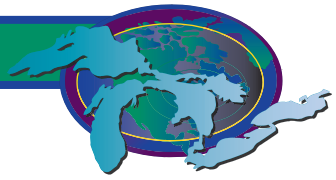

Contaminants in Young-of-the-Year Spottail Shiners

Indicator #114

Overall Assessment

Status:	**Mixed**
Trend:	**Improving**
Rationale:	**Although levels of PCBs in forage fish have decreased below the guideline at many sites around the Great Lakes, PCB levels remain elevated. As well, DDT levels in forage fish have declined but remain above the guideline at most of the tested Great Lakes locations.**

Lake-by-Lake Assessment

Lake Superior

Status:	Mixed
Trend:	Improving
Rationale:	PCB concentrations in Lake Superior forage fish have declined over the period of record and are currently below the guideline at all sample sites. DDT levels have declined to levels near the guideline, except for Nipigon Bay, where the most current levels (1990) were elevated.

Lake Michigan

Status:	Not Assessed
Trend:	Not Assessed

Lake Huron

Status:	Mixed
Trend:	Improving
Rationale:	PCB levels in Lake Huron forage fish have remained static or declined over the period of record and are currently at or below the guideline. DDT levels, however, remain elevated at Collingwood Harbour.

Lake Erie

Status:	Mixed
Trend:	Improving
Rationale:	PCB levels in Lake Erie forage fish have declined to levels at or below the guideline. DDT levels have also declined over the period of record but remain above the guideline.

Lake Ontario

Status:	Mixed
Trend:	Improving
Rationale:	PCB levels in Lake Ontario forage fish have declined significantly over the period of record and the most recent levels are at or below the guideline. At some sites, DDT levels in forage fish have declined considerably. However, levels remain at or above the guideline at all sites. Levels of mirex have also declined and have remained below the detection limit in recent years.

Purpose

- To assess the levels of persistent bioaccumulative toxic (PBT) chemicals in young-of-the-year spottail shiners
- To infer local areas of elevated contaminant levels and potential harm to fish-eating wildlife
- To monitor contaminant trends over time for the nearshore waters of the Great Lakes

Ecosystem Objective

Concentrations of toxic contaminants in juvenile forage fish should not pose a risk to fish-eating wildlife. The Aquatic Life Guidelines in Annex 1 of the Great Lakes Water Quality Agreement (GLWQA, United States and Canada 1987), the New York State Department of Environmental Conservation (NYSDEC) Fish Flesh Criteria (Newell *et al.*, 1987) for the protection of piscivorous wildlife, and the Canadian Environmental Quality Guidelines (Canadian Council of Ministers of the Environment (CCME) 2001) are used as acceptable guidelines for this indicator. Contaminants monitored in forage fish and their respective guidelines are listed in Table 1.

State of the Ecosystem

Contaminant levels in fish are important indicators of contaminant levels in an aquatic ecosystem due to the bioaccumulation of organochlorine chemicals in fish tissue. Contaminants that are often undetectable in water may be detected in juvenile fish. Juvenile spottail shiner (*Notropis hudsonius*) was originally selected by Suns and Rees (1978) as the principal biomonitor for assessing trends in contaminant levels in local or nearshore areas. It was chosen as the preferred species because of its limited range in the first year of life; undifferentiated feeding habits in early stages; importance as a forage fish; and its presence throughout the Great Lakes. The position it holds in the food chain also creates an important link for contaminant transfer to higher trophic levels. However, at some sites along the Great Lakes, spottail shiners are not as abundant as they once were, and therefore can be difficult to collect. In this updated indicator report, bluntnose minnow (*Pimephales notatus)* have been included in the Lake Huron/Georgian Bay dataset.

Contaminant	Tissue Residue Criteria (ng/g)
PCBs	100*
DDT, DDD, DDE	14† (formerly 200)
Chlordane	500
Dioxin/Furans	0.00071[a] (formerly 0.003)
Hexachlorobenzene	330
Hexachlorocyclohexane (BHC)	100
Mirex	below detection*
Octachlorostyrene	20

Table 1. Tissue Residue Criteria for various organochlorine chemicals or chemical groups for the protection of wildlife consumers of aquatic biota.

