

*Creosote treated piling
-perceptions versus reality-*

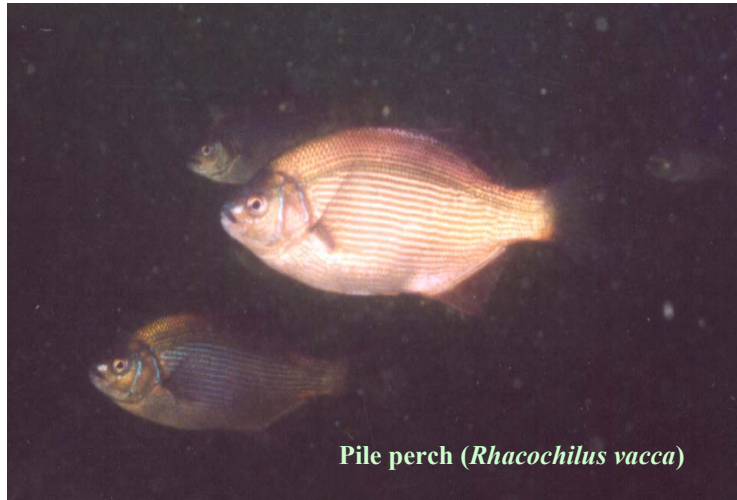


Creosote treated piling in Sooke Basin

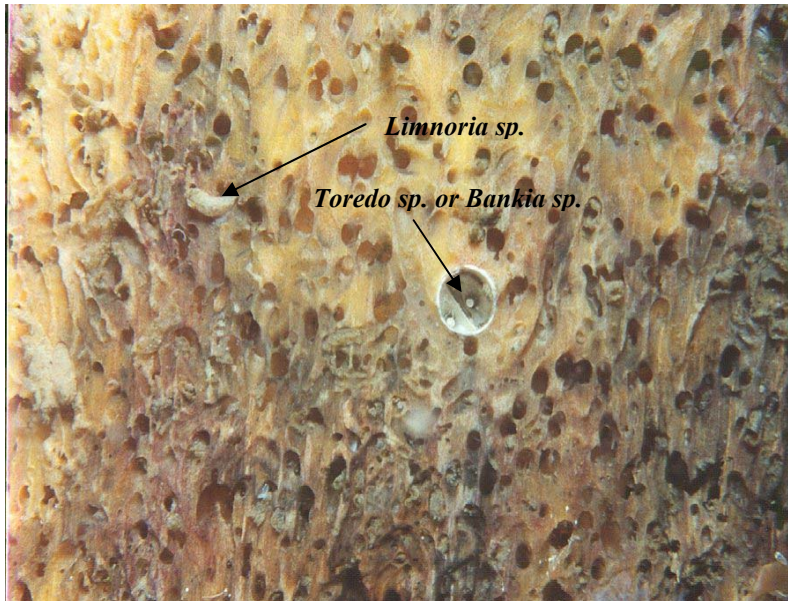
By Dr. Kenneth M. Brooks

Note: The author has been studying the environmental response to creosote and other forms of pressure treated wood for twelve years under contract to the U.S. and Canadian governments and the pressure treated wood industry. He has published numerous articles describing the results of these studies in the scientific literature.

When I was a boy of 8 or 10, my dad sometimes took me fishing at the public pier in Halfmoon Bay, California. I can still feel the fresh Pacific air and recall the smell of sardines that we cut into tiny squares before impaling them on small hooks and casting them into a jungle of kelp growing on the support piling. We cast our bait there because that's where most of the fish were and because it was fascinating to watch all of the life thriving on the pilings. At the time, I didn't realize that all of this life was thriving on creosote treated wood.



In 1992, I was approached by a dentist in Chuckanut Bay on Puget Sound with a request to appraise the environmental risks associated with his proposed use of creosote treated piling for a dock at his home. The scientific literature indicated that small amounts of creosote would be lost from the piling over time and that these would be naturally degraded. A simple computer model predicted concentrations of polycyclic aromatic hydrocarbons (PAH) in the water or buried in the sediments that were too low to have any adverse environmental effect and his dock was permitted and built. Since



that time, I have conducted numerous studies for the U.S. and Canadian governments and for various industries to model and assess the environmental risks associated with the use of creosote treated railway ties, timber bridges and marine piling.

