



# POLYCHLORINATED BIPHENYLS (PCBs) AND POLYBROMINATED DIPHENYLETERS (PBDEs) IN CURRENT AND HISTORICAL SAMPLES OF AVIAN EGGS FROM NESTING SITES IN BUZZARDS BAY, MA, USA



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## Introduction

Well-documented effects of contaminants such as PCBs and chlorinated pesticides have resulted in US regulations limiting their release to the environment. More recently, polybrominated diphenyl ethers (PBDEs) have been added to the list of contaminants of 'emerging concern'. PBDEs are part of a larger class of contaminants called brominated flame retardants that are used to reduce the intensity and spread of fire in household and commercial products such as televisions, computers and electronic equipment. PBDEs are similar to PCBs in chemical and physical properties, and similarly persistent in the environment. Like PCBs, PBDEs can bioaccumulate in humans and wildlife. However unlike PCBs, PBDE levels have been increasing in avian populations breeding in the US. Migratory avian species are exposed to a wide variety of contaminants through diet at their breeding grounds and also at their over-wintering habitats. Avian eggs are useful for environmental monitoring because maternally transferred contamination has the potential to cause serious effects in sensitive early life stages.

Here we present the results of studies measuring PCBs and PBDEs in eggs of migratory bird species with summer breeding habitats near or at a PCB Superfund site. These avian species were selected because their diets and feeding strategies differ, and these differences might be reflected in varying egg contamination. Common terns (*Sterna hirundo*) feed on small fish within 20 km of the breeding colonies. Tree swallows (*Icthyophaga bicolor*) feed on insects within meters of the nesting site. Terns were also selected for study because archived eggs provided an opportunity to study temporal changes in egg contamination.

This project represents collaborative efforts by various partners. Massachusetts Division of Fisheries and Wildlife collected common tern eggs from Ram Island in Buzzards Bay, MA, in spring of 1994-96, 98-99 and 2005, and additional eggs (collected by I.C.T.N. Nisbet and Reynolds 1984) were available through Canadian Wildlife Service archives (1972). In cooperation the US Geological Survey, tree swallow eggs were collected in 2003 from nest boxes at a PCB Superfund site, New Bedford Harbor (NBH) MA, adjacent to Buzzards Bay. Chemical analyses were developed and conducted by the U.S. EPA, Atlantic Ecology Division, Narragansett, RI.

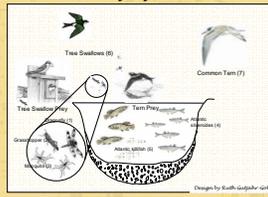
## Chemical Analysis

Homogenized eggs were extracted using acetonitrile and pentane. PCBs were analyzed on a Gas Chromatograph (GC) (Agilent 6890) equipped with an electron capture detector. PBDEs were analyzed on a GC-Mass Spectrometer (Agilent) in negative chemical ionization mode.

The mean concentration of PCBs is the sum of NIST 18 congeners and that of PBDEs is the sum of 10 congeners. The extraction and analysis procedures were the same for tree swallow eggs collected in 2003 from the Superfund site, New Bedford Harbor, MA. Archived PCB extracts stored at -4°C were analyzed for PBDES in 2007 April.

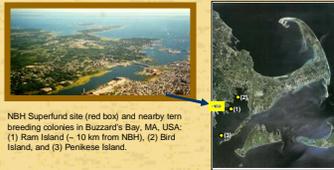
Acknowledgements: Christine and Tom Coates, USGS, for Tree Swallow samples; New Bedford Harbor PCBs Cleanup Support; and Patricia DeGalea, CSC, for graphic assistance.

## Study System



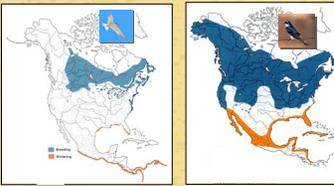
Food web diagram: Schematic representation of routes for trophic transfer and bioaccumulation of sediment PCBs. Study species are Common tern (T), piscivores nesting in colonies offshore from the Superfund site, and feeding over a broad area (map below) on fish species including Atlantic silversides (*Menidia menidia*, 4) and Atlantic killifish (*Fundulus heteroclitus*, 5). Shown for comparison are tree swallows nesting in boxes (6), and feeding locally on insects (1, 2, 3).

