Overview of Solent Eutrophication and Recovery (External)

Background

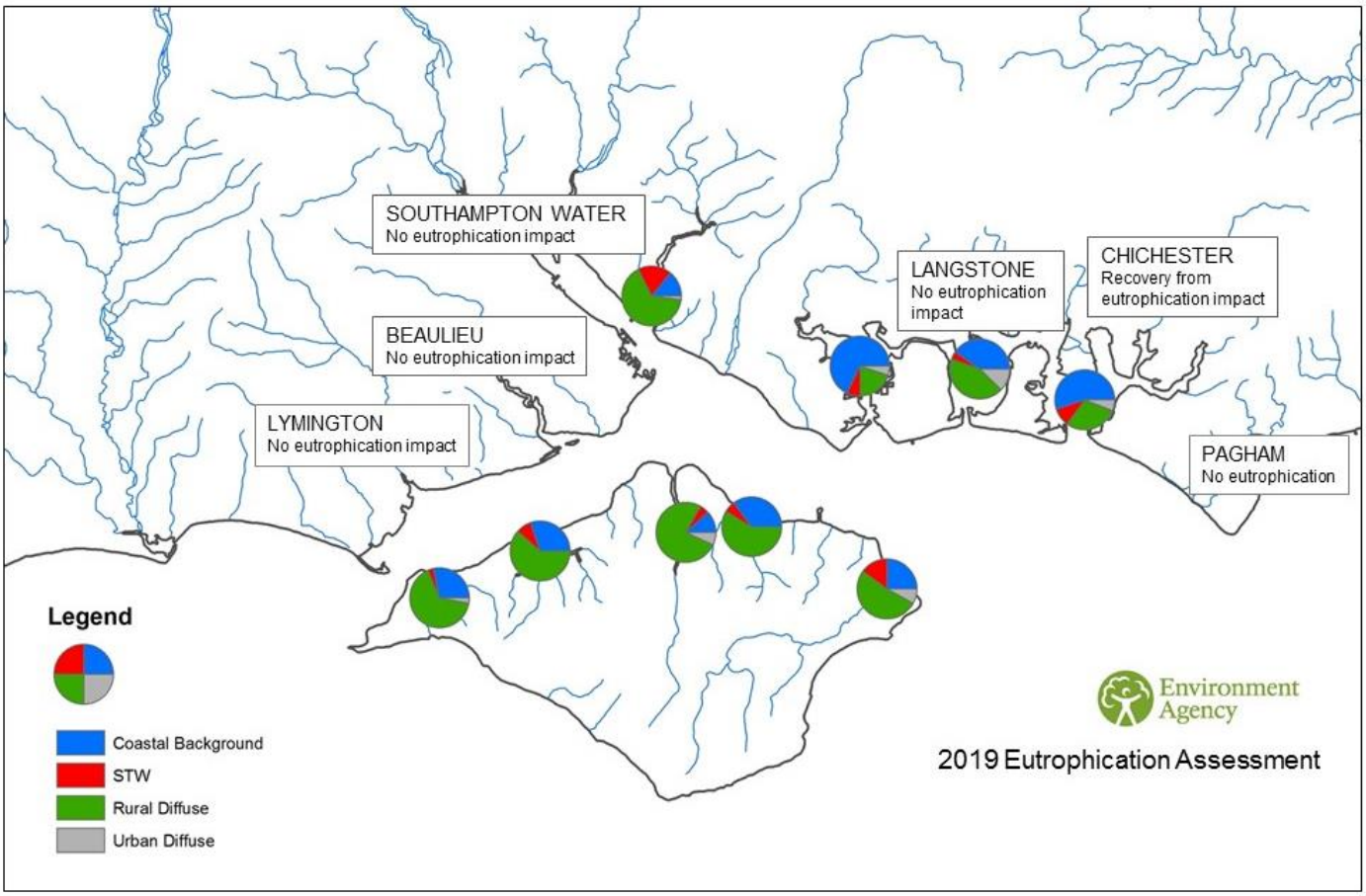
Nitrogen (especially nitrate) enrichment in some Solent estuaries has contributed to the excessive growth of green macroalgae on intertidal mudflats (Figure 1) which can have adverse effects on ecology, eg impacts on birds.

