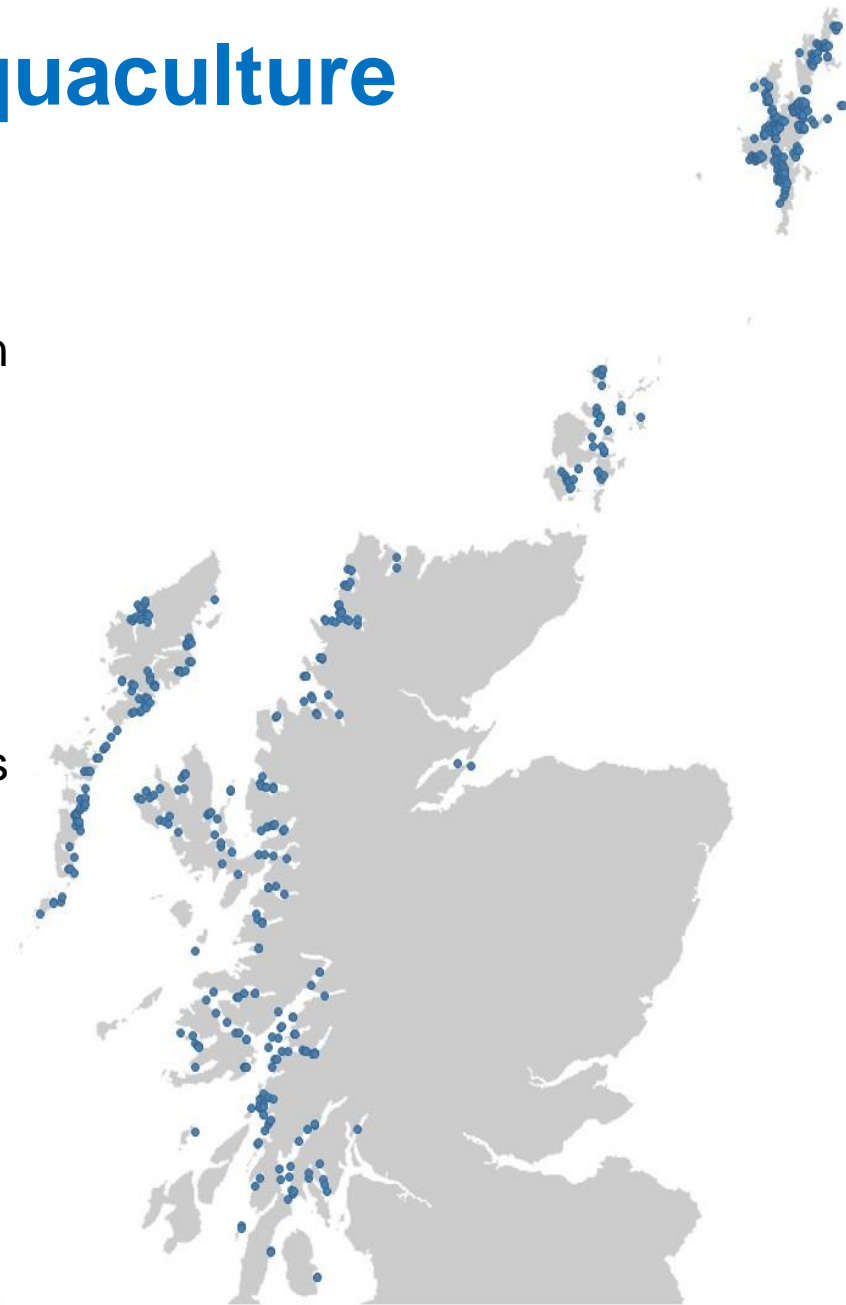


Influencing Aquaculture Expansion in Scottish Waters

Andrew Berkeley, Gunda Wieczorek, Rebecca Seal, Ted
Schlicke and Alan Hills
OceanMet Unit,
Scottish Environment Protection Agency

Scottish aquaculture

- Dominated by Atlantic Salmon
- 463 licenced marine farms
- 235 operational in last 3 years
- 179,755 tonnes produced in 2015



Regulatory challenges

Discharges

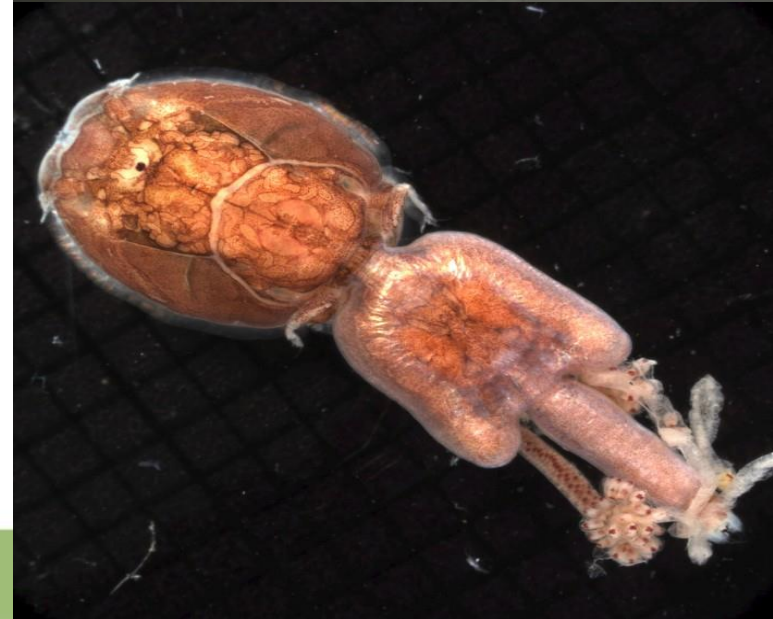
- Organic solids
- In-feed anti-parasitic medicines
- “bath” medicines

Variety of environments

- e.g. sea loch, tidal strait, open
- Impacts vary according to hydrodynamics

Expansion to 210,000 tonnes by 2020 (+20%)

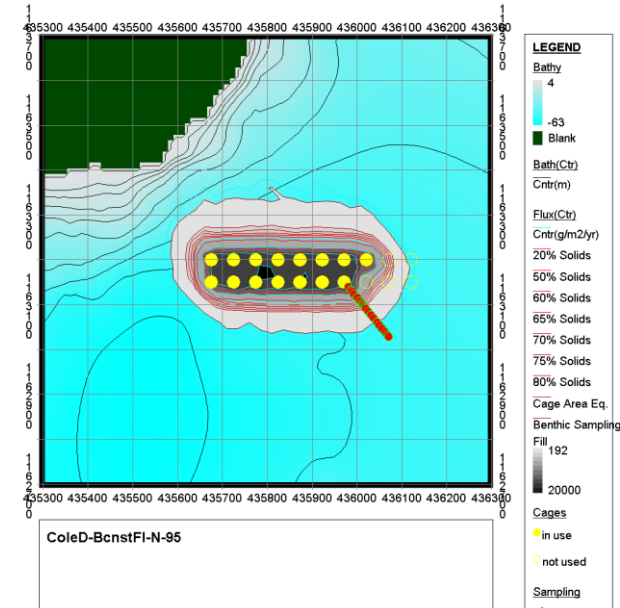
How to accommodate this sustainably?



Regulatory challenges

Simple modelling tools

- Driven by ADCP data so use uniform flow field
- Simple geometries
- Single discharges only



