Estuaries

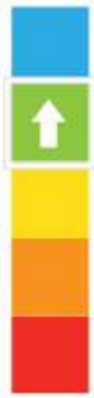
Scottish estuaries are important resources for wildlife and humans, and 85% are in good or high environmental condition. However, they remain under pressure from human activity, particularly from nutrient enrichment and the damaging impacts of climate change.

Summary

Key messages

- In Scotland there are 49 estuaries assessed as part of the Water Framework Directive (WFD), including nine salt-water lagoons, covering an area of approximately 1,000 km^2. The Solway estuary alone covers 300 km^2.
- Just over half of the estuaries are in good condition, with a further third at high status.
- A range of pressures from human activities have a significant impact on the remainder.
- Estuaries have been lost or damaged by land claim, building and sea defence walls.
- Historically, some estuaries (e.g. Forth and Clyde) have been affected by chemical contamination, but this has been greatly reduced.
- Nutrient enrichment from diffuse pollution is still a problem in some estuaries, although inputs are reducing.

State and trend



State: Good - high agreement, medium evidence

Trend: Improving - high agreement, medium evidence

There is an explanation of the diagram and further information on how we carried out the assessments on the summary pages.

- This is based on a Water Framework Directive perspective.
- Assessments are of the current "average condition"; some estuaries are in a worse condition, and others are in a better one. Equally, the condition of some estuaries is improving, while others are declining or stable.
- Making any overall assessment is necessarily a simplification
- We have taken account of the scale of any damage to the environment in these assessments; impacts can be locally damaging, but may have little effect on a national scale.
- We have stated how confident we are in the assessments based on the level of agreement between the specialists involved, and the quality and quantity of the supporting evidence.

Overview

Estuaries connect rivers and the sea. Scotland's predominantly low-lying east coast is dominated by the three major firths and their adjacent estuaries – the Forth, Tay and Moray. The west coast, however, is quite different, characterised by a highly indented landscape with long, narrow fjordic sea lochs and the two major estuaries of the Solway and the Clyde. In estuaries the fresh water from rivers becomes increasingly salty (saline) as it mixes with seawater. The Clyde estuary is an example of a stratified estuary (where freshwater and salt water doesn't mix thoroughly). In contrast, estuaries on the east coast are usually partially or well mixed.

Some estuaries contain saline lagoons, which are often almost entirely cut off from the sea and have ecological conditions somewhere between freshwater lochs and the sea.

In Scotland there are 49 estuaries assessed as part of the WFD, including nine salt-water lagoons, covering an area of approximately 1,000 km^2. The Solway estuary alone accounts for 30% of the total area of estuaries in Scotland.

Human activity around estuaries has often developed around important transport routes, and today many contain ports and harbours, industry and large population centres – most large conurbations in Scotland are located on estuaries. As a result, these estuaries receive large volumes of treated sewage and industrial waste water (treated sewage and industrial effluent), which can contaminate sediments.

Estuaries provide valuable habitats and breeding grounds for fish and birds, and the surrounding organic-rich mudflats and salt marshes provide an abundant food supply for these species. Migratory water fowl are attracted to Scottish estuaries by the milder weather; over half a million waterbirds spend the winter in Scotland. Animals and plants living in estuaries have adapted to cope with the changes in saline levels and the depth of the water, which occur twice a day with the ebb and flow of the tide.

Many Scottish estuaries are protected because they are home to national or international important habitats and wildlife. They include:

- Sites of Special Scientific Interest (SSSIs) – some contain intertidal features of interest (such as eelgrass beds, saline lagoons, sand flats and reefs);
- Special Protection Areas with marine or coastal aspects – these are designated to protect birds;
- Special Areas of Conservation – these include a range of habitats and species.

Marine habitats and their diversity of organisms provide a range of ecosystem services and benefits of significant value to Scotland. These are discussed in detail in the Marine chapter of the National Ecosystem Assessment.

