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Status Report 2009/2010

Editors

Todd D. O'Brien, William K. W. Li, and Xosé Anxelu G. Morán

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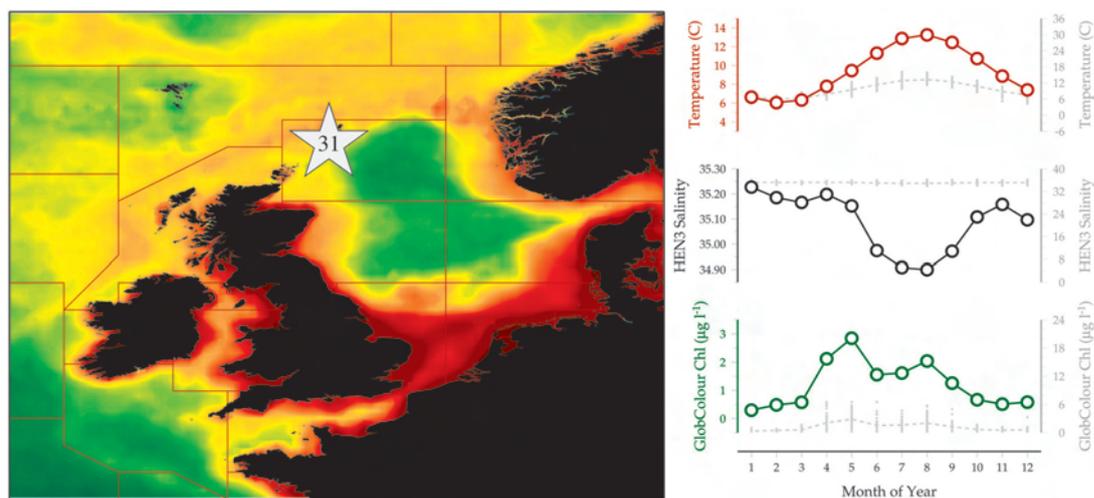
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6.2 Scalloway, Shetland Isles (Site 31)

Eileen Bresnan

Figure 6.2.1
Location of the Scalloway, Shetland Isles plankton monitoring area (Site 31), plotted on a map of average chlorophyll concentration, and its corresponding environmental summary plot (see Section 2.2.1).



Marine Scotland Science (MSS) operates a Coastal Ecosystem Monitoring Programme at a number of sites around the Scottish coast. A variety of physical, chemical, and biological parameters are monitored in order to generate datasets that will allow variability and change in the marine ecosystem to be identified and investigated. Scalloway (60°08.06'N 1°16.95'W) in the Shetland Isles has been participating in this monitoring programme since 2002. Samples are collected by the North Atlantic Fisheries College (<http://www.nafc.ac.uk>), and their input to the success of this programme is gratefully acknowledged.

The Shetland Isles lie over 100 miles north of the UK mainland. Atlantic water from west of the UK enters the North Sea between the Orkney and Shetland Islands and also around northeast of Shetland through the Norwegian trench. Scalloway is located on the southwest coast of the Shetland mainland. The monitoring site is moderately exposed, and samples are collected from a pontoon close to the North Atlantic Fisheries College. The sampling site is less than 10 m deep. Temperature is measured using a minilogger, and surface-water samples are taken for salinity and chemical analysis. An integrated tube sampler is used to collect samples for phytoplankton community analysis. Phytoplankton samples are preserved in Lugol's iodine and analysed using the Utermöhl method (Utermöhl, 1958).

Seasonal and interannual trends (Figure 6.2.2)

Temperature demonstrates a distinct seasonality, with lowest temperatures in March and warmest in August. The lowest temperatures are observed during spring (ca. 6°C) and the warmest temperatures towards late summer. The temperature at this site rarely exceeds 14°C. A strong annual cycle can be seen in the phytoplankton community at this site. During winter, phytoplankton growth is reduced. Diatoms begin to increase in spring, whereas dinoflagellates become more abundant during summer. In contrast to other sites in the programme, the summer dinoflagellate *Ceratium* is rarely observed at this site. Instead, members of the dinoflagellate genera *Gonyaulax* and *Alexandrium* can become abundant. During some years, small thecate dinoflagellates such as *Heterocapsa* can form dense blooms during early summer.

Since 2006, diatom abundance has increased throughout summer. This community has been dominated by *Thalassiosira*, *Chaetoceros*, and *Pseudo-nitzschia*. Increased numbers of dinoflagellates during 2008 and 2009 were the result of the high abundance of thecate dinoflagellates such as *Gonyaulax*, *Heterocapsa*, and *Scrippsiella*. Blooms of *Karenia mikimotoi* have also been recorded in this area, and a bloom in 2003 resulted in significant mortalities of farmed fish. Further information and links to the data collected at this site can be found at the Marine Scotland website <http://www.scotland.gov.uk/Topics/marine/science/MSInteractive/Themes/Coastal>.

