



▲ River Etive, Highlands • © Sandra Marks

8. Rivers, Streams and Standing Waters

Summary

- The areas of Standing Waters and Canals Broad Habitat did not change in Scotland between 1998 and 2007. The areas of Rivers and Streams Broad Habitat increased slightly over the same period.
- The number of ponds increased by 6% in Scotland between 1998 and 2007.
- In 2007, ponds in Scotland supported an average of 9.6 wetland plant species per pond. In total, 9.9% of ponds met Priority Habitat status based on quality criteria for plants.
- Plant species richness of streambanks decreased by 12% in Scotland between 1998 and 2007. Since 1990 there has been a successional change, with vegetation becoming taller and with more competitive species.
- Plant species richness within streams increased in Scotland between 1998 and 2007 and there was a high turnover of species.
- The physical characteristics of streams improved in Scotland between 1998 and 2007.

Note on Chapter 8:

- The methodology for sampling these Freshwater Habitats differs substantially from other terrestrial habitats.
- For further information on the Broad Habitat classification and terminology see *Chapter 1 Methodology (UK Report)*.

8.1 Introduction

This Chapter presents the results for the two freshwater Broad Habitats: Standing Waters and Canals, and Rivers and Streams. In Scotland extensive areas are covered by sea and freshwater lochs which are not adequately sampled using Countryside Survey (CS) methodology and do not form part of the estimates of these Broad Habitats. Hence it is more useful to look at changes in CS estimates rather than their actual values. The freshwater Broad Habitats are important features of the Scottish landscape, both aesthetically and functionally, as they collect and transport water, sediment, nutrients and pollutants through the countryside. When in good condition, these freshwater habitats can support a wide range of plants and animals, many of which are listed in the UK Biodiversity Action Plan. Particular types of freshwater habitat are also listed as Priority Habitats e.g. ponds, rivers and lakes. Freshwater habitats also provide a valuable economic and recreational resource for people.



▲ Canal scene • © SNH



▲ Bog pool • © SNH

8.2 Description of Broad Habitats

The Standing Waters and Canals Broad Habitat includes ponds, lochs, canals, ditches and reservoirs.

The Rivers and Streams Broad Habitat includes running watercourses ranging from small headwater streams to large rivers.

Both these Broad Habitats include the open water itself and the vegetation along the water's edge. They can be extremely variable in character depending on the size of the water body and the nature of the local terrain.

In 2007 CS estimated the current area of both Broad Habitats in Scotland and the changes from previous surveys. For the first time in 2007, CS is able to report the estimated number of ponds across all of Scotland.

The condition of certain water body types within these Broad Habitats was assessed in a number of different ways (*Section 1.4.4 and Chapter 8, UK Report*). Measures of vegetation and habitat quality of streams (*section 8.5*) refer to headwater streams, defined as small watercourses within 5km of its source and draining a land area of less than 20km².

8.2 Area of Habitat

- The areas of Standing Waters and Canals Broad Habitat did not change in Scotland between 1998 and 2007. The areas of Rivers and Streams Broad Habitat increased slightly over the same period.
- The number of ponds increased by 6% in Scotland between 1998 and 2007.

Standing Waters and Canals, as sampled by CS, covered 89,000ha in 2007 (*Table 8.1*). There was no significant change in the area of Standing Waters and Canals Broad Habitat over the past decade (*Table 8.1*).

▼ **Table 8.1:** Estimated area ('000s ha) and percentage of land area of the Standing Waters and Canals Broad Habitat in each Environmental Zone and in Scotland from 1990 to 2007. Arrows denote significant change ($p < 0.05$) in the direction shown.

	1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
EZ4	5	0.2	6	0.3	6	0.3	
EZ5	35	1.4	36	1.4	35	1.4	
EZ6	35	1.1	45	1.4	47	1.5	
Scotland	75	0.9	88	1.1	89	1.1	

▼ **Table 8.2:** Change in the number of ponds ('000s) in Scotland between 1998 and 2007. Arrows denote significant change ($p < 0.05$) in the direction shown.