Estuaries can be damaged as a result of building development as well as by contamination from waste water and fertilisers used in agriculture.

Damaging estuaries can result in the loss of socio-economic benefits (e.g. their use for transport and for cooling during the process of electricity generation), income from tourism, water storage (increasing the risk of flooding) and important habitats, as well as their role as nursery and overwintering grounds for commercially important fish species.

State

Overall, half of Scotland's estuaries are in good environmental condition, with generally clean water and little evidence of human alteration. A further third are at high status. The condition of the remaining seven of Scotland's estuaries are affected by high levels of nutrients entering the water, or factors (such as damaged habitats and invasive non-native species (INNS)), which have a negative impact on a smaller number of estuaries.

Impacts from INNS and climate change may become more common in the future, as the climate changes.

The environmental condition of estuaries is classified using the WFD classification scheme. Estuaries given a 'high' status show very little human alteration from undisturbed conditions, and those with a 'good' status have only low levels of human alteration. Estuaries with a 'moderate', 'poor' or 'bad' status show progressively more impact from human activities.

If an estuary has been significantly altered by human activity to provide an important socio-economic benefit (such as a harbour) then it cannot meet good status. In these cases, the estuary will be classified according to its potential - whether the estuary is in as good a condition as it can be, accepting that it has already been significantly physically altered.

You can find more details about the classification scheme in the 2008 State of the water environment report, and the scheme is explained further in the Policy Statement relating to the Water Environment and Water Services (Scotland) Act 2003.

Estuaries in a good condition:

- are clean and free from levels of pollutants that would harm the water and the plants and animals it supports;
- have minimal changes to their habitats and tidal regime;
- are not negatively affected by invasive non-native species.

Overall, over 85% of our estuaries have a high or good status (Table 1 and Figure 1).

Table 1: Classification of Scotland's estuaries, 2012.

Indicator	Status									
	High		Good		Moderate		Poor		Bad	
	Number of water bodies	Area (km^2)	Number of water bodies	Area (km^2)	Number of water bodies	Area (km^2)	Number of water bodies	Area (km^2)	Number of water bodies	Area (%)
Overall status/potential	16	120	26	433	6	431	1	10	0	0
Water quality	25	237	18	326	6	430	0	0	0	0
Bed and shores	32	742	10	196	3	40	2	11	2	5

