

Algal toxins



Key message

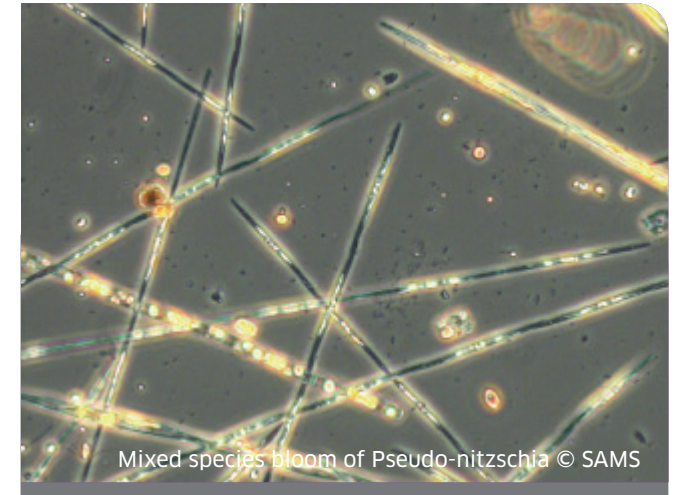
Some marine algae produce biotoxins that contaminate bivalve molluscs such as mussels and oysters, causing human illness when these shellfish are eaten. Between 2010 and 2018, biotoxins above allowable levels were detected in 1,793 shellfish samples. This led to the closure of shellfish harvesting sites lasting, in some cases, for up to six months.

Background

The cultivation, harvesting and sale of bivalves are important to the overall Scottish economy and that of coastal rural areas. This group of shellfish includes mussels, oysters, clams, cockles and scallops, which are aquatic molluscs with shells formed from two parts hinged together. They grow by filtering the microscopic marine algae found floating in the water column, called phytoplankton. Phytoplankton are the organisms at the bottom of the marine food chain and, although most of them are harmless, some species produce biotoxins that are dangerous to birds and mammals, including humans. Through the process of filter-feeding, bivalve molluscs can accumulate high concentrations of life-

threatening biotoxins within their flesh that cannot be destroyed by cooking or freezing.

When humans consume shellfish containing biotoxins, it can lead to three different types of poisoning: amnesic (short-term memory loss), paralytic (affects nervous system), and diarrhetic shellfish poisoning (gastrointestinal). The main cause of concern for the shellfish aquaculture industry is the presence of diarrhetic shellfish toxins. These can result in harvesting bans throughout the year, often for prolonged periods. The potentially fatal biotoxins that cause amnesic and paralytic



Mixed species bloom of Pseudo-nitzschia © SAMS

shellfish poisoning are also found in Scottish coastal waters, usually in spring and summer, when the algae blooms. Amnesic shellfish toxins rarely exceed allowable levels, but harvesting is banned due to the presence of paralytic shellfish toxins in most years.

Both biotoxins and phytoplankton are routinely monitored by Food Standards Scotland (FSS) under Regulation (EC) No. 854/2004. Harvesting areas are closed, when necessary, in order to prevent consumption of contaminated shellfish.

