Supplementary data

Catchments

Barwon Catchment

The Barwon River is a gaining river system with a catchment area of ~2700 km^2 that is mainly cleared of native eucalyptus vegetation and used for dryland grazing with minor tree plantations. Streamflow and SC data from the Ricketts Marsh (223224), Kildean Lane (223247), Winchelsea (223201), Inverleigh (223218), and Pollocksford (233200) gauges on the main Barwon River and the Agroforestry (233250), Birregurra (223211), Warrambine (223223), and Leigh (223213) tributaries are used (Department of Land, Environment, Water and Planning, 2020). The catchment comprises mainly Piocene-Pleistocene Newer Volcanics Province basalts interbedded with marine and freshwater sediments (Dahlhaus et al., 2008; Cartwright et al., 2013, 2014). Annual rainfall is between 600 to 1050 mm with July to September (the austral winter) the wettest months (Bureau of Meteorology, 2021). Total annual streamflows in the Barwon River increase downstream and 60% of the annual flow occurs between July and September (Department of Land, Environment, Water and Planning, 2021). Between 1994 and 2020, the maximum SC in the Barwon River were 11,200 μS/cm at gauge 223218 and as high as 25,762 μS/cm at gauge 223211. Higher SC values are recorded during the lower summer streamflows. The main Barwon River records flow for >95% of the time during the monitoring period (Table 1). The tributaries have a higher intermittence (flow for 33 to 99% of the study period). Shallow groundwater in the Barwon catchment typically has SC values of 5000-20,000 μS/cm (Department of Land, Environment, Water and Planning, 2021).

Corangamite catchment

The Corangamite catchment is also located on the basalt plains of the Newer Volcanics (Department of Jobs, Precincts and Regions, 2021). The catchment includes several permanent and intermittent saline to hypersaline lakes that represent groundwater discharge points in topographic lows in the basalt surface. Data are from four gauges: 234200 (Woady Yallock River at Cressy), 234201 (Woady Yallock River at Pitfield), 2344209 (Deans Creek), and 234212 (Browns Waterholes) (Department of Environment, Land, Water and Planning) that are upstream of the lakes. As with the Barwon catchment, rainfall (~720 mm/yr: Bureau of Meteorology, 2021) and streamflow are higher in the winter months. The streams recorded between 83 and 100% flows over the study period and the maximum SC values range from 4547 to 21790 μS/cm (Table 1). The catchment has been largely cleared for dryland agriculture with only local groundwater use, mainly for stock watering. Groundwater salinity varies from ~1000 μS/cm in the south of the catchment to >50,000 μS/cm (Department of Land, Environment, Water and Planning, 2021).

Goulburn Catchment

The Goulburn catchment is part of the Riverine Plain of the Murray Basin (Cartwright and Weaver, 2004). The shallowest sediments are the heterogeneous terrestrial sands, silts, and clays of the Pliocene to Holocene Shepparton Formation and the contiguous Quaternary Coonambidgal Formation; these onlap basement Proterozoic granites and metamorphosed turbidites in the south of the catchment (Lawrence, 1988). Data are from four gauges from unregulated tributaries to the highly-regulated Goulburn River: 405212 (Sunday Creek), 405226 (Pranjip Creek), 405240 (Sugarloaf Creek), and 405246 (Castle Creek) (Department of Environment, Land, Water and Planning, 2021). Annual rainfall decreases southwards from 675 to 450 mm/yr (Bureau of Meteorology, 2021). Rainfall and streamflow are again higher in the winter months. The streams recorded between 37 and 77% flows over the study period and the maximum SC values range from 498 to 2370 μS/cm (Table 1). The catchment has been largely cleared and comprises a mix of dryland and irrigated agriculture. Groundwater salinity is mainly <5000 μS/cm although local zones of higher salinity (up to 20,000 μS/cm) groundwater exist in the easy of the catchment (Department of Land, Environment, Water and Planning, 2021).

