R1/6

Not to be cited without reference to the FRS Marine Laboratory, Aberdeen

FRV *Clupea*

Cruise 0606C

REPORT

2-19 May 2006

Loading: Fraserburgh, 02 May
Unloading: Fraserburgh, 19 May
Half Landing: Lochinver, 11 May

Personnel

Matt Gubbins (In charge)
Jennifer Graham
Clare Greathead
Dougal Lichtman

Out-turn days: AE11s 13 days, AE1192 5 days

Equipment

Zodiac inflatable
2 outboard engines
SB 15 Sealogger CTD/Rosette
2 Day grabs, 1 wooden table
2nd freezer for wetlab
80 L unleaded fuel
Zooplankton 'bongo' net
3 x phytoplankton hoses

Objectives

To conduct a 'spring' survey of a suite of sea lochs / voes impacted to varying degrees by nutrient releases from fish farming activity. This survey forms part of an ongoing programme of work to assess the potential for eutrophication arising from nutrient 'hotspots' linked to aquaculture. This will be undertaken by measuring the following parameters at multiple stations in each loch:

1. CTD and dissolved oxygen
2. Nutrients (inc. silicates)
3. Chlorophyll a
4. Phytoplankton
5. Shoreline macroalgae
6. Organic carbon in sediments
7. Algal toxins in wild shoreline mussels, phytoplankton and water

These determinands will be assessed against criteria as defined by the OSPAR Eutrophication Task Group and used for future eutrophication assessment of Scottish coastal waters. Data will also be compared to that collected during previous cruises and will be used to inform estimates of internal mixing within sea lochs / voes to improve laboratory models to predict nutrient enhancement from aquaculture.

In addition zooplankton will be sampled by bongo net from 1 hydrostation in each loch and fixed in ethanol and formalin.

Sediment samples from close to fish farms will also be taken to determine the levels of copper and persistant organic pollutants.

Narrative

Scientific staff boarded the vessel at 1300 on 2 May, but departure from Fraserburgh was delayed until 1000 on 3 May due to a poor forecast. *Clupea* made passage for the West coast, anchoring for a few hours overnight in Loch Eriboll on the night of 3 May. Scientific work commenced in Loch Clash on the morning of 4 May with a single sediment grab sample for passive sampler experiments. A CTD cast was then conducted off Badcall Bay and *Clupea* then steamed to Loch Glendhu, past Kylesku bridge to sample another single sediment grab for passive sampler use. *Clupea* then steamed to Little Loch Broom where hydrostations across the inner sill were surveyed by CTD/rosette during the ebb tide. *Clupea* anchored overnight outside Little Loch Broom and recommenced survey work in the loch on 5 May. The remaining hydrostations, including 4 stations across the outer sill, were surveyed by CTD and phytoplankton samples were taken.

Clupea then steamed to Loch Ewe and completed survey work with CTD casts and phytoplankton samples throughout the loch. Five Day grab samples were also taken close to the Isle of Ewe fish farm to provide material along a suspected contamination gradient for organics, metals and passive sampler analysis. A sediment sample was also taken from the long term phytoplankton monitoring site in the loch for analysis for resting phytoplankton cysts. Following the completion of survey work, *Clupea* steamed to Loch Torridon and anchored overnight at the head of the upper loch.

Survey work in loch Torridon consisted of CTD casts in the upper loch and across the sill into the upper loch during the flood tide. Stations in the outer loch and 2 stations outside the loch were also sampled by CTD/rosette. A single grab sample was taken for phytoplankton resting cyst identification from the upper loch. *Clupea* then steamed towards Loch Duich, pausing to sample using the CTD/rosette at a station off Loch Kishorn. A survey over the sill in Loch Duich was conducted during peak flood tide using the CTD and further hydrostations within and outside the loch were sampled by CTD. After the completion of survey work in Loch Duich, Clupea moored alongside the pier at Kyle of Lochalsh overnight.

On 7 May, single grab samples were taken by Day grab from Loch Nevis and Loch Hourn (for passive sampler work) and a survey by CTD across the sill during flood tide was completed in Loch Nevis. It was then decided to omit surveys of Lochs Skiport and Portree from the cruise in order to keep on schedule. *Clupea* therefore steamed to North Skye, stopping outside Loch Portree to conduct a single CTD cast, before anchoring overnight in Uig Bay.