* IJC Aquatic Life Guideline for PCBs (IJC 1988); [a] Environment Canada, 2000 (CCME 2001); † Environment Canada, 1997 (CCME 2001). All other values from NYSDEC Fish Flesh Criteria (Newell *et al.* 1987). Guidelines based on mammals and birds.

With the incorporation of the CCME guidelines, the total dichloro-diphenyl-trichloroethane (DDT) tissue residue criterion is exceeded at most locations. After total DDT, polychlorinated biphenyls (PCB) is the contaminant most frequently exceeding the guideline. Mirex was historically detected and exceeded the guideline at Lake Ontario locations. However, mirex concentrations over the past 10 years have been below detection. Other contaminants listed in Table 1 are often not detected, or are present at levels well below the guidelines.

Lake Erie

Trends of contaminants in spottail shiners were examined for four locations in Lake Erie: Big Creek, Thunder Bay Beach, Grand River and Leamington (Figure 1). Overall, the trends show higher concentrations of PCBs in the early years (1970s) with a steady decline over time. At Big Creek, PCB concentrations were elevated (greater than 300 ng/g) until 1986. Since 1986, concentrations have remained near the guideline (100 ng/g). At the Grand River and Thunder Bay Beach locations, PCB concentrations exceeded the guideline in the late 1970s, but have declined in recent years and are currently below the GLWQA guideline (100 ng/g). At Leamington, PCB concentrations were considerably higher than at the other Lake Erie sites. Although they declined from 888 ng/g in 1975 to 204 ng/g in 2001, the concentrations exceeded the guideline in all years except for a period in the early to mid-1990s. In the most recent collection (2004), levels have declined to 136 ng/g, which only marginally exceeds the GLWQA guideline.

Total DDT concentrations at Lake Erie sites have also been declining. Concentrations of total DDT at Big Creek, Grand River and Thunder Bay Beach have declined considerably to levels close to the guideline (14 ng/g). Maximum concentrations at these sites were found in the 1970s and ranged from 38 ng/g at Thunder Bay Beach to 75 ng/g at Big Creek. At Leamington, however, total DDT levels peaked at 183 ng/g in 1986. Since then, levels have declined, but they remain above the guideline.

Lake Huron

Trend data are available for two Lake Huron sites: Collingwood Harbour and Nottawasaga River (Figure 2). At Collingwood Harbour, the highest PCB concentrations were found when sampling began in 1987 (206 ng/g). Since then, PCB concentrations have remained near or just below the guideline. At the Nottawasaga River the highest concentration of PCBs was observed in 1977 (90 ng/g). Concentrations declined to less than the detection limit by 1987 and in 2002 were detected at very low levels.

Total DDT concentrations at Collingwood Harbour have remained near 40 ng/g since 1987. The guideline of 14 ng/g was exceeded in all years. At the Nottawasaga River site, there has been a steady decline in total DDT levels since 1977 when concentrations peaked at 106 ng/g. In 2002, levels were below the guideline.

