**Supplement of**

**Investigating Relationships Between Nitrogen Inputs and In-Stream Nitrogen Concentrations and Exports Across Catchments in Victoria, Australia**

**Olaleye Babatunde et al.**

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# **Table S1:** Summary of catchment characteristics, land use, and nitrogen (N) inputs and exports for each catchment (provided as an attached Excel file).

# **Table S2.** Catchment characteristics and data Sources.

|  |  |
| --- | --- |
| **Characteristics** | **Sources** |
| Land Area Covered by Forests (%) | Victorian Land Use Information System (2017) |
| Land Area Covered by Water (%) | Victorian Land Use Information System (2017) |
| Land Area for Intensive Uses (Urban) (%) | Victorian Land Use Information System (2017) |
| Land Area Used for Cropping (%) | Victorian Land Use Information System (2017) |
| Land Area Used for Dairy Farming (%) | Victorian Land Use Information System (2017) |
| Land Area Used for Horticulture (%) | Victorian Land Use Information System (2017) |
| Land Area Used for Mixed Farming and Grazing (%) | Victorian Land Use Information System (2017) |
| Land Area Used for Livestock (Non-Dairy (%)) | Victorian Land Use Information System (2017) |
| Runoff-Area Normalized Streamflow (mm yr⁻¹) | Derived from streamflow (Victorian Water Quality Monitoring Network) and Catchment area (Geofabric tool, BoM 2012) |
| Annual Temperature (°C) | Geoscience Australia (2011) |
| Catchment Slope (°) | Geoscience Australia (2011) |
| Mean Annual Rainfall (mm yr⁻¹) | Bureau of Meteorology, 30-year mean (1991–2020) |
| Runoff Pereniality (°) | Geoscience Australia (2011) |

# **Table S3**. Summary of datasets used to estimate nitrogen fertiliser inputs.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **s/n** | **Data Source** | **Spatial Coverage** | **Temporal Coverage** | **Data Applied in the Study** | **Reference URL** |
| 1 | Australia's National Statistical Agency (ABS) | 10 CMA in Victoria | Two years (2016–2017 and 2018–2019) | Fertiliser weight` (t) and area fertilised (ha) for various land uses. | <https://www.abs.gov.au/statistics/industry/agriculture/land-management-and-farming-australia/latest-release#data-downloads> |
| 2 | Bureau of Meteorology | Whole of Victoria | 30-year mean annual rainfall (1991–2020) | Mean Annual rainfall (MAR) (mm/year) used in fertiliser-rainfall relationship. | <http://www.bom.gov.au/climate/maps/averages/rainfall/?period=an&region=vc> |
| 3 | Victorian Land Use Information System | Whole of Victoria. | 2017 (Latest Classification) | Land use categories (e.g., dairy, cropping) based on ALUMv8.  Irrigated land parcel. | https://discover.data.vic.gov.au/dataset/victorian-land-use-information-system-2016-2017 |
| 4 | Australia's National Statistical Agency (ABS) | 10 CMA in Victoria | Two years (2016–2017 and 2018–2019) | Irrigation water (mm) applied to irrigated land use specifically Dairy and Cropping. | https://www.abs.gov.au/statistics/industry/agriculture/water-use-australian-farms |
| 5 | Dairy  and Livestock  Monitoring  Program | Selected  Farms  in Northern  Victoria,  Southwest  Victoria, and  Gippsland. | Dairy: Two years (2016–2017, 2018–2019)  Livestock: (2018–2019, 2019–2020, 2020–2021, 2021–2022) | Proportion of nitrogen (N) applied to dairy and livestock in various regions. | https://www.dairyaust  ralia.com.au/industry  -reports/dairy-farm-  monitor-  project/dairy-farm-  monitor-project---vic  https://agriculture.vic  . gov.au/about/agricult  ure-in-  victoria/livestock-  farm-monitor- project#h2-3 |