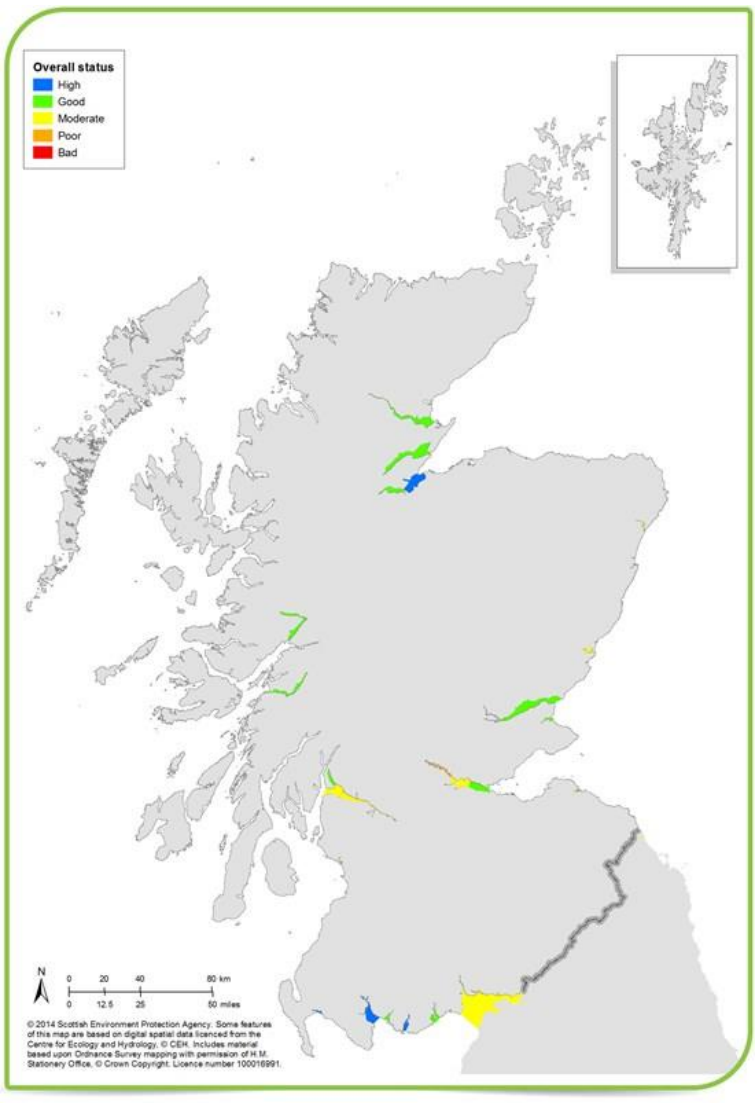


Figure 1: Overall status of estuaries in 2012.

Water quality

Water quality in estuaries is affected by:

- diffuse pollution;
- waste-water discharge.

Just six of Scotland's estuaries have a status of moderate because of relatively high concentrations of nutrients that can harm wildlife.

The Solway estuary, the Montrose basin and the Ythan estuary are all at moderate status because of high nutrient inputs from agriculture. The Montrose basin and the Ythan estuary are small estuaries on the east coast, but the Solway accounts for 30% of the total area of estuaries in Scotland.

Although a rich nutrient supply makes our estuaries productive, an excessive nutrient supply can upset the balance of the ecosystem, leading to eutrophication. Excessive input of nutrients accelerates the growth of algae and other water plants. The decay of these plants at the end of the growing season may cause oxygen depletion, which impacts on wildlife. Aquatic animals can also be starved of oxygen as a result of the breakdown of organic matter in waste water discharges (e.g. in sewage), using up oxygen as it decays.

Although most estuaries are at good or high status for oxygen, the Clyde and upper Forth estuaries have altered oxygen levels, due to waste-water discharges. The sediments in both estuaries contain organic matter from previously untreated discharges, and this contributes to the problem.

Some chemicals in water that damage wildlife are defined as hazardous substances. When attached to sediments, hazardous substances can persist for many years, and when in animals they can accumulate through the food chain.

Contaminants in sediments and mussels in the Forth and Clyde estuaries are relatively high, mainly because of historic discharges. There is evidence that contaminant concentrations in mussels are decreasing, although the concentrations in sediments have not yet decreased to the same extent.

The population of sediment-dwelling animals in intertidal and subtidal sediments in the Forth estuary has gradually become more varied over the last decade; an indication that this estuary is recovering from contamination from previously untreated discharges.

At present the concentrations of hazardous substances in all of Scotland's estuaries are within national and international standards and the WFD classification for these substances indicates that they do not pose a threat to wildlife.

Habitats

Habitats around estuaries can be affected by development and dredging.

Most estuaries in Scotland have been modified to some extent by building sea defences, reclaiming land, constructing ports and harbours, and dredging. However, only seven of our 49 estuaries are currently at moderate, poor or bad status as a result of these modifications.

Mudflats and salt marshes are rich food sources for fish and bird life, and important nursery and overwintering habitats for many fish species. Land claim (taking land to build on or to construct sea defences and ports) has resulted in the loss of areas of mudflats and salt marshes. [1]In the Forth estuary it is estimated that land claim has led to the loss of 45-55% of the Forth's intertidal areas over the last 400 years. This leads to fewer fish, which ultimately affects animals such as seals and dolphins.

Commercial dredging (to maintain navigation and commercial fishing for shellfish such as prawns and scallops) has also damaged fish breeding grounds and sea-bed habitats in some areas.