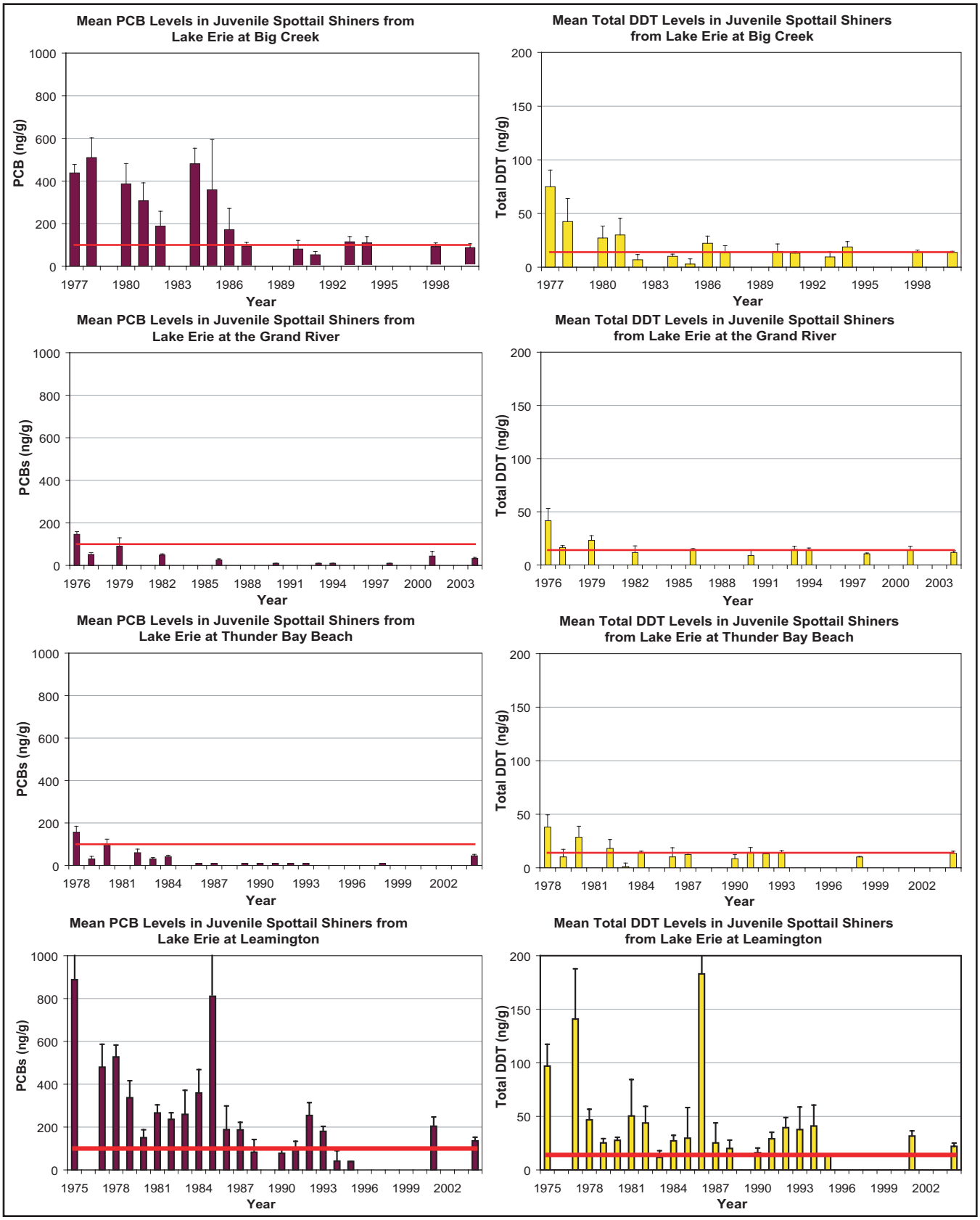

Figure 1. PCB and total DDT levels in juvenile spottail shiners from four locations in Lake Erie.

The figures show mean concentration plus standard deviation. The red line indicates the wildlife protection guideline. When not detected, one half of the detection limit was used to calculate the mean concentration.