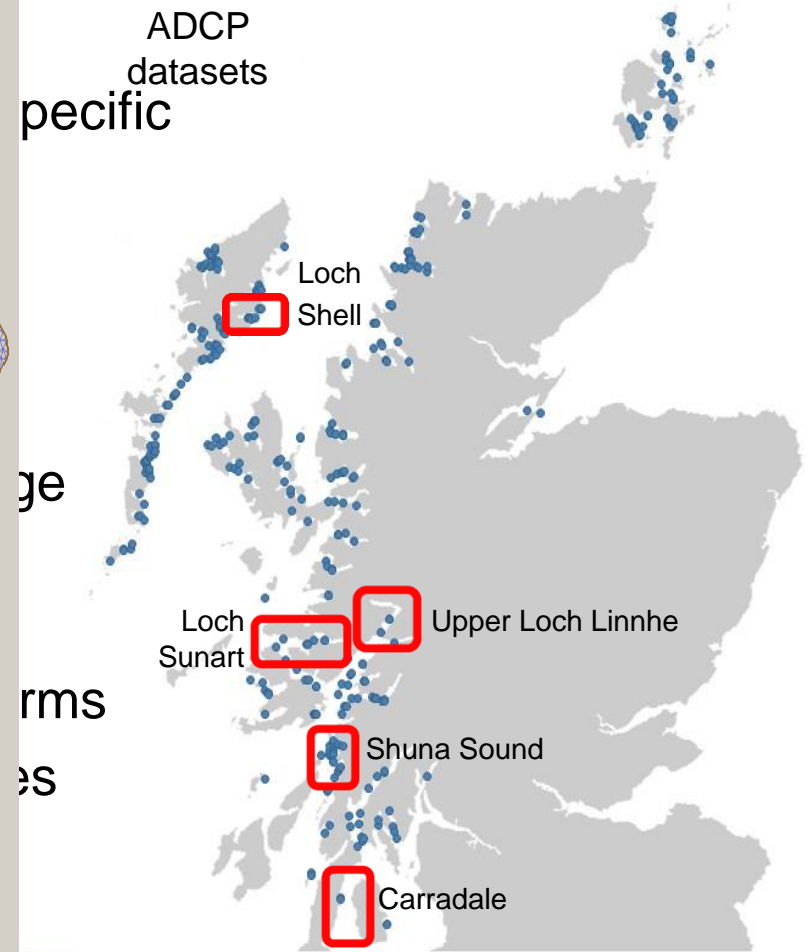
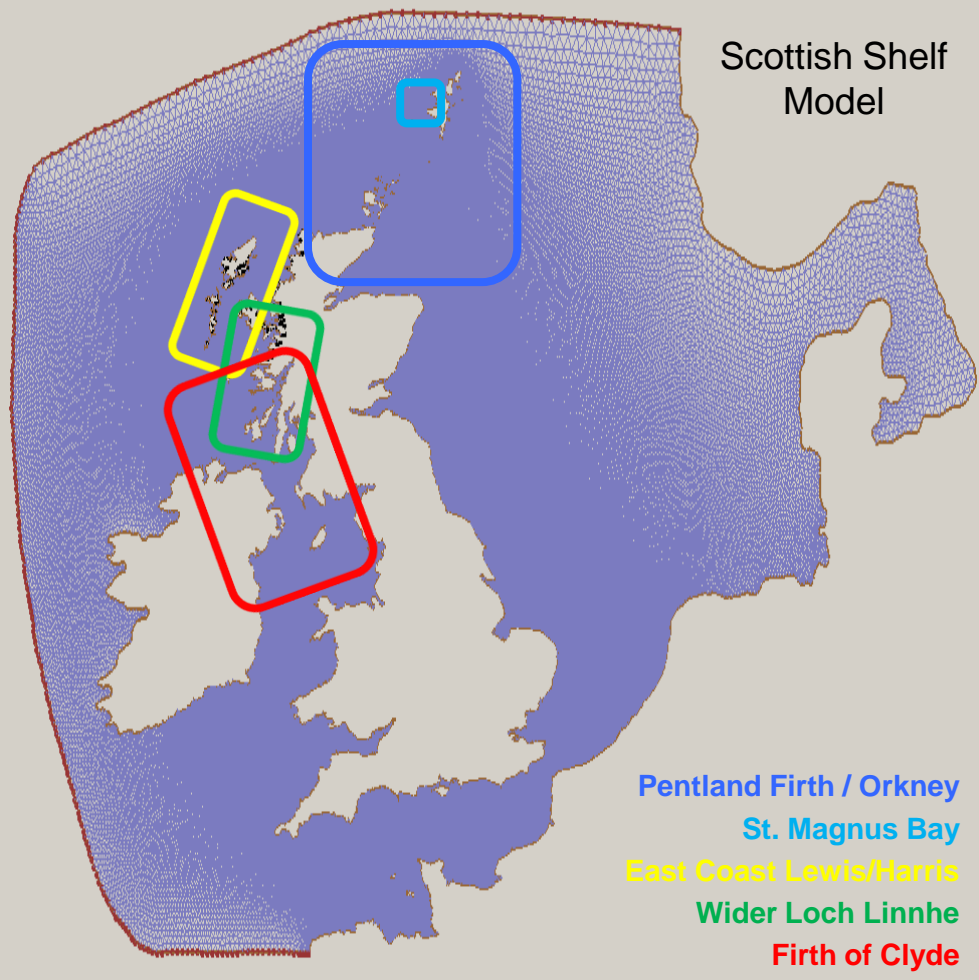
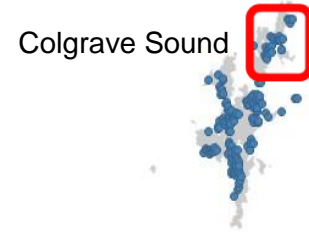
Limitations

- Limited spatial scales
- No farm interactions

17					
18	Cage Data				
19	# of cages :	9			
20	Cage shape :	Round			
21	Diameter/Width (m) :	31.8			
22	Working depth (m) :	10			
23	Stocking density (kg/m ³) :	18.751			
24					
25	Treatment				
26	No. of cages possible to treat in 3 hours :	3.00			
27	Initial Treatment Depth (m) :	1.12			
28	Treatment Depth Reduction Increment (m) :	0.1			
29					
30	Hydrographic data analysis				Excursio
31	Mean current speed (m/s) :	0.072			
32	Residual Parallel Component U (m/s) :	0.005			1.30km
33	Residual Normal Component V (m/s) :	0.007			1.81km
34	Tidal Amplitude Parallel Component U (m/s) :	0.117			1.67km
35	Tidal Amplitude Normal Component V (m/s) :	0.023			0.33km
36					

Model Building...

- Too many farms to model!