Scalloway - Shetland Isles

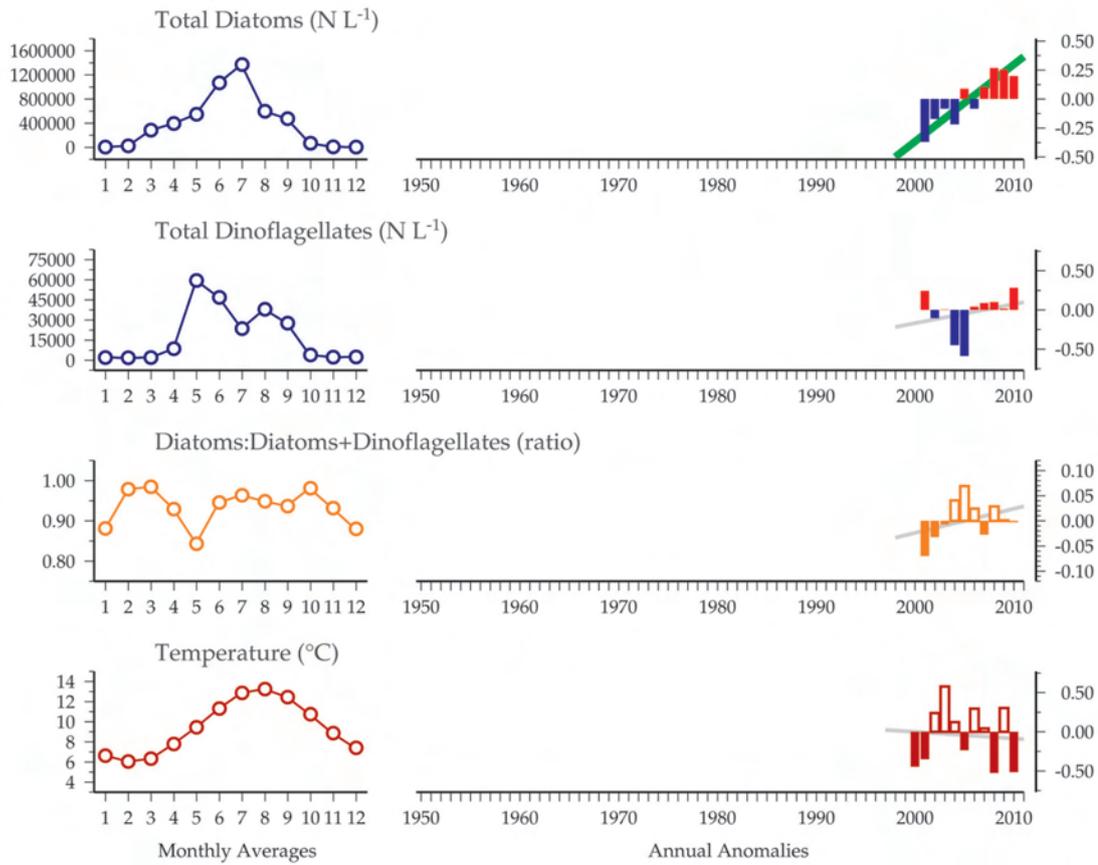
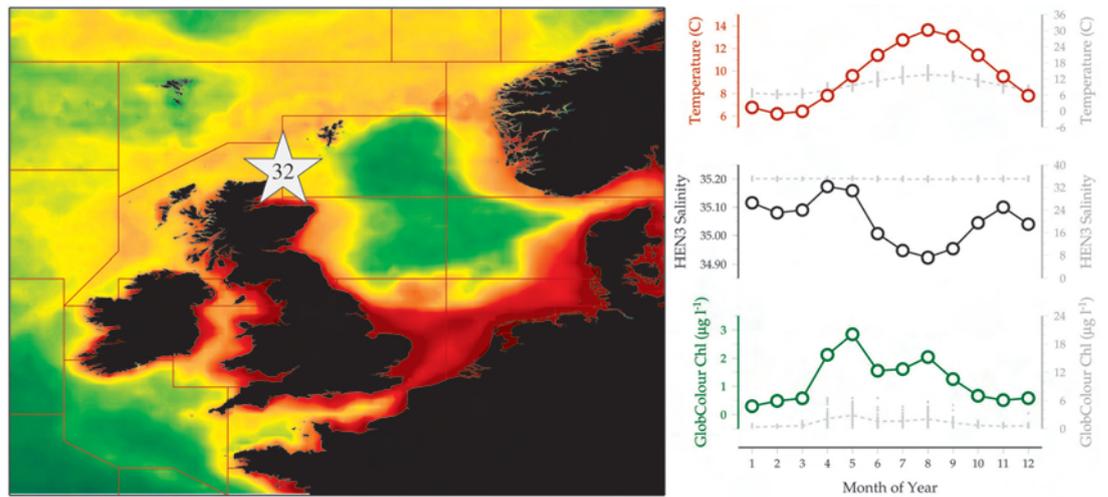


Figure 6.2.2
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of select cosampled variables at the Scalloway, Shetland Isles plankton monitoring site. Additional variables from this site are available online at <http://wgpme.net/time-series>.

6.3 Scapa Bay, Orkney (Site 32)

Eileen Bresnan

Figure 6.3.1
Location of the Scapa Bay, Orkney plankton monitoring area (Site 32), plotted on a map of average chlorophyll concentration, and its corresponding environmental summary plot (see Section 2.2.1).



Scapa Bay in Orkney has been participating in the Marine Scotland Science Coastal Ecosystem Monitoring Programme since 2002. Samples are collected by Orkney Islands Council Marine Services and their input to the success of this programme is gratefully acknowledged.

The Orkney Isles are an archipelago of over 70 islands which lie just over 50 miles north of the Scottish mainland. They are separated from the mainland by the Pentland Firth, a tidally dynamic area where the waters of the Atlantic meet the waters of the North Sea.

The Scapa Bay monitoring site is located at Scapa Pier. Temperature is measured using a minilogger, and surface-water samples are taken for salinity and chemical analysis. A 10 m integrated tube sampler is used to collect samples for phytoplankton community analysis. Phytoplankton samples are preserved in Lugol's iodine and analysed using the Utermöhl method (Utermöhl, 1958).

Seasonal and interannual trends (Figure 6.3.2)

Temperature observes a strong seasonality at this site. The lowest temperatures are observed during spring (ca. 6°C) and the warmest temperatures towards late summer. The water temperature rarely exceeds 14°C at this site. Examination of the phytoplankton data reveals a similar pattern in the seasonality of the phytoplankton community as seen in other sites in the monitoring programme. During winter, phytoplankton growth is reduced. A spring

diatom bloom is succeeded by a summer community dominated by dinoflagellates. An autumn diatom bloom of larger diatoms such as *Rhizosolenia* and *Pseudo-nitzschia* spp. type cells is also observed. An increase in the abundance of the diatom *Skeletonema* has been observed since 2005. Since 2006, diatoms have become more abundant throughout summer, increasing the diatoms:diatoms+dinoflagellates ratio at this site. This summer diatom community consists of centric diatoms such as *Thalassiosira* and *Chaetoceros*.

