

Bird Study: Update from Year 1 and Proposal for Year 2
Dan Cristol, Dept. Biology, College of William & Mary

Progress at achieving objectives:

We achieved most of our Year 1 and Year 2 objectives during the first field season. Our original goals were three-fold:

1) To compare levels of total mercury at contaminated and reference sites in two target species (tree swallow and eastern screech-owl) and determine the feasibility of collecting adequate sample size of a less common piscivorous bird (belted kingfisher) in year 2. By erecting 200 swallow nestboxes we were able to collect blood and feather samples from 99 adults and 505 chicks, exceeding our sample size goals for years 1 and 2. Our 100 screech-owl boxes were not used due to the fact that owls had already chosen nest sites before we erected the boxes. However, by changing our strategy we were able to net 16 owls, exceeding our Year 1 sample size expectation. By canoeing the entire navigable portion of the North, Middle, South and South Fork Shenandoah Rivers (south of Elkton) we located 27 kingfisher nests and accessed 19 of these, sampling 25 adults and 97 chicks, and exceeding our Year 1 and 2 goals.

2) Our second goal was to assess reproductive success of swallows, owls and kingfishers nesting in contaminated and reference sites. We obtained extensive reproductive success data on 125 swallow nests (growth rate, fledging success, hatching success, developmental stability (a.k.a. fluctuating asymmetry), etc.) and limited data on 17 kingfisher nests (clutch size, hatching success, fledging success, fledging mass). No active owl nests were found, but we expect them to use nestboxes in large numbers next year because they are abundant on the study site and some nestbox exploration was observed.

3) The third goal was to census breeding bird diversity and density at contaminated and reference sites. Point counts lasting 10 minutes were performed at 20 contaminated and 20 reference sites along the South and Shenandoah Rivers and portions of the Middle and North Rivers near the confluence. Each count was replicated by a different observer (leaders in the local birdwatching community). Each count covered a circle with radius 100 m and centered 100 m from the shoreline. Point counts allow the calculation of territorial species richness and diversity, as well as distance-adjusted density. Birds flying over, but not using, the habitat were not counted.

4) A fourth goal was to determine levels of total mercury in blood of other species nesting in emergent wetlands along the contaminated portion of the river and potentially facing exposure risk. Because no suitable wetlands were located, we netted 90 birds of 22 non-target songbird species occupying territories within 50 m of the shoreline in floodplain forest with potential exposure to mercury in flood-deposited sediments. Sample sizes varied, with > 5 adults sampled from 6 species (Carolina wren, eastern bluebird, song sparrow, northern rough-winged swallow, northern cardinal, gray catbird).

Results

Many results await analysis, as the field season ran through August, 2005. Thus far we have determined that total mercury in blood of belted kingfishers, tree swallows and eastern screech-owls at contaminated sites is significantly higher than at reference sites. Mean levels in adults of each species are approximately an order of magnitude higher at contaminated sites than at reference sites (i.e., approximately 2 ppm versus 0.2 ppm wet weight). Preliminary analysis of chick blood indicates that levels are an order of magnitude lower than adults at the same sites, but further analysis of feathers is required to interpret this result, because rapidly growing young birds transfer mercury out of blood and into growing feathers. The most surprising result is that adult birds of two species with no apparent direct connection to the aquatic food web, screech-owls and Carolina wrens, had levels higher than piscivorous kingfishers or aquatic-feeding swallows, suggesting that methylmercury is available in the terrestrial food chain. Other terrestrial species had lower levels, but still were elevated above what would be expected in an uncontaminated area (based on studies elsewhere). Analysis of feathers and blood samples will continue, as well as further analysis of existing data. An additional surprise was that the peak in blood mercury levels for tree swallows occurred not near the Invista plant, but 10 river miles downstream (Augusta Forestry Center), with levels falling off after the confluence at Port Republic.

No detectable differences have been found in success of swallow nests or kingfisher nests on contaminated and uncontaminated sites. Nests were abundant and hatching and fledging success were high in both species. Further analysis of the data may still reveal subtle differences.

No detectable differences have been found in the number of species censused at contaminated and reference sites (65 species at each), or the densities of each species or all species combined. Further analysis in which birds are lumped into feeding guilds could reveal subtle differences.

Overall, mercury availability is high for birds using both aquatic and terrestrial food chains for more than 10 river miles downstream, but reproductive affects or population affects were not obvious in preliminary analyses.

Year 2 plan:

We have three objectives for Year 2:

- 1) Determine the route of exposure for terrestrial birds in contaminated areas. We will combine collection of invertebrate, plant and soil samples from riverside bird habitats with collection of prey brought to young by adults to determine the diets of Carolina wrens, song sparrows and eastern bluebirds. All of these species are common, ground-feeding songbirds with broad diets, yet blood mercury (total) in wrens is more than 3-fold higher than that in sparrows. Comparing the diets of these three species, one off which (sparrow) is bioaccumulating mercury to a potentially "safe" level of < 1 ppm, will allow us to pinpoint the components of songbird diet that lead to high risk for certain species.

A comparison of the prey brought back to tree swallow and rough-winged swallow nests would also be instructive because both species feed on aerial insects above the water, but rough-winged swallows exhibited “safe” (<1 ppm) mercury levels in blood.

2) Determine if fledgling birds experience increased blood mercury levels once they can no longer shunt mercury into newly growing feathers. Because this occurs after the birds leave the nest, it is a difficult goal to accomplish, and requires a large bird that will not migrate. We will radio-track fledgling screech-owls or another species when they are close to leaving the nest, and then follow these young birds as they move about the habitat. Those remaining close to the contaminated portion of the river will be sampled repeatedly to determine whether mercury levels in blood increase when feather growth ceases.

3) Determine whether waterfowl breeding in the contaminated portion of the river exceed safe consumption levels for hunters. We will capture woodduck, mallard and Canada goose and biopsy muscle tissue for total and methylmercury analysis. Female waterfowl (15-20 of each species) will be captured in nestboxes (woodducks), baited traps (mallards) or by round-up during the flightless molt period (geese). Blood samples will be obtained so that, if a strong correlation exists between blood and muscle tissue levels, future monitoring can be performed by blood sample alone. If some ducks exceed recommended consumption levels, further studies of marked birds will be suggested to determine whether contaminated waterfowl disperse or migrate to other areas where they might be hunted.

4) Determine whether contaminated and reference sites differ in the return rates (i.e. estimated relative survivorship) of adult and young birds banded in Year 1. Tree swallows are the ideal species this study because they were banded in large numbers and have few places to nest other than our nestboxes. Because adults will return and re-claim their nestboxes, we will erect an additional 100-200 nestboxes at the same sites to attract returning young birds.