

Technical Assistance

Otter Prey Study: Contaminant Assessment of Their Potential Prey Base

Submitted to
New Mexico Department of Game and Fish,
Conservation Services Division

By

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May 12, 2008

The purpose of the analysis was to determine the presence of contaminants within the fish community and thus the potential contaminant risk to River otters if restored within their historic range in the upper middle Rio Grande basin. In this study, three species of fish were analyzed for concentrations of a suite of organochlorine pesticides, chlorinated hydrocarbons (DDT and its metabolites: *p,p'*-DDD and *p,p'*-DDE), polychlorinated biphenyls (PCBs; all 209 species or congeners), arsenic, lead, selenium and methylmercury.

Ecological risk of environmental contaminants can be assessed using a simple screening approach in which benchmarks are compared. The Lowest Observable Adverse Effect Concentration (LOAEC) represents a benchmark or threshold level at which adverse effects of a specified chemical will likely manifest in some effect (e.g., low litter size, pup mortality, pathology). The LOAEC is typically compared to the No Observable Adverse Effect Concentration (NOAEC) in which concentrations of the chemicals are presumed to be non-hazardous to the biota and can be excluded from further consideration.

Both mink and River otter are included in the Mustelidae family. The mink is considered to be the most sensitive mammal to persistent contaminants such as polychlorinated biphenyls (PCBs) followed by organochlorines (pesticides). The diet of the River otter is made up of fish and aquatic invertebrates. The otter's diet represents an excellent pathway for the accumulation of these compounds because of their tendency to be stored in fat as well as their ability to increase through the aquatic food chain. Although I was unable to locate studies in which River otter were exposed to chronic or low levels of toxic contaminants over the animal's entire life time (to assess reproduction and survival), the mink has long been used as the surrogate in assessing contaminant effects in River otter populations. Thus, the majority of the literature used here pertains to the mink.

Fish Collection and Analysis:

In 2003 and 2004, the Fisheries Division of the New Mexico Department of Game and Fish surveyed a series of sites on the Rio Grande from Embudo to the Colorado state line. The survey revealed a fish community dominated by white sucker (73%) followed by brown trout (11%), smallmouth bass (6%) and common carp (3%). Thus, the predominant fish species, representative of trophic status as well as abundance (from predatory brown trout to the detritivorous or benthic feeding carp) were obtained from areas within the upper Rio Grande.

Brown trout were collected using electroshocking below the State-operated Red River Hatchery. White sucker and common carp were captured using electroshocking at the confluents of the Rio Grande and Taos. Composites of 3 to 5 individuals of each species were submitted for whole body analysis. Brown trout varied in size from 330 to 375 mm. Common carp varied in size from 530 to 570 mm and white sucker varied in size from 360 to 390 mm.

Chemicals Analyzed (PCBs):

Polychlorinated biphenyls (PCBs) consist of 209 related compounds known as congeners. At very low concentrations (part per trillion) these compounds contribute to many adverse health effects in humans and wildlife including cancer. Total concentration of the 209 PCB congeners (ng/g or part per billion) is reported in Table 1. Concentrations range from 11.18 to 68.98 ng/g in the composite fish tissues. These values can be compared to values from the literature in Table 2. Note that the values in the fish composites are well below the NOEC (threshold of No Observable Effect Concentration) that would affect reproduction in mink (NOEC = 145 ppb). Values are also well below the LOEC (threshold for the Lowest Observable Effect Concentration) that would affect litter size in mink (LOEC = 371 – 1360 ppb).

Table 1. Total PCB concentrations (ng/g or part per billion) from 209 congeners from composite samples of brown trout, common carp and white sucker. The concentrations were blank-corrected.

	Brown Trout Red River (706080-01)	Common Carp Taos Junction (706080-02)	White Sucker Taos Junction (706080-03)
Total PCB	14.68	68.98	11.18

Table 2. Total PCB concentrations (ng/g, part per billion, wet weight) for No Observable Effect Concentrations (NOAEC), Lowest Observable Effect Concentrations (LOAEC), and the Effective Concentration at which 50% of the population is affected for dietary PCBs in mink populations. References indicated in subscript letters are included. EC50 represents the effective concentration at which one-half of the population (median) is affected (end points will vary).

Effect End Point	NOEC	LOEC	EC50 (total PCBs, wet weight)
Kit survival	-	3700 ^d	200 ^a
Litter size	145 ^b	371 ^b 640 ^c 1,360 ^e	1,200 ^a
Haematology	-	-	-
Pathology	-	-	-

^a Leonards et al. (1995)

^b Mazet et al. (2005) cited Leonard et al. (1994)

^c Blevins et al. (1980)

^d Bursian et al. (2003)

^e Halbrog et al. (1999)

Dioxin-like PCB congeners:

Twelve of the 209 PCB congeners behave similarly to the most toxic compound known to man-dioxin or 2,3,7,8- tetrachlorobenzo-p-dioxin (2,3,7,8-TCDD). The toxicity equivalency of 2,3,7,8-TCDD has been assigned to each of the 12 congeners as their Toxic Equivalency Factors (TEF). Each factor is multiplied by the congener concentration and these are summed to obtain a Toxic Equivalency Quotient (TEQ). Thus, the toxicological hazard associated with this group of dioxin-like congeners as a mixture in fish is referred to as the TEQ. The TEQ can then be used to assess risk of one of the most toxic compounds known to humans and wildlife as if the compound were actually present in the organism. One can evaluate the effects of the dioxin-like congeners as a function of the contaminant concentration in the tissues. For example, adverse effects on mink reproduction can be expected when PCB concentrations in mink tissues exceed a TEQ of 77 pg/g (see Table 4). From the fish composites, TEQ values varied from 0.456 pg/g in the white sucker to as high as 1.956 pg/g in common carp. Despite the elevated TEQ value in common carp, this value is still well below the LOAEC or lowest observable adverse effect concentration of 12 pg/g for pathological effects observed in mink.

