Satellite-based water quality monitoring for shellfish farms to support management decisions

Peter Miller
Satellite monitoring for shellfish farms

- Satellite discrimination of harmful algal blooms
- Applications for aquaculture industry
  - Early warning for Scottish salmon farmers
  - BBSRC ShellEye project on shellfish monitoring
- Linking satellite monitoring and risk modelling
Examples of harmful algal blooms

- *Chattonella* killed 350 tons of Norwegian farmed salmon in 1998
- *Karenia* killed 500,000 Shetland salmon in 2001

- Early warning for fish farming and aquaculture

- *Chattonella verruculosa* in North Sea (11 May 2000)
- *Karenia mikimotoi & Noctiluca scintillans* in English Channel (20 Jul 2000)
Recent & ongoing aquaculture projects

- Scottish Salmon HAB monitoring (2008-present)
- EC FP7 AQUA-USERS (2013-16)
- UK BBSRC ShellEye (2015-17)
- UK BBSRC Advective HABs (2015-17)
Example bulletin for Scottish fish farms

Traffic-light map

Chlorophyll-a

Enhanced colour

- Dense bloom

5, 10, 20, 30 mg

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Multivariate HAB discrimination method

Ocean colour scenes

Manual training

Training samples

Classifer

Multivariate analysis

R Stats

Ocean properties

Harmful Algae
Harmless Algae
No Bloom

Lwn(\lambda)

a(\lambda)

bb(\lambda)
**Discrimination of harmful algal blooms**

Weekly HAB risk maps of *Karenia mikimotoi* algal bloom in the Western English Channel in summer 2010

*Phaeocystis globosa* bloom in the Southern North Sea in spring 2003

- **HAB risk**
- **harmless**
- **no bloom**
- **not classified**

Improving the sustainability of shellfish aquaculture through satellite monitoring

- Satellite-based harmful algal bloom early warnings for shellfish farms;
- Develop early warning indicators of microbiological hazards - *E. coli*, norovirus;
- Develop advanced hazard bulletins for the shellfish industry.
Extend EO HAB classifier to species affecting shellfish

MERIS Full Resolution (300m), 17 June 2006

RGB composite

Chl-a map

Pseudo-nitzschia HAB map

- HAB risk
- harmless
- no bloom
- not classified

Also Dinophysis and Azadinium
Equivalent Algal Populations – deals with dense blooms

Standard chl-a (mg m$^{-3}$) EAP chl-a

Cell diameter (µm)
### Combined sewer overflow (CSO) events

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<th>ShellFish Water</th>
<th>Event Start Date</th>
<th>Event Start Time</th>
<th>Event Stop Date</th>
<th>Event Stop Time</th>
<th>Duration (Hours)</th>
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River plumes are pollution pathways

10 Jun. 2015 Landsat-8
Suspended sediment
Fal Estuary

30 Sep. 2015 Landsat-8
Suspended sediment

Los Angeles, US

3 km
Norovirus prediction in Louisiana, US

- SST
- Rainfall
- Water level
- Wind
- Salinity
- Artificial network

Area 7: Closed on March 24; Total Case: 14; Norovirus GI; FirstOnsetDate: 03/29/2010 (recall of all oysters harvested from Area 7 since 03/06/2010)

Area 13: Closed on March 30; Total Case: 19; Norovirus GII-12; FirstOnsetDate: 03/28/2010 (recall of all oysters harvested from Area 23 since 03/26/2010)

Area 3 (?): Closed on March 26; Total Case: 14; Norovirus GII; FirstOnsetDate: Unknown (recall of all oysters harvested from Area 23 since 03/20/2010)
Advanced bulletins for shellfish farmers

Forested Sea Surface currents for the next five days

07 April 2015
08 April 2015
09 April 2015
Satellite monitoring for shellfish farms

- ShellEye project is applying satellite monitoring to shellfish aquaculture;

- Certain harmful algal blooms can be discriminated using ocean colour;

- Satellite data on river plumes is combined with other risk factors for microbiological pollution.

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