

# THE WAVES OF LAKE ERIE AT SOUTH BASS ISLAND

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## ABSTRACT

South Bass is an island with a two-lobed outline near the southwest end of Lake Erie. It is composed of eastward-dipping dolomite rock. Wave erosion has produced high cliffs, characterized by spurs alternating with coves, which often have small pebble beaches, on the west shore, while low rock ridges separated by banks and beaches occur on the east. Locally on the west, large fallen blocks of dolomite partly protect the cliffs from the waves. On the east shore, flotsam is one of the major factors affecting the nature of the shoreline. Waves are locally dampened by masses of tape grass and, in winter, by water heavy with snow-curd and slush-balls. Cusps and cones of ice and splash-ice structures are also formed on shoals by winter waves.

South Bass Island is located about 190 miles from the northeast end and about 40 miles from the southwest end of Lake Erie. Storm paths align with the long axis of this lake, and the island is buffeted by waves from all directions. Because of the longer fetch, waves from the northeast are more effective agents of erosion than those from the southwest. Storm winds cause changes of lake level of

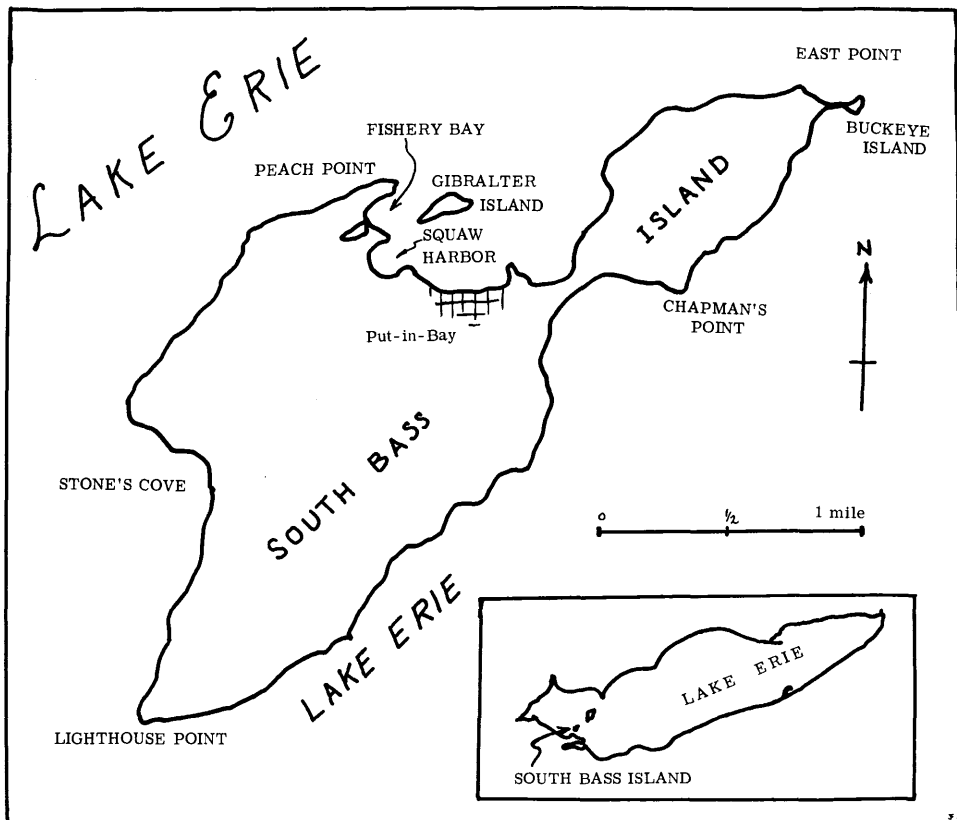


FIGURE 1. Map of South Bass Island.

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about 4 ft and, since the mean level of Lake Erie has varied slightly over 5 ft during recent years, the vertical zone over which the level has ranged totals about 9 ft. This zone is hit by waves, soaked by splash-water, fractured by frost and plant roots, and shoved by sheet-ice.

South Bass Island consists of two lobes which were separated by a small swampy area until 1910 when the swamp was filled, so the lobes now are connected by a narrow neck of land (fig. 1). The South Bass Island dolomite, with overlying shaly dolomite and underlying soft shale, dips gently to the east. Erosion of the high western shoreline has left a series of alternating spurs and small coves, with zones in which each of the three materials listed above is at water level. Along the northwestern shore, the soft shales near lake level have been eroded away, leaving the massive dolomite projecting as a ledge over shallow caverns (fig. 2).



FIGURE 2. West shore: ledge over shallow caverns.