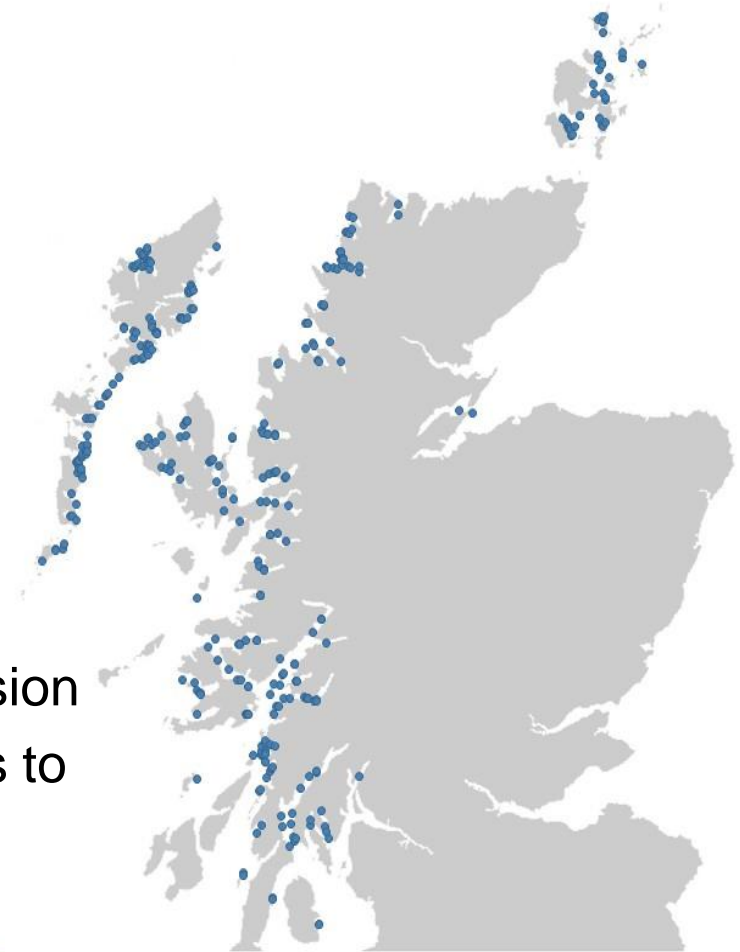


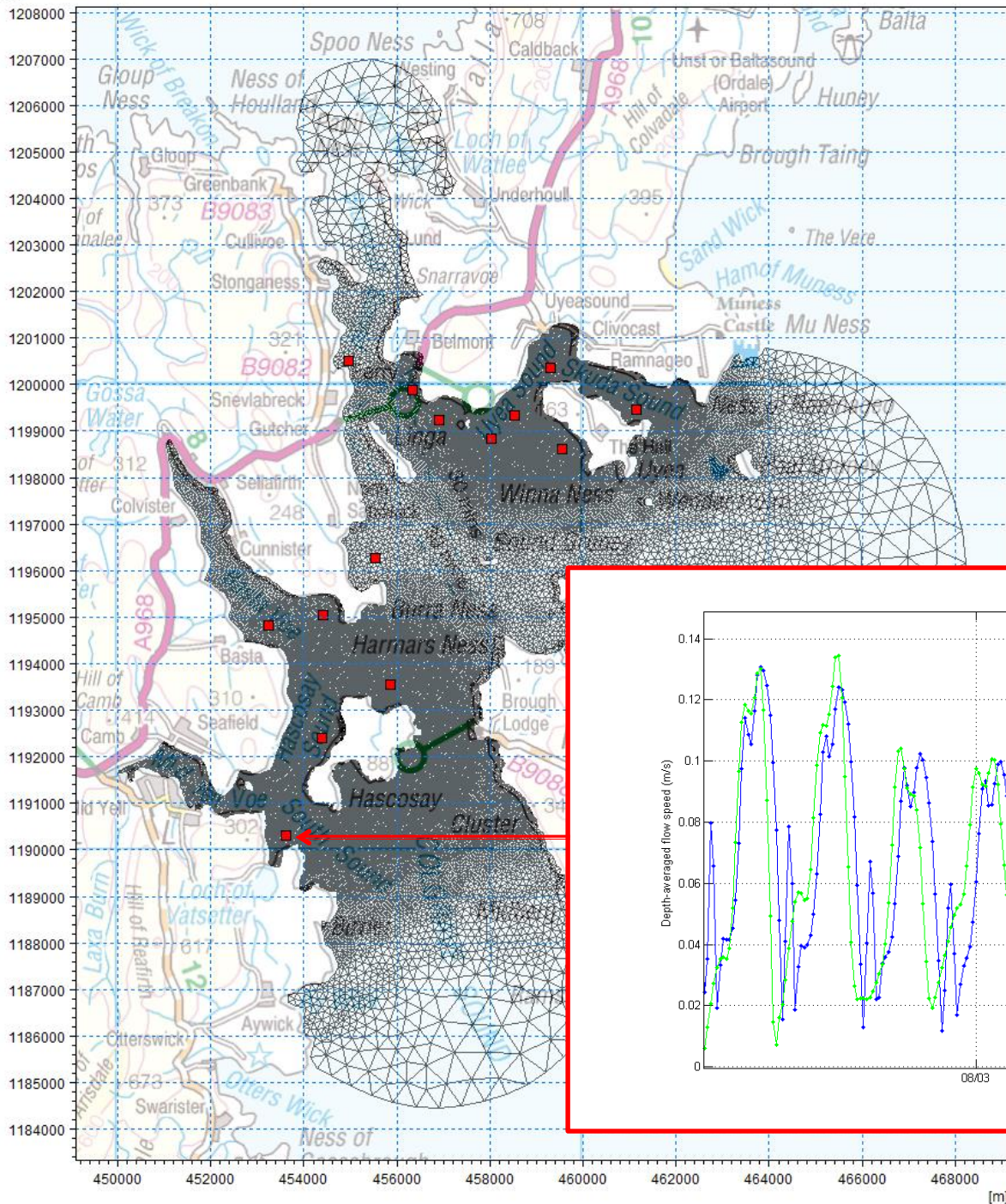


Colgrave Sound Model



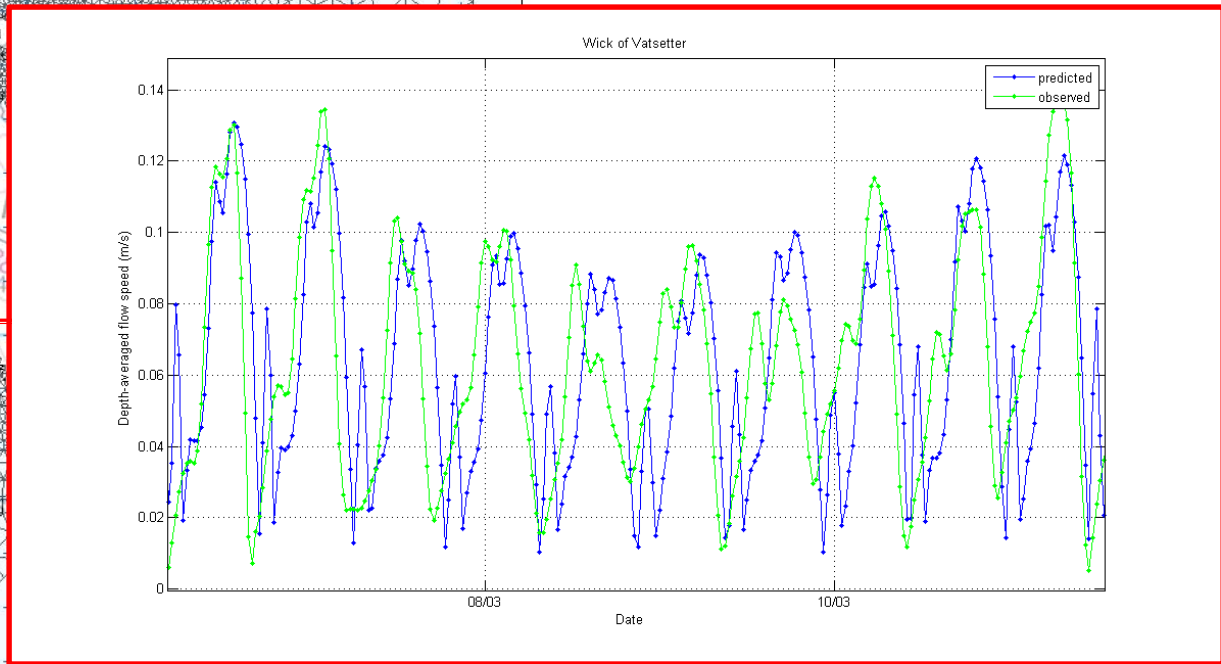
- 15+ licenced farms
- High energy tidal straits
- Low medicine usage
- Potential area for expansion
- Need to understand risks to wider system





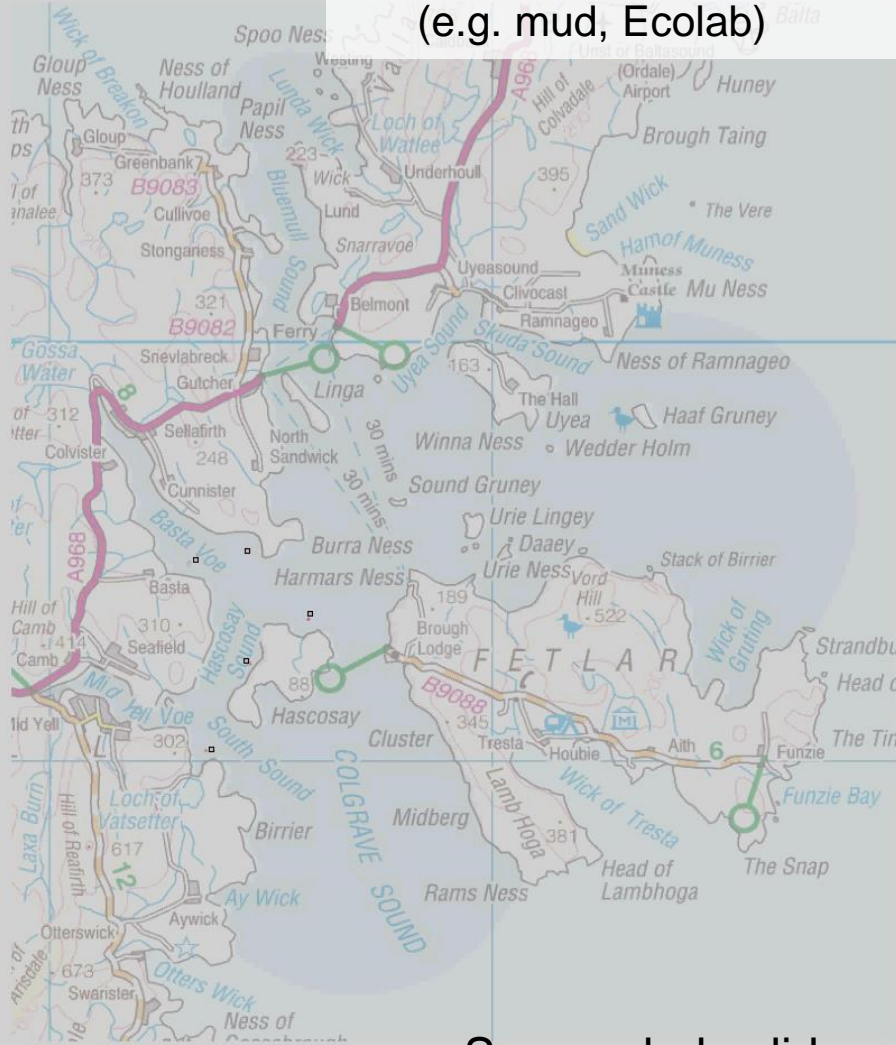
Colgrave Sound

- MIKE21 FM
- 3 open boundaries
- Forced by PFLOW
- Calibrated for flow and water levels
- Solids modelled using Particle Tracking module