	1998			2007			Direction of significant changes 1998-2007
	Lower 95% CL	Number of ponds ('000s)	Upper 95% CL	Lower 95% CL	Number of ponds ('000s)	Upper 95% CL	
EZ4	9	14	20	11	18	25	↑
EZ5	44	126	262	49	130	265	↑
EZ6	30	48	70	32	50	72	
Scotland	100	187	330	110	198	344	↑



▲ Lowland pond • © SNH

Rivers and Streams covered 21,000ha (0.3%) in Scotland in 2007, a small increase of 600ha on the 1998 estimate, with 7,000ha in each of the three Environmental Zones (EZs) where they comprised between 0.2 and 0.3% of the EZ area.

The area covered by the two freshwater Broad Habitats is small in relation to other Broad Habitats, together representing about 1.4% of Scotland. While the area of Rivers and Streams in each of the three EZs is approximately equal, across the three Environmental Zones, the majority of Standing Waters and Canals are in the Intermediate Uplands and Islands (EZ5) and True Uplands (EZ6) of Scotland.

8.2.1 Number of Ponds

There was a 6% increase in the number of ponds in Scotland between 1998 and 2007 to an estimated total of 198,000 ponds.

The increase in pond numbers was particularly large in the Lowlands (EZ4) and could be beneficial to the fauna and flora that are characteristic of these habitats, but only if the new ponds are at least of equivalent biological condition to existing and lost ponds. New ponds may help reverse the losses in the middle years of the 20th century that followed the intensification of agriculture.

8.3 Habitat Condition

- In 2007, Scottish ponds supported an average of 9.6 wetland plant species per pond. In total, 9.9% of ponds met Priority Habitat status based on quality criteria for plants.

8.3.1 Biological condition of Ponds

The CS in 2007 data provide a baseline describing the condition of ponds across Scotland, based on their plant communities. There were not sufficient ponds surveyed in the Lowlands (EZ4) or True Uplands (EZ6) to report reliably on plant species richness in these zones.

In 2007, Scottish ponds supported an average of 9.6 (± 1.4 , 95% CI) wetland plant species per pond. Ponds in the Intermediate Uplands and Islands (EZ5) contained on average 9.4 (± 1.6 , 95%CI) wetland plant species per pond. Across all 81 ponds surveyed in Scotland, 137 different plant species were recorded; 33 were submerged species, 6 were floating-leaved species and 98 were species associated with pond margins.



▲ Upland river • © SNH

8.3.2 Assessment of Pond Priority Habitat

The CS pond condition assessments in 2007 were based on plant data. These data have been used to identify priority ponds in Scotland using two plant criteria:

- **Criterion 1: *the presence of rare plant species.*** Of the ponds surveyed, eight (9.9%) qualified as Priority Habitat Ponds on the basis of this criterion.
- **Criterion 2: *species-rich plant communities.*** None of the surveyed ponds qualified on the basis of this criterion.

In total, 9.9% of the ponds qualified as Priority Habitat Ponds using these two plant-based criteria. It is probable that more of the surveyed ponds would qualify if groups like invertebrates and amphibians were also surveyed. This means that the current CS can only be used to provide a minimum estimate of the number of Priority Habitat Ponds in Scotland and a baseline for comparison with future surveys.

8.4 Change in vegetation condition alongside rivers and streams

- **Plant species richness of streambanks decreased by 12% in Scotland between 1998 and 2007. Since 1990 there has been a successional change, with vegetation becoming taller and with more competitive species.**

8.4.1 Changes in the Rivers and Streams Broad Habitat (1990-2007)

The vegetation growing alongside streams, ditches and rivers was sampled in 10m long x 1m wide 'Streamside Plots' (Table 1.3, UK Report). Most of these Plots were on small headwater streams, defined as small watercourses within 5km of its source and draining

a land area of less than 20km² (because they are more frequent in the countryside), but some Plots were also placed alongside larger rivers.

