Manx Marine Environmental Assessment

Physical Environment

Climate Change in Manx Waters

Invasive algae, *Sargassum muticum* (wireweed), in Castletown Bay. Photo: F. Gell.

MMEA Chapter 2.2

October 2018 (2nd edition)

Lead Author:
Prof. S. J. Hawkins - Ocean and Earth Science, National Oceanography Centre, Southampton and Marine Biological Association of the UK, Plymouth

Manx Marine Environmental Assessment

Second Edition: October 2018

This document was produced as part of the Manx Marine Environmental Assessment, a Government project with external stakeholder input, funded and facilitated by the Department of Infrastructure, Department for Enterprise and Department of Environment, Food and Agriculture.

This document is downloadable from the Isle of Man Government website at:
https://www.gov.im/about-the-government/departments/infrastructure/harbours-information/territorial-seas/manx-marine-environmental-assessment/

Contact:
Manx Marine Environmental Assessment
Fisheries Division
Department of Environment, Food and Agriculture
Thie Slieau Whallian
Foxdale Road
St John's
Isle of Man
IM4 3AS

Email: fisheries@gov.im
Tel: 01624 685857

Suggested Citations:
Chapter
Hawkins, S.J. 2018. Climate Change in Manx Waters. In: Manx Marine Environmental Assessment (2nd Ed). Isle of Man Government. pp. 11

Contributors to 1st edition:
Stephen J. Hawkins[1,2], M. A. MacLean[1], L. Firth[3] and N. Mieszkowska[2,4]
Ocean and Earth Science, National Oceanography Centre, Southampton[1], Marine Biological Association of the UK Plymouth[2], University of Plymouth[3], School of Environment , University of Liverpool[4.]
Dr Fiona Gell - Department of Environment, Food and Agriculture
Dr K. Kennington – Government Laboratory, Department of Environment, Food and Agriculture
Laura Hanley* – formerly Department of Environment, Food and Agriculture

Disclaimer:
The Isle of Man Government has facilitated the compilation of this document, to provide baseline information on the Manx marine environment. Information has been provided by various Government Officers, marine experts, local organisations and industry, often in a voluntary capacity or outside their usual work remit. Advice should always be sought from relevant contacts where queries arise.

The editors have taken every care to ensure the accuracy of the information contained but accept that errors and omissions may be present. The editors accept no responsibility for the accuracy or currency of information provided on external sites.

All MMEA chapters may be amended and improved upon in light of new information or comments received. As such, all chapters should be considered as working documents.
Any initial guidelines or recommendations within the document are provided to help facilitate future discussions between stakeholders, Government Departments, future developers and the general public, and should be read only in the context of the document as a whole. This document does not provide legal or policy advice but rather a statement of known information about Manx territorial waters.

The mapping detail contained in this document is subject to the limitations of scale and depiction of any feature, does not denote or infer right of way and no claim is made for the definitive nature of any feature shown on the mapping. New marine datasets created for the project have not been subject to formal verification.

Climate Change in Manx Waters

Broader context

The British Isles including the Isle of Man straddle a biogeographic boundary zone (Forbes 1859, Lewis 1964). Many marine species with warm-water Lusitanian affinities reach the southern and western shores of the British Isles and Ireland. They do not penetrate into the colder Eastern English Channel (Crisp & Southward 1958) and southern North Sea (Lewis 1964) which is strongly influenced by the continental effects in the winter. In the summer isotherms of sea temperature run west to east with colder temperatures to the north; in the winter they run north-south with colder temperatures in the North Sea (Lewis 1964). Many cold-water boreal species reach their southern limits in the British Isles, although some species reach as far south as the Iberian Peninsula (Southward *et al*. 1995).

Since instrumental records began in the late 19th century – (including those of the Marine Biological Station at Port Erin from 1904 onwards, latterly Port Erin Marine Laboratory), there have been fluctuations in sea temperature reflecting wider climatic variability in the North East Atlantic and North West Europe (Hurrell *&* Deser 2009). The 1880s to the 1890s was a fairly warm period followed by a cold period (1900s-1920). From the 1920s onwards there was evidence of warming up, until the late 1950s and early 1960s (Hawkins et al. 2010a). There were still however, occasional cold winters during this period (e.g. 1948). The extremely cold winter of 1962/1963 heralded two decades of cooler conditions. Then there was a much warmer period from the late 1980s onwards, which has been punctuated with cold winters, especially in the last few years (2009/2010, 2010/2011) with a very cold late winter in 2018.

