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OCEANOGRAPHY OF LONG ISLAND SOUND, 1952–1954

I. INTRODUCTION

By

Gordon A. Riley

Bingham Oceanographic Laboratory

During the last fifteen years, the Bingham Oceanographic Laboratory has examined and reported on various aspects of the local waters off southern New England. Riley (1941) described the plankton and associated chemical oceanographic factors in a small area in the north-central part of Long Island Sound. A study of Block Island Sound from 1943 to 1946 and again in 1949 resulted in papers on the fish population (Merriman and Warfel, 1948, and others) fish eggs and larvae (Merriman and Sclar, 1952), benthic fauna (Smith, 1950), and plankton (Deevey, 1952a, 1952b; Riley, 1952b). The 1949 survey, together with observations obtained by the Woods Hole Oceanographic Institution in 1946, supplied data for an analysis of the physical oceanography of the Long Island and Block Island Sounds (Riley, 1952a).

The region as a whole provides a variety of environments ranging from open coastal waters to shallow, protected bays and sounds with markedly reduced salinity. The plankton concentration in these protected waters averages perhaps an order of magnitude larger than those in exposed seaward areas, although the species composition is relatively limited. The quantity of bottom fauna is also large, and shellfish are commercially important. In Block Island Sound and the outer coastal region, commercial interests are primarily centered in the fin fisheries.

It is one of the long term aims of the Bingham Laboratory to accumulate detailed descriptive information on the populations and environmental characteristics of several representative localities within this region and to explain the ecological reasons for observed differences. The region poses a vast number of ecological questions, and the answers, many of which are perceived dimly if at all at the present time, are of general interest because the region is similar in its broad oceanographic aspects to many other temperate coastal waters.

To list a few of the most general questions: Do the shallow, protected areas produce more phytoplankton than the open waters? Superficially this appears to be so, considering the comparative size of the standing crops, but the latter could be affected drastically by differences in the rate of removal by feeding or physical dissipation. Are there regional differences in the efficiency of transformation of phytoplankton into animal tissue? What makes one area different from another with respect to the kinds of large and commercially useful animals that are produced? What can be learned from a broad and intensive oceanographic survey that will throw light on the problem of annual fluctuations of fish production and the so-called "optimum catch"?

What is the role of freshwater drainage? How damaging are pollution effects? Does land drainage enrich the coastal area, or is this effect insignificant compared with the transport of nutrients by physical oceanographic processes? What effect do silt and bottom sediments have on the transparency of the water and how seriously do they influence phytoplankton production and animal behavior?

The answers to such questions can be obtained only by a long term program of broad scope. They are ultimate rather than immediate problems, and only a few partial answers will be found in the papers that follow. However, these and similar questions need to be borne in mind if the investigation of the moment is to make a serious contribution to the over-all problem of coastal oceanography.

With the completion, at least for the time being, of the Block Island Sound survey, attention has again been turned to Long Island Sound (Fig. 1). This is a semienclosed body of water roughly 100 nautical miles long, with an area of about 930 square miles. It has a maximum depth of 100 m near the eastern end, but elsewhere there is little water of more than 30 m. At the eastern end there is free exchange between the Long Island and Block Island Sounds through a series of passes. Through a narrow channel at the western end, limited exchange takes place with the waters of New York Harbor.

The drainage basin is 13 times the area of the Sound, but more than 75% of the runoff enters the relatively open eastern end, where its effect on the Sound as a whole is minimal. The western end is

