

EFFECTS OF NEAR SHORE DEVELOPMENT ON LAKE ECOSYSTEMS INDIANA DIVISION OF FISH AND WILDLIFE

Decisions about near shore development, which includes piers, seawalls and beaches, should take into account the cumulative effects of shoreline development on the fishery. The percentage of the lakeshore that can be developed should depend on the lake bathymetry, trophic status, and fish community found within the lake. Currently, the widespread shoreline development of Indiana lakeshores is degrading the quality of the fishery resources within the lakes.

Habitat complexity is necessary in order to support a healthy fishery. As part of the development of Indiana's lakes, piers, seawalls, and beaches have been created and are now found to dominate the shoreline in many of the lakes. As the lake shorelines and riparian areas are developed, the cumulative effects of this development have contributed to the loss of habitat complexity due to the removal of aquatic macrophytes and complex woody debris (CWD) that characterize the habitat necessary for a quality fishery resource (Christensen et al. 1996; Brazner and Beals 1997). In addition, simplified shorelines also create energetically unfavorable shoreline conditions that allow for damage such as erosion resulting from wind-wave action (Wilson and Keddy 1986; Randall et al. 1996; Höök et al. 2001).

Shoreline development has a significant negative impact on the lake ecosystem, in particular, predator-prey interactions. The loss of complex prey refuge habitat resulting from shoreline development represents a disadvantage to larval and juvenile fish recruitment as well as other prey species. In the absence of complex habitat, structure-oriented ambush predators, such as largemouth bass, can be found around piers and have the advantage over prey species, such as bluegill, because there is no habitat present that would enable bluegills to effectively evade predation from the bass (Crowder and Cooper 1982; Werner et al. 1983a; Lynch and Johnson 1989). While this may be good news for anglers upon first inspection since bass growth would initially increase, it is bad news in the long run. In general, sustainable predator-prey interactions require the existence of prey refuge to prevent the elimination of the prey organism, i.e., if largemouth bass decimate the bluegill population, the condition and growth of bass ultimately declines, thereby decreasing the quality of the fishery.

The development of lakeshores by the installation of piers, seawalls, and beaches, has been documented from several studies to degrade fish communities by simplifying the littoral zone habitat (Beauchamp et al. 1994; Ward et al. 1994; Jennings et al. 1999; Jennings et al. 2003). Growth rates of two species of juvenile fish maintained in cages under piers in the Hudson River estuary exhibited negative growth rates compared to juveniles of the same species maintained in cages deployed in the open water (Duffy-Anderson and Able 1999). These growth rate differences resulted because of fewer feeding opportunities available under piers than in open water, demonstrating that areas under piers are less productive and provide inadequate habitat for juvenile fish survival. In Lake Baldwin, Florida, piers have been shown to provide habitat for some largemouth bass in the absence of aquatic macrophytes; however, piers do not provide enough complex habitat and fish are forced to move around more frequently than those bass that are typically found associated with aquatic macrophytes (Colle et al. 1989). Substrate embeddedness increases along developed shorelines, leading to a decrease in interstitial spaces necessary for larval and juvenile fish habitat and prey refuge (Schlosser 1987; Lynch and Johnson 1989; Beauchamp et al. 1994; Jennings et al. 2003). Bulkheads and seawalls do not provide any interstitial spaces and are also detrimental because they reduce the availability of

shallow water habitats used by larval fish (Hall and Werner 1977; Beauchamp et al. 1994; Ward et al. 1994). Beaches simplify the available littoral habitat by eliminating aquatic vegetation and providing no complex habitat for prey fish species (Brazner and Beals 1997).

In general, aquatic macrophytes and complex woody debris increase the structural complexity of the littoral habitats, thereby increasing fish species richness and density, and providing a quality fishery for Indiana residents to enjoy (Crowder and Cooper 1982; Savino and Stein 1982; Werner et al. 1983b; Christensen et al. 1996; Randall et al. 1996; Höök et al. 2001). Permits for new piers, seawalls, and beaches should be considered more carefully and before they are approved, the effects of cumulative shoreline development on the lake ecosystem should be understood and accounted for in the process.