# **Table S4.** Average fertiliser nitrogen (N) input at the Catchment Management Authority (CMA) level. Data sources are provided in Supplement Table S3.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Catchment Management Authority (CMA) | Area (km²) | Average N Input Grazing (kg ha⁻) (2016-17 and 2018-19)  **ABS** | Average N Input (kg ha⁻) (2016-17 and 2018-19) kg/ha **Dairy Monitoring** | Average N Input (kg ha⁻) (2019-20 - 2022-23) kg/ha **Livestock Monitoring** | Proportion of N Input Livestock to **Dairy (%) Monitoring** | N Input Dairy (2016-17 and 2018-19) kg ha⁻Adjusted | N Input Livestock (2019-20 - 2022-23) kg ha⁻Adjusted | Average Cropping Input (2016-17 and 2018-19) kg ha⁻ |
| Goulburn Broken | 24,060 | 152 | 115 | 7 | 6 | 143 | 9 | 236 |
| Mallee | 39,324 | 72 | 115 | 7 | 6 | 68 | 4 | 99 |
| North Central | 29,653 | 121 | 115 | 7 | 6 | 114 | 7 | 118 |
| Northeast | 19,799 | 181 | 115 | 7 | 6 | 170 | 11 | 182 |
| Wimmera | 23,449 | 103 | 115 | 7 | 6 | 97 | 6 | 96 |
| West Gippsland | 17,236 | 269 | 193 | 13 | 7 | 251 | 19 | 382 |
| East Gippsland | 21,047 | 146 | 193 | 13 | 7 | 136 | 10 | 267 |
| Corangamite | 13,371 | 157 | 149 | 11 | 7 | 146 | 11 | 213 |
| Glenelg Hopkins | 26,729 | 220 | 149 | 11 | 7 | 204 | 16 | 183 |
| Melbourne Water | 12,783 | 216 | 149 | 11 | 7 | 201 | 15 | 236 |

# **Table S5.** Mean rainfall for each land use and average irrigation water use at the Catchment Management Authority (CMA) level. Data sources are provided in Supplement Table S3.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Catchment Management Authority (CMA) | Area (km²) | Average Cropping Rainfall (mm) | Average Dairy Rainfall (mm) | Average Livestock (Non-Diary) Rainfall (mm) | Average Mixed Farming and Grazing Rainfall (mm) | Average Irrigation Water Use (mm) |
| Goulburn Broken | 24,060 | 461 | 448 | 509 | 651 | 321 |
| Mallee | 39,324 | 314 | 310 | 268 | 301 | 355 |
| North Central | 29,653 | 389 | 374 | 485 | 493 | 291 |
| Northeast | 19,799 | 797 | 963 | 842 | 755 | 295 |
| Wimmera | 23,449 | 393 | 420 | 514 | 465 | 188 |
| West Gippsland | 17,236 | 972 | 782 | 924 | 789 | 343 |
| East Gippsland | 21,047 | 684 | 759 | 718 | 706 | 181 |
| Corangamite | 13,371 | 535 | 797 | 653 | 645 | 217 |
| Glenelg Hopkins | 26,729 | 542 | 732 | 671 | 634 | 308 |
| Melbourne Water | 12,783 | 753 | 929 | 836 | 790 | 313 |

# **Table S6.** Nitrogen (N) inputs from biological nitrogen fixation used in this study.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Farming Type** | **Mean Value (kg ha⁻)** | **Sources** |
|  |  |  |  |
| Nitrogen Fixation | Crop (Legume and Non-Legume) | 43 | Mckee & Eyre., 2000 |
|  | Horticulture | 10 |
|  | Forest | 5 |
|  | Pasture (Improved and unimproved) | 12 |
|  |  |  |  |
|  |  |  |  |

# **Table S7: Regional averages of stocking rate (cows ha⁻¹) and purchased feed per milking cow (t DM cow⁻¹ yr⁻¹) for Gippsland, North Victoria, and South-West dairy systems, derived from the Dairy Farm Monitor Project for 2016–2017 and 2018–2019.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Region** | **2016–2017** | **2018–2019** | **Two-year mean** |
| **Stocking rate (cows ha⁻¹)** |  |  |  |
| Gippsland | 1.7 | 1.9 | 1.8 |
| North Victoria | 1.7 | 1.6 | 1.65 |
| Southwest | 1.1 | 1.1 | 1.1 |
| **Purchased feed (t DM cow⁻¹ yr⁻¹)** |  |  |  |
| Gippsland | 1.8 | 2 | 1.9 |
| North Victoria | 2.7 | 2.7 | 2.7 |
| Southwest | 2.2 | 2.06 | 2.13 |