A decrease in the abundance of the dinoflagellate *Ceratium* has been observed until 2009, and more recently, blooms of *Prorocentrum cf. minimum* have been observed during early summer. This site has also been subject to impacts from *Karenia mikimotoi* blooms, with mortalities of fish and lugworms recorded during 2001 and 2006. A *K. mikimotoi* bloom in 2003 resulted in significant mortalities of farmed fish in the area. Previous studies performed at this site have focused on the presence of harmful algal species and shellfish toxicity, as during the late 1990s, high concentrations of paralytic shellfish toxins were routinely recorded in shellfish tissue from Scapa Bay (Joyce, 2005; Bresnan *et al.*, 2005, 2009). Further information and links to the data collected at this site can be found at the Marine Scotland website <http://www.scotland.gov.uk/Topics/marine/science/MSInteractive/Themes/Coastal>.

Scapa Bay - Orkney

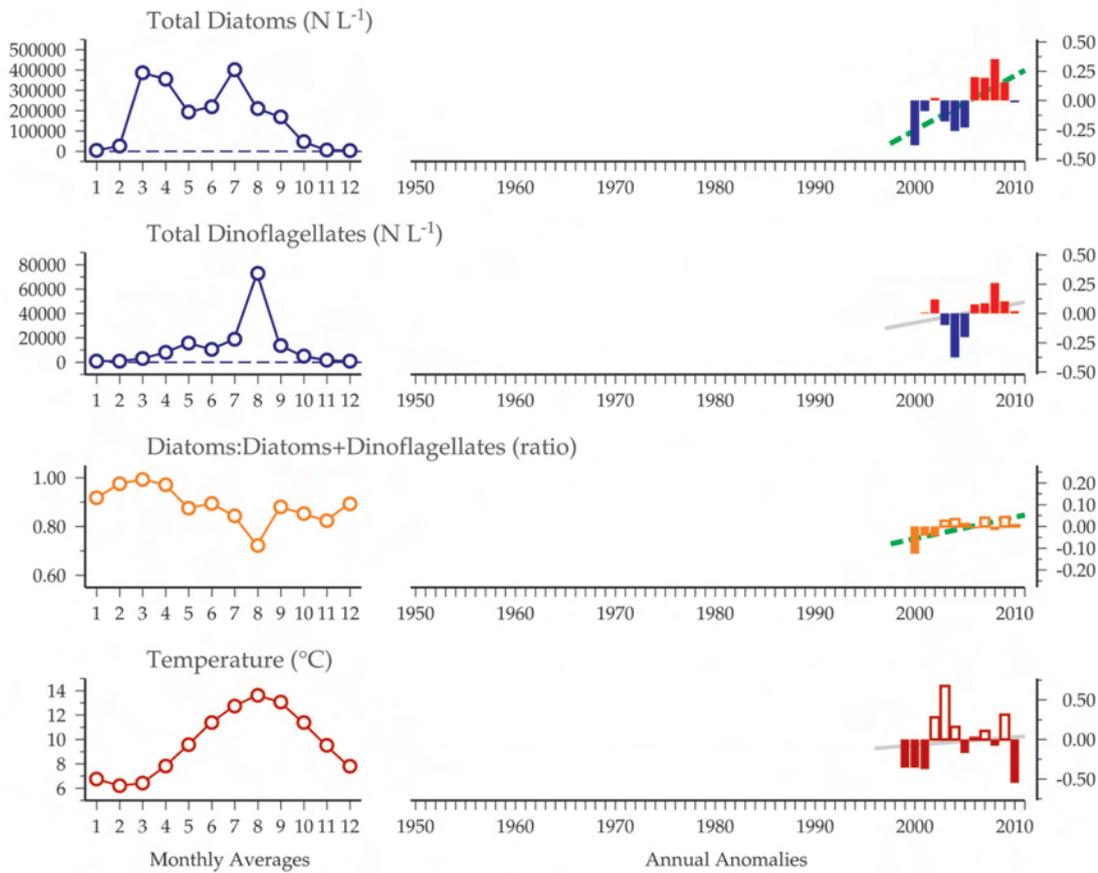
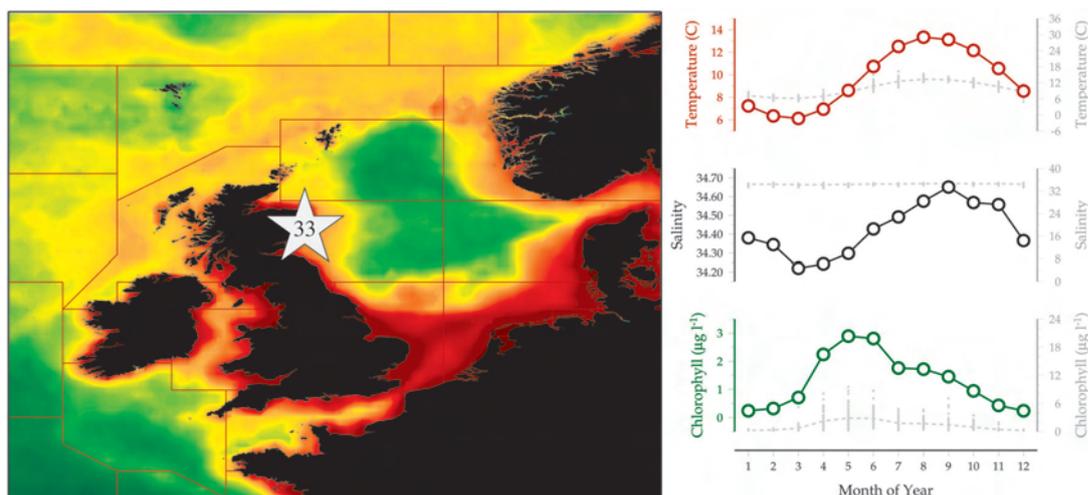


Figure 6.3.2
 Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of select cosampled variables at the Scapa Bay, Orkney plankton monitoring site. Additional variables from this site are available online at <http://wgpme.net/time-series>.

6.4 Stonehaven (Site 33)

Eileen Bresnan

Figure 6.4.1
Location of the Stonehaven plankton monitoring area (Site 33), plotted on a map of average chlorophyll concentration, and its corresponding environmental summary plot (see Section 2.2.1).



