TRI-BUTYL TIN INFORMATION SUMMARY: SEPTEMBER 1988

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The use of antifouling paints containing tributyl tin became a political issue in New South Wales during the second half of 1988, resulting in the State Government announcing a partial ban on the application of those paints effective from March 1989. The Oyster Farmers Association of Australia requested the ban on the basis that tributyl tin was damaging their industry. At the time no Australian studies on the effects of tributyl tin had been published. In response to requests for information, I prepared a summary of work undertaken in Australia and some of the work undertaken overseas on the impacts of tributyl tin on the marine environment.

Although the use of tributyl tin based paints on most recreational craft is no longer permitted in NSW, this outline of the case supporting the implementation of the ban may be of interest, as little of the background information has been generally available. This account is not a formal scientific paper, but it is hoped that the detailed scientific evidence will be published elsewhere.

Antifouling paints release small quantities of biocides into the water column in order to kill fouling organisms before they attach to the bottom of the boat. Tributyl tin (TBT) based antifouling paints are the most effective antifouling paints on the market.

In France, there is convincing evidence that tributyl tin has been responsible for oyster crop losses. Reductions in TBT levels resulted in revival of the French oyster industry. Use of TBT has also been related to dramatic reductions in whelk populations on the English coastline, and has been implicated as an environmental problem in New Zealand, USA, Canada, Germany Switzerland and Japan. TBT has not been linked with disorders in mammals (including humans) or birds, but is toxic at low concentrations to fish, algae, crustaceans and molluscs.

Regulatory strategies limiting the use of TBT have been introduced in France, the United Kingdom, Germany Switzerland, USA, Tasmania and now New South Wales.

TBT was introduced onto the English market in 1969, and subsequently introduced onto the Australian market. In 1970 the oyster farmers in Sand Brook Inlet (known locally as Brooklyn Bay), in the Hawkesbury estuary, first observed oysters with deformed shells amongst the natural population. By 1974 oysters with deformed shells had become apparent amongst the cultivated oysters in Brooklyn Bay. By the early 1980s, cultivated oysters in this bay had an extremely high incidence of oysters with deformed shells, along with very high rates of mortality. By 1985, young oysters at other commercial lease sites in the Hawkesbury were observed with the same shell deformities.

Oyster farmers on the Hawkesbury River have observed a gradual decline in productivity throughout the River since the mid seventies. Brooklyn Bay has not produced a commercial oyster since 1980. This area was formally one of the most productive bays in the estuary.

My research revealed a correlation between high densities of moored boats in the Hawkesbury River, and significantly higher rates of mortality of oysters, together with dramatic increases in the incidence of oysters with deformed shells. Laboratory experiments indicated that the active ingredient in modern antifouling paints (TBT) is extremely toxic to oysters and that detergent used to clean boats is also toxic to oysters. When TBT and detergent are both present the rate of mortality are not significantly higher than when TBT is alone. The effects of boat pollution were observed to be more toxic to oysters at reduced salinity levels.

An experiment was designed to examine the effects of TBT in the environment at the levels found in Brooklyn Bay (213 nano grams of TBT per litre).

Oysters were grown under three pollution regimes:

1) Low levels of TBT (63 ng TBT/1), with low levels of other pollutants associated with boats
2) High levels of TBT (213 ng TBT/1), with low levels of other boat pollutants
3) High levels of TBT (213 ng TBT/1) and high levels of other boat pollutants.

Analysis of data on mortality from this experiment could not distinguish between treatments 2 and 3, but significantly lower rates of mortality were observed under treatment 1.

This experiment was a pilot study but it indicated that TBT was likely to be a major problem in Brooklyn Bay.

Lake Wapengo on the south coast is considered by the Division of Fisheries, N.S.W. Department of Agriculture and Fisheries, to be in excellent condition. Measurements of water quality have found little evidence of pollution in this estuary.