Between 1998 and 2007 there was a significant and widespread decrease in plant species richness and numbers of Bird and Butterfly larvae Food Plant species along watercourses in Scotland; this trend was not evident between 1990 and 1998 (Table 8.3). This decrease was aligned with increases in competitive species and shade casting/shade-tolerant species and decreases in plant species of open/disturbed ground indicating that streambanks may be becoming overgrown as a result of reduced management. Many of the changes were consistent across the whole of Scotland, although there were fewer changes in types of vegetation present in streambanks in the True Uplands (EZ6) between 1998 and 2007.

Changes between 1990 and 2007 were consistent with those since 1998 (Table 8.3). Species associated with fertile conditions increased along watercourses in the Lowlands (EZ4), but there was no change in upland areas.

8.5 Changes in the vegetation and physical quality of streams

- **Plant species richness within streams increased in Scotland between 1998 and 2007 and there was a high turnover of species.**
- **The physical characteristics of streams improved in Scotland between 1998 and 2007.**



▲ Yellow flag • © SNH

The diversity and cover of aquatic (within the river) plants were recorded over a 100m length of stream channel at 162 sample squares in both 1998 and 2007.

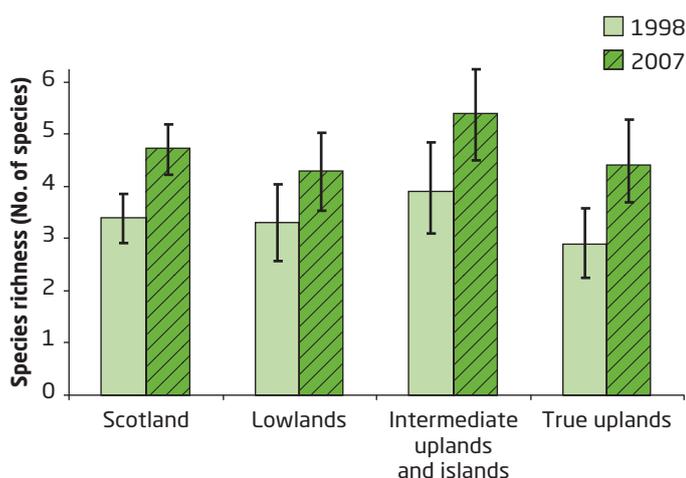
▼ **Table 8.3:** Changes in the characteristics of vegetation in 10m x1m Streamside Plots in the Rivers and Streams Broad Habitat across Scotland between 1990 and 2007. Arrows denote significant change ($p < 0.05$) in the direction shown. The condition measures are described in **Box 1.3, UK Report**.

Vegetation Condition Measures	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
	1990	1998	2007	S	EZ4	EZ5	EZ6	S	EZ4	EZ5	EZ6	S	EZ4	EZ5	EZ6
Species Richness (No. of Species)	21.7	21.7	19.2	↓	↓	↓	↓					↓	↓	↓	↓
No. of Bird Food Species	6.2	6.1	5.3	↓	↓	↓	↓		↓		↑	↓	↓	↓	↓
No. of Butterfly Food Species	7.8	7.8	6.9	↓	↓	↓	↓					↓	↓	↓	↓
Grass:Forb Ratio	0.53	0.57	0.51												
Competitor Score	2.54	2.57	2.6	↑		↑		↑	↑			↑	↑	↑	↑
Stress Tolerator Score	2.97	2.94	2.94					↓	↓			↓			
Ruderal Score	2.14	2.11	2.08	↓	↓	↓		↓	↓			↓	↓	↓	
Light Score	6.79	6.82	6.77	↓	↓	↓		↑		↑	↑		↓		↑
Fertility Score	3.88	3.88	3.9		↑								↑		
Ellenberg pH Score	4.63	4.61	4.62												
Moisture Score	6.5	6.54	6.56			↑		↑	↓	↓		↑	↓		

8.5.1 Species richness in headwater streams

The number of plant species in Scottish streams increased between 1998 and 2007 (*Fig. 8.1*). This trend was seen in all three EZs and continues a trend of increasing diversity in streams recorded between 1990 and 1998 (based on macroinvertebrates). Pooled plant species richness across (see *Glossary, Annex 1: UK Report*) Scotland as a whole increased between 1998 and 2007, with a particularly substantial increase in the True Uplands (EZ6) (*Table 8.4*).

