Estimating monetary values for improvements to the Scottish water environment

This paper is split into two main sections. The first section describes how values developed for improvements to the water environment in England and Wales have been applied to Scotland. The second section describes how these values have been adapted for application in the SEPA Disproportionate Cost Assessment (DCA) method.

1. Transfer of England and Wales environment improvement values to Scotland

The Environment Agency has developed monetary values for the benefits delivered by meeting WFD objectives in the water environment. The values are heavily dependent on the resident population density in a water body locality, this is because people assign higher values to the water environment where they live. However, it does not mean that people don't have any value for water bodies located away from where they live and a proportion of the value for all water bodies also comes from the national population. More information is available about how the EA derived their values and their relevance to Scotland in this paper. The latest EA river values rivers, specific to English and Welsh catchments, and for lakes, coastal and transition waters, specific to English and Welsh areas, are taken from the paper Updating the National Water Environment Benefit Survey values: summary of the peer review - GOV.UK (www.gov.uk).

1.1. For rivers

Estimate population density in Scottish water body catchments –

a. Using ONS data identify population densities for all Scottish local authority areas. This information is in the 'Value transfer' spreadsheet ('Scotland' sheet). Data originated from: http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-319259 – Population estimates for UK, England and Wales, Scotland and Northern Ireland, Mid 2011.
b. Assign all Scottish local authority areas to a population rank as shown in Table 1:

Table 1: Population density ranks

	Low	Medium	High	Very high
Population people/ha	<0.35	0.35 to <2	2 to <10	10 to <35
Number of local authority areas	8	9	11	4

The number of local authorities in each rank is approximately equal. Though the 'very high' category only contains 4 local authorities – these are Aberdeen City, City of Edinburgh, Dundee City and Glasgow City – which have particularly high population densities of more than twice that in the highest 'high' population density local authority (see 'Scotland' worksheet in value transfer workbook).

c. Assign each Scottish water body to a local authority area and to a catchment (see 'Scot catch popn' worksheet in value transfer workbook).

d. For each water body catchment average the local authority population densities for all water bodies in the catchment to estimate the population density in the catchment (see 'Scot catch popn' worksheet in value transfer workbook).

e. Assign each water body catchment to a population density category (using the ranks in Table 1) (see 'Scot catch popn' worksheet in value transfer workbook).

f. Figure 1 illustrates the population density categories for all Scottish water body catchments.

Select England and Wales catchments that have similar populations to each Scottish water body catchment category. Assume that the monetary values for the England and Wales water body catchments directly reflect the population density in those catchments, so high value catchments represent high population density areas (See E&W catch values sheet in value transfer workbook). The central monetary benefit value for each England and Wales catchment was used to assign a

population density category to the catchments, the following assumptions were made:

g. The England Wales catchments with the lowest benefit values are assumed to have population densities most similar to the lowest population density areas in Scotland.

h. The England and Wales catchments with the highest benefit values, and therefore population densities, do not relate to any areas in Scotland because even the highest population density areas in Scotland do not have population densities as high as the most densely populated areas in England and Wales.

i. The areas in Scotland with very high population density have relatively higher benefit values than the low, medium and high population density areas because their population density is significantly greater (as described above).

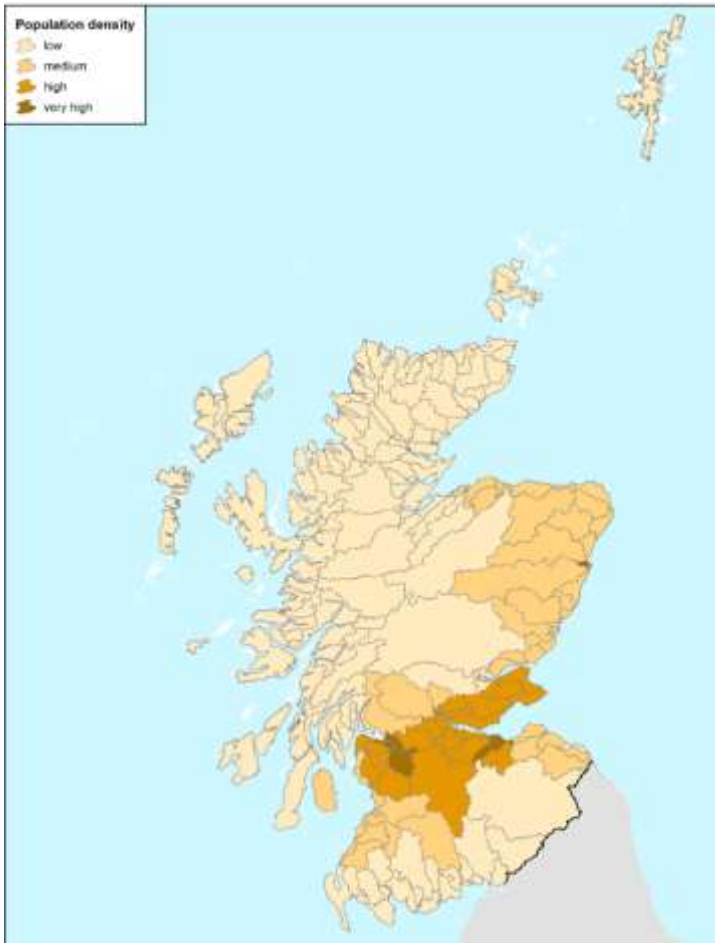
j. On this basis England and Wales catchments were selected to represent each of the different population density categories shown in Table 1. Table 2 shows the England and Wales river catchments that were selected to be representative, and the monetary values (in £/km/year) for status improvements to their rivers (also shown in 'Rep English catchments' spreadsheet of value transfer workbook) to be representative of the Scottish population density categories.