Figure 1 Green macroalgae (Chichester Harbour)

This process is known as eutrophication. Note that the problem is not nitrate concentration per se but the effect on ecology in some Solent estuaries – there are much higher nitrate levels elsewhere around the UK with no adverse effect on ecology. The levels of nitrate are elevated in the Solent, enough to stimulate plant growth in some locations, but they are not high. The Solent does not have problem phytoplankton blooms.

Source apportionment work has confirmed that the main sources of nitrogen (N) to Solent estuaries are diffuse sources from agriculture (on average about 50% N is from agriculture, often via rivers) and point sources from sewage discharges (on average about 10% N is from sewage). The remainder includes coastal background and urban sources. The exact proportions vary between different estuaries. Figure 2 shows the proportion of N sources in estuaries around the Solent and highlights the estuaries where there are no eutrophication impacts as levels of macroalgae achieve Good status.

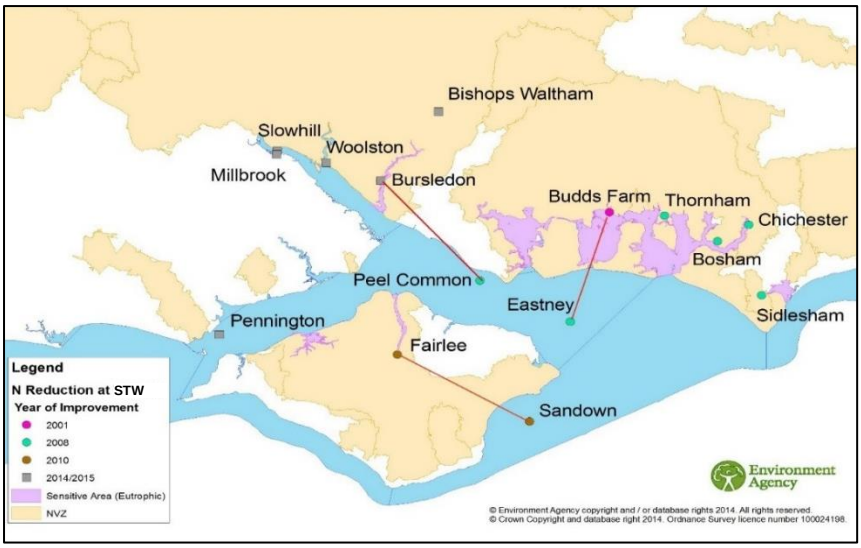
Figure 2 Sources of Nitrogen into Solent Estuaries



Nutrient reductions

The Environment Agency has been aware for several decades of eutrophication in some Solent estuaries. Consequently, during this time we have undertaken a series of eutrophication reviews and used regulatory means to reduce nitrogen inputs (see Appendix 3). These N reductions have included N removal from sewage discharges from both marine and riverine environments (via the Urban Waste Water Treatment Directive (UWWTD) and Habitats Directive) and reduced N inputs from agriculture (via the Nitrates Directive, which enabled designation of Nitrate Vulnerable Zones (NVZ) and subsequent actions required by farmers). Figure 3 summarises the designated eutrophic areas in the Solent and the regulatory measures that have been required to reduce N inputs.