Two small boats were painted with TBT based antifouling paint and placed in Lake Wapengo. The first boat was introduced eleven months before the second, the second was in the water for one month. After introduction of the second boat, shell deformities appeared on the November overcatch. Both boats were then removed from the estuary, measurements were taken one week after removal. Shell deformities were apparent on the November overcatch up to

820 meters away from the boats, along the shore line; and up to 570 meters along the channel. The closer the oyster was to the moored boats the greater the level of shell deformation (see Fig 1).

Oysters growing on the boat side of the channel showed much higher levels of shell deformation than oysters growing on the other side of the channel. The channel acted as a natural barrier to the agent which causes shell deformities in oysters. It appears that the introduction of TBT antifouling paint on two boats, with an approximate bottom area of 24 m^2, resulted in shell deformations on oysters (maximum age 7 months) grown over an area of approximately 154 000 m^2.

Fisheries and MSB data were used to test the model that declines in oyster production, which correlate with the presence of boats, were responsible for the total decline in NSW oyster production. Nine estuaries were selected from the approximately forty estuaries that produce oysters in NSW. Three were randomly selected from the four estuaries that contain more than 700 permanently moored vessels, Group 2 (Sydney-Newcastle area). Three were randomly chosen from the estuaries north of the Sydney-Newcastle area, and contain fewer than 150 permanently moored vessels, Group 1, and three were randomly selected from southern NSW, also containing fewer than 150 moored vessels. Production during each financial year for each estuary was divided by the mean production during the period 1969 to 1971 inclusive, then multiplied by one hundred to make it a percentage. This produced nine comparable data sets which were then used to determine the average production of Groups 1, 2 and 3 estuaries. Estuaries with large numbers of permanently moored vessels (Group 2) have suffered dramatic declines in productivity since 1978 (Fig. 2). Data from estuary Groups 1, 2 and 3 were then used to predict total NSW oyster production for the 1970 to 1985 period. The decline in oyster production in the four oyster producing estuaries with more than 700 moored boats appears to be responsible for the decline in total NSW oyster production (Fig. 3).

