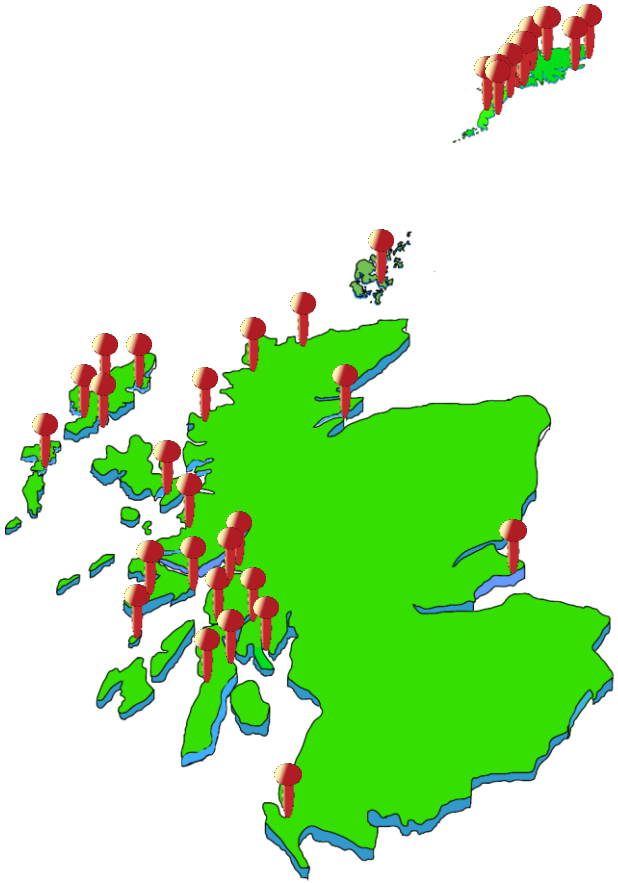
Scottish HAB Early Warning System (EWS)

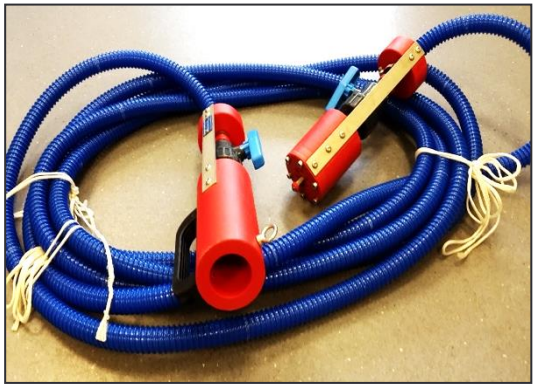
Paola Acre, Dimitry Aleynik, Keith Davidson, Steve Gontarek, Sharon McNeill, Euan Patterson, Rachel Saxon, Callum Whyte

Callum.whyte@sams.ac.uk

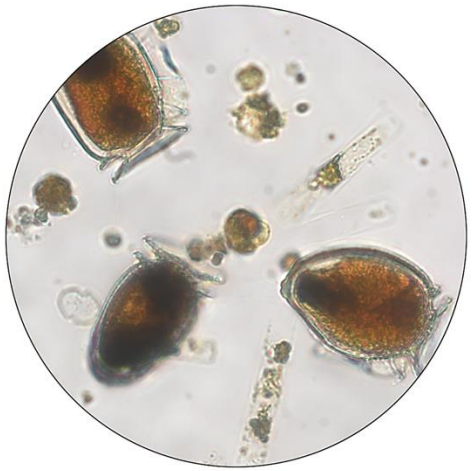
SAMS Scottish Association for Marine Science | A partner of UHI

Monitoring for Toxin Producing Microplankton in Scottish Waters



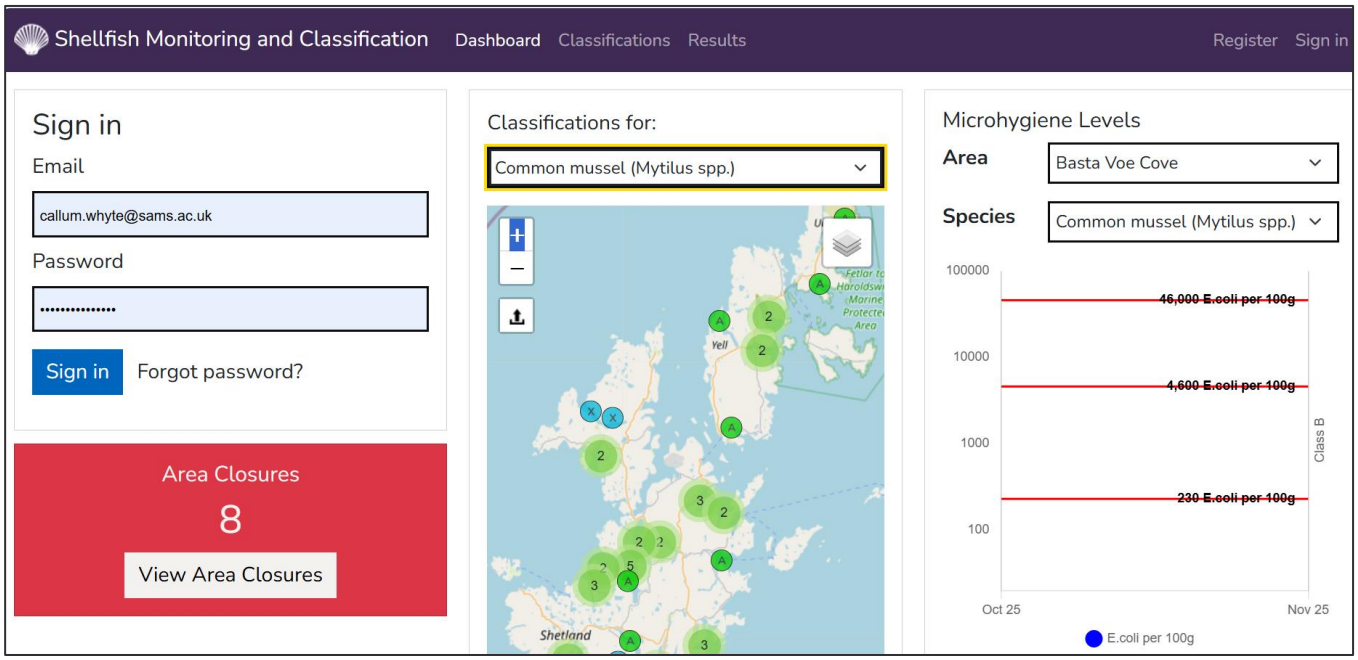


In 2025, SAMS will monitor **40 active** shellfish growing sites **weekly** – analysing approximately **1250 samples** during the year



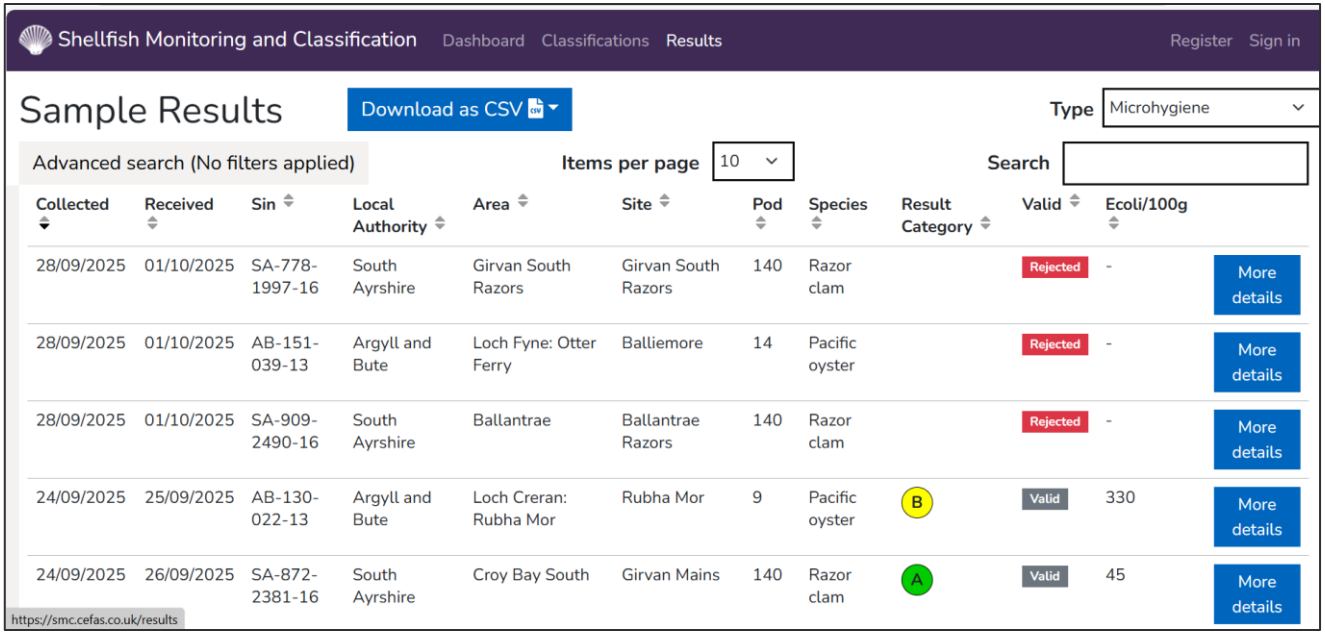
Analysis of samples is carried out by **inverted microscope** at **200x** magnification undertaking:

- Full chamber counts or
- Selected **Field of Views** 10-40 depending on **concentration** of target cells.



SAMS uploads a **daily report** to the FSS by 4pm

A **colour coded** weekly report highlighting numbers of **cells above set trigger levels** is also sent to FSS



Shetland suspends mussel harvesting after food poisoning

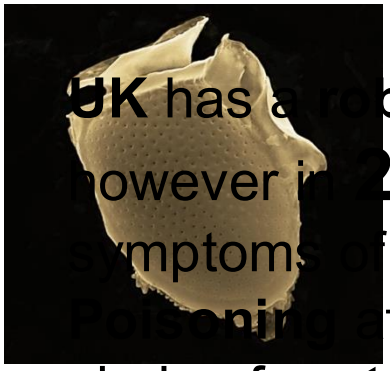
70 people report symptoms consistent with having consumed shellfish toxins, some in restaurants owned by Belgo chain

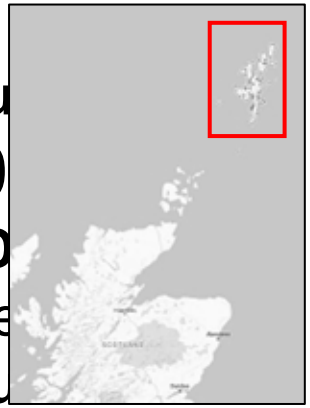
James Meikle
The Guardian, Thursday 25 July 2013 18.42 BST

Shetland Mussels says all the mussels from the affected batch have either been eaten or disposed off. Photograph: Jerry Lampen/EPA

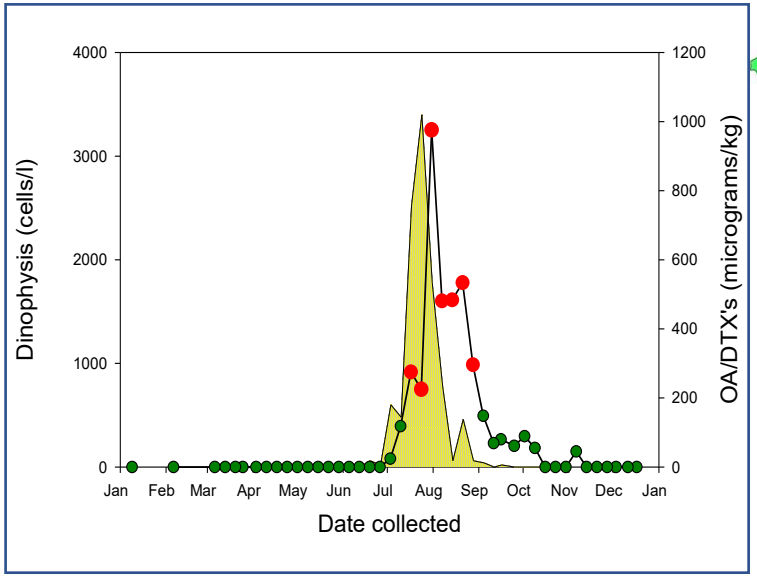
The mussels industry in Shetland has suspended all commercial harvesting after food poisoning incidents linked to restaurants belonging to the Belgo chain and others in south-east England.

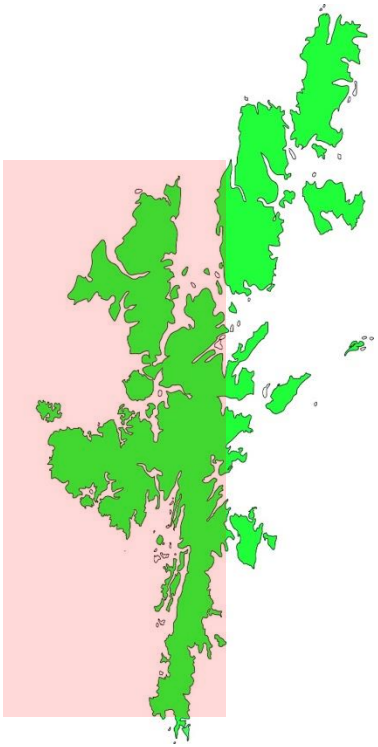
About 70 people have reported symptoms consistent with having consumed shellfish toxins, most between 10 and 12 days ago, the UK Food Standards Agency) said. The company that supplied the shellfish, Shetland Mussels, says all the mussels from the affected batch have either been eaten or disposed off. Other farmers have voluntarily





UK has a **ro**bu
however in **20**
symptoms of **D**
Poisoning afte
chain of **restau**
South East England

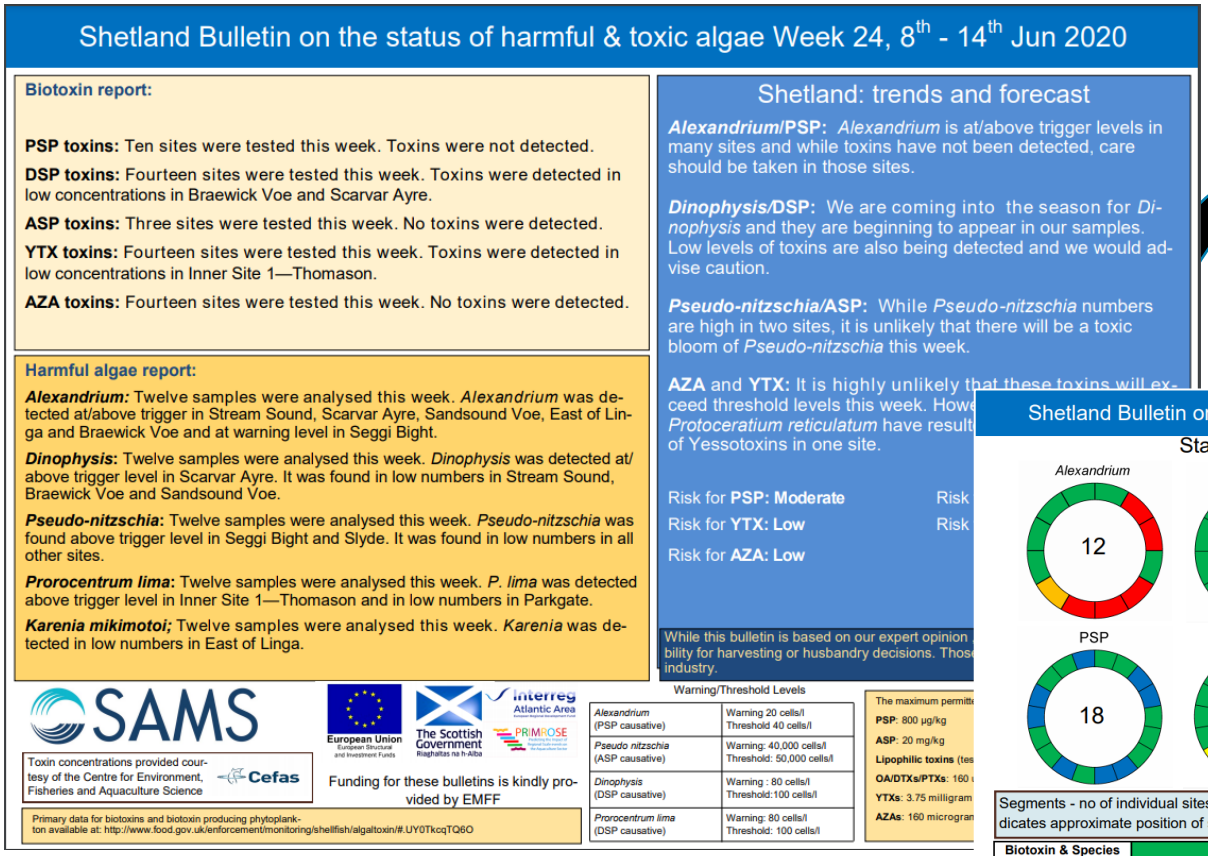




SO MUCH TO SEA...

