

4. APPLYING THE DARWIN-DALY REGIONAL AUSRIVAS MODELS

4.1 Predictor Variables

A predictor variable is an environmental feature used within an AUSRIVAS model to predict taxa which should occur at a site, in the absence of environmental stress (Coysh et al. 2000).

A total of 25 predictor variables were tested by Dostine (2004) for the Darwin-Daly genus-level model. Of these, seven were used as input variables in the AUSRIVAS genus model (Table 3). The same 25 predictor variables were tested for the Darwin-Daly family-level model, four of which were used in the model (Table 3) (Barlow & Lamche 2005). The derivation of the variables used in the models is described in the following section.

Table 3: Predictor variables selected for the Darwin-Daly region AUSRIVAS models

Variable (variable code as used in AUSRIVAS)	Selected for Darwin-Daly GENUS model	Selected for Darwin-Daly FAMILY model
Latitude (LATITUDE)		Yes
Longitude (LONGITUDE)		Yes
Distance from source (DFS)	Yes	
Stream order (STORDER)	Yes	
Average width (STREAMWIDTH)	Yes	Yes
Alkalinity (ALKALINITY)	Yes	
Average velocity (AVVELOCITY)	Yes	
Standard deviation of elevation (SDVTOP)	Yes	
Riparian rainforest in 100m radius (RIP100)	Yes	
Riparian rainforest in 500m radius (RIP500)		Yes

4.1.1 Latitude/Longitude:

The coordinates are collected in the field using a GPS (WSG84). Coordinates need to be entered in decimal degrees preferably to 4 digits after the point. Latitude is entered with the negative sign, i.e. -13.3769, Longitude i.e. 132.1247.

4.1.2 Distance from source (km):

The distance is measured between the source of the stream and the sample site. The source is often a spring, but can also be a wetland. The distance of the sampling site to the source is derived from 1: 50,000 or 1:100,000 topographical maps and is measured in kilometers. This can also be done using GIS software.

4.1.3 Stream order (no dimension):

The Strahler stream ordering method is used to obtain the stream order from 1:100 000 (preferred) or 1:250 000 topographic maps. The uppermost creeks and streams for each sub-catchment are assigned a stream order of one. A second order stream is produced when two first order streams meet. A stream order will only change when two streams of the same order meet. Therefore, a

lower stream order flowing into a higher order stream will not change the order of the higher stream. Figure 3 depicts the stream order structure:

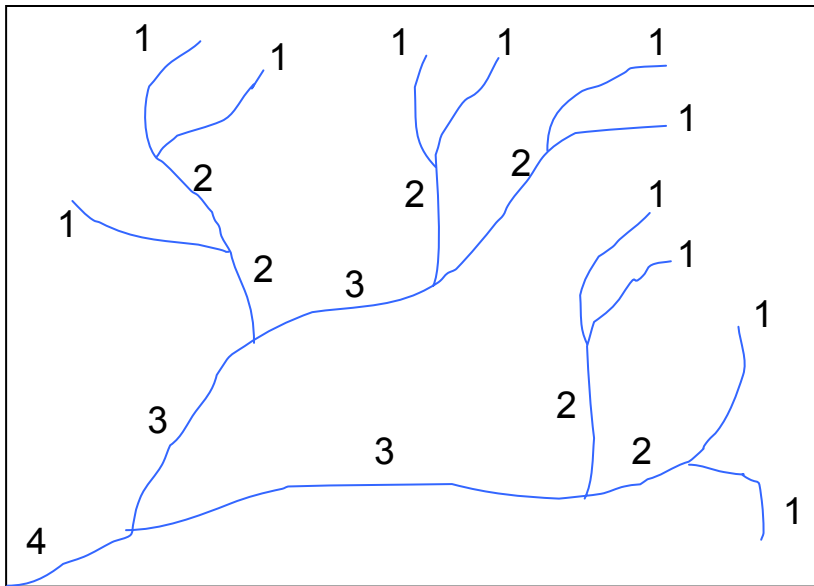


Figure 3: Strahler method to determine stream order.