[1] T.C. Smout & M. Stewart (2102) The Firth of Forth: An Environmental History. Birlinn Limited, Edinburgh. ISBN: 9781780270647

Invasive non-native species

Invasive non-native species can cause serious problems to estuaries; they can harm native species and alter the ecology. Although only five of our estuaries are affected by invasive non-native species (INNS), the "Current condition and challenges for the future" report estimated that more than 20% of estuaries are at risk of failing to meet environmental objectives because of them.

Some marine non-native species are widespread in Scotland. They can cause serious problems to the environment and the economy. Examples include the carpet sea squirt, which can reproduce and spread rapidly and tends to smother other marine life that grows on the sea bed and underwater structures such as pontoons. Wireweed can alter the shore ecology and, in large quantities, it can get entangled in propellers or block engine cooling systems.

Pressures affecting estuaries

Waste water

Large volumes of waste water (treated sewage and industrial effluent) are discharged to some of Scotland's estuaries. Waste water can contain the following.

- **Organic matter, such as sewage** – this can accumulate in sediments and remove oxygen from the water. Organic enrichment of sediments unbalance the species community, and decrease diversity.

- **Nutrients** – in excess, these can stimulate the growth of algal mats in intertidal areas. These mats smother the sediment, preventing colonisation by organisms that are an important food source for wading birds. The decay of these plants can remove oxygen from the water, damaging wildlife.
- **Hazardous substances** – these can affect the diversity and abundance of plants and animals. Some substances can cause disruption to the sexual characteristics of organisms and develop disorders.

Diffuse pollution

Diffuse pollution arises from activities across a river catchment, and cannot be linked to any specific discharge point. Diffuse pollution can come from:

- **agriculture** – nutrients, sediments, pesticides and organic matter washed off the land into water courses;
- **urban** – pollutants washed off roads into storm drains and sewage overflows;
- **oil spills** – from shipping and recreational craft;
- **shipping and maintaining navigation routes** – for example, anti-fouling treatments (applied to boats to prevent the nuisance growth of organisms), and sediment stirred up during dredging and dumping of the spoil.

Habitat modifications

Estuaries can be modified by the construction of ports, harbours and sea defences and the land taken to build them. In addition, dredging and canalisation can also make significant changes to the sea bed and shoreline.

Climate change

The Marine Climate Change Impacts Partnership (MCCIP) publishes Annual Report Cards (ARC) on our understanding of how climate change is affecting UK seas. The latest one, ARC 2013, tells us that:

- temperature records continue to show an overall upward trend, despite short-term variability;
- changes to plant growth are expected throughout the UK;
- climate-change projections suggest that the distribution of fish species will shift northwards at a faster rate than at present.

Water abstraction

There are 20 water abstractions from Scottish estuaries, the majority of which use the water for cooling.

Cooling water is screened to remove sediment, weeds and fish that could block the pipes. The removal of fish may have a significant impact on estuaries; it has been estimated that nearly 12.5 million fish, weighing about 75 tonnes, were trapped on the cooling water screens of Longannet Power Station in 1999[1]. A system to return the fish to the estuary is currently being considered at Longannet. This would reduce the number of fish that die and return all fish (alive and dead) to the estuary to reduce the impact on the estuarine ecosystem.

[1] *Greenwood MFD. (2008) Fish mortality by impingement on the cooling-water intake screens of Britain's largest direct-cooled power-station. Marine Pollution Bulletin 56, 723–739.*

Noise

Underwater noise is generated by dredging, shipping and construction. This may cause species that communicate by sound to avoid important areas (for example, spawning grounds) and reduce their ability to detect food. It may even damage their hearing, affecting their ability to communicate with each other about food, danger and reproduction. More evidence is needed on the extent of noise disturbance and its impact on wildlife.

Dredging

Marine Scotland regulates dumping on the sea bed by issuing licences under the Marine (Scotland) Act 2010. Since the 1980's, dumping at sea has progressively reduced, with bans imposed on dumping radioactive waste (1982), colliery mine stone (1995) and sewage sludge (1998). Only the disposal of dredged material from ports, harbours and marinas is currently allowed.