The recent warm period has been associated with more frequent negative North Atlantic Oscillation Index winters, when more westerly Atlantic influenced weather occurs over the British Isles (Wang *et al*. 2010).

It has long been known that marine life has responded to such climatic fluctuations (e.g. Russell et al. 1971; Cushing 1975; Southward 1980). Some of the best studies were made in the Western English Channel by the Marine Biological Association of the United Kingdom (MBA) (see Hawkins et al. 2003 and Southward et al. 2005 for recent reviews). The 'Russell Cycle' (Cushing & Dickson 1976) involved fluctuations from cold-water species of fish (e.g. herring (*Clupea harengus)* and cod (*Gadus morhua*)) and plankton in the 1920s to warmer water assemblages (pilchards (also known as sardines)(*Sardina pilchardus*), red mullet (*Mullus surmuletus*) and various sea bream species) in the 1950s. There was then a switch back to colder water plankton and fish in the 1960s and 1970s (Southward 1980; Hawkins *et al*. 2003). Historical studies showed that such fluctuations have occurred since the Middle Ages (Southward *et al*. 1988). The recent warming has seen the return of pilchards (*S. pilchardus*) and other warm water fish in the Western English Channel (Southward *et al*.

1995; Hawkins *et al*. 2003; Genner 2004, 2010) and the wider shelf seas (Perry *et al*. 2005; Dulvy *et al*. 2008; Simpson *et al*. 2011).

The Continuous Plankton Recorder Survey (CPR) operated by the Sir Alister Hardy Foundation (SAHFOS) has also charted major shifts in distribution, composition and phenology in planktonic species in the wider North East Atlantic (Beaugrand *et al*. 2001; Edwards & Richards 2004; Reid *et al*. 2004) and the North Sea (Reid 1975).

The Irish Sea and Manx Waters

Have these wider changes around the British Isles occurred in the Irish Sea and Manx Waters? The North Irish Sea, as a semi-enclosed basin, is more susceptible to weather-driven fluctuations in temperature and is also strongly influenced by freshwater input. This can make distinguishing climate signals and global change from the noise of natural fluctuations and other local and regional impacts more difficult than in more oceanic settings such as the Western English Channel. The signature of climate driven change is apparent in Manx waters and the wider Northern Irish Sea. The Irish Sea has broadly followed the temperature patterns seen in the Western English Channel (See Hawkins *et al*. 2010b). There is good long-term data on sea temperature (from 1904), salinity and nutrients (from the 1950s) and phytoplankton has been monitored in Manx waters since 1996 from the Cypris station in Manx waters (Silke *et al*. 2012). In 2006, researchers from Port Erin Marine Laboratory analysed over 40+years of wider Irish Sea SAHFOS, data that showed a considerable decrease in zooplankton population abundance over the time-period (See Kennington & Rowlands 2006). There has not been regular monitoring of fish as in the English Channel. There have also been some re-surveys of the benthos, but initially in the context of intensive scallop dredging (Pennington *et al*. 1998; Hill *et al*. 1999; Bradshaw *et al*. 2002) and more recently to inform fisheries management and conservation (Hinz *et al*. 2010). There are baselines from rocky shore surveys made in the 1950s by Southward and Crisp that have been repeated in recent years by Hawkins and co-workers as part of the MarClim Project. Please see, www.mba.ac.uk/marclim/. The Isle of Man Marine Fauna (Bruce *et al*. 1963) provides a catalogue of faunal diversity up until the early 1960s, including species records from the warm period of the 1950s.

Allen et al. (1998) building on work by Slinn (1974) showed that nutrients such as phosphate and nitrate were increasing in the Irish Sea, perhaps leading to basin-wide eutrophication. Although agreeing that nutrients have increased, further analysis by Gowen *et al*. (2002, 2005, 2008) provided evidence that the central Irish Sea is not eutrophic. Climate change was not implicated in these changes. More recent analysis has shown that both nitrate and phosphate has decreased in recent decades see MMEA Chapter 2.4 (Physical Environment - Marine Pollution).