The Stonehaven monitoring site (56°57.8'N 002°06.2'W) has been a part of the Coastal Ecosystem Monitoring Programme operated by Marine Scotland Science (MSS) since 1997. This site acts as a reference site to fulfill the requirements of the EU Water Framework Directive and test the development of tools to identify “Good Environmental Status” for the Marine Strategy Framework Directive.

The Stonehaven monitoring site is 50 m deep and is located 5 km offshore. Samples to measure temperature, salinity, and nutrients are collected using a reversing bottle and digital thermometer from surface (1 m) and bottom (45 m) depths. A 10 m integrated tube sampler is used to collect samples for chlorophyll and phytoplankton community analysis. Phytoplankton samples are preserved in Lugol’s iodine and analysed using the Utermöhl method (Utermöhl, 1958). Zooplankton samples for community analysis are collected using a 200 µm mesh bongo net. Since 2009, weekly samples have also been taken for total alkalinity and dissolved inorganic carbon measurements. Scanning electron microscopy of selected samples to identify and enumerate the coccolithophores present is also being performed. Samples are collected weekly, weather permitting. Information about the zooplankton community at this site can be found in the ICES Zooplankton Status Report.

Seasonal and interannual trends (Figure 6.4.2)

The Stonehaven site is a dynamic site, with strong southerly flow. It is well mixed for most of the year. Temperature and salinity show a strong seasonality. The lowest temperatures are observed during spring (ca. 6°C) and the warmest towards late summer. The temperature at this site rarely exceeds 14°C. Salinity follows a similar pattern, with lowest salinity observed in spring and highest in late summer. Nutrients show a seasonal pattern typical to high latitudes, with the concentration of total nitrates, phosphate, and silicate increasing over winter, when phytoplankton growth is reduced, and decreasing during the phytoplankton growing period.

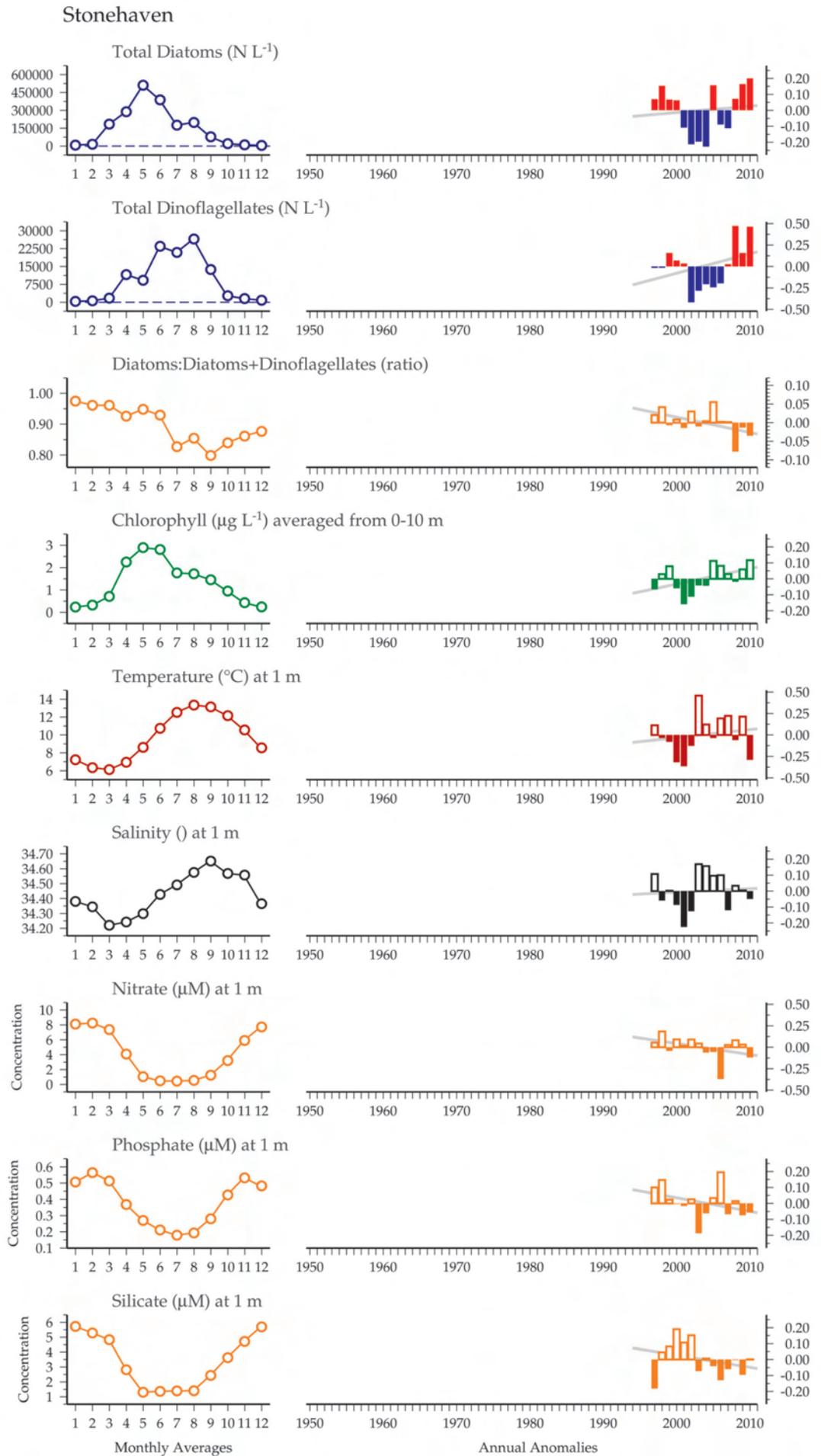
The phytoplankton community observes a strong seasonality at the Stonehaven monitoring site. During winter, phytoplankton growth is reduced. Diatom cells begin to increase in abundance from March, and during most years, there is a strong spring bloom dominated by diatom genera such as *Chaetoceros*, *Thalassiosira*, and *Skeletonema*. Dinoflagellates such as *Ceratium* become a more important part of the phytoplankton community during summer. In some years, but not all, an autumn diatom bloom of larger diatoms such as *Rhizosolenia* and *Pseudo-nitzschia* spp. type cells can be observed.