Table 2: Values for representative English river catchments (000£/km/year) (from[1])

England and Wales river catchments		Ecological status improvement								
Value comparators		Bad to poor			Poor to moderate			Moderate to good		
Population density	Comparison England and Wales catchments	Low	Central	High	Low	Central	High	Low	Central	High
Low	Tweed	9.5	11.6	13.6	10.5	12.8	15.1	11.8	14.4	17.0
Mid	South-West Lakes	10.5	12.8	15.0	11.7	14.2	16.9	13.3	16.2	19.2
High	Dorset	13.2	16.1	19.1	15.1	18.4	21.7	17.4	21.2	25.0
Very	Don and Rother	19.	23.4	27.5	22.	27.1	32.1	26.0	31.7	37.5

high		2			3					

Figure 1: Population density of Scottish water body catchments



1.2. For lakes, coastal and transitional water bodies

Assign Scottish water bodies to catchments and population densities as for rivers (Estimate population density in Scottish water body catchments) of rivers method above.

Select England and Wales areas that have similar populations to each Scottish water body catchment. As for rivers, assume that the monetary values for the England and Wales areas directly reflect the population density in those areas, so high value areas represent high population density areas. Rank the lake, coastal and transitional water body values for English and Welsh areas from low to high. As for rivers, assume:

- The England and Wales areas with the lowest benefit values have population densities most similar to the lowest population density areas in Scotland.
- The England and Wales areas with the highest benefit values and therefore population densities do not relate to any areas in Scotland because even the highest population density areas in Scotland do not have population densities as high as the most densely populated areas in England and Wales.
- The very high population density areas in Scotland have relatively higher benefit values than the low, medium and high population density areas because their population density is significantly greater (as described in Estimate population density in Scottish water body catchments above).

Select England and Wales areas that represent the low, medium, high and very high Scottish population densities, these are shown in Table 3 below (see Rep English areas spreadsheet in value transfer workbook).

Table 3: Showing values for improvements in status for English and Welsh lakes, coastal and transitional water bodies in representative England and Wales catchments (values in £000s/km2/year)

England and Wales water body areas		Ecological status improvements								
Value comparators		Bad to poor			Poor to moderate			Moderate to good		
Population density	Comparison England and Wales areas	Low	Central	High	Low	Central	High	Low	Central	High
Low	Solway Tweed	3.6	4.5	5.3	4.1	5.0	6.0	4.6	5.6	6.7
Mid	South West	4.6	5.6	6.6	5.2	6.3	7.5	6.0	7.3	8.6
High	Severn	5.2	6.4	7.5	6.0	7.3	8.6	6.9	8.4	9.9
Very high	Humber	6.3	7.7	9.0	7.3	8.9	10.5	8.5	10.4	12.2

2. Assign a value category to all Scottish lochs, coastal and transitional water bodies based on the population density in their water body catchment (see 'Scot wb values' in value transfer workbook).

Note: Value adjustment for Inverness Coastal catchment

The value categories that have been assigned to Scottish water body catchments are based on population densities across a whole local authority region. This is a reasonable approach to take in most cases because it allows broad estimates of population density to be made. However, for some water bodies that occur in relatively densely populated areas but in sparsely populated local authority areas the values may not be appropriate. A sense check on the data shows that this is particularly the case for the 'Inverness coastal' water body catchment which occurs in Inverness city but in Highland local authority area.