SeafoodShetland
incorporating Shetland Fish Processors and Shellfish Growers

Paper based weekly report for Seafood Shetland



Shetland Bulletin on the status of harmful & toxic algae Week 24, 8th - 14th Jun 2020

Biotoxin report:

PSP toxins: Ten sites were tested this week. Toxins were not detected.

DSP toxins: Fourteen sites were tested this week. Toxins were detected in low concentrations in Braewick Voe and Scarvar Ayre.

ASP toxins: Three sites were tested this week. No toxins were detected.

YTX toxins: Fourteen sites were tested this week. Toxins were detected in low concentrations in Inner Site 1—Thomason.

AZA toxins: Fourteen sites were tested this week. No toxins were detected.

Harmful algae report:

Alexandrium: Twelve samples were analysed this week. *Alexandrium* was detected at/above trigger in Stream Sound, Scarvar Ayre, Sandsound Voe, East of Linga and Braewick Voe and at warning level in Seggi Bight.

***Dinophysis*:** Twelve samples were analysed this week. *Dinophysis* was detected at/above trigger level in Scarvar Ayre. It was found in low numbers in Stream Sound, Braewick Voe and Sandsound Voe.

***Pseudo-nitzschia*:** Twelve samples were analysed this week. *Pseudo-nitzschia* was found above trigger level in Seggi Bight and Slyde. It was found in low numbers in all other sites.

***Prorocentrum lima*:** Twelve samples were analysed this week. *P. lima* was detected above trigger level in Inner Site 1—Thomason and in low numbers in Parkgate.

Karenia mikimotoi; Twelve samples were analysed this week. *Karenia* was detected in low numbers in East of Linga.

Shetland: trends and forecast

***Alexandrium*/PSP:** *Alexandrium* is at/above trigger levels in many sites and while toxins have not been detected, care should be taken in those sites.

***Dinophysis*/DSP:** We are coming into the season for *Dinophysis* and they are beginning to appear in our samples. Low levels of toxins are also being detected and we would advise caution.

***Pseudo-nitzschia*/ASP:** While *Pseudo-nitzschia* numbers are high in two sites, it is unlikely that there will be a toxic bloom of *Pseudo-nitzschia* this week.

AZA and **YTX:** It is highly unlikely that these toxins will exceed threshold levels this week. Howe
Protoceratium reticulatum have result
of Yessotoxins in one site.

Risk for **PSP: Moderate** Risk
Risk for **YTX: Low** Risk
Risk for **AZA: Low**

While this bulletin is based on our expert opinion
bility for harvesting or husbandry decisions. Thos
industry.

SAMS

Toxin concentrations provided courtesy of the Centre for Environment, Fisheries and Aquaculture Science — Cefas

Funding for these bulletins is kindly provided by EMFF

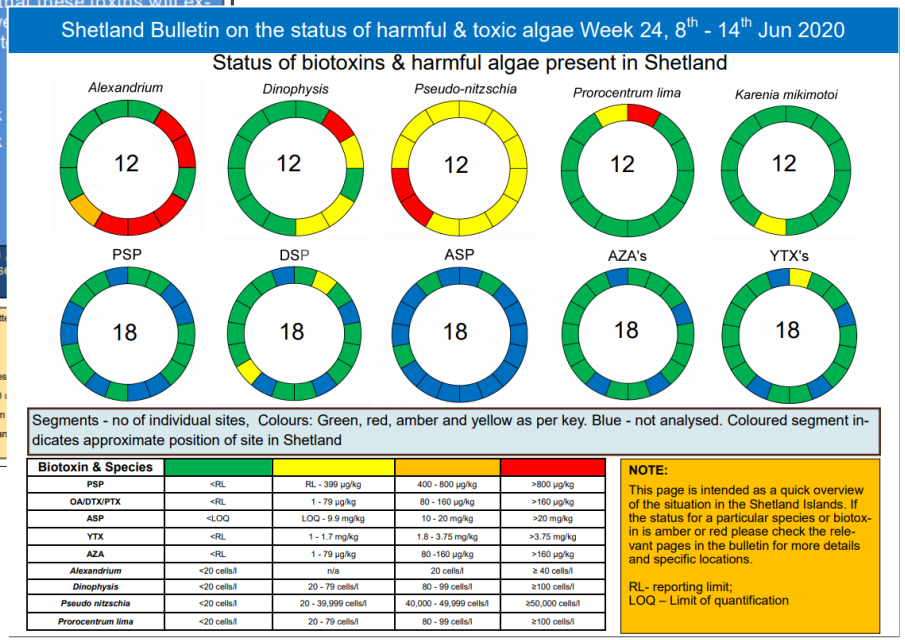
Primary data for biotoxins and biotoxin producing phytoplankton available at: http://www.food.gov.uk/enforcement/monitoring/shellfish/algaltoxin/#.UY0TkcqTQ6O

Warning/Threshold Levels

Alexandrium (PSP causative)	Warning 20 cells/l Threshold 40 cells/l
Pseudo nitzschia (ASP causative)	Warning: 40,000 cells/l Threshold: 50,000 cells/l
Dinophysis (DSP causative)	Warning : 80 cells/l Threshold:100 cells/l
Prorocentrum lima (DSP causative)	Warning: 80 cells/l Threshold: 100 cells/l

The maximum permitte
PSP: 800 µg/kg
ASP: 20 mg/kg
Lipophilic toxins (tes
OA/DTXs/PTXs: 160
YTXs: 3.75 milligram
AZAs: 160 microgran

Blended approach: Same information but presented as an infographic



Shetland Bulletin on the status of harmful & toxic algae Week 24, 8th - 14th Jun 2020

Status of biotoxins & harmful algae present in Shetland

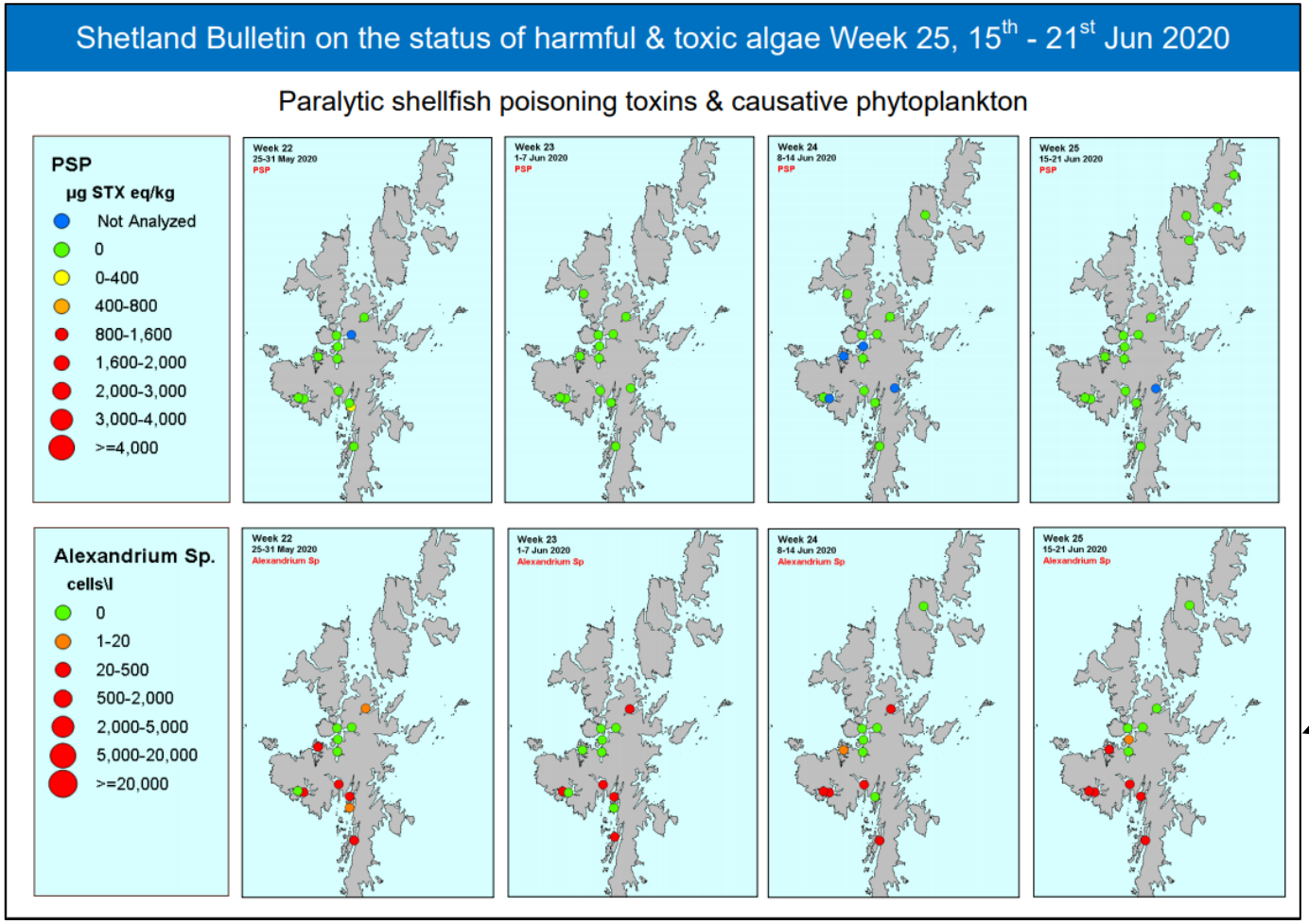
Segments - no of individual sites, Colours: Green, red, amber and yellow as per key. Blue - not analysed. Coloured segment indicates approximate position of site in Shetland

Biotoxin & Species				
PSP	<RL	RL - 399 µg/kg	400 - 800 µg/kg	>800 µg/kg
OA/DTX/PTX	<RL	1 - 79 µg/kg	80 - 160 µg/kg	>160 µg/kg
ASP	<LOQ	LOQ - 9.9 mg/kg	10 - 20 mg/kg	>20 mg/kg
YTX	<RL	1 - 1.7 mg/kg	1.8 - 3.75 mg/kg	>3.75 mg/kg
AZA	<RL	1 - 79 µg/kg	80 -160 µg/kg	>160 µg/kg
Alexandrium	<20 cells/l	n/a	20 cells/l	≥ 40 cells/l
Dinophysis	<20 cells/l	20 - 79 cells/l	80 - 99 cells/l	≥100 cells/l
Pseudo nitzschia	<20 cells/l	20 - 39,999 cells/l	40,000 - 49,999 cells/l	≥50,000 cells/l
Prorocentrum lima	<20 cells/l	20 - 79 cells/l	80 - 99 cells/l	≥100 cells/l

NOTE:
This page is intended as a quick overview of the situation in the Shetland Islands. If the status for a particular species or biotoxin is amber or red please check the relevant pages in the bulletin for more details and specific locations.

RL- reporting limit;
LOQ – Limit of quantification

Summary Page: Toxins, Phytoplankton Trends, Risk assessment



PSP

Maps of Sites with toxin and phytoplankton concentrations in this example the toxin is Saxitoxin and the causative species is *Alexandrium.*

Alexandrium

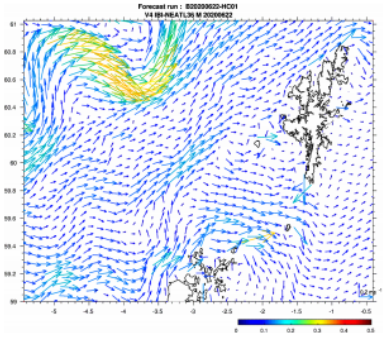
Preceding three weeks week

Current

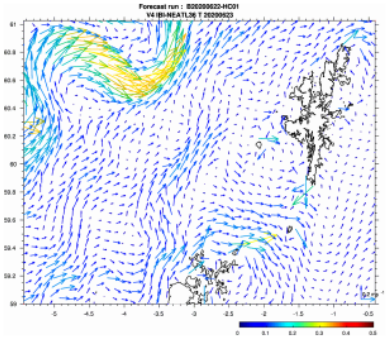
Shetland Bulletin on the status of harmful & toxic algae Week 25, 15th - 21st Jun 2020

Forecasted Sea Surface currents for the next few days

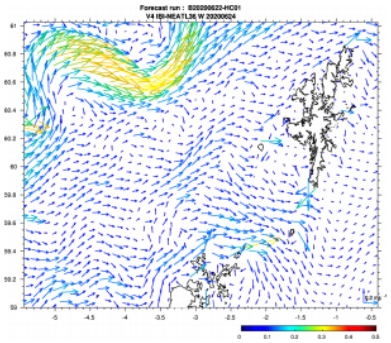
22 Jun 2020



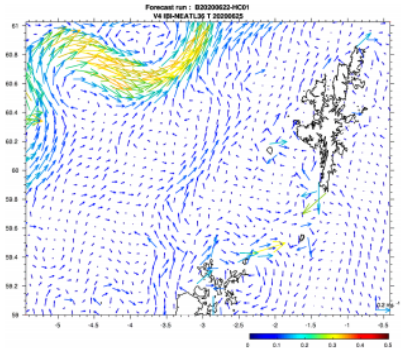
23 June 2020



24 June 2020

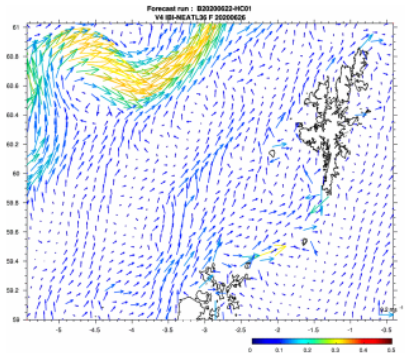


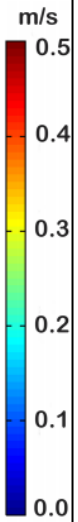
25 June 2020



These diagrams show the predicted current directions around Shetland for the next few days. Greens to reds indicate stronger currents. In general strong currents run parallel to the deep water channel between the Faroes and Shetland. Problems can arise when these currents turn Eastwards potentially carrying *Dinophysis* and *Karenia mikimotoi* blooms, from the shelf edge, into shore.

26 June 2020





Forecast provided by the model-NEATL-PHY-1/36°-AF-D-PGS (IBI36QV4R1-PGS) courtesy of Mercator.

