An evaluation of Paralytic Shellfish Toxin occurrence and magnitude around the UK coast since 2008; using chemotaxonomy to maximise routine monitoring data

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Introduction

HABs are becoming a more serious issue as their frequency increases. This is partly due to new or improved monitoring but expansion of HABs in well monitored areas has also been documented (Anderson 2009). The UK is potentially at threat from expanding populations or more severe incidents of resident HAB species. The UK has a well-established monitoring programme conducted on behalf of the UK Competent Authorities for classified shellfish. Cefas provides this toxin monitoring for Great Britain. Here monitoring data has been used to evaluate recent changes in occurrence of toxins in shellfish and the implications this has for causative algal species. We aim to determine if PST toxicity levels and timing can be used alongside toxin profile to determine the likely identity of the causative species.

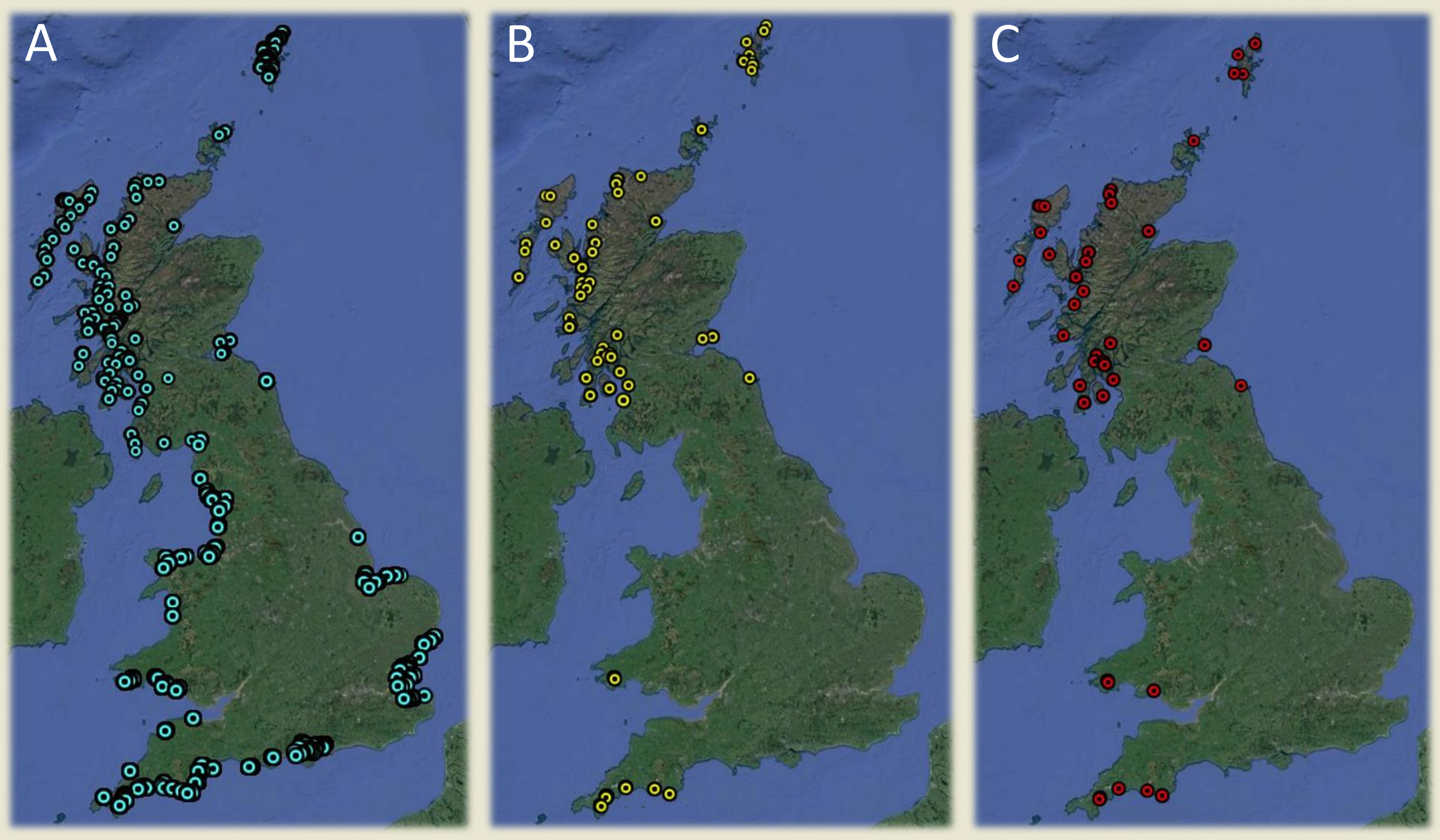

Figure 1: Map series showing distribution of monitoring sites and occurrence of PSTs in classified shellfish. A: monitoring sites from 2011 – present. B: PSTs above the reporting limit (RL) - 160µg STX eq/kg but below the maximum permitted level (MPL) – 800µg STX eq/kg . C: PSTs detected above the MPL - 800µg STX eq/kg

- PSTs are confined to Scotland and a few areas in South West England and Wales.
- Many sites which have experienced low levels of PSTs have also breached regulatory limits.
- The West coast of Scotland is the most heavily affected but also the most heavily monitored.

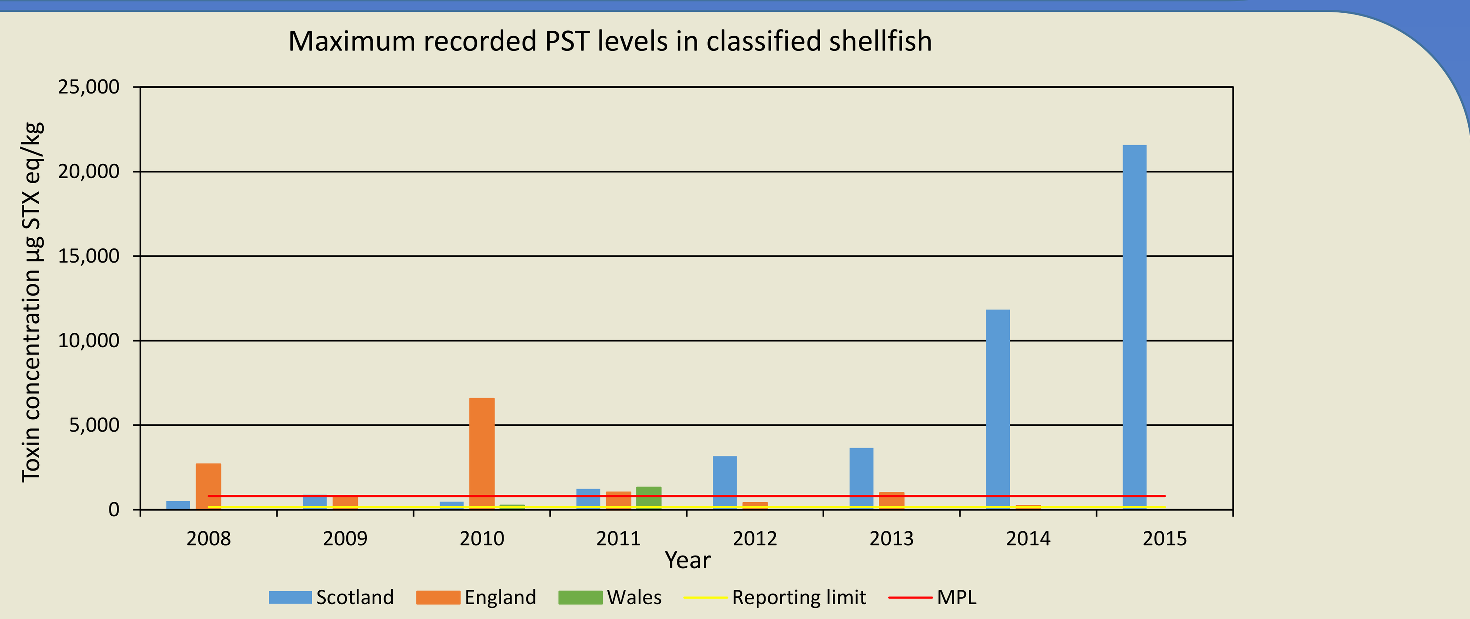

Figure 2: Histogram displaying maximum detected PST concentration by country. Reporting limit (RL) and maximum permitted level (MPL) are displayed for context.