Figure 3 Solent designated Sensitive Areas (Eutrophic) and locations of regulatory Nitrogen reductions



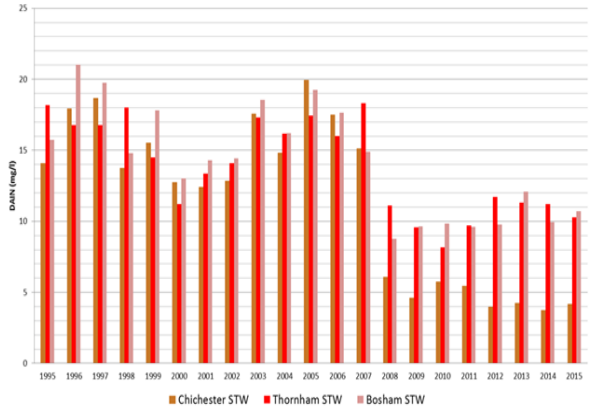
Notes: The Eastern Yar (Bembridge Harbour) also has a eutrophication designation – it is a Polluted Water (Eutrophic). Woolston STW was improved in 2018.

Figure 3 shows that most of the Solent is a designated NVZ, especially those areas that drain to eutrophic waters. The NVZ designations occurred in 2008 so for many years subsequently, landowners in NVZs have had to reduce N inputs to water. A 2015 study by ADAS[1] suggests that as a result of NVZ designations in the Solent area, N inputs from agriculture to Solent estuaries have decreased by 8% on average. Voluntary measures such as Catchment Sensitive Farming and Environmental Stewardship schemes have resulted in additional, smaller reductions.

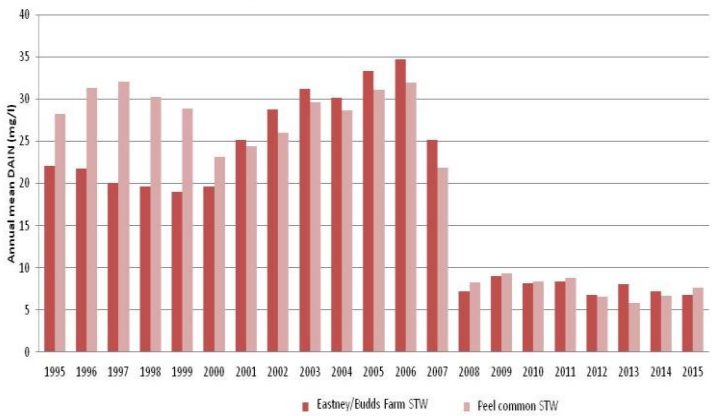
Figure 3 also shows the 11 sewage treatment work (STW) discharges to rivers or marine/estuarine waters that have had N reductions via changes to their permits, and the 3 sewage discharges that have been moved out of estuaries. These improvements have been delivered between 2001 and 2018, so some have had time to contribute to environmental improvement, others are too recent. EA data confirms that N in the improved discharges has generally decreased by over half, although this varies with individual STW discharges. Figure 4 shows an example of the decrease in N from some of these discharges. Significant reductions in N from STW discharges have occurred throughout the Solent area, despite population growth in the catchments. N reductions were based on each STW's 'fair-share' contribution to eutrophication and the permits included a small allowance for development growth up to 'headroom'.

Figure 4 – Nitrogen reductions at example sewage discharges that were improved in 2008

(i) Discharges into Chichester Harbour



(ii) Discharges into the Solent



Environmental Recovery

As a result of all the reductions in N that have occurred over the last 20 years, we are now seeing reduced amounts of green macroalgae in several Solent estuaries, plus other encouraging signs of recovery. As predicted, it has taken time to see signs of recovery due to biological time lag and the influence of groundwater. Figure 5 shows photos illustrating the reduction in macroalgal biomass in Chichester and Portsmouth Harbours from 2004/2011 to 2019. Note that the amount of macroalgae does vary annually due to environmental factors (eg wet winters flush more nutrients into estuaries which fuel spring growth), but EA data confirms that both harbours demonstrate sustained reductions in macroalgae compared to historic levels of growth. Indeed, some harbours, such as Chichester and Langstone Harbours, now meet their target classifications of GOOD status for macroalgae under the Water Framework Directive (WFD) which achieves their Natura 2000 eutrophication objective set in 2015 ('*Improve water quality to a level that biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) achieve GOOD WFD overall status').* Natura 2000 objectives that were agreed in 2015 are shown in Appendix 1.

