Pesticide Accumulation in Point Pelee Amphibians

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Abstract

*Environmental contamination with pesticides has been implicated in the decline and disappearance of amphibians from many areas around the world. Amphibian species diversity has declined by 50% at Point Pelee National Park in southern Ontario over the last 50 years. Habitat loss alone cannot account for the number of amphibian extirpations documented in the park. Similar amphibian species diversity declines have not occurred at nearby southern Ontario wetlands. Amphibian extirpations at Point Pelee follow a period of DDT application on agricultural lands located in the Park. DDT and metabolite concentrations were greatest in terrestrial amphibians (*Pseudacris crucifer *and* Bufo americanus*) and least in aquatic amphibians (*Rana clamitans *and* Rana pipiens*). These data indicate that the historic use of pesticides may be an important determinant of local distribution of amphibians in southern Ontario.*

Introduction

Over half of the amphibian fauna (six of 11 species) at Point Pelee National Park has been lost this century, while similar areas on the north shore of Lake Erie have not experienced similar losses. Current amphibian censuses from Long Point and Rondeau Provincial Parks indicate eleven and thirteen amphibian species respectively, and no extirpations are recorded for either park. Amphibian extirpations at Point Pelee include the tiger salamander (*Ambystoma tigrinum*) in 1915, Fowler's toad (*Bufo woodhousei fowleri*) in 1949, Blanchard's cricket frog (*Acris crepitans blanchardi*) in 1972, the grey tree frog (*Hyla versicolor*) in 1986, and the bullfrog (*Rana catesbeiana*) in 1990. The status of the mudpuppy (*Necturus maculosus*) at Point Pelee is presently unknown but it has not been observed since 1979. Five amphibian species remain at Point Pelee National Park: the green frog *(Rana clamitans),* leopard frog (*Rana pipiens*), American toad (*Bufo americanus*), spring peeper (*Pseudacris crucifer*), and chorus frog (*Pseudacris triseriata*).

Potential factors influencing amphibian declines in southern Ontario include habitat loss, UV-b irradiation (Blaustein et al., 1994a), global climate change (Pounds and Crump, 1994), acid precipitation, pathogens and parasites (Blaustein et al., 1994b), over-collection, introduction of exotic predators or competitors (Hecnar and M'Closkey, 1997), and environmental contamination with toxic chemicals (Russell et al., 1995; 1997). This discussion explores possible factors affecting the extirpation of amphibian species at Point Pelee National Park.

Methods

Amphibians were collected from six sites on the north shore of Lake Erie (Figure 1). Green frogs *(R. clamitans)* were the dominant species at all study locations and were collected from all six sites. Green frogs, leopard frogs (*R. pipiens*), American toads (*B. americanus*), and spring peepers (*P. crucifer*) were collected from Point Pelee National Park. Amphibian samples were prepared for electron capture gas chromatography for sixty-two chlorinated organic chemicals and pesticides by solid-solid extraction techniques (Lazar et al., 1992).