Loddon Catchment

The Loddon catchment is also part of the Riverine Plain of the Murray Basin and has similar hydrogeology to the Goulburn area (Lawrence, 1988). Data are from six gauges from unregulated tributaries to the regulated Goulburn River: 407211 (Bet Bet Creek at Bet Bet), 407239 (Middle Creek), 407252 (Barr Creek), 407284 (Calivil Creek), 407288 (Bet Bet Creek at Lillicur), and 407289 (Nine Mile Creek) (Department of Environment, Land, Water and Planning, 2021). Annual rainfall decreases southwards from 580 to 420 mm/yr (Bureau of Meteorology, 2021). Rainfall and streamflow are again higher in the winter months. The streams recorded between 54 and 94% flows over the study period and the maximum SC values range from 1896 to 36919 μS/cm (Table 1). Shallow groundwater in the

Barwon catchment typically has SC values of 7000-30,000 μS/cm (Department of Land, Environment, Water and Planning, 2021). The catchment is largely cleared and predominantly used for dryland agriculture.

BFI from the CMB method

Figure S1. Variations in annual BFI and Discharge (Q in m^3/sec) for the Barwon Catchment calculated using the constant SC (squares) and variable SC (diamonds) method.

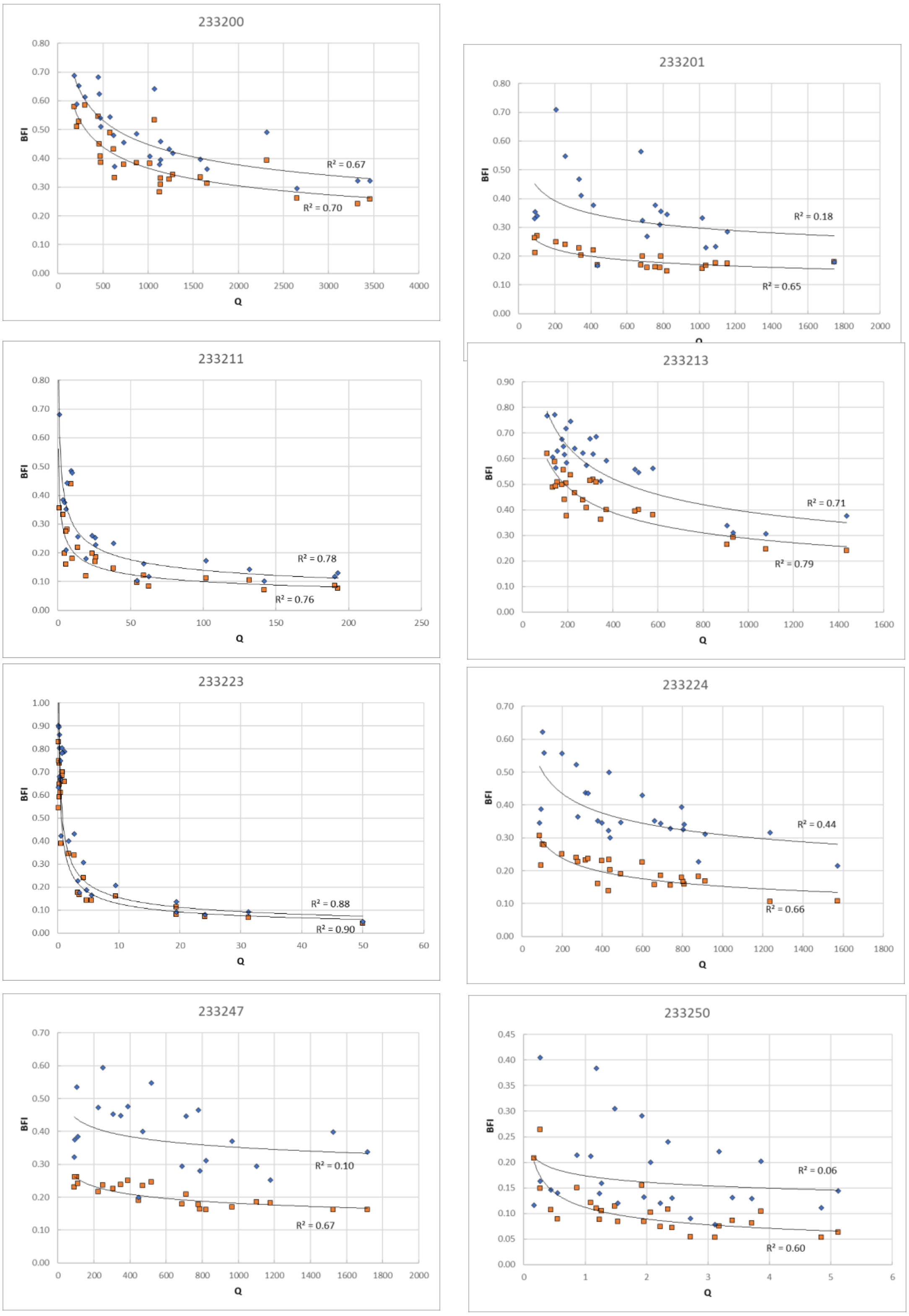


Figure S2. Variations in annual BFI and Discharge (Q in m^3/sec) for the Corangamite Catchment calculated using the constant SC (squares) and variable SC (diamonds) method.

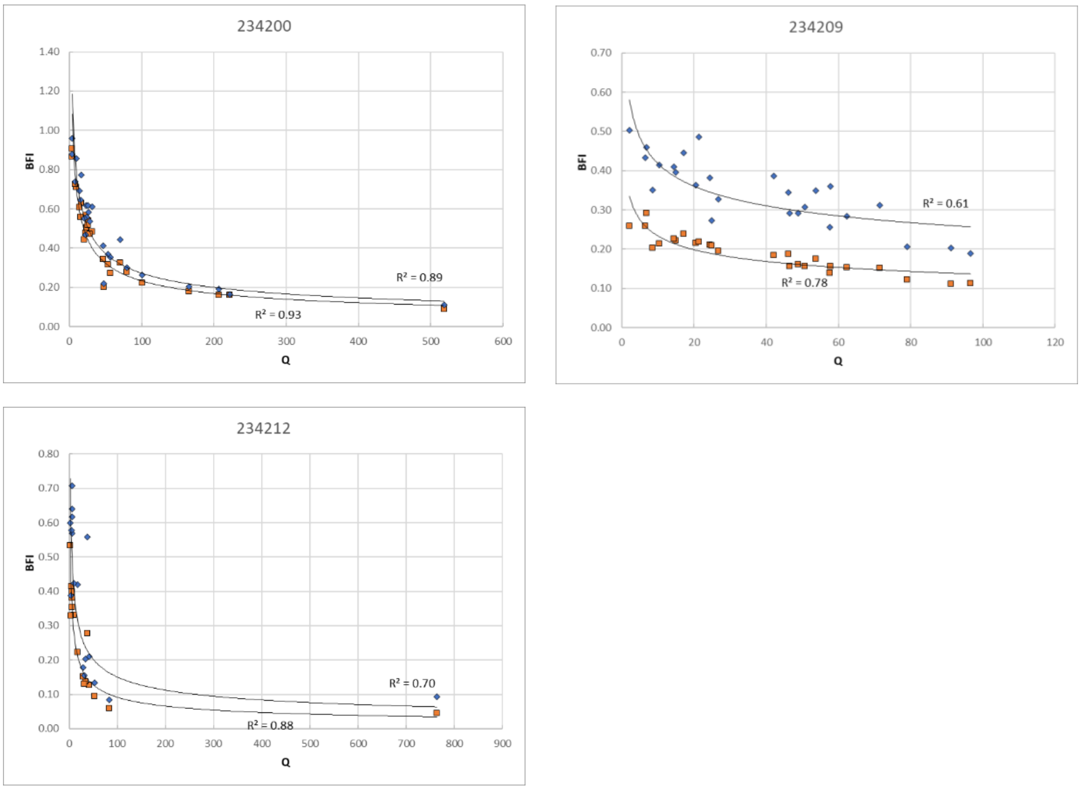


Figure S3. Variations in annual BFI and Discharge (Q in m^3/sec) for the Goulburn Catchment calculated using the constant SC (squares) and variable SC (diamonds) method.

