Fish Deformities in the “Newberg Pool”

At the Wilsonville Library on June 30, 2004, a team of professors from Oregon State University presented the findings of their multi-year research on fish deformities in the Willamette River. The team of investigators included:

Dr. Larry Curtis
Professor and Department Head, Environmental & Molecular Toxicology

Dr. Michael Kent
Director, Center for Fish Disease Research
Professor, Departments of Microbiology and Fisheries & Wildlife

Dr. Douglas Markle
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Dr. Kim Anderson
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Dr. Jeff Jenkins
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Here's a summary of what the researchers presented. Further information about this study is available on OSU's website at: www.science.oregonstate.edu/mfbsc/

Microbiology
Microscopic analysis documented the statistically significant and readily visible relationship between spinal deformities and two categories of parasites. The life cycle of the most prevalent parasite involves three "host" organisms. The parasite begins its life in a snail; then is released into the water where it infects fish. Once inside the fish, the parasite has a particular affinity for bone structures. This causes spinal deformities which in turn make the infected fish more visible and susceptible to predation by birds - - the ultimate host for the adult stage of the parasite's life cycle. The parasite offspring infect snails and the cycle repeats itself. The relationship between parasite and fish was further documented when lab-reared fish were exposed to infected snails. Laboratory exposure to the snails resulted in an incidence of fish deformities corresponding to that found in nature.

Fisheries
The distribution of deformed fish over space and time in the Willamette River was described. While segments of the River (such as the "Newberg pool") have a higher incidence of deformities, there are other factors that seem to have even greater impact. For example, species of fish having the highest incidence of spinal deformities are “broadcast spawners.” That is, they release their eggs into the water and let the current disperse them. The newly hatched fish swim into shallow water to avoid being eaten by larger, predatory fish. While in the shallow water the juvenile fish are more likely to encounter parasite-infected snails. Other species of

fish, however, rear their young in nests further offshore. These species have a far lower rate of spinal deformities. The incidence of spinal deformities is also associated with whether the hatch occurs early in the season or later in the season. In short, a fish born at a time and place where parasites are abundant is more likely to have deformities than the same fish born at a different time and place.

Chemistry

The research team faced two challenges in seeking to analyze water quality in the Willamette. One is the possibility that contaminants enter the river in "pulses" rather than as steady, continuous inputs. In other words, if you happen to grab a sample one afternoon you may miss a "pulse" of chemicals released into the river during the middle of the night. To address this challenge, the researchers devised sampling equipment that simulated biological uptake of chemicals from the river 24 hours per day, 7 days a week, from May through mid-July (i.e., the season when fish deformities are most prevalent).

The other challenge the chemists faced was studying contaminants that are so dilute they are below the detection limit of laboratory methods specified for this purpose by the Environmental Protection Agency (EPA). The researchers therefore developed analytical methods 1000 times more sensitive than the EPA methods. The resulting detection limits are fractions of a part per trillion. To illustrate this level of sensitivity, if one orange golf ball were placed on the football playing field at Reser Stadium and then one trillion white golf balls were added to create one part per trillion, the white golf balls would more than fill up the entire stadium. In fact, Reser Stadium would need to be one mile tall to hold a trillion golf balls. Even at this extraordinary level of laboratory precision, the majority of target chemicals in the Willamette were still below the detection limit. Those compounds that could be detected were far below any health or environmental criteria for chronic (i.e., repeated, long-term) exposure.

Toxicology

There may be other chemicals in the river besides the target compounds being monitored. In theory, one of those other chemicals might be causing or contributing to fish deformities. Alternatively, perhaps one chemical in and of itself is not harmful but with trace levels of other “harmless” chemicals the combination may have a toxic effect. To address these concerns, the research team collected (and concentrated) water from the “Newberg pool” as well as other locations in the Willamette. Under laboratory conditions fish were reared in these different water supplies. The researchers then compared the groups in terms of spinal or other irregularities. At the 95% confidence interval, there were no differences between the control group, the fish reared in Newberg pool water, the fish reared in Corvallis water, the fish reared in concentrated Newberg pool water, or the fish reared in concentrated Corvallis water.

Taking yet another tack, one of the team members attempted to determine a level of human health risk from pesticides in the Willamette. Since it is mathematically impossible to calculate the risk of "non-detected" chemicals, he relied on the more sensitive lab methods used by the chemists as noted above. Even so, none of the pesticides were detected in the main stem of the Willamette River. By going upstream into the tributaries of the Willamette, some pesticides could in fact be detected at extremely low concentrations. Assuming these chemicals made their way to the main stem (where they would become diluted below even the most sensitive lab tests), one can mathematically compute what the concentration of those pesticides might be in the Willamette. He then compared this computed level of contamination with drinking water standards obtained from EPA and the World Health Organization. The chemical which came the closest to approaching a drinking water standard was lindane. Its computed concentration was 1000 times below the drinking water standard. The rest of the chemicals had even greater margins of safety, with DCPA having the largest margin of safety (i.e., 1 billion times below the EPA standard). These are the (computed) levels in the water before it enters Wilsonville's water treatment plant, which further purifies the water to create an even greater margin of safety.

Implications

Given all this information, the question remains: Why is there a higher incidence of fish infections in the Newberg pool than elsewhere in the Willamette basin? The research panel offered these possibilities:

Life cycle/ecology of the parasites

- more snails (hence parasites) in the Newberg pool?
- higher prevalence of infection in snail hosts?
- habitat better for transmission?

Host susceptibility

- innate host specificity?
- time and location of hatch?
- fish immunity compromised by contaminants?

During the question/answer period:

One person stated that despite studies indicating it is safe for an adult to drink treated water from the Willamette, he felt there is too big a risk to let children drink treated water from the Willamette.

A few people commented that SOMETHING must be different about the "Newberg pool." They questioned whether chemical contamination (from municipal sewage or industrial waste) might be making fish in this segment of the river more susceptible to infection. The panelists said they cannot rule out this possibility, but it doesn't seem the most likely explanation. One panelist noted that if chemicals were having a toxic effect in the river, one would expect the snail population to be similarly impacted. In fact, snails may be more abundant where high nutrient concentrations (from municipal/industrial discharges) enrich the growth of algae that snails use as food. The panelists also noted that if toxic chemicals were a factor, one would expect to see a higher incidence of fish deformities in the tributaries than in the main stem. This does not correlate with the observed distribution of deformed fish in the basin.

One person asked if temperature plays a role in fish infection/deformity. The panelists indicated that temperature does not appear to be a decisive factor. They noted that river temperature rises during the course of the summer season; yet fish hatching early in the season have greater incidence of infection/deformity than fish hatching later when the water is warmer. One panelist noted that day length might be more significant than temperature. This person speculated that in June when sunlight is at its greatest there might be more algal growth in the river, hence more food for snails, hence greater opportunity for parasites to infect their host species.

One person asked what the health implications are for people who may eat fish that are infected with these parasites. The panel noted that freezing or cooking fish will kill the parasite. Even if a person ate raw infected fish, these parasites could cause only a mild case of infection in a human being. **[Note:** *While not mentioned at the forum, it is unlikely an infectious form of the parasite would enter Wilsonville's water treatment plant. Even if such a thing happened, the process of ozone treatment would kill it and the sand/carbon filter would remove it.***]**