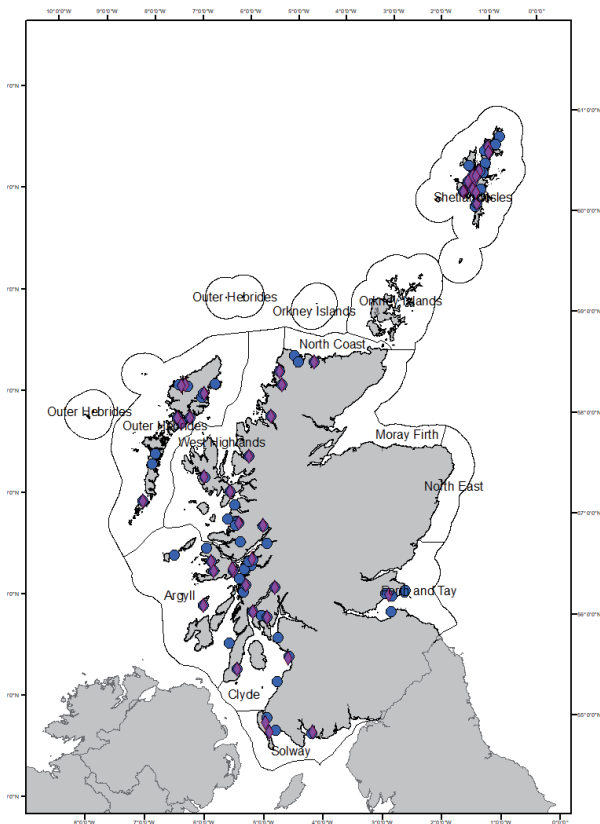


Figure 1: Shellfish samples were collected from biotoxin monitoring sites in 2018 (blue circles). Seawater samples were collected from the phytoplankton monitoring sites (purple diamonds). The blue areas are the Scottish Marine Regions (SMRs) and the Offshore Marine Regions (OMRs). Source: FSS

Results

Amnesic shellfish toxins were most prevalent between May and September, coinciding with blooms of *Pseudo-nitzschia* in the plankton. Between 2010 and 2018, six harvesting sites were closed due to elevated levels of these toxins in shellfish. The highest reported concentration was almost two and a half times the regulatory limit (the allowable amount) and was found in mussels from the Clyde in May 2016. Amnesic shellfish toxins above the regulatory limit were also found in mussels from Argyll in August 2012, cockles from the Outer Hebrides in August 2013, and razor clams collected from both the Outer Hebrides and the Clyde in June 2016. Toxin concentrations varied considerably between years and both frequency of occurrence and intensity were relatively low in 2015 and 2018.

Paralytic shellfish toxins were present between March and September, coinciding with *Alexandrium* detected in coastal waters from early spring into late summer. Raised levels of toxins resulted in the closure of sites on sixty-three occasions between 2010 and 2018. Exceptionally high toxin concentrations were recorded in mussels from the Clyde in April 2015, with the highest being almost thirty-five times the regulatory limit. High concentrations were also observed in mussels from other sites in the Clyde in June 2014, May 2015 and April 2016. Fifteen sites around the Clyde, Argyll, the West Highlands, and the Outer Hebrides were closed in 2015. In contrast, no harvesting sites were closed as a result of paralytic shellfish toxins in 2010, and only two sites were affected in 2016, both in the Clyde area.

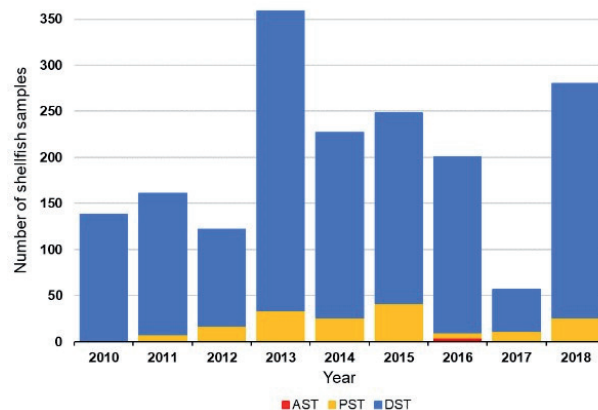


Figure 2: Number of shellfish samples in each year when the main biotoxin groups exceeded maximum permitted levels. AST = Amnesic Shellfish Toxins; PST = Paralytic Shellfish Toxins; DST = Diarrhetic Shellfish Toxins.

