X.1 Introduction

Many harmful algal blooms (HABs) are marked by the presence of toxic or noxious algae that result in a negative impact on human activities. Mass mortalities of fish and shellfish (farmed and natural), decreases in fecundity in fish, and death of marine mammals and birds have been reported as a result of the consumption of toxic algae. Transfer of toxins through the food web may lead to human illnesses as well (see Table 1.1 in Anderson et al., 2001; Table 1.1 in Cullen, 2005). Harmful algal species can also have deleterious effects on ecology without producing toxins, e.g., mucilage-producing or spine-bearing species that clog or damage gills of fish and other invertebrates (Zingone and Enevoldsen, 2000) and large blooms that cause hypoxia or anoxia as HABs decline and biomass decays, leading to fish kills (Horner et al., 1997). These problems often result in extreme economic losses in coastal regions, affecting the fish and shellfish industries, aquaculture, and tourism.

It was once thought that HABs were small, localized problems but recent evidence suggests that these phenomena occur in nearly every coastal region throughout the world (Anderson, 1995). Despite the increasing occurrences of HABs and the escalating number of affected resources, existing detection and prediction techniques are limited and many present-day monitoring efforts are time intensive and/or costly. Most current HAB monitoring programs are not designed to focus on understanding the environmental or anthropogenic conditions that contribute to the formation and cessation of HABs. Consequently, they have limited potential for prediction. This is changing through the establishment of HAB research programs.

Subhead: Examples of HAB programs

Since 1992, the California Department of Health Services (CDHS) has enlisted the help of more than 20 research institutions to collect water samples along the California coast on a weekly basis. These water samples are then shipped to the CDHS in northern California for laboratory analyses (species identification, cell concentration, chemical analyses, etc.). The CDHS then compiles the data and releases Monthly Biotoxin Reports (e.g., CDHS, 2001) that describe the health of California's coastal waters. Several other coastal regions worldwide have implemented HAB sampling programs similar to that of the CDHS (e.g., Harmful Algal Bloom Initiation and Prediction in Large European Marine Ecosystems (HABILE) in the North Sea, Fisheries & Oceans Canada, South Carolina Task Group on Harmful Algae; see Anderson et al., 2001).

Some other monitoring programs enlist volunteer fishermen, beach goers, and/or trained citizens to report any signs of HAB formation to responsible authorities (e.g., University of Maine Red Tide Monitoring Network; "the fish farm observation network" in Norway, Johnson and Sakshaug, 2000; Kawaga fish culture monitoring in Japan; and Chilean Salmon Farmer's Association; Anderson et al., 2001). This method has reduced human consumption of toxic organisms and provides educational outreach to the local community, but does not advance research on the scientific problem of HAB formation. HAB monitoring efforts such as the CDHS or the fish farm observation network, although detail-oriented, accurate, and relatively low-cost, may ignore shorter-lived or small-scale, patchy HABs. HABs can persist for as short as a few days to as long as