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Morecambe Bay estuaries and catchments

The group of estuaries that comprise Morecambe Bay form the largest area of intertidal mudflats and sands in the UK. The four rivers discharging into the bay are the Leven (with Crake) and Kent (with Bela) in the North, and Lune and Wyre in the East (Figure 1).

Fig 1. The four contributory areas of the estuarine system of Morecambe Bay in Northwest England (below) of the Leven, Kent, Lune and Wyre rivers (left). The neighbouring rivers of the Ribble and South West Lakes region are also shown[1]

The Leven and Kent basins cover over 1,000 km^2 (1,426 km^2 when grouped with the neighbouring River Duddon), the Lune 1,223 km^2 and Wyre 450 km^2, with all draining into Morecambe Bay between the towns of Barrow-in-Furness in the Northwest and Blackpool in the South. The city of Lancaster and towns of Ulverston, Broughton-in-Furness, Ambleside, Windermere, Bowness-on-Windermere, Grange-over-Sands, Sedburgh, Kendal, Kirkby Lonsdale, Ingleton, Carnforth, Morecambe, Garstang, Fleetwood and Blackpool lie within the basins.

Leven and Kent basins: River Leven is sourced on both Bow Fell (902 m) at the head of the Langdale Valley and Dollywagon Pike (858 m) above Dunmail Raise. These fells comprise of volcanic rocks of the Borrowdale Volcanic Group that characterise the central Cumbrian Mountains. The source on Bow Fell is only 3 km from the wettest place in the UK with the Sprinkling Tarn raingauge recording 6,528 mm in 1954. Both tributary streams flow through Lake Windermere (Fig. 2) that is England's largest lake with a surface area of 14.7 km^2. The smaller lakes of Easedale Tarn, Grasmere, Rydal Water, Little Langdale Tarn, Elterwater, Blelham Tarn and Esthwaite are also located in the headwaters. Within its tidal reaches, the River Leven is joined by the River Crake that starts on the Coniston Fells (comprising Coniston Old Man at 803 m, Swirl How at 802 m and Wetherlam at 763 m) and flows via Coniston Water. To the East of the River Leven basin, the River Kent originates in the vicinity of the 'High Street' Roman road above the Kentmere reservoir, and flows through the

town of Kendal towards the estuary to the west of the Arnside and Silverdale ANOB. Here it is joined by the much smaller River Bela that flows from the low fells around Killington (canal) reservoir.