Lochs Greshornish and Snizort on Skye were surveyed on 8 May. The inflatable was launched in Loch Greshornish to take water and sediment samples (by hand held Van Veen grab) along a transect away from the fish farm in the loch and shoreline macroalgal samples were sampled for nitrogen isotope ratio analysis. Day grab sediment samples close to the fish farm were also sampled from *Clupea* to provide larger volume samples for passive sampler experiments. Hydrostations throughout the loch were also sampled by CTD and phytoplankton hose, including a series of stations across the sill during flood tide. Loch Snizort was then surveyed by CTD/rosette and phytoplankton hose, prior to anchoring overnight in Uig Bay.

Clupea steamed to the Western Isles on 9 May and commenced survey work in Loch Seaforth with CTD casts at hydrostations throughout the loch. In order to sample the station at the head of the loch, the inflatable was launched and water samples taken using reverser bottle and phytoplankton hose. A single grab sample was taken from the loch for phytoplankton cyst identification. After steaming North to Loch Shell, further hydrostations throughout the loch were sampled using the CTD/rosette. Phytoplankton and zooplankton samples were also taken at selected hydrostations and the Day grab was used to take 5 sediment samples at different distances from a fish farm on the South shore of the loch. After anchoring overnight, the inflatable was launched to take a sediment sample closer to the fish farm than was possible from *Clupea* the previous day and take a sample of mussels for algal toxin analysis. Two final hydrostations were sampled by CTD/rosette in Loch Shell before steaming North to Loch Erisort/Leurbost.

Survey work in loch Erisort/Leurbost was completed on 10 May with CTD/Rosette sampling at stations throughout both lochs and phytoplankton/zooplankton sampling at selected sites. The inflatable was launched to provide a sample of shoreline mussels for algal toxin analysis and a single day grab sample was taken to provide a sediment sample for phytoplankton cyst identification. After sampling outside Loch Grimshader with the CTD/rosette, *Clupea* steamed to Lochinver for a half landing.

On 11 May, samples were unloaded from the laboratory freezers and sent back to MLA for storage and analysis. The rest of 11 May was spent at rest. At 0400 on 12 May, passage was made for Shetland, arriving at 2300 in Scalloway where the night was spent alongside the pier.

CTD/rosette and plankton samples were taken from Scalloway harbour (a long term phytoplankton monitoring site) whilst moored alongside the pier. Survey work was then commenced in Stromness Voe using the inflatable, launched from *Clupea* whilst at anchor in Whiteness Voe. The inflatable was also used to sample a transect away from the Stromness fish farm and collect macroalgae from established stations on the shoreline for nitrogen isotope ratio determination.

A survey of stations across the sill was conducted in Sandsound Voe during peak flood tide and additional stations were sampled from further inside and outside the loch by CTD/rosette and plankton hose/net to complete survey work in Sandsound. A station outside Weisdale Voe was sampled by CTD/Rosette and Clupea then anchored in Weisdale Voe overnight.

Hydrostations in Weisdale Voe were completed on the morning of 14 May and the vessel was moved to Gruting Voe. Gruting Voe was sampled using the CTD/Rosette and plankton samplers and the inflatable was launched to obtain a mussel sample for algal toxin analysis. A single grab sample was taken for phytoplankton cyst identification.

Clupea then steamed to the North of Shetland via Ronas Voe for a single CTD cast outside the Voe, before mooring alongside Sullom Voe pier for the night.

On 15 May, it was decided to survey Balta Sound and Basta Voe prior to the arrival of forecasted Easterly winds. Hydrostations in Balta Sound were sampled first by CTD/Rosette and Clupea then moored to the Balta pier. The inflatable was launched to sample macroalgae and conduct a transect of samples at distances from a fish farm in the outer sound. Two stations in Basta Voe were then sampled for plankton and the inflatable was launched for sampling of macroalgae and to conduct a transect for water samples close to an active fish farm in the Voe. After anchoring overnight in the Voe, hydrostations were surveyed using the CTD/Rosette and a single grab sample was taken for phytoplankton cyst analysis. *Clupea* was then taken to Whalefirth Voe (control loch), where the outer section of the Voe was surveyed by CTD/Rosette from *Clupea*. A submerged obstruction prevented passage further into the Voe, so the inflatable was launched and the remaining hydrostations were sampled by reversing bottle from the inflatable. Macroalgae samples were also taken from the shoreline and a grab sample from the outer Voe was taken to complete the survey in this area.

After steaming to Sullom Voe, most of the hydrostations in this Voe were surveyed by CTD/Rosette and the vessel was anchored overnight in the Voe. On the morning of 17 May the inflatable was launched to sample mussels from the shoreline and two final hydrostations were sampled by CTD/Rosette. A single Day grab sediment sample was also taken before leaving Sullom Voe for Swinister Voe. Five Day grab samples were taken from close to a fish farm at Lunna Ness to provide material for contaminants analysis and passive sampler experiments. A single CTD cast was then taken from outside Swinister Voe and passage made South to Dury Voe.