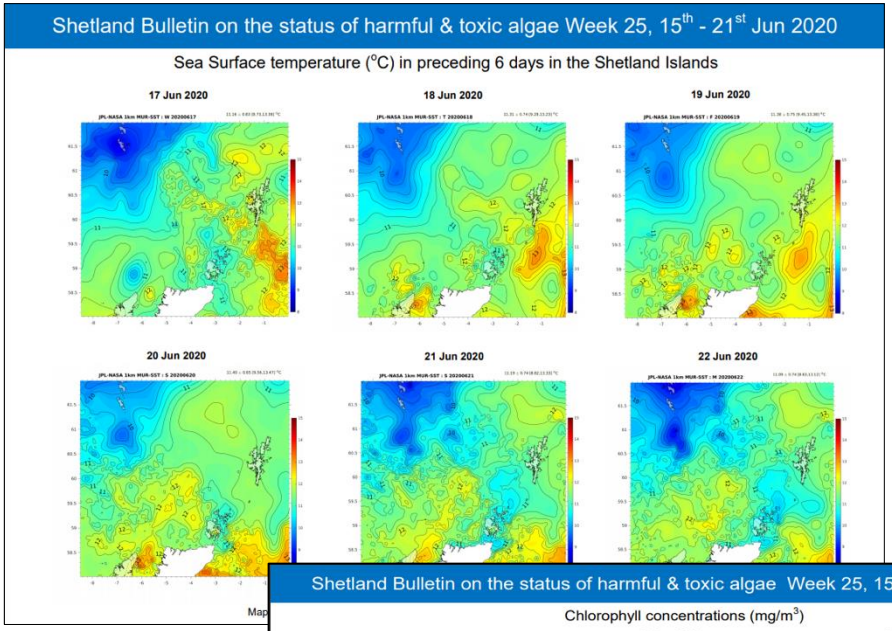
Mercator Ocean
Ocean Forecasters

Forecasted Sea Surface Currents 3 - 4 days

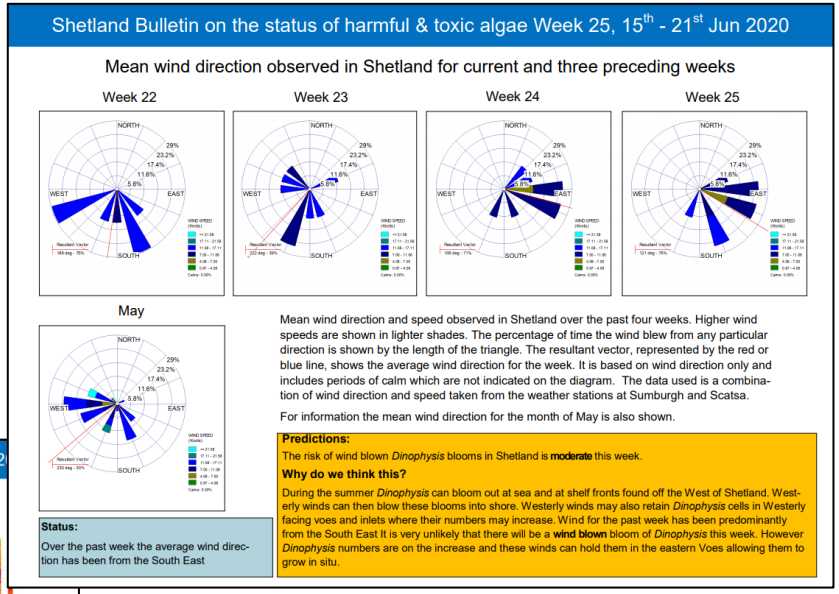
Forecast provided courtesy of

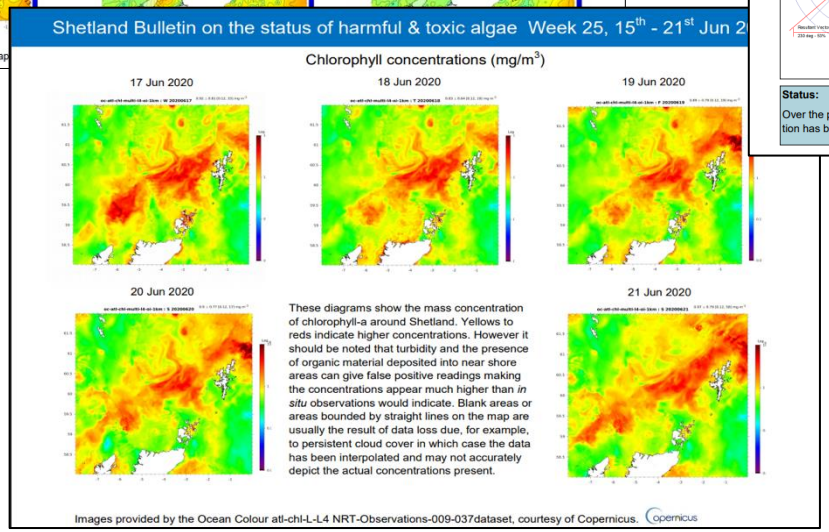
Copernicus
Europe's eyes on Earth

Sea Surface Temperatures



Wind direction and speed





Chlorophyll concentrations

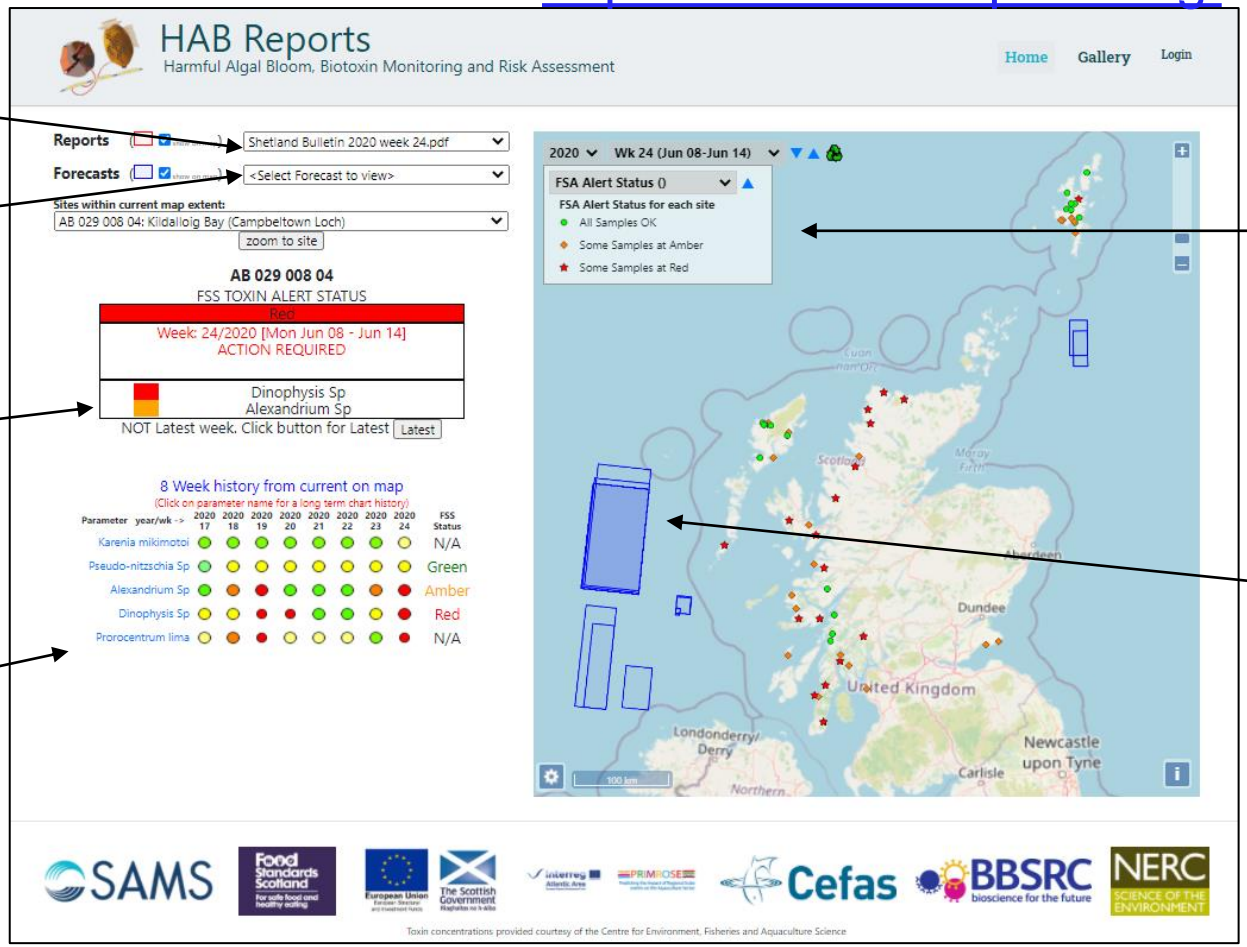
Available online at: https://www.habreports.org/

Select Reports

Select Models

Alert level For site

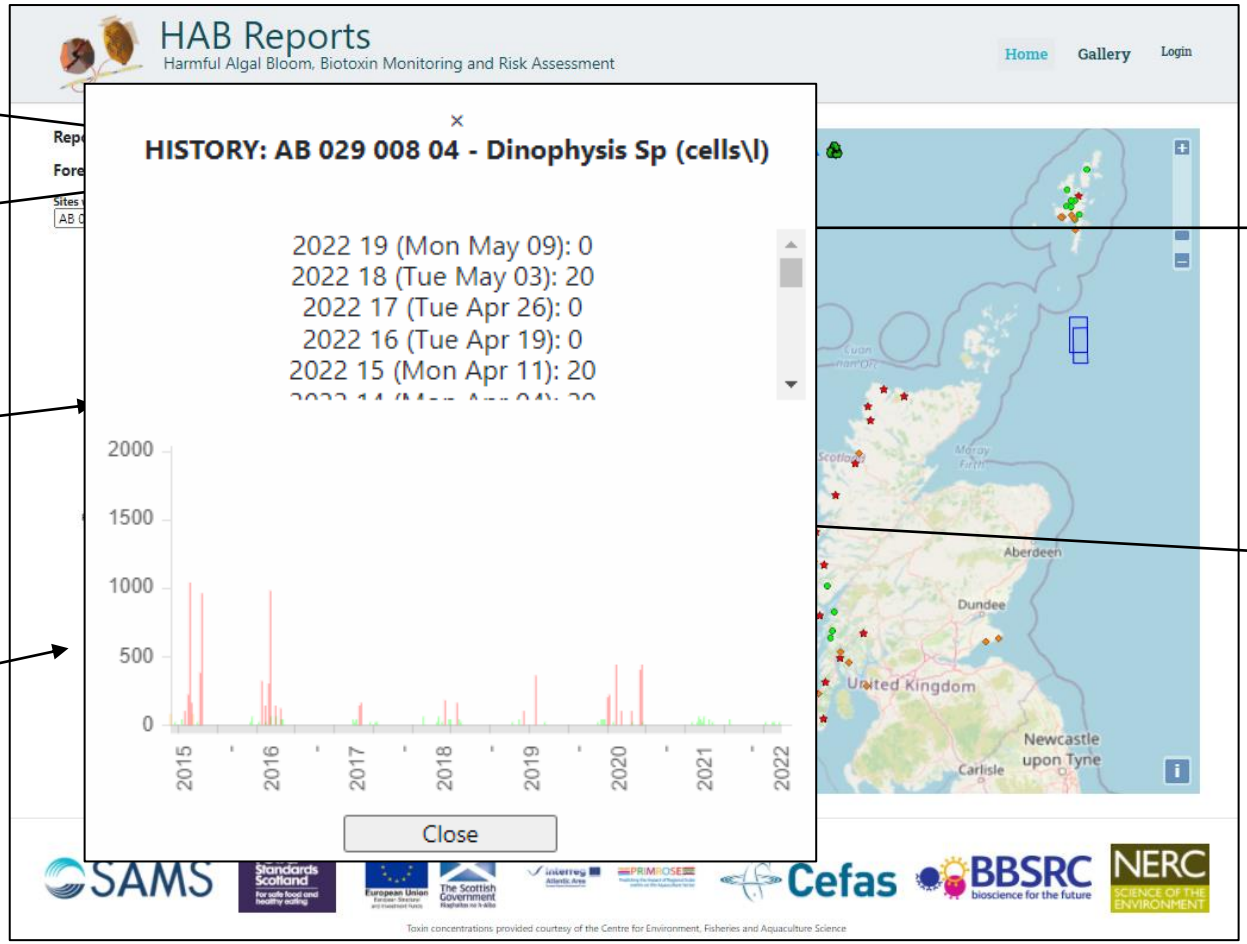
Select phytoplankton Or toxin For plot of historic events



Interactive map with several layers selected from drop down menus

Available Model boundaries

Available online at: https://www.habreports.org/



Select Reports

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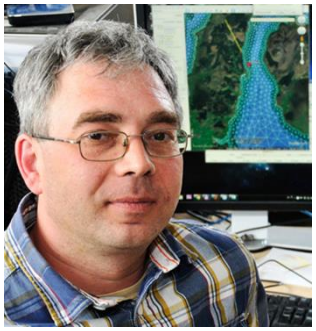
Interactive map with several layers selected from drop down menus

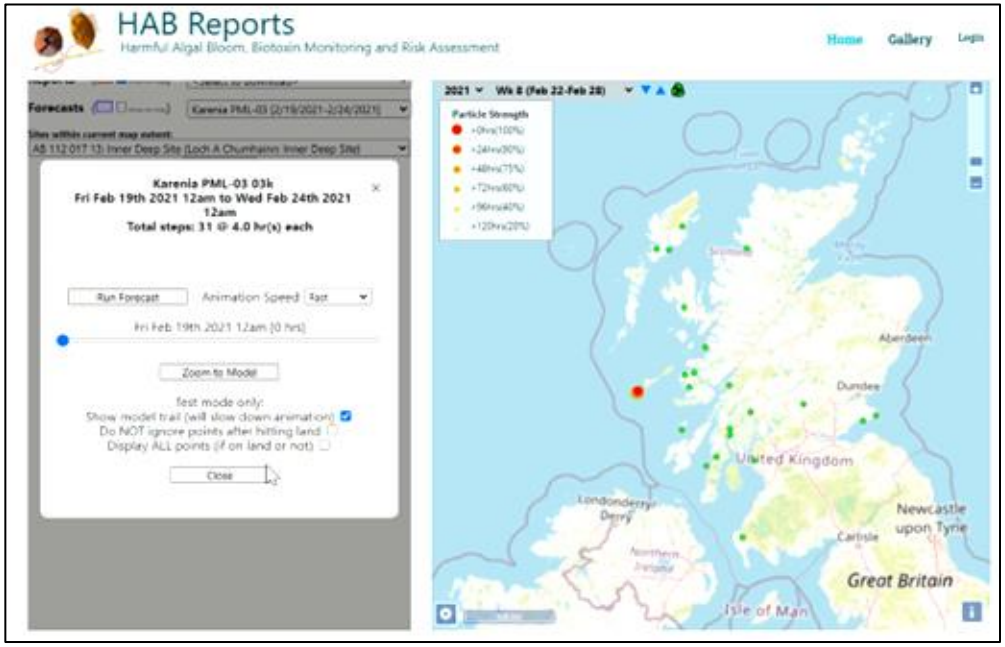
Available Model boundaries



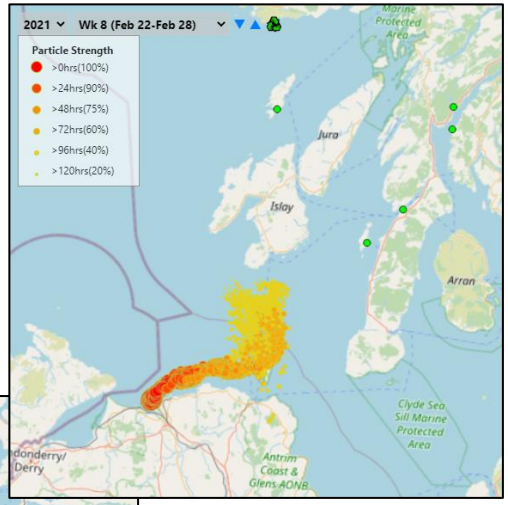
Dr Dmitry Aleynik

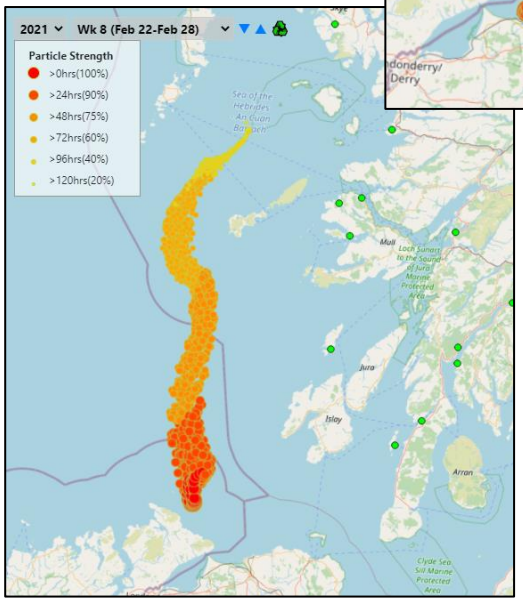
Aleynik, D. Davidson, K., Dale A. C., Porter, M. (2016) A high resolution hydrodynamic model system suitable for novel harmful algal bloom modelling in areas of complex coastline and topography. *Harmful Algae*, 53(3):102–117, 10.1016/j.hal.2015.11.012

