Great Lakes region, south Florida, central Ontario, and coastal regions of Georgia, South Carolina and North Carolina.

The scope of the present Report was intended to be national in scale. It was determined, therefore, that any effort to assess the risk of mercury to a given species living in a defined location would be inappropriate. Instead, an effort was made to compare mercury exposure and effects in a general way using data collected from throughout the country and, in so doing, to develop qualitative statements about risk.

Consistent with this broader-scale approach, an effort was made to derive a wildlife criterion (WC) value for mercury that is protective of piscivorous wildlife. This WC is defined as the concentration of mercury in water that, if not exceeded, protects avian and mammalian wildlife populations from adverse effects resulting from ingestion of surface waters and from ingestion of aquatic life taken from these surface waters. The health of wildlife populations may, therefore, be considered the assessment endpoint of concern. Although not generally derived for the purpose of ecological risk assessment, WC values incorporate the same type of exposure and effects information used in more standard approaches. Such calculations also provide for a simple assessment of risk in any given situation; that is, by determining whether the concentration of mercury in water exceeds the criterion value.

The principal factors used to select wildlife species for WC development were: (1) exposure to bioaccumulative contaminants; (2) species distributions; (3) availability of information with which to calculate criterion values; and (4) evidence for bioaccumulation and/or adverse effects. All of the species selected feed on or near the top of aquatic food webs. The avian species selected were the bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), common loon (*Gavia immer*) and belted kingfisher (*Ceryle alcyon*). The mammalian species selected were the mink (*Mustela vison*) and river otter (*Lutra canadensis*).

Because this assessment depends to a large extent on the assignment of BAFs for mercury in fish at trophic levels 3 and 4, an effort was made to review published field data from which these BAFs could be estimated. A Monte Carlo analysis was then performed to characterize the variability around these estimates. The results of this effort are reported in Appendix D of Volume III and are summarized in Table ES-2.

A WC value for mercury was estimated as the ratio of an RfD, defined as the chronic NOAEL (in µg/kg bw/d), to an estimated mercury consumption rate, referenced to water concentration using a BAF. Individual wildlife criteria are provided in Table ES-3. This approach is similar to that used in non-cancer human health risk assessment and was employed previously to estimate a WC for mercury in the Water Quality Guidance for the Great Lakes System (GLWQI). The present effort differs, however, from that of the GLWQI in that the entire analysis was conducted on a methylmercury basis. Additional differences resulted from the availability of new data, including measured residue levels in fish and water, and a re-evaluation of the toxicity data from which RfD estimates were derived. In this Report, a more sensitive endpoint was selected for mammalian species, with the goal of assessing the full range of effects of mercury. These changes reflect the amount of discretion allowed under Agency Risk Assessment Guidelines.

Species-specific WC values for methylmercury were estimated for selected avian and mammalian wildlife (identified above). A final WC was then calculated as the lowest mean of WC values for each of the two taxonomic classes (birds and mammals). The final WC for methylmercury was based on

Table ES-3
Wildlife Criteria for Methylmercury

Organism	Wildlife Criterion (pg/L)
Mink	57
River otter	42
Kingfisher	33
Loon	82
Osprey	82
Bald eagle	100

individual WC values calculated for mammalian species, and was estimated to be 50 picograms (pg) methylmercury/L water.

The WC for methylmercury can be expressed as a corresponding mercury residue in fish though the use of appropriate BAFs. Using the BAFs presented in Table ES-2 (50th percentile), a WC of 50 pg/L corresponds to methylmercury concentrations in fish of 0.077 µg/g and 0.346 µg/g for trophic levels 3 and 4, respectively. In addition, a WC for total mercury can be calculated using an estimate of methylmercury as a proportion of total mercury in water. Based upon a survey of speciation data, the best current estimate of dissolved methylmercury as a proportion of total dissolved mercury was determined to be 0.078. Using this value, a methylmercury WC of 50 pg/L corresponds to a total dissolved mercury WC of 641 pg/L. An additional correction is needed if the WC is to be expressed as the amount of total mercury in unfiltered water. The available data, although highly variable, suggest that on average total dissolved mercury comprises about 70 percent of that contained in unfiltered water. 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.

Conclusions

The following conclusions are presented in approximate order of degree of certainty in the conclusion, based on the quality of the underlying database. The conclusions progress from those with greater certainty to those with lesser certainty.

- Mercury emitted to the atmosphere deposits on watersheds and is translocated to waterbodies. A variable proportion of this mercury is transformed by abiotic and biotic chemical reactions to organic derivatives, including methylmercury. Methylmercury bioaccumulates in individual organisms, biomagnifies in aquatic food chains and is the most toxic form of mercury to which wildlife are exposed.

- The proportion of total mercury in aquatic biota that exists as methylmercury tends to increase with trophic level. Greater than 90% of the mercury contained in freshwater fish exists as methylmercury. Methylmercury accumulates in fish throughout their lifetime, although changes in concentration as a function of time may be complicated by growth dilution and changing dietary habits.

- Piscivorous avian and mammalian wildlife are exposed to mercury primarily through consumption of contaminated fish and accumulate mercury to levels above those in prey items.

- Toxic effects on piscivorous avian and mammalian wildlife due to the consumption of contaminated fish have been observed in association with point source releases of mercury to the environment.

- Concentrations of mercury in the tissues of wildlife species have been reported at levels associated with adverse health effects in laboratory studies with the same species.

- Piscivorous birds and mammals receive a greater exposure to mercury than any other known receptors.

- BAFs for mercury in fish vary widely; however, field data are sufficient to calculate representative means for different trophic levels. These means are believed to be better estimates of mercury bioaccumulation in natural systems than values derived from laboratory studies. The recommended methylmercury BAFs for tropic levels 3 and 4 are 1,600,000 and 6,800,000, respectively (dissolved basis).

- Based upon knowledge of mercury bioaccumulation in fish, and of feeding rates and the identity of prey items consumed by piscivorous wildlife, it is possible to rank the relative exposure of different piscivorous wildlife species. Of the six wildlife species selected for detailed analysis, the relative ranking of exposure to mercury is this: kingfisher > otter > loon = osprey = mink $\geq$ bald eagle. Existing data are insufficient to estimate the exposure of the Florida panther relative to that of the selected species.

- Local emissions sources (<50 km from receptors) have the potential to increase the exposure of piscivorous wildlife well above that due to sources located more than 50 km from the receptors (i.e., "remote" sources).

- Field data are insufficient to conclude whether the mink, otter or other piscivorous mammals have suffered adverse effects due to airborne mercury emissions.

- Field data are insufficient to conclude whether the loon, wood stork, great egret, or other piscivorous wading birds have suffered adverse effects due to airborne mercury emissions.

- Field data are suggestive of adverse toxicological effects in the Florida panther due to mercury. Unfortunately, the interpretation of these data is complicated by the co-occurrence of several other potentially toxic compounds, habitat degradation, and loss of genetic diversity. Field data suggest that bald eagles have not suffered adverse toxic effects due to airborne mercury emissions.