style that does not reflect the degree of uncertainty or evidence base for which some of the primary assertions are made. Greater relevance must be paid to the protection endpoints.

Chapter 1

Sets the objectives of the report and defines its protection goal as working towards setting recommendations that are protective of the habitats and species outlined in the section above. The report authors then go on to describe the different types of wood treatment.

Chapter 2

This section looks at models of leaching rates from metals. These models are largely empirical and based on the results of laboratory studies. The models reviewed demonstrate a high degree of variance suggesting that the models are inadequate for dealing with natural systems. The Brooks (2005) model, however, appears to provide fairly robust short-term predictions, but is unable to address chronic leaching which may be underestimated by as much as twice. This section leads on to more obvious statements and conclusions regarding the ability of models to predict environmental metal concentrations from leaching (2.4.3). The underlying assertion is that the available models are inadequate in predicting actual field metal concentrations because of the highly complex nature of individual site scenarios (this message is not as clear for the creosote report where the data and models are equally deficient). I concur with the authors. A list of conclusions is presented on page 2-27 and I would agree with each. I would further add that the prediction of a chemical in the environment is a measure of its potential to cause harm, but not necessarily one that says harm will occur. The uptake of metals is via metal-ion interactions and the result of available metal species in the aqueous and other phases. The underlying uptake of heavy metals is not considered in this report.

Chapter 3

This section deals with the toxicity of wood treatment chemicals to aquatic organisms through different exposure routes: Water, sediment, food and the implication of both direct and indirect toxicity. The section is fairly detailed using the consultants brief to pre-select examples only relevant for the US situation. However, what is missing from this entire chapter is a series of highlights, summaries recommendations and bullet points underlying the key interpretations of the data presented. Much more could be made of this section.

Chapter 4

This chapter addresses the risk(s) from metal impregnated timbers posed to the sensitive habitats and species required to be protected as described above. My comments on this chapter are repeated later for the creosote report. I regard this chapter to be the weakest of all within the review and to my mind (and I am a practicing risk assessor) does not address a formulative approach to risk assessment. The risk assessment process is not described; the chapter represents a series of case studies and scenarios with no clear outputs. The factors to be considered (section 4.3) are important but reflective issues to be considered during a risk assessment rather than dictating or driving the process itself – if you like - these factors all represent degrees of uncertainty that would be required to be addressed during a risk assessment process, and where it is not possible to do so they

weigh heavily in the process as uncertainties. This section does not address a risk assessment methodology or process. Moreover the authors do not address the requirements to be protective of the species or habitats of concern; e.g. salmonids and their habitats. The list of factors to be considered in the Aquatic risk assessment (RA) is useful but not unexpected given the foregoing. I would like to see greater perception and understanding of the risk assessment process and the utility of site specific risk assessment prior to the use of metal treated timber products in each case – a clear requirement not addressed.

Chapter 5

This section considers alternative material in place of treated timbers. The comments below are repeated in my review of the creosote report also. Overall the report fails to consider alternative or more novel methods in place of treated timbers for the protection of the marine environment, including the use of naturally durable woods (e.g. those with high silica content species such as *Dalium*, *Parinari*, etc.) or wood species with natural resistance attributed to natural plant exudates e.g. *Euclyptus marginata*. Other considerations might be the use of other chemical preservation techniques: protection using physical barriers, e.g. plastic sheathing, plastic coatings for example, pile guard etc., fish oils or creosote floating collars etc. The use of dual treatments of creosote plus CCA/ACA is not mentioned. Novel treatments using the incorporation of other organic pesticides (fungicides, mollusicide and insecticides) are not covered and perhaps such warrant a brief mention as an alternative approach.

Chapter 6

This section looks at the different legislative and other guidance documents in existence for the protection of the environment from treated timbers during both the prior consideration of their use in different applications, through to guidance on construction techniques etc. Again, these BMPs and legislative guidance do not necessarily link to the described risk assessment process, a clearly designed tiered hierarchical risk assessment framework would be able to adopt or interchange relevant legislation and guidance for a given situation with a degree of confidence. Currently it is difficult to find a roadmap through this chapter with an underlying certainty of adopting the correct procedure. It is useful to note that the European Commission has prepared a draft proposal (Directive (76/769/EEC) to prohibit the use of copper chrome arsenic (CCA) as a wood preservative. This proposal is based on a potential risk to children's health from wood treated with preservatives containing CCA in playground equipment and risks to human health from the use of treated wood. The risks related to domestic household burning of CCA treated wood will also be addressed. The Commission's scientific committee (CSTEE) also reached a number of conclusions, in particular that the substance is both genotoxic and a well-known carcinogen, and that it may be appropriate to assume that no safe level exists. Based on this advice, the European Commission brought forward proposals to restrict the marketing and use of CCA.