West Scotland Coastal Ocean Modelling System (WeStCOMS)



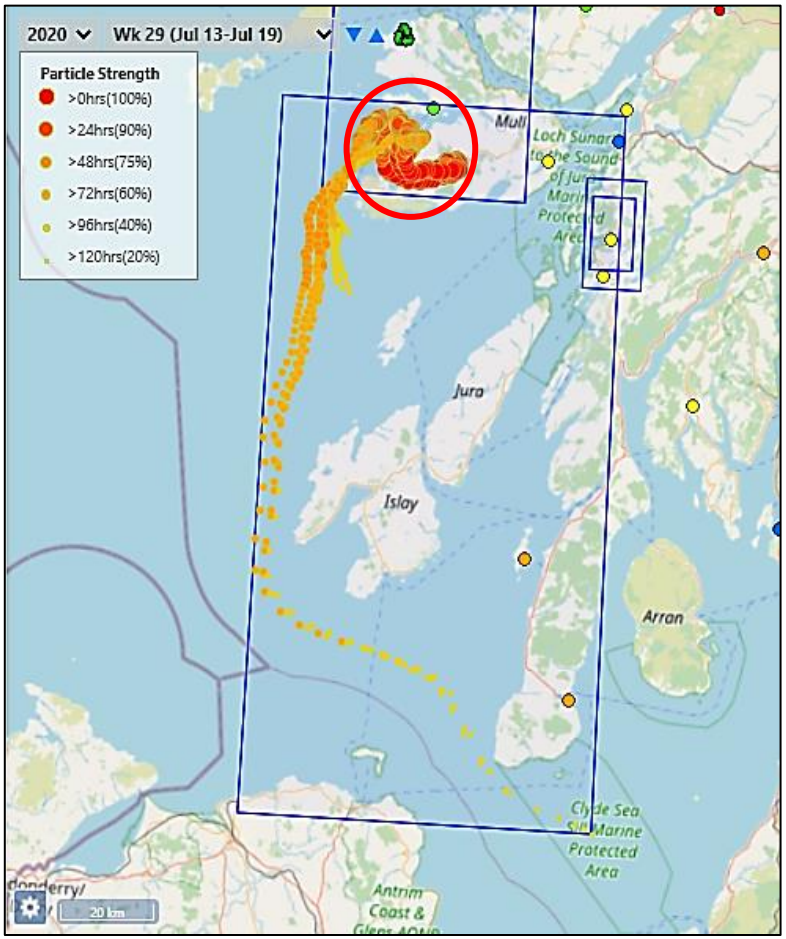
Particle trail left after model run

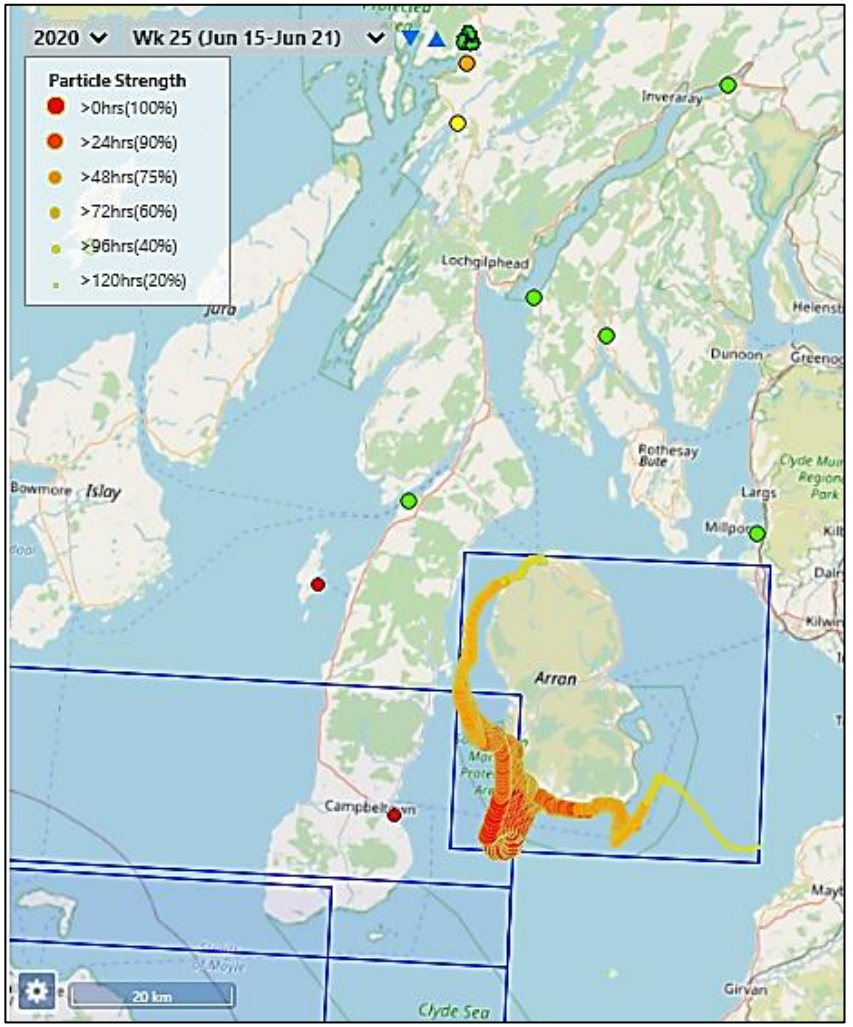




Colours change and size of points diminish with time

Model run triggered by high numbers of phytoplankton detected during official control monitoring



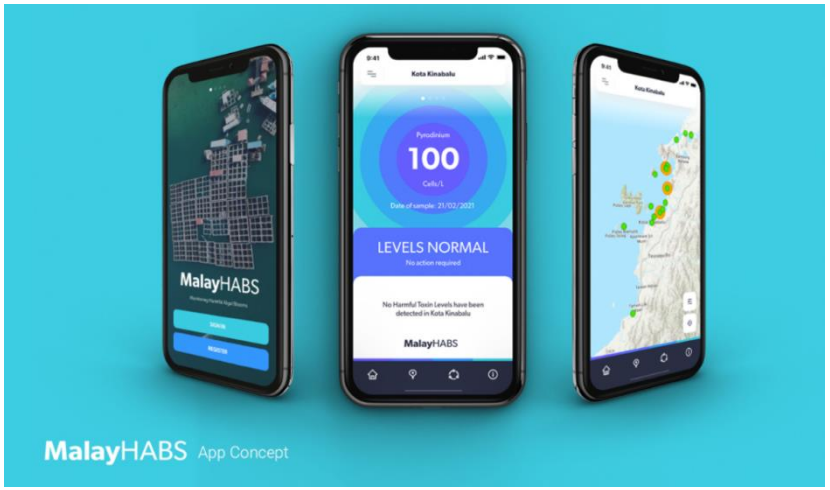


Prof. Po Teen Lim

Alan MacDonald

Will Harvey

Mobile Phone App



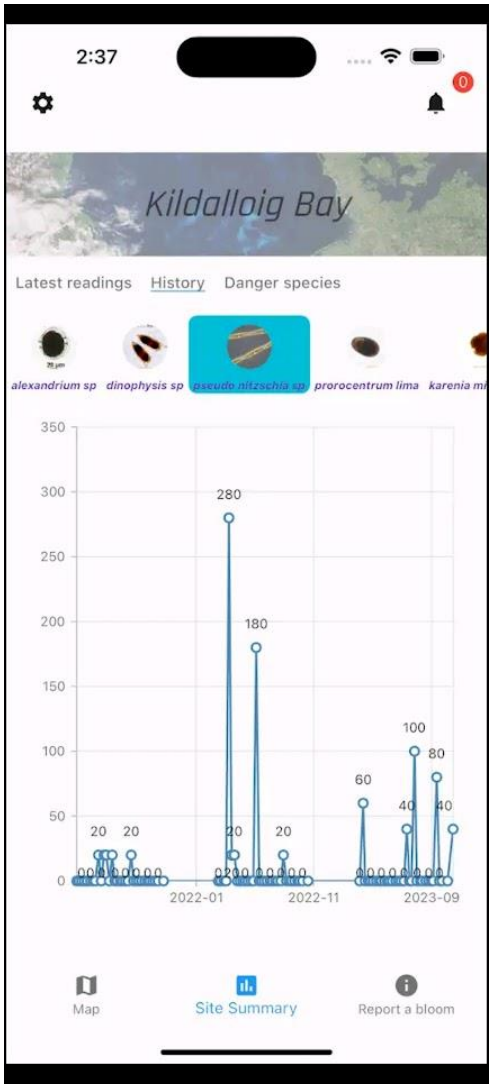
SAMS

UNIVERSITI MALAYA

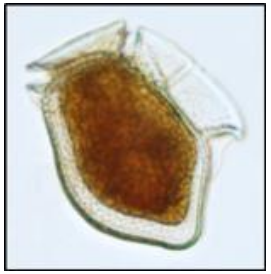
OCCAM

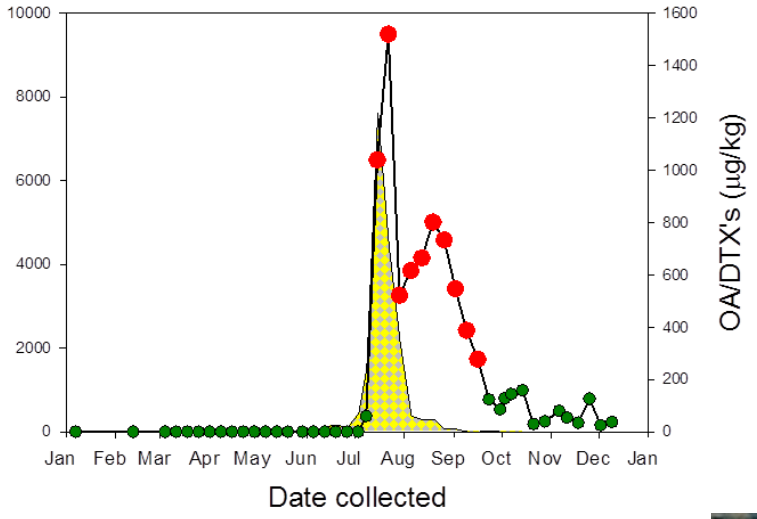

09:55
88%
Vágur
Enter site location
0
Lerwick
Kirkwall
Inverness
Aberdeen
Dunde
Andrews
Edinburgh
United Kingdom
Newcastle upon Tyne
Google
Map
Site Summary
Report a bloom


09:56
88%
0
Dubh Aird
Latest readings
History
Danger species
Mar 3, 2025
pseudo nitzschia sp
99170 cells litre⁻¹
prorocentrum lima
20 cells litre⁻¹
Map
Site Summary
Report a bloom


2:37
0
Kildalloig Bay
Latest readings
History
Danger species
alexandrium sp
dinophysis sp
pseudo nitzschia sp
prorocentrum lima
karenia m
350
300
250
200
150
100
50
0
280
180
100
80
60
40
40
20
20
20
20
2022-01
2022-11
2023-09
Map
Site Summary
Report a bloom

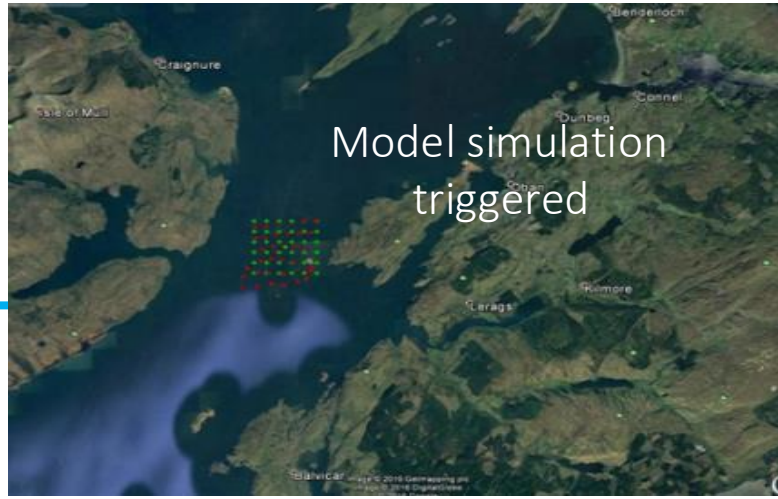
Integrating model alerts into HABreports.org