Creosote treated wood is smelly, black and sticky – but that doesn't mean it hurts our environment

Newly treated creosote preserved wood smells like a road paved with asphalt on a hot summer day and the black sticky tar can stain your clothes and it will increase the chances of sunburn if you rub it on your skin. Despite these obviously obnoxious characteristics, creosote has been used since the 1850's to protect wood used for railway ties, bridges and marine structures. This waste product from the manufacture of steel has for over 150 years saved trees, helped transport our goods by rail, and preserved wood used in the sea against attack by a host of marine borers that quickly decimate untreated wood. In all that time there is very little evidence that these products have caused adverse environmental effects. That is an enviable record.

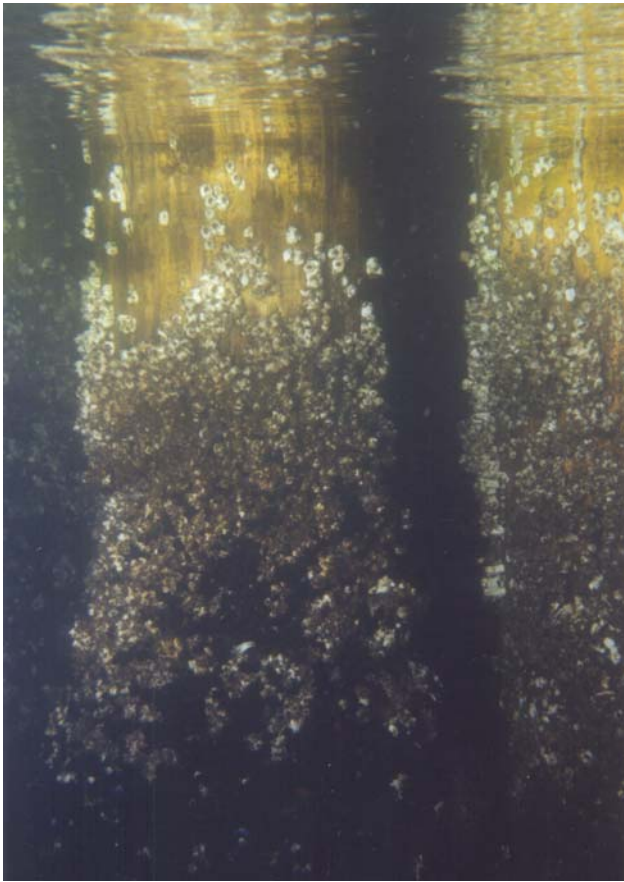
My efforts over the last 12 years have been to shed light on the environmental response to pressure treated wood and to develop predictive models useful in insuring that their long history of safe use is not interrupted in the future. In all of these efforts, the approach has been to study and model *worst cases* in an effort to see adverse effects should they be present. In 1994, the Canadian government undertook studies to determine how creosote treated wood affects marine environments. The *Sooke Basin Study*, completed by myself and Dr. Darcy Goyette from Environment Canada lasted five years and compared the environmental response to newly treated (shown above) and 8 year old creosote treated piling with untreated Douglas fir piling.