It is this type of context that is missing from the current report, i.e. what is happening elsewhere and advances in other regions.

Chapter 7

I actually quite like this section and I concur with the statements, recommendations and conclusions drawn. One has to ask, however, where the authors were able to draw these conclusions from given the lack of summary evidence in the preceding chapters. If these conclusions are an accumulation of suggestions, recommendation and observations collated from the bulk of the document, then it is not transparent how or necessarily why several of these conclusions were reached. Again, a call for better road mapping through the document is made.

Other general comments

GLOBAL TRENDS IN THE WOOD PRESERVATION INDUSTRY

The following global trends in the Wood Preservation Industry have been identified which may have an impact upon the consultants report.

<u>The CCA issue</u>

CCA preservatives will not be used for treating timber destined for residential (domestic and contact) uses in the US and Canada after December 2003, and in the EU after June 2004. In addition to domestic uses, CCA preservatives will also not be used for timber destined for marine and most agricultural uses in the EU after June 2004. The Wood Preservation Industry estimates that the reduction in CCA applications may reduce the volume of CCA-treated timber produced in the US by about 80%, meaning that 52% of all treated timber will be treated with a different preservative. Due to the varying concentrations of preservatives in working solutions, the impact on the total volume of high risk chemicals being used (identified in the US as CCA, pentachlorophenol and creosote) may only be reduced by about 5%.

This trend away from CCA-treated timber has been driven by four factors.

1. The most recently completed risk assessment of arsenic, carried out by the Commission of the European Communities CSTEE (Scientific Committee for Toxicity, Ecotoxicity and the Environment) concluded that it is appropriate to consider that no threshold exists for the carcinogenic effect of arsenic. The US EPA and the Canadian Pest Management Regulatory Authority (PMRA) have not assessed that CCA-treated wood poses unreasonable risks to the public or the environment when used in accordance with normal handling procedures. The US EPA and the US Consumer Products Safety Commission are currently conducting a probabilistic assessment of potential cancer risks to children from exposure to CCA in residential settings.

2. Following from the CSTEE's risk assessment, the CSTEE concluded that it would be appropriate to apply the precautionary principle, and move to reduce the production of CCA-treated timber.

3. The US wood preservation industry perceived a consumer demand shift away from CCA-treated timber, driven by increased public awareness of arsenic risks, and media coverage of recent studies into the risk of preservatives leaching from treated timber playground equipment.

4. Viable alternative preservatives are now available on the market to replace CCA, and maintain the same level of hazard protection for the timber product. Alternatively treated timber costs between 8–15% more than CCA-treated timber, but this premium is expected to be diluted through economies of scale once production expands to fill the current CCA market.

INTERNATIONAL REGULATORY STATUS OF PRODUCTS CONTAINING CCA

There has been a significant level of action taken internationally in relation to the continued availability and use of CCA timber treatment products.

US Environmental Protection Agency (US EPA)

On 12 February 2002, US EPA announced a voluntary decision by industry to move away from timber treatments containing arsenic by December 31 2003, in favour of new alternatives. This transition affects virtually all residential uses of wood treated with CCA, including wood used in play-structures, decks, picnic tables, landscaping timbers, residential fencing, patios and walkways/boardwalks. US EPA will not allow CCA products to be used to treat wood intended for any of these residential uses from 1 January 2004.

The US EPA has not concluded that there is unreasonable risk to the public from these products, but is of the view that any reduction in exposure to arsenic is desirable. This action comes ahead of the US EPA completing its regulatory and scientific assessment of CCA.

United States Consumer Products Safety Commission (CPSC)

More recently (February 2003), a report by the United States CPSC raised further concerns about the potential health risks associated with CCA-treated timber in playgrounds.

PMRA Canada

Canadian regulatory authorities are working in collaboration with the US EPA to effect similar actions in Canada.