As a result, it has been decided to increase the population and value ranking for water bodies in the Inverness Coastal catchment to 'medium' in spite of the local authority population density being low.

3. Adaptation of water environment improvement values in the SEPA DCA method

3.1. Use of minimum values

The SEPA DCA method uses the monetary benefit values as a screen to quickly decide if improvements to the water environment might be disproportionately expense. If this is potentially the case, then the method requires a more detailed assessment of the benefits that will arise as a result of the improvements proposed. Because they are simply used for screening purposes, it is appropriate that minimum monetary values for improvements to the water environment are used (these are shown in the shaded columns of Tables 2 and 3).

4. Working out present values for benefits

The SEPA DCA method requires use of present values for benefits associated with water body improvements so that they can be compared with present values for costs. Calculating a present value is particularly important for the environmental benefits which arise on an annual basis after a water body improvement has taken place. Determining present values requires discounting to take account of the fact that a benefit received in the future has a lower value than one received today.

Discounted benefit values for different improvements in different population density catchments to rivers and lochs, coastal and transitional water bodies are shown in Table 4 and 5 respectively. The benefit values have been discounted over a 40 year time period using the Government recommended social discount rate of 3.5% for years 0 to 30 and 3% for years 30 to 40 and rounded to the nearest £50,000.

Table 4: Present values for different status improvements to rivers in areas of different population density (000£/km, rounded to nearest £50k)

Population density in catchment	Ecological status change		
	Bad to poor	Poor to moderate	Moderate to good
Low	250	250	300
Medium	250	300	350
High	350	350	400
Very high	450	500	550

Table 5: Present values for different status improvements to lochs, coastal or transitional water bodies in areas of different population density (000£/km2, rounded to nearest £50k)

Population density in catchment	Ecological status change		
	Bad to poor	Poor to moderate	Moderate to good
Low	50	100	100
Medium	100	100	100
High	100	100	150

Very high	150	150	150

To work out a total value for benefits that a project will deliver you need to multiply the values in the tables above by the length (for rivers) or area (for lochs, coastal and transitional water bodies) of the water body that is improved.

Table 6: Water environment benefit values for Scottish catchments (expressed as 40-year present values)

Catchment	Population density estimate (people/ha)	Population density category	Rivers (000£/km)			Lochs and TraCs (000£/km)		
			Bad to poor	Poor to moderate	Moderate to good	Bad to poor	Poor to moderate	Moderate to good
Aberdeen South Coastal	12.0	very high	450	500	550	150	150	150
Abhainn Ghriomarstaidh	0.1	low	250	250	300	50	100	100
Allan Water	0.6	medium	250	300	350	100	100	100
Appin Coastal	0.1	low	250	250	300	50	100	100
Ardgour Coastal	0.1	low	250	250	300	50	100	100
Ardnamurchan Coastal	0.1	low	250	250	300	50	100	100
Arran Coastal	1.6	medium	250	300	350	100	100	100
Banff Coastal	0.4	medium	250	300	350	100	100	100

Beauly Coastal	0.1	low	250	250	300	50	100	100
Benbecula Coastal	0.1	low	250	250	300	50	100	100
Berriedale Water	0.1	low	250	250	300	50	100	100
Bervie Water	0.4	medium	250	300	350	100	100	100
Berwick Coastal	0.2	low	250	250	300	50	100	100
Black Cart Water	6.6	high	350	350	400	100	100	150
Brora Coastal	0.1	low	250	250	300	50	100	100
Buchan Coastal	1.1	medium	250	300	350	100	100	100
Cowal / Clyde Sealochs Coastal	0.1	low	250	250	300	50	100	100
Cromarty Coastal	0.1	low	250	250	300	50	100	100
Dighty Water	0.5	medium	250	300	350	100	100	100
Dornoch Coastal	0.1	low	250	250	300	50	100	100
Dumfries Coastal	0.2	low	250	250	300	50	100	100
Dunbeath Water	0.1	low	250	250	300	50	100	100
Dundee Coastal	0.4	medium	250	300	350	100	100	100