Figure 5 Photos showing reducing macroalgal cover in Chichester Harbour and Portsmouth Harbour

Chichester Harbour at Dell Quay in July 2011 and July 2019

Portsmouth Harbour at Grove Avenue July 2004 and July 2019

Other significant signs of recovery from eutrophication in Solent estuaries, and signs and improved water quality, include the following:

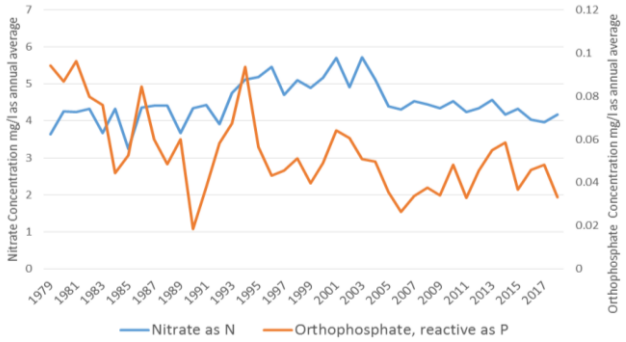
1. Pagham Harbour now meets its target classification of GOOD status for macroalgae under WFD (in addition to Langstone Harbour and Chichester Harbour as mentioned above). Portsmouth Harbour's macroalgae classification has improved and is now on the Good/Moderate boundary.
2. In estuaries where buried* macroalgae was recorded frequently (eg Chichester and Portsmouth Harbours) it is no longer found.
3. In estuaries where macroalgae used to persist throughout the winter* months it is now significantly reduced or no longer persists.
4. In Portsmouth Harbour seagrass beds are extending - one of the original macroalgae survey sites is now within a seagrass bed!
5. In Chichester harbour, we recorded seagrass during the 2018 macroalgae survey in locations we have never seen it before.
6. Seahorses are now frequently observed in surveys in Southampton Water and Chichester Harbour.

**See Appendix 2 for notes on the relevance of buried and over wintering macroalgae to environmental recovery.*

Environmental improvement in Rivers

Many Solent rivers are no longer increasing in N and some are even decreasing in N. In addition phosphorus (P), mostly as phosphate, is decreasing in most rivers as a result of improvement actions and reductions in detergents over many years. (P is also a plant nutrient and is needed for growth; P tends to be the limiting nutrient for plant growth in freshwaters whereas in saline waters N is usually the limiting nutrient). Figure 6 shows slowly reducing concentrations of N in the River Medina since its peak in 2001, along with a general trend of reduced P over a longer period.

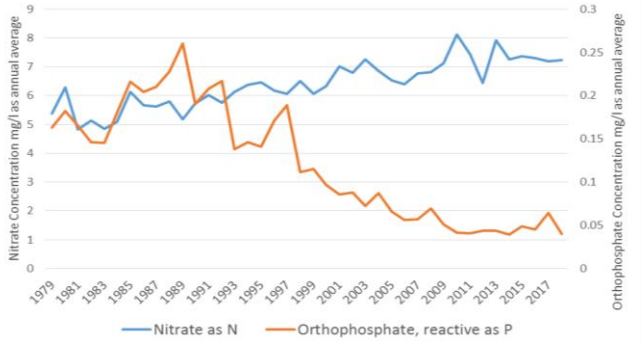
Figure 6: Trends in concentrations of N and P in the River Medina (at Shide Wier)



Environmental improvement in Groundwater

But some rivers like the Test & Itchen are strongly fed by groundwater which can 'hold up' historic N for many years, and so N in these rivers is still increasing. Current N concentrations in such rivers reflect historic farming practices. Figure 7 shows N and P concentrations in the River Test. N continues to rise due to the influence of groundwater, but P (which is not 'held up' in groundwater) is reducing due to improvement actions in the catchment. Once younger groundwater comes through, which is lower in N, we will see even more environmental improvement.