Commission of the European Communities

A risk assessment conducted by the EC Scientific Committee on Toxicity, Ecotoxicity and the Environment (CSTEE) noted that the main risks associated with CCA were those to human health from the disposal of timber treated with CCA and in particular risks to children's health from the use of CCA–treated timber in playground equipment. The CSTEE raised further concerns regarding the potential for children to be exposed to CCA through ingestion and/or inhalation of sand particles in playground equipment. They concluded that arsenic is both carcinogenic and genotoxic. The CSTEE also identified a risk to the aquatic environment in certain marine waters.

Structure of the report (Creosote)

The report provided for review follows a logical framework and is similar in structure to the previous report on Treated Wood in Aquatic Environments: Technical Review and Use Recommendations.

The report follows a general introduction, addressing the nature and use of creosotes their composition and current regulations, policies and Best Management Practises (BMPs). Chapter 2 moves to looking at the available models of PAH leaching from treated wood and consequences for environmental exposure. This chapter is broken into 4 sections examining: 1) Factors affecting PAH leaching from treated wood, 2) Models of PAH leaching, 3) Predicted environmental concentrations (PECs) of PAH resulting from treated wood, and 4) conclusions section. Chapter 3 goes on to examine the toxicity of creosote to estuarine organisms, and again is split into four sections, examining: 1) the toxic components of creosote, 2) routes of exposure, 3) toxicities, and 4) conclusions, including a discussion on biological effects. Chapter 4 provides a framework for a risk evaluation and again four sections describe: 1) previous risk assessments, 2) risk assessments based on PAH leaching models, 3) laboratory and field studies, and 4) factors to be considered in a risk assessment. There is then a section containing references.

In terms of overall layout, structure and readability, I feel the report could focus the reader by providing;

1) An executive summary

2) A list of recommendations

3) Greater numeration of sections for ease of reference

4) A critical re-evaluation and set of conclusion(s) at the end of each section/ chapter or statement clearly identifiable from the remainder of the report

5) It would be useful to have a chapter providing an overview of the current legislative status of creosote treated wood, comparing policy and guidance from e.g. US EPA with other sources such as Canada and Europe

6) A summary at the end of each chapter addressing the key aspects.

7) A "Recommended Use" section appears to be missing despite being part of the report title

8) A section detailing site specific risk assessment and the processes involved

9) A final conclusion, ways forward, recommendations section (as a separate Chapter 5)

Overall the report is written in a style that does not reflect the complexity of the subject matter nor the degree of uncertainty or evidence base for which some of the primary assertions are made. The focus is almost entirely on PAHs and not on creosote. There is also limited consideration of the endpoints dictated by the study objectives; i.e.

"The purpose of the ESA is to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved, to provide a program for the conservation of threatened and endangered species and to take steps that may be appropriate to achieve this conservation. Conservation is defined in the ESA to mean using, and the use of all methods and procedures necessary to bring any endangered or threatened species to the point at which the protections provided by the ESA are no longer necessary."

Furthermore, … "The Magnuson-Stevens Fishery Conservation and Management Act established procedures designed to identify, conserve, and enhance EFH for those species regulated under a Federal fisheries management plan. EFH regulates an activity with an eye toward its impact on habitat characteristics. EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity. Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle. Essential Fish Habitat for Salmonids includes their saltwater and fresh water ranges".

The report suffers from the brief to use only literature examples from the US, there are many instances where work has been described elsewhere that could certainly fit the brief given. To this end may I suggest that the book by Peter Douben (Douben, 2003) be

consulted? Furthermore, there is a complete lack of linkage of the chapter tasks to the need to link to the protection of particular species or habitats types (as detailed above).

Generic comments on the overall report

Chapter 2

Based on the overall simplicity and generic assumptions made in the development and application of models to predict leaching rates, the conclusions derived by the reviewers are relevant. However, the models presented are limited in the quality of their predicted outputs and thus appear at best to be poor substitutes for real data collected from water or sediments, or through the use of SPMEs. In my opinion, the utility of the models is over played by the paucity of the data presented. They appear to either grossly under/ or over estimate water and sediment PAH concentrations as a consequence of variable leaching rates. Mostly this is a consequence of the highly variable (noisy) environments that the applications are attempting to model. More effort invested in defining better model parameters would be time usefully spent. Again the focus of all the models is on predicting the fate and behaviour of only the PAH fraction of creosotes, as we recall creosote is a chemical mixture of up to 300 different compounds, including polycyclic aromatic hydrocarbons (PAHs) some of which are known carcinogens.

