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Evaluation of an Electric Fish Dispersal Barrier in the Chicago Sanitary and Ship Canal

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Abstract.—In 1990, the U.S. Congress authorized the Army Corps of Engineers to study barriers to prevent the downstream movement of round gobies *Apollonia* (formerly *Neogobius*) *melanostomus* and other harmful, invasive fishes from southern Lake Michigan through the Chicago canal system into the Illinois River (a tributary of the Mississippi River). A demonstration electric barrier was activated too late (April 18, 2002) to block the gobies, but it was the only barrier to upstream movement of Asian carps from the Illinois River to Lake Michigan and provided useful information for design of a second, improved barrier (Barrier 2). We surgically implanted combined radio-and-acoustic transmitters in 130 common carp *Cyprinus carpio* that we released 20 m downstream of the demonstration barrier in the Chicago Sanitary and Ship Canal to assess the ability of the barrier to prevent upstream passage of fish. Movements of these fish were monitored from April 2002 through December 2006, within and beyond the 8.7-km reach bounded upstream by the electric barrier and downstream by the Lockport Dam and Lock. Fixed hydrophones and radio antennas continuously monitored the canal immediately upstream and downstream of the barrier for signals from the transmitters. In addition, 32 surveys were conducted with boat-mounted receivers to locate transmitters that were out of range of the fixed receivers. The fixed receivers detected 109 of the 130 transmitters; most detections occurred within a few days after release of the fish. The tracking boat located 120 of the transmitters at least once and 100 at least twice. Most of the transmitters remained well downstream of the barrier and upstream of the lock, but one moved downstream beyond the lock,

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one passed upstream through the barrier, four moved upstream within 60–400 m of the barrier after moving downstream, and three remained at the release point for their entire battery life, indicating that the fish had died or the transmitters had been expelled. On two occasions, common carp were visually observed within half a meter of the surface (the limit of visibility) at the barrier. These fish were not observed to move beyond the downstream margin of the electric field. The traverse of the barrier on April 3, 2003 occurred at the same time as a tow was passing. A tow consists of steel barges that are lashed together and pushed by a diesel-powered boat. The tow may have facilitated the passage of the fish, either by entraining the fish or by distorting the electric field. The tracking boat detected the transmitter upstream of the barrier on April 10, 2003. The transmitter did not move more than 100 m during the remaining life of the transmitter, indicating that the fish was probably dead. After we reported the passage, Smith-Root, Inc. (operators of the electric barrier, under contract to the U.S. Army Corps of Engineers) increased the duty cycle of the electric field by fivefold. We did not detect any further passages of transmitters, suggesting that the existing electric field (Barrier 1) prevented upstream movement of adult common carp and that the new, improved barrier, in combination with Barrier 1, may be effective against the more recently introduced Asian carps. The response of Asian carps to electric barriers still needs further study because the behavior of the Asian carps differs from common carp. Also, there are ways these carps could bypass Barriers 1 and 2 that need to be addressed. These potential bypasses may explain the recent detections of DNA shed from these carps in canal water upstream from the barriers.