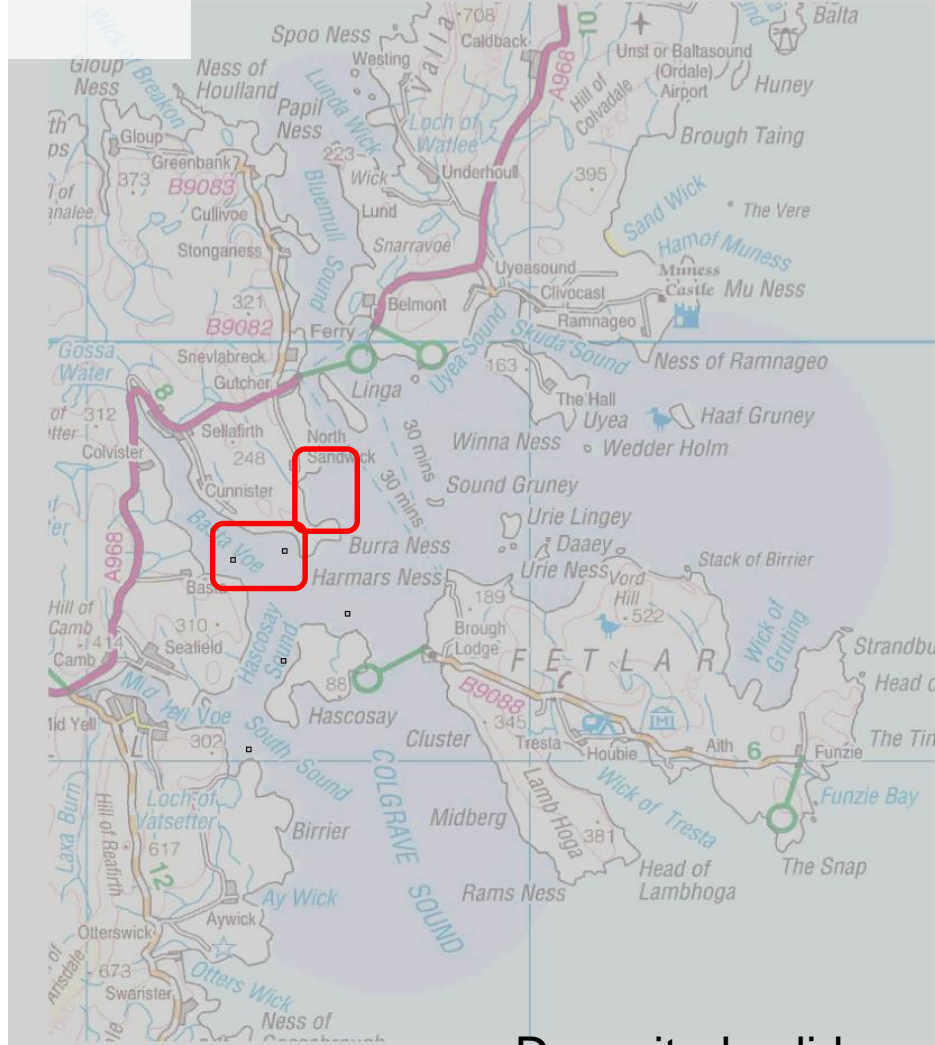


- High degree of interaction
- Seabed impacts generally very low
- Highest risk areas identified
- Need to consider other methods (e.g. mud, Ecolab)

Organic solids, 5 farms



Suspended solids

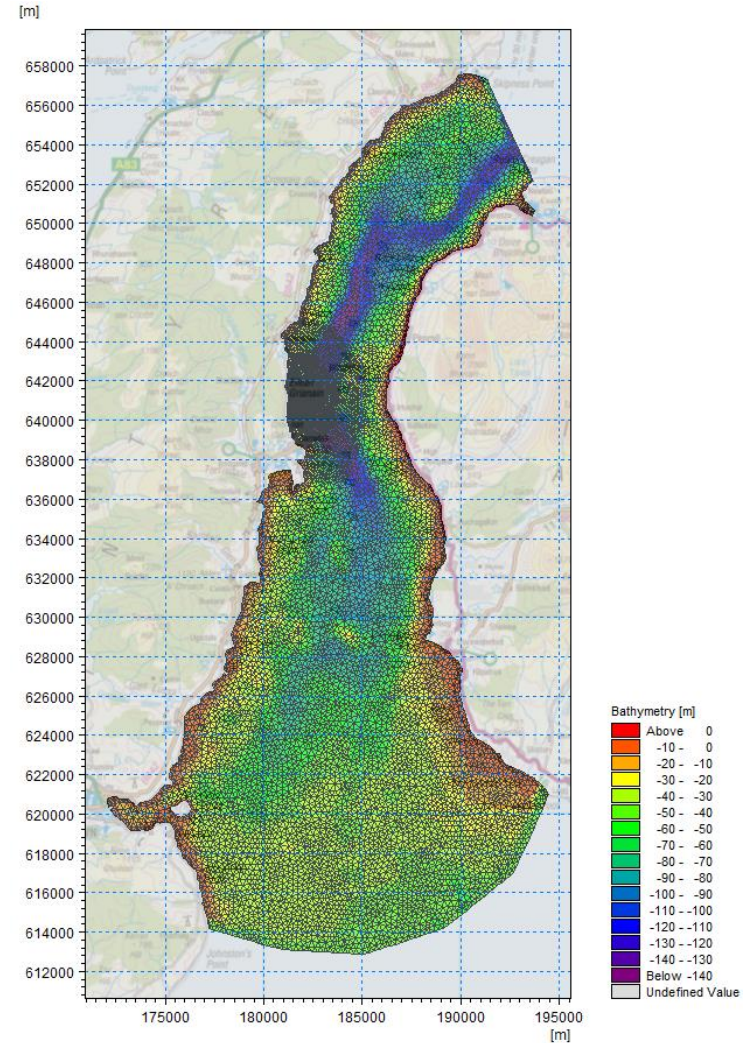
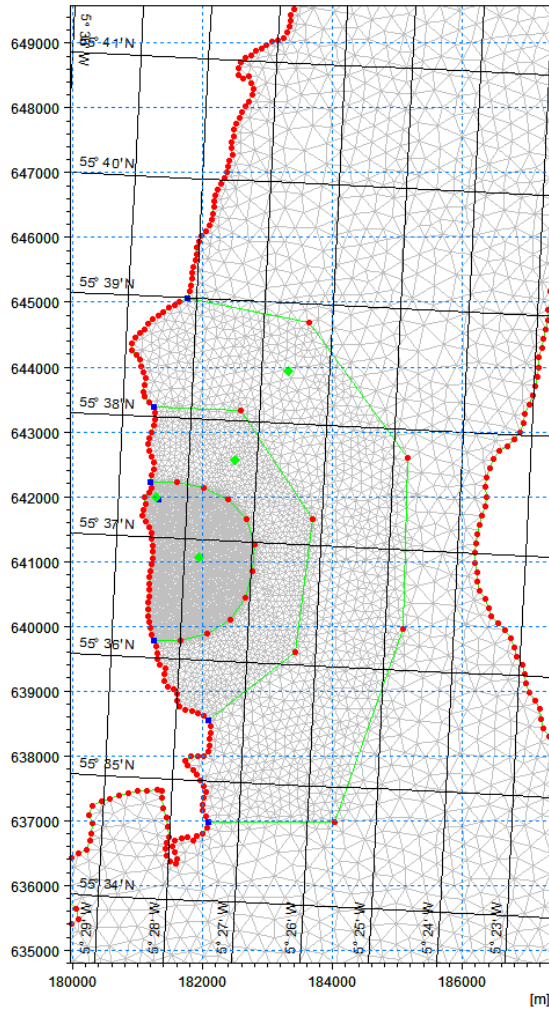


Deposited solids

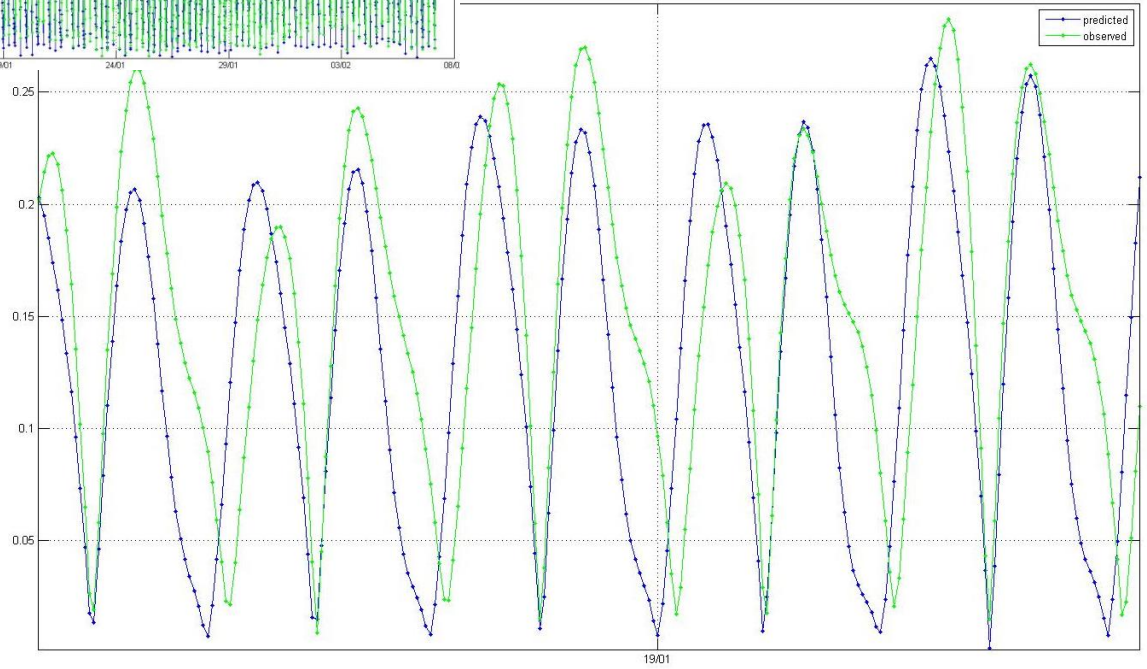
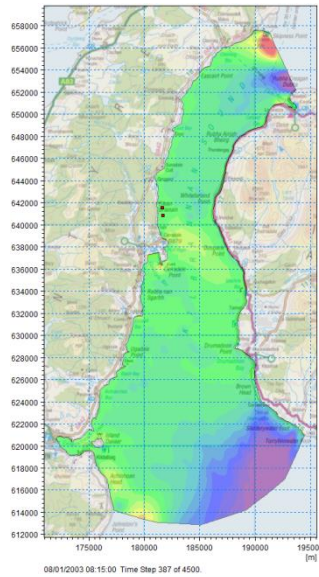
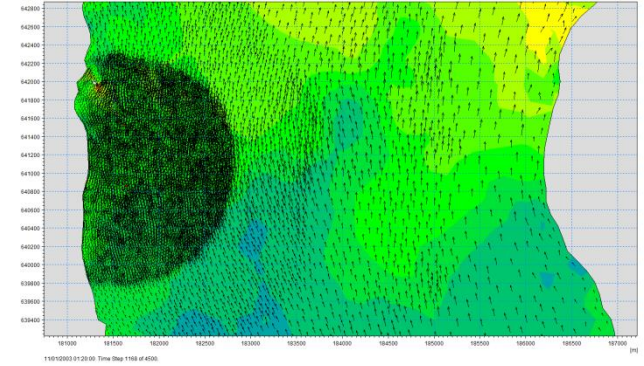
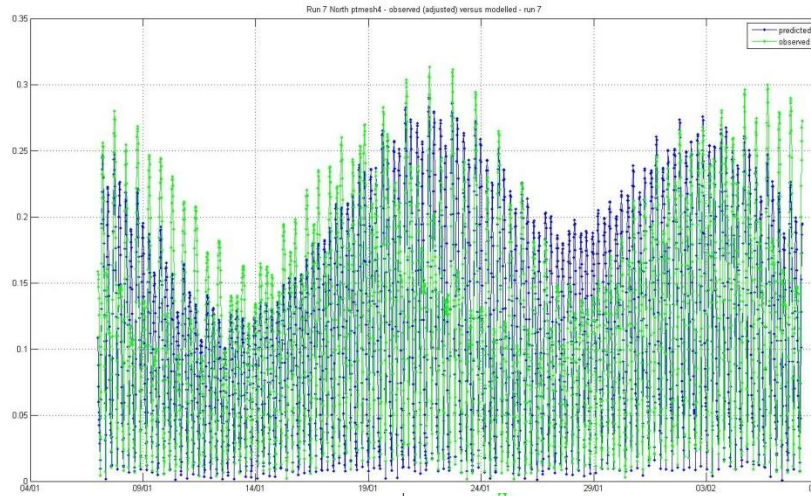
Carradale Model