Chapter 3

Begins to examine the toxicity of creosote to estuarine organisms and again focuses largely on the impact of PAHs on biota. The chapter is largely effects based, rather than estimating the significance of any measured effects in terms of consequences for ecosystem harm. The chapter covers in fair depth a series of experimental studies in both lab and field and collates evidence form these. This evidence is not necessarily interrogated or criticised, for example, links between measured biomarkers and health of animal populations are not made – partly, I would imagine, because the evidence is absent. I wonder how the conclusion drawn on page 3-14 "…the response measures described in the preceding sections of this chapter appear to be appropriate and <u>reasonably</u> protective of aquatic receptors in evaluating wood-treating <u>projects</u>"(?), I presume that products should be substituted for projects. I see little evidence to justify this statement. Indeed there is not a chapter summary, detailed conclusion, or firm set of recommendations forthcoming from the literature review of this section.

Chapter 4

This chapter addresses the risk posed to the sensitive habitats and species required to be protected as described above. This chapter is the weakest of all within the review and to my mind (and I am a practicing risk assessor) does not address a formulative approach to risk assessment in any form. The risk assessment process is not described; the chapter represents a series of case studies and scenarios. The conclusions drawn (section 4.3.5) do not address a risk assessment methodology or process. Moreover they do not address the requirements to be protective of the species or habitats of concern; e.g. salmonids and their habitats. The list of factors to be considered in ARA is useful but not novel. I would like to see greater perception and understanding of the risk assessment process and the utility of site specific risk assessment prior to the use of creosote treated timber products in each case – a clear requirement is not addressed.

Other general comments

Overall the report fails to consider alternative or more novel methods for the protection of the marine environment including the use of naturally durable woods (e.g. high silica content species such as *Dalium, Parinari*, etc.) or wood species with natural resistance attributed to natural plant exudates, e.g. *Euclyptus marginata*. Other considerations might be the use of other chemical preservation techniques; protection using physical barriers, e.g. plastic sheathing, plastic coatings for example, pile guard etc., fish oils or creosote floating collars etc. The use of dual treatments of creosote plus CCA/ACA is not mentioned. Novel treatments using the incorporation of other organic pesticides (fungicides, mollusicide and insecticides) are not covered and perhaps such warrant a brief mention as an alternative approach. It is worthy of note that in December 2002, the largest creosote producer in the US, Kerr-McGee LLP, announced that it was leaving the forest products industry following several law suits involving harm caused by wood preservation plants using creosote. A factor in this trend is the availability of viable alternative materials, such as steel, composites and concrete, for the applications of creosote-treated timber. This was not considered in the consultants report.

Specific Comments addressing the points highlighted by the specific terms of reference (ToR)

Evaluate the synthesis and interpretation of the toxicology information, and state whether or not the conclusions regarding the potential effects to ESA and EFH regulated species and habitats are supported by the scientific evidence.

What is missing from this entire section is a series of highlights, summaries recommendations and bullet points underlying the key interpretations of the data presented. Much more could be made of this section. The issue of CCA is not explicit, many countries including the US are working towards banning such a timber treatment for marine and other applications.

Creosote

Serious ecological damage from PAHs has been recorded locally as a consequence of severe oil spills. Less dramatically leakages from offshore oil operations have also caused local pollution issues. Most reported harmful effects are from the physical action of the oil rather than the toxicity of PAHs. So although it has been relatively easy to demonstrate local short term effects of "oil" pollution establishing longer term effects on marine organisms or ecosystems has proved more difficult to demonstrate for PAHs, notwithstanding the persistence of PAH residues in sediments. In various studies outside of those cited (i.e. non-US situation), indicator organisms have been shown to demonstrate negative effects along a pollution gradient in the neighbourhood of an oil terminal. The impacts of PAHs were assessed using a suite of biomarkers. The study by Moore et al. (1987) and Livingstone et al. (1988) showed a strong correlation between tissue concentrations of 2 and 3 ring PAHs and health of marine mussels. Although this work may be criticised on the grounds that other contaminants could have followed the same pollution gradient, there was some supporting evidence from a controlled mesocosms study which showed a similar dose/response relationship. Thus strong evidence exists that harmful effects are possible in individuals, but what is not clear is whether these affects can lead to population declines. The authors of the report also link the presence of high PAH levels in the marine environment with a high incidence of tumours in fish. Again these may not be linked to population declines but certainly influence the value of fish as a consumer commodity, and may be symptomatic of a cascade of health implications. The ecological implication of much of the evidence presented by the authors, however, is not known.

