is there a planktonic signal?
Objectives

INSITE

“The magnitude of the effects of man-made structures compared to the spatial and temporal variability of the North Sea ecosystem, considered on different time and space scales”
Objectives

**INSITE**

“The magnitude of the effects of man-made structures compared to the spatial and temporal variability of the North Sea ecosystem, considered on different time and space scales”

**SIGNAL**

“The magnitude of the effects of man-made structures compared to the spatial and temporal variability of the North Sea ecosystem, considered on different time and space scales”
Objectives

**INSITE**

“The magnitude of the effects of man-made structures compared to the spatial and temporal variability of the North Sea ecosystem, considered on different time and space scales”

**SIGNAL**

“The magnitude of the effects of man-made structures compared to the spatial and temporal variability of the North Sea ecosystem, considered on different time and space scales”
Objectives

INSITE

“The magnitude of the effects of man-made structures compared to the spatial and temporal variability of the North Sea ecosystem, considered on different time and space scales”

SIGNAL

“The magnitude of the effects of man-made structures compared to the spatial and temporal variability of the North Sea ecosystem, considered on different time and space scales”
Plankton: Why?

the first layer of the oceanic food chain
Plankton: Why?

Fundamental compartment in Ecosystems

Trap carbon

oxygen

Plankton Science for Our Future Oceans

www.sahfos.ac.uk
Plankton: Why?

Fundamental compartment in Ecosystems

Trap carbon

Oxygen

Food

www.sahfos.ac.uk

Plankton Science for Our Future Oceans
Plankton: Why?

Fundamental compartment in Ecosystems

Trap carbon

oxygen

Food

Resilience

Bioresource

www.sahfos.ac.uk

Plankton Science for Our Future Oceans
SAHFOS: About Us

Ships of opportunity (SOOPS)

Sir Alister Hardy Foundation for Ocean Science
Plankton Science for Our Future Oceans

www.sahfos.ac.uk
SAHFOS: Continuous Plankton Recorder

A platform for Integrated Ocean Observing

Sir Alister Hardy Foundation for Ocean Science
Plankton Science for Our Future Oceans

Plankton Science for Our Future Oceans

www.sahfos.ac.uk
CPR: from 1931 to present

longest running, most extensive marine ecological survey

6,647,274 nm (32x Earth-Moon)

> 250,000 samples

> 175,000,000 biological records
SAHFOS: North Sea

longest running, most extensive marine ecological survey

From 1970 to 2015
~55000 samples

Per year
~1200 samples

Per Month
~100 samples

www.sahfos.ac.uk

Plankton Science for Our Future Oceans
Objectives

“The magnitude of the effects of man-made structures compared to the spatial and temporal variability of the North Sea ecosystem, considered on different time and space scales”
Objectives

“The magnitude of the effects of man-made structures compared to the spatial and temporal variability of the North Sea ecosystem, considered on different time and space scales”
Objectives

"The magnitude of the effects of man-made structures compared to the spatial and temporal variability of the North Sea ecosystem, considered on different time and space scales"

Signal

Planktonic

~800 taxa

Selection

www.sahfos.ac.uk
Data: plankton selection

MMS = artificial substrate

Data: plankton selection

MMS = artificial substrate

Echinoderms (starfish)

Planktonic

Benthic


www.sahfos.ac.uk

Plankton Science for Our Future Oceans
Data: plankton selection

Meroplankton: Only a part of their lives as plankton

Copyright Robin K Herman. Scientific Illustrator. www.rkherman.net
Data: plankton: selection

Holoplankton as a “control”

Meroplankton

Holoplankton

www.sahfos.ac.uk

Plankton Science for Our Future Oceans
Data: plankton: selection

10 taxa or groups

Holoplankton  Meroplankton  Echinoderms larvae  Decapods larvae  Phytoplankton  Copepods

www.sahfos.ac.uk  Plankton Science for Our Future Oceans
Data: Man-Made Structures (MMS)

~1500 MMS
Data: Man-Made Structures (MMS)

~1500 MMS

www.sahfos.ac.uk

Plankton Science for Our Future Oceans
Data: Man-Made Structures (MMS)

