total dissolved mercury comprises about 70 percent of that contained in unfiltered water (Back and Watras, 1995; Driscoll et al., 1995; Mason and Sullivan, 1997; Watras et al., 1995a). Making this final correction results in a WC of 910 pg/L (unfiltered, total mercury), which is approximately 70 percent of the value published previously in the GLWQI.

5.4.8 Calculation of a Wildlife Criterion for the Florida Panther

Estimates of the NOAEL and LOAEL in domestic cats were not used in the derivation of a WC for Florida panthers, but were presented instead to provide a comparison with other mammals. The chronic NOAEL for cats (20 μg/kg bw/d) is close to that derived from mink data (18.3 μg/kg bw/d). Cats, therefore, do not appear to be uniquely sensitive or insensitive to the toxic effects of mercury.

Derivation of a WC to protect the panther is complicated by the possibility that prey items (e.g., the raccoon) accumulate mercury to an even greater extent than the fish represented by trophic level 4. Other prey (e.g., deer) probably contain relatively lower levels of mercury. Calculation of a WC protective of the panther, therefore, requires collection of additional information on the diet of this species and mercury residues contained therein. These residues would then have to be related to corresponding levels in water through the use of PPFs (e.g., raccoon/fish or other aquatic biota) and BAFs (aquatic biota/water). Existing data are insufficient to support such an analysis but could be collected and developed for this purpose.

5.4.9 Comparison of GLWQI Criteria with WC Derived in this Report

The evaluation of data and calculation of WC values in this Report was done in accordance with the methods published in the draft GLWQI (U.S. EPA 1993a). The availability of additional data and differences in interpretation of those data led to differences in the calculated values of the WC in this Report and those published in the final GLWQI (U.S. EPA 1995b). Both evaluations employed the same methodology as described in Section 5.4.1 of this Volume. Both used the same studies as the basis for WC calculation: for birds, the three generation reproduction study in mallards (Heinz, 1974, 1975, 1976a,b, 1979) and, for mammals, the subchronic dietary studies in mink (Wobeser et al., 1976a,b). In addition to these studies, this Report also relies on Wobeser's dissertation (Wobeser, 1973), which provided some additional information that was augmented by discussions with the author.

To provide a basis for comparing methylmercury WC values derived in this Report with values calculated in the GLWQI, it was necessary to convert all methylmercury values to corresponding total mercury estimates (see Section 5.4.6 of this Volume). Table 5-3 presents a comparison between the WC values calculated in the GLWQI (U.S. EPA, 1995b) and this Report (converted to total mercury in unfiltered water). All of the WC values calculated in this Report are lower (i.e., more conservative) than those published in the GLWQI. All species-specific WC values, however, differ by a factor of three or less. Expressed as total mercury, the WC derived in this Report is approximately 70 percent of the WC derived in the GLWQI.

In the evaluation of effects in birds, both the GLWQI and this Report identified a LOAEL for reproductive effects in the second generation of mallards exposed to 0.5 ppm mercury in diet (Heinz 1976b, 1979). This LOAEL was adjusted to 0.078 mg/kg bw/d by applying an average food ingestion rate for treated mallards of 0.156 kg/kg/d. In calculating the wildlife reference dose, the GLWQI used a UF_A of 3 and a UF_L of 2. This Report used a UF_A of 1 and a UF_L of 3 (see Section 5.4.11.2 for a discussion of UF_L).

In the effects assessment for piscivorous mammals, both the GLWQI and this Report used data on mink administered mercury in the diet. The GLWQI identified a NOAEL of 1.1 ppm. At this dietary

Table 5-3
Species-specific Wildlife Criteria Calculated in the Great Lakes Water Quality Initiative (GLWQI)[a] and in the Mercury Study Report to Congress

Species	Wildlife Criterion (pg/L)	
	GLWQI	Mercury Study Report to Congress
Mink	2880	1038
Otter	1930	764
Kingfisher	1040	598
Osprey	Not done	1498
Eagle	1920	1818

[a] U.S. EPA, 1995b

exposure, there were changes in the liver, lesions in the central nervous system, and axonal degeneration; moreover, two of the animals in this treatment group were observed at the end of treatment to move slowly by comparison to other mink. The study authors reported their opinion that mink treated at 1.1 ppm in the diet for longer than the study would be expected to show clinical signs of nervous system damage. Animals treated at the next dose, 1.8 ppm, were observed with anorexia, ataxia and increased mortality. Based on these considerations, this Report considered 1.1 ppm to be a LOAEL and, as described in Section 4.3, used data from the first part of the study to identify a NOAEL of 0.33 ppm. This Report also used data from Wobeser (1973) to establish the weights of female mink and kits used in this part of the study; this resulted in slight differences in conversion of dose in ppm diet to μg/kg bw/d