Dredging tears up sea-bed habitats and can pose a contamination risk, with the re-suspension of hazardous material contained in the sediment, or its deposition at the dumping site of the dredged material. The Clyde, Forth, Tay and Dee estuaries are regularly dredged to maintain navigable channels for shipping, and the Tay estuary is dredged to remove sand for commercial use. The Forth and Tay estuaries contain licensed dump sites for dredged material.

Invasive non-native species

Invasive non-native species can significantly alter the ecology of our native communities, as well as causing problems for shipping and aquaculture.

Invasive non-native species can be introduced by visiting ships and recreational craft (either attached to the hull or in ballast water), floating litter and by aquaculture (escaped farmed species, and, more commonly, unintentional introduction alongside the farmed species). Once established, it is extremely difficult to get rid of an invasive species in the marine environment.

Litter

Litter causes harm to wildlife by ingestion or entanglement. Litter can come from sewage, recreational activities, shipping and commercial fishing.

There are currently no systematic data on the presence of litter in estuaries, but it is known to be widespread on the shore and the sea bed. Most litter is plastic; this slowly degrades into micro-particles, and can be found throughout Scotland's seas.

What is being done

Legislation has been introduced over many years, which is designed to protect the environmental quality of estuaries. In addition, some good-practice initiatives, and financial aid for land managers, are in place to tackle problems such as diffuse pollution.

Policy and legislation

Water quality in estuaries has improved in recent decades as a result of improvements to effluent treatment prompted by European legislation.

The European Water Framework Directive provides a framework for protecting and improving the condition of the water environment across Europe, through the development of River Basin Management Plans (RBMPs). In Scotland we are implementing the WFD through the Water Environment and Water Services (Scotland) Act 2003, which makes SEPA responsible for coordinating the development of the RBMPs, working in partnership with many sectors, public bodies and non-governmental organisations, These same sectors and organisations are responsible for the successful implementation of the plans, by developing partnership initiatives, and delivering public investment programmes and responsibilities.

Any new activities likely to have an adverse impact on the water environment are controlled under the Water Environment (Controlled Activities) (Scotland) Regulations 2011, known as 'CAR'. These include discharges of wastewater or industrial effluent, cooling water abstractions and engineering activities that can cause damage to estuarine habitats.

Planned improvements to the status of estuaries, which are to be achieved through the WFD, are shown in Table 2 and discussed in the river basin management plans. River-basin planning is a collaborative approach to managing and improving the environment, and offers opportunities for more effective co-ordination between partners. Actions needed to improve the quality of estuaries to the status of 'good' are detailed in individual water body data sheets. Overall, the objective is for 99% of our estuaries to be at good or high status by 2027.

Table 2: Planned improvements to the status of estuaries to be achieved through the WFD.

Overall status/potential	Target area (km^2) by year		
	2015	**2021**	**2027**
High	217	217	217
Good	336	336	767
Moderate	430	430	9
Poor	10	10	0
Bad	0	0	0
Total	**992**	**992**	**992**
Proportion of total at good or better status (%)	**56**	**56**	**99**

Diffuse inputs of nitrates from agriculture are regulated by the Nitrates Directive (91/676/EEC). Areas where the nitrate concentration in groundwater is high are designated as nitrate-vulnerable zones and action is being taken to reduce the inputs of nitrates from agriculture in these areas. The catchments of the Solway estuary, the Montrose basin and the Ythan estuary all contain nitrate-vulnerable zones. Sources of nitrate entering the River South Esk, which drains into the Montrose Basin and the River Ythan, are also being studied as part of SEPA's diffuse-pollution monitoring programme, which aims to reduce diffuse pollution through encouraging best practice in land management.