Literature Cited

- Beauchamp, D. A., E. R. Byron, and W. A. Wurtsbaugh. 1994. Summer habitat use by littoral-zone fishes in Lake Tahoe and the effects of shoreline structures. *North American Journal of Fisheries Management* 14:385-394.
- Brazner, J. C., and E. W. Beals. 1997. Patterns in fish assemblages from coastal wetland and beach habitats in Green Bay, Lake Michigan: a multivariate analysis of abiotic and biotic forcing factors. *Canadian Journal of Fisheries and Aquatic Sciences* 54:1743-1761.
- Christensen, D. L., B. R. Herwig, D. E. Schindler, and S. R. Carpenter. 1996. Impacts of lakeshore residential development on coarse woody debris in north temperate lakes. *Ecological Applications* 6:1143-1149.
- Colle, D. E., R. L. Cailteux, and J. V. Shireman. 1989. Distribution of Florida largemouth bass in a lake after elimination of all submersed aquatic vegetation. *North American Journal of Fisheries Management* 9:213-218.
- Crowder, L. B., and W. E. Cooper. 1982. Habitat structural complexity and the interaction between bluegills and their prey. *Ecology* 63:1802-1813.
- Duffy-Anderson, J. T., and K. W. Able. 1999. Effects of municipal piers on the growth of juvenile fishes in the Hudson River estuary: a study across a pier edge. *Marine Biology* 133:409-418.
- Hall, D. J., and E. E. Werner. 1977. Seasonal distribution and abundance of fishes in the littoral zone of a Michigan lake. *Transactions of the American Fisheries Society* 106:545-555.
- Höök, T. O., N. M. Eagan, and P. W. Webb. 2001. Habitat and human influences on larval fish assemblages in northern Lake Huron coastal marsh bays. *Wetlands* 21:281-291.
- Jennings, M. J., E. E. Emmons, G. R. Hatzenbeler, C. Edwards, and M. A. Bozek. 2003. Is littoral habitat affected by residential development and land use in watersheds of Wisconsin lakes? *Lake and Reservoir Management* 19:272-279.

- Jennings, M. J., M. A. Bozek, G. R. Hatzenbeler, E. E. Emmons, M. D. Staggs. 1999. Cumulative effects of incremental shoreline habitat modification on fish assemblages in north temperate lakes. *North American Journal of Fisheries Management* 19:18-27.
- Lynch, W. E., Jr., and D. L. Johnson. 1989. Influences of interstice size, shade, and predators on the use of artificial structures by bluegills. *North American Journal of Fisheries Management* 9:219-225.
- Randall, R. G., C. K. Minns, V. W. Cairns, and J. E. Moore. 1996. The relationship between an index of fish production and submerged macrophytes and other habitat features at three littoral areas in the Great Lakes. *Canadian Journal of Fisheries and Aquatic Sciences* 53(Suppl.):35-44.
- Savino, J. F., and R. A. Stein. 1982. Predator-prey interaction between largemouth bass and bluegills as influenced by simulated, submersed vegetation. *Transaction of the American Fisheries Society* 111:255-266.
- Schlosser, I. J. 1987. The role of predation in age- and size-related habitat use by stream fishes. *Ecology* 68:651-659.
- Ward, D. L., A. A. Nigro, R. A. Farr, and C. J. Knutsen. 1994. Influence of waterway development on migrational characteristics of juvenile salmonids in the lower Willamette River, Oregon. *North American Journal of Fisheries Management* 14:362-371.
- Werner, E. E., J. F. Gilliam, D. J. Hall, and G. G. Mittelbach. 1983a. An experimental test of the effects of predation risk on habitat use in fish. *Ecology* 64:1540-1548.
- Werner, E. E., G. G. Mittelbach, D. J. Hall, and J. F. Gilliam. 1983b. Experimental tests of optimal habitat use in fish: the role of relative habitat profitability. *Ecology* 64:1525-1539.
- Wilson, S. D., and P. A. Keddy. 1986. Species competitive ability and position along a natural stress/disturbance gradient. *Ecology* 67:1236-1242.

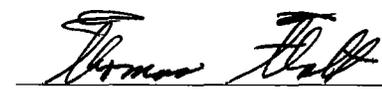
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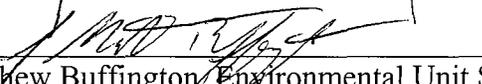

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