In its assessment of exposure to birds through consumption of prey, the GLWQI made assumptions that were appropriate to the Great Lakes region. In particular the GLWQI assumed that mercury contaminated herring gulls constitute 6% of the diet of bald eagles. As this Report is a nationwide assessment, use of this region-specific assumption was not considered appropriate; eagles were assumed to consume non-fish prey, with no mercury contamination, as 8% of the total diet. The largest numerical difference in the exposure assessment between the GLWQI and this Report is in the calculation of BAFs. The GLWQI used a BAF of 27,000 for trophic level 3 and a BAF of 140,000 for trophic level 4. Total mercury BAFs corresponding to the methylmercury-based values reported in Table 5-1 (and assuming that methylmercury constitutes 7.8 % of total mercury) are 124,800 and 530,400 for trophic levels 3 and 4, respectively.

Thus, the differences between the WC in the GLWQI and in this Report are a result of several factors. First, this Report uses more recent data to derive BAFs. The Supplementary Information Document to the final Water Quality Guidance for the Great Lakes System noted that a preliminary draft of the Mercury Report to Congress was available but was not used because it had not been completed at the time the final guidance was published (U.S. EPA 1995b, p. 144). Second, the GLWQI appropriately used some region-specific assumptions that were not used in this nationwide assessment (e.g., consumption of herring gulls by eagles). Third, different toxicity endpoints were used in this Report. In the GLWQI, a risk-management decision was made to base the

WC on endpoints that comprise direct effects on growth, reproduction, or development. In this Report, more sensitive endpoints were considered with the goal of assessing a greater range of toxic effects. Finally, different uncertainty factors were employed in the two assessments. In general, uncertainty factors used in the GLWQI are more conservative than those used in this Report.

5.4.10 Uncertainty Analysis

A formal analysis of uncertainty around the WC estimate was not attempted. Such an analysis would require specification of numeric distributions for each of the parameters in the equation. Data for several of the parameters in the equation, in particular the NOAEL and UF estimates, are presently sufficient to generate point estimates only. A partial uncertainty analysis has been conducted for the bioaccumulation part of the WC approach (see Appendix D of Volume III).

5.4.11 Sensitivity Analysis

In a sensitivity analysis, an attempt is made to characterize the extent to which a calculated value changes with changes in the parameters upon which its calculation depends. Examination of the equation for calculation of WC values suggests that a proportional relationship exists between the WC and the NOAEL, UF or Wt_A. The relationships between the WC and parameters that appear in the denominator are not as apparent and must be explored by varying these parameters one-by-one in systematic fashion. The analysis is also complicated by the variable relationship that exists between FD_3 and FD_4. In the otter and eagle, FD_3 and FD_4 tend to be reciprocal (although in the eagle these values do not add up to 1). In the mink, however, FD_3 is assigned a value of less than 1, and the remainder of the diet is assumed to consist of prey that are not aquatic in origin and are not contaminated with mercury.

Nevertheless, general conclusions can be reached regarding the sensitivity of WC estimates to changes in these parameters. These can be described as follows:

- A decrease in any parameter that appears in the denominator will have a larger effect on WC than an equivalent percentage-wise increase.

- When BAF_3 appears alone in the denominator, a percentage-wise increase in BAF_3 or FD_3 will cause a less than proportional decrease in the WC; conversely a decrease in BAF_3 or FD_3 will cause a greater than proportional increase in the WC.

- When both BAF_3 and BAF_4 appear in the denominator, an equivalent percentage-wise change in BAF_4 (and by extension PPF_4) has a greater impact on the WC than a change in BAF_3, but in either case, the effect is less than proportional.

- If BAF_3 and BAF_4 are both allowed to change (holding PPF_4 constant), a percentage-wise increase in BAF_3 (and by extension BAF_4) will have a less than proportional effect on WC, while a decrease in BAF_3 will have a greater than proportional impact.

- Under all circumstances, a percentage-wise increase in F_A will cause a less than proportional decrease in WC, while a decrease in F_A will cause a greater than proportional increase in WC.