Table 3. TEQ (pg/g, part per trillion, wet weight) for 12 dioxin-like congeners from composite samples of brown trout, common carp and white sucker. The concentrations were blank-corrected. TEQ is calculated using 2005 World Health Organization TEFs in which ½ the detection limit was applied to concentrations below the detection limit.

	Brown Trout Red River (706080-01)	Common Carp Taos Junction (706080-02)	White Sucker Taos Junction (706080-03)
TEQ	0.475	1.956	0.456

Table 4. TEQ reference values (pg/g, part per trillion, wet weight) for No Observable Effect Concentrations (NOAEC), Lowest Observable Effect Concentrations (LOAEC), and the Effective Concentration for dietary PCB and their effects in mink populations. References indicated in subscript letters are included. EC 50 represents the effective concentration at which one-half of the population (median) is affected (end points will vary).

Effect End Point	NOAEC (pg/g)	LOAEC (pg/g)	EC50 (TEQ wet weight)
Kit survival	17 ^a	96 ^a	-
Litter size	50 ^a	77 ^a	160 ^a
Haematology	0.9 ^b	21 ^b	-
Pathology	0.9 ^b	12 ^b	-

^a Leonards et al. (1995)

^b Heaton et al. (1995)

Other organochlorine contaminants of importance: Concentrations of total 4,4' – DDT in the fish composites were relatively high with a range from 26.91 ng/g in the brown trout to 55.57 ng/g in common carp (see Table 5). Concentrations of DDT in the liver of sea otters in California averaged 850 ng/g. Although these levels are 15 times greater than concentrations reported in fish tissues collected from the Rio Grande, these concentrations in the California sea otters were not considered exceptionally high (Bacon et al. 1999). These authors referenced earlier work in which DDT concentrations in otter livers along the California coast were as high as 13,000 ng/g between 1968 and 1973. A more extensive review of the literature is needed to better compare fish tissue levels of total DDT concentrations with effects exhibited in mink or otters.

Table 5. Concentrations of 4,4' DDT and its metabolites (ng/g, part per billion) from composite samples of brown trout, common carp and white sucker. The concentrations were blank-corrected. 4,4' – DDE accounted for 86 - 91% of the total DDT concentrations in fish composites. One can deduce from the higher DDE concentrations that no recent DDT contamination in the environment has occurred.

	Brown Trout Red River (706080-01)	Common Carp Taos Junction (706080-02)	White Sucker Taos Junction (706080-03)
4,4' - DDT	0.37	1.20	1.05
4,4' - DDD	1.79	6.02	2.73
4,4' - DDE	24.75	48.35	23.85
Total	26.91	55.57	27.63

The remainder of the organochlorine compounds was at or below the detection limits of the instrumentation (see data provided by the analytical company “<”). The associated numerical value is based on the lowest calibration point of the initial calibration curve. Compounds receiving specified flags (i.e., “J”) indicate that the compound was present in the fish, but the concentration was below the instrumentation’s calibration limit. In other words, there is not a 100% certainty in the value presented.

Metals Analysis:

Metal concentrations for the fish composites are provided in Table 6 and reflect relatively low concentrations. Although concentrations of selenium in the common carp are slightly higher than the other fish species, this may be due to the relatively large size of the fish.

Table 6. Total concentrations of arsenic, lead, selenium and methylmercury (mg/kg, or part per million, wet weight) from composite samples of brown trout, common carp and white sucker.

	Arsenic (mg/kg)	Lead (mg/kg)	Selenium (mg/kg)	Methylmercury (mg/kg)
Brown trout	1.11	ND	1.18	0.035
Common carp	1.30	ND	6.16	0.10
White sucker	1.22	ND	2.50	0.038

Summary: The comparison of exposure estimates from the three species of fish to literature derived NOAEC and LOAEC for TEQ indicates low to moderate risk to the River otter if large carp (530 – 570 mm) predominate in their diet. Despite the banning of the majority of organochlorine pesticides and PCBs in the 1970's, these compounds are very persistent and are still found in the environment accumulating up through the food chain resulting in harmful effects in wildlife. Additional review of the existing literature is needed to fully characterize the potential effects of dietary DDT concentrations on River otter populations. The DDT levels, however, reflect relatively low concentrations and thus of low toxicological concern at the population level.

Recommendations: There should be additional or ongoing collection and analysis of fish throughout the area that would be representative of the otter's prey base. An emphasis should be placed on obtaining smaller carp (less than 30 cm) as well as crayfish, bivalves, and amphibians. Larger fish will typically exhibit greater body burden of persistent organic chemicals such as PCBs, and DDT. In addition, methylmercury bioaccumulates and biomagnifies through the food web. If otters are to be reintroduced, consideration should be given to collection and analysis of otter feces (see Van den Brink and Jansman 2006), anal gland material, and hair clippings to assess body burden of these bioaccumulating contaminants at the time of reintroduction. These levels would represent baseline values that could be tracked through time to better assess changes in contaminant burden in the River otter if a population were established in the upper Rio Grande of New Mexico.

Literature Cited

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