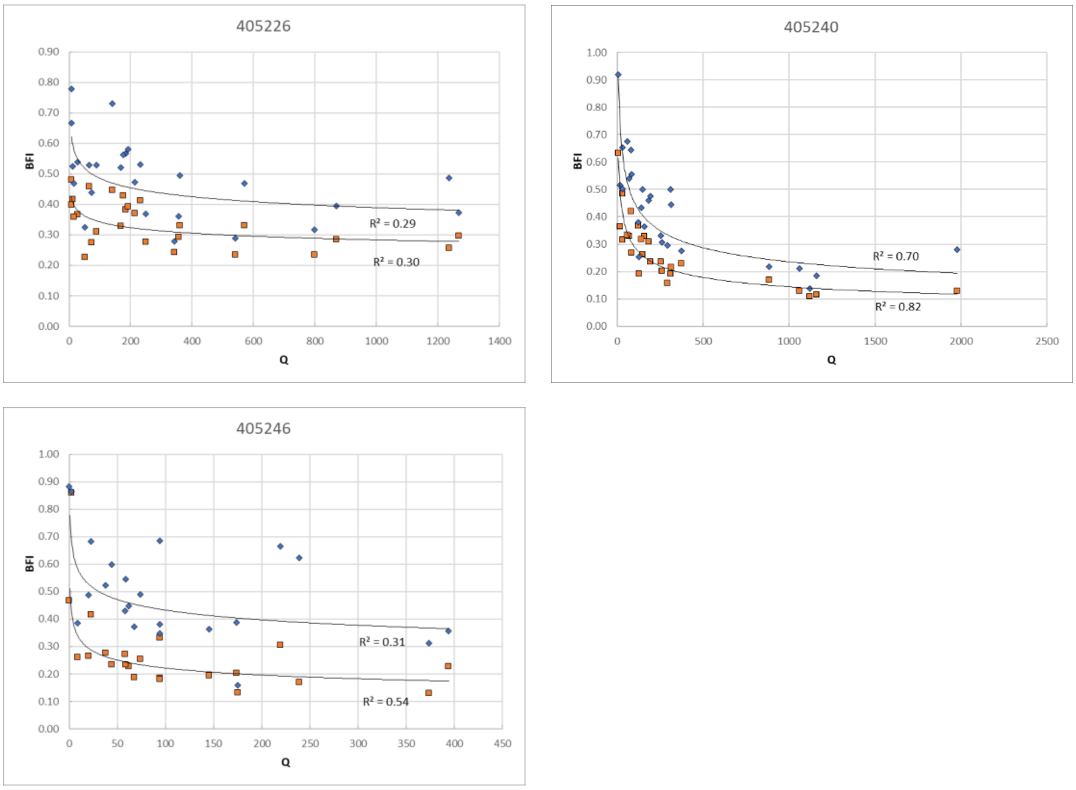
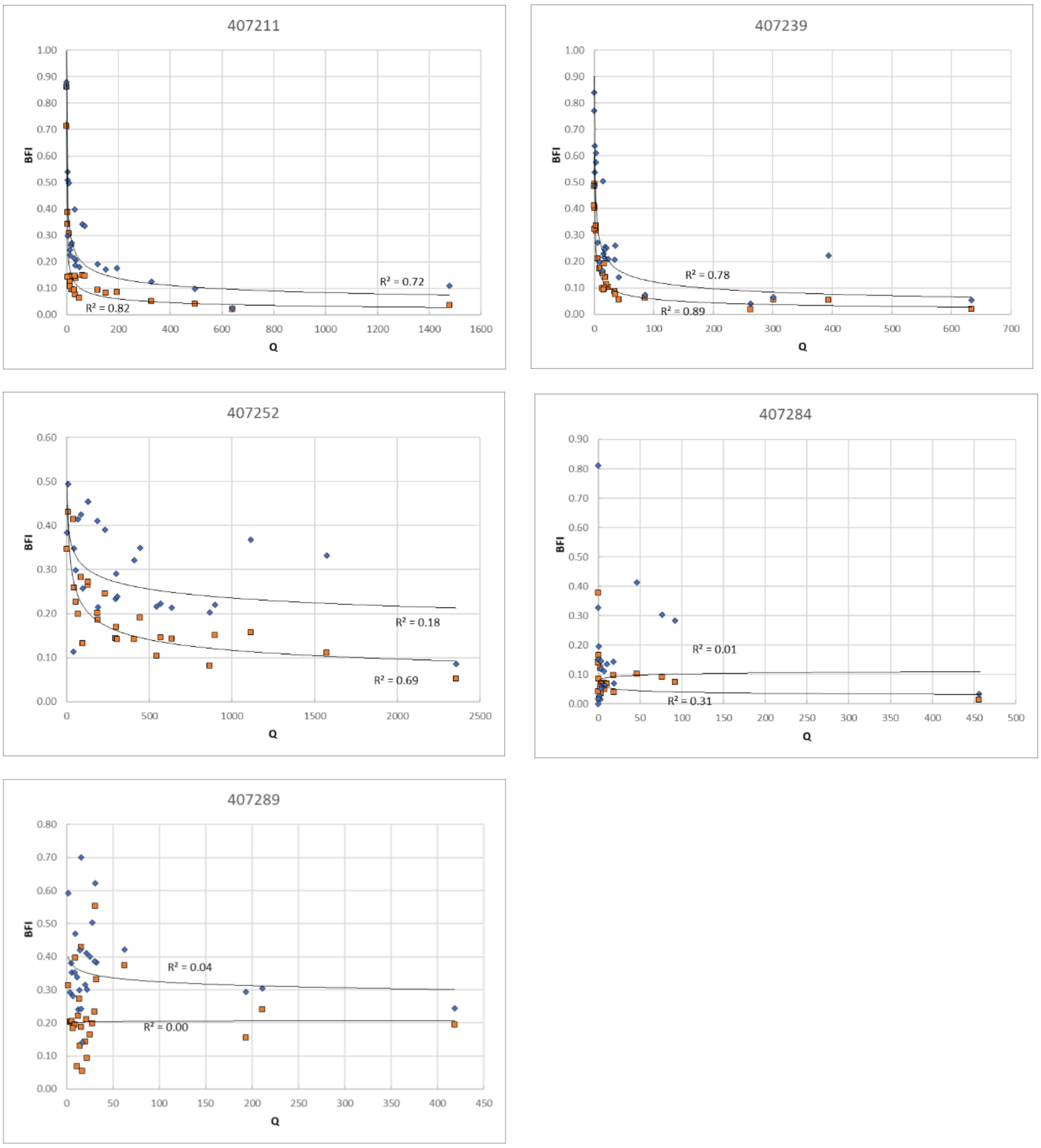