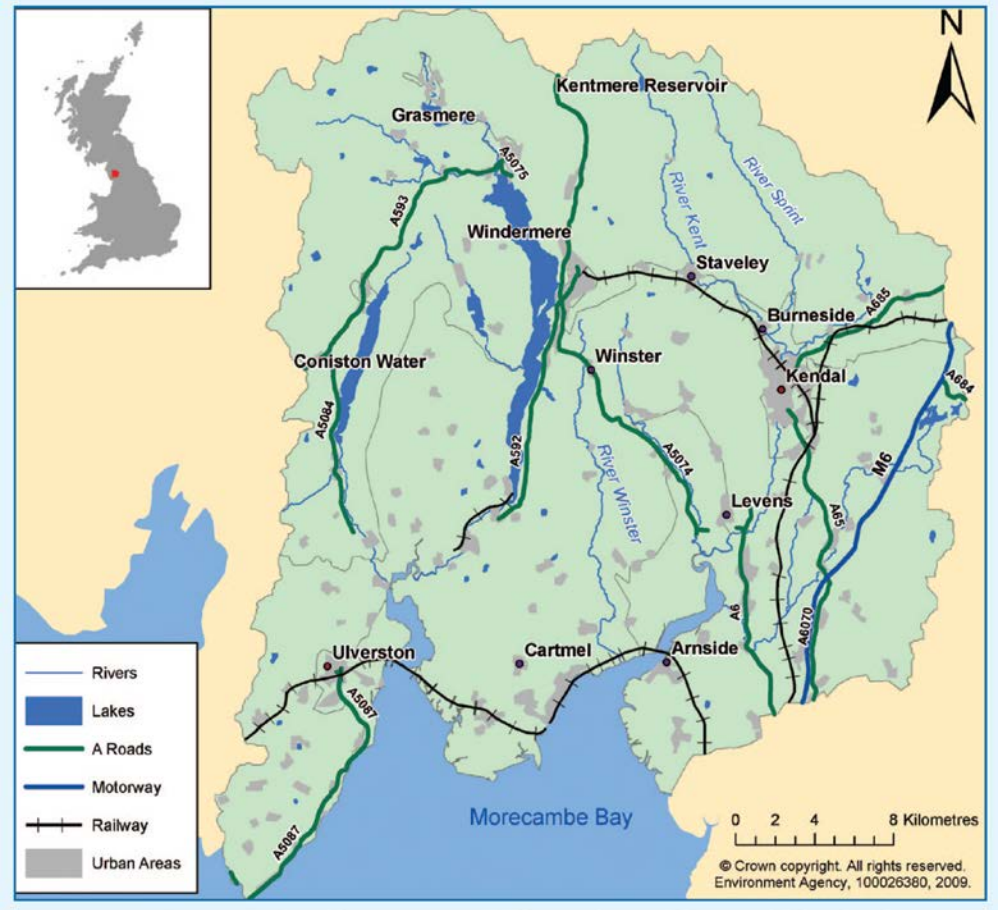

Fig 2. Kent and Leven basins on the northern edge of Morecambe Bay[2].

Two thirds of the Leven and Kent basins are within the Lake District National Park. The rivers support excellent populations of the native white clawed crayfish (*Austropotamobius pallipes*), small populations of freshwater pearl mussels (*Margaritifera margaritifera*), and a range of fish species, including Atlantic Salmon (*Salmo salar*). Coniston Water and Windermere support populations of the rare Arctic Charr (*Salvelinus alpinus*)[3]. The wider basins support a range of important habitats and fauna. Habitats of note include the upland oak woodland of Dodgson Wood (Coniston), calcareous grassland of Scout Scar and Whitbarrow Scar, and the lowland raised mires of Roudsea and Rusland Valley Mosses. The RSPB Nature Reserve at Leighton Moss is also located on the eastern shores of the Kent estuary. Within the basins, particular conservation efforts are directed towards bats, red squirrel, water vole, barn owl, song thrush, great crested newt and high brown / pearl-bordered fritillary butterflies[4].

Lune basin: The River Lune originates on the northern slopes of the Howgill Fells (with an additional contribution from Shap Fells). Sandstone and gritstone rocks of the Silurian and Ordovician periods characterise the Howgill area. At Sedburgh town the main stem of the Lune is joined by the rivers Rawthey (from Cautley Spout Waterfall), Clough and Dee (from Dentdale). Further down the Lune Valley ('Lunesdale'), it is joined by the rivers Greta (from the limestone caves of the Yorkshire Dales National Park around Ingleton), Wenning and Hindburn/Roeburn (from the northern slopes of the

Forest of Bowland ANOB). Further downstream, historic Lancaster city is located on the banks of the River Lune. The small rivers of the Conder, Cocker and Pilling Water join before or shortly after the Lune enters Morecambe Bay at Plover Scar.