Toxins associated with diarrhetic shellfish poisoning were present in shellfish in every month of the year, but most of the occurrences above the regulatory limit were between June and September. Between 2010 and 2018, 286 sites were affected, with some sites being closed on more than one occasion within the same year. One such harvesting ban in 2012 at a mussel site in the Clyde lasted for 28 weeks. Forty-one harvesting sites were closed in 2013 as a result of diarrhetic shellfish toxins, and thirty-five were closed in 2018. By

comparison, in 2017 only fifteen sites were affected. A high toxin concentration of over 43 times the regulatory limit was recorded in mussels from the Shetland Isles in July 2013. This was linked to seventy reported cases of diarrhetic shellfish poisoning. *Dinophysis* bloomed most frequently between June and August, and was especially abundant in 2013 and 2018, with some dense blooms observed in the Clyde, the West Highlands, and the Shetland Isles between 2016 and 2018. Toxins produced by other organisms (*Azadinium* and *Amphidoma*) were at their highest in late summer and autumn, with periods of shellfish contamination through the winter, particularly in 2011, 2012 and 2013.

Conclusion

The marine algae, *Pseudo-nitzschia*, is found in coastal waters all year round, but only blooms when environmental conditions become favourable. *Pseudo-nitzschia* does not always produce biotoxins, and the amount of toxin contained within each individual algal cell is variable. Contamination of shellfish with amnesic shellfish toxins was usually preceded by, or coincided with, an

increase in *Pseudo-nitzschia* blooms, but rarely resulted in the closure of harvesting sites.

Similarly, *Alexandrium* does not always produce paralytic shellfish toxins, but shellfish harvesting sites were closed in most years when toxin concentrations reached high levels. Due to the formation of *Alexandrium* cyst beds, contamination of shellfish tends to occur at the same locations every year.

Toxins that cause diarrhetic shellfish poisoning were almost always associated with increased levels of *Dinophysis*, and dense blooms were occasionally observed. Sometimes it took several months for the shellfish to eliminate the toxins and become safe to eat again. Diarrhetic shellfish toxins produced by other algae were found between 2011 and 2013 but have only been detected at low concentrations since then.

Some exceptional biotoxin events between 2010 and 2018 highlight the importance of the regulatory biotoxin and phytoplankton monitoring programmes to protect both human health and the rural economy.



















Knowledge gaps

Not all shellfish harvesting sites were monitored for both biotoxins and phytoplankton. Where this was the case, and the frequency of routine biotoxin testing was less than weekly, the lack of phytoplankton counts may have led to toxin events being missed, as no additional biotoxin tests were scheduled. When sites were subject to closure due to the presence of toxins above regulatory limits, testing was not performed for other toxin groups, even when the phytoplankton results indicated an increased risk. Hence, the occurrence of amnesic and paralytic shellfish toxins may have been underestimated, due to extended site closures for diarrhetic shellfish toxins.

Status and trend assessment

Due to high variability in both the presence of potentially toxic phytoplankton above threshold level, and the frequency and intensity of biotoxin events between 2010 and 2018, it is not possible to identify any discernible trend regarding on overall increase or decline in the toxin contamination of shellfish.