Source: Ontario Ministry of the Environment

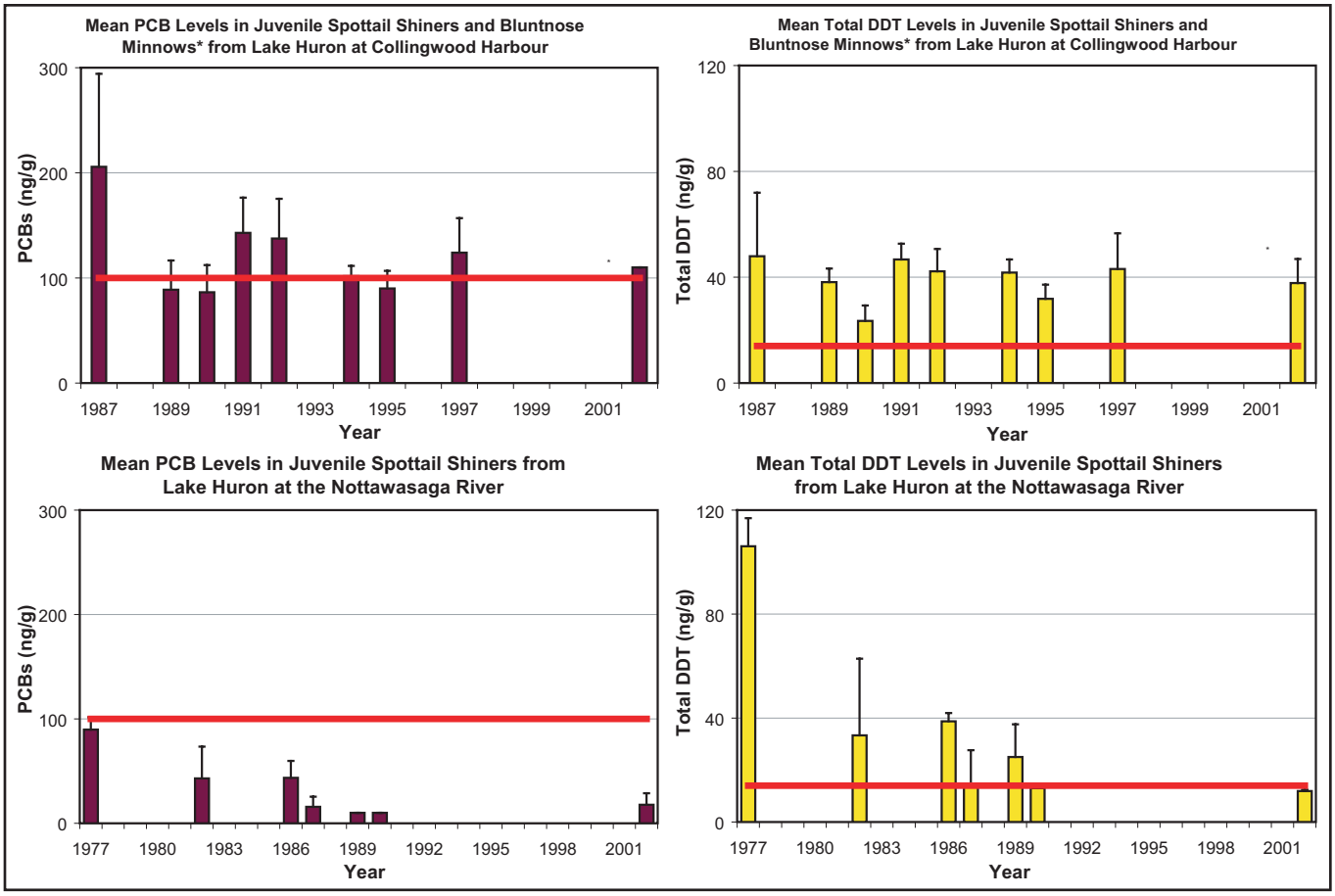

Figure 2. PCB and total DDT levels in juvenile spottail shiners from two locations in Lake Huron. The figures show mean concentration plus standard deviation. The red line indicates the wildlife protection guideline. When not detected, one half of the detection limit was used to calculate the mean concentration.

Source: Ontario Ministry of the Environment

Lake Superior

Trend data were examined for four locations in Lake Superior: Mission River, Nipigon Bay, Jackfish Bay and Kam River (Figure 3). Recent data are not available for the first three locations.