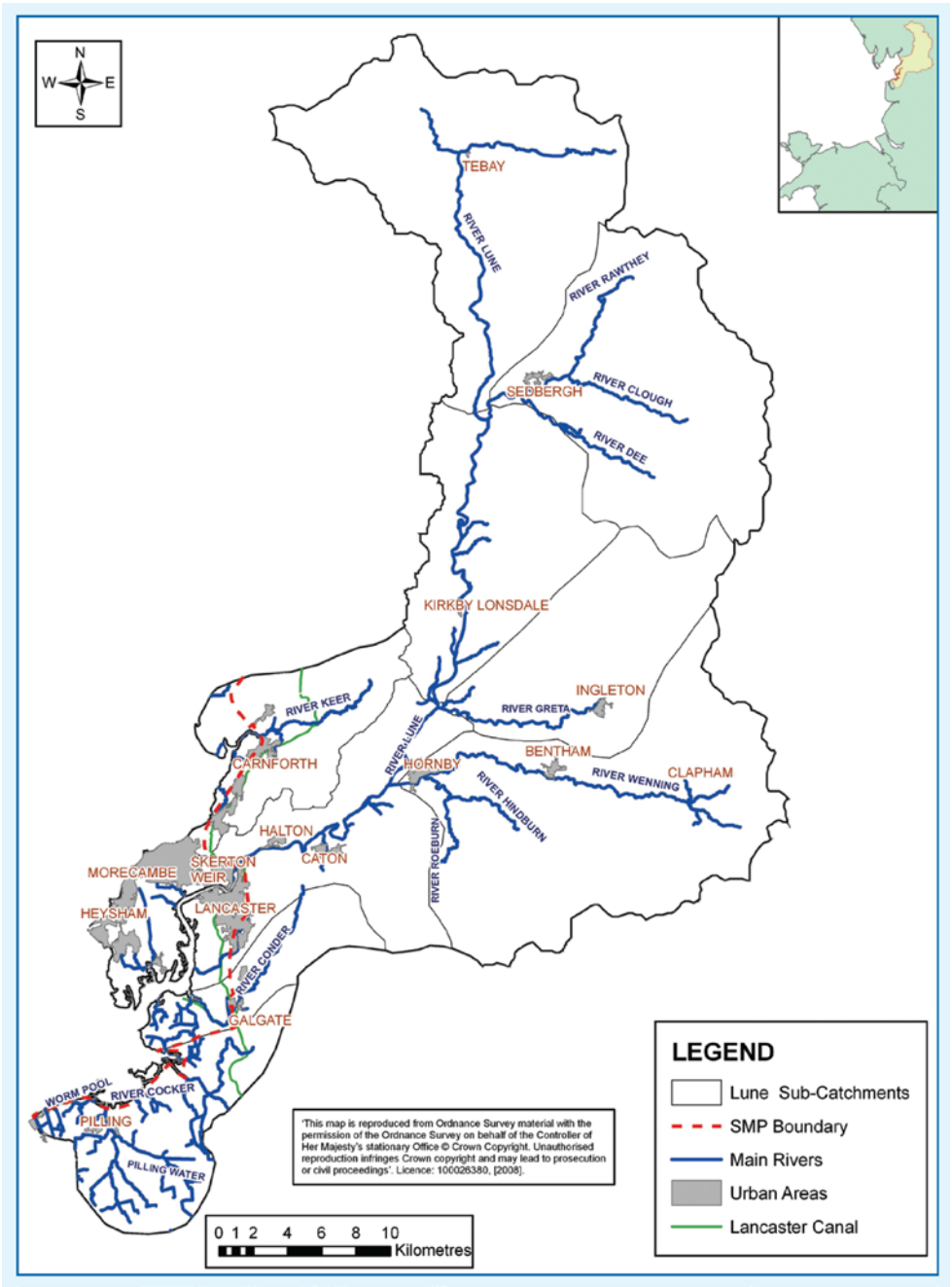

Fig 2. Lune basin on the eastern edge of Morecambe Bay[5]

An abstraction from the Lune at Caton provides one third of Lancaster and Morecambe's water supply, with a third brought in from the neighbouring upper Wyre catchment, and the remaining third abstracted from Thirlmere aquaduct that brings raw water from northern Cumbria. The Lune is a rural catchment and contains numerous SSSIs, SACs and NNRs (e.g., Bowland Fells SSSI and Ingleborough NNR[6]), with the conservation of barn owls, red squirrels, freshwater pearl mussels and sea trout being some of the faunal species of current interest[7]. The coastal region also has

interesting habitats (e.g., Winmarleigh Moss SSSI), though its villages on the Fylde Plain are at considerable risk from flooding by tidal surges[8].

Wyre basin: The River Wyre originates from springs at Ward's Stone (560 m) on Tarnbrook Fells in the Forest of Bowland ANOB. The geology of the headwater area comprises of sedimentary rocks (i.e., millstone grits, sandstones, limestones and shales) of the Carboniferous period. South of Garstang town it is joined by the Rivers Calder and Brock before entering Morecambe Bay at Fleetwood port. Much of Blackpool is considered part of the lower reaches of Wyre basin. Central within the basin is the Franklaw waterworks that forms the hub of the UK's first Conjunctive Use Scheme combining groundwater, reservoir water (from Bowland Fells) with water abstracted from the Wyre, supported by a transfer from the neighbouring River Lune basin. Also central within the basin are the innovative Garstang and Catterall Flood Alleviation Basins operated to protect villages such as St Michaels on Wyre from fluvial flooding; activated most recently in December 2015 during Storm Desmond. The rivers draining into Morecambe Bay have a recorded history of fluvial flooding extending back to the 1680s[9].