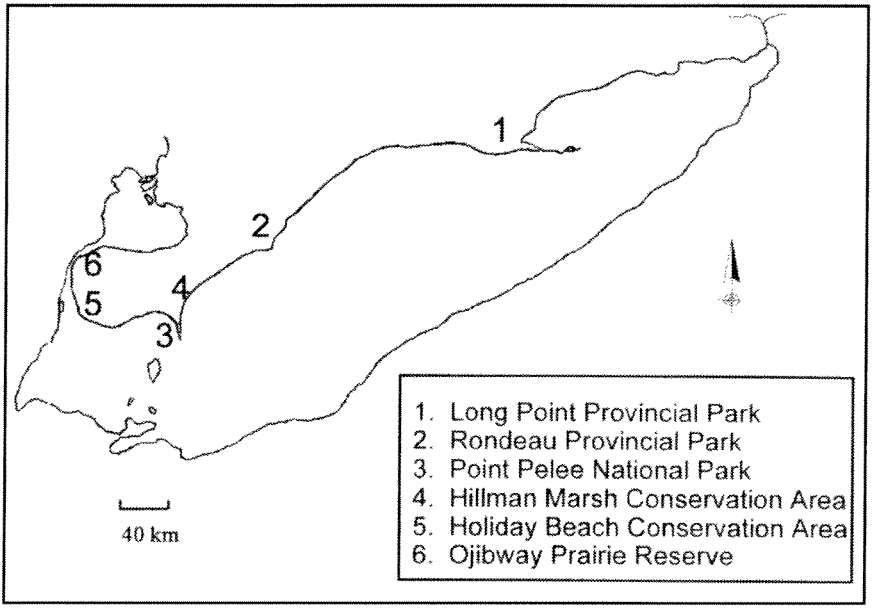

Figure 1. Sampling locations in southern Ontario.

Results and Discussion

Habitat loss is a major concern in the Great Lakes region and this may explain all or part of the amphibian extirpations observed at Point Pelee National Park. At the turn of the century, the Point Pelee marsh was reduced from 3,633 to 1,620 ha by agricultural activities. Using historic and current Point Pelee amphibian species lists, 11 and five species respectively, and the species-area relationship (MacArthur and Wilson, 1967):

$$S = cA^z$$

where: S is the number of species;
c is an empirically derived constant;
A is area; and,
z is the species-area exponent (slope of logS versus logA plot)

the expected influence of habitat loss on amphibian species diversity can be quantified. With z = 0.37 (calculated for Lake Erie islands amphibians in King et al., 1997), it is clear that habitat loss can explain loss of three species, but not six at Point Pelee. The remaining extirpations may be due to a combination of the above discussed factors.

Global climate change and increases in UV-b irradiation are large scale events and are unlikely causes of the differential in species losses, as observed at Point Pelee, Rondeau Park, and Long Point (Figure 1) because the scale of this study is much smaller than these phenomena. Acidification, while an important factor in amphibian larval development, is not an issue at Point Pelee National Park due to the highly buffered Lake Erie water. Over-collection of amphibians, pathogens and parasites, and introduction of exotic competitors and predators on amphibians have not been documented within Point Pelee National Park boundaries. Of sixty-two anthropogenic contaminants included in the chemical analysis, DDE, a metabolite of the pesticide DDT was found in high concentrations in Point Pelee amphibian tissues. Environmental contamination with DDT can be considered a potential factor in amphibian declines at Point Pelee.

Comparing DDE concentrations in green frogs from three similar areas (Point Pelee, Rondeau Park, Long Point), indicated that Point Pelee frogs accumulated the greatest amounts (Figure 2). All three study areas are sand spits on the north shore of Lake Erie which are similar in size, physical structure, and history; however, Point Pelee experienced limited agriculture within the Park until the 1970s. The source of DDT contamination was the historic use of pesticides in the Park for agriculture and for mosquito control from 1948 until 1967. On a more limited local scale, DDE concentrations in Point Pelee green frogs were greater than in green frogs from Hillman Marsh Conservation Area, Holiday Beach Conservation Area, and the Ojibway Prairie Reserve (Figures 1 and 3). Point Pelee marsh and Hillman Marsh were connected prior to 1900, at which time marshlands in the area were drained