In the marine environment, there can be significant levels of PAH locally as a result of many sources, including creosote treated pilings. PAHs can be biomagnified by some aquatic invertebrates, but not in organisms higher in the food chain that undergo rapid metabolism. To fish, however, they can show considerable toxicity in the presence of UV light as a consequence of their photooxidation. In humans, the main concern of PAHs has been about their mutagenic and carcinogenic properties. However, the ecological concerns of PAHs remain uncertain.

It is an extremely low level of PAH that is required to produce a behavioural effect in aquatic organisms. Considering the contamination of water or sediments, contamination of sediments with relatively high levels of PAHs is probably of most importance with respect to any potential effects on fish behaviour. It is not known whether the large quantities of PAHs in water after immersion of pilings might affect important behavioural responses in fish, such as alteration of homing behaviour to natural rivers by salmon, but compounds with greater solubility and aromaticity possibly within the complex creosote mixture are also likely to be of great importance.

Therefore although PAHs are ubiquitous in the environment, demonstrating a causative linkage between their occurrence and ecosystem harm is very difficult.

Evaluate the synthesis and interpretation of fate and transport information and state whether or not the conclusions regarding potential effects to ESA and EFH regulated species and habitats are supported by the scientific evidence

Generally, the information is insufficiently presented to be able to demonstrate linkages to the protected species or habitats – partly because such linkages would be hard to demonstrate for any toxin and partly because of the limited use of international examples.

Creosote
Given my comments above on the inadequate nature of the modelling and the interpretation of the data, in particular the focus on PAHs alone, I doubt that the approach or the conclusions reached are sufficient to guarantee the protection from potential from deleterious effects to the ESA and EFH regulated species and habitats; given the high degree of uncertainty surrounding the model data. There is uncertainty of predicted sediment concentrations and the unknown implication of exposure to acute low concentrations of PAHs and the other compound used in creosote on natural populations. It is unlikely that the conclusions and recommendations from the report (where made) would safeguard the species of concern in every situation.

If the conclusions are not supported by the available evidence, please provide a detailed explanation and new conclusions.

The conclusions presented reflect the evidence provided.

The models as described (some incompletely) reflect a high degree of variability and uncertainty. I do not believe that as described the evidence is sufficiently compelling to warrant their use in ERA, and although the authors of the report hint at this in their section 2 conclusions it is not sufficiently explicit to the reader. I would rather use empirical measurements or real data collected from a site.

Creosote
If one summarizes the data and information available for the past 15 years concerning the impacts of PAHs, and complex mixtures containing PAHs then a consensus can be built using a weight of evidence approach that may be used for assessing the ecotoxicological potential of PAHs for fish. This approach is useful because of the improbability of establishing either a strict scientific or legal standard of causal evidence for regulatory bodies to use in assessing environmental effects associated with mixed contamination.

Combining field and laboratory data and using a weight of evidence approach, it is suggested that levels of PAHs commonly found near pilings in many marine and freshwater environments are causing or contributing to health effects in fish. Effects have recently been reported (See comprehensive overview in Douben (2003)) with very low concentrations of PAHs in water. This points to a potential for effects on fish and especially larvae.

Evaluate the review of the leaching and environmental concentration models presented in the report.

Creosote

Furthermore, the complex and jointly ubiquitous nature of PAHs, halogenated hydrocarbons and metal contaminants often found in creosote or creosote combinations or creosote versus other marine contaminants makes it difficult to identify biological responses caused by PAHs. Separation of PAH effects from the effects of whole creosote is also difficult. The PAN Pesticides database (www.pesticideinfo.org) has very little information actually listed for creosote including a complete absence of acute toxicity test data. I am concerned that the focus of the review was almost entirely devoted to demonstrating the effects of PAHs in isolation of the parent complex mixture that is creosote.