~1500 MMS

MMS positions

Weight underwater

www.sahfos.ac.uk

Plankton Science for Our Future Oceans
Data: Area selection

Areas with MMS and high quality biology

www.sahfos.ac.uk

Plankton Science for Our Future Oceans
Data: Area selection

Areas with MMS and high quality biology
Signals: Extraction

Meroplankton
Signals: Extraction

Meroplankton

Physical environment

Timeseries

www.sahfos.ac.uk
Signals: Extraction

Meroplankton

Physical environment

Timeseries

www.sahfos.ac.uk  Plankton Science for Our Future Oceans
Objectives

**SIGNAL**

“The signal of man-made structures compared to the spatial and temporal variability of the North Sea planktonic ecosystem, considered on different time and space scales”
Objectives

**SIGNAL**

“The signal of man-made structures compared to the spatial and temporal variability of the North Sea planktonic ecosystem, considered on different time and space scales”

Domination of environment
Objectives

**SIGNAL**

“The signal of man-made structures compared to the spatial and temporal variability of the North Sea planktonic ecosystem, considered on different time and space scales”

**Domination of environment**

**Notion of temporal scales**

- Influence throughout all scales
- Influence at small scales (month)
- Influence at medium scales (seasons)
- Influence at large scales (years)
Treat the signals: investigate scales
Treat the signals: investigate scales

Timeseries

dbMEM
Treat the signals: investigate scales

- Large (several years)
- Medium (seasonal)
- Fine (several months)
- Very Fine (few months)

Timeseries

dbMEM

www.sahfos.ac.uk

Plankton Science for Our Future Oceans
Treat the signals: investigate scales
Treat the signals: investigate scales

Timeseries = raw signals

All scales are mixed (from months to decades)
Treat the signals: investigate scales

dbMEM

All scales

Large scales
Treat the signals: investigate scales

Pure large scales signal
Focused on inter-annual variability
Treat the signals: investigate scales