Figure S4. Variations in annual BFI and Discharge (Q in m^3/sec) for the Goulburn Catchment calculated using the constant SC (squares) and variable SC (diamonds) method.



Comparison of BFI from CMB and hydrograph-based techniques

Figure S5. Comparison BFI calculated from the RDF and SM methods with the BFI from CMB using the variable and constant SC calculations for the Barwon Catchment (symbols as for Fig. 5).

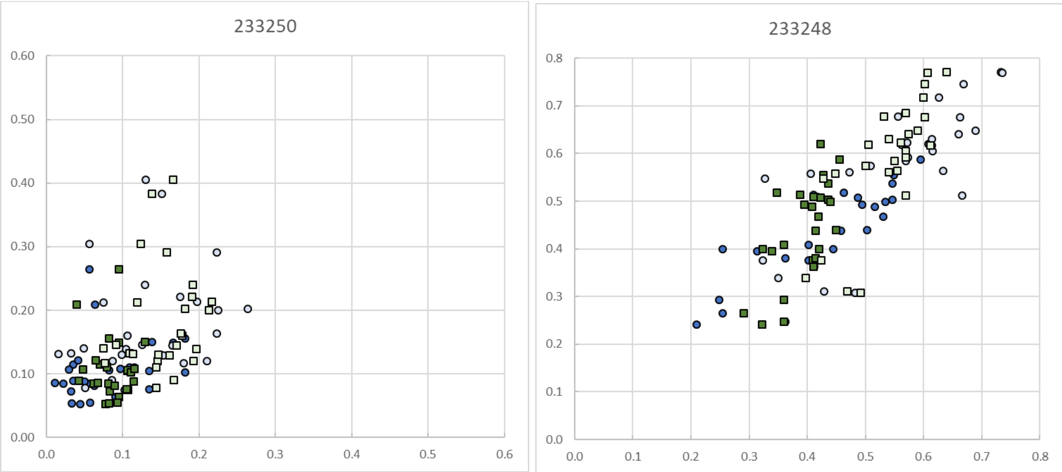


Figure S6. Comparison BFI calculated from the RDF and SM methods with the BFI from CMB using the variable and constant SC calculations for the Corangamite Catchment (symbols as for Fig. 5).