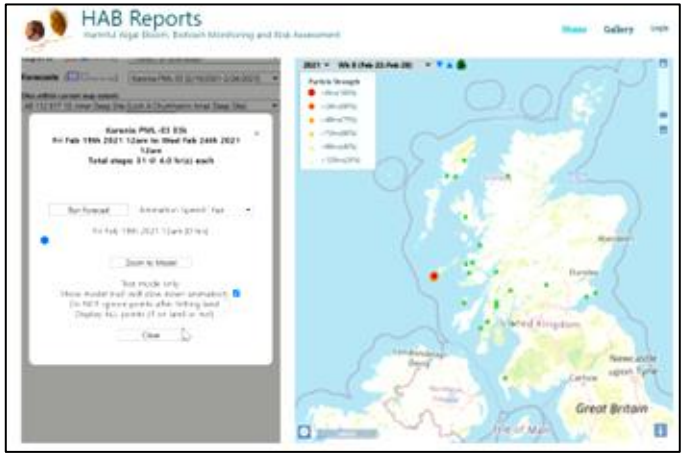


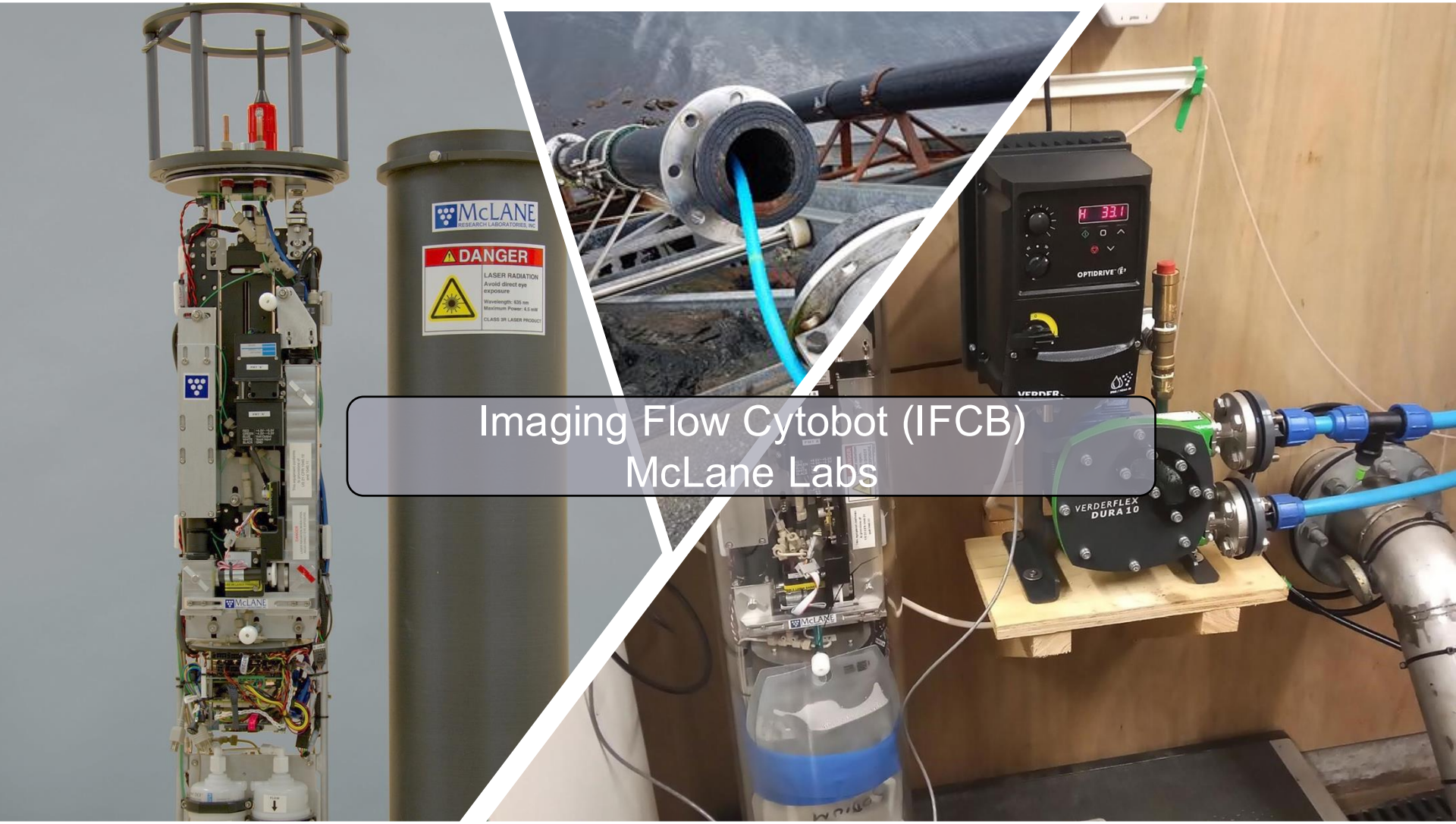


HAB alert

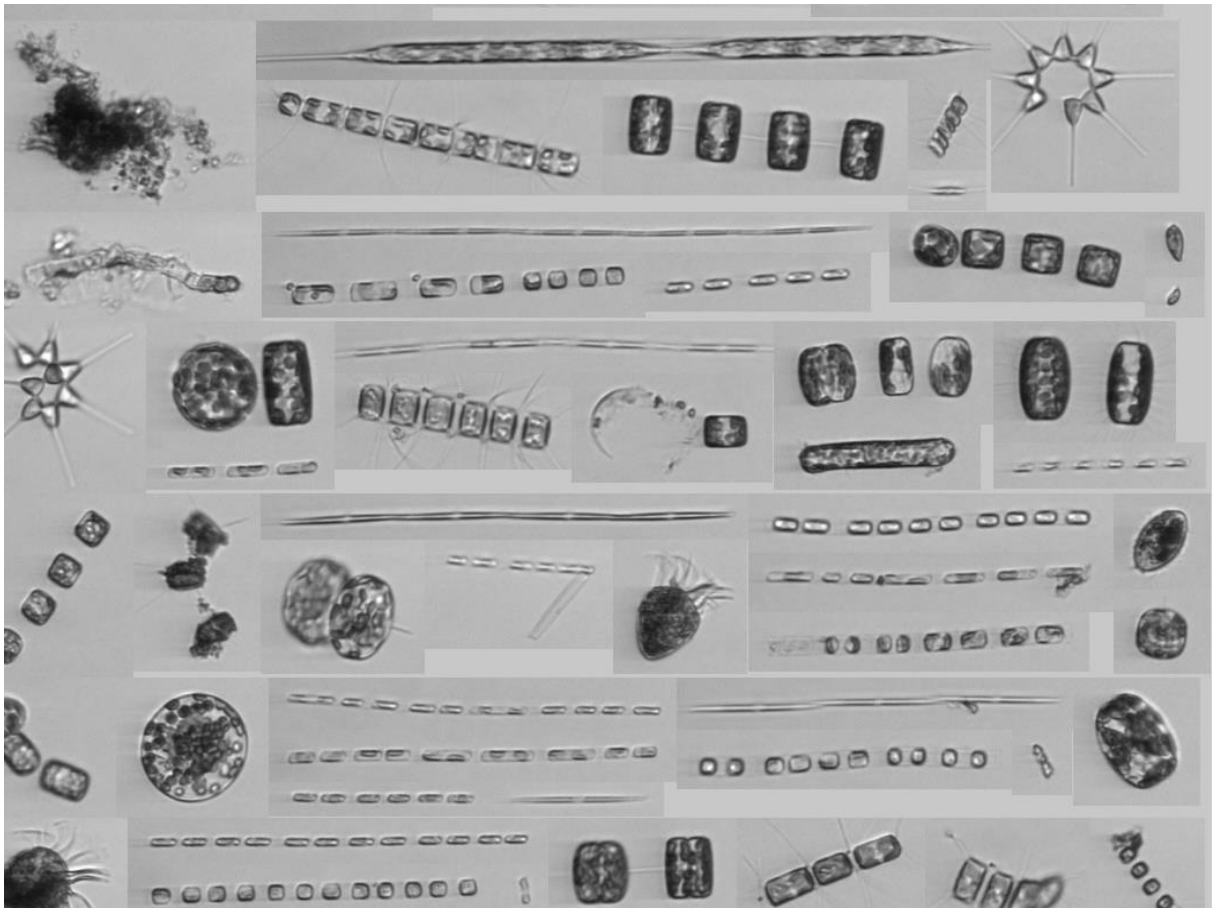
Location, date, species, density





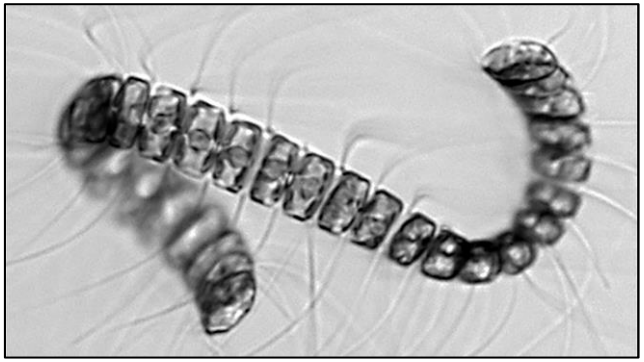


Imaging Flow Cytobot (IFCB)
McLane Labs



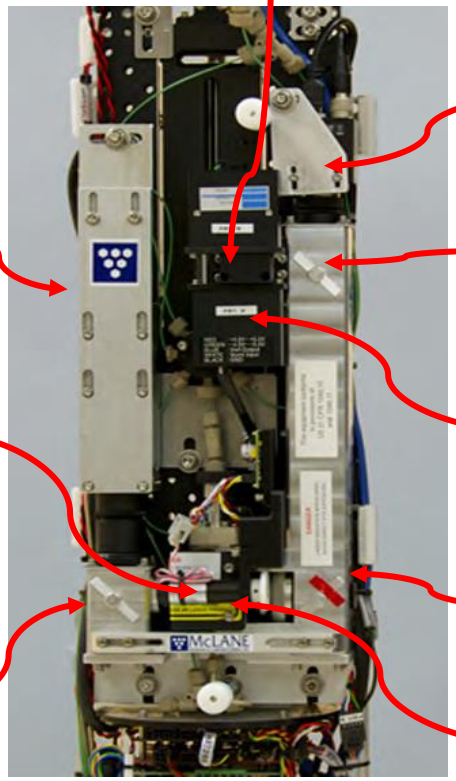
Effectively an IFCB is an underwater microscope and camera, capable of photographing phytoplankton in situ.

Processes a 5ml sample every 25-30 minutes



Housing (40m)