- The peak toxicity of events in Scotland has increased in recent years.
- Peak toxicity of events in England and Wales have been more variable, notable highs have occurred during 2008 at Holy Island and 2010 in the Fowey.

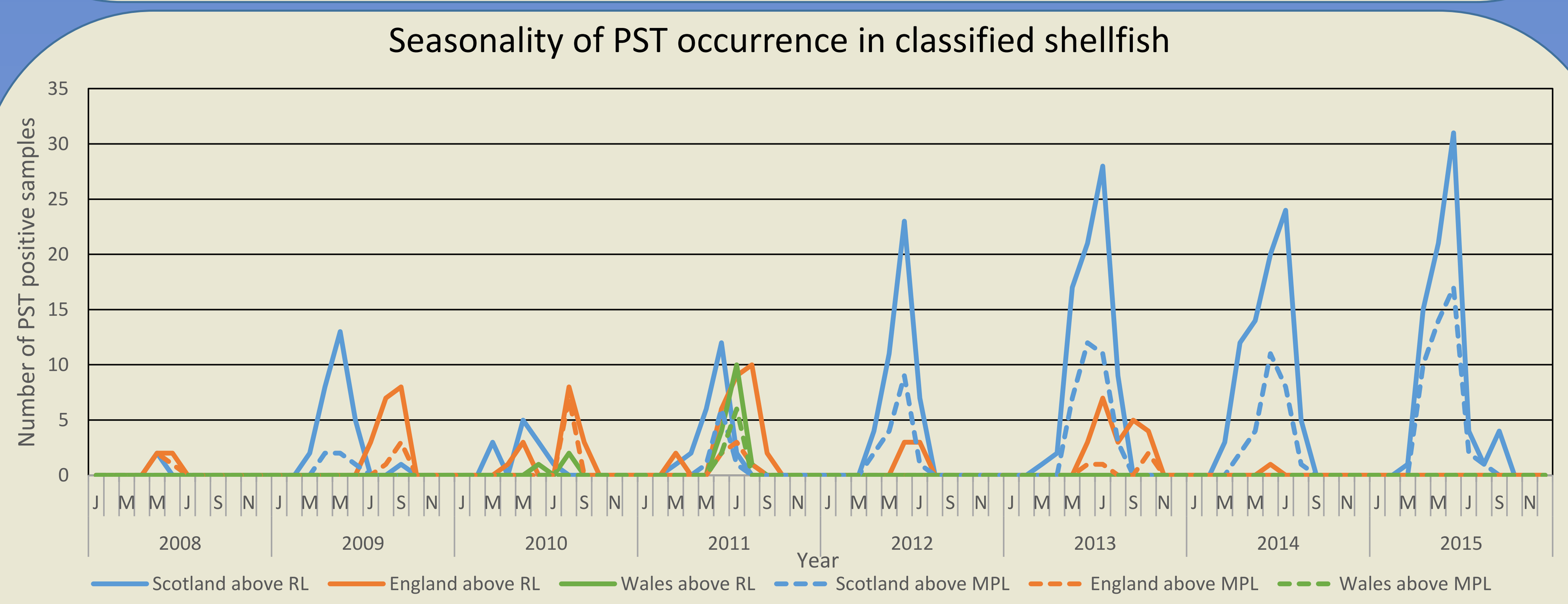

Figure 3: Line graph displaying total number of samples returning PST values above the reporting limit (RL) and those with concentrations above the maximum permitted level (MPL), by country.

- The annual Scottish toxicity event begins in early spring, consistently earlier than that in England and Wales.
- In 2008 events in Scotland and England overlap. In England the site was situated in the NE and the PST profile in *Mytilus sp.* was similar to that seen in Scotland rather than SW England & Wales.
- High levels of PSTs follow a similar trend to all reported positives.

- Dinoflagellates belonging to the genus *Alexandrium* are known to produce PSTs around GB.
- Definitive identifications of causative organisms for all affected shellfish sites remain rare.
- Utilisation of chemotaxonomy, based upon toxin profiles in shellfish can offer a tool for tentative identification.
  - A number of issues with this approach have been highlighted, principally variability of toxin profile within a species.
  - Due to variability of toxin profile in different shellfish species data presented below are for *Mytilus sp.* only.