# **Table S8: Regional averages of stocking rate (DSE ha⁻¹) and proportion of metabolizable energy (ME) obtained from purchased feed (% of total) for Gippsland, North Victoria, and South-West livestock systems.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Region** | **2019-20** | **2020-21** | **2021-2022** | **2022-23** | **four-year mean** |
| **Annual stocking rate (DSE/ha\*)** |  |  |  |  |  |
| Gippsland | 16.5 | 16.4 | 16.2 | 17.5 | 16.7 |
| North Victoria | 10.3 | 12.6 | 12.6 | 1.6 | 9.3 |
| Southwest | 17.4 | 17.7 | 17.1 | 15.7 | 17 |
| **Purchased feed as a % of ME consumed (% of total)** |  |  |  |  |  |
| Gippsland | 3% | 2% | 1% | 1% | 2 |
| North Victoria | 5% | 3% | 3% | 3% | 4 |
| Southwest | 4% | 6% | 5% | 6% | 5 |

# **Table S9.** Estimated total nitrogen (N) inputs, measured total nitrogen (TN) concentrations, TN exports (obtained through WRTDS), calculated Nox: TN ratio, and estimated riverine export (percentage of inputs exported)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sites** | **Sites name** | **Total Nitrogen Input (kg ha⁻¹)** | **Total Nitrogen Concentration (mg L⁻¹)** | **Nox: TN** | **Riverine Export (kg ha⁻¹)** | **Riverine Export (% of Inputs)** |
| 235237 | SCOTTS CREEK @ CURDIE (DIGNEYS BRIDGE) | 183.82 | 2.39 | 0.20 | 8.75 | 4.76 |
| 235203 | CURDIES RIVER @ CURDIE | 167.06 | 1.76 | 0.20 | 5.10 | 3.05 |
| 234203 | PIRRON YALLOCK CREEK @ PIRRON YALLOCK (ABOVE H'WY BR.) | 139.57 | 2.41 | 0.10 | 3.19 | 2.29 |
| 235211 | KENNEDYS CREEK @ KENNEDYS CREEK | 118.29 | 1.73 | 0.30 | 4.45 | 3.76 |
| 235224 | GELLIBRAND RIVER @ BURRUPA | 72.97 | 0.90 | 0.30 | 3.36 | 4.61 |
| 237200 | MOYNE RIVER @ TOOLONG | 70.85 | 1.13 | 0.10 | 2.01 | 2.84 |
| 227200 | TARRA RIVER @ YARRAM | 68.53 | 1.12 | 0.50 | 4.19 | 6.11 |
| 233224 | BARWON RIVER @ RICKETTS MARSH | 68.43 | 0.84 | 0.10 | 1.47 | 2.14 |
| 233218 | BARWON RIVER @ INVERLEIGH | 60.31 | 1.03 | 0.10 | 0.85 | 1.42 |
| 227211 | AGNES RIVER @ TOORA | 51.26 | 1.37 | 0.40 | 7.36 | 14.37 |
| 235234 | LOVE CREEK @ GELLIBRAND | 48.62 | 0.94 | 0.20 | 1.43 | 2.95 |
| 402222 | KIEWA RIVER @ KIEWA (MAIN STREAM) | 48.02 | 0.36 | 0.20 | 2.16 | 4.49 |
| 403223 | KING RIVER @ DOCKER ROAD BRIDGE | 42.88 | 0.35 | 0.30 | 1.42 | 3.30 |
| 403213 | FIFTEEN MILE CREEK @ GRETA SOUTH | 40.62 | 0.38 | 0.30 | 1.27 | 3.12 |
| 402205 | KIEWA RIVER @ BANDIANA | 39.64 | 0.34 | 0.20 | 1.52 | 3.84 |
| 237207 | SURRY RIVER @ HEATHMERE | 37.38 | 0.46 | 0.10 | 1.25 | 3.33 |
| 238228 | WANNON RIVER @ HENTY | 35.07 | 1.35 | 0.10 | 0.87 | 2.48 |
| 403241 | OVENS RIVER @ PEECHELBA | 34.65 | 0.38 | 0.30 | 1.23 | 3.54 |
| 415207 | WIMMERA RIVER @ EVERSLEY | 32.75 | 1.13 | 0.00 | 0.50 | 1.53 |
| 404207 | HOLLAND CREEK @ KELFEERA | 31.90 | 0.71 | 0.20 | 1.50 | 4.72 |
| 238202 | GLENELG RIVER @ SANDFORD | 31.46 | 1.23 | 0.10 | 0.71 | 2.26 |
| 238206 | GLENELG RIVER @ DARTMOOR | 30.47 | 1.47 | 0.40 | 0.73 | 2.38 |