Syringe



Camera

Lamp

Mirror

Flow cell

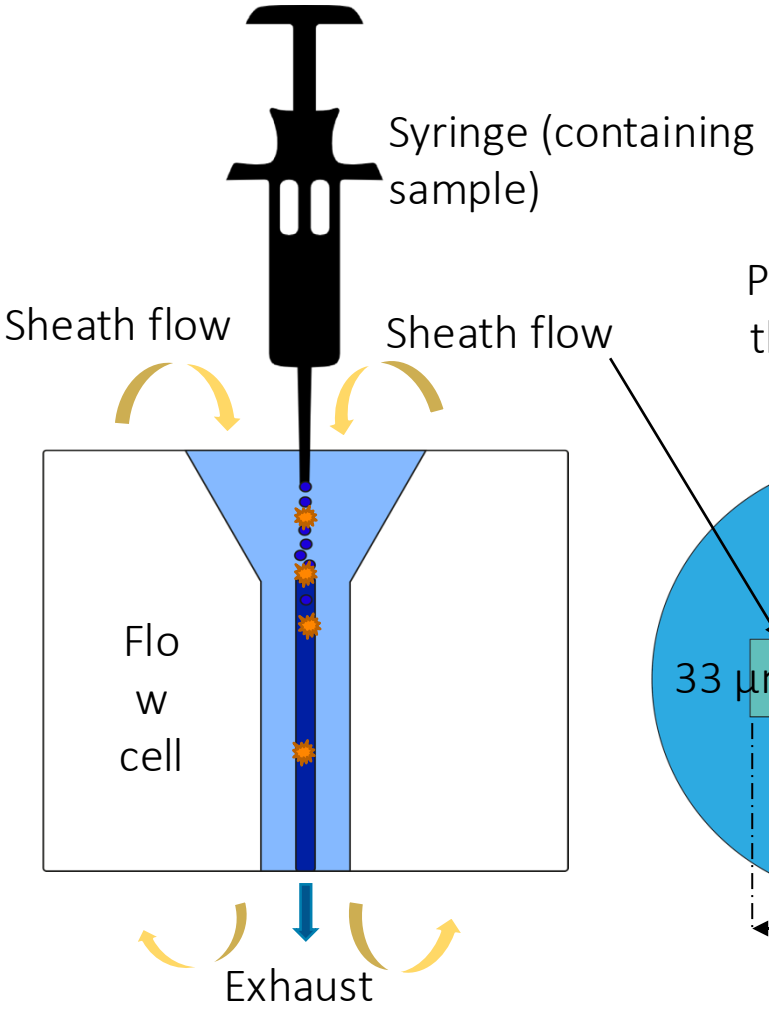
Sensors

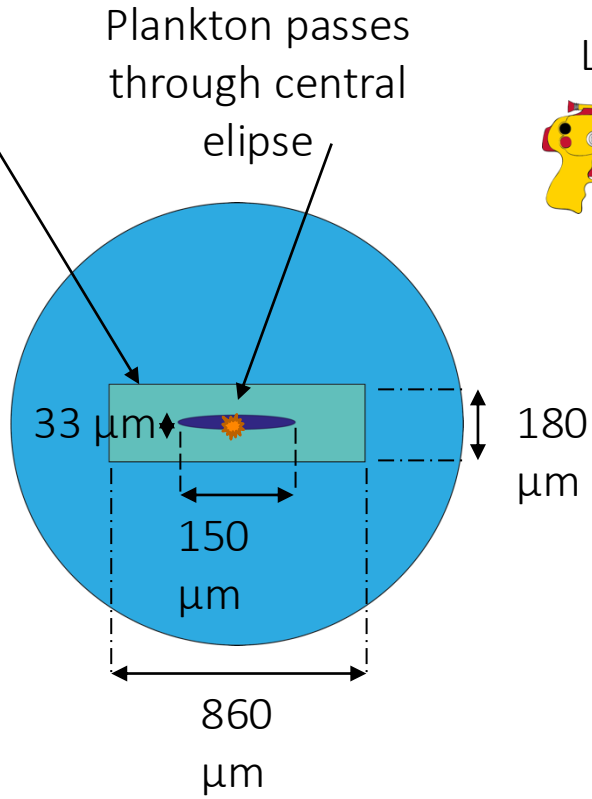
Mirror

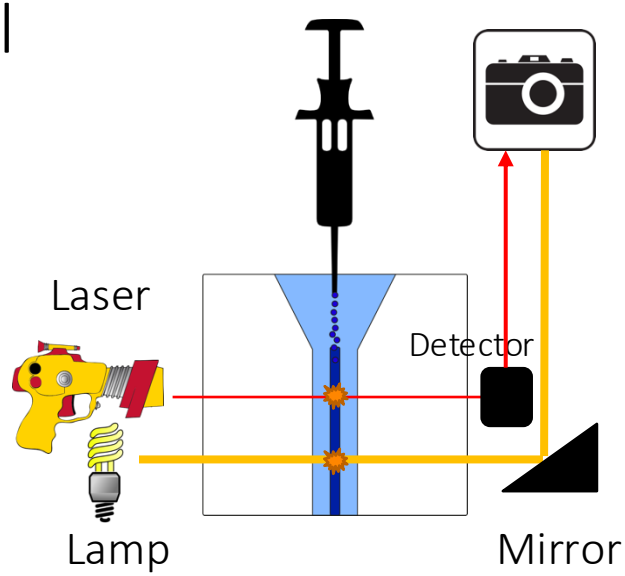
Mirror

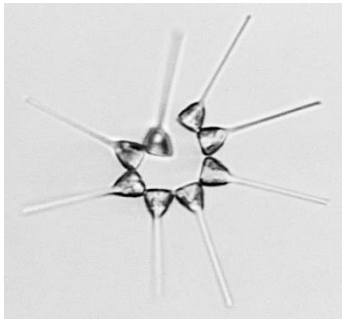
laser

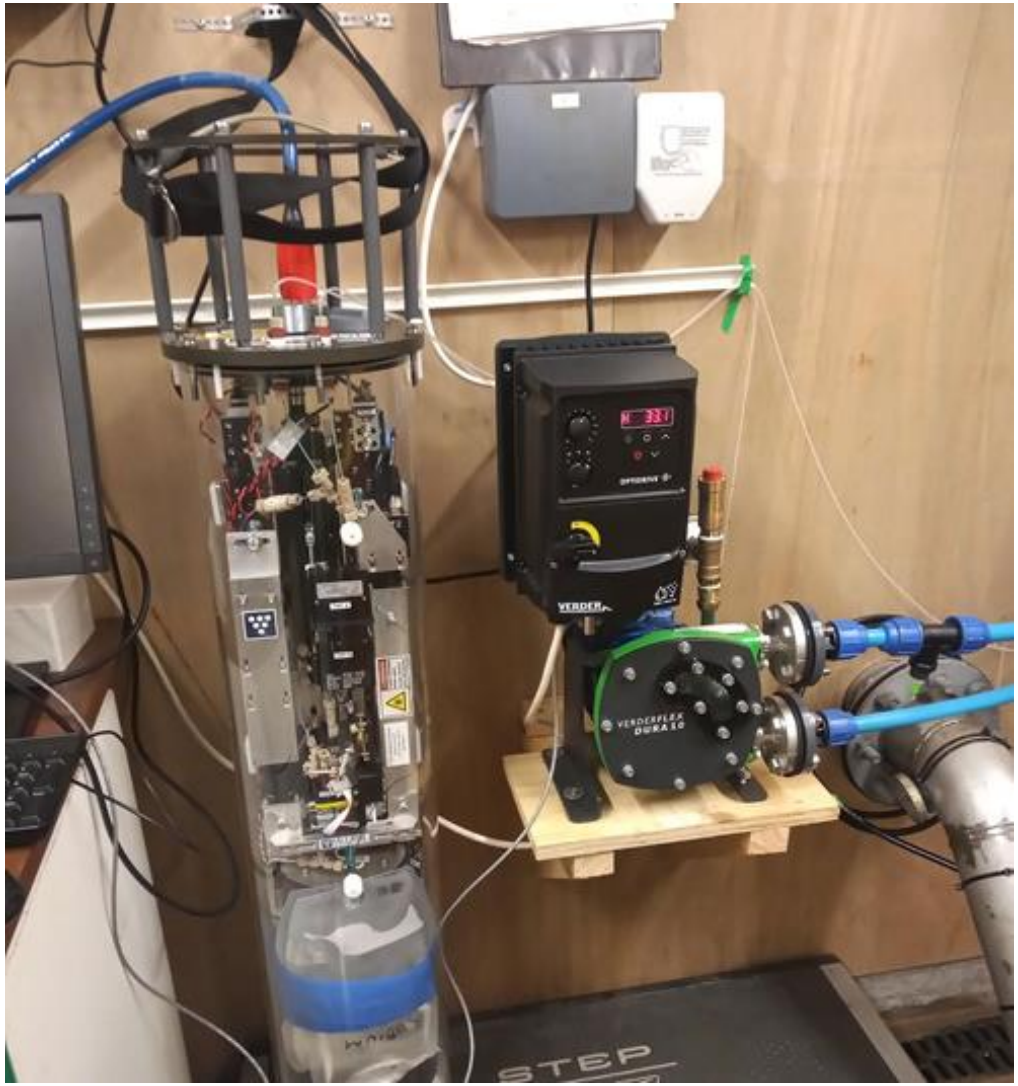
Flow cell


Syringe (containing sample)
Sheath flow
Sheath flow
Flo
w
cell
Exhaust


Plankton passes through central elipse
33 µm
150 µm
180 µm
860 µm


Laser
Detector
Lamp
Mirror





IFCB

Situated in former hatchery pump house

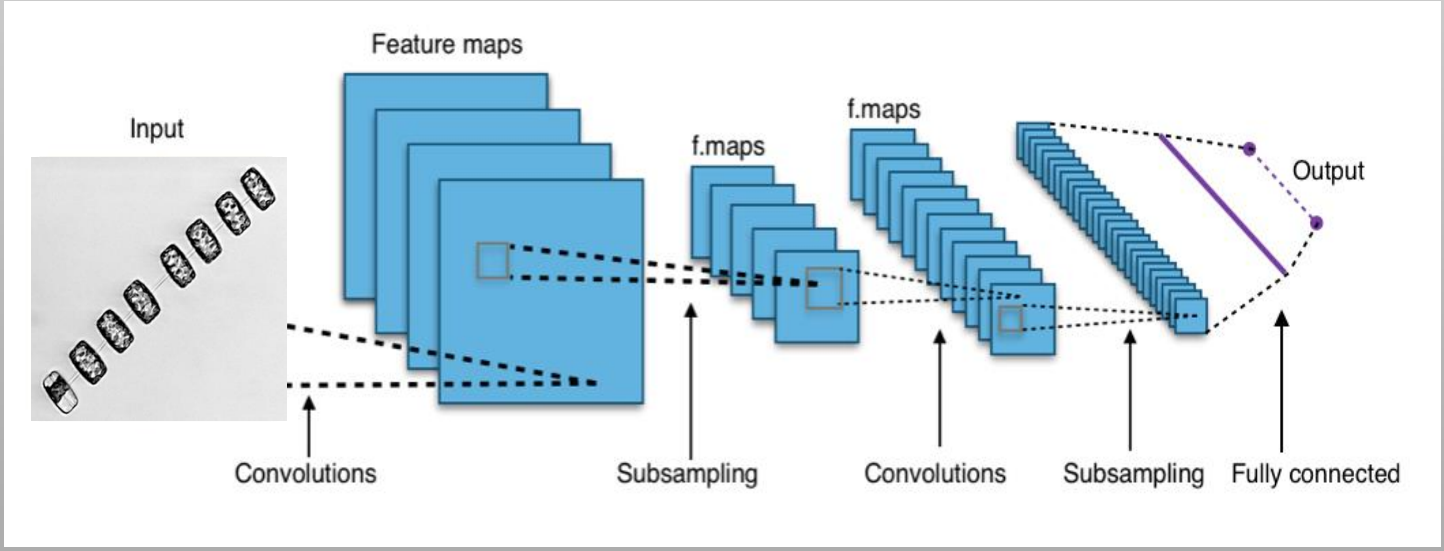
Water pumped from the sea using industrial impeller pump rated for constant use

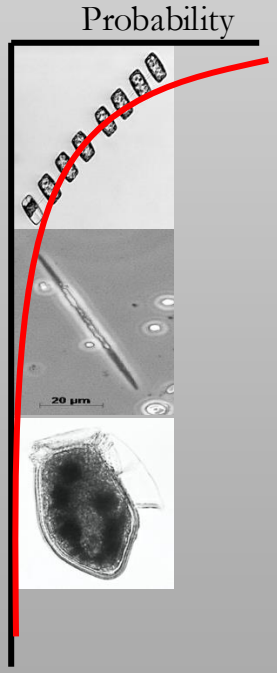
Cost £150,000

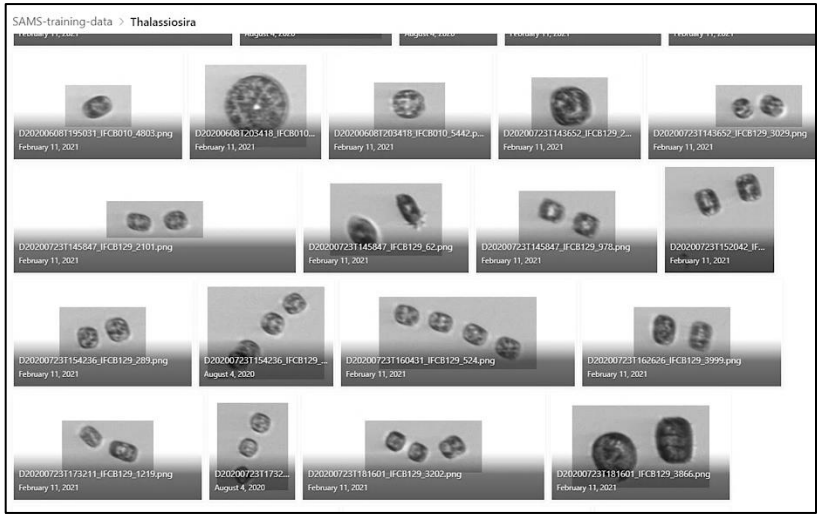
Would you leave this dangling on the end of a buoy?

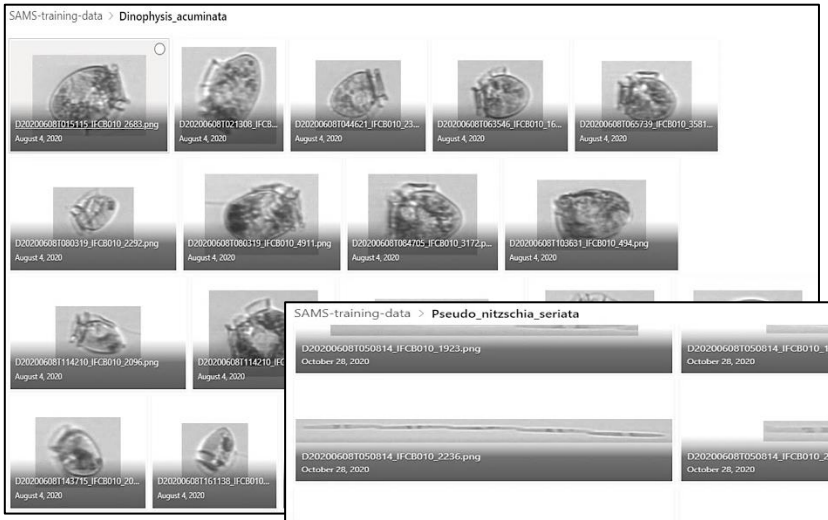
Where we are going?
Artificial intelligence – more specifically:

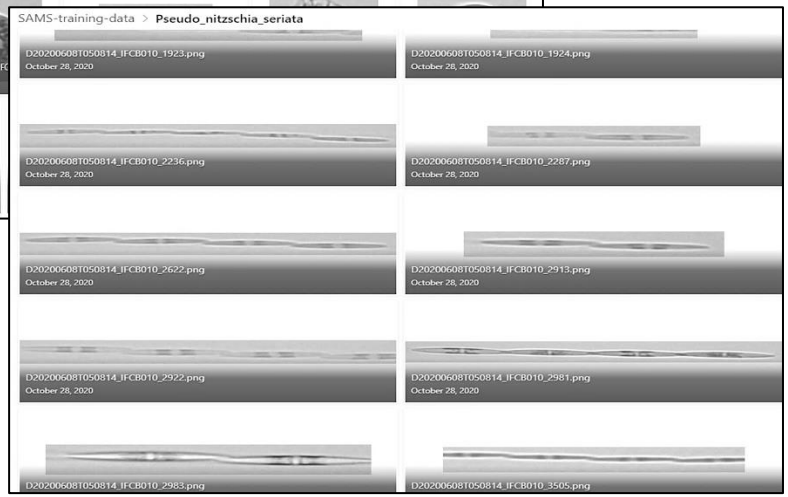
Convolutional Neural Network (CNN)





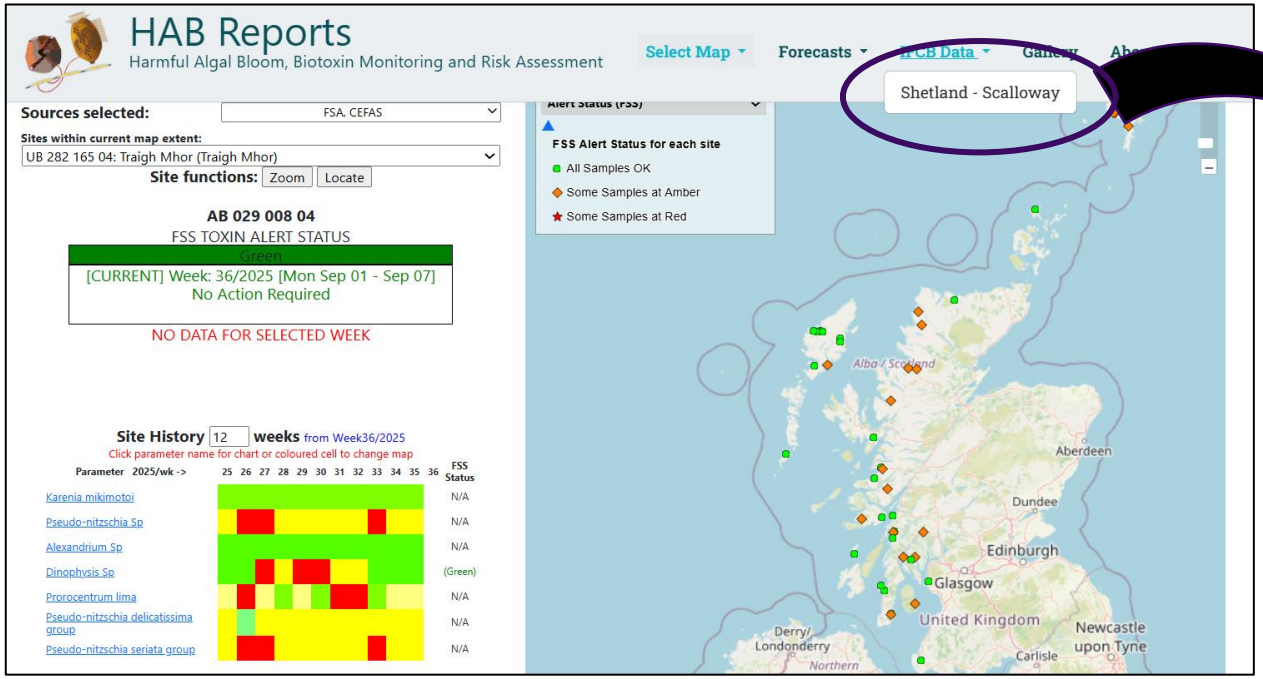


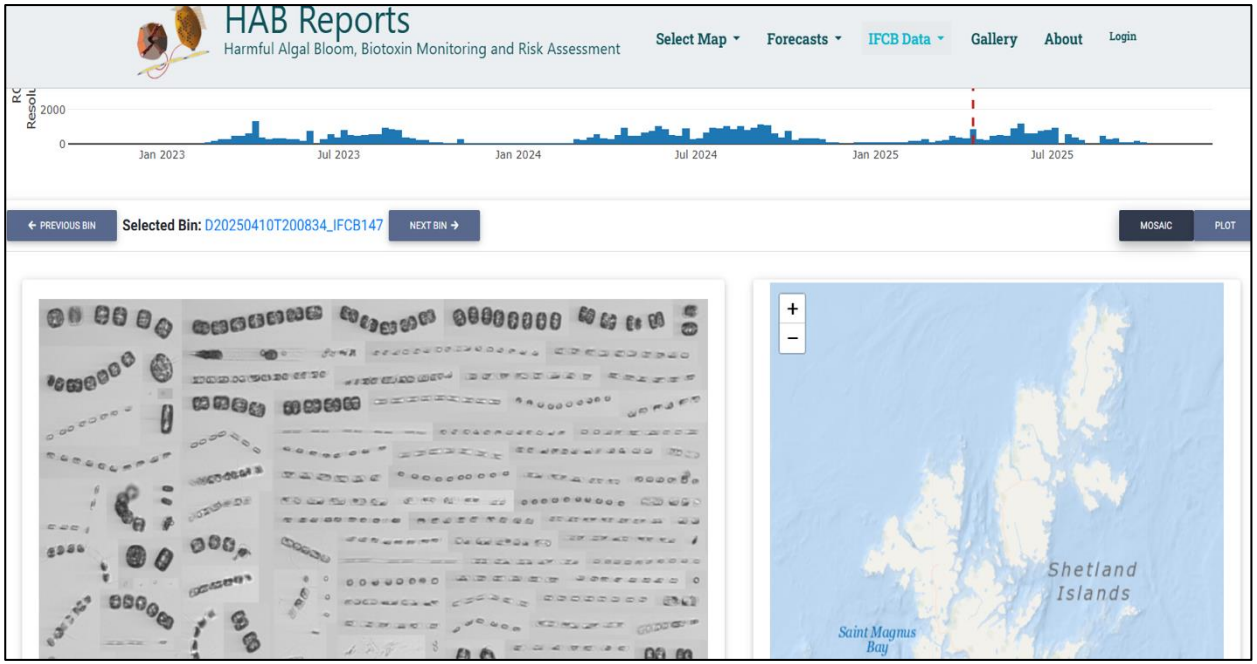




Training the CNN to recognise different *species/genera* requires large datasets of images, approx. 1000 images per class.

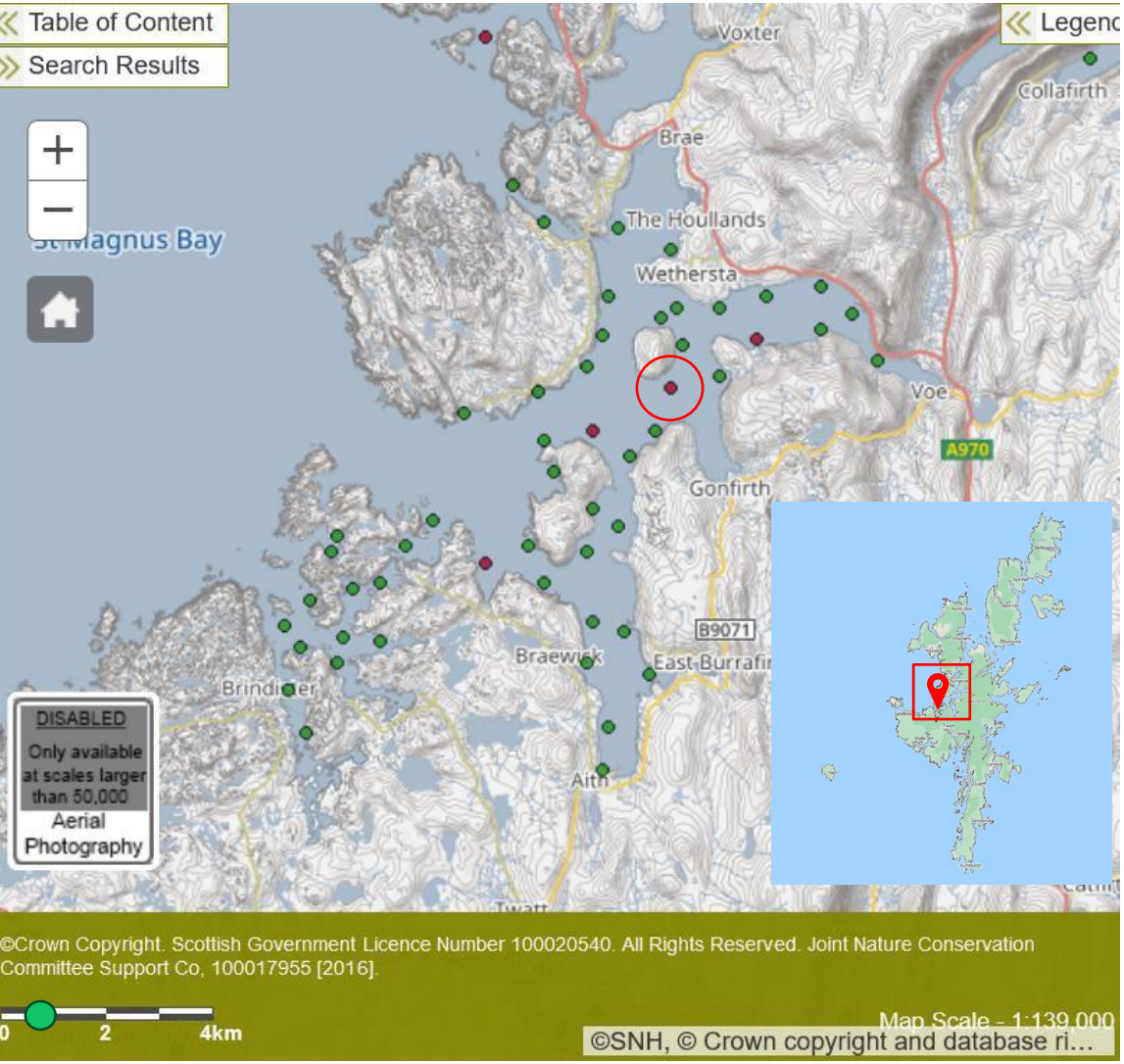
Each image has to be properly identified by a trained taxonomist
To date SAMS has classified over 60,000 images