A number of changes have been observed in the phytoplankton community at this site since monitoring began. A period of reduced annual chlorophyll concentrations was observed from 2000 to 2004. This corresponds to a period when the intensity of the spring bloom was reduced. Chlorophyll concentrations increased again in 2005, with *Skeletonema* observed at high cell densities during the spring bloom. This increase in *Skeletonema* was also observed at the other monitoring sites in the programme.

Since 2000, a decrease has been observed in the large thecate dinoflagellates, such as *Ceratium*, that occur during summer, whereas dense blooms of small *Prorocentrum cf. minimum* cells have been observed in early summer. This change in *Ceratium* has also been observed at other sites in the programme and also in the Continuous Plankton Recorder data (Hinder *et al.*, 2012).

A preliminary description of the hydrography, chemistry, and phytoplankton community can be found in Bresnan *et al.* (2009). A description of a transect survey around this monitoring site can be found in McCollin *et al.* (2011). Further information and links to the data collected at this site can be found at the Marine Scotland website <http://www.scotland.gov.uk/Topics/marine/science/MSInteractive/Themes/Coastal>.

Figure 6.4.2
 Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of select cosampled variables at the Stonehaven plankton monitoring site. Additional variables from this site are available online at <http://wgpme.net/time-series>.



7.1 Loch Ewe (Site 37)

Eileen Bresnan

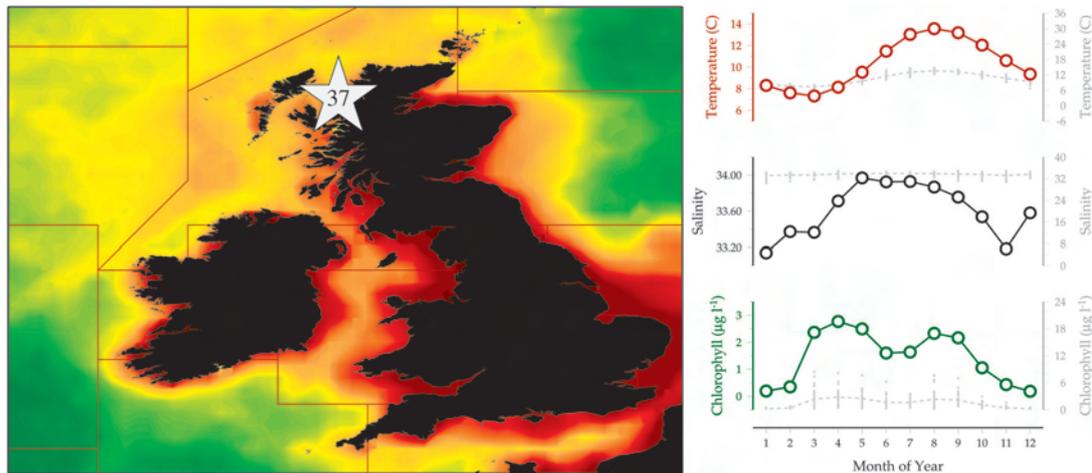


Figure 7.1.1
Location of the Loch Ewe plankton monitoring area (Site 37), plotted on a map of average chlorophyll concentration, and its corresponding environmental summary plot (see Section 2.2.1).

Loch Ewe (Site 37, 57°50.14'N 5°36.61'W), a sea loch on the west coast of Scotland, has been part of the Marine Scotland Science Coastal Ecosystem Monitoring Programme since 2002. This site acts as a reference site to fulfill the requirements of EU Water Framework Directive and to test the development of tools to identify "Good Environmental Status" for the Marine Strategy Framework Directive. Samples have been collected by Isle of Ewe Shellfish and their input to the success of the programme is gratefully acknowledged.

The Loch Ewe monitoring site is 40 m deep and located at the northerly face of the sea loch. Samples are collected weekly. Samples to measure temperature, salinity, and nutrients are collected using a reversing bottle and digital thermometer from surface (1 m) and bottom (35 m) depths. A 10m integrated tube sampler is used to collect samples for chlorophyll and phytoplankton community analysis. Phytoplankton samples are preserved in Lugol's iodine and analysed using the Utermöhl method (Utermöhl, 1958).

Seasonal and interannual trends (Figure 7.1.2)

Water movement in this loch is strongly influenced by wind and tide. The loch faces north and has variable exchange with the North Minch, which is influenced by influxes of Atlantic water. Temperature and salinity show a strong seasonality. The lowest temperatures are observed during spring (ca. 7°C) and the warmest towards late summer. The temperature at this site rarely exceeds 14°C. The

temperature at this and other west coast sites can be up to 1–2°C warmer during spring than the sites at the east coast, Orkney, and Shetland. Salinity follows a similar pattern, with lowest salinity observed in spring and highest in late summer.

Nutrients show a seasonal pattern typical to high latitudes, with concentration of total nitrates, phosphate, and silicate accumulating over winter, when phytoplankton abundance is reduced and concentrations decrease during the phytoplankton growing period.