4.1.4 Stream width (m):

The stream width (m) is measured or estimated during the sampling process at six positions within 100 m upstream of the sampling site (refer to Section 3.2.8.3). The average of the six values is used as the predictor variable.

4.1.5 Alkalinity (mg/L CaCO₃):

A water sample is taken *in situ* and transported on ice back to the laboratory. The alkalinity is measured as CaCO₃ in mg/L by an accredited chemistry laboratory (see section 3.2.5.1 and 3.2.4.3.1).

4.1.6 Average stream velocity (m/s):

The stream velocity (m/s) is measured at three locations, *in situ*, on the sampled edge habitat (see section 3.2.8.2). Calibration sheets for the Pygmy Fan Set should be used in the calculation of stream velocities, from the number of revolutions measured in the field. If a FlowTracker is used, the velocity is measured directly and no further calculation is necessary.

The three velocity measurements are averaged. The average velocity in m/s is used as a predictor variable.

4.1.7 Standard deviation of elevation (m):

The elevation of a sample site is derived from a Digital Elevation Model (DEM) raster dataset, 3 Seconds (resolution 90 m) – available from spatial data providers such as Geoscience Australia or Geoimage P/L. ArcGIS (version 9.1 or later) is used for spatial data processing and all datasets are projected in Geocentric Datum of Australia 1994 (GDA94).

The standard deviation of the elevation in 5x5 neighbouring cells is calculated from the DEM using the ‘Focal Statistics’ function in Spatial Analyst extension. The values at each site are then extracted using the ‘Extract Values to Points’ function.

The standard deviation of elevation within the 5x5 cell window characterizes the landscape morphology. For example, a high value in the elevation standard deviation indicates hilly or steep country, while a low value denotes a flat landscape.

If there is difficulty in obtaining the required DEM raster dataset or in calculating the standard deviation and range of the DEM in a 5x5 cell window, users should contact the Aquatic Health Unit (AHU) of the Department of Natural Resources, Environment and the Arts (NRETA).

4.1.8 Riparian rainforest areas (km²):

The riparian rainforest in 100 m and 500 m radius are variables used in the Darwin-Daly models. Both variables are derived in a similar manner.

Rainforest areas in the vicinity of a stream are retained in accordance with the NT land clearing guidelines. Thus rainforest areas in the vicinity of a stream fulfill the condition of a predictor variable not being affected by human activity.

Rainforest areas have been mapped by the NT Government (Russell-Smith & Lucas unpubl. 1978-89). The data were derived from interpretation of aerial photography at varying scales, mapped at 1:100 000 for the Darwin region and 1:250 000 elsewhere and are available as vector data (GDA 1994).

The rainforest areas in a 100 m and 500 m radius of the sampling sites are calculated using the buffer and intersect functions within ArcGIS. The rainforest type is distinguished in riparian and spring rainforest.

The rainforest dataset is freely shared within NT government. Users outside the NT government are advised to contact the Aquatic Health Unit (AHU) of NRETA. One possibility is to share the data set under a standard agreement. The AHU would also be able to calculate the values needed to run the Darwin-Daly region AUSRIVAS models if provided with the coordinates of the macroinvertebrate sampling sites. The coordinates need to be in Easting and Northing or latitude and longitude (decimal degrees) with reference to the datum/projection, e.g. GDA94 or World Geodetic System of 1984 (WGS84). It is likely that the dataset will be publicly available in the future through NRETAmaps (<http://www.nt.gov.au/nreta/nretamaps/>).

4.2 Running of Darwin-Daly region AUSRIVAS models

Access to the AUSRIVAS software is organised via the internet at <http://ausrivas.canberra.edu.au/Bioassessment/Macroinvertebrates/>. The AUSRIVAS manuals (Coyish et al. 2000; Ransom et al., 1997) provide sufficient information to prepare data and run the predictive modelling software as well as interpret results. In addition, the AUSRIVAS team at the University in Canberra (<http://ausrivas.canberra.edu.au/>) runs courses on the use of AUSRIVAS. Information on this can also be found on the website above.