| 238223 | WANDO RIVER @ WANDO VALE | 30.13 | 1.14 | 0.10 | 1.53 | 5.08 |
| 235227 | GELLIBRAND RIVER @ BUNKERS HILL | 29.09 | 0.61 | 0.40 | 2.99 | 10.27 |
| 405251 | BRANKEET CREEK @ ANCONA | 27.70 | 0.76 | 0.30 | 0.90 | 3.26 |
| 405209 | ACHERON RIVER @ TAGGERTY | 23.86 | 0.37 | 0.40 | 1.88 | 7.86 |
| 225201 | AVON RIVER @ STRATFORD | 23.83 | 0.39 | 0.30 | 1.18 | 4.94 |
| 403217 | ROSE RIVER @ MATONG NORTH | 23.54 | 0.30 | 0.40 | 1.05 | 4.47 |
| 405203 | GOULBURN RIVER @ EILDON | 23.50 | 0.27 | 0.40 | 0.79 | 3.38 |
| 401215 | MORASS CREEK @ UPLANDS | 18.15 | 0.85 | 0.00 | 0.59 | 3.23 |
| 402203 | KIEWA RIVER @ MONGANS BRIDGE | 17.32 | 0.23 | 0.30 | 2.44 | 14.07 |
| 223214 | TAMBO RIVER @ U/S OF SMITH CREEK | 16.54 | 0.39 | 0.10 | 0.32 | 1.93 |
| 401226 | VICTORIA RIVER @ VICTORIA FALLS | 16.05 | 0.32 | 0.10 | 0.60 | 3.71 |
| 401203 | MITTA MITTA RIVER @ HINNOMUNJIE | 15.58 | 0.19 | 0.10 | 0.61 | 3.90 |
| 401204 | MITTA MITTA RIVER @ TALLANDOON | 15.46 | 0.27 | 0.30 | 0.57 | 3.69 |
| 223202 | TAMBO RIVER @ SWIFTS CREEK | 14.66 | 0.30 | 0.10 | 0.80 | 5.48 |
| 403230 | OVENS RIVER @ ROCKY POINT | 14.13 | 0.31 | 0.40 | 1.23 | 8.71 |
| 401211 | MITTA MITTA RIVER @ COLEMANS | 13.90 | 0.22 | 0.20 | 0.45 | 3.21 |
| 403210 | OVENS RIVER @ MYRTLEFORD | 13.08 | 0.24 | 0.40 | 1.14 | 8.72 |
| 403205 | OVENS RIVER @ BRIGHT | 10.30 | 0.20 | 0.30 | 1.07 | 10.43 |
| 226226 | TANJIL RIVER @ TANJIL JUNCTION | 7.47 | 0.44 | 0.50 | 2.72 | 36.46 |
| 221211 | COMBIENBAR RIVER @ COMBIENBAR | 7.42 | 0.53 | 0.50 | 1.91 | 25.79 |
| 224213 | DARGO RIVER @ LOWER DARGO ROAD | 6.81 | 0.21 | 0.20 | 1.00 | 14.75 |
| 221212 | BEMM RIVER @ PRINCES HIGHWAY | 6.12 | 0.54 | 0.50 | 2.49 | 40.65 |
| 401216 | BIG RIVER @ JOKERS CREEK | 5.89 | 0.12 | 0.10 | 0.96 | 16.27 |
| 224203 | MITCHELL RIVER @ GLENALADALE | 5.88 | 0.23 | 0.10 | 0.74 | 12.63 |
| 221201 | CANN RIVER (WEST BRANCH) @ WEERAGUA | 5.50 | 0.38 | 0.30 | 1.11 | 20.17 |
| 221208 | WINGAN RIVER @ WINGAN INLET NATIONAL PARK | 5.47 | 0.42 | 0.10 | 1.38 | 25.29 |
| 233214 | BARWON RIVER EAST BRANCH @ FORREST | 5.30 | 0.33 | 0.30 | 2.66 | 50.16 |
| 224206 | WONNANGATTA RIVER @ CROOKED RIVER | 5.11 | 0.13 | 0.10 | 0.65 | 12.71 |
| 405264 | BIG RIVER @ D/S OF FRENCHMAN CREEK JUNCTION | 5.10 | 0.30 | 0.40 | 1.84 | 35.99 |
| 403244 | OVENS RIVER @ HARRIETVILLE | 5.07 | 0.11 | 0.30 | 0.76 | 14.97 |
| 238231 | GLENELG RIVER @ BIG CORD | 5.03 | 0.31 | 0.00 | 0.42 | 8.36 |
| 405219 | GOULBURN RIVER @ DOHERTYS | 5.01 | 0.15 | 0.30 | 0.92 | 18.29 |
| 402223 | KIEWA RIVER WEST BRANCH @ U/S OF OFFTAKE | 5.01 | 0.11 | 0.20 | 1.55 | 31.04 |
| 405205 | MURRINDINDI RIVER @ MURRINDINDI ABOVE COLWELLS | 5.00 | 0.46 | 0.40 | 2.05 | 40.88 |
| 401212 | NARIEL CREEK @ UPPER NARIEL | 5.00 | 0.14 | 0.20 | 0.77 | 15.33 |
| 222217 | RODGER RIVER @ JACKSONS CROSSING | 5.00 | 0.46 | 0.40 | 2.01 | 40.24 |
| 223204 | NICHOLSON RIVER @ DEPTFORD | 5.00 | 0.40 | 0.30 | 0.96 | 19.26 |