Large pieces of the ledge-rock have fallen, those blocks lying closest to shore serving as baffles which protect the cliff against waves and ice.

Where waves from the west hit a solid rock wall, they are deflected away, but where they occlude the aperture of a cavern and then continue into the cavern, the compression requires relief. Although the relief usually comes by jetting out along the upper edge of the aperture, it may come by forcing an opening along a weak line in the rock. One blow-hole has appeared in recent years and the water spouts high out of it whenever a wave enters the cavern at the shoreline.

Some of the limestone which has fallen into the lake has been reduced by waves to small sizes, making pebble beaches in the indentations along the north-west shore. In one of these little coves, the pebbles have been rolled around until many of them have become marble-sized spheres. Some of the materials which have been eroded from the west shore have been carried by currents around the end of this shoreline, named Peach Point, into Fishery Bay. The coarse sediments have been dropped just inside of the point and have formed a gravel spit there, which is usually exposed during low water. Finer sediments have been carried across Fishery Bay and spread by waves in a big semi-circle which extends



FIGURE 3. N.E. waves converging along bar connecting East Point and Buckeye Island.

from Gibraltar Island to the base of Peach Point. A similar but smaller deposit has been made of materials which have been carried around the eastern end of Gibraltar Island and dropped against that rocky point.

The most complete section of the bedrock of South Bass Island may be seen at the southernmost tip of the island, known as Lighthouse Point. Northwards from this point, various zones disappear (Carman, 1946). Mid-length of the western shore, the capping dolomite is missing and the underlying shales have been eroded, thus notching the shoreline and forming Stone's Cove. The beach at the inside of Stone's Cove consists of flat fragments of shale.

The north shore of the island has a wide embayment which is limited by the cliffs of Peach Point and East Point (the eastern and smaller lobe of South Bass

Island). This bay has a natural breakwater in the elongate, six-acre mass of Gibraltar Island. The narrows between the lobes of the island are at the inside of the bay. The village of Put-in-Bay, on the larger lobe of South Bass Island, faces this natural harbor. A cove of the harbor, at its western end, is called Squaw Harbor. The harbor is affected by changes of lake level which occur with storms from either southwest or northeast, but only storms from the northeast send damaging waves into the harbor of Put-in-Bay.

The tip of East Point is a low mass of rock which becomes separated from the island by high water, and is called Buckeye Island. Waves from the northeast reach Buckeye Island before they hit the rest of South Bass Island. Such waves pass on around Buckeye Island and then converge along the line leading to the tip of East Point. A bar of gravel and boulders has formed along this line of convergence (fig. 3), which now commonly projects well above water.

The southeastern shoreline consists of a series of rock ridges which are separated by banks and beaches. The ridges project into the lake, dipping toward the southeast; they were surely once covered with soil which has been eroded away by frost and waves, as the present banks are now being eroded. There is a shingle ridge on the south side of East Point; Moseley (1904: 179) attributed this deposit



FIGURE 4. Ice blocks hovering off projecting points of the west shore.

to the waves of a violent storm on the night of June 28, 1902. Gravel now forms the beach line of this ridge, with additions and removals by waves and currents, protected by rocky Chapman's Point. Waves from the east reach an unprotected beach near the southern end of the island at acute angles. Pebbles are rolled up this beach at an angle, then are rolled downward at an equal angle and thus are displaced by a zigzag motion the length of the beach. No rounded pebbles may be found at this beach, and the movement of sharp-angled pebbles engenders noise.

Massive floating objects, wave-tossed, may make quick changes in shorelines. Such objects of flotsam as trees or large fragments of wood are used by waves,



FIGURE 5. Splash-ice on cliff and on cliffside vegetation.



FIGURE 6. Cusps and cones of slush-balls, and ice-feet on a sloping shoreline.

but they are less important at South Bass Island than are blocks of ice. Waves from the northeast pass under the edges of sheet-ice and break off panel after panel, then break up each panel into pancakes or small floes. Flotsam hovers



FIGURE 7. Tapegrass leaves floating at surface of Fishery Bay.



FIGURE 8. Boat paths through a surface film, westward from Put-in-Bay.

