In the mid-1900s, the industrial boom in the United States gave rise to new products, new production processes, and new economic prosperity. However, many of these industrial processes produced heavily contaminated effluents, which were then released into nearby rivers and lakes. This waste contained stable organochlorines, including polychlorinated biphenyl (PCBs) and dioxins, which settled into the sediments of the rivers or traveled air/water-borne throughout the world. These persistent organochlorines can enter the aquatic food chain through ingestion by microorganisms and accumulate exponentially in the fatty tissue of higher predators such as fish and birds. Studies of fish-eating waterbirds have found the presence of these pollutants to cause immunological impairments, eggshell thinning, reduced embryonic viability, physical deformities, and chick edema. Such studies led to the banning of many harmful chemicals, but not before these pollutants built up in the environment to significant levels. Highly polluted areas were designated as ‘Areas of Concern’ (AOCs) by the US Fish and Wildlife Service under the Water Quality Agreement. AOCs are reassessed annually with the aim of determining if the environmental pollutant levels are still impairing the health and recreational benefits provided by the AOCs.

Researchers from Calvin College monitor AOCs in the Saginaw Bay and the River Raisin. Reference sites are located in the St. Mary’s River, an area with insignificant organochlorine contamination. Herring gulls and Caspian terns, located at the top of an aquatic food chain, are the ideal avian species to work with to re-assess the effects of these persistent pollutants on population, growth and development.

Unhatched eggs were collected in the spring and the contents were processed for contaminant analysis. At the same stage, eggs were measured and assessed for embryonic viability. AOCs tended to have higher levels of embryonic non-viability, due to infertility or failed development within the egg. Enclosures were set up around nests to contain hatching chicks, which were then studied at three and four weeks of age. Three-week-old chicks were given an injection (of phytohemagglutinin) in the wing web to produce a quantitative inflammatory response. A relatively large amount of swelling indicates a healthy immune system. Chicks at AOCs had significantly lower immune responses than chicks at reference sites. An injection of sheep red blood cells (SRBC) was also administered to chicks at three weeks of age. The SRBCs function similarly to an inoculation, stimulating an antibody response from the chicks’ immune system to fight the invader. Blood samples were drawn from chicks in the enclosures at three and four weeks of age and processed for plasma and white blood cells. The plasma from week four was used to determine the antibody response to the SRBCs, and white blood cells are used to determine the quality of the chicks’ immune systems through cell proliferation cultures. At three and four weeks of age, body measurements were collected from chicks inside the enclosures to determine if the chicks were growing at a healthy rate. Growth rates vary between sites and years, due to the effects of pollutants and other environmental factors.

The reassessment of these particular AOCs is a long term process. Current studies show that chicks at AOCs still exhibit impairments as a result of organochlorine contamination.

This project provided the opportunity to learn many new laboratory techniques, as well as sample collection and processing in the field. Careful studying of related scientific literature resulted in a deeper understanding of the interaction of chemicals with the environment and their effects on organisms.