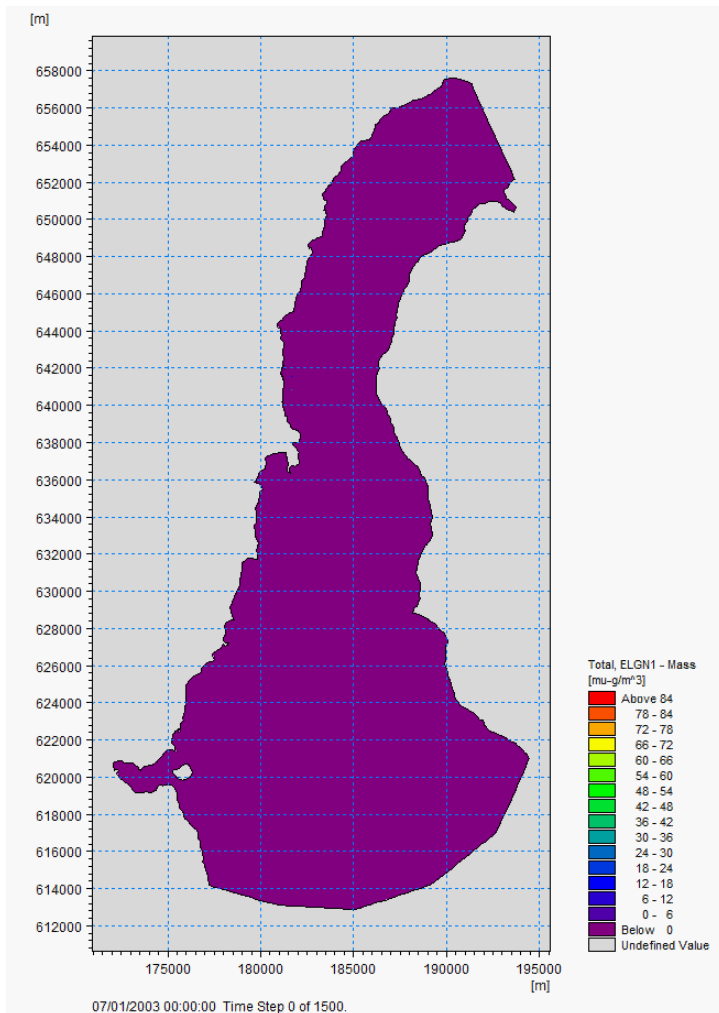
Hydrodynamic Model Setup



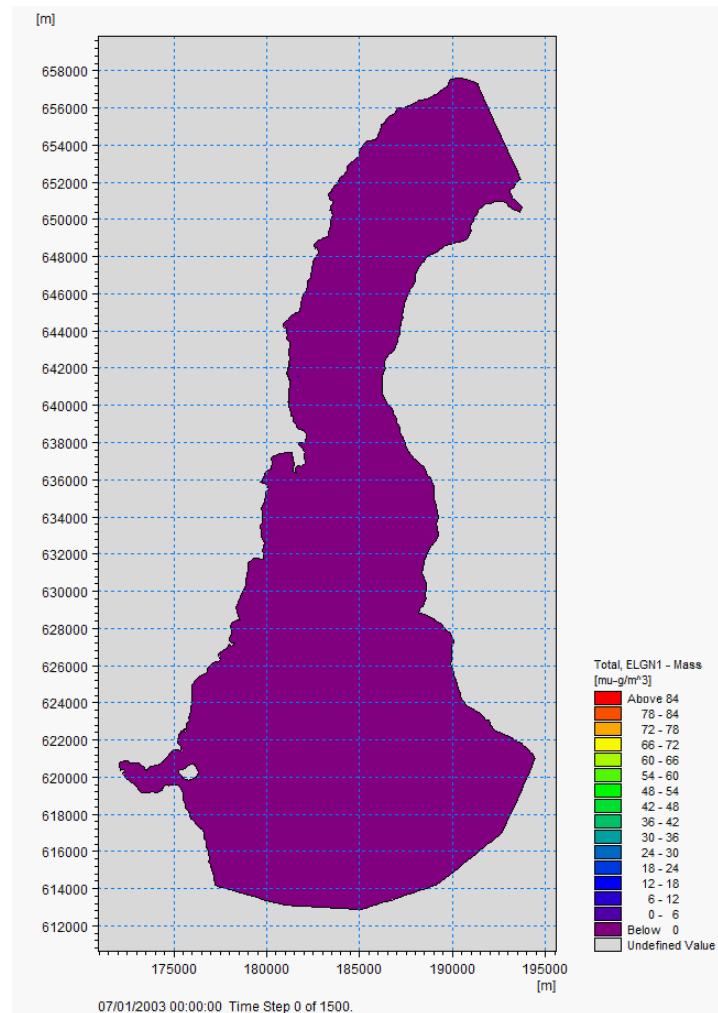
Hydrodynamic Model



Particle Tracking

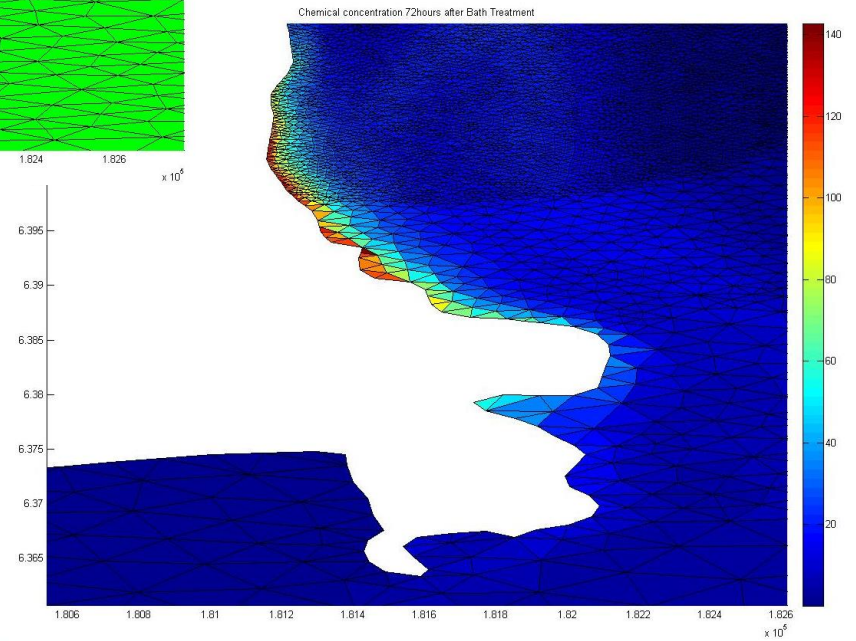
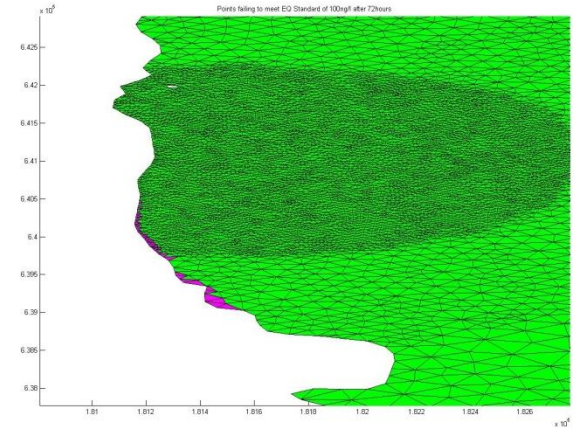
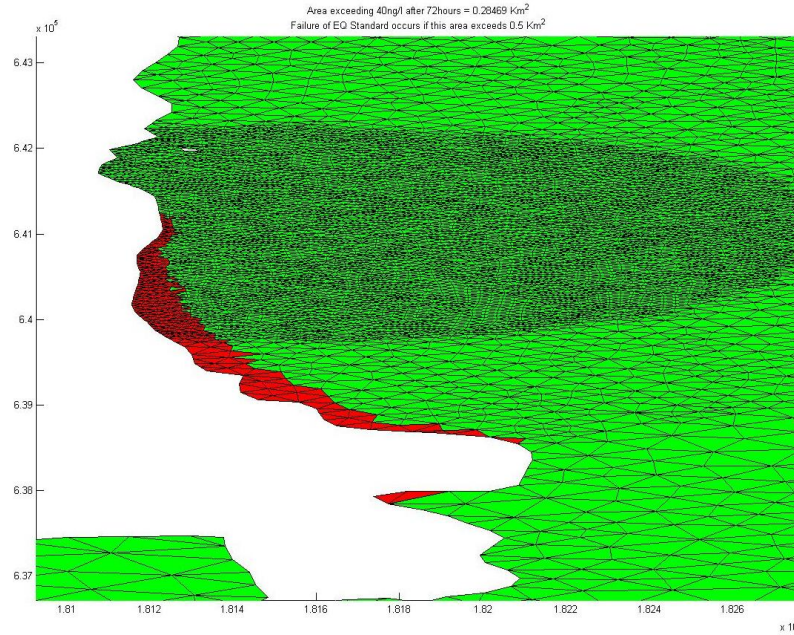


