

Influence of Double-Crested Cormorants on Food Web Productivity in Freshwater Ponds

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ABSTRACT: Conflicts with wildlife are often based on the perceptions and concerns of citizens, industries, and managers. The gregarious nature of Double-crested Cormorants (*Phalacrocorax auritus*; DCCO) makes their colonies highly conspicuous. Their feeding habits on forage and commercially important fishes have incited a human/wildlife conflict with this species. Colonies re-use roosting and nesting sites. In these areas guano deposits accumulate and are released into the environment where they have the potential to alter the food web through changes in productivity. This alteration can ultimately change the composition, abundance, and condition of fishery resources.

We investigate the influence of bird-derived nutrients in a semi-controlled pond system. We used a combination of Seabird Guano[®] and Triple Super Phosphate[®] to simulate nutrient excretions of *P. auritus* at densities of 40,000 birds water acre⁻¹. Our experiment was conducted in 3 phases. Phase 1 simulated a low-impact treatment where nutrients were added once every three weeks. Samples of planktonic organisms were collected 12-48 hours before and after fertilization. Phase 2 was the high-impact treatment where fertilizer was added twice per week, and planktonic organisms were sampled weekly. Phase 3 was a recovery period where no additional nutrients were added to the system and samples were collected every 10 days. Six replicate collections occurred for each phase, and each set was comprised of six samples. Control ponds received no fertilizer and every effort was made to minimize cross-contamination of equipment and safety gear between fertilized and unfertilized ponds.

In unfertilized ponds, phytoplankton (primarily *Volvox spp.*) abundance did not change throughout the study period ($p = 0.902$), although a peak in abundance was noted in late July 2012 at the end of Phase 1. Similarly, zooplankton (composed predominantly of ostracods and crayfish larvae) abundance was not different throughout the study period ($p = 0.064$), but a decreasing trend was observed, especially during Phase 2 of our experiment. In fertilized ponds, a non-linear increase in phytoplankton was observed as Phase 1 and 2 of our study continued, with a decrease in abundance during the recovery phase ($p = 0.034$). A steady decline in zooplankton abundance occurred during Phase 1. However, the zooplankton abundance remained consistent throughout Phase 2 and the recovery phase. Phytoplankton abundance did not change during Phase 1 when samples collected before and after fertilization were compared ($p = 0.852$), but zooplankton abundance was consistently higher 3 weeks after nutrients were added to the ponds ($p = 0.0217$), suggesting a time lag in consumer response to increased resources.

Trends of primary producers and first-order consumers suggest that zooplankton abundance is controlled by upper trophic levels, effectively reducing the consumptive pressures on phytoplankton in systems where nutrient inputs are not elevated. When supplemental nutrients are applied, a stronger relationship between phytoplankton and zooplankton abundance is apparent, suggesting zooplankton production at high nutrient concentrations is high enough to overcome predation pressures. We did not compare fluctuations in fish populations for this assessment, but we suspect strong similarities exist at higher trophic levels and we will be evaluating those relationships in the future. Based on our findings, we conclude nutrient inputs similar to those delivered by DCCO colonies have the potential to support

higher first-order consumer populations of aquatic food webs. Because we observed no blooms of toxic algal species, we do not suspect cormorant colonies support harmful algal blooms. At this time, DCCO-derived alterations in food web dynamics do not appear to be negative. Additional studies of this nature would assist managers in deciding on the degree to which cormorant colonies should be managed for apparent damage.

Key Words: cormorants, environmental impact, freshwater ponds, guano

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