Generally PCB concentrations were low in all years and at all locations. The highest PCB concentrations in Lake Superior were found at the Mission River in 1983 (139 ng/g). All other analytical results were below the guideline (100 ng/g). The highest concentrations of PCBs at the other three Lake Superior sites also occurred in 1983 and ranged from 51 ng/g at Nipigon Bay to 89 ng/g at Jackfish Bay.

At Mission River and Nipigon Bay, total DDT levels were high in the late 1970s but decreased below the guideline (14 ng/g) by the mid-1980s. In 1990, the DDT level at Nipigon Bay was 66 ng/g, which is the highest concentration observed in juvenile fish from any Lake Superior site to date. At Jackfish Bay and the Kam River, total DDT levels were below the guideline each year, except for the Kam River in 1991 when levels rose to 37 ng/g.

Lake Ontario

Contaminant concentrations from five sites were examined for trends: Twelve Mile Creek, Burlington Beach, Bronte Creek, Credit River and the Humber River (Figure 4). PCBs, total DDT and mirex were generally higher at these (and other Lake Ontario) locations than elsewhere in the Great Lakes. Overall, PCBs at all locations tended to be higher in the early years, ranging from 3 to 30 times the guideline. The highest concentrations of PCBs were found at the Humber River in 1978 (2938 ng/g). In recent years PCBs at the five sites generally have ranged from 100 ng/g to 200 ng/g.