The Oslo and Paris Commission (OSPAR) has been working to reduce inputs of hazardous substances to the marine environment for over 20 years by regulating industries and phasing out the use of some substances, for example:

- **polychlorinated biphenyls** – UK sales were stopped in 1986;
- **brominated flame retardants** – banned from 2004;
- **tri-butyl-tin** – use was banned on all boats from 2008.

Although these have been banned, they can still be detected in some parts of the environment due to their persistence and their continued release from materials made using them.

SEPA uses controlled activity regulations to regulate the discharge of hazardous substances, and policy 61 outlines the controls on the discharges of these substances.

Litter

The recent European Marine Strategy Framework Directive includes a requirement to assess litter, and set targets for reducing litter by 2020. Other legislation designed to reduce litter include:

International Convention for the Prevention of Marine Pollution from Ships, which prohibits the at-sea disposal of plastics and rubbish from ships; EU Port Waste Reception Directive on port reception facilities for ship-generated waste and cargo residues;

Marine (Scotland) Act

The Marine (Scotland) Act helps balance competing demands on Scotland's seas. It aims to protect and enhance the marine environment and boost economic investment and growth in areas such as marine renewables. The Act will be implemented in the following ways.

- The marine planning system balances the need for resources with the need to protect our marine environment. The National Marine Plan sets out objectives and national priorities, while regional marine plans provide the context in which conflicts between different sectors can be resolved and key areas for key uses can be defined.
- There is a marine licensing system for developments in coastal waters that require approval.
- There are new powers to designate Marine Protected Areas (MPAs). This provides greater flexibility for Ministers to use area-based measures to conserve marine biodiversity as well as nationally important historic assets such as historic shipwrecks. The Scottish Government is in the process of establishing new (MPAs) of national importance to meet international commitments for protecting our seas.
- Improved protection for seals and a new comprehensive licence system will ensure appropriate management when necessary.

Sustainable management

A range of practical water and catchment-management activities have been introduced to improve the environmental condition of estuaries.

Diffuse pollution

Sustainable Drainage Systems are being encouraged as a way to reduce contaminants from built up areas entering the environment.

In rural areas, several initiatives are in place to encourage, and contribute to the costs of, better land use practices to reduce diffuse pollution from agriculture.

Modified habitats

The loss of habitat due to land claim is difficult and costly to reverse. However, there are already some small-scale restoration projects in Scotland that aim to restore intertidal habitat, encouraging wildlife and reducing flooding by increasing the amount of water held back in the wetlands. Examples include;

- Black Devon Wetland (Forth Estuary);
- Skinflats (Forth Estuary);
- Nigg Bay (Cromarty Firth).

The RSPB is planning a larger-scale project to restore a network of intertidal habitats in the Forth estuary.

Litter

There are several practical initiatives to reduce litter in Scotland's environment.

- Scottish Water's Bag It and Bin It campaign aims to stop contamination of beaches caused by sanitary waste through the sewerage network.
- The Keep Scotland Beautiful beach award scheme.
- The Forth Estuary Forum and Firth of Clyde Forum actively campaign to reduce litter on beaches in their areas.
- The Fishing For Litter project encourages fishermen to return litter caught in their trawls for monitoring and proper disposal. It has been estimated that litter costs the marine fishing industry up to £30,000 per year per boat, due to contamination of catches, broken gear and fouled propellers.

Recreation

The Green Blue organisation gives guidance to recreational boat users on how to reduce their impact on the water environment. The Green Blue's Marine Toolkit is designed to help managers of leisure-boating businesses and leaders of boat clubs keep to the regulations and reduce waste.

Oil spills

Port authorities have a responsibility to respond to spills from boats in their harbour area. Clearwater Forth is an example of an emergency response plan for the Forth.

In the event of a major spill from shipping or offshore oil and gas installations, the national contingency plan is implemented.

Invasive non-native species

The Invasive Non-Native Species Framework Strategy for Great Britain sets out the agreed hierarchical approach to invasive non-native species:

1. prevention;
2. early detection, surveillance, monitoring and rapid response;
3. mitigation, control and eradication.