▼ **Figure 8.1:** Change in mean headwater stream plant richness across Scotland and in each Environmental Zone between 1998 and 2007. Asterisks denote a statistically significant change between surveys (* $p < 0.05$). 95% Confidence Intervals are shown for each data point.



There was a considerable turnover of plant species between 1998 and 2007. Only 46% of all 137 aquatic plant taxa encountered were recorded in both years. Of the 63 persistent taxa, 36 increased in frequency across Scotland between 1998 and 2007, while 19 decreased in frequency, though none substantially.



▲ Freshwater surveyor • © SNH

▼ **Table 8.4:** Change in pooled headwater stream plant species richness across Scotland and in each Environmental Zone between 1998 and 2007. Arrows denote significant change ($p < 0.05$) in the direction shown.

	1998 Total richness	2007 Total richness	Change total richness	Direction of significant changes 1990-2007
EZ4	49	56	+7	
EZ5	69	74	+5	
EZ6	41	60	+19	↑
Scotland	93	107	+9	↑

▼ **Table 8.5:** Change in Mean Trophic Rank (MTR) score per headwater stream site in Scotland and in each Environmental Zone between 1998 and 2007. Arrows denote significant change ($p < 0.05$) in the direction shown.

	1998 MTR	2007 MTR	MTR change	Mean change MTR	MTR change Upper 95%	Direction of significant changes 1990-2007
EZ4	47.4	52.1	-0.4	4.7	10.8	
EZ5	64.3	68.1	-1.4	3.8	9.4	
EZ6	78	81.6	-1.7	3.6	8.8	
Scotland	63.8	67.8	1	4	7.2	↑



▲ Stream, Orkney • © SNH

The predominantly emergent vascular plants e.g. Brooklime (*Veronica beccabunga*), Bulbous Rush (*Juncus bulbosus*), Marsh Violet (*Viola palustris*) and Creeping Bent grass (*Agrostis stolonifera*) became more prevalent between 1998 and 2007, as did the submerged Alternate Water Milfoil (*Myriophyllum alterniflorum*) and the bryophytes *Racomitrium aciculare* and *Pellia*.

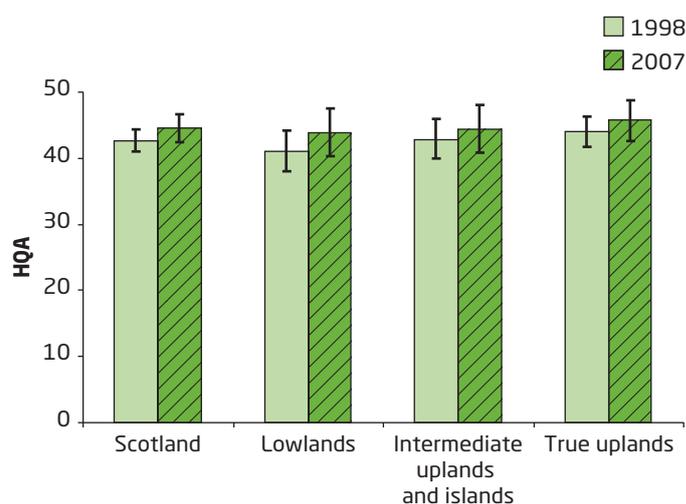
The temporal variability of the aquatic plant species pool in Scotland was also evident in each of the three EZs, with between 40 and 48% of taxa occurring in each EZ in both 1998 and 2007. The turnover of species shows the highly dynamic nature of the streamside habitat, resulting both from its location between land and water as well as from changes in the quality of the water and the physical structure of streams.