HAB Reports
Harmful Algal Bloom, Biotoxin Monitoring and Risk Assessment
Select Map
Forecasts
IFCB Data
Shetland - Scalloway
Sources selected:
FSA, CEFAS
Sites within current map extent:
UB 282 165 04: Traigh Mhor (Traigh Mhor)
Site functions:
Zoom
Locate
AB 029 008 04
FSS TOXIN ALERT STATUS
Green
[CURRENT] Week: 36/2025 [Mon Sep 01 - Sep 07]
No Action Required
NO DATA FOR SELECTED WEEK
FSS Alert Status for each site
All Samples OK
Some Samples at Amber
Some Samples at Red
Site History 12 weeks from Week36/2025
Click parameter name for chart or coloured cell to change map
Parameter 2025/wk ->
25 26 27 28 29 30 31 32 33 34 35 36
FSS Status
Karenia mikimotoi N/A
Pseudo-nitzschia Sp N/A
Alexandrium Sp N/A
Dinophysis Sp (Green)
Prorocentrum lima N/A
Pseudo-nitzschia delicatissima group N/A
Pseudo-nitzschia seriata group N/A
Alba / Scotland
Aberdeen
Dundee
Edinburgh
Glasgow
United Kingdom
Derry/ Londonderry
Northern
Carlisle
Newcastle upon Tyne


HAB Reports
Harmful Algal Bloom, Biotoxin Monitoring and Risk Assessment
Select Map
Forecasts
IFCB Data
Gallery
About
Login
2000
0
Jan 2023
Jul 2023
Jan 2024
Jul 2024
Jan 2025
Jul 2025
PREVIOUS BIN
Selected Bin: D20250410T200834_IFCB147
NEXT BIN
MOSAIC
PLOT
Shetland Islands
Saint Magnus Bay

Warning

Some viewers may find the following slides distressing



IFCB 147 (Ostrea) – Currently deployed at Cole Deep - **Scottish Sea Farms**

Feb 2023 – Current

76.1 million images

http://aquaculture.scotland.gov.uk/map/map.aspx

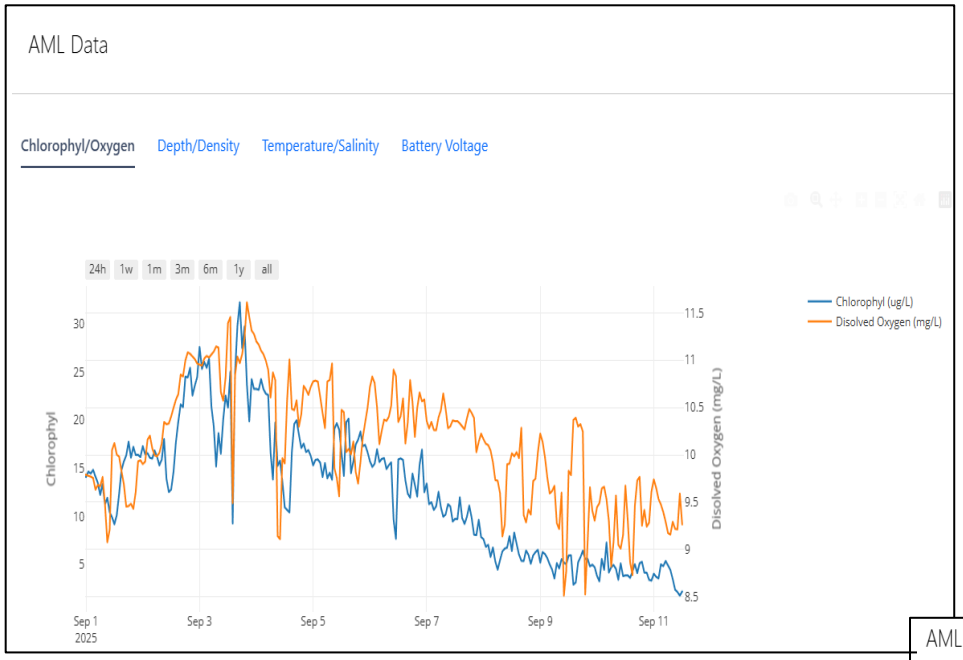
AML 6XC CTD

1. Conductivity
2. Temperature
3. Pressure
4. UV Anti Biofouling
5. Oxygen
6. Chlorophyll

Integration kit available from McLane Res. Labs.

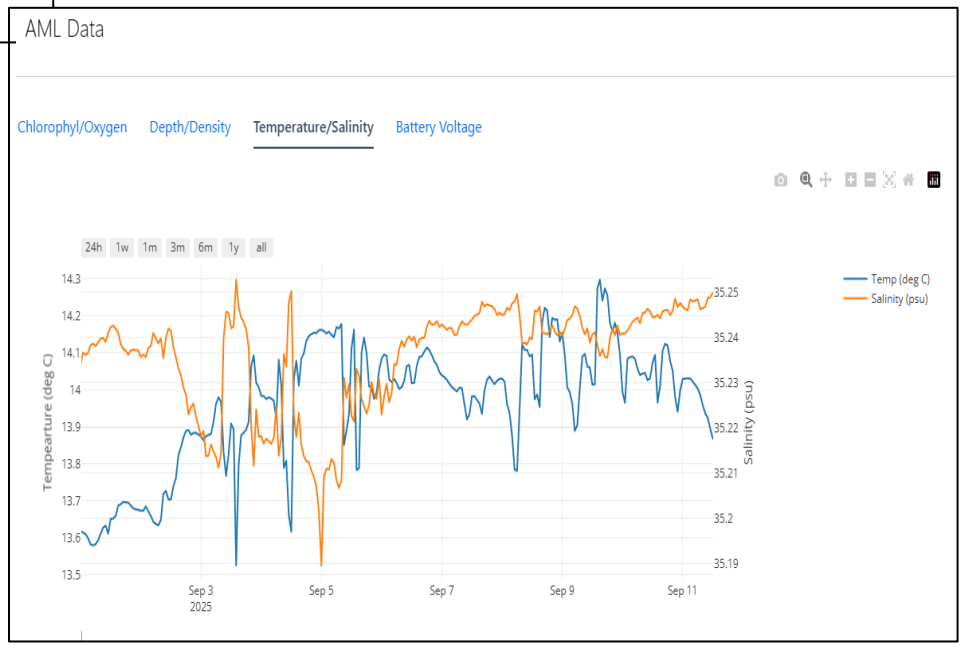
Connected to IFCB for power and data via bulkhead port

Live data now integrated to dashboard – https://ifcb-portal.sams.ac.uk/AMLData/7



Chlorophyll

Dissolved oxygen

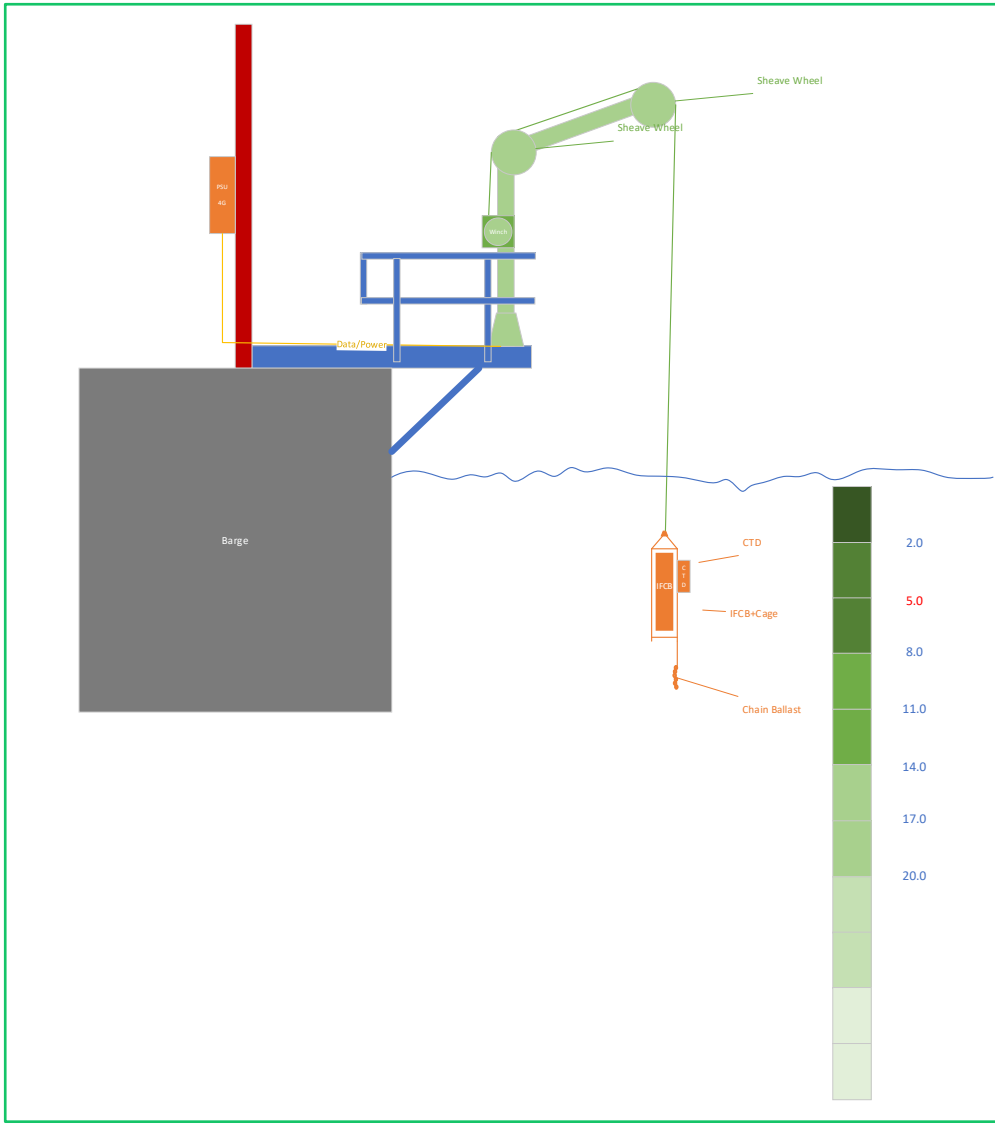


Temperature

Salinity

Depth profiling

- Barge power usually available ‘daytime’
- **8 stations** (~2h at each)
  - 2, 5, 8, 11, 14, 17, 20, 23 m
- **3 CTD ‘full column transects’ per day** (07:30, 16:00 and 00:00)
- **Repeating 4-day sequence** designed to avoid depth samples being taken at same time of day
- **Automated via Python script** run on connected RaspberryPi



Shetland suspends mussel harvesting after food poisoning

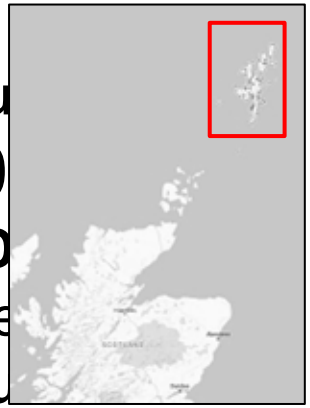
70 people report symptoms consistent with having consumed shellfish toxins, some in restaurants owned by Belgo chain

James Meikle
The Guardian, Thursday 25 July 2013 18.42 BST

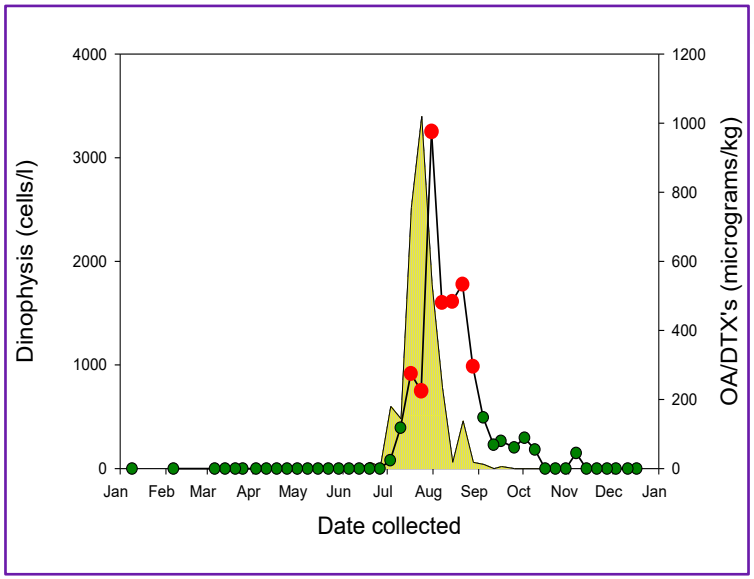
Shetland Mussels says all the mussels from the affected batch have either been eaten or disposed off. Photograph: Jerry Lampen/EPA

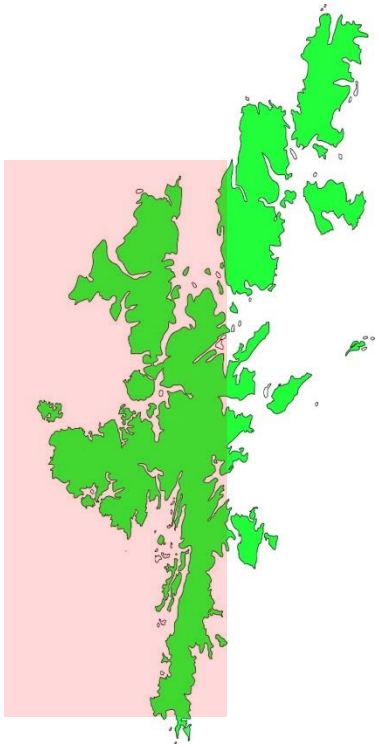
The mussels industry in Shetland has suspended all commercial harvesting after food poisoning incidents linked to restaurants belonging to the Belgo chain and others in south-east England.

About 70 people have reported symptoms consistent with having consumed shellfish toxins, most between 10 and 12 days ago, the UK Food Standards Agency) said. The company that supplied the shellfish, Shetland Mussels, says all the mussels from the affected batch have either been eaten or disposed off. Other farmers have voluntarily

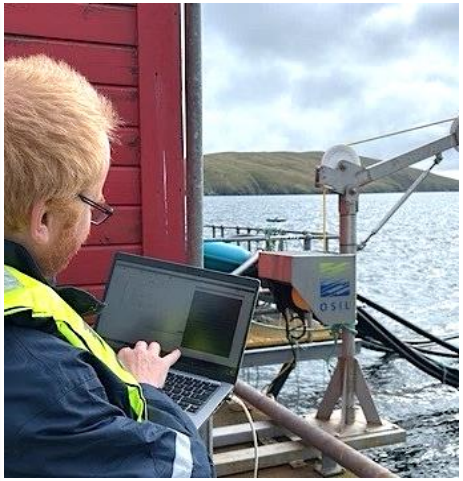


UK has a **robu**
however in **20**
symptoms of **D**
Poisoning afte
chain of **restau**
South East England









(Ocean Scientific International Ltd.)