# **Table S10**. Trend analysis of total nitrogen flux (kg ha⁻¹ yr⁻¹) for high export sites (S = significant (*p* ≤ 0.05); NS = not significant (*p* > 0.05)).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Site ID** | **Sites Names** | **Slope** | **Intercept** | **R²** | ***P-*value** | **Significance** |
| 235237 | Scotts Creek @ Curdie | 0.002 | -4.09 | 0.42 | 0.03 | S |
| 227211 | Agnes River @ Toora | 0.001 | -2.05 | 0.15 | 0.23 | NS |
| 235203 | Curdies River @ Curdie | 0.001 | -2.79 | 0.50 | 0.02 | S |
| 235211 | Kennedys Creek @ Kennedy | 0.001 | -1.93 | 0.50 | 0.01 | S |
| 227200 | Tarra River @ Yarram | 0.000 | -0.93 | 0.02 | 0.72 | NS |
| 235224 | Gellibrand River @ Burrupa | 0.000 | -0.62 | 0.19 | 0.18 | NS |
| 234203 | Pirron Yallock Creek | 0.001 | -1.57 | 0.38 | 0.04 | S |
| 235227 | Gellibrand River @ Bunker | 0.000 | -0.03 | 0.00 | 0.95 | NS |
| 226226 | Tanjil River @ Tanjil Junction | 0.000 | -0.97 | 0.10 | 0.36 | NS |
| 233214 | Barwon River East Branch @ Forrest. | 0.000 | -0.48 | 0.03 | 0.59 | NS |
| 221212 | Bemm River @ Prince Highway | 0.000 | -0.80 | 0.06 | 0.47 | NS |
|  |  |  |  |  |  |  |

# **Table S11.** Correlation between land use and Nox: TN ratio for high (>2.5 kg ha⁻¹ yr⁻¹), low (<2.5 kg ha⁻¹ yr⁻¹) and all TN export catchments. S = significant (*p* ≤ 0.05); NS = not significant (*p* > 0.05).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **TN Export Level** | **Land Use** | **Nox: TN Correlation** | ***p*-value** | **Significance** | **Stream N Speciation** |
|  |  |  |  |  |  |
| **> 2.5 (kg ha⁻¹ yr⁻¹)** **(High Export Sites)** | Forests (%) | 0.68 | 0.032 | S | Nitrate (NOx) |
| Dairy (%) | -0.73 | 0.016 | S | Organic N/Ammonia |
| Horticulture (%) | 0.22 | 0.539 | NS | Nitrate (NOx) |
| Mixed Farming and Grazing (%) | -0.29 | 0.423 | NS | Organic N/Ammonia |
| Livestock (Non-Dairy (%)) | -0.47 | 0.174 | NS | Organic N/Ammonia |
|  |  |  |  |  |  |
| **<** 2.5 (kg ha⁻¹ yr⁻¹) **(Low Export Sites)** | Forests (%) | 0.425 | 0.002 | S | Nitrate (NOx) |
| Cropping (%) | -0.14 | 0.333 | NS | Organic N/Ammonia |
| Dairy (%) | -0.187 | 0.194 | NS | Organic N/Ammonia |
| Horticulture (%) | 0.097 | 0.503 | NS | Nitrate (NOx) |
| Mixed Farming and Grazing (%) | -0.283 | 0.046 | S | Organic N/Ammonia |
| Livestock (Non-Dairy (%)) | -0.387 | 0.005 | S | Organic N/Ammonia |
|  |  |  |  |  |  |
| **All Export Sites** | Forests (%) | 0.32 | 0.01 | S | Nitrate (NOx) |
| Dairy (%) | -0.01 | 0.95 | NS | Organic N/Ammonia |
| Cropping (%) | -0.16 | 0.22 | NS | Organic N/Ammonia |
| Horticulture (%) | 0.04 | 0.79 | NS | Nitrate (NOx) |
| Mixed Farming and Grazing (%) | -0.24 | 0.07 | NS | Organic N/Ammonia |
| Non-Dairy (%) | -0.42 | 0.00 | S | Organic N/Ammonia |