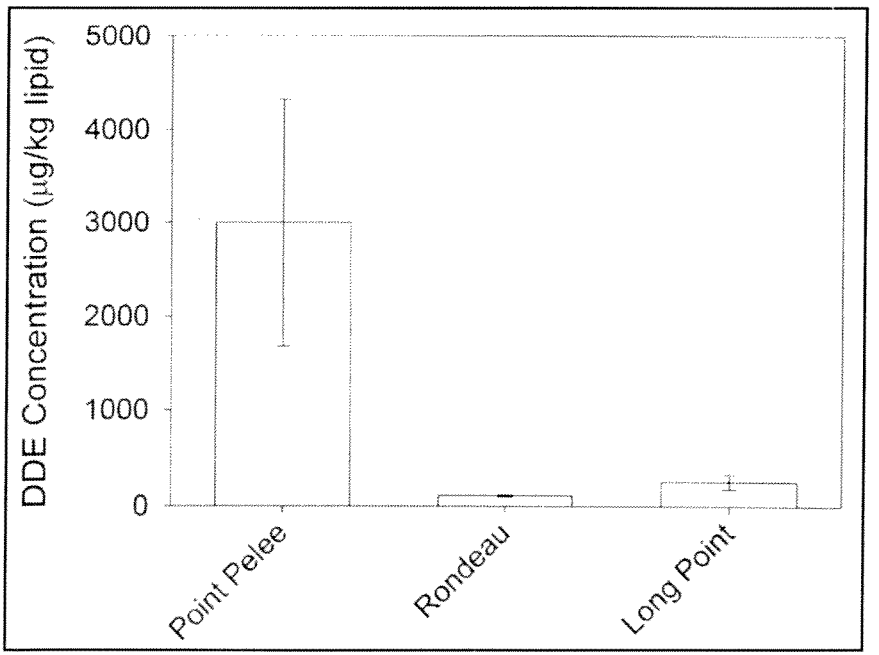

Figure 2. DDE in Point Pelee, Rondeau Park, and Long Point green frogs. Concentrations are expressed in mg/kg lipid.

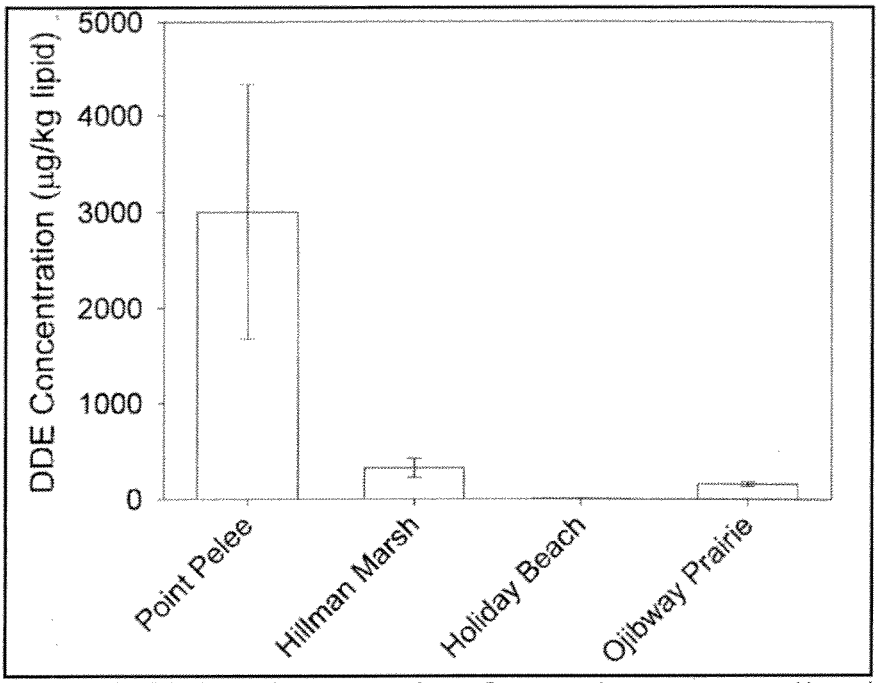

Figure 3. DDE in Essex County green frogs. Concentrations are expressed in mg/kg lipid.

dividing these two wetlands by agricultural development. The differences in DDE accumulation in green frogs from Point Pelee and from Hillman Marsh highlight the point source nature of chemical contamination at Point Pelee.