## Breeding site: one source of contamination



NBH Superfund site (red box) and nearby tern breeding colonies in Buzzards Bay, MA, USA. (1) Ram Island (~ 10 km from NBH), (2) Bird Island, and (3) Penikese Island.

## Wintering site(s): other sources of contamination(s)?

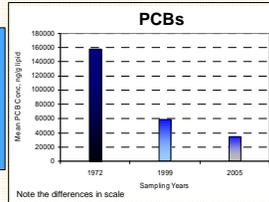


Breeding ranges for common terns in North America, wintering ranges extend south to N. Argentina. Source: Birds of North America. Summer / breeding range of the tree swallow. Winter (nonbreeding) breeding range of the tree swallow.

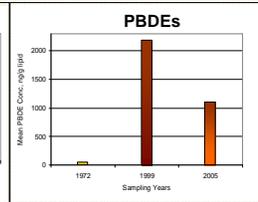
## Results

### Ram Island common tern eggs 1972-2005

#### PCBs declined

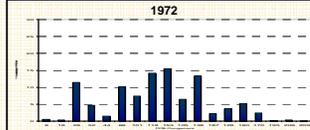


#### PBDEs increased

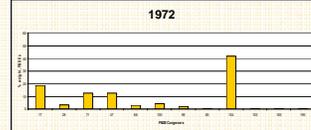


### Congener Patterns shifted over time in Ram Island common tern eggs

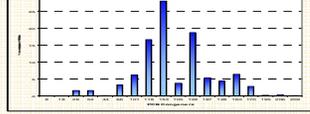
#### PCBs



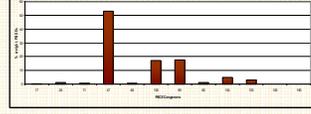
#### PBDEs



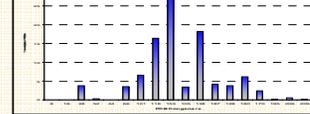
#### 1999



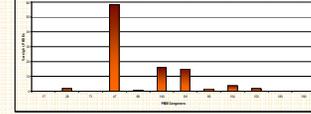
#### 1999



#### 2005



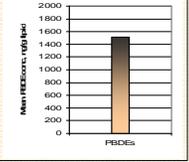
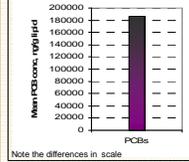
#### 2005



Note the differences in scale

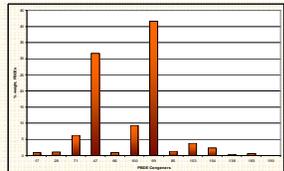
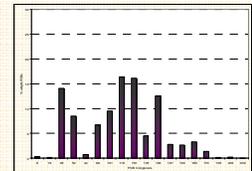
### New Bedford Harbor tree swallow eggs 2003

#### Mean PCB and PBDE concentrations in tree swallow eggs 2003



Note the differences in scale

### PCB and PBDE Pattern in tree swallow eggs



## Conclusions

- Temporal patterns in common tern eggs:**
  - Total PCB concentrations in recently collected eggs (2005) have declined to 22% of 1972 levels;
  - PCB congener patterns have also changed during this period in a manner consistent with environmental trends (data not shown).
- In contrast to PCBs, total PBDEs have increased during this same period to 3079% of 1972 levels;
  - PBDE patterns from recent samples (1999-2005) suggest exposure to a penta BDE source.
- Comparing recent samples of tree swallow (2003) and common tern (2005) eggs:**
  - Total PCB concentrations are higher in tree swallow eggs: 537% of total PCBs in common tern eggs;
  - PCB congener patterns showed that 61% of the total PCB weight was contributed by tri, tetra and penta PCB congeners, while in terns the percentage was 25%.
  - Total PBDE concentrations were similar in eggs of both species
  - PBDE patterns in tree swallow eggs differed from patterns found in tern eggs. PBDE 47 was the dominant congener in tern eggs and in tree swallows, PBDE 99 was the dominant congener.