Sooke Basin piling

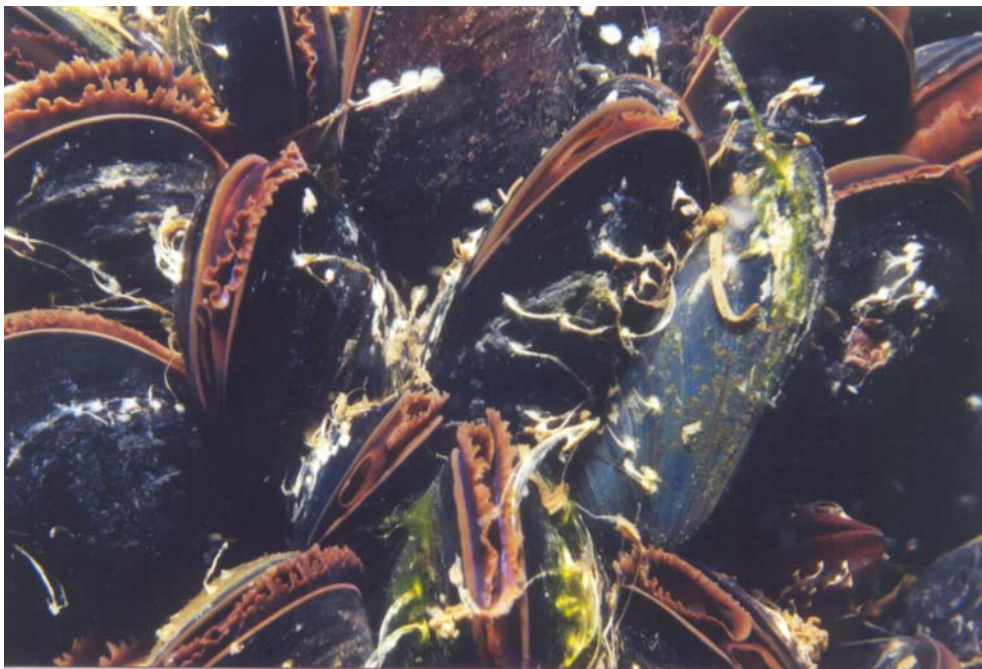
What we found was a surprise!

From above water, the piling appeared dull and lifeless, but below water these structures came alive. First with barnacles, which were found growing just below the high water mark (next page). At about mid tide level, the invertebrate community was quickly dominated by mussels (bottom of next page). High molecular weight PAH, that represent a very small proportion of the compounds in creosote, are known to be carcinogenic. These are the same compounds, like benzo(a)pyrene that are common in smoked fish and in meat cooked over a fire or open coals. And like other creatures, our bodies have adapted enzyme systems to breakdown and excrete these compounds.



This is an important point, because PAH are ubiquitous in earth's biosphere and they have likely been here since there was life. Major sources of these compounds include forest fires, natural oil seeps and accidental spills, coal deposits, peat bogs and anywhere that organic matter is consumed by fire – including in your automobile engine, your BBQ, or the warm crackling fire in your fireplace. In Sooke Basin, we examined mussel tissues for the presence of PAH and found concentrations of these high molecular weight compounds that were well below levels associated with any human or environmental health concerns. In fact, after the first year, there was less PAH in the mussels growing on the creosote treated wood piling than there were at the reference station where there was no treated wood.

The mussels growing directly on the wood were found to spawn and their larvae developed as normally as mussels from the reference area.





Anemones, which are related to jellyfish, became increasingly abundant on the piling in deeper water (left). Food is collected on the tentacles of these animals using stinging cells called nematocysts, which are triggered by contact with prey. These tiny spears are tipped with poison that quickly subdues copepods, amphipods and other living organisms. In Puget Sound, mussels are generally found high in the intertidal, or on piling in the Pacific Northwest because the bottom is home to a host of species of starfish who are voracious predators

on these and other bivalves. The Sooke Basin creosote treated pilings were no exception and armies of starfish, like the ochre stars (*Pisaster ochraceus*) seen at right were frequently found grazing on the barnacles and mussels that had settled on the piling.

The piling became home to a community of animals that any aquarium would be proud of.



Mussels, barnacles and starfish were not the only creatures found on Sooke Basin's creosote treated piling. Several species of shrimp (below center), nudibranchs (below right), and tunicates (below left) were frequently observed on the piling as were a host of small amphipods, annelids and even bivalves living in the tangled mass of mussel byssal threads.



Sessile animals living on creosote treated piling were inventoried in a more recent study. A total 124 different kinds of invertebrates with an abundance equivalent to 31,378 animals/m² were observed in the six samples, each covering a area six inches square, were collected directly from the piling. The piling supported a community which had twice as many kinds and nearly 8 times as many animals as are typically found in Pacific Northwest sediments. Any aquarium would be proud of a community this diverse and abundant.