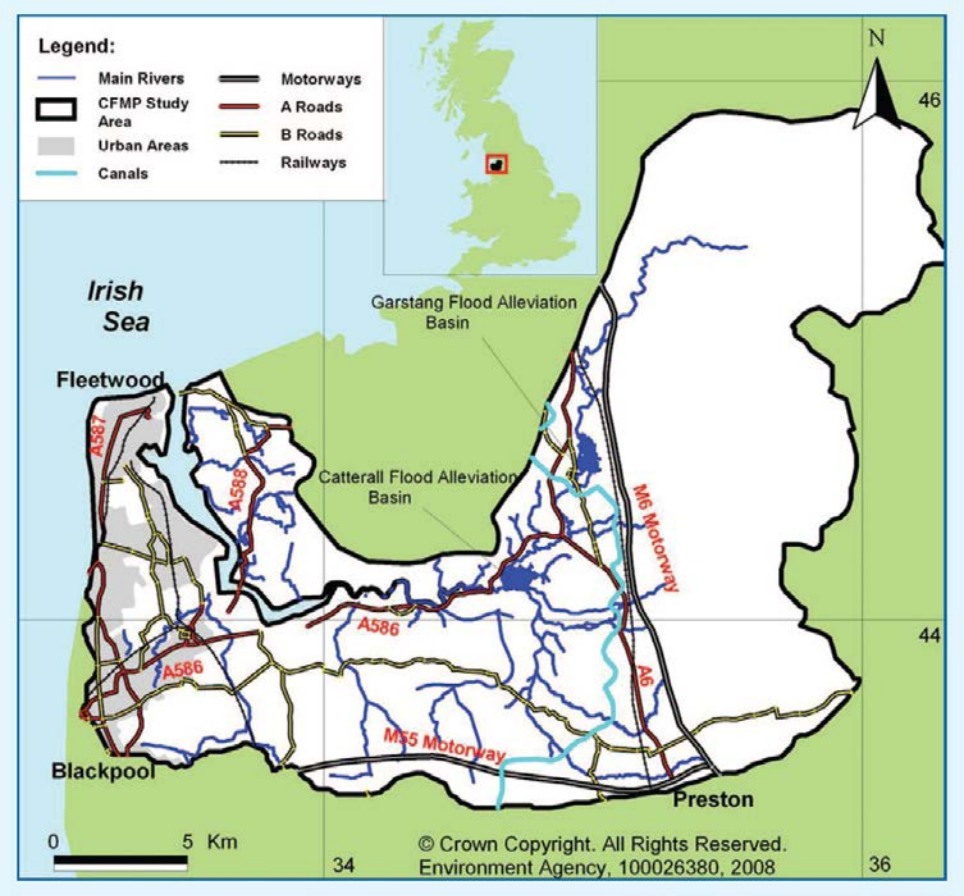

Fig 3. Wyre basin on the eastern edge of Morecambe Bay[10]

The basin contains a range of important habitats, including blanket bog. Blanket bog is the most extensive semi-natural habitat to be found in the UK, and the Forest of Bowland has some of the best blanket bog in England, supporting scarce plant species such as bog rosemary. Birds such as the meadow pipit, golden plover, dunlin, curlew, short-eared owl, and grouse utilise this habitat[11].

Morecambe Bay estuaries: Morecambe Bay itself is a wetland site of international importance – with some 369 km^2 classified Ramsar site No. 863[12]. It also has national importance being classified as a Special Area for Conservation (SAC), Special Protection Area (SPA) and Site of Special Scientific Interest (SSSI). In addition to being largest continuous intertidal area of mud and sandflats in the UK, there are associated saltmarshes, shingle beaches, and other important coastal habitats. Indeed, Morecambe Bay forms part of a series of west coast estuaries of outstanding importance for numerous species of passage, breeding and wintering water-birds. The area supports the third largest number of wintering wildfowl in the UK[12].

References

1) Adapted from http://www.catchmentbasedapproach.org

2) Adapted from Environment Agency (2009a) Kent Leven Catchment Flood Management Plan. Summary Report. Environment Agency, Warrington.

3) http://www.catchmentbasedapproach.org/north-west/kent-leven

4) http://www.lakelandwildlife.co.uk

5) Adapted from Environment Agency (2009b) Lune Catchment Flood Management Plan. Summary Report. Environment Agency, Warrington.

6) http://www.magic.gov.uk

7) http://luneriverstrust.org.uk

8) Environment Agency (1997) Coastal flooding in the North West. Environment Agency, Warrington.

9) Watkins, S. and Whyte, I. (2008) Extreme flood events in upland catchments in Cumbria since 1600: the evidence of historical records. *North West Geography* 8(1): 33-41.

10) Adapted from Environment Agency (2009c) Wyre Catchment Flood Management Plan. Summary Report. Environment Agency, Warrington.

11) http://forestofbowland.com

12) http://www.ramsar.org

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