exhibited generalized symptoms of stress, including emaciation of tissues, shell deformity (cupped, left valve outgrowing the right valve), and in some cases, fragile, poorly calcified shells, and 5) other bivalve species cultured in the same system were generally unaffected (e. g., hard clams, *Mercenaria mercenaria* in Oyster Bay, NY, and the European oyster, *Ostrea edulis,* in the Damariscotta River, ME). Mortalities could not be traced to a single hatchery or a common broodstock. Tissue samples were collected at several sites and examined by pathologists at several laboratories. Standard techniques for the detection of known oyster pathogens, including tissue section histology, failed to demonstrate any recognized organism (Rask 1990).

Existing documentation of episodic juvenile oyster mortalities was limited or anecdotal, and insufficient to allow more than speculation of associated causes. Mortalities could be attributed to one or a combination of factors, including primary or secondary infection by a undetected pathogen, or environmental stress due to anthropogenic contaminants, toxic and/or nutritionally unsuitable microalgae, hypoxia, extreme temperatures or overcrowding. Increased susceptibility to disease or other stress factors may also be related to the organisms' genetic makeup (e.g. Ford 1988), as well as their prior history and physiological condition during post-settlement stages in the hatchery, prior to transfer to the field.

The goal of the present study was to implement a rapid-response, comprehensive sampling program that would document juvenile oyster mortalities and help to identify potential cause(s) at two non-contiguous growout sites: Oyster Bay, NY (Frank M. Flower and Sons, Inc.) and Fishers Island, NY (The Clam Farm Inc.). Flower & Sons is the leading producer of oysters in New York State and has successfully grown oysters with current technology for over 30 years. The Clam Farm has been growing oysters on a much smaller scale since 1988. Specific objectives of the study were to describe the relationship between oyster growth, mortality and environmental parameters (temperature, salinity and phytoplankton composition), and to characterize histopathology of the juvenile oyster mortality syndrome as well as to identify potential organisms associated with affected oysters at these two sites.

MATERIALS AND METHODS

Sampling Program at the Oyster Bay Study Site

We monitored growth, mortality, and histopathological condition of two 1991 oyster cohorts produced at the Flower hatchery, which were held in a growout raft system in Mill Neck Creek, Oyster Bay, on the north shore of Long Island, NY. These oysters were the product of two spawnings, conducted on March 18 (large cohort) and April 25 (small cohort) 1991, using local broodstock from Oyster Bay (different individuals for each spawn). Experimental oysters were set on 0.2 to 0.8 mm crushed hard clam shell, and moved from the hatchery to floating trays for field growout on May 25 (large cohort) and June 3 (small cohort). On June 14 mechanical grading of each cohort yielded two experimental groups of relatively uniform size (referred to hereafter as small and large cohorts, SC and LC, respectively), which averaged 6.4 and 16.1 mm in shell height (greatest dimension from the umbo to the posterior margin of the shell) respectively. Oysters were placed in 0.8 m X 1.2 m X 8 cm trays, open at the top and lined on the bottom with 1 mm mesh window screen. Stocking densities included one typically used for commercial growout by the Flower Co. (hereafter referred to as high density) and one lower density (Table 1). The low density treatment was included to determine if growth and mortality in the trays were density-dependent.

Large and small cohorts were suspended in the water column (depth = 3.7 m at low water) in adjacent stacks of six trays each. High-density experimental oysters of a given size were held in the top and bottom trays of each stack (trays 1 and 6, respectively), and low-density groups in trays 2 and 5. The upper tray was suspended about 12 cm below the surface, while the lower tray remained at least 2.5 m off-bottom. Two replicate stacks were maintained for each cohort. During maximum summer production, up to 432 stacks (2592 trays) are typically used to grow oysters and hard clams at this site, with clams occupying only up to 12–23% of available space (J. Zahtila, Flower Co., pers. comm.).

Oysters were sampled (without replacement) approximately every 2 weeks between June 14 and September 20, 1991, although mortalities of small oysters were determined through November 7. A random sample of each replicate was removed after thoroughly mixing the contents of two trays from a given stack (e.g. 1 and 6). Because the growout area is relatively shallow and well mixed, no attempt was made to resolve differences in growth and mortality with depth. Oysters were thinned by random removal of oysters over time (see Table 1). Stocking densities and thinning frequency of the high-density group were decided upon by Flower's personnel. No grading and culling of live oysters, a standard procedure employed by commercial growers, was carried out during the present study. Mechanical grading and culling of dead oysters, however, was conducted on August 9 on a rotary, cylindrical drum sieve. This was necessary because accumulation of shell debris and large numbers of dead oysters, which were by then significantly smaller than live individuals, interfered with effective sampling. Culling removed only dead oysters and did not affect the size distribution of survivors. To allow calculation of cumulative losses, mortality of oysters retained in the system was determined immediately prior to, and following culling. Grading/culling on August 9 effectively removed dead oysters from the small cohort (e.g. 92% of dead oysters from high density trays), but for unknown reasons removed only 34 to 48% of those from the large cohort, and therefore a second culling of this cohort was carried out on September 20 (Fig. 1).

Thus, stocking densities (of the high-density group) and handling protocols were kept similar to standard commercial practices, except that grading and culling was minimal throughout the study, and the identity of experimental oyster groups was maintained over time. Additionally, experimental oysters were held in suspended culture longer than normal at this commercial facility, where oysters are generally removed from growout trays and planted on the bottom at about 20-30 mm in shell height.

On July 26, a third group of oysters, referred to as the "late cohort,' ' was included in the sampling program. These oysters originated from a June 6 spawning of Oyster Bay broodstock (different individuals than those used to produce earlier experimental groups), set on June 27, and were moved to floating trays on July 26, at an initial mean size of 7.7 mm (SE = 0.2, n = 42). This cohort was sampled at weekly intervals, but data are available only through August 29, since the identity of this group was not maintained after this date.

Surface water temperature, determined with a hand-held thermometer, and salinity, determined with a refractometer, were measured at least twice a week at the growout location. Surface water samples were collected weekly and preserved with Lugol's