During the late 1980s and early 1990s basking sharks (*Cetorhinus maximus*) became very common in the Irish Sea, in spring and early summer having not been regularly observed for the previous 20 years or so. One hypothesis for their greater occurrence could be stronger frontal systems off the Isle of Man in the calmer, warmer summers leading to greater concentration of their planktonic food. For further information please see MMEA Chapter 3.5 (Basking Shark).

During the late 1980s and 1990s southern species such as trigger fish (*Balistes capriscus*), cuttlefish (*Sepia officinalis*) and red mullet (*Mullus surmuletus*) were caught by fishermen and in the case of red mullet in research trawls by Port Erin Marine Laboratory. Catches of hake (*Merluccius gayi*) became more common in the Irish Sea reflecting more southern species. Anglers also caught more southern species such as bass (*Dicentrarchus labrax*) and black sea bream (*Spondyliosoma cantharus*). This largely anecdotal evidence suggested that southern species were penetrating further into the Northern Irish Sea basin.

Sea bass (*Dicentrarchus labrax*), a more southerly species, caught in Manx waters. Photo: B. Walmsley 2012.

Recent rocky shore surveys have found a southern species of barnacles for the first time (*Chthamalus stellatus*) in 2004. A single specimen of the southern species of limpet (*Patella depressa*) in 2010. Previously these species reached their northern limit in the Irish Sea on Anglesey; although *P. depressa* was quite common on Anglesey in the 1950s it has not been found in significant quantities north of the Lleyn Peninsula in recent re-surveys in the 2000s. A single *Cystoseira* (probably the species *tamariscifolia*) individual, a warm-water fucoid seaweed, was found at Langness in the tide pools in the early 2000s. Other southern species seemed to become more common (*Chthamalus montagui*, *Gibbula umbilicalis*) compared to the 1970s and early 1980s (S.J. Hawkins, anecdotal memories).

The cold-water limpet (*Testudinalia testudinalis)* was quite common in the 1970s, but has not been found in recent years. Its southern limit in Europe is the Irish Sea, so this species is likely to be susceptible to warming (Helmuth *et al*. 2006; Mieszkowska *et al*. 2005).

The only other change on Manx rocky shores has been the arrival of the large invasive Asian algae – *Sargassum muticum (wireweed)*. This species arrived from Ireland sometime in the mid-2000s and has become much more common in the last 3 years or so. The non-native Pacific oyster has been found on the outside of Ramsey Harbour since the 2000s (T. Holt, pers.com)(although these have been removed during 2018). These have probably recruited from Cumbria (oyster farms on Walney Island). They have not yet been found elsewhere on Manx rocky shores.

Further south in North Wales there have been more changes in trochids with Phorcus (*Osilinus*) *lineatus* increasing in abundance leading to a range expansion along the North Welsh coast (Helmuth *et al*., 2006; Mieszkowska *et al*., 2007) and *Gibbula umbilicalis* increasing in abundance. *Chthamalus montagui* has also been found East of Anglesey as far as the Wirral. *Sabellaria alveolata* has recovered to levels found in the 1930s along the Cheshire and North Welsh shore, perhaps aided by new sea defences (Firth *et al*. 2015). Both *Sabellaria* and *Osilinus* have not made the leap to the Isle of Man – despite increases in abundance on adjacent coasts in Ireland (*Phorcus* (*Osilinus),* Simkanin *et al*. 2005) and on the English and Welsh coasts (*Sabellaria*, Frost *et al*. 2006).

Summary

Climate-driven changes on the seashore are apparent in Manx Waters, but not to the same extent as in North Wales and Northern Ireland. This probably reflects the isolation of the Isle of Man in the Irish Sea.

Changes in fish have occurred but lack of routine monitoring means that records are largely anecdotal.

There is good long-term data in Manx waters for sea temperature (over 100 years), salinity and nutrients (since 1954) and phytoplankton has been monitored in Manx waters since 1996.