- All scales
- Seasonal scales
Treat the signals: investigate scales

Pure medium scales signal
Focused seasonal variability
Results

Meroplankton signal at large temporal scales: 1 area
Results

Meroplankton signal at large temporal scales: all 21 areas
Results

Meroplankton signal at large temporal scales: all 21 areas
Results

Meroplankton at large temporal scales
Results

Mero plankton at large temporal scales
Results

Meroplankton at large temporal scales versus MMS
Results

Merooplankton at large temporal scales *versus* SST
Results

Meroplankton at large temporal scales *versus* Wind
All results

21 areas of interest

10 species/groups of plankton

4 environmental parameters

4 scales investigated
All results

21 areas of interest

10 species/groups of plankton

4 environmental parameters

4 scales investigated

~300 timeseries

~1200 models

~3000 correlations
## All results

### All results large scales

<table>
<thead>
<tr>
<th>Pixels</th>
<th>C. finmarchicus'</th>
<th>C. helgolandicus'</th>
<th>C. longipes'</th>
<th>Decapod'</th>
<th>Echinoderm'</th>
<th>Meroplankton'</th>
<th>PCI</th>
<th>Sea Surface Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>-0.20</td>
<td>0.15</td>
<td>0.22</td>
<td>0.14</td>
<td>0.34</td>
<td>0.11</td>
<td>0.38</td>
<td>0.11</td>
</tr>
<tr>
<td>47</td>
<td>0.31</td>
<td>0.31</td>
<td>0.31</td>
<td>0.18</td>
<td>0.18</td>
<td>0.18</td>
<td>0.11</td>
<td>0.31</td>
</tr>
<tr>
<td>62</td>
<td>0.34</td>
<td>0.31</td>
<td>0.31</td>
<td>0.18</td>
<td>0.18</td>
<td>0.18</td>
<td>0.11</td>
<td>0.31</td>
</tr>
<tr>
<td>67</td>
<td>0.35</td>
<td>0.35</td>
<td>0.35</td>
<td>0.23</td>
<td>0.23</td>
<td>0.23</td>
<td>0.23</td>
<td>0.23</td>
</tr>
<tr>
<td>68</td>
<td>0.36</td>
<td>0.36</td>
<td>0.36</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>71</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.28</td>
<td>0.28</td>
<td>0.28</td>
<td>0.28</td>
<td>0.28</td>
</tr>
<tr>
<td>72</td>
<td>0.38</td>
<td>0.38</td>
<td>0.38</td>
<td>0.31</td>
<td>0.31</td>
<td>0.31</td>
<td>0.31</td>
<td>0.31</td>
</tr>
<tr>
<td>73</td>
<td>0.39</td>
<td>0.39</td>
<td>0.39</td>
<td>0.33</td>
<td>0.33</td>
<td>0.33</td>
<td>0.33</td>
<td>0.33</td>
</tr>
<tr>
<td>74</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
<td>0.35</td>
<td>0.35</td>
<td>0.35</td>
<td>0.35</td>
<td>0.35</td>
</tr>
<tr>
<td>76</td>
<td>0.41</td>
<td>0.41</td>
<td>0.41</td>
<td>0.38</td>
<td>0.38</td>
<td>0.38</td>
<td>0.38</td>
<td>0.38</td>
</tr>
<tr>
<td>77</td>
<td>0.42</td>
<td>0.42</td>
<td>0.42</td>
<td>0.41</td>
<td>0.41</td>
<td>0.41</td>
<td>0.41</td>
<td>0.41</td>
</tr>
<tr>
<td>78</td>
<td>0.43</td>
<td>0.43</td>
<td>0.43</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
</tr>
<tr>
<td>79</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.46</td>
<td>0.46</td>
<td>0.46</td>
<td>0.46</td>
<td>0.46</td>
</tr>
<tr>
<td>81</td>
<td>0.45</td>
<td>0.45</td>
<td>0.45</td>
<td>0.48</td>
<td>0.48</td>
<td>0.48</td>
<td>0.48</td>
<td>0.48</td>
</tr>
<tr>
<td>83</td>
<td>0.46</td>
<td>0.46</td>
<td>0.46</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>92</td>
<td>0.47</td>
<td>0.47</td>
<td>0.47</td>
<td>0.52</td>
<td>0.52</td>
<td>0.52</td>
<td>0.52</td>
<td>0.52</td>
</tr>
<tr>
<td>93</td>
<td>0.48</td>
<td>0.48</td>
<td>0.48</td>
<td>0.54</td>
<td>0.54</td>
<td>0.54</td>
<td>0.54</td>
<td>0.54</td>
</tr>
<tr>
<td>94</td>
<td>0.49</td>
<td>0.49</td>
<td>0.49</td>
<td>0.56</td>
<td>0.56</td>
<td>0.56</td>
<td>0.56</td>
<td>0.56</td>
</tr>
<tr>
<td>95</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.58</td>
<td>0.58</td>
<td>0.58</td>
<td>0.58</td>
<td>0.58</td>
</tr>
<tr>
<td>98</td>
<td>0.51</td>
<td>0.51</td>
<td>0.51</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
</tr>
</tbody>
</table>

---

**www.sahfos.ac.uk**

**Plankton Science for Our Future Oceans**
Synthesis

is there a planktonic signal?
Is there a planktonic signal?

Signals in plankton are linked with environment (STT)
Especially at large and seasonal scales
Below seasonal level, it is very hard to get a clear signal
Synthesis

**SIGNAL**

is there a planktonic signal?

Signals in plankton are linked with environment (STT)
Especially at large and seasonal scales
Below seasonal level, it is very hard to get a clear signal

Remove environmental signal from biology
Remaining signal can’t be explain by MMS
Conclusion

SIGNAL

is there a planktonic signal?

No. At least not a those scales.
Future research opportunities

Exploring finer scales => need new data
Future research opportunities

Exploring finer scales => need new data

New Measurements

Fluorometer
+ oil detection

Holographic particle imager

www.sahfos.ac.uk

Plankton Science for Our Future Oceans
Future research opportunities

Exploring finer scales => need new data

New Measurements
Fluorometer + oil detection
Holographic particle imager

Sampling
New routes
Security ships

www.sahfos.ac.uk
Plankton Science for Our Future Oceans
Future research opportunities

Exploring finer scales => need new data

New Measurements
- Fluorometer + oil detection
- Holographic particle imager

Sampling
- New routes
- Security ships

New CPR
- Static CPR
- Mini CPR

www.sahfos.ac.uk

Plankton Science for Our Future Oceans
Thank you.