Concentrations of PAH increased in sediments, but not in the water

Sophisticated methods were used to measure dissolved concentrations of PAH in the water column at Sooke basin within six inches of the downcurrent most piling. The concentrations, found to be about 20 parts per trillion, were not higher than found at the



reference station where there was no treated wood. In contrast, measurably increased concentrations of PAH were found in the sediments within about 30 feet of the piling. At the base of the piling, these concentrations reached levels where they might affect particularly sensitive invertebrates living in the sediments (infauna). However, repeated inventories of the infaunal community revealed no significant adverse effects. About 1,000 days following construction, computer models predict that the loss of new

creosote from piling will not occur as quickly as the compounds are broken down in sediments by bacteria. At that point, sediment concentrations are expected to decline. Measurements in the last three years of this five year study showed that the sediment concentrations of PAH declined earlier and faster in Sooke Basin than was predicted by the models. In fact, the sediments came alive with numerous fish and invertebrates that were feeding on all of the organic debris that was constantly raining down from the community of invertebrates described above. Most spectacular were the armies of Dungeness crabs (*Cancer magister*) seen foraging around the base of the creosote treated structures (below).



The most striking changes in the sediments were caused by the organic debris from the community of invertebrates living on the piling

Organic waste from dense communities of organisms inevitably causes changes, particularly in sediments, associated with the depletion of oxygen as bacteria break down the organic matter. These changes occur naturally as seen at right in the mass of recently spawned and now dead sockeye salmon on the Horsefly River in British Columbia (right) or under the masses of algae and eelgrass seen on this



beach at the native village of Tatitlek in South Central Alaska. The breakdown of carbon in these enriched environments results in the depletion of oxygen and the creation of free sulfides, which smells like rotten eggs. These sulfides combine with iron to give these sediments a dark color. In describing the environmental response to intensive aquaculture, the author has found that many invertebrates are very sensitive to sulfide in sediments and that the number of kinds of animals decreases by about half when sulfide concentrations reach between 500 and 1000 micromoles. Sulfide concentrations this high are not uncommon in naturally productive environments.



Nearly all of the affects on animals living in sediments near the creosote treated piling in Sooke Basin were caused by high sulfide concentrations

The quantities of organic debris from the community living on piling in Sooke Basin were determined using canister studies and their effect in sediments measured using ion specific probes to measure the concentrations of sulfides and oxygen. The debris included mussel and barnacle metabolic products and the shells of numerous animals eaten by crabs and starfish.



The biological oxygen demand created by bacteria consuming this organic waste resulted in free sulfide concentrations ranging between 7,394 micromoles 18 inches from the piling to 5,258 micromoles 16 feet away. These anaerobic conditions created by the explosion of life on the piling had a far greater affect on animals living in the sediments than did the diminishing concentrations of PAH released during the first year or two of the 70 plus year life span of these treated wood structures. The most surprising results from Sooke Basin were that the perceptions gained by looking at and smelling the barren above water parts of a creosote treated piling are very different from the reality of the vibrant community of animals living below the water's surface. Now I understand why as a young boy I caught so many more fish by casting my bait back in amongst the wooden piling in Halfmoon Bay!

But you haven't looked at projects having hundreds or thousands of creosote treated pilings

The results of the Sooke Basin study led Environment Canada and Department of Fisheries and Oceans to develop a rational policy for the use of treated wood in aquatic environments. However, in the United States, a few incredulous regulators, one of whom had earlier predicted that a single creosote treated piling would contaminate sediments with tens of thousands of parts per million with PAH was that "you haven't looked at projects having hundreds or thousands of creosote treated pilings." Most large wharves and marine waterfront structures built today are constructed of steel or concrete because of their higher load bearing capacity. New marine structures proposed to be constructed with creosote treated wood are

typically small and involve a few dozen to a few hundred piling. In contrast, during the early to mid 20th century some very large wharves, railway trestles and piers were constructed of creosote treated wood and after 50 years many of these are still serviceable. In 2001, Creosote Council II funded a study to examine sediments



around larger structures and to further evaluate the uptake of PAH from creosote treated wood to blue mussels. Sediment and invertebrate samples were collected at four sites in Puget Sound. The smallest structure examined was Port Townsend, Washington's municipal pier having 82 piling. The pier and wharf at Fort Ward in Rich passage (above) included to a 410' long x 20' wide pier and an 80' x