Other pressures such as nutrient enrichment, non-native species and the side effects of scallop fishing (Veale *et al*. 2001; Bradshaw *et al*. 2001) are likely to have prompted significant changes in addition to climate (Shephard *et al*. 2010; Murray *et al*. 2011; Hinz *et al*. 2011).

References

Allen J.R., Slinn D.J., Shammon T.M., Hartnoll R.G. and Hawkins, S.J. (1998). Evidence for eutrophication of the Irish Sea over four decades, Limnology and Oceanography, 43 (8): 1970-1974.

Beaugrand G., Ibanez F. and Lindley J.A. (2001). Geographical distribution and seasonal and diel changes in the diversity of calanoid copepods in the North Atlantic and North Sea, Marine Ecology Progress Series, 219: 189-203.

Bradshaw C., Veale L.O., Hill A.S. and Brand A.R. (2002). The role of scallop-dredge disturbance in long-term changes in the Irish Sea benthic communities: a re-analysis of an historical dataset, Journal of Sea Research, 47 (2): 161-184.

Bradshaw C., Veale L.O., Hill A.S. and Brand A.R. (2001). The effects of scallop dredging on Irish Sea benthos: experiments using a closed area, Hydrobiologia, 465: 129-138.

Bruce J.R., Colman J.S. and Jones N.S. (1963). Marine Fauna of the Isle of Man, Liverpool University Press.

Crisp D.J. and Southward A.J. (1958). The distribution of intertidal organisms along the coasts of the English Channel. Journal of the Marine Biological Association of the United Kingdom 37 (1): 157-208.

Cushing D.H. and Dickson R.R. (1976). The biological response in the sea to climatic changes. Advances in Marine Biology, 14: 1-122.

Cushing D.H. (1975). Marine Ecology and Fisheries, Cambridge University Press, Cambridge.

Dulvy N.K., Rogers S.I., Jennings S., Stelzenmüller V., Dye S.R. and Skjoldal H.R. (2008). Climate change and deepening of the North Sea fish assemblage: a biotic indicator of warming seas, Journal of Applied Ecology, 45: 1029-1039.

Edwards M. and Richardson A.J. (2004). Impact of climate change on marine pelagic phenology and trophic mismatch, Nature, 430: 881-884.

Firth L.B., Mieszkowska N., Grant L.M., Bush L.E., Davies A.J., Frost M.T., Moschella P.S., Burrows M.T., Cunningham P.N., Dye S.R. and Hawkins S.J. (2015). Historical comparisons reveal multiple drivers of decadal change of an ecosystem engineer at the range edge. Ecology and Evolution, 5 (15): 3210-3222.

Forbes E. (1859). The natural history of the European seas (edited and continued by Robert Goodwin-Austin). John van Voorst, London.

Frost M. T, Jefferson R. and Hawkins S. J. (Editors). (2006). The evaluation of time series: their scientific value and contribution to policy needs. Report prepared by the Marine Environmental Change Network (MECN) for the Department for Environment, Food and Rural Affairs (DEFRA). Marine Biological Association, Plymouth. Contract CDEP 84/5/311. Occasional Publications of the Marine Biological Association of the United Kingdom, 22: 94.

Genner M.J., Sims D.W., Southward A.J., Budd G.C., Masterson P., McHugh M., Rendle P., Southall E.J., Wearmouth V.J. and Hawkins S.J. (2010). Body size-dependent responses of a marine fish assemblage to climate change and fishing over a century-long scale, Global Change Biology, 16: 517-527.

Genner M.J., Sims D.W., Wearmouth V.J., Southall E.J., Southward A.J., Henderson P.A. and Hawkins S.J. (2004). Regional climatic warming drives long-term community changes of British marine fish. Proceedings of the Royal Society of London, Biological Sciences, 271: 655-661.

Gowen R.J., Tett P., Kennington K., Mills D.K., Shammon T.M., Stewart B.M., Greenwood N., Flanagan C., Devlin M. and Wither A. (2008). The Irish Sea: Is it eutrophic? Estuarine Coastal and Shelf Science, 76: 239-254.