Table 1: Showing average toxin composition of PST profile in *Mytilus sp.* since 2008 nationally and from 3 selected sites, showing a range of variability, each from the FSS and FSA monitoring programme.

Area	Scotland		Loch Slapin		Sound of Gigha		Dornoch Firth	
	Profile composition	Relative Standard Deviation	Profile composition	Relative Standard Deviation	Profile composition	Relative Standard Deviation	Profile composition	Relative Standard Deviation
GTX 1/4	49.5%	20.3%	55.8%	25.2%	60.0%	29.2%	64.1%	20.6%
dcNEO	0.2%	448.7%	0.0%		0.0%		0.0%	
NEO	11.0%	40.5%	9.1%	93.6%	8.8%	55.8%	5.7%	101.7%
dcGTX 2/3	0.8%	211.8%	0.2%	336.8%	1.5%	277.4%	0.2%	372.1%
C 1/2	2.7%	45.1%	3.3%	47.9%	1.6%	20.4%	5.1%	38.1%
dcSTX	0.2%	88.2%	0.1%	222.7%	0.1%	213.2%	0.1%	387.3%
GTX 2/3	12.0%	23.7%	10.8%	44.5%	10.9%	16.9%	13.9%	48.8%
GTX 5	0.4%	99.4%	0.3%	120.6%	0.1%	181.8%	0.5%	164.7%
STX	23.3%	33.0%	20.4%	40.0%	17.0%	71.2%	10.4%	43.8%
Area	England & Wales		Fal		Fowey		Milford Haven	
	Profile composition	Relative Standard Deviation	Profile composition	Relative Standard Deviation	Profile composition	Relative Standard Deviation	Profile composition	Relative Standard Deviation
GTX 1/4	0.2%	70.5%	0.2%	692.8%	0.2%	305.0%	0.3%	424.3%
dcNEO	0.0%		0.0%		0.0%		0.0%	
NEO	0.0%		0.0%		0.0%		0.0%	
dcGTX 2/3	0.2%	33.8%	0.3%	265.1%	0.2%	230.2%	0.1%	293.1%
C 1/2	0.4%	79.0%	0.2%	245.7%	0.8%	72.8%	0.2%	169.4%
dcSTX	0.1%	40.4%	0.2%	250.6%	0.1%	180.3%	0.1%	172.2%
GTX 2/3	73.3%	24.9%	89.4%	7.5%	64.7%	18.5%	87.3%	10.7%
GTX 5	0.0%	200.0%	0.0%		0.0%	255.1%	0.0%	
STX	25.9%	70.3%	9.8%	65.0%	34.0%	34.6%	12.0%	78.3%

- Toxin profile differs between *Mytilus sp.* from Scotland and England & Wales.
- Variability of profiles is high over broad geographic ranges.
- Profile variability is lower on a per site basis.
  - Principle toxins (>50% of profile) vary by as little as 7.5%.
- England and Wales show reduced variability compared with Scotland but have a less complex profile.
- Using chemotaxonomy to compare shellfish toxin profiles and those from literature causative organisms are suspected to be:
  - *Alexandrium minutum*, England and Wales (profile dominated by GTX 3, trace N-hydroxylated toxins). (Nascimento et al 2005, Percy 2006)
  - *Alexandrium tamarense* Scotland (Complex profile containing N-hydroxylated toxins). (Brown *et al.* 2010)

Conclusions

- Distribution of PST events remains limited in England and Wales with a broader but fairly consistent distribution around Scotland.
- The annually recorded levels of total PSTs has been increasing in recent years around the coast of Scotland.
- Seasonally the annual Scottish events occur earlier, potentially due to a different causative species or different climatic conditions.
- Seasonally events in England and Wales cluster together.
- Toxin profile shows a divide between the North and South. (Turner *et al.* 2013)
- Toxin profiles exhibit reasonable local stability, accounting for the natural variability associated with broad temporal scales.
- Inference of causative organism adds context to monitoring efforts, supports analysts and allows for targeted further work.
- Chemotaxonomy can be combined with routine plankton monitoring data to strengthen identification.
- Long term data sets can be analysed to investigate toxin profile stability of natural populations to discover the real world variance within toxic species.

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