Figure 7: Trends in concentrations of N and P in the River Test (at Testwood)



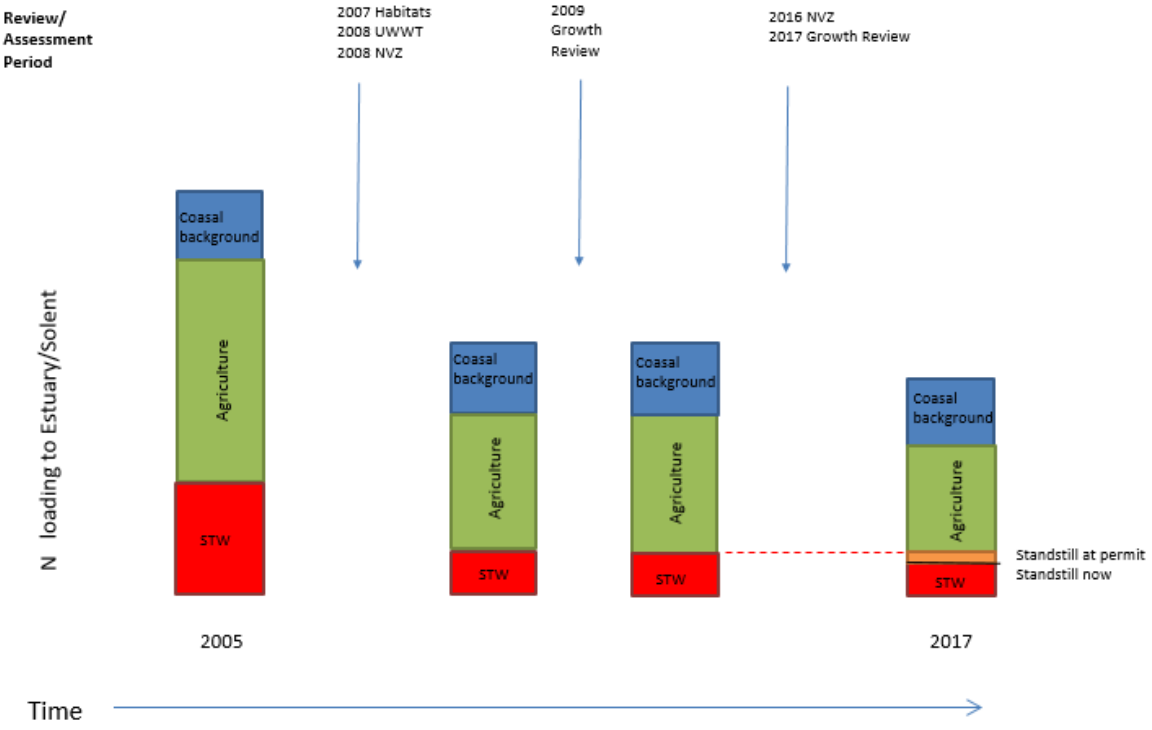
In other areas of the Solent catchments, groundwater N has already started to reduce. For example, in the Chichester catchment, in the relatively young groundwater at Lavant, peak nitrate levels have already occurred and groundwater N levels are now reducing. In the same catchment at Funtington, N is predicted to peak soon (around 2023) then reduce slowly, whereas at Walderton where much of the groundwater is older, nitrate peaks are still about a decade away.

Overview

A great deal of work and investment has occurred to tackle eutrophication in the last 20 years. The Environment Agency frequently reviews what measures are required to protect the Solent marine sites from eutrophication, most recently including NVZ reviews in 2016 and water industry Periodic Reviews in 2019. There has been a net reduction in nutrient inputs but catchment measures need to continue to reduce the large diffuse agricultural sources of N, over and above what is required from NVZ designation. We are seeing improvements to the ecology now from the existing improvements so we have confidence that recovery is likely. In addition further substantial reductions are predicted once groundwater nutrients reduce in the next decade.