Gowen R.J. and Stewart B.M. (2005). The Irish Sea: nutrient status and phytoplankton, Journal of Sea Research, 54: 36-50.

Gowen R.J., Hydes D.J., Mills D.K., Stewart B.M., Brown J., Gibson C.E., Shammon T.M., Allen M. and Malcolm S.J. (2002). Assessing trends in nutrient concentrations in coastal shelf seas: a case study in the Irish Sea, Estuarine, Coastal and Shelf Science, 54: 927-939.

Hawkins S.J., Sugden H.E., Mieszkowska N., Burrows M.T. and Baxter J.M. (2010a). Chapter 6, Managing marine species in a rapidly changing world pp 91-109, In: Species Management: Challenges and solutions for the 21st Century, (Eds. Baxter, J.M. and Galbraith C.A.) Scottish Natural Heritage.

Hawkins S.J., Sugden H.E., Moschella P.S., Mieszkowska N., Thompson R.C. and Burrows M.T. (2010b). Chapter 33, The Seashore, pp 591-615, In Silent Summer: The state of wildlife in Britain and Ireland, (Ed. Maclean, N.). Cambridge: Cambridge University Press.

Hawkins S.J., Southward A.J. and Genner M.J. (2003). Detection of environmental change in a marine ecosystem – evidence from the Western English Channel. Science of the Total Environment, 310: 245-246.

Helmuth B., Mieszkowska N., Moore P. and Hawkins S.J. (2006). Living on the edge of two changing worlds: forecasting responses of rocky intertidal ecosystems to climate change. Annual Review of Ecology, Evolution & Systematics, 37: 373-404.

Hinz H., Murray L.G., Gell F., Hanley L., Horton N., Whiteley H. and Kaiser M. (2010). Seabed habitats around the Isle of Man. Fisheries & Conservation report No. 12, Bangor University. pp.29.

Hinz H., Tarrant D., Ridgeway A., Kaiser M.J. and Hiddink J.G. (2011). Effects of scallop dredging on temperate reef fauna, Marine Ecology Progress Series, 432: 91-102.

Hill A.S., Veale L.O., Pennington D., Whyte S.G., Brand A.R. and Hartnoll R.G. (1999). Changes in Irish Sea benthos: Possible effects of 40 years of dredging, Estuarine Coastal and Shelf Science, 48 (6): 739-750.

Hurrell J.W. and Deser C. (2009). North Atlantic climate variability: The role of the North Atlantic Oscillation, Journal of Marine Systems, 78: 28-41

Kennington K. and Rowlands W. (2006). SEA area 6 Technical Report – Plankton Ecology of the Irish Sea. (In) Offshore Energy Strategic Environmental Assessment – SEA6 Irish Sea. Department of Trade and Industry. Crown Copyright. URL: http://www.offshore-sea.org.uk/consultations/SEA_6/SEA6_Plankton_PEML.pdf

Lewis J. R. (1964). The Ecology of Rocky Shores: London, English University Press.

Mieszkowska N., Hawkins S.J., Burrows M.T. and Kendall M.A. (2007). Long-term changes in the geographic distribution and population structures of *Osilinus lineatus* (Gastropoda:Trochidae) in Britain and Ireland, Journal of the Marine Biological Association of the United Kingdom, 87 (2): 537-545.

Mieszkowska N., Leaper R., Moore P., Kendall M.A., Burrows M.T., Lear D., Poloczanska E., Hiscock K., Moschella P.S., Thompson R.C., Herbert R.J., Laffoley D., Baxter J., Southward A.J. and Hawkins S.J. (2005). Marine Biodiversity and Climate Change: Assessing and predicting the influence of climatic change using intertidal rocky shore biota. Occasional Publications of the Marine Biological Association of the United Kingdom, 20: 53.

Murray L.G., Hinz H. and Kaiser M.J. (2011). Functional response of fishers in the Isle of Man scallop fishery, Marine Ecology Progress Series, 430: 157-169.

Pennington D., Veale L.O. and Hartnoll R.G. (1998). Re-analysis of an historical benthic data set from the Irish Sea, Estuarine Coastal and Shelf Science,46 (5): 769-776.