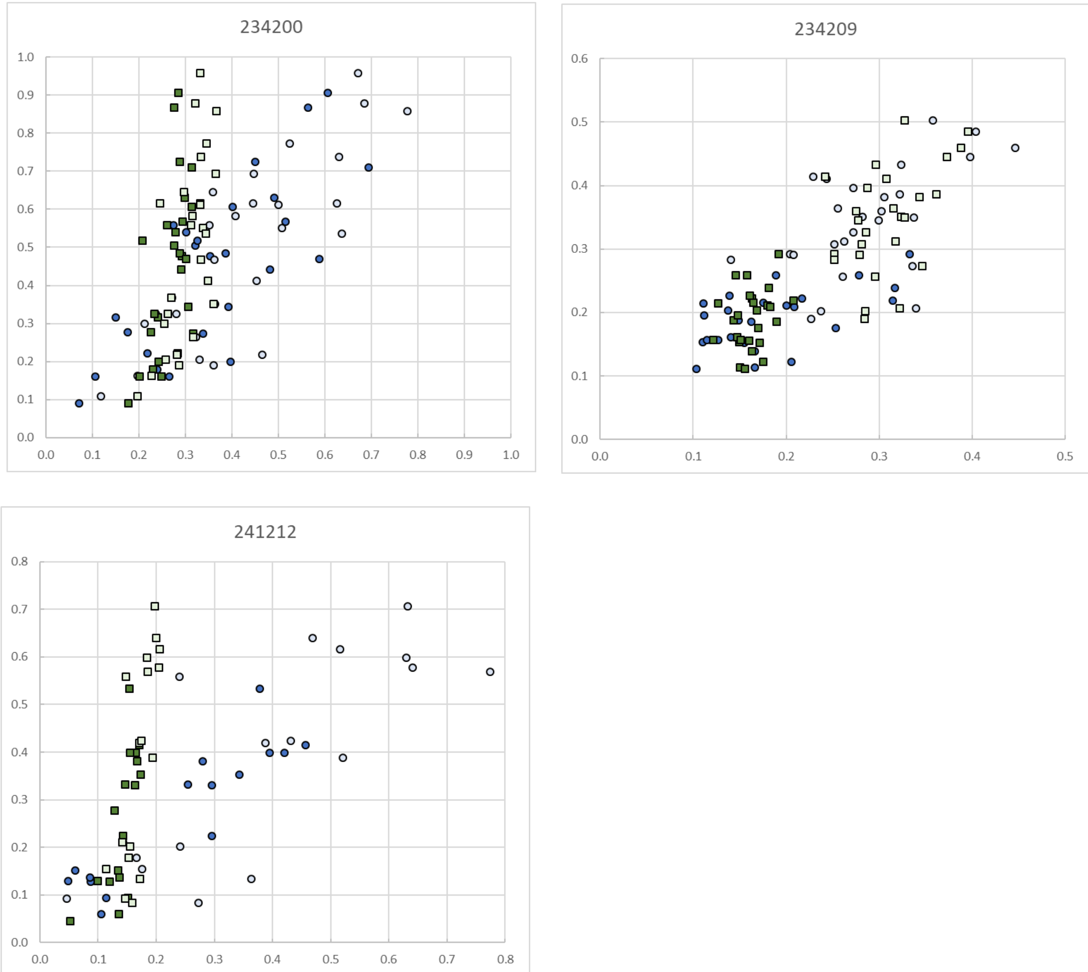


Figure S7. Comparison BFI calculated from the RDF and SM methods with the BFI from CMB using the variable and constant SC calculations for the Goulburn Catchment (symbols as for Fig. 5).

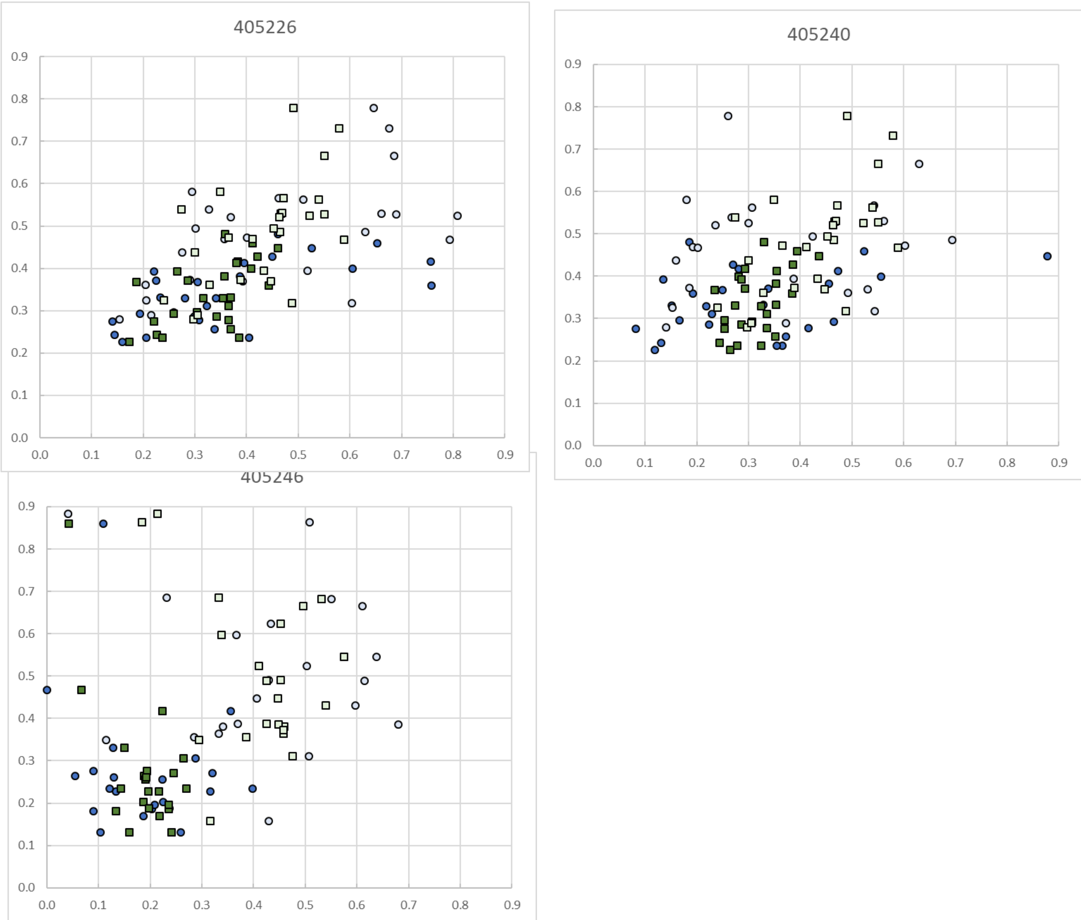


Figure S8. Comparison BFI calculated from the RDF and SM methods with the BFI from CMB using the variable and constant SC calculations for the Loddon Catchment (symbols as for Fig. 5).

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