The significant increase in the Mean Trophic Rank (MTR) score (see *Glossary, Annex 1: UK Report*) in Scotland since 1998 (*Table 8.5*) indicates that nutrient enrichment of small watercourses has reduced. As would be expected, there was a gradient of increasing MTR scores, indicating lower nutrient levels in streams, going from the Lowlands (EZ4) to the True Uplands (EZ6).

8.5.2 Headwater Stream Physical Habitat Diversity

A River Habitat Survey (RHS) of physical habitat diversity (see *Glossary, Annex 1: UK Report*) was included in CS for the first time in 1998; the repeat survey in 2007 provided the first comparison over time.

▼ **Figure 8.2:** Change in the Habitat Quality Assessment (HQA) of headwater streams across Scotland and in each Environmental Zone between 1998 and 2007. Asterisks denote statistically significant change (* $P < 0.05$). 95% Confidence Intervals are shown for each data point.



There were small but significant improvements in habitat quality of headwater streams in Scotland between 1998 and 2007 (*Fig. 8.2*), though the trends were not significant by EZ. Between 1998 and 2007, natural riparian land cover (within 50 m of the stream) increased e.g. woodland and in-stream woody debris, and natural bank features e.g. gravel side bars.



▲ Lochan at Inshriach • © SNH

8.6 Summary and Discussion

8.6.1 Summary - Changes in Freshwaters

The extent of Scottish freshwater Broad Habitats has remained stable over the past decade, though the number of ponds has increased. With an average of fewer than 10 plant species, Scottish ponds (lochans) are some way short of the richness expected for ponds in good condition, although in nutrient poor conditions, as found in many upland habitats, fewer species would be expected.

In the Rivers and Streams Broad Habitat there has been a continued improvement in the biological and physical condition of Scottish headwater streams across most areas of Scotland. Streamside vegetation has continued to shift toward a late-successional assemblage, with an associated loss of species and increase in competitive herbaceous plants and woody species

CS also collects information on the stream-bed macroinvertebrate fauna in headwater streams, which can be used to provide a robust assessment of change in biological condition back to 1990. These data are currently being processed and will be reported in the CS Headwater Streams Report (due October 2009) where they will be compared to the results presented here.

8.6.2 Discussion

Standing Water and Canals Broad Habitat

Overall, the area of Standing Water and Canals Broad Habitat in Scotland has changed little since 1990. In the Lowlands, the significant increase in area between 1990 and 1998 was probably due to particularly wet conditions during 1998. The lack of change since then may also be a result of wet conditions having occurred again during the 2007 survey period, which may also in part account for the larger number of ponds recorded.

Pond numbers in Scotland declined during the second half of the 20th century, as many were infilled or lost following damage from land use intensification and pollution from agricultural run-off and acid deposition. Part of the increase in pond numbers in the Lowlands since 1998 may be due to pond creation, suggesting that incentives have been effective, although the inclusion of temporary ponds in the results makes interpretation difficult without further analysis. The effects of nutrient pollution and water body isolation caused by previous pond loss may still be contributing to poor pond quality; this also requires further analysis.

Data from CS in 2007 will provide useful baseline information for future monitoring of pond quality. Ponds were assessed against only two of the Priority Habitat criteria, on the basis of plant information. Information on aquatic macroinvertebrates, adult insects or amphibians was not assessed, and although incomplete, this assessment should provide a useful baseline against which any future data can be compared. If animal groups and other criteria are included in future assessments, it should be possible to obtain an improved estimate of the number of Priority Habitat ponds in Scotland.