Perry A.L., Low P.J., Ellis J.R. and Reynolds J.D. (2005). Climate change and distribution shifts in marine fishes, Science, 308 (5730): 1912-1915.

Reid P.C., Fischer A.C., Lewis-Brown E., Meredith M.P., Sparrow M., Andersson A.J., Antia A., Bates N.R., Bathmann U., Beaugrand G., Brix H., Dye S., Edwards M., Furevik T., Gangsto R., Hatun H., Hopcroft R.R., Kendall M., Kasten S., Keeling R., Le Quere C., MacKenzie F.T., Malin G., Mauritzen C., Olafsson J., Paull C., Rignot E., Shimada K., Vogt M., Wallace C., Wang Z.M. and Washington R. (2004). Impacts of the oceans on climate change, Advances in Marine Ecology, 56:1-150.

Reid P.C. (1975). Large–scale changes in North-Sea phytoplankton, Nature, 257 (5523): 217-219.

Russell F.S., Southward A.J., Boalch G.T. and Butler E.I. (1971). Changes in biological conditions in the English Channel off Plymouth during the last half century, Nature, 234:468-470.

Silke J., Kennington K., Bresnan E. and Cusack C. (2012). Phytoplankton and microbial plankton of the Northeast Atlantic.(In) O'Brien, T.D., W.K.W. Li, X.A.G. Moran (Eds). 2012. ICES Phytoplankton and Microbial Plankton Status Report 2009/2010. ICES Cooperative Research Report No. 310. 196 pp.

Simkanin C., Power A.-M., Myers A., McGrath D., Southward A., Mieszkowska N., Leaper R. and O'Riordan R. (2005). Using historical data to detect temporal changes in the abundances of intertidal species on Irish shores, Journal of the Marine Biological Association of the United Kingdom, 85: 1329-1340.

Shephard S., Beukers-Stewart B., Hiddink J.G., Brand A.R. and Kaiser M.J. (2010). Strengthening recruitment of exploited scallops Pecten maximus with ocean warming, Marine Biology, 157 (1): 91-97.

Simpson S.D., Jennings S., Johnson M.P., Blanchard J.L., Schon P.J., Sims D.W. and Genner M.J. (2011). Continental shelf-wide response of a fish assemblage to rapid warming of the sea, Current Biology, 21 (18): 1565-1570.

Slinn D.J. (1974). Water circulation and nutrients in the Northwest Irish Sea, Estuarine and Coastal Marine Science, 2 (1):1-25.

Southward A.J., Langmead O., Hardman-Mountford N.J., Aiken J., Boalch G.T., Dando P.R., Genner M.J., Joint I., Kendall M., Halliday N.C., Harris R.P., Leaper R., Mieszkowska N., Pingree R.D., Richardson A.J., Sims D.W., Smith T., Walne A.W. and Hawkins S.J. (2005). Long-term oceanographic and ecological research in the Western English Channel. Advances in Marine Biology, 47: 1-105.

Southward A.J., Hawkins S.J., and Burrows M.T. (1995). Seventy years' observations of changes in distribution and abundance of zooplankton and intertidal organisms in the western English Channel in relation to rising sea temperature. Journal of Thermal Biology, 20 (1-2): 127-155.

Southward A.J., Boalch G. T. and Maddock L. (1988). Fluctuations in the Herring and Pilchard fisheries of Devon and Cornwall linked to change in climate since the 16th century, Journal of the Marine Biological Association of the United Kingdom, 68 (3): 423-445.

Southward A.J. (1980). The Western English Channel – an inconstant ecosystem? Nature, 258: 361-366.

Veale L.O., Hill A.S., Hawkins S.J. and Brand A.R. (2001). Distribution and damage to the by-catch assemblage of the northern Irish Sea scallop dredge fisheries, Journal of the Marine Biological Association of the United Kingdom, 81 (1): 85-96

Wang C., Liu H. and Lee S.-K. (2010). The record-breaking cold temperatures during the winter of 2009/2010 in the Northern Hemisphere, Atmospheric Science Letters, 11: 161-168.

Web References:

www.mba.ac.uk/marclim/. Mar-Clim. Marine Biodiversity and Climate Change. Last Accessed 18/06/2018.