Current Biomass (2500tonnes per farm)

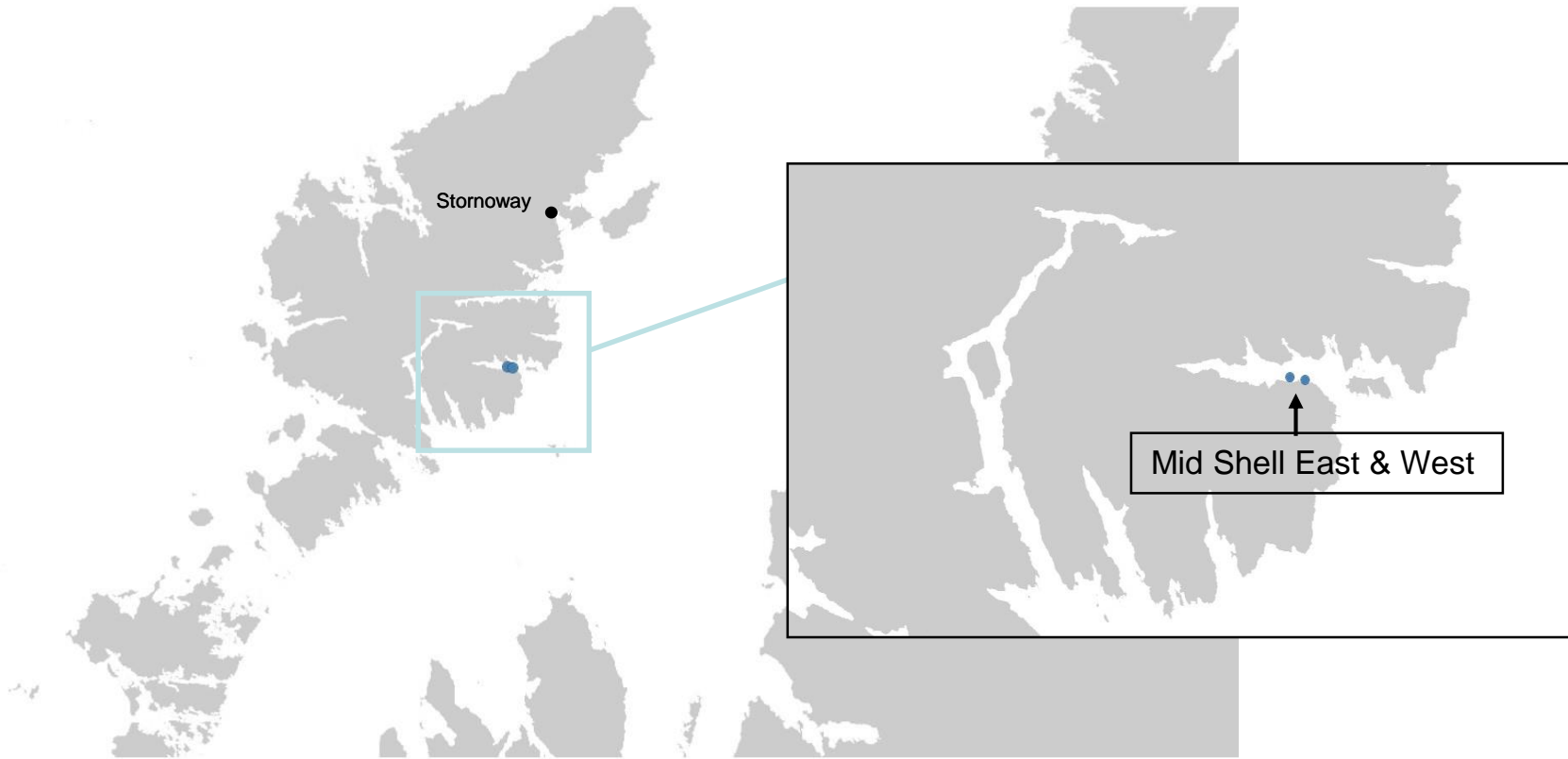


5000tonnes per farm

Particle Tracking

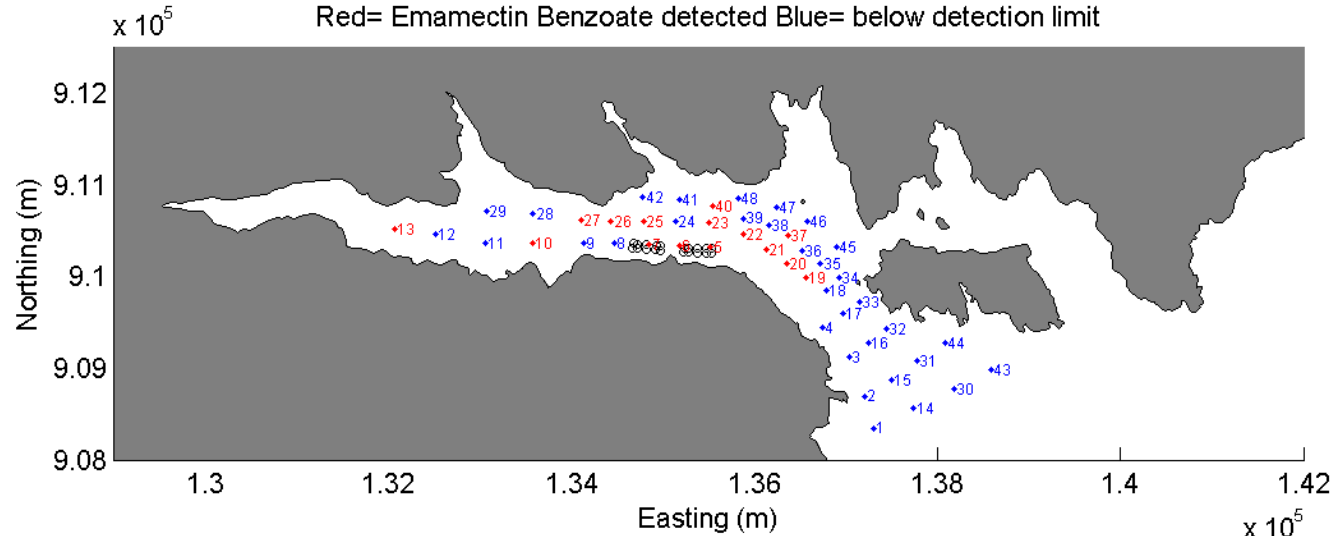


Loch Shell – Isle of Lewis

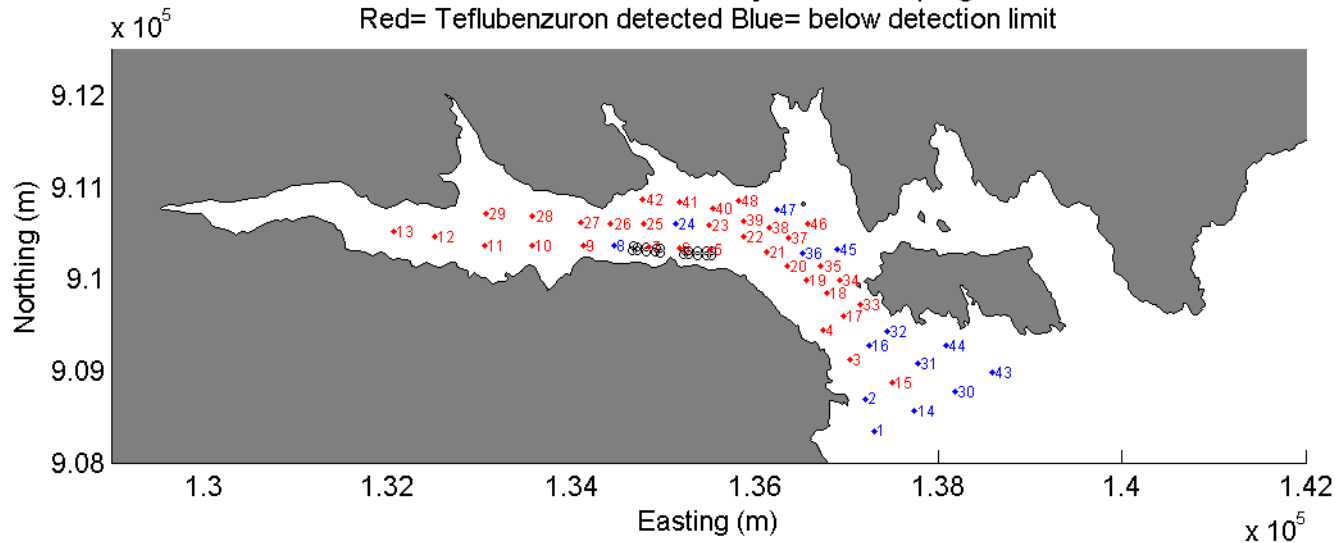


Residue Results

Loch Shell Chemical Residue Survey 2016 - Sampling Locations
Red= Emamectin Benzoate detected Blue= below detection limit