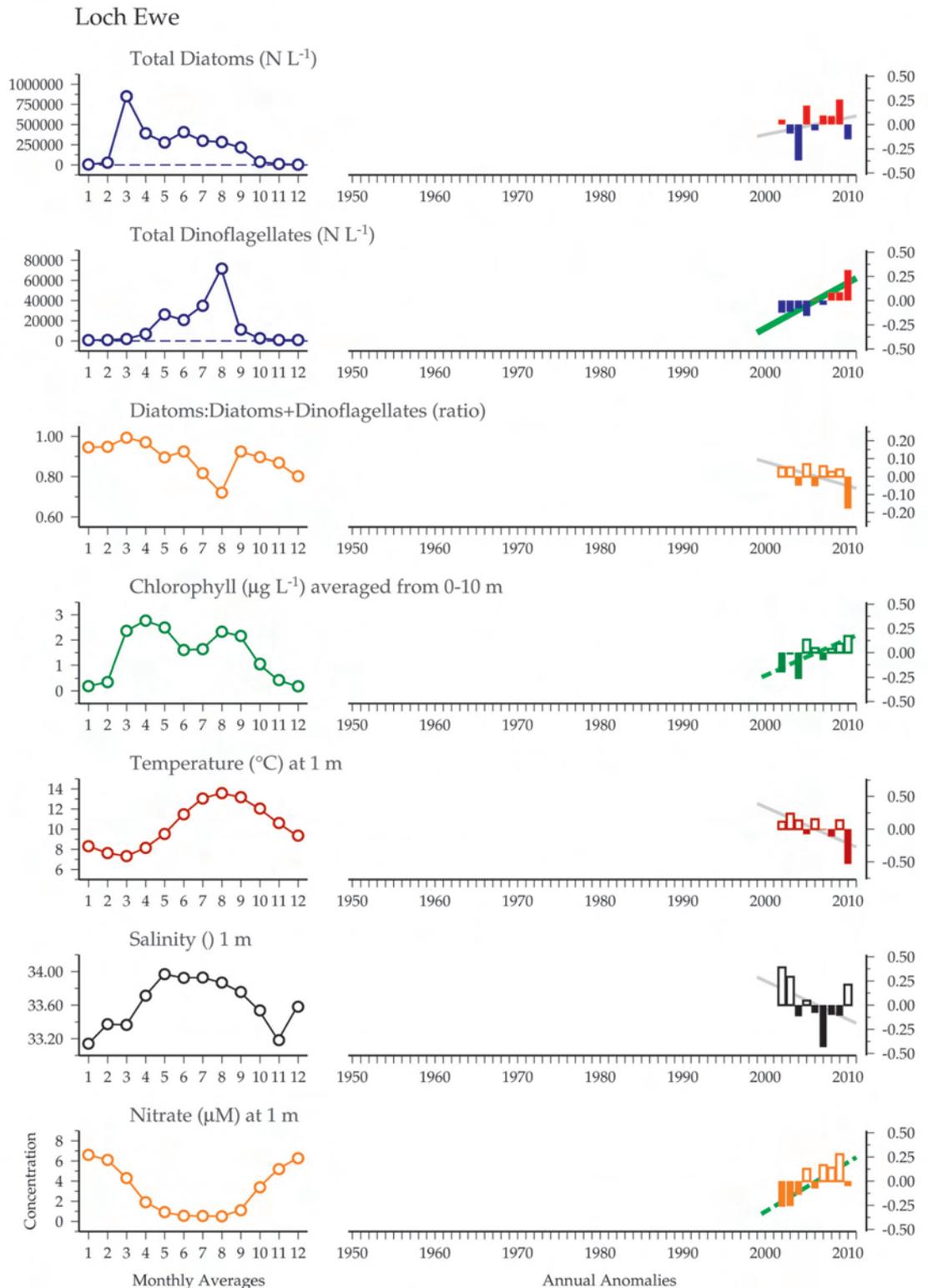
The phytoplankton community observes a similar seasonal pattern to other sites in Scotland, with a strong spring bloom dominated by diatoms. The spring bloom occurs earlier on the west coast (February/March) than on the east (March/April), likely the result of the warmer water temperature. Dinoflagellates become an important component of the phytoplankton community during summer. The autumn diatom bloom is more intensive than on the east coast and is dominated by larger diatoms, such as the *Rhizosolenia* and *Pseudo-nitzschia* spp. type species.

Annual average plots show an increase in dinoflagellates over the last five years. Increased numbers of athecate dinoflagellates have been observed during summer. The pattern of diatom abundance during the spring bloom is similar to that on the east coast, with an increase in abundance of *Skeletonema* observed since 2005 at this site. Chlorophyll data demonstrate an increase, primarily occurring during winter over the last

three years. Similar to other sites, a decrease in the abundance of *Ceratium* has been observed over the last decade. This site also experienced a devastating *Karenia mikimotoi* bloom in late summer 2006 (Davidson *et al.*, 2009), with significant mortalities of benthic fauna recorded.

This site was the focus of an intensive study of the presence of shellfish toxin-producing species and algal toxins (Bresnan *et al.*, 2005). Further information and links to the data collected at this site can be found at the Marine Scotland website <http://www.scotland.gov.uk/Topics/marine/science/MSInteractive/Themes/Coastal>.

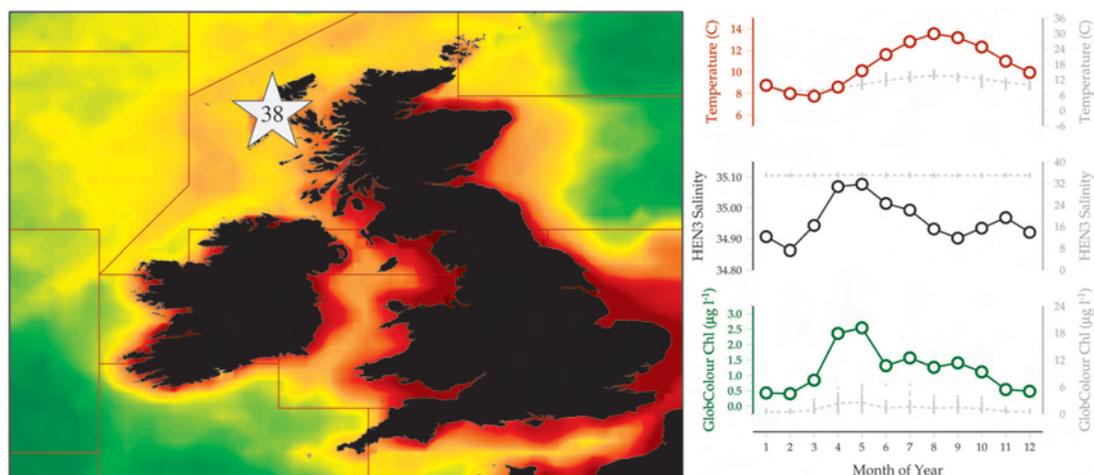
Figure 7.1.2
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of select cosampled variables at the Loch Ewe plankton monitoring site. Additional variables from this site are available online at <http://wgpme.net/time-series>.



