



4J. NEARSHORE HABITATS OF THE GREAT LAKES

State of the Ecosystem

Anthropogenic activities have dramatically altered the Great Lakes basin through agricultural practices, urban development, industrial and commercial activities, and introduction of non-native species (Christie *et al.* 1987, Steedman and Regier 1987, Edsall 1996). These activities have altered the natural physical and ecological processes throughout the Basin (Regier and Hartman 1973, Steedman and Regier 1987). The nearshore zone, in particular, has been heavily impacted by chemical pollution, nutrient enrichment, and physical alterations resulting from intense industrialization and urbanization (Krieger *et al.* 1992). The resulting habitat degradation is of great concern because Great Lakes littoral areas have high fish diversity and are important to the life histories of most native Great Lakes fishes (Goodyear *et al.* 1982, Lane *et al.* 1996a,b, Brazner 1997). Coastal margin and nearshore areas also have diverse wetland, benthic, and planktonic communities that comprise the lower portion of food web. These organisms provide other important ecosystem services as well.

The pattern and distribution of Great Lakes nearshore habitats are controlled, in part, by the underlying physical characteristics of the Basin and interactions between energy, water, and the landscape (e.g., Sly and Busch 1992; Higgins *et al.* 1998; Mackey 2005). Coastal margin and nearshore aquatic habitats are three-dimensional and dynamic. **Aquatic habitats are defined by a range of physical characteristics and energy conditions that can be delineated geographically and meet the needs of a single species, biological community, or ecological function related to life stage** (Figure X-1). To be utilized as habitat, these physical characteristics and energy conditions must exhibit an organizational pattern, persist, and be “repeatable” – elements that are essential to maintain a sustainable and renewable resource (Peters and Cross 1992).

Insert Figure 1. Fundamental characteristics of aquatic habitat.

Within the Great Lakes, individual species, biological communities, and the ecosystem have adapted and utilize the natural range of available habitats, including seasonal patterns and movement of water, energy, and materials through the system (e.g. Busch and Lary 1996; Jones *et al.* 1996). Moreover, coastal and nearshore habitats are created and maintained by interaction between coastal landscapes, water-level regimes, open-lake circulation processes and patterns, nearshore coastal processes, and the pathways and connections along which these processes act. Nearshore coastal processes include oscillatory and unidirectional flows generated by waves and currents. These factors control the distribution of materials and substrates in coastal margin and nearshore zones (areas encompassed by water depths generally less than 15 m) and also regulate the ecological utilization of energy, materials, and water as it is conveyed through these shallow-water systems.

Pressures

The habitat requirements for fish are highly variable and depend on the species and life stage of the organism. Benthic communities are highly dependent on substrate type and stability. For example underwater video data show that complex habitat structure (rugosity) and areas with bathymetric relief are preferred habitats that attract a diverse range of fish species. Many species require relatively shallow, well-oxygenated waters flowing through coarse gravel and cobble substrates with protective interstitial spaces. In many cases, spawning areas are adjacent to nearshore nursery areas and rely on regional circulation patterns to transport larval fish into adjacent nursery areas. However, anthropogenic actions along the shoreline and in coastal watersheds have affected coastal and nearshore processes, pathways, and connections

For example, anthropogenic alterations to river mouths and the “armoring” of shorelines modify flow paths and disrupt nearshore coastal processes that create and maintain coastal margin and nearshore habitats. Reductions in the volume of available littoral sand has led to the “coarsening” of nearshore substrates and the gradual replacement of mobile sand sheets with stable heterogeneous lag deposits resting on bedrock or cohesive clay substrates. The loss of protective sand sheets has significantly altered the pattern and distribution of nearshore aquatic habitats and has created ideal conditions for colonization by Dreissenids, round gobies, and other non-native species who use coarse-grained substrates as habitat. Non-native species have altered the physical, chemical, and biological characteristics

of historical spawning sites as well. Colonization by Dreissenids has reduced or eliminated interstitial spaces (potential spawning habitat) in many coarse-grained substrates.

