

MARKERS IN FISH FROM THE HUDSON RIVER, NEW YORK, USA

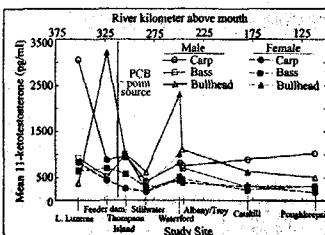


Figure 8. Mean 11-ketotestosterone concentration in male and female fish.

- Mean 11-ketotestosterone concentrations were generally lower in male and female fish at Stillwater.
- 11-ketotestosterone levels in male carp were highest at upstream and downstream sites; those in male bass were relatively low throughout the basin.
- Levels in male bass were lower than in females at Feeder Dam and Stillwater and equal to those in females at Thompson Island and Poughkeepsie.
- 11-ketotestosterone levels in male bullhead were high at one reference site and Waterford and low at sites downstream and at another reference site.

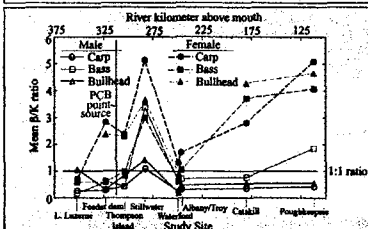


Figure 9. Mean ratio of 17-beta-estradiol to 11-ketotestosterone (B/K ratio) for male and female fish.

- The mean ratio of 17-beta-estradiol to 11-ketotestosterone (B/K ratio) was usually greater than 1 for mature female fish and less than 1 for male fish.
- The average ratio was greater than 1 for males of all fish species at Stillwater/Coveville.
- The average ratio was less than 1 for female carp at Lake Luzerne, for female bullhead at Waterford, and for female bass at Lake Luzerne, Feeder Dam, Thompson Island Pool, and Waterford.

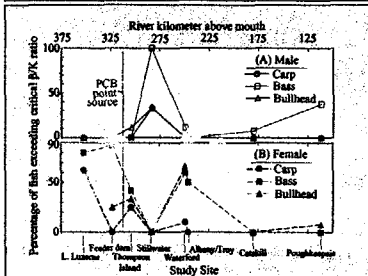


Figure 10. Percentage of (A) male fish with a B/K ratio greater than 1.4 and (B) female fish with a B/K ratio less than 0.8.

- All male bass and 34% of male carp and bullhead at Stillwater, and 38% of male bass at Poughkeepsie, had a B/K ratio greater than 1.4 (fig. 10A).
- High ratios corresponded to decreased 11-ketotestosterone and increased 17-beta-estradiol levels in male fish at Stillwater and Poughkeepsie.
- Altered B/K ratio in male fish at Stillwater and only moderate PCB concentrations in sediments indicate that contaminants, other than PCBs may be responsible for the variations observed in the B/K ratio and in other biomarkers.
- About 64% of female carp at Lake Luzerne, and 80 to 88% of female bass at Lake Luzerne and Feeder Dam, had B/K ratios less than 0.8 (fig. 10B).

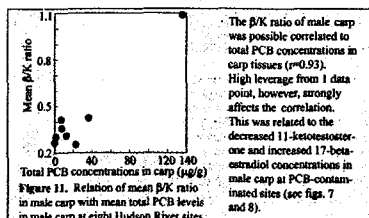


Figure 11. Relation of mean B/K ratio in male carp with mean total PCB levels in male carp at eight Hudson River sites.

Table 1. Significant ($p < 0.05$) and - correlations of sediment PCBs and total or lipid-normalized tissue PCB concentrations with biomarkers in male and female fish from eight sites on the Hudson River.

Variable	Significant correlations	
	Male	Female
Sediment PCBs	Vitellogenin 17-beta-estradiol 11-ketotestosterone B/K ratio	Can. Bas. Bullhead Can. Bas. Bullhead
Tissue PCBs	Vitellogenin 17-beta-estradiol 11-ketotestosterone B/K ratio	Can. Bas. Bullhead Can. Bas. Bullhead

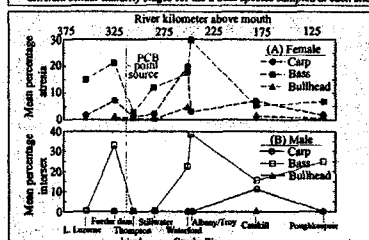


Figure 12. Percentage (A) female fish with atresia (resorbing oocytes), and (B) male fish with intersex (developing oocytes), in their gonads.

