Harmful Algae 53 (2016) 86–101

Contents lists available at ScienceDirect

Harmful Algae

journal homepage: www.elsevier.com/locate/hal

Harmful algal bloom forecast system for SW Ireland. Part II: Are operational oceanographic models useful in a HAB warning system

Caroline Cusack [a,*], Tomasz Dabrowski [a], Kieran Lyons [a], Alan Berry [a], Guy Westbrook [a], Rafael Salas [a], Conor Duffy [a], Glenn Nolan [a,b], Joe Silke [a]

[a] Marine Institute, Rinville, Oranmore, Co. Galway, Ireland
[b] EuroGOOS AISBL, 231 Avenue Louise, Ixelles 1050, Brussels, Belgium

ARTICLE INFO

Keywords:
HAB
Nowcast/forecast
Ireland
Modelled products
Pseudo-nitzschia
Dinophysis

ABSTRACT

This study investigated the application of a three-dimensional physical hydrodynamic model in a harmful algal bloom forecast system for Bantry Bay, southwest Ireland. Modelled oceanographic conditions were studied and used to help understand observed changes in the chemical and biological patterns from the national biotoxins and phytoplankton monitoring program. The study focused on two toxic events in 2013. An upwelling event was predicted by the model prior to the appearance and population increase of potentially toxic diatoms, *Pseudo-nitzschia*, and associated domoic acid in shellfish. A downwelling episode was provided as a forecast in the model prior to the arrival of a *Dinophysis* bloom and detection of its associated biotoxins in Bay shellfish. The modelled forecast products developed included expected surface, mid-depth and bottom current pathways at the mouth of the Bay and on the adjacent shelf. The rate and direction of water volume flow at the mouth and mid-bay sections were produced by the model to examine predicted upwelling and downwelling pulses. The model also calculated the evolution of water properties (temperature, salinity and density) with depth along the Bay axis and on the adjacent continental shelf. Direct measurements of water properties at a fixed point, mid-bay, were comparable to model calculations. The operational model for southwest Ireland produces a reliable 3-day physical hydrodynamic forecast of the dominant regional physical processes that result in water exchange events between Bantry Bay and its adjacent shelf. While simulated physical hydrodynamics were provided as a 3-day forecast, the upwelling and downwelling signals from the model, closely linked to toxic HAB episodes, were evident up to 10 days prior to the contamination of shellfish in the Bay.

1. Introduction

The sudden arrival and development of harmful algal blooms (HABs) in coastal areas is often the result of mesoscale advective processes that transport shelf populations inshore (GEOHAB, 2013; Berdalet et al., 2014). Adverse effects of phytoplankton blooms have been widely reported along western Europe coastlines, e.g. Ireland (Silke et al., 2005), Scotland (Bruno et al., 1989; Davidson et al., 2009) and France (Gentien et al., 2007). In Ireland, one of the earliest published records of discolored water was off the southwest coast in 1865 (Wyatt, 2009). In the late 1970s, HAB research and monitoring commenced in response to the death of caged finfish and shellfish caused by large monospecific blooms of a single dinoflagellate species, *Karenia mikimotoi* ((Miyake & Kominami ex Oda) Gert Hansen & Ø.Moestrup); formerly referred to as *Gyrodinium aureolum* (E.M.Hulburt) by Irish taxonomists (Ottway et al., 1979; Roden et al., 1980; Jenkinson and Connors, 1980). Since the early 1980s, finfish and shellfish production and monitoring activities have evolved (McMahon, 2000). Today, in Irish waters, we recognize ~16 phytoplankton genera with members that can potentially proliferate into dense nuisance blooms and 9 genera linked to biotoxin production; icthyo- and shellfish biotoxins (source: Marine Institute data archive). Toxic and harmful phytoplankton are now monitored throughout the year at more than 100 Irish coastal sites and data gathered is used

* Corresponding author. Tel.: +353 91 387200.
E-mail addresses: caroline.cusack@marine.ie (C. Cusack), tomasz.dabrowski@marine.ie (T. Dabrowski), kieran.lyons@marine.ie (K. Lyons), alan.berry@marine.ie (A. Berry), guy.westbrook@marine.ie (G. Westbrook), rafael.salas@marine.ie (R. Salas), conor.duffy@marine.ie (C. Duffy), glenn.nolan@eurogoos.eu (G. Nolan), joe.silke@marine.ie (J. Silke).

http://dx.doi.org/10.1016/j.hal.2015.11.013
1568-9883/

Table 1
Weekly shellfish farm closures off southwest Ireland 1984–2013 calculated with data from the Marine Institute biotoxin archive. Filled squares (see legend) represent weeks when one or more farms experienced shellfish tissue biotoxin levels above EU regulatory limits for ASP, DSP, AZP and PSP biotoxins. Bioassay results are presented from 1984 to 2002 as chemical methods had not yet been developed.