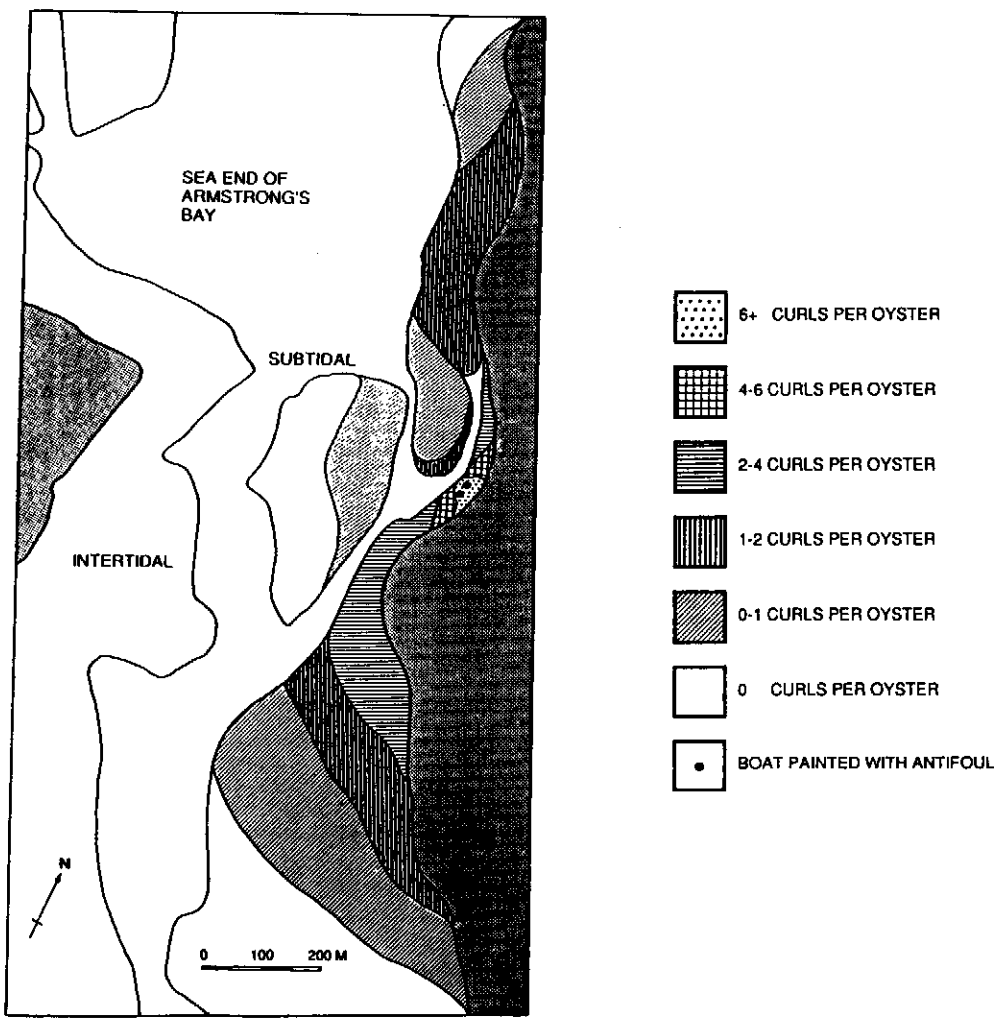

Figure 1. Map of shell deformities on young oyster (less than 7 months old) in Lake Wapengo after the introduction of boats painted with TBT based antifoul.

Data from estuaries with small numbers of permanently moored vessels (fewer than 200) were then used to predict total NSW production in the absence of boat pollution (Fig. 4). The decline in production from 1978 to 1981 inclusive was approximately 33% and from 1982 to 1985 inclusive the decline in production was 50.3%. The 50.3% decline equates to approximately 59 000 bags of oysters (100 dozen per bag) per annum, with a current market value of $18 900 000.

Work done with CSIRO indicated that adult oysters containing less than 100 nano grams of TBT per gram of tissue had normal shells, while adult oysters containing 100 or more nano grams of TBT per gram of tissue, had deformed shells. Brooklyn Bay oysters contained the highest measured levels of TBT, up to 875 nano grams per gram of tissue. Young oysters from Lake Wapengo indicated that shell deformities occurred when tissue burdens were as low as 30 nano grams of TBT per gram of tissue. Even in estuaries with very small numbers of moored boats, 30 nano grams per gram of oyster tissue is not unusual. TBT levels in water samples did not correlate with TBT levels in oyster tissue.

Copper, PCBs, nickel, zinc and organotins (like TBT), in combination with Thiruan, DDT and various other toxins, have all been used in antifouling paint formulations over the last decade. All of these active ingredients are detrimental to the marine environment, but there are non-toxic alternatives. The use of leaching oils and fluoropolymers from silicone based paints have proved effective in at least one instance. These paints work by lubricating the surface, making it difficult for fouling organisms to attach. One coating on a tugboat hull, cleaned approximately every six months, remained viable for seven years. Teflon coatings have also proved effective.

The argument traditionally used by paint manufacturers, "that there is no evidence that TBT effects Australian species", is clearly false. The evidence that TBT is toxic to Australian species can be found on the bottom of any moored boat painted with this type of antifouling paint. We know it kills Australian fouling organisms. We know that it leaches into the marine environment. We have some information regarding the levels at which it is toxic in the marine environment, but we do not know how to manage such a chemical in the marine environment.

Information from France indicates that the change from TBT to copper based antifouling paints on recreational vessels did not cause an increase in the levels of copper in commercial oysters. The SPCC estimated that the cost to the NSW recreational boating community of changing from TBT based antifoulants to ablative copper antifoulants would be in the order of $4 000 per annum.

The TBT problem is only a symptom of the real problem facing our marine environment, which is the total lack of adequate policies for managing marine environments.

