Polychlorinated biphenyls (PCBs) and Polybrominated diphenylethers (PBDEs) in current and historical samples of avian eggs from nesting sites in Buzzards Bay, MA, USA

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Introduction

ocumented effects of contaminants such as PCBs and ated pesticides have resulted in US regulations limiting lease to the environment. More recently, polybrominated yl ethers (PBDEs) have been added to the list of tinants of 'emerging concern'. PBDEs are part of a larger f contaminants called brominated flame retardants that ed to reduce the intensity and spread of fire in household mmercial products such as televisions, computers and nic equipment. PBDEs are similar to PCBs in chemical ysical properties, and similarly persistent in the nment. Like PCBs, PBDEs can bioaccumulate in humans ldlife. However unlike PCBs, PBDE levels have been sing in avian populations breeding in the US. Migratory pecies are exposed to a wide variety of contaminants n diet at their breeding grounds and also at their over- ng habitats. Avian eggs are useful for environmental ring because maternally-transferred contamination has ential to cause serious effects in sensitive early life

e present the results of studies measuring PCBs and s in eggs of migratory bird species with summer breeding s near or at a PCB Superfund site. These avian species elected because their diets and feeding strategies differ, ese differences might be reflected in varying egg mination. Common terns *(Sterna hirundo)* feed on small hin 20 km of the breeding colonies. Tree swallows *cineta bicolor*) feed on insects within meters of the g site. Terns were also selected for study because d eggs provided an opportunity to study temporal es in egg contamination.

oject represents collaborative efforts by various partners. chusetts Division of Fisheries and Wildlife collected n tern eggs from Ram Island in Buzzards Bay, MA, in of 1994-96, 98-99 and 2005, and additional eggs ed by I.C.T.N, Nisbet and Reynolds 1984) were le through Canadian Wildlife Service archives (1972). peration the US Geological Survey, tree swallow eggs ollected in 2003 from nest boxes at a PCB Superfund ew Bedford Harbor (NBH) MA, adjacent to Buzzards Bay. cal analyses were developed and conducted by the U.S. tlantic Ecology Division, Narragansett, RI.

Chemical Analysis

genized eggs were extracted using acetonitrile and ne. PCBs were analyzed on a Gas Chromatograph (GC) nt 6890) equipped with an electron capture detector. s were analyzed on a GC-Mass Spectrometer (Agilent) gative chemical ionization mode.

ean concentration of PCBs is the sum of NIST 18 ners and that of PBDEs is the sum of 10 congeners. xtraction and analysis procedures were the same for tree w eggs collected in 2003 from the Superfund site, New rd Harbor, MA. Archived PCB extracts stored at -4°C nalyzed for PBDES in 2007 April.

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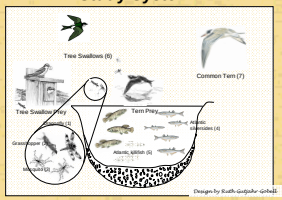
Study System



Food web diagram: Schematic representation of routes for trophic transfer and bioaccumulation of sediment PCBs. Study species are Common tern (7), pisivores 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 Buzzard's Bay, MA, USA: (1) Ram Island (~ 10 km from NBH), (2) Bird Island, and (3) Penikese Island.

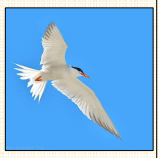
Wintering site(s): other sources of contamination(s)?

Breeding range for common terns in North America, wintering ranges extend south to N.Argentina. Source: Birds of North America

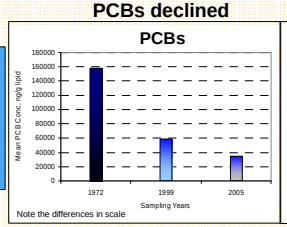
Summer / Breeding range of the tree swallow.
Winter (nonbreeding) breeding range of the tree swallow.

Results

Ram Island common tern eggs 1972-2005

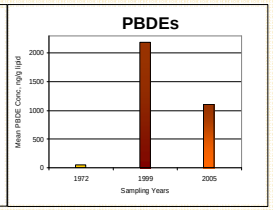


PCBs declined



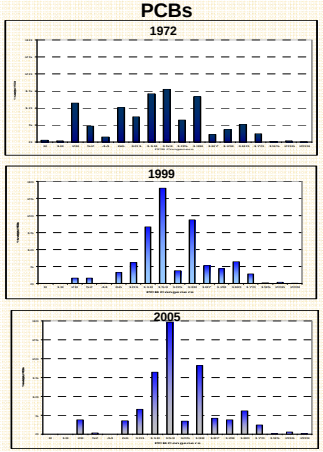
Note the differences in scale

PBDEs increased

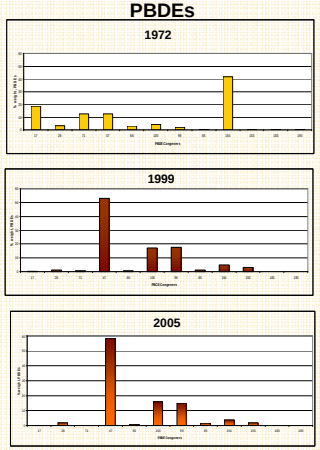


Congener Patterns shifted over time in Ram Island common tern eggs

PCBs



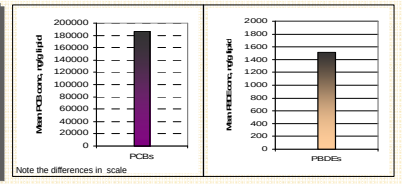
PBDEs



Note the differences in scale

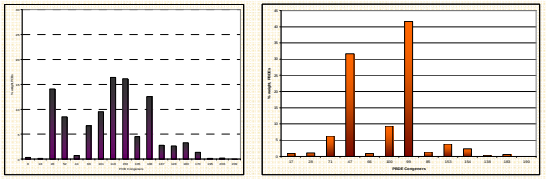
New Bedford Harbor tree swallow eggs 2003

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;
  - o 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;
  - o 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;
  - o 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
  - o 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.