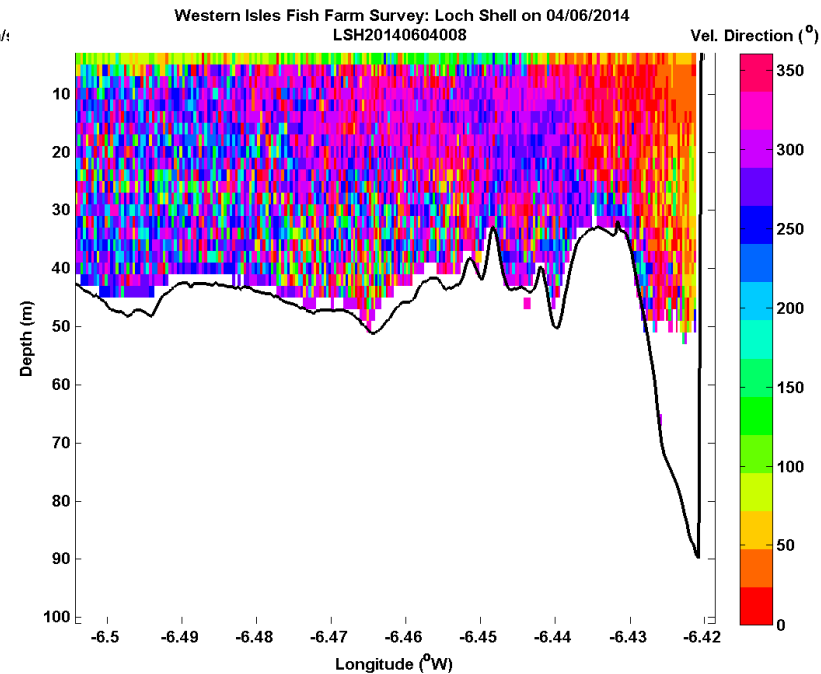
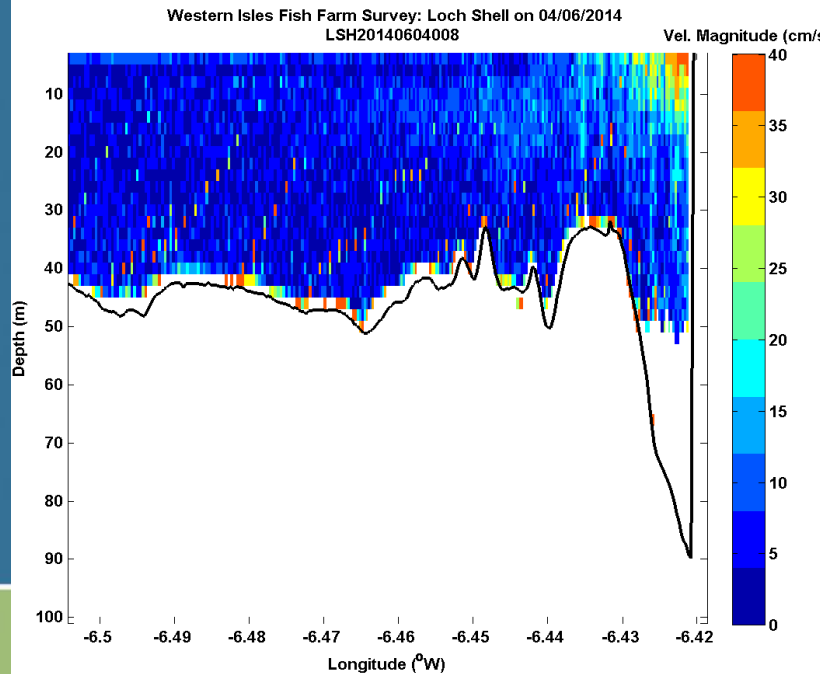
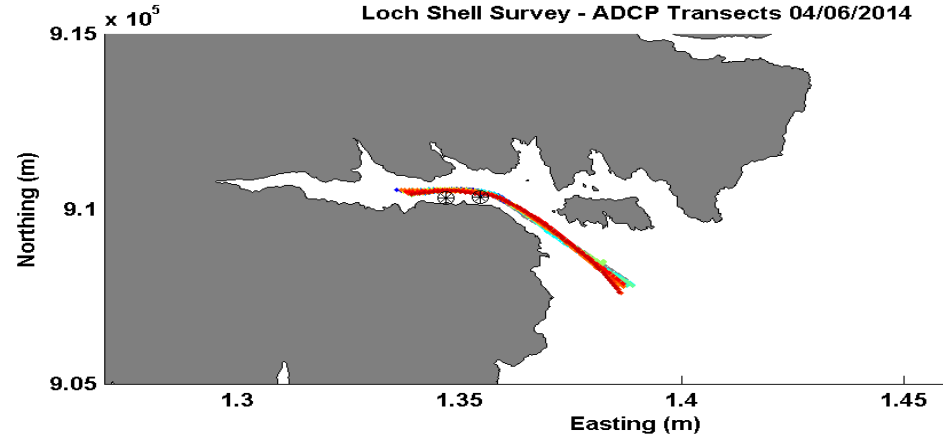


Loch Shell Chemical Residue Survey 2016 - Sampling Locations
Red= Teflubenzuron detected Blue= below detection limit