Insert Figure 2.

However, coarse-grained substrates show little evidence for active erosion and/or recent disturbance (Mackey unpublished data). These deposits are heavily colonized by Dreissenids and *Cladophora* and form an armored pavement on the lakebed. Moreover, exposed cohesive clay deposits have been observed on the lakebed in approximately two-thirds of the nearshore sites surveyed. Multiple sites had cohesive clay deposits exposed on the lakebed either as flat eroded surfaces or elongate clay ridges and swales. These clay ridges range from 0.5 to 2 m in height from the lakebed with rippled coarse-grained sand and Dreissenid shell fragments in the adjacent swales. Field observations and underwater video from multiple sites show that cohesive clay deposits are not colonized by Dreissenids or *Cladophora*. When cohesive clays are exposed on the lakebed, the surface of the cohesive clays starts to soften creating smooth slick surface that ablates very slowly during turbulent flow events (storms). Ablating clay surface prevents attachment of Dreissenid bistle threads and/or if they do attach, they are swept clean by turbulent flows during the next storm event. Adjacent coarse-grained lag deposits (boulders, cobbles, gravel) are extensively colonized by Dreissenids and *Cladophora* indicating that suitable hard substrates will be colonized at these locations (Goforth et al. 2008).

Insert Figure 3.

Recent nearshore habitat assessments and mapping work done in Lake Michigan and in Lake Erie **suggest that many of the substrate and habitat changes are not new and are the long-term result of actions taken many decades earlier**. In other words, with respect to nearshore coastal processes, we have passed through several major habitat “tipping” points decades ago and are now attempting to manage the remaining habitat in severely degraded systems.

Moreover, land cover changes in watersheds have altered flow paths to tributaries, changing flow regimes and dramatically increasing sediment and nutrient loads, causing channel erosion and instability, and degrading the quality of tributary flows into the Great Lakes. Tributary waters must flow through coastal margin and nearshore habitats to reach the open lake, and are therefore affected by anthropogenic actions in the watersheds. Chemical contaminants, nutrients, and fine-grained sediments have adversely affected nearshore habitat structure and ecosystem function. Even though steps have been taken to slow the rate of degradation, continued population growth and associated changes in land cover in Great Lakes watershed will continue cause further degradation of coastal margin and nearshore habitats.

Through climate variability and/or artificial flow management, lower Lake water levels may change open-lake circulation patterns and connectivity; alter open-lake thermal structure; affect nearshore coastal processes; and reduce hydraulic connectivity between coastal margin wetland/barrier systems and the Lakes. Continued coastal development pressures and submerged lands ownership issues do not bode well for natural ecosystem adjustments to long-term changes in Great Lakes water levels.

Management Implications

The trend towards habitat degradation is expected to continue, necessitating the implementation of enlightened management strategies to ensure the future sustainability of remaining nearshore habitats critical to maintaining native biodiversity. Ecological integrity is achieved by protecting and restoring water level regimes, nearshore coastal processes, and flow paths and connections that structure, organize, and regulate coastal margin systems and create regional-scale patterns that link coastal margin and open-lake areas within the Basin.