Rivers and Streams Broad Habitat

Since 1998, the greatest changes in vegetation condition in Rivers and Streams Broad Habitat have been in the Lowlands (EZ4) and Intermediate Uplands and Islands (EZ5). The decline in the number of species along watercourses, including Bird and Butterfly larvae Food Plants, is potentially of concern. Increased numbers of competitive plant species associated with fertile soils indicate that eutrophication and succession are continuing to take place, the latter suggesting reduced physical disturbance from adjacent agricultural practices. This may be related to the fencing off of watercourses as a diffuse pollution control measure. Generally such fenced off areas are relatively unmanaged, leading to reductions in disturbance and direct nutrient input (e.g. from livestock). Changes in prevalence of non-native, invasive plant species may also have contributed to changes in vegetation condition, but it is not possible to use Countryside Survey to assess this due to insufficient data in either 1998 or 2007.

Catchment-sensitive management practices to reduce the impacts of diffuse pollution are now being encouraged. Options for managing water margins previously available under agri-environment schemes such as Rural Stewardship have now been incorporated into the Scotland Rural Development Programme (SRDP). They include a requirement for maintaining appropriate grazing management to reduce invasive or competitive plant species, and control of non-native invasive plant species. Take-up of these options should enhance biodiversity whilst protecting water margins from erosion and watercourses from pollution by agricultural run-off.

In the True Uplands (EZ6), where fewer changes in vegetation condition since 1998 were recorded, watercourses are often small, fast flowing streams, with little or no aquatic vegetation. Thus the species most often recorded tend to be those associated with the habitats through which the rivers and streams flow, rather than typical species of marginal aquatic, or aquatic habitats.

The significant increase in Mean Trophic Rank (MTR) in headwater streams suggests that the changes observed in stream plant communities are, in general, indicative of an improvement in condition; however, this trend should be treated with caution because CS sites, in common with sites generally in any river or stream, often have restricted MTR species richness such that the assessment can only be based on between one and three scoring species. This makes the MTR score vulnerable to even slight changes in species composition. Within Scottish streams across all EZs, the trend of increasing diversity since 1990 and the increase in the number of plant species between 1998 and 2007 requires further analysis to ascertain whether this represents improved biological condition.

Continuing improvements in the biological and physical condition of headwater streams in Scotland may well be a consequence of efforts made over the past 20 years to strengthen environmental regulations and improve management of rivers and streams. Most recently, this includes the introduction of a regulatory framework, as part of the implementation of the Water Framework Directive (WFD), which should contribute to the protection and continued improvement of Scotland's water environment into the future.

Further information

More details of the methodology, analyses and results from Countryside Survey can be found in other companion reports and data resources available for the Countryside Survey website [www.countrysidesurvey.org.uk] including:

Reports:

- UK Headline Messages – *published November 2008*
- UK Results from 2007 – *published November 2008*
- Detailed Northern Ireland Countryside Survey results – *published April 2009*
- England Results from 2007 – *due to be published August 2009*
- Scotland Results from 2007 – *due to be published June 2009*
- Wales Results from 2007 – *due to be published July 2009*
- Ponds – *due to be published July 2009*
- Streams – *October 2009*
- Soils – *November 2009*
- Integrated Assessment – *2010*

Data resources:

- Web access to **summary data** – a systematic summary of the results used to inform the UK and country level reports – launched in November 2008 and updated in January 2009
- Web access to the **actual data** – data from individual survey squares used to generate all the results presented in Countryside Survey reports from the 2007 survey – licensed access available from June 2009
- The UK Land Cover Map for 2007 – September 2009

The data generated by Countryside Survey will continue to be investigated in conjunction with other information such as climate, pollution and agricultural statistics. It is anticipated that future analysis of Countryside Survey data will lead to many scientific journal articles over the coming years. These investigations will improve understanding about the possible causes of the changes detected in the countryside and, for example, provide an opportunity to explore the results for Priority Habitats in more detail.

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The Countryside Survey partnership has endeavoured to ensure that the results presented in this report are quality assured and accurate. Data has been collected to estimate the stock, change, extent and/or quality of the reported parameters. However, the complex nature of the experimental design means that results can not necessarily be extrapolated and/or interpolated beyond their intended use without reference to the original data.



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