110' wharf (below). These structures were supported on 284 creosote treated pilings that were generally spaced ten feet apart in each direction. The most densely packed structure was the old ammunition wharf at Fort Worden in Port Townsend, which is currently home to the city's Marine Science Center. The wharf covers 18,995 square feet and the 20' wide pier is 362 feet long. The wharf and pier are protected on their perimeters by a continuous wave breaking fence construction of creosote treated piling. Over 800 creosote treated piling are used at Fort Worden. In addition to the piling there are large numbers of creosote treated braces and support beams. As previously noted, structures of this size are no longer typically constructed of creosote treated piling. However, their analysis is considered important in understanding the range of effects that could be expected from the use of creosote treated wood.



Detailed results of this latest study are available in a scientific report. However, conditions were similar to those observed in Sooke Basin. All of the piling supported vibrant communities of plants and animals. One hundred twenty-four different types of animals were collected from the piling and the density of life was nearly eight times that found in pristine Pacific Northwest sediments. These sample were collected at only one depth. As explained by George Grall in a beautifully illustrated and photographed National Geographic article published in July 1992, the community growing on marine piling changes dramatically with water depth. The numbers of types of animals found on Puget Sound piling would likely increase several times if samples were collected at a variety of depths.

Mussels, barnacles and feather duster worms (*Eudistylia vancouveri*) seen at right, were the most easily observed animals on creosote treated

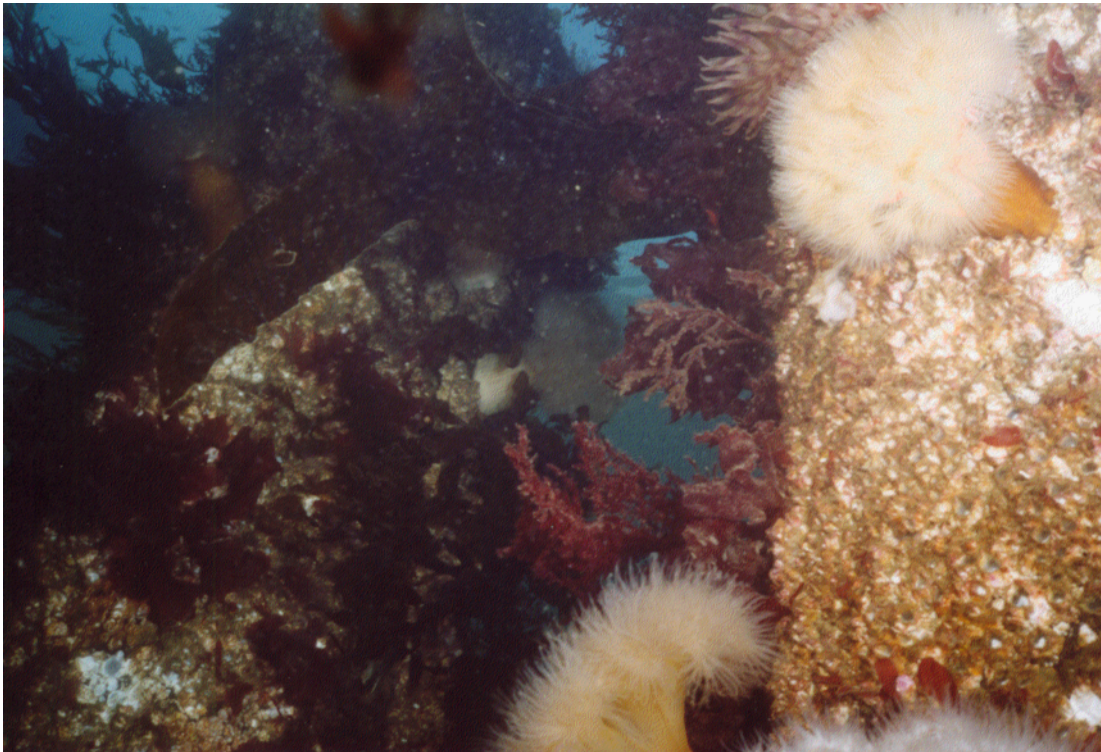


piling, but the inventory of animals collected in small samples from six inch square areas of the piling revealed 54 types of annelids, 18 types of bivalves and gastropods, 42 crustacean species like the kelp crab (*Pugettia producta*) seen at the

top of the previous page and ten other types of animals like the white plumose anemones behind the crab and the beautifully colored *Tealia crassicornis* at lower left on the previous page. Most of the animals living on creosote treated piling are too small to be seen clearly with the naked eye. But as seen below, buried in the habitat created by larger animals is an entire community of small living creatures that find refuge and food in this complex environment.