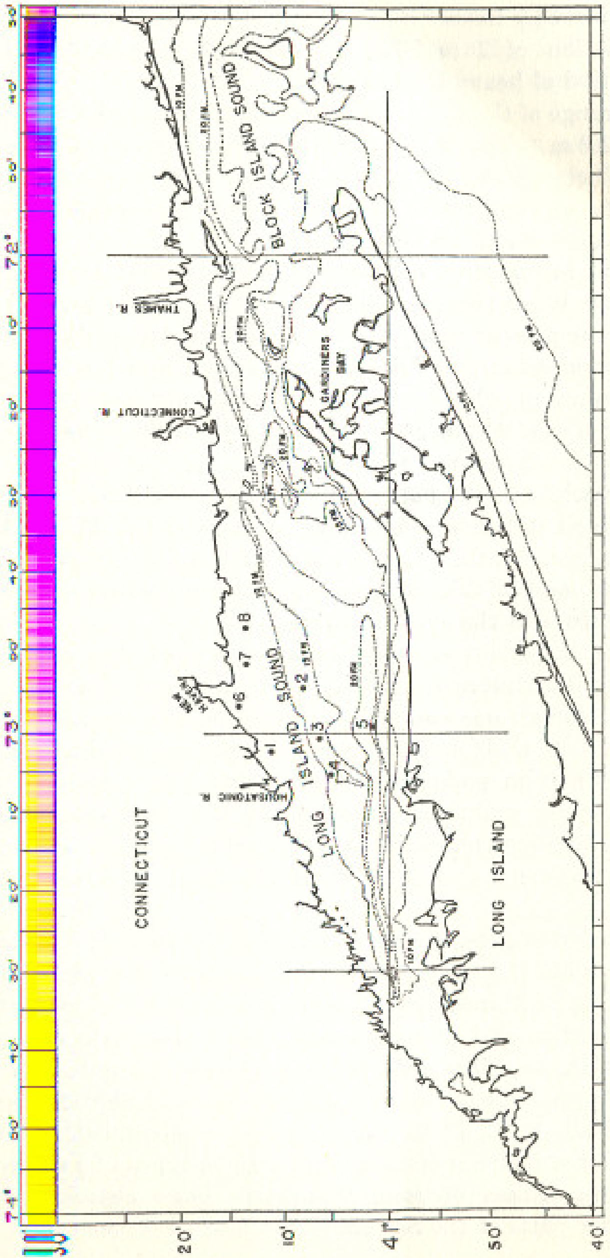

Figure 1. Chart of Long Island Sound and adjacent waters. Bottom depths are contoured at 10, 15, and 20 fathoms in Long Island Sound and 10 and 20 fathoms elsewhere. Routine station positions in the central part of the Sound are shown as numbered dots.

normally about 5‰ fresher than the eastern end, and there is a seasonal variation of 2 to 3‰, the minimum corresponding with the spring period of heavy land drainage.

The mean range of the tide is 0.75 m in the eastern end and increases westward to 2.2 m. The volume of tidal inflow is 8.2% of the volume of the Sound below mean low water. Strong tidal currents are found in the vicinity of the passes. Farther west the average tidal speed generally lies between 10 and 60 cm/sec.

The existing information on nontidal currents and transport was summarized by Riley (1952a). The problem will be reopened later. It suffices for the present to say that in Long Island Sound, as in many other sounds and estuaries, there is a tendency toward a two-layered transport system in which a relatively fresh surface layer moves eastward out of the Sound and is replaced by saline water moving inward along the bottom. An elementary application of the salt continuity principle in the paper cited suggested a total interchange by transport and diffusion amounting to about 30% of the volume of the Sound per month. Further work by more refined methods will somewhat modify this conclusion, but it serves to indicate the order of magnitude of the exchange rate.

In planning a general oceanographic survey of the region, it is apparent that descriptive knowledge of local populations and their environment, though necessary, is not sufficient in itself to provide a clear concept of their ecology. It is important to determine the extent to which local populations are modified by transport. Productivity must be evaluated in terms of the combined effects of enrichment by freshwater drainage, the gain and loss of nutrients by horizontal water movements, and the local rate of biological turnover.

Practical considerations of time and available personnel have made it desirable to divide the survey into two phases: For a period of two years, beginning in March 1952, weekly observations of physical and chemical properties and plankton have been obtained at positions indicated in Fig. 1. This area, while relatively limited, is believed to be fairly representative of the central basin of the Sound from Longitude 72°30′ W to 73°05′ W. At less frequent intervals there have been bottom fauna collections and various types of physiological studies. Three cruises of longer duration have obtained similar data from other parts of the Sound.

The first products of this investigation are reported herein, with papers on physical and chemical oceanography and various aspects of the biological program. Other parts of the survey will be published subsequently.

In March 1954, the scope of the investigation was broadened to general coverage of the Sound at approximately monthly intervals. There were four main purposes: (a) To obtain at least a minimum of data on regional variations in populations and seasonal cycles for comparison with the more detailed survey of these first two years. (b) To refine present knowledge of the movements of water within the Sound and the rate of exchange between the Sound and adjacent waters. (c) To attempt to distinguish between local biological events and transport effects in the development of pelagic populations. (d) To budget the cycle of nitrogen (the most important chemical element from the standpoint of limitation of plant growth) with respect to internal biological transformations, transport effects, and freshwater enrichment. This phase of the program is expected to continue for two or three years.

It is a pleasure to acknowledge our gratitude to the Office of Naval Research, which has supplied generous financial assistance to the project. Field work has been carried out aboard the laboratory vessel of the U. S. Fish and Wildlife Service Station at Milford, Connecticut. To Dr. Victor L. Loosanoff, Director of the Station, and to Captain Herman R. Glas of the SHANG WHEELER, we are deeply indebted for their kindness and help throughout the work. The work of various members of the group has been aided by part time undergraduate assistants: Charles E. Weems, Louis K. Mowbray, Francisco Wong, Jack Fu, and Henry Schurr. Special thanks are given to Daniel Merriman, who has given his time unstintingly in scientific and editorial advice and in administrative work in connection with the project.

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