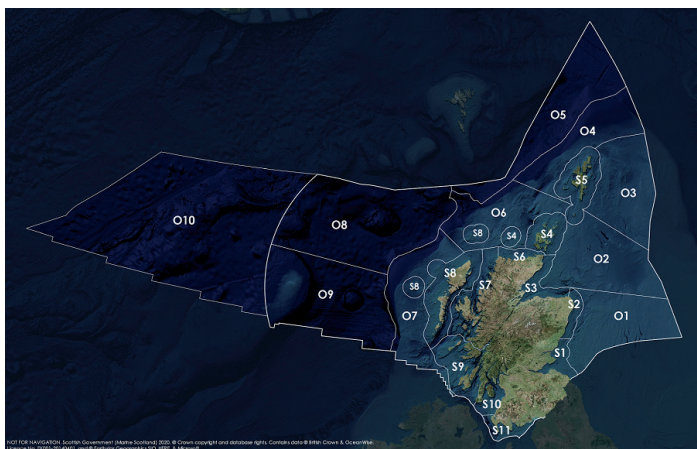
Status and trend assessment legend

| Status assessment (for Clean and safe, Healthy and biologically diverse assessments) | | Trend assessment (for Clean and safe, Healthy and biologically diverse and Productive assessments) | |
|---|---|---|----------------------|
|  | Many concerns |  | No / little change |
|  | Some concerns |  | Increasing |
|  | Few or no concerns |  | Decreasing |
|  | Few or no concerns, but some local concerns |  | No trend discernible |
|  | Few or no concerns, but many local concerns |  | All trends |
|  | Some concerns, but many local concerns | Confidence assessment | |
|  | Lack of evidence / robust assessment criteria | | |
|  | Lack of regional evidence / robust assessment criteria, but no or few concerns for some local areas |  | Low |
|  | Lack of regional evidence / robust assessment criteria, but some concerns for some local areas |  | Medium |
|  | Lack of regional evidence / robust assessment criteria, but many concerns for some local areas |  | High |

Overall confidence

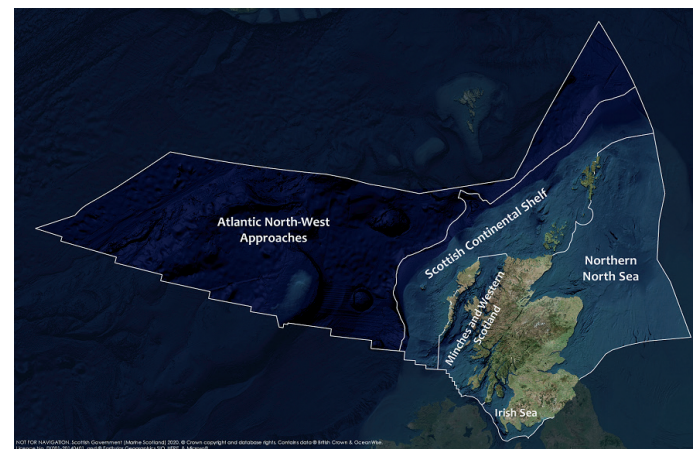


Assessment regions

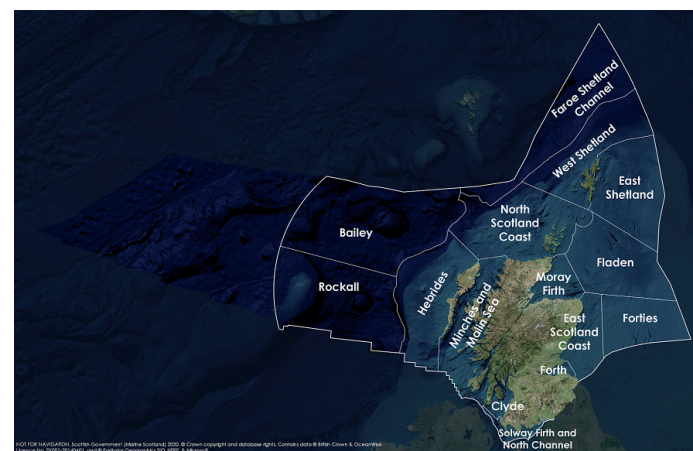


The Scottish Marine Regions (SMRs; S1 - S11) and the Scottish Offshore Marine Regions (OMRs, O1 - O10)

Key: S1, Forth and Tay; S2, North East; S3, Moray Firth; S4 Orkney Islands; S5, Shetland Isles; S6, North Coast; S7, West Highlands; S8, Outer Hebrides; S9, Argyll; S10, Clyde; S11, Solway; O1, Long Forties, O2, Fladen and Moray Firth Offshore; O3, East Shetland Shelf; O4, North and West Shetland Shelf; O5, Faroe-Shetland Channel; O6, North Scotland Shelf; O7, Hebrides Shelf; O8, Bailey; O9, Rockall; O10, Hatton.



Biogeographic, Charting Progress 2 (CP2) Regions. These have been used as the assessment areas for hazardous substances.



Scottish Sea Areas as used in Scotland's Marine Atlas 2011. These are sub divisions of the biogeographic, or Charting Progress 2 (CP2), Regions.