- SS davit
  - Collapsable arm
  - Slewing
- Winch
  - Programmable
  - Compact: 45 kg, 430 x 465 x 452 mm
  - Holding capacity: 50-100 kg
  - Automatic internal brake
  - 240V (24v DC is an option)
- Overhang mounting position
  - clearance from barge
- Skeleton cage

Holocam integration

weeHoloCam

Since 2021 - most compact and light weight subsea digital holographic camera of its kind:

Dimensions	9 cm dia. 60 cm long
Weight	< 5 kg
Depth rating	**2000 m**
Sensor	**7mm x 8mm**
Particle size range imaged	**25 µm to 5 mm**
Internal memory	1 TB – up to 200,000 holograms in a single dive
Sampling rate	240 ml/s

- FastScan hologram processor integrated with image classifier (1 hologram/s)

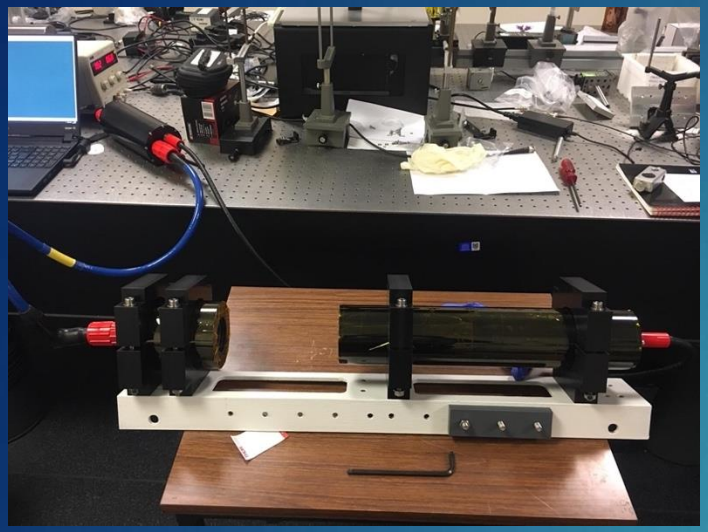
CELEBRATING 100 YEARS School of Engineering

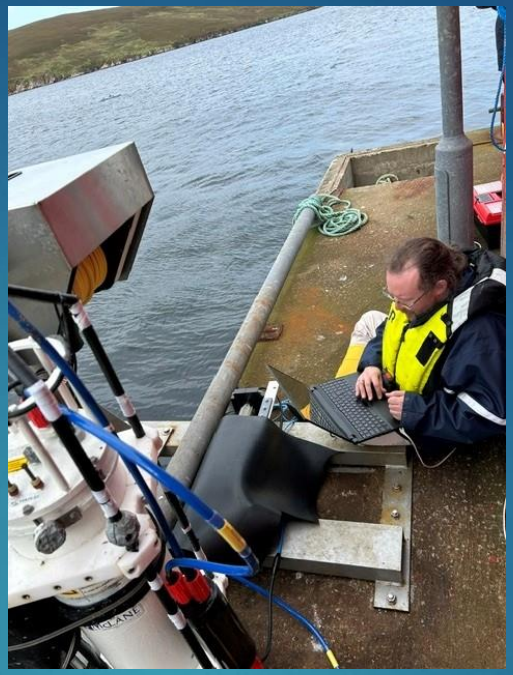
1495 UNIVERSITY OF ABERDEEN

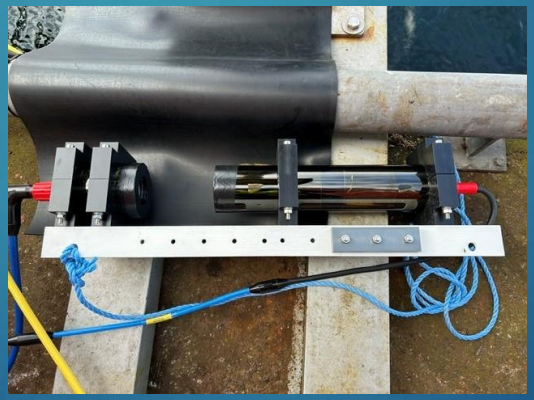
t.thevar@abdn.ac.uk

HI-Z 3D

UHI | SHETLAND SAMS

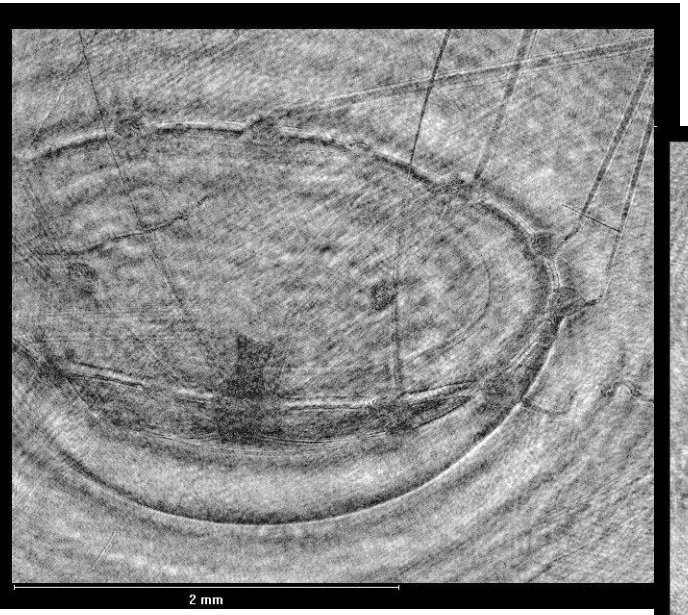






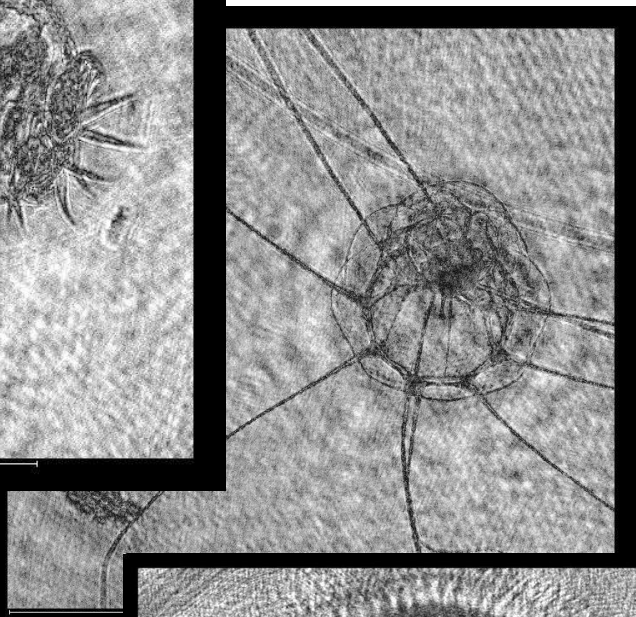
UHI | SHETLAND SAMS


Average Particles / Second: 4.53
Average Particles / Volume: 0.06 P/mL

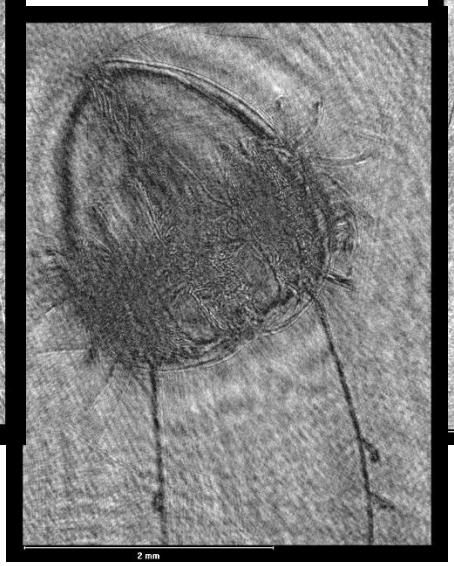

2 mm

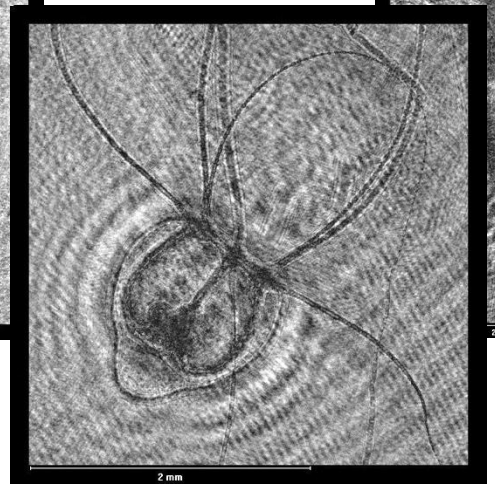

2 mm

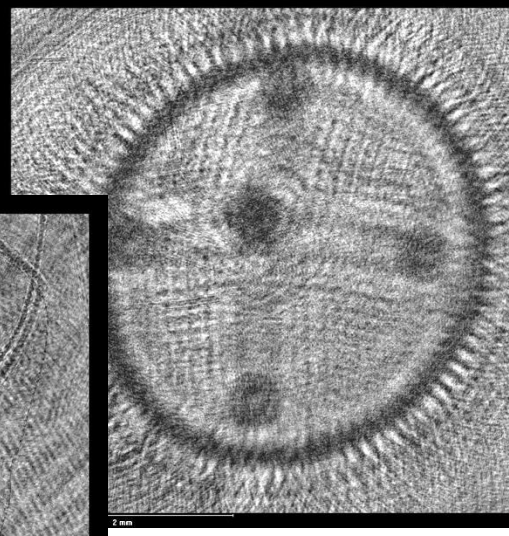

1 mm




1 mm


2 mm


2 mm


2 mm

Dr Tim Szewczyk

Dr Tim Szewczyk

Ensemble models improve near-term forecasts of HAB and biotoxin risk

HAB & biotoxin monitoring

Weather & biogeochemistry

Spatiotemporal patterns

Machine Learning & Bayesian models

- Multilevel Bayesian
- Ridge Regression
- MARS
- Neural Network
- Random Forest
- XGBoost

Ensemble meta-model

Weekly Ensemble Risk Forecasts

Pseudo-nitzschia + DA
Alexandrium + PSTs
Dinophysis + DSTs
Karenia mikimotoi

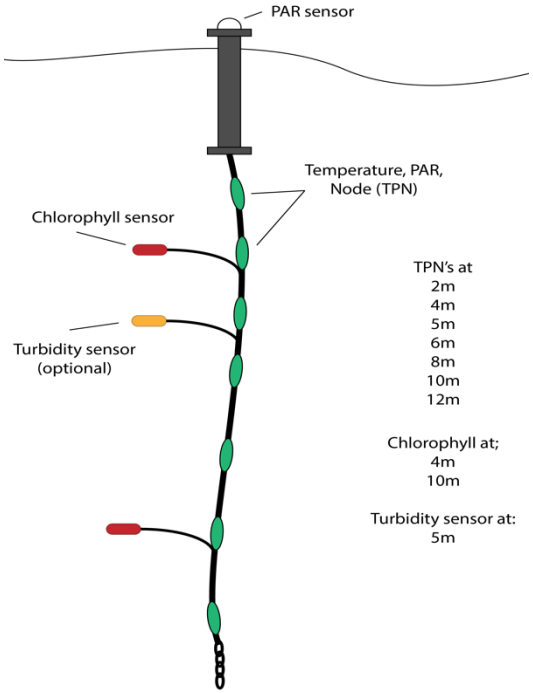
Szewczyk TM, D Aleynik, K Davidson. 2024. Harmful Algae.

Ensemble Risk Forecasts

- Weekly probabilistic forecast of HAB risk at each monitoring site
- Predictions from six independent models (ML, statistical) are used as predictors in an ensemble meta-model
- Ensemble increases performance across a range of metrics

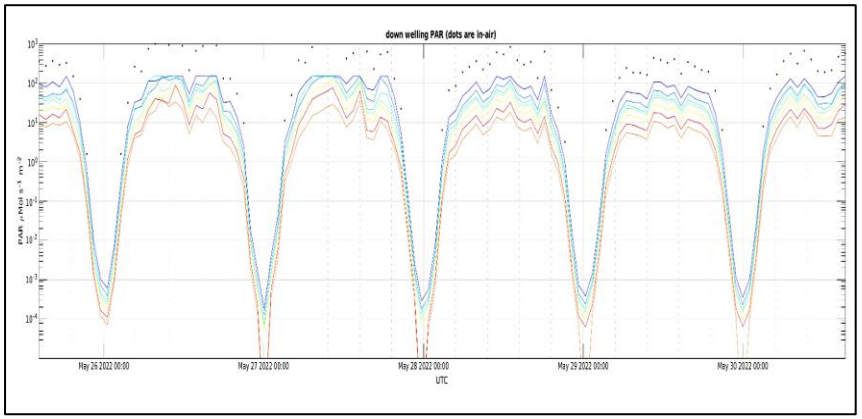
Monitoring target	Threshold (cells/L; µg/kg)
Alexandrium sp.	1
PST (Paralytic Shellfish Toxins)	400
Dinophysis sp.	80
DST (Diarrhetic Shellfish Toxins)	80
Pseudo-nitzschia sp. - *seriata* group - *delicatissima* group	40,000
AST (Amnesic Shellfish Toxins)	0.001
Karenia mikimotoi	0.001

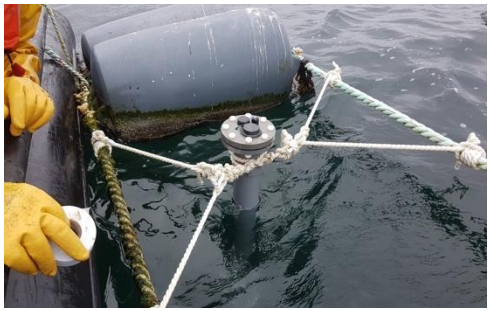
OptiCAL sensor Chain



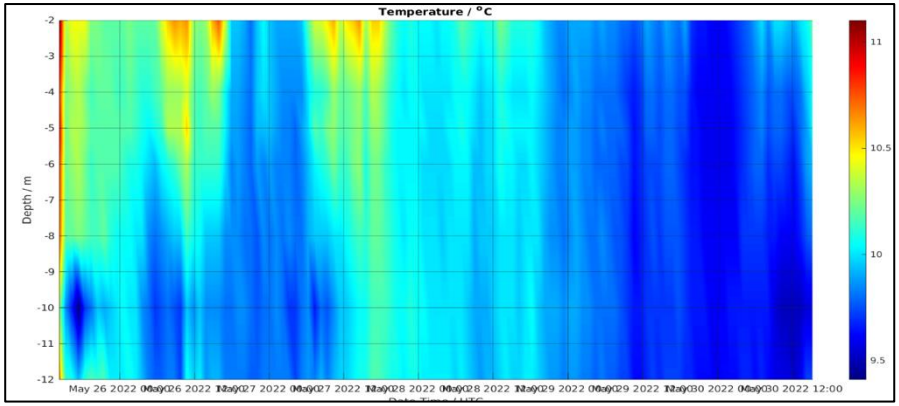
Sensor chain with surface PAR, 7 temperature and PAR nodes at 2, 4, 5, 6, 8, 10 and 12 m, **2 Chlorophyll** sensors at 4 and 10m and a **turbidity sensor at 5m**

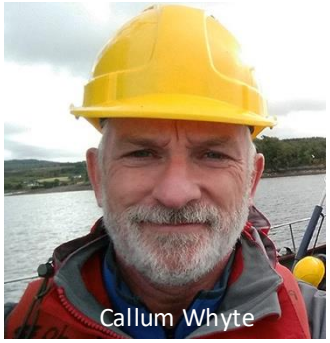
Down welling PAR

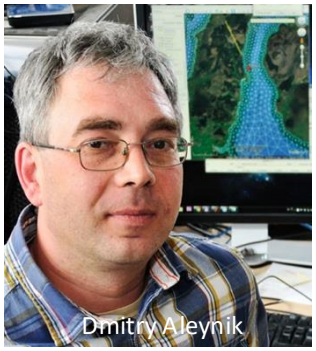




Temperature (C)

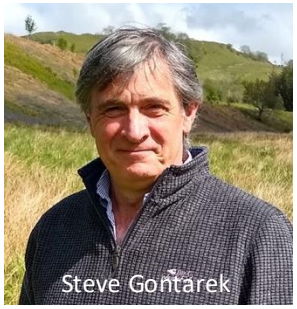



Callum Whyte


Dmitry Aleynik


Gregg Arthur


Gary Groves


Steve Gontarek


Ruth Henderson


Alan MacDonald


Tim Szewczyk


Sarah Swan


Solene Giraudeau-Potel


Fatima Gianella

Scottish HAB Early Warning System (EWS))

Paola Acre, Dimitry Aleynik, Keith Davidson, Steve Gontarek, Sharon McNeill, Euan Patterson, Rachel Saxon, Callum Whyte

Callum.whyte@sams.ac.uk

SAMS Scottish Association for Marine Science | A partner of UHI