Did the review adequately characterize these models by addressing model assumptions, uncertainties, and their applicability to ESA listed salmonids and the habitats of NOAA's Trust Resources? If not, provide explanation(s) and how subsequent conclusions are affected.

Creosote

The conclusion derived at by the reviewers should be more pointed and clearly highlight the uncertainties associated with using the models presented. I do not believe they are appropriate to be used to protect Salmonids or their habitats.

The review concluded that most of the factors present in the models would lead to an increase in leaching in the field compared to that observed in the laboratory. Is this conclusion supported by the scientific evidence? Please explain in detail why the models do or do not result in an under prediction of leaching.

Creosote

The justification presented in the text is sufficiently robust to indicate the degree of variability associated with the extrapolation of laboratory based measurements used to calibrate the models with real field data where variability is greater and control lost. The models are insufficiently robust to be able to accurately reflect what is happening to the 300 or so compounds contained in creosote, not least the inadequacies associated with simply predicating PAH concentrations.

Are additional precautions required to add a margin of safety to the model predictions? Provide examples?

The current models are insufficiently robust to be used as anything other than a qualitative estimate.

All these points are covered in detail above – the models are demonstrated by the authors of the report to be insufficient for risk assessment purposes.

The risk evaluation chapters in both reports conclude with a list of factors to be considered in risk assessments concerning the use of treated wood. Are there any other factors missing from the lists?

The factors are comprehensive, what is missing as described above is a detailed risk assessment protocol, although the final chapter alludes to this.

Creosote

In the EU there are New Regulations to prohibit the use of Creosote in certain circumstances. Most European countries have met the obligation to implement the provisions (in part) of European Directive 94/60/EC (the 14th Amendment to the Marketing and Use 76/769/EEC). This Regulation prohibits the placing on the market of wood treated with creosote and prohibits, subject to an exception for old treated wood, the use of treated wood in certain circumstances. Given the hazards of creosote and treated wood the regulation seeks to minimise the overall risk to man and the environment. A similar review is taking place in the US led by the EPA. Worthy of considerable note and relevant in the context of this report is that the decision to ban the use of creosote was based not on sound scientific evidence but on the principle of uncertainty and the precautionary principal.

The Directive was negotiated in 1993/94 by DTI (Department for Trade and Industry) and HSE (Health and Safety Executive) and was as stated above not based on a detailed risk assessment. However, the risks posed by creosote are well documented. Creosote placed on the market can have widely different compositions and thus exhibit different properties. Potentially they may cause skin irritation and cause harm when swallowed. Furthermore, all creosote contains aromatic type substances, some of which are known carcinogens. All contain phenols, which may pose a threat to the water compartment of the environment. It was this information in itself with the associated degree of uncertainty regarding the nature of the products in terms of their environmental safety that led to the ban.

It is this lack of accounting within the current report that causes me some unease. Correct, it is very difficult to show categorically that PAHs are deleterious to the environment, equally due to lack of documented information. It is virtually impossible to

demonstrate this for creosote itself. So, you are left with the requirement to make decisions surrounded by a huge degree of uncertainty and lacking evidence. It is in this environment where the risk based approach (RBA) (detailing and highlighting the site specific risk assessment is crucial) and it is this aspect of the work that is lacking. The models portrayed are insufficient, in my opinion, to accurately predict harm to ecosystems (partly because that was never their intention) but partly because the model parameters are not constants.

One approach would be to use a risk based management approach, based around identifying and reducing risks associated with contamination to a level protective of the environment. In the context of RBM, risk is the measure of the likelihood and magnitude of an adverse effect including injury disease, ecological loss or economic loss arising from the realisation of a hazard. Within this approach the contamination is only identified as representing a risk if all three elements of a contamination linkage are present;

- A source;
- A sensitive receptor, and;
- A pathway linking the source to the receptor.

If one of these pathways is absent there can be no significant risk to the receptor. This is the basis of the site specific risk assessments necessary to be undertaken and such an approach requires elaboration within this report structure.

The copper treated wood report contains a chapter concerning alternative materials and includes a brief examination of toxicity considerations regarding these products. Are there any other considerations that are not mentioned in this chapter?

See text and comment above.