- The mean percentage of atresia female fish gonads (fig. 12A) indicate that egg resorption was generally lowest in female carp, bass, and bullhead from the most highly PCB-contaminated sites and that it was highest at less contaminated sites (Albany/Troy and Feeder Dam).
- Similar trends were evident for the proportion of male fish that exhibited developing oocytes (intersex) in their gonads (fig. 12B).
- The percentage of male bass exhibiting intersex were lowest at the most highly PCB-contaminated sites (Thompson Island Pool and Stillwater) and percentages increased at sites upstream and downstream (fig. 12B).

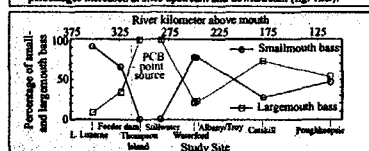


Figure 13. Percentage of smallmouth and largemouth bass sampled at sites.

- Intersex and atresia levels at the most highly PCB-contaminated sites (fig. 12) were unexpected if PCBs adversely affected fish endocrine systems.
- The response of bass may (within limits of our sample) be related to the proportion of smallmouth bass (*Micropterus dolomieu*) at each site.
- Largemouth predominance at sites in the lower basin, and smallmouth predominance at Albany/Troy and at sites above Thompson Pool (fig. 13).
- (b) Largemouth were the only black bass species collected at the most PCB-contaminated sites in the upper basin.
- (c) The normal proportion of intersex male and atresia in smallmouth bass was typically higher (30 to 50%) than in largemouth bass (10 to 15%).
- Elevated levels of atresia and intersex in smallmouth bass over extended periods at Thompson Island Pool and Stillwater, could hypothetically have inhibited their reproductive systems and affected local populations.

CONCLUSIONS

PCB concentrations in the environment directly affect PCB residues in fish.

Endocrine biomarkers are altered to different degrees in largemouth bass, common carp, and brown bullhead.

PCBs in the Hudson River appear to be partly responsible for observed variations in endocrine biomarkers of target fish species.

Altered biomarker levels at sites with little PCB contamination suggest that other contaminants may also affect the endocrine system of target species in parts of the basin.

Changes in endocrine biomarkers were most evident in carp and, to a lesser extent, in bullhead and largemouth bass; variations may be related to different life-history strategies for each fish species.

Changes in reproduction indices suggest that populations of resident fish species may be at risk from changes in the endocrine system.

Though this study was not designed to sample and quantify species populations, the absence of mature smallmouth bass in our collections at Thompson Island Pool and Stillwater/Coveville leads to speculation that local populations may have been adversely affected by high PCB concentrations, changes in endocrine function, and reduced reproductive success.

The above findings need to be confirmed by further investigation of:
 (a) seasonal timing of reproductive stages (sexual maturity) and normal biomarker fluctuations in select fish species,
 (b) loads of toxic metals, PCBs, and other organic contaminants in water and bed sediments across the basin,
 (c) the effects of altered endocrine biomarkers on the reproductive success and viability of local fish populations, and
 (d) habitat characteristics, suitability, and interrelations with distribution of local fish (especially black bass) populations in the Hudson River Basin.

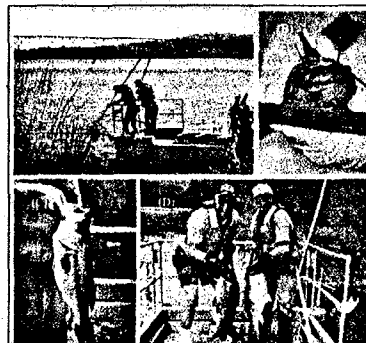


Figure 14. (A) Electroshocking at Catskill, (B) brown bullhead with lesions and burnt barbels, (C) largemouth bass, and (D) common carp.

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For more information contact - baldigo@usgs.gov