7.2 Loch Maddy (Site 38)

Eileen Bresnan

Figure 7.2.1
Location of the Loch Maddy plankton monitoring area (Site 38), plotted on a map of average chlorophyll concentration, and its corresponding environmental summary plot (see Section 2.2.1).



Loch Maddy (Site 38, 57°36.09'N 7°08.48'W) is located on the Island of North Uist, part of the Western Isles. It is a unique site with a diverse saline lagoon system opening into the sea loch, which contains a mix of rocky reefs and soft sediment habitats. This system supports a rich diversity of marine life and, as a result, has been designated a marine special area of conservation (SAC). Loch Maddy has been participating in the Marine Scotland Science Coastal Ecosystem Monitoring Programme since 2003. Samples have been collected by Comann na Mara and Loch Duart Salmon and their input to the success of this programme is gratefully acknowledged.

Temperature is measured using a minilogger, and surface water samples are taken for salinity and chemical analysis. An integrated tube sampler is used to collect samples for phytoplankton community analysis. Phytoplankton samples are preserved in Lugol's iodine and analysed using the Utermöhl method (Utermöhl, 1958).

Seasonal and interannual trends (Figure 7.2.2)

Temperature demonstrates a distinct seasonality, with lowest temperatures in March and warmest in August. The lowest temperatures are observed during spring (ca. 7°C) and the warmest towards late summer. The temperature at this site rarely exceeds 14°C. In common with the other sites from Scotland, this site demonstrates a similar pattern in the seasonality of the phytoplankton community, with a spring bloom of diatoms dominated by *Skeletonema* and *Chaetoceros*. Dinoflagellates become more abundant in summer, and blooms of the dinoflagellate *Prorocentrum balticum/minimum* have been observed during early summer. High abundance of *Karenia mikimotoi* was observed at this site during 2006. In contrast to other sites along the west coast, diatom blooms can occur during summer, and the autumn diatom bloom is not as pronounced. Owing to the relative shortness of the sampling programme, long-term trends in hydrography or biology are not conclusive at this point.

Further information and links to the data collected at this site can be found at the Marine Scotland website <http://www.scotland.gov.uk/Topics/marine/science/MSInteractive/Themes/Coastal>.

Loch Maddy

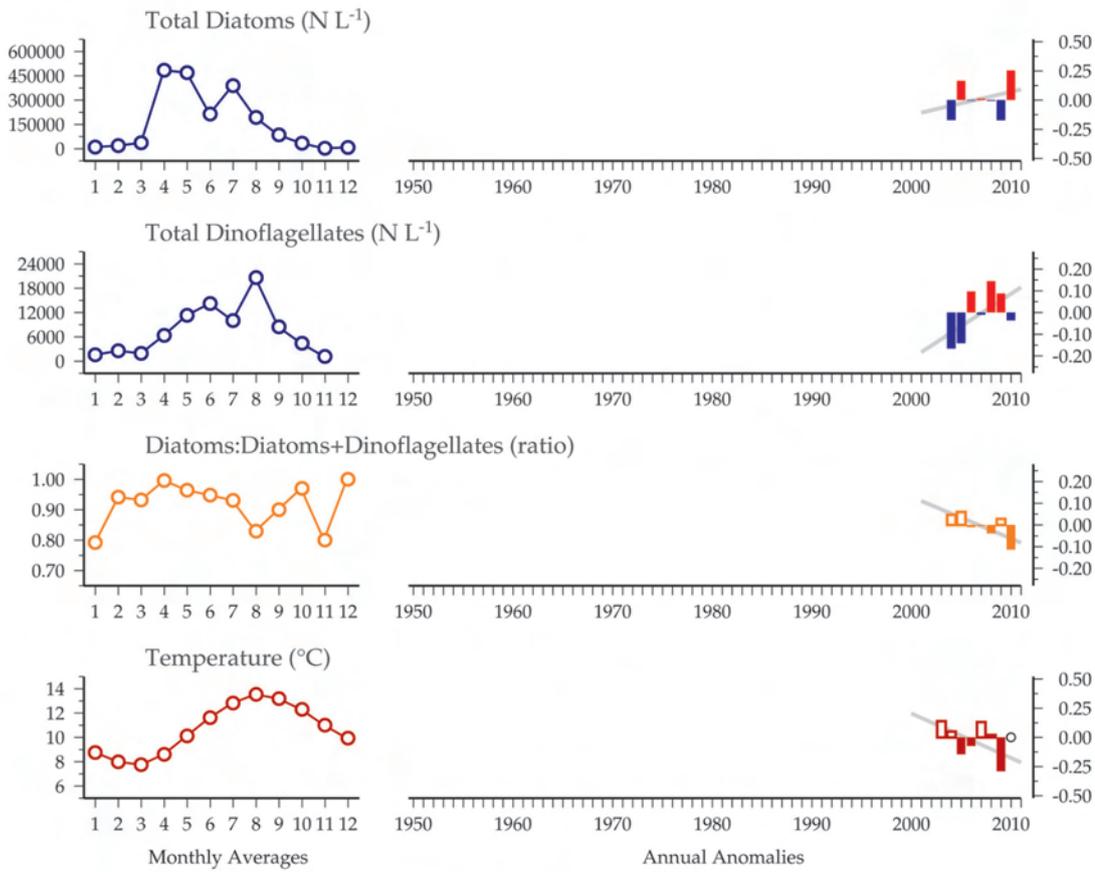
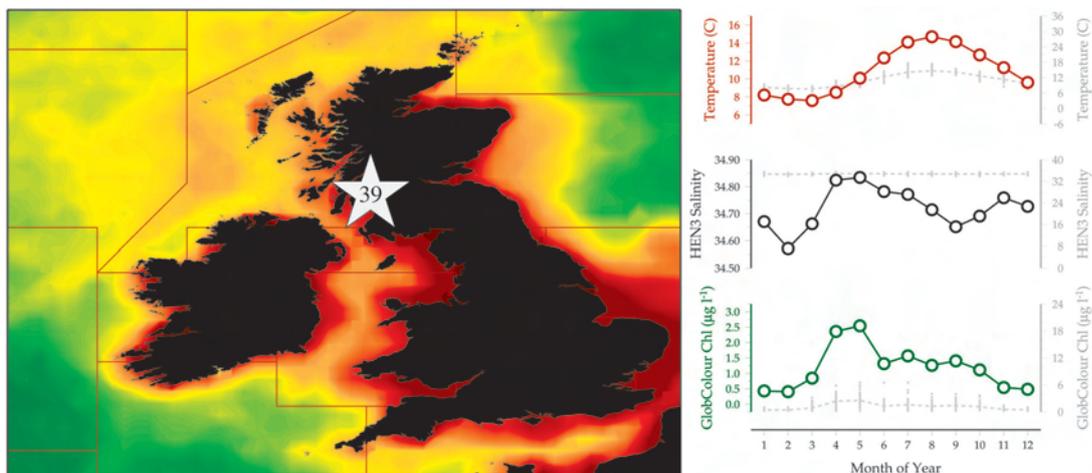