Acknowledgments

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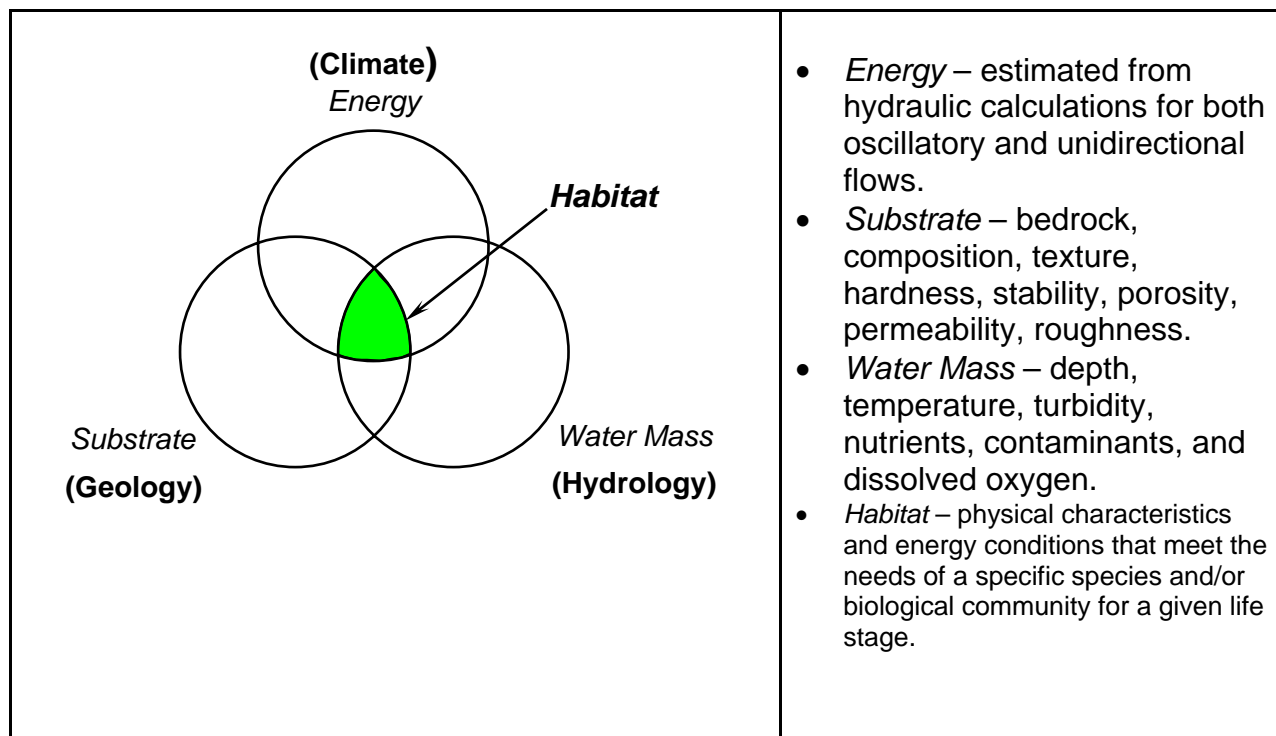


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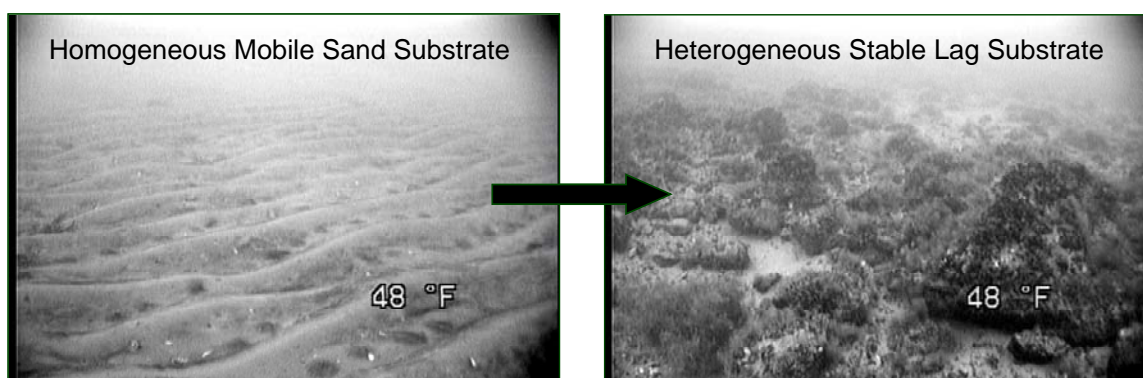


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