The current regulations and best management practices (BMP) chapter in this report discusses BMPs put forth by the industry as well as several government agencies. Do you feel that the available scientific evidence warrants the use of these BMPs? Do you think that utilization of the BMPs, given consideration of the site specific factors listed at the end of the risk evaluation chapters will provide protection to individuals of ESA listed species and to the habitat components of EFH?

See specific comments above.

Do any of the BMPs or restrictions seem unwarranted or are there additional BMPs or restrictions which should be utilized? Please provide explanations to answers including any site specific factors that should be considered in making decisions regarding the use of treated wood products in aquatic environments.

See specific comments above and further details given below covering aspects of the use of creosote treated wood.

The consultants report does not review the BMPs that exist but alludes to their location and literature source. In the absence of such detailed information it is difficult to make further judgements. However, one would envisage a Best Working/ Management Practice that considers a site specific risk assessment and details the process that should ensure as a consequence of such a requirement being triggered.

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Appendix A: Statement of Work

Consulting Agreement Between the University of Miami and Dr. Timothy Townsend

February 20, 2006

Background

The purpose of the technical review documents requiring independent review is to present an analysis of the potential effects and mitigations for the use of treated wood products in aquatic environments. The documents focus on copper treated wood, primarily ammoniacal copper zinc arsenate (ACZA), as this is the most prominent material used on the west coast of the United States and in Alaska, and creosote treated products.

These products are being examined by NOAA's National Marine Fisheries Service (NOAA Fisheries) to determine the risks generated by their usage to the living marine resources which NOAA is responsible for managing, referred to as NOAA's Trust Resources. These include anadromous salmonids managed under the Endangered Species Act (ESA) and Essential Fish Habitat (EFH) as designated by the Magnuson-Stevens Fishery Management and Conservation Act. The use of treated wood in or near aquatic environments commonly requires a permit issued by the U.S. Army Corps of Engineers under section 404 of the Clean Water Act. Under the ESA, federal agencies are to consult with NOAA Fisheries to insure that any action authorized, funded or carried out by the federal agency does not jeopardize the continued existence of any threatened or endangered anadromous salmonids or result in the destruction or adverse modification of designated critical habitat. The issuance of this permit by the U.S. Army Corps of Engineers requires consultation under the ESA to determine whether its approval action would jeopardize Federally-listed species or adversely modify designated critical habitat, and requires an EFH assessment to determine whether its approval action would adversely affect EFH. Since the use of treated wood materials in situations that may expose aquatic ecosystems is widespread along the west coast of the United States and in Alaska, development of these guidelines should help to streamline the review of permitting processes as well as the permitting processes themselves. In some instances, these guidelines may be used to update existing policies regarding treated wood.

The purpose of the ESA is to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved, to provide a program for the conservation of threatened and endangered species and to take steps that may be appropriate to achieve this conservation. Conservation is defined in the ESA to mean using, and the use of all methods and procedures necessary to bring any endangered or threatened species to the point at which the protections provided by the ESA are no longer necessary. It is the policy of Congress, as declared in the ESA, that all Federal departments and agencies shall seek to conserve endangered and threatened species and

shall utilize their authorities in furtherance of the purposes of the ESA. ESA regulates an activity with an eye toward its impact to as little as a single listed individual. These guidelines are meant to clarify the extent to which these authorities need to be applied for the use of treated wood.

The Magnuson-Stevens Fishery Conservation and Management Act established procedures designed to identify, conserve, and enhance EFH for those species regulated under a Federal fisheries management plan. EFH regulates an activity with an eye toward its impact on habitat characteristics. EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity. Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle. Essential Fish Habitat for salmonids includes their saltwater and fresh water ranges.

Effects of treated wood that need to be examined under the ESA and EFH regulations include direct, indirect, and cumulative effects. An example of direct effects includes the acute and sublethal impacts of copper and polycyclic aromatic hydrocarbons to salmonids and EFH regulated species. An example of an indirect effect includes the adverse impacts to the prey base upon which ESA listed and EFH regulated species depend. An example of a cumulative effect includes the impacts of multiple structures and contaminants in an area with or without additional loading from urban sources, historic mining, smelters, ships’ hulls or any other source. The synthesis of these effects to habitat and to individuals, coupled with local environmental conditions and specific species of concern, defines the risk of a project proposing the use of treated wood.