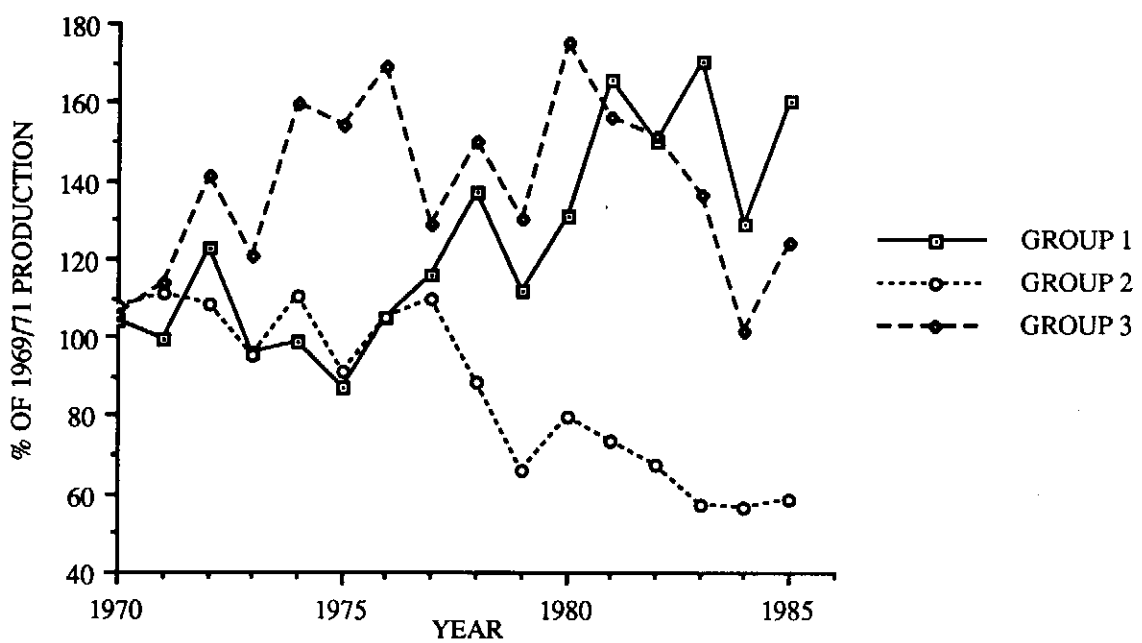

Figure 2. Mean production of oysters in nine NSW estuaries for 1970 - 1985. Values are shown as a percentage of the mean annual production from 1969 to 1971 for each estuary in each group. Group 1: three estauaries north of Group 2 each containing less than 150 permanently moored vessels. Group 2: three estuaries with more than 700 moored vessels. Group 3: three estuaries south of Group 2.