Figure 9 shows a schematic diagram of N reduction in Solent area including a summary of some of the reviews and assessments we have undertaken.

Figure 9 schematic diagram of N reduction in Solent area (arrows are EA reviews, orange bar is development growth)



Reference

1. ADAS UK Ltd, 'Solent Harbours Nitrogen Management Investigation'. Report for Natural England by Gooday R., Hockridge B. and Lee, D. (March 2015).

Please send any enquiries about this Overview to the Environment Agency at SSDEnquiries@environment-agency.gov.uk

For data retrieval please use the following links:

Open data, Water Quality archive: http://environment.data.gov.uk/water-quality/view/landing

Open data, Biosys archive: https://data.gov.uk/data/search?q=biosys

Appendix 1 Eutrophication objectives for marine Natura 2000 sites agreed by NE and EA in 2015 are as follows:

> ***Maintain*** *water quality (mean winter dissolved inorganic nitrogen) at existing levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) achieve GOOD WFD overall status.*
>
> ***Improve*** *water quality (mean winter dissolved inorganic nitrogen) to a level that biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) achieve GOOD WFD overall status.*

Appendix 2 Notes on the relevance of buried and over wintering macroalgae

The presence of **buried** macroalgae increases the impact on designated intertidal habitats and birds, by increasing the risk that changes in sediment conditions will occur, resulting in a change in the benthic community. It can also provide a nutrient source in the sediment which fuels macroalgae growth in the spring/summer and potentially delays the recovery time of intertidal habitats.

The presence of **over wintering** macroalgae increases the impact on designated wintering birds by affecting their access to prey species and increasing the risk of altering the benthic community. It can also enable a greater and more rapid growth spurt of macroalgae in the spring.

Appendix 3 Timeline of eutrophication reviews/designations and implementation of regulatory measures in the Solent area. (Additional voluntary measures are not shown for clarity).

Designations and Reviews	Year	Environmental Status	Regulatory Measures tackling N
	1994	1994 – 2002 Baseline macroalgae and nutrient status	
	1995		
	1996		
	1997		
UWWTD Sensitive Area designations (1998)	1998		
	1999		
Natura 2000 designations (Birds Directive & Habitats Directive)	2000		
	2001		2001 – Eastney/Budds Farm STW improvement and transfer (from Langstone) under UWWTD
UWWTD Sensitive Area designations (2002)	2002		
	2003		
Periodic Review assessments (2004)	2004		
	2005		
	2006		
Habitats Directive Review of Consents (2007)	2007		
UWWTD SA & Nitrates Dir NVZ designations (2008)	2008		2008 – various STW improvements under UWWTD
Population growth assessments (2009)	2009	2009 - 2014 Interim macroalgae and nutrient status. Too early to see improvements	2009 – NVZ measures tackling diffuse inputs
Periodic Review assessments (2009)			
Diffuse Water Pollution Plans (2010)	2010		2010 – Fairlee STW transfer (Medina)
	2011		
	2012		
	2013		
WFD nutrient Investigations internal (2013/14)	2014		2014/2015 – Habitats Directive improvements to STWs in Southampton Water and Solent
Periodic Review assessments (2014)	2015		
NVZ Reviews (2016)	2016		
Population growth assessments (2017)	2017	Beginning to see signs of environmental recovery	
	2018		2018 Woolston STW improvement
Periodic Review assessments (2019)	2019		
Solent DWPP Judicial Review (2019/2020)	2020		
	2021		
	2022		
	2023		
	2024		
	2025		
	2026		
	2027		
	2028	Predicted reduction in macroalgae following timelag in groundwater N, uptake of N in sediments etc	
	2029		
	2030		
	2031		
	2032		
	2033		
	2034		
	2035		
	2036		