Differences in DDE accumulation exist among four species of amphibians collected from Point Pelee (Figure 4). Green frogs and leopard frogs can be considered aquatic amphibians based on the amount of time spent in and around bodies of water, and because they hibernate on the bottom of ponds. American toads and spring peepers can be considered terrestrial amphibians based on their terrestrial hibernation and habitat use. The aquatic amphibians are also distinguished from the terrestrial amphibians by the amount of DDE accumulated by these different groups (Figure 4). The low solubility of DDE in water indicates that diet is a major chemical uptake route in these organisms. A detailed analysis of gut contents of amphibians captured at Point Pelee showed no differences in taxa consumed by these four species; however, there were size differences in consumed insects. This suggests that dietary exposure to DDE was similar for the four species of amphibians examined. Differences in DDE accumulation between the terrestrial and aquatic species may be due to habitat use differences whereby toads and spring peepers are exposed to higher concentrations of DDE than their more aquatic counterparts. Habitat utilization differences could also affect chemical elimination through the semi-permeable skin of amphibians where aquatic amphibians have a greater potential to eliminate accumulated chemicals to water through the skin due to the greater amount of time spent in water. Accumulation of DDE may also be related to

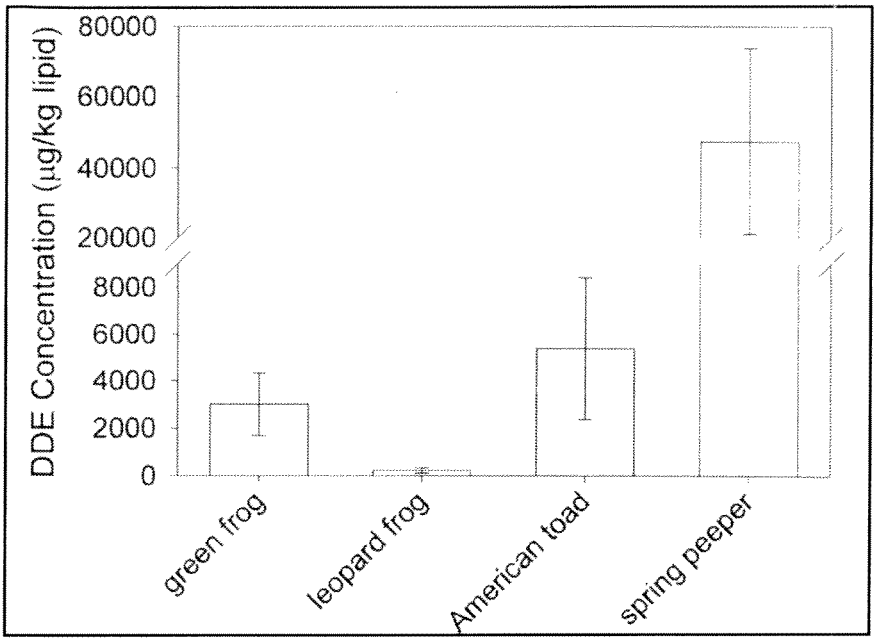

Figure 4. DDE in Point Pelee green frogs, leopard frogs, American toads, and spring peepers. Concentrations are expressed in mg/kg lipid.

the presence of cryoprotectants in specific organisms. Cryoprotectants are chemicals produced by an organism in response to freezing temperatures to prevent tissue and organ damage. Spring peepers are the only amphibians in this study to produce cryoprotectants, which may alter their ability to eliminate accumulated chemicals.

DDE and its parent compound DDT are known to be endocrine disruptors. These chemicals can change the normal course of embryonic and larval development in amphibians at low doses as well as causing acute toxic effects at high doses. The unusually high number of amphibian extirpations at Point Pelee National Park compared to similar areas, coupled with elevated DDE concentrations in Park amphibians indicate that the historic use of DDT within Park boundaries may be a major factor in the decline of Point Pelee amphibians.

Acknowledgement

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