Dury Voe was surveyed by CTD/Rosette and the inflatable was launched to conduct a transect of samples close to the fish farm. Macroalgae samples were also collected from the shoreline. CTD casts were conducted at hydrostations outside Dales Voe and Laxfirth Voe, completing the survey work for the cruise. *Clupea* then moored in Lerwick for 2 hours prior to departing for Fraserburgh at 2200. *Clupea* returned to Fraserburgh on 18 May and was offloaded on the morning of 19 May.

Results

Sediment samples from Lochs Clash, Glendhu and Hourn were obtained for organic contaminants analysis and laboratory experimentation with passive sampling devices.

CTD casts were also performed in coastal waters offshore from the following lochs, to aid data gathering on seasonal conditions in coastal waters to conrtribute to carrying capacity models for aquaculture (ROAME AE1192): Badcall and Calbha Bays, Loch Kishorn, Portree, Loch Odhairn, Loch Grimshader, Vaila Sound, Ronas Voe, Swinister Voe, Laxfirth Voe and Dales Voe.

Fish farms in Lochs Ewe, Greshornish, Shell and Swinister Voe were also sampled at different distances from the farms by Day grab from *Clupea*. This has provided samples for organic and metal contaminants analysis as well as passive sampler studies to investigate the level of sediment contamination associated with fish farming.

Lochs Little Broom, Torridon, Duich, Nevis, Greshornish and Sandsound Voe were subject to ‘sill surveys’ comprising repeated frequent CTD casts over the sills during peak flood tides to provide density profiles of use in informing mixing estimates to aid carrying capacity model

development (ROAME AE1192). The inner sill in Little Loch Broom and the sill of Loch Duich were surveyed during peak ebb tide since waiting for the flood tide would have delayed the cruise programme.

Routine phytoplankton monitoring stations at Loch Ewe and Scalloway harbour were sampled by CTD and phytoplankton hose to ground truth the spring survey against long term time series at these sites.

19 of the scheduled 21 sea lochs in the cruise programme were surveyed. Surveys of Lochs Portree and Skiport and stations at Loch A'laip and Loch Maddy were not conducted due to lack of time and the need to steam to Shetland and complete survey work in that region. The lochs surveyed and the sampling conducted in each loch is shown in the Table below:

Loch	Hydro-stations	Farm transect	Phyto-samples	Toxic phyto-samples	Zoo-samples	Macroalgae sites	Sediment samples
Little Loch Broom 4-5/05	11	N	6	2	2	0	0
Loch Ewe 5/05	9	N	6	2	2	0	6
Loch Torridon 6/05	12	N	6	2	1	0	1
Loch Duich 6/5	9	N	6	2	1	0	0
Loch Nevis 7/05	9	N	5	1	1	0	1
Loch Greshornish 8/05	11	Y	6	2	2	6	5
Loch Snizort Beg 8/05	9	N	6	2	2	0	0
Loch Seaforth 9/05	10	N	6	2	2	0	1
Loch Shell 9-10/05	10	N	4	2	2	0	6
Erisort/Leurbost 10/05	15	N	6	3	3	0	1
Stromness Voe 13/05	6	Y	4	1	1	5	0
Sandsound Voe 13/05	11	N	6	2	2	0	0
Weisdale Voe 14/05	9	N	4	2	2	0	0
Gruting Voe 14/05	11	N	6	2	2	0	1
Baltasound 15/05	7	Y	4	2	2	6	0

Loch	Hydro-stations	Farm transect	Phyto-samples	Toxic phyto-samples	Zoo-samples	Macroalgae sites	Sediment samples
Basta Voe 15-16/05	9	Y	6	2	2	6	1
Whalefirth Voe 16/05	10	N	6	2	2	6	1
Sullom Voe 16-17/05	11	N	6	2	0	0	1
Dury Voe 17/05	9	Y	6	0	1	6	1

Sediment samples from a variety of the areas surveyed were kept under seawater in the cool and dark for later analysis of phytoplankton cysts by phytoplankton ecology group.

Plankton samples from all lochs were negative for paralytic shellfish toxins. Lochs Little Broom, Ewe, Torridon, Nevis, Greshornish, Snizort, Seaforth, Shell, Erisort and Leurbost yielded plankton samples positive for amnesic shellfish toxins. None of the plankton samples from Shetland were positive for either shellfish toxin group.

Water, phytoplankton, sediment and shellfish samples are awaiting analysis at MLA and will contribute towards an overall assessment of the surveyed areas for OSPAR planned for 2006.

Matt Gubbins
27 July 2006

Seen in draft: A Simpson, OIC *Clupea*