Earn Coastal	0.3	low	250	250	300	50	100	100
East Lothian Coastal	1.5	medium	250	300	350	100	100	100
Edinburgh Coastal	12.6	very high	450	500	550	150	150	150
Etive Coastal	0.1	low	250	250	300	50	100	100
Eye Water	0.5	medium	250	300	350	100	100	100
Forss Water	0.1	low	250	250	300	50	100	100
Forth Estuary (South) Coastal	3.5	high	350	350	400	100	100	150
Galloway Coastal	0.2	low	250	250	300	50	100	100
Glasgow Coastal	17.4	very high	450	500	550	150	150	150
Gretna Coastal	0.2	low	250	250	300	50	100	100
Gruinard River	0.1	Low	250	250	300	50	100	100
Halladale River	0.1	low	250	250	300	50	100	100
Hoy Coastal	0.2	low	250	250	300	50	100	100
Inverclyde Coastal	3.9	high	350	350	400	100	100	150
Inverness Coastal*	0.1	medium	250	300	350	100	100	100

Island of Bute Coastal	0.1	low	250	250	300	50	100	100
Island of Mull Coastal	0.1	low	250	250	300	50	100	100
Islay Coastal	0.1	low	250	250	300	50	100	100
Isle of Skye Coastal	0.1	low	250	250	300	50	100	100
Jura Coastal	0.1	low	250	250	300	50	100	100
Kincardine and Angus Coastal	0.4	medium	250	300	350	100	100	100
Kintyre Coastal	0.1	low	250	250	300	50	100	100
Knapdale Coastal	0.1	low	250	250	300	50	100	100
Lewis and Harris Coastal	0.1	low	250	250	300	50	100	100
Loch Fyne Coastal	0.1	low	250	250	300	50	100	100
Loch of Stenness	0.2	low	250	250	300	50	100	100
Lochar Water	0.2	low	250	250	300	50	100	100
Lunan Water	0.5	medium	250	300	350	100	100	100
Minch Coastal	0.1	low	250	250	300	50	100	100

Moray Coastal	0.4	medium	250	300	350	100	100	100
Muckle Burn	0.25	low	250	250	300	50	100	100
no data	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
North Ayrshire Coastal	1.3	medium	250	300	350	100	100	100
North Fife Coastal	2.8	high	350	350	400	100	100	150
North Uist Coastal	0.1	low	250	250	300	50	100	100
Orkney Coastal	0.2	low	250	250	300	50	100	100
Perth Coastal	0.3	low	250	250	300	50	100	100
River Add	0.1	low	250	250	300	50	100	100
River Aline	0.1	low	250	250	300	50	100	100
River Almond	6.1	high	350	350	400	100	100	150
River Alness	0.1	low	250	250	300	50	100	100
River Annan	0.2	low	250	250	300	50	100	100
River Avon	5.0	high	350	350	400	100	100	150
River Awe	0.1	low	250	250	300	50	100	100

River Ayr	1.0	medium	250	300	350	100	100	100
River Beauly	0.1	low	250	250	300	50	100	100
River Bladnoch	0.2	low	250	250	300	50	100	100
River Borgie	0.1	low	250	250	300	50	100	100
River Broom	0.1	low	250	250	300	50	100	100
River Brora	0.1	low	250	250	300	50	100	100
River Carron (Falkirk)	3.2	high	350	350	400	100	100	150
River Carron (Sutherland)	0.1	low	250	250	300	50	100	100
River Carron (Wester Ross)	0.1	low	250	250	275	50	100	100
River Cassley	0.1	low	250	250	300	50	100	100
River Clyde	4.3	high	350	350	400	100	100	150
River Conon	0.1	low	250	250	300	50	100	100
River Cree	0.3	low	250	250	300	50	100	100
River Dee (Grampian)	1.6	medium	250	300	350	100	100	100

River Dee (Solway)	0.2	low	250	250	300	50	100	100
River Deveron	0.4	Medium	250	300	350	100	100	100
River Devon	3.1	high	350	350	400	100	100	150
River Don	1.9	medium	250	300	350	100	100	100
River Doon	1.0	medium	250	300	350	100	100	100
River Eachaig	0.1	low	250	250	300	50	100	100
River Earn	0.3	low	250	250	300	50	100	100
River Eden	2.8	high	350	350	400	100	100	150
River Esk (Lothian)	2.2	high	350	350	400	100	100	150
River Esk (Solway)	0.2	low	250	250	300	50	100	100
River Etive	0.1	low	250	250	300	50	100	100
River Ewe	0.1	low	250	250	300	50	100	100
River Findhorn	0.2	low	250	250	300	50	100	100
River Fleet	0.1	low	250	250	300	50	100	100
River Forth	0.4	medium	250	300	350	100	100	100