# **Equation S1.** Dairy purchased-feed N input (kg N ha⁻¹ yr⁻¹)

Where:

* nitrogen input from purchased feed (kg N ha⁻¹ yr⁻¹),
* *Stocking rate* = milking cows per hectare (cows ha⁻¹),
* *Purchased feed* = tonnes of dry matter (DM) purchased per cow per year (t DM cow⁻¹ yr⁻¹),
* *1000* = conversion from tonnes to kilograms, and
* = nitrogen fraction of purchased feed (0.024855 kg N kg⁻¹ DM).

# **Equation S2.** Non-dairy purchased-feed N input (kg N ha⁻¹ yr⁻¹)

where:

* ​ = nitrogen input from purchased feed (kg N ha⁻¹ yr⁻¹),
* *Stocking rate* = dry sheep equivalents per hectare (DSE ha⁻¹),
* *Purchased ME* = percentage of metabolizable energy supplied by purchased feed (%),
* *7.6 × 365* = annual metabolizable energy requirement per DSE (MJ DSE⁻¹ yr⁻¹),
* *10.8* = metabolizable energy content of feed (MJ kg⁻¹ DM), and
* ​=0.0235 kg N kg−1 DM = nitrogen fraction of purchased feed.

A graph with different colored lines

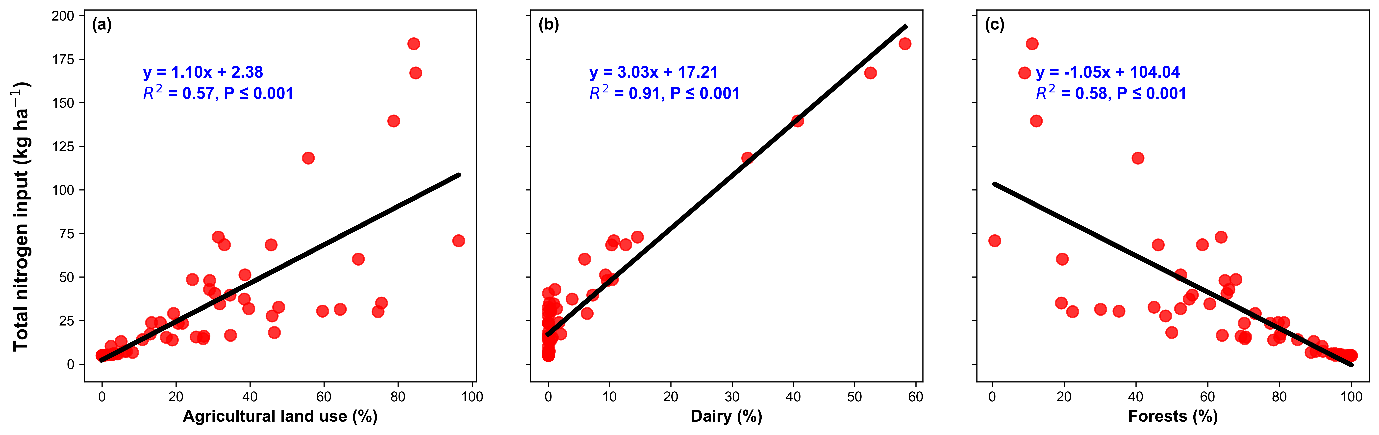
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# **Figure S1.** Trend of nitrogen application to dairy farms across different regions in Victoria.

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AI-generated content may be incorrect.