The objective of the technical review and use recommendations development was to establish a solid scientific basis from which guidance development and implementation could proceed, particularly concerning potential direct and indirect effects.

Objectives of the CIE Review

The information presented for review has been developed by a consulting firm under contract to NOAA Fisheries. The use of an independent firm was determined to be the best way to initiate and complete a thorough review of the best available science concerning effects of treated wood, effects of the most likely contaminants coming from treated wood, and policies and guidelines already developed and in use throughout the United States, Canada and/or other jurisdictions involving the use of treated wood products. A brief review of the economic aspects of treated wood and its leading competitors as well as engineering aspects of all these materials was also commissioned as part of the process.

The review panelist is required to review the following reports (*Treated Wood in Aquatic Environments: Technical Review and Use Recommendations* and *Creosote – Treated Wood in Aquatic Environments: Technical Review and Use Recommendations*), in particular, the aquatic toxicology, the fate and transport aspects of the suite of contaminants that may result from its use, and the modeling that is used in conducting risk assessments concerning treated wood. These sections make up the bulk of the submitted documents and have been an area of considerable debate for many years.

Specific terms of reference for the review include:

- Evaluate the synthesis and interpretation of the toxicology information, and state whether or not the conclusions regarding the potential effects to ESA and EFH regulated species and habitats are supported by the scientific evidence.
- Evaluate the synthesis and interpretation of fate and transport information and state whether or not the conclusions regarding potential effects to ESA and EFH regulated species and habitats are supported by the scientific evidence.
- If the conclusions are not supported by the available evidence, please provide a detailed explanation and new conclusions.
- Evaluate the review of the leaching and environmental concentration models presented in both of the reports.
  - B) Did the review adequately characterize these models by addressing model assumptions, uncertainties, and their applicability to ESA listed salmonids and the habitats of NOAA's Trust Resources? If not, provide explanation(s) and how subsequent conclusions are affected.
  - C) The review concluded that most of the factors present in the models would lead to an increase in leaching in the field compared to that observed in the laboratory. Is this conclusion supported by the scientific evidence? Please explain in detail why the models do or do not result in an under prediction of leaching.
  - D) Are these models sufficient to predict leaching concentrations for use in ecological risk assessments concerning ESA listed species and their habitat?
  - E) Are additional precautions required to add a margin of safety to the model predictions? Provide examples?
- The risk evaluation chapters in both reports conclude with a list of factors to be considered in risk assessments concerning the use of treated wood. Are there any other factors missing from the lists?
- The copper treated wood report contains a chapter concerning alternative materials and includes a brief examination of toxicity considerations regarding these products. Are there any other considerations that are not mentioned in this chapter?
- The current regulations and best management practices (BMP) chapter in the copper treated wood report discusses BMPs put forth by the industry as well as several government agencies. Do you feel that the available scientific evidence warrants the use of these BMPs? Do you think that utilization of the BMPs, given consideration of the site specific factors listed at the end of the

risk evaluation chapters, will provide protection to individuals of ESA listed species and to the habitat components of EFH?

- Do any of the BMPs or restrictions seem unwarranted or are there additional BMPs or restrictions which should be utilized? Please provide explanations to answers including any site specific factors that should be considered in making decisions regarding the use of treated wood products in aquatic environments.

Specific Activities and Responsibilities

The review panelist's duties shall occupy a maximum of 5 workdays (i.e., a few days for document review and a few days to prepare a Review Report). The review panelist will review the treated wood technical review and use recommendations documents and develop a review report in the context of responsiveness to the terms of reference. See Annex 1 for further details on report contents.

No later than March 13, 2006, the review panelist shall submit the Review Report to the CIE for review[1]. The CIE reports shall be addressed to "University of Miami Independent System for Peer Review," and sent to Dr. David Die, via e-mail to ddie@rsmas.miami.edu and to Mr. Manoj Shivlani via e-mail to mshivlani@rsmas.miami.edu.

[1] All reports will undergo an internal CIE review before they are considered final.

Appendix B: Background material

Stratus Consulting, 2005. Treated Wood in Aquatic Environments: Technical Review and Use Recommendations. 160 pp.

Stratus Consulting, 2005. Creosote-treated Wood in Aquatic Environments: Technical Review and Use Recommendations. 104 pp.