River Garnock	2.4	High	350	350	400	100	100	150
River Glass	0.1	low	250	250	300	50	100	100
River Gryfe	6.0	high	350	350	400	100	100	150
River Helmsdale	0.1	low	250	250	300	50	100	100
River Hope	0.1	low	250	250	300	50	100	100
River Inver	0.1	low	250	250	300	50	100	100
River Irvine	2.7	High	350	350	400	100	100	150
River Kelvin	7.3	high	350	350	400	100	100	150
River Kirkaig	0.1	low	250	250	300	50	100	100
River Laxford	0.1	low	250	250	300	50	100	100
River Leven (Fife)	2.3	high	350	350	400	100	100	150
River Leven (Loch Lomond)	1.8	medium	250	300	350	100	100	100
River Leven (Lochaber)	0.1	low	250	250	300	50	100	100
River Ling	0.1	low	250	250	300	50	100	100
River Lochy	0.1	low	250	250	300	50	100	100

River Lossie	0.4	medium	250	300	350	100	100	100
River Morar	0.1	low	250	250	300	50	100	100
River Nairn	0.1	low	250	250	300	50	100	100
River Naver	0.1	Low	250	250	300	50	100	100
River Ness	0.1	low	250	250	300	50	100	100
River Nith	0.4	medium	250	300	350	100	100	100
River North Esk (Tayside)	0.5	medium	250	300	350	100	100	100
River Oykel	0.1	low	250	250	300	50	100	100
River Shiel	0.1	low	250	250	300	50	100	100
River Shin	0.1	low	250	250	300	50	100	100
River South Esk (Tayside)	0.5	medium	250	300	350	100	100	100
River Spey	0.2	low	250	250	300	50	100	100
River Stinchar	0.9	medium	250	300	350	100	100	100
River Strathy	0.1	low	250	250	300	50	100	100

River Tay	0.3	low	250	250	300	50	100	100
River Thurso	0.1	low	250	250	300	50	100	100
River Tweed	0.3	low	250	250	300	50	100	100
River Tyne	1.5	medium	250	300	350	100	100	100
River Ugie	0.4	medium	250	300	350	100	100	100
River Ythan	0.4	medium	250	300	350	100	100	100
Rousay Coastal	0.2	low	250	250	300	50	100	100
Rum Coastal	0.1	low	250	250	300	50	100	100
Shetland Coastal	0.2	low	250	250	300	50	100	100
Sounds Coastal	0.1	low	250	250	300	50	100	100
South Ayrshire Coastal	0.9	medium	250	300	350	100	100	100
South Fife Coastal	2.8	high	350	350	400	100	100	150
South Uist Coastal	0.1	low	250	250	300	50	100	100
Spey Bay Coastal	0.4	medium	250	300	350	100	100	100
Stewartry Coastal	0.2	Low	250	250	300	50	100	100

Stirling Coastal	2.4	high	350	350	400	100	100	150
Thurso Coastal	0.1	low	250	250	300	50	100	100
Tiree Coastal	0.1	low	250	250	300	50	100	100
Tongue Coastal	0.1	low	250	250	300	50	100	100
Torridon Coastal	0.1	low	250	250	300	50	100	100
Unst Coastal	0.2	low	250	250	300	50	100	100
Urr Water	0.2	low	250	250	300	50	100	100
Water of Girvan	0.9	medium	250	300	350	100	100	100
Water of Leith	11.7	very high	450	500	500	150	150	150
Water of Luce	0.2	low	250	250	300	50	100	100
White Cart Water	19.6	very high	450	500	550	150	150	150
Whiteadder Water	0.6	medium	250	300	350	100	100	100
Wick Coastal	0.1	low	250	250	300	50	100	100
Wick River	0.1	low	250	250	300	50	100	100
Yell Coastal	0.2	low	250	250	300	50	100	100

*Adjusted value for Inverness Coastal catchment due to higher population density (see note above)

Note: Treat values with caution

The monetary values for the Scottish waterbodies should be treated with caution. They should be treated as estimates intended to give an indication of value and they are particularly intended for use as part of the disproportionate cost assessment process.

Note: Inflation

The water benefit values study that was used as a basis for the values suggested above was carried out in 2013. To take account of inflation that has occurred since these values were derived, all of the benefit values for Scottish water bodies have been inflated by 10.1977%. This figure is based on Consumer Price Index (CPI) inflation figures from: www.ons.gov.uk/economy/inflationandpriceindices/timeseries/d7g7/mm23