Sediment concentrations of PAH within the densest clusters of piling at Fort Worden were as high 17.0 mg Total PAH/kg dry sediment when normalized to organic carbon. Two of the 23 samples collected at Fort Worden exceeded the Washington State sediment quality criteria by small amounts. However, these exceedances were restricted to the immediate vicinity of the piling and the concentrations declined exponentially with distance reaching background levels at less than 10 meters. The actual concentrations were about a thousand times less than predicted in sediments near a single creosote treated piling by the National Marine Fisheries Service. As one might expect from these results, no adverse effects were seen in the community of animals living on and in the sediments. In fact, the numbers of kinds of animals was as high as or higher at half a meter distance (18") from the creosote treated piling than they were at the local reference stations and their abundance was about 10 times higher than at the pristine reference station. In the end, it was not the very small amounts of PAH lost from the creosote treated piling that most affected life on and in the sediments at Fort Worden, it was enrichment of the sediments by the luxurious fouling community that created the superabundance of life in sediments at the base of the pilings.



Recall that over 800 piling were placed in a small area at Fort Worden. It is unlikely that structures such as this would be constructed of creosote treated wood in the 21st century. But Fort Ward's wharf and the piers at Port Townsend and Fort Ward are structures which could certainly be constructed of treated wood in today's world. In no case did any sample exceed Washington State's standard for total PAH. The biological results at Fort Ward's wharf and pier were similar to those observed at Fort Worden. There were as many or more kinds of animals living in sediments near the creosote

treated piling as there were at the reference station. In all cases, there were about ten times as many invertebrates living within 18” of the piling as were found at the reference stations or as are typically found in any reference area of Puget Sound.

***In a well educated and intelligent society,
reality should be more important than perceptions***

Multitudes of people care about our environment and are committed to insuring that future generations enjoy the abundance and diversity of life that have graced this planet during our lifetime. There are many hazards that threaten our natural resources and careful management of human activities is essential. However, sustainable management carries with it a responsibility to segregate real from perceived threats and to focus our energy on the real hazards. Creosote treated wood products have been used for well over a century with few records of any demonstrated adverse effect caused by their use in open aquatic environments. These products supported nearly all wharves and piers in the last half of the 19th and the first half of the 20th centuries during a period of time when we still enjoyed abundant stocks of many kinds of fish that have since been decimated by poor management of both recreational and commercial fishing. Creosote has proven effective in protecting wood from a host of crustaceans and mollusks that destroy unprotected wood in a matter of a few years in marine environments. From that point of view, wood preservatives, including creosote, are important tools for sustaining our forests. Long lasting creosote treated wood products mean that aquatic structures don’t need to be replaced or repaired as often – avoiding the disturbances that occur during construction and their use results in fewer trees and less energy being needed to support our marine infrastructure.

Yes – creosote treated wood is black and it does smell of hydrocarbons – particularly on hot summer days. Yes – creosote treated wood is sticky and it will increase your chance of sunburn if it is rubbed on your skin. Because of these properties, there is a perception that creosote must be harmful to aquatic life. But empirical evidence shows that those perceptions are not the reality. All of the evidence suggests that below the waterline, creosote treated wood



structures create stable habitats that allow for the development of wonderfully diverse and abundant communities of organisms that would not otherwise be there. These communities fascinated me as a boy and they have fascinated others who have described piling supporting commercial wharves as *Pillars of Life*. Good environmental stewardship cannot be based on perceptions and theory – it must be based on careful examination of sound empirical evidence – otherwise we deny ourselves the use of products needed for achieving true sustainability.