# **Figure S2.** Trend of nitrogen application to livestock (non-dairy) farms across different regions in Victoria.

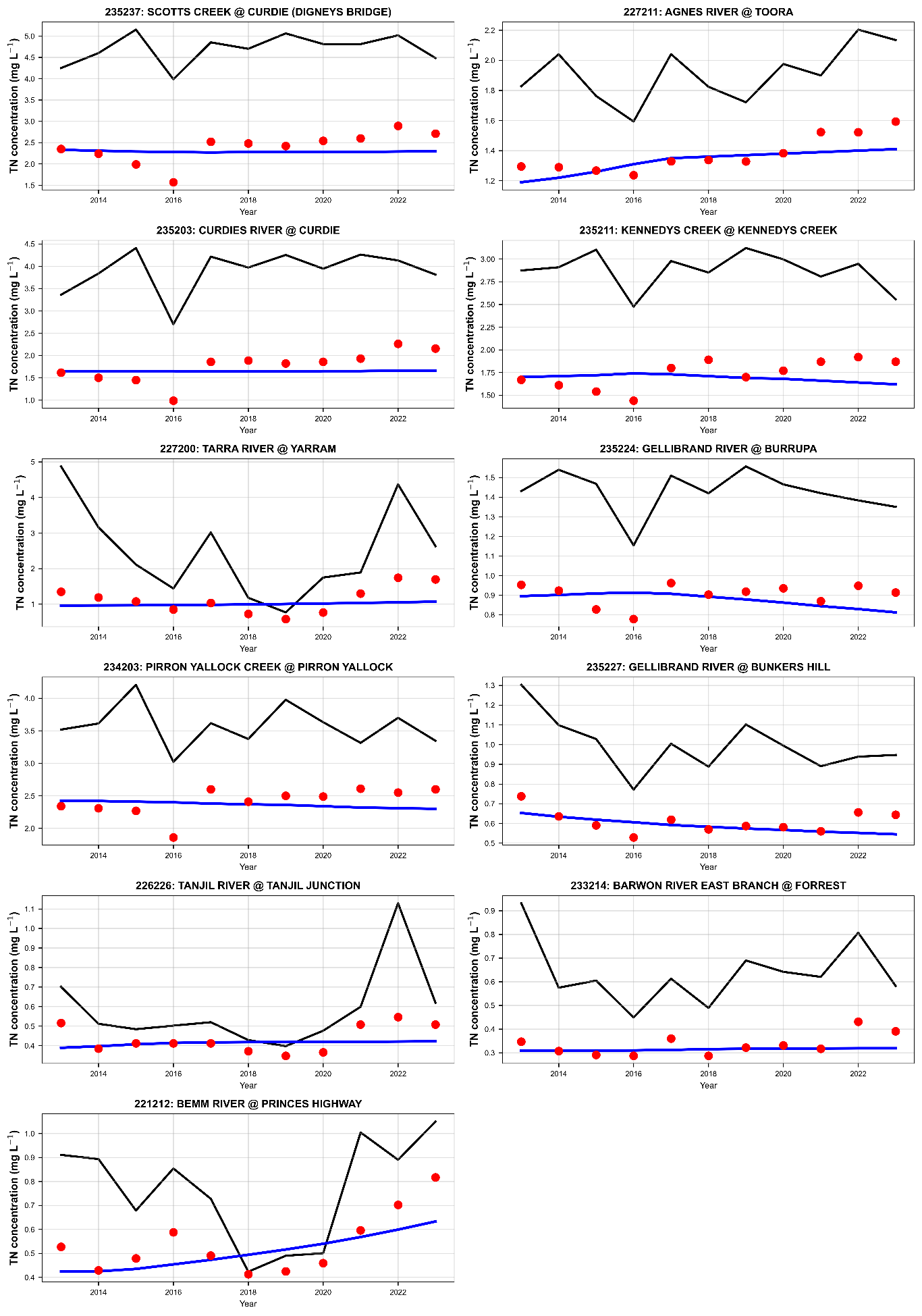


# **Figure S3**. Relationship between total nitrogen (N) inputs and (a) agricultural land use (%), (b) dairy, and (c) forests (%).

A graph of red and grey bars

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# **Figure S4:** Percentage change in total nitrogen (TN) export at high export sites.



# **Figure S5:** Flow-normalized concentrations are shown as blue lines, annual values as red dots, and flow-weighted concentrations as black lines for high export sites.

A graph of different colored bars

AI-generated content may be incorrect.

# **Figure S6:** Comparison of the coefficient of variation (CV) across high export sites.

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# **Figure S7.** Land use distributions across high export sites.