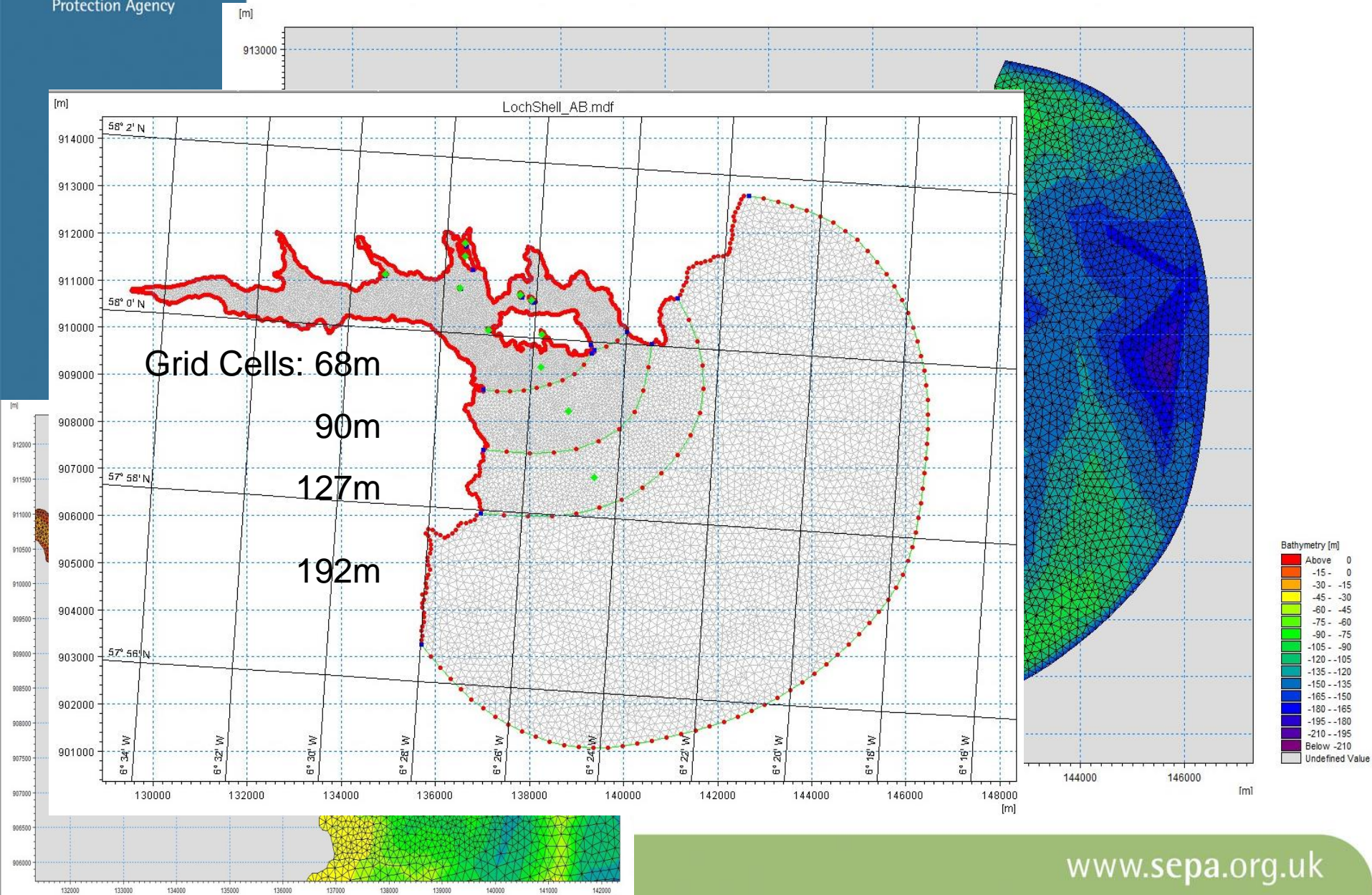


Current Measurements

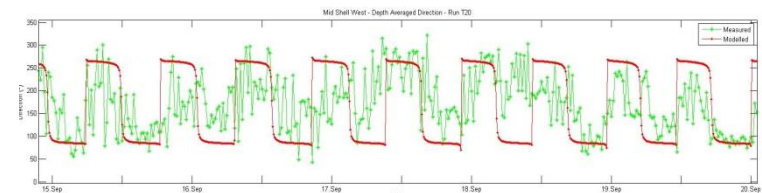
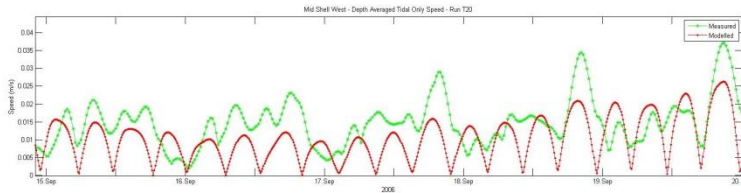
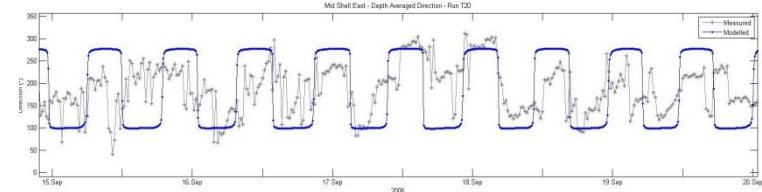
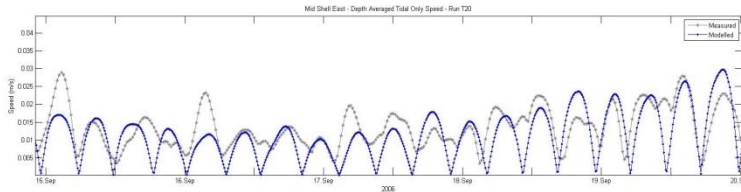
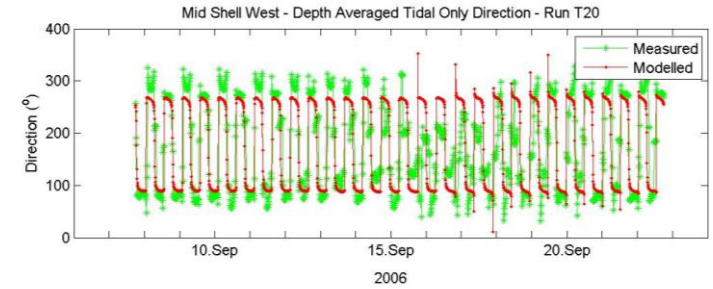
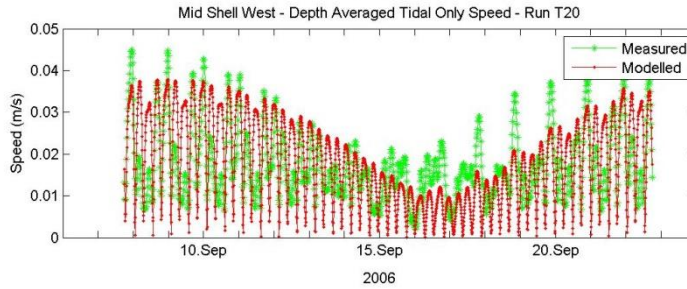
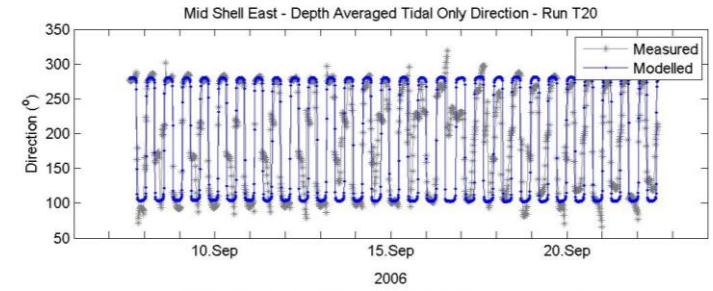
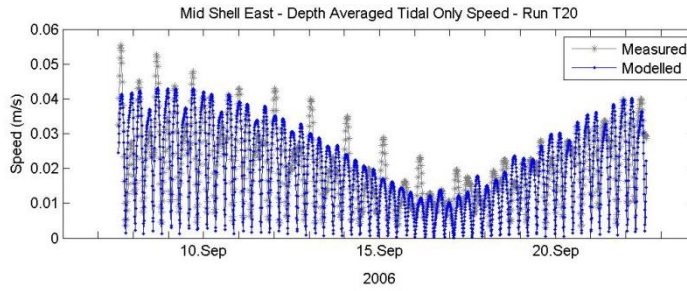
- Investigation of transport mechanism of pollutants in a Sea



Model Grid



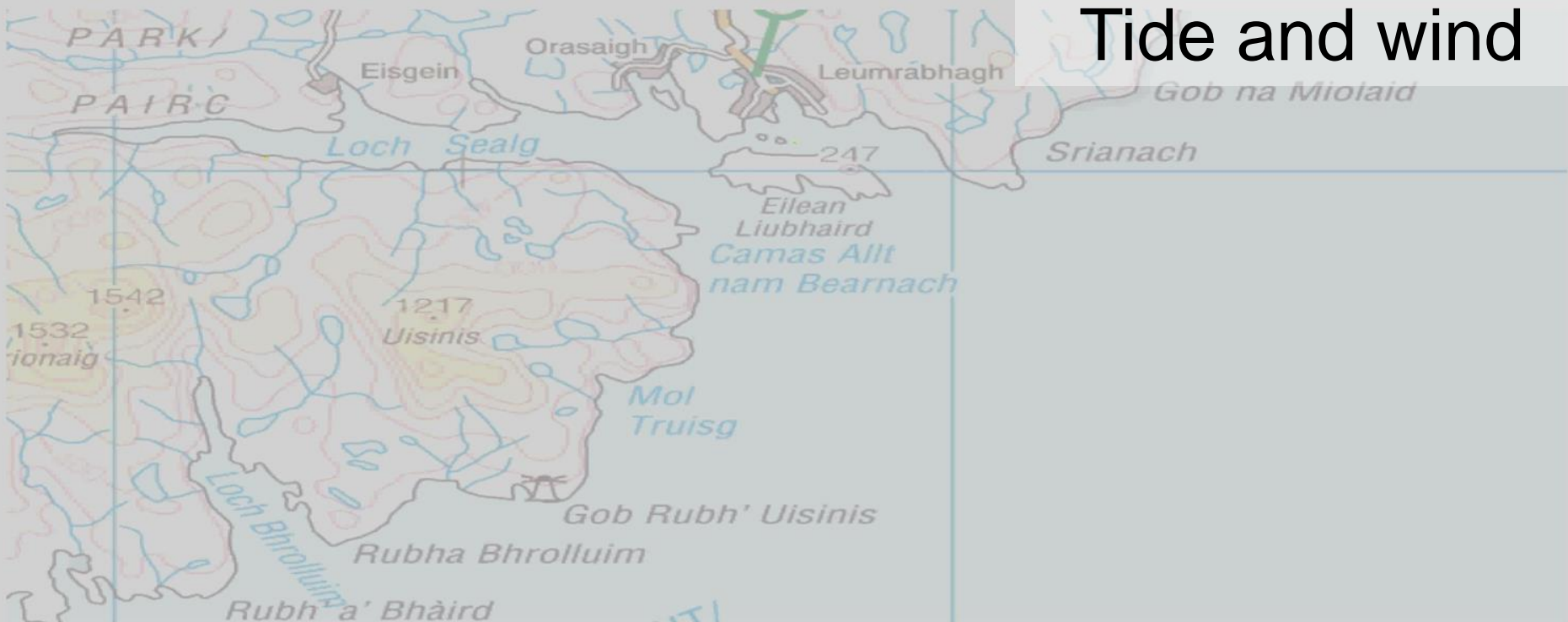
Model Results



Tide only



Tide and wind



Summary

- Numerical Hydrodynamic Modelling is required to address the challenges of a growing aquaculture sector in Scotland
- SEPA are applying MIKE21 FM to a range of locations and policy challenges

Next steps

- Investigate most suitable sediment transport approach
- Calibrate for solute and sediment dispersion
- MIKE 3 FM model development where required (e.g. sea lochs)