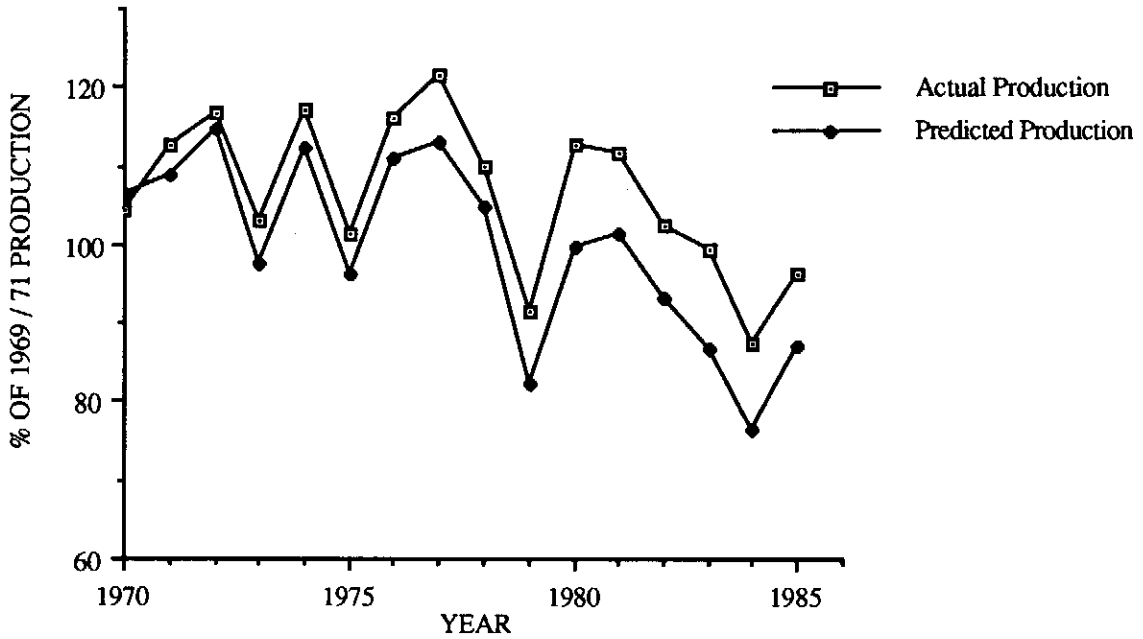

Figure 3. Actual and predicted yearly production of oysters in NSW. Predicted production is calculated from the 9 estuaries used in Fig 2.

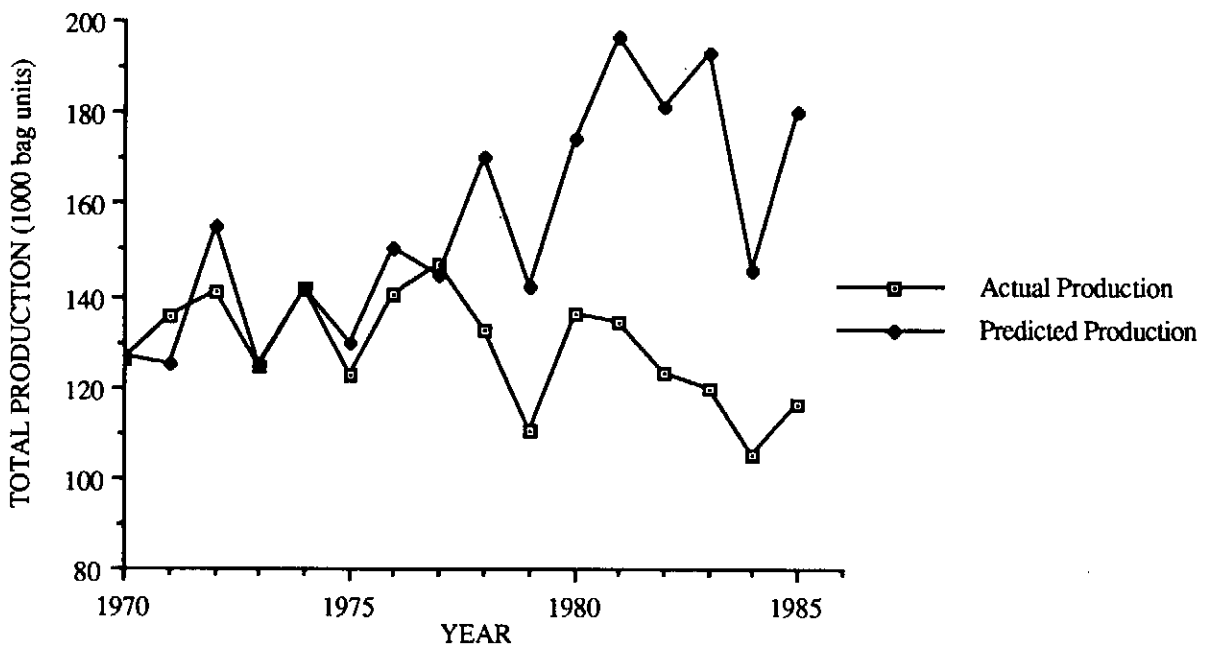

Figure 4. Total yearly production of oysters in NSW 1970 - 1985. Actual production is from the 40 odd estuaries producing oysters. Predicted production is derived from that in the 6 estuaries, with small numbers of moored boats (Groups 1 and 3), used in Fig. 2.