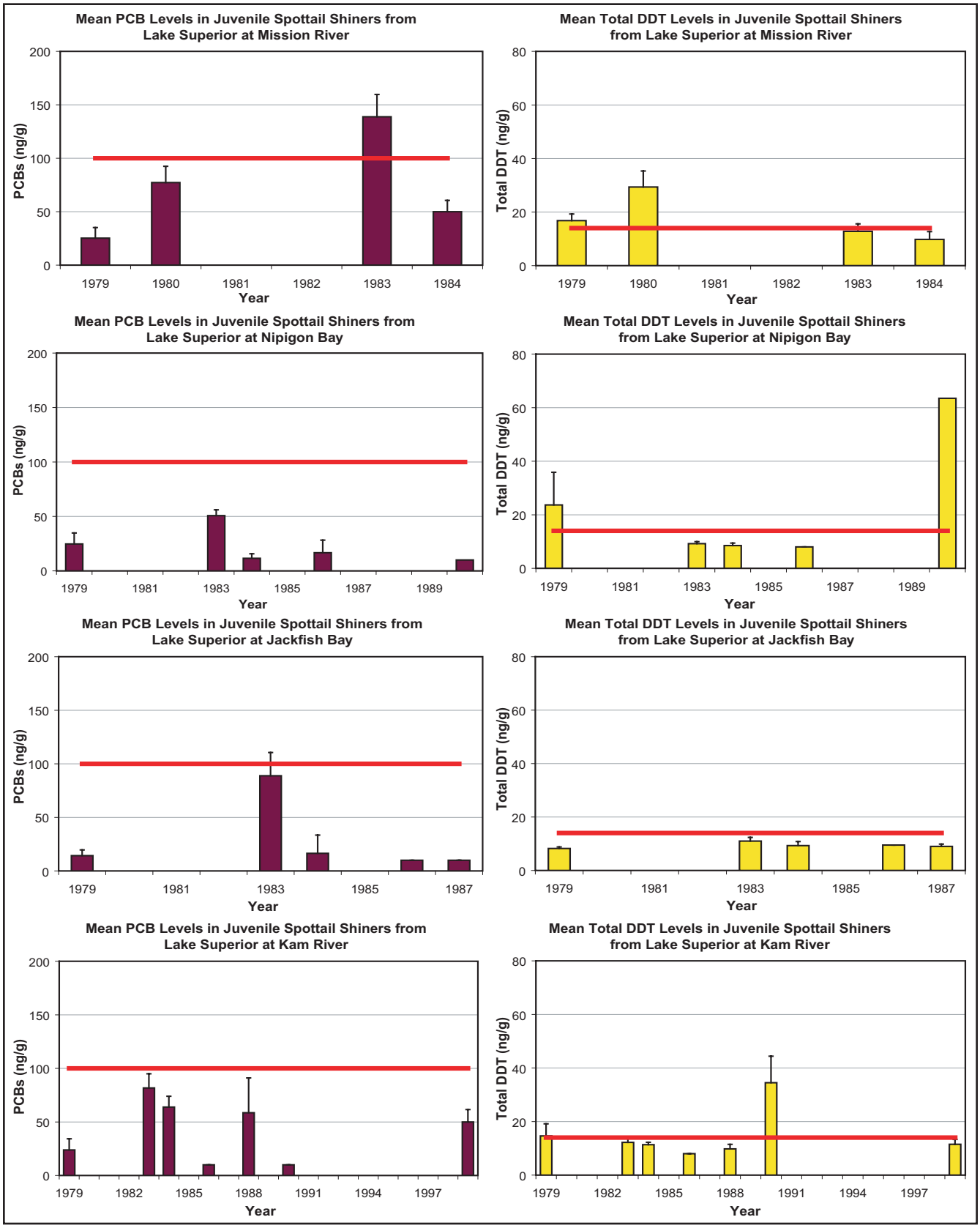

Figure 3. PCB and total DDT levels in juvenile spottail shiners from four locations in Lake Superior.

The figures show mean concentration plus standard deviation. The red line indicates the wildlife protection guideline. When not detected, one half of the detection limit was used to calculate the mean concentration.