Figure 7.2.2
 Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of select cosampled variables at the Loch Maddy plankton monitoring site. Additional variables from this site are available online at <http://wgpme.net/time-series>.

7.3 Millport (Site 39)

Eileen Bresnan

Figure 7.3.1
Location of the Millport plankton monitoring area (Site 39), plotted on a map of average chlorophyll concentration, and its corresponding environmental summary plot (see Section 2.2.1).



Millport (Site 39, 55°44.97'N 4°54.33'W) has been participating in the Marine Scotland Science Coastal Ecosystem monitoring programme since 2005. Samples are collected by the University Marine Biological Station Millport (<http://www.gla.ac.uk/centres/marinestation/index.php>) and their input to the success of this programme is gratefully acknowledged.

Temperature is measured using a minilogger at Keppel Pier. An integrated tube sampler is used to collect samples for phytoplankton community analysis at Fairlie Channel. The sampling site is approximately 35 m deep. Phytoplankton samples are preserved in Lugol's iodine and analysed using the Utermöhl method (Utermöhl, 1958).

Seasonal and interannual trends (Figure 7.3.2)

Temperature demonstrates a distinct seasonality, with lowest temperatures in March and warmest in August. The phytoplankton time-series at this site is relatively short. A strong phytoplankton spring bloom, dominated by *Skeletonema*, can be observed at this site. Dinoflagellates become more abundant during summer, and large thecate dinoflagellates, such as *Dinophysis* and *Ceratium*, are observed at higher cell densities at this site than at other sites in the programme. Blooms of *Karenia mikimotoi* can be observed during some years. An increase in diatom cell densities during autumn is not observed at this site.

Further information as well as data collected at this site can be found at the Marine Scotland website <http://www.scotland.gov.uk/Topics/marine/science/MSInteractive/Themes/Coastal>.

Mill Port

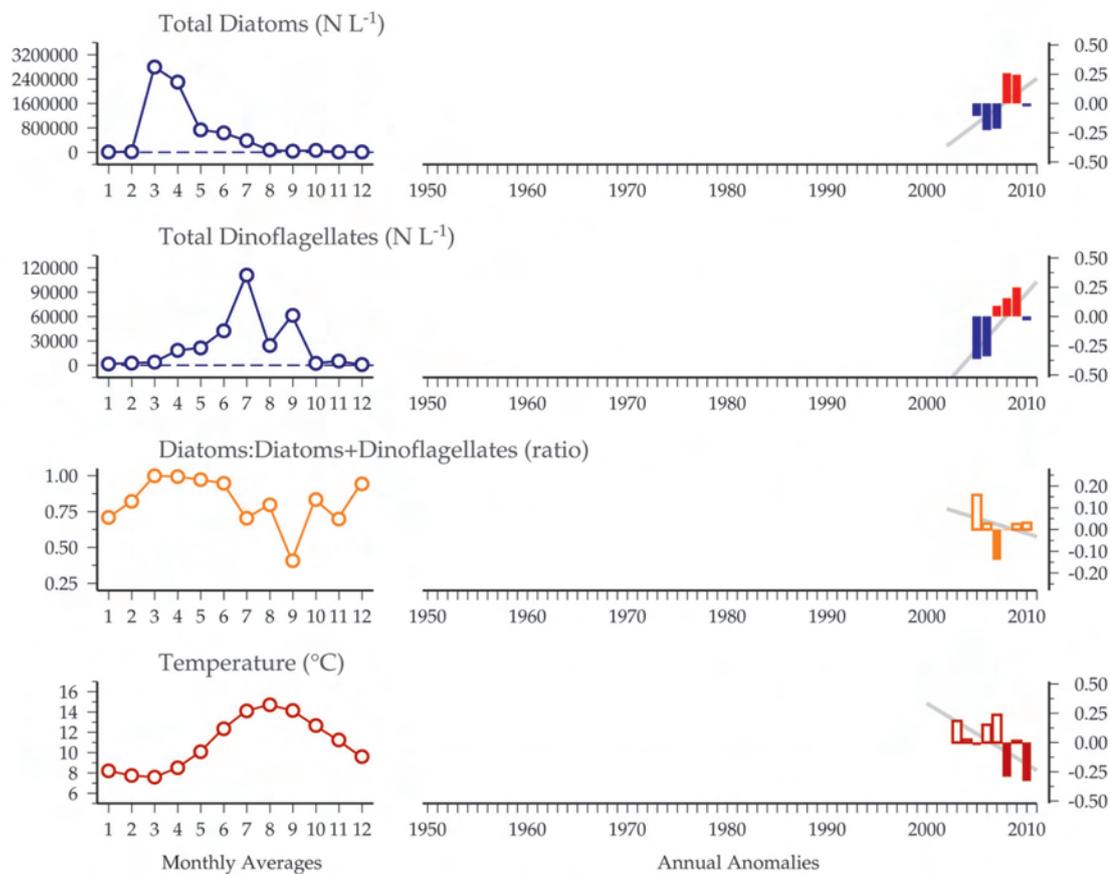


Figure 7.3.2
 Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of select cosampled variables at the Millport plankton monitoring site. Additional variables from this site are available online at <http://wgpme.net/time-series>.