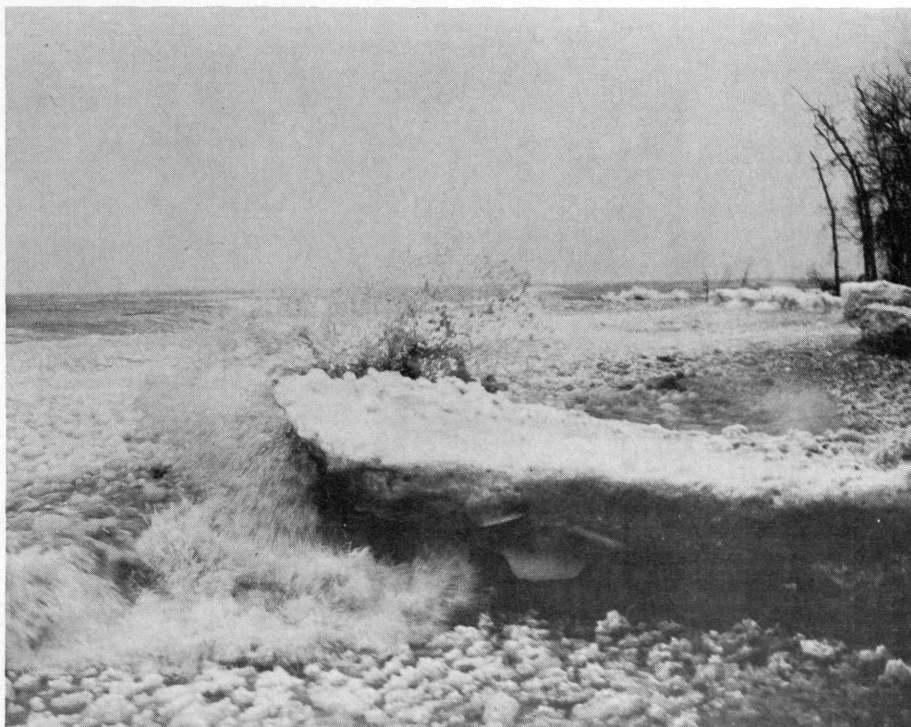


FIGURE 9. Heavy water, with slush-balls, breaking against a cusp of shore-ice.

offshore at projecting points (fig. 4), but in coves floating objects are thrown violently against the shorelines, wherever such shores are banks or cliffs.

While waves, breaking in cold air, build up picturesque masses of splash-ice on cliffs and on cliffside vegetation (fig. 5), they also make distinctive structures when they move up sloping shoals. Cusps of ice form, and each wave, moving shorewards between cusps, ends with a splash upwards. This splash-water freezes, and a cone of ice, notched towards the waves, grows between each set of two cusps. Series of alternating cusps and cones are anchored to the bottom, so they are left in situ when the lake level is lowered by a strong wind from the southwest. New series of cusps and cones are formed at lower levels, and prolonged storms may produce three or four of these "ice-feet" (fig. 6).

There is little protection afforded the shorelines of South Bass Island by dense mats of tree roots, as occurs elsewhere, but some observations have been made of the effects of tapegrass, an aquatic plant, on waves in Fishery Bay (Langlois, 1954: 36). The long leaves of tapegrass lie on the surface of the water during the summer months (fig. 7), and waves break off the tips of some of these leaves, and move others of the leaves so much that the roots are pulled out, but the waves are retarded and reduced in size by the plants. Masses of tapegrass leaves and entire plants are deposited during every storm from the northeast on the beach at the inside of the bay, and waves rise and fall *within* these masses, without moving beach materials up-slope from the mass of plant material.

Surface films, formed of the protein products of plant excretion or decomposition (Goldacre, 1949), can be found on all parts of Lake Erie, produced by leafy plants in shallow bays and by small floating plants everywhere in the lake. Films are most easily noted on calm water, and calm water occurs mostly at night. Night films get cracked open by wavelets with the light breezes which come at dawn, and the contrast at such times between the smoothness of the film-covered areas with the ripples of the filmless zones is readily perceived. Boat paths through the surface films on summer days are also easily seen, as they persist for some time (fig. 8).

Water becomes more dense as it cools towards the freezing point, and waves are affected by this increased "heaviness." Snow often falls upon open water when the air is much colder than the water and persists as blankets of snow on the water. Waves put folds in these snow blankets and sometimes break the blankets into fragments. When the fragments are small enough, they resemble curds of cream. These curds sometimes persist. Since these curds float, partly exposed to cold air, they may grow into balls of slush-ice. Heavy water, loaded with slush-balls (fig. 9), dampens waves, but even small waves, thus loaded, hit eroding banks very damaging blows.

Many instances of wave genesis have been seen when winds pass the length of Fishery Bay. Each gust of wind puts patches of ripples on the water, thus revealing the occurrence of small zones of down-pressure. The ripples grow to be small waves before the patches of them move out of the bay and join the surging seas of the open lake (Langlois, 1954: 35). As long as the wind keeps pushing against the backsides of the waves, the waves grow in height and length; whenever the waves of the open lake stop breaking, they reveal the lack of this pressure from behind (Bascom, 1964: 43).

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