Source: Ontario Ministry of the Environment

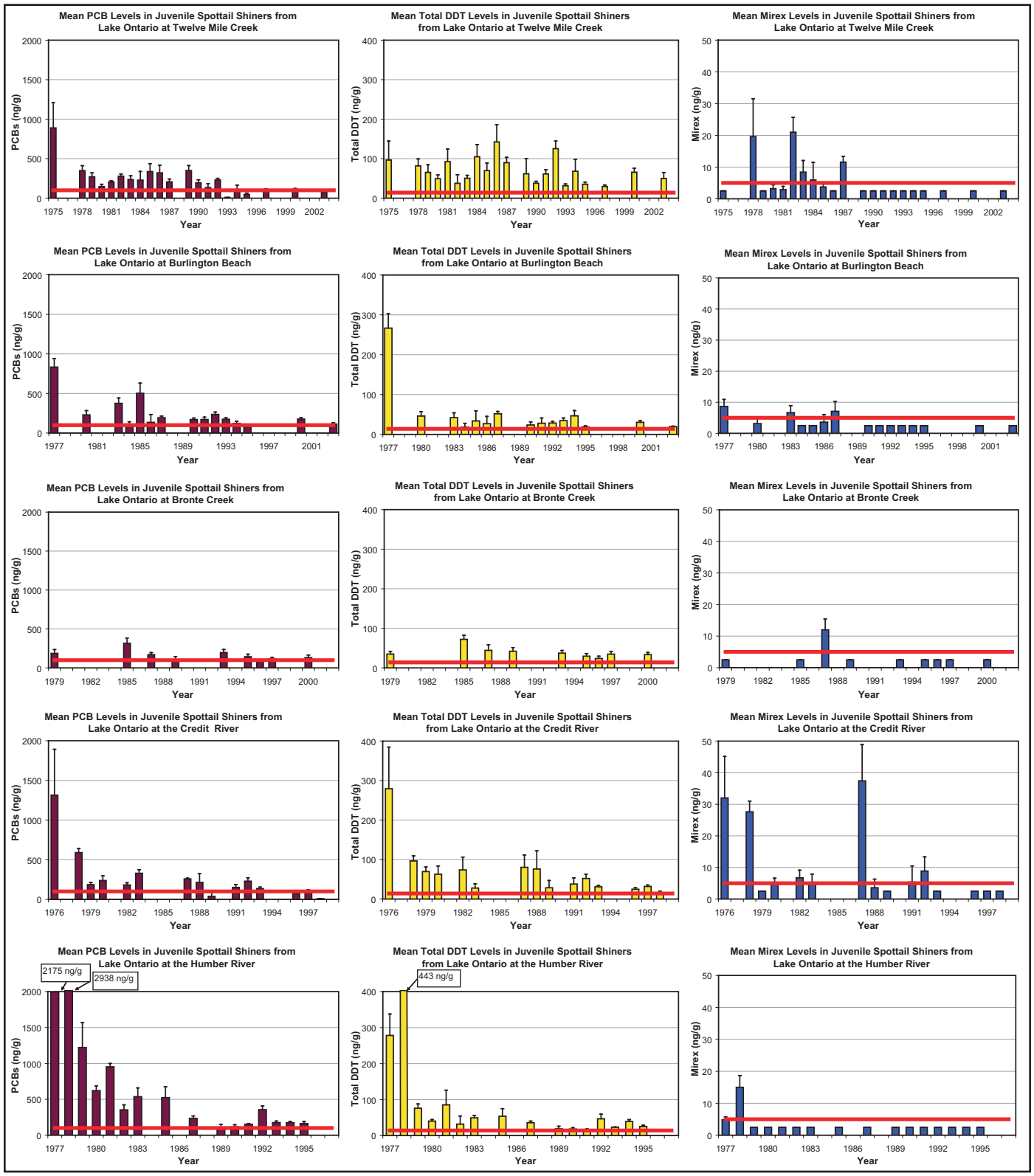

Figure 4. PCB, mirex and total DDT levels in juvenile spottail shiners from five locations in Lake Ontario.

The figures show mean concentration plus standard deviation. The red line indicates the wildlife protection guideline for PCBs and total DDT. For mirex, the red line indicates the detection limit (5ng/g). When not detected, one half of the detection limit was used to calculate the mean concentration.

Source: Ontario Ministry of the Environment

Total DDT concentrations at all five locations have declined considerably since the late 1970s and early 1980s. However, at all of these locations, levels in juvenile fish still exceed the guideline (14 ng/g). The maximum reported concentration was at the Humber River in 1978 (443 ng/g). Currently, the typical concentration of total DDT at all five locations is approximately 50 ng/g. Mirex has been detected intermittently at all five locations. The maximum concentration was 37 ng/g at the Credit River in 1987. Since 1993, mirex has been below the detection limit at all of these locations.

Lake Michigan
No spottail shiners were sampled from Lake Michigan.

Pressures
New and emerging contaminants, such as polybrominated diphenyl ethers (PBDEs), may apply new pressures on Great Lakes water quality. However, analytical methods need to be developed and tissue residue guidelines need to be established for these contaminants.

Management Implications
For those contaminants that exceed the wildlife protection guidelines, additional remediation efforts may be required. Continued monitoring is essential to determine the status of contaminants in forage fish from the Great Lakes, and the initiation of additional monitoring components (e.g., location, frequency, contaminants) would be helpful.

Comments from the author(s)
Organochlorine contaminants have declined in juvenile fish throughout the Great Lakes. However, regular monitoring should continue for all of these areas to determine if levels are below wildlife protection guidelines. Analytical methods should be improved to accommodate revised guidelines and to include additional contaminants such as dioxins and furans, dioxin-like PCBs and PBDEs. For Lake Superior, the historical data do not include toxaphene concentrations. Since this contaminant is responsible for some consumption restrictions on sport fish from this lake (Ontario Ministry of the Environment (OMOE), 2005), it is recommended that analysis of this contaminant be included in any future biomonitoring studies in Lake Superior.

Spottail shiners have been a useful indicator of contaminant levels in the past. However, this species is less abundant than it has been. Due to the difficulties in collecting this species in all areas of the Great Lakes, consideration should be given to adopting other forage fish species as indicators when spottail shiners are not available. This year, bluntnose minnows were used for one site in Georgian Bay. This will improve temporal and spatial trend data and result in a more complete dataset for the Great Lakes.

Acknowledgments
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