When opening the AUSRIVAS software, the Darwin-Daly region models are located under the following pathway:

Choose 'Model' from the menu, choose 'run model', enter username and password, select: NT – Early – then choose either: 'Northern Territory – Darwin + Daly – Early – Family – Edge' or: 'Northern Territory – Darwin + Daly – Early – Genus – Edge'.

The results can be exported to a spreadsheet program for manipulation and reporting purposes.

4.3 Assessing stream health or condition

4.3.1 AUSRIVAS model outputs

Basic interpretation of the AUSRIVAS analysis and results are covered in the AUSRIVAS manuals (Coyish et al. 2000; Ransom et al., 1997) and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ 2000a, chapter 3 and Volume 2 Appendix 3).

Table 4: The AUSRIVAS banding scheme

Band	Description	O/E Taxa	O/E Taxa Interpretations
X	More biologically diverse than reference	O/E greater than 90th percentile of reference sites used to create the model.	More families found than expected. Potential biodiversity "hot-spot" or mild organic enrichment. Continuous irrigation flow in a normally intermittent stream.
A	Similar to reference	O/E within range of central 80% of reference sites used to create the model.	Expected number of families within the range found at 80% of the reference sites.
B	Significantly impaired	O/E below 10th percentile of reference sites used to create the model. Same width as band A.	Potential impact either on water and/or habitat quality resulting in a loss of families.
C	Severely impaired	O/E below band B. Same width as band A.	Many fewer families than expected. Loss of families from substantial impairment of expected biota caused by water and/or habitat quality.
D	Extremely Impaired	O/E below band C down to zero.	Few of the expected families and only the hardy, pollution tolerant families remain. Severe impairment.

AUSRIVAS compares the expected (E) number of taxa to the actually observed (O) number of taxa at each site (see section 3.2.1). The AUSRIVAS system only considers taxa that were calculated to have a probability of 50% or greater of occurring at a test site. The OE50 score is therefore the ratio of the observed to expected number of taxa with a probability of 50% or greater of occurring. This OE50 score is the major output score used in the NT to assess the health of the macroinvertebrate community at the test site.

To simplify interpretation of the OE50 score and to aid management decisions, a banding scheme is used representing different levels of biological condition. The interpretation of the bands is summarised in Table 4 (Coyish et al 2000).

The banding thresholds vary for each AUSRIVAS model and are shown for the Darwin-Daly regional models in Table 5.

Table 5: Band thresholds for the two Darwin-Daly region models

Band	Genus level model OE50	Family level model OE50
X	> 1.14	>1.18
A	0.86-1.14	0.82-1.18
B	0.58-0.85	0.45-0.81
C	0.29-0.57	0.07-0.44
D	<0.29	<0.07

It is important to note that the use and applicability of SIGNAL scores are not established in the Northern Territory (Dostine 2002) and so their use at this stage is discouraged. The use of the 'OE50' score and the 'Band' is well established in the NT and these are the recommended outputs to be used for stream health assessment.

4.3.2 Assessing stream health or condition

As indicated previously (section 3.1), while the AUSRIVAS analysis provides information on the health of a stream or reach, the results by themselves are not sufficient to determine the possible causes of impact or impairment should scores indicate a degraded stream condition. To place the AUSRIVAS scores into context, it is important to use the environmental information collected, either for its own assessment or for interpreting the biological results. Recommended (albeit broad) approaches that may be applied to data analysis and site assessment may be summarized briefly as follows.

4.3.2.1 General habitat and water quality assessment

Riparian or general habitat condition may be assessed using standard protocols, for example the 'Tropical Rapid Appraisal of Riparian Condition' TRARC (Dixon et al. 2006) (see also section 3.2.9.4).

Values for the water quality variables should be compared with the respective trigger values in the Australian and New Zealand water quality guidelines (ANZECC & ARMCANZ 2000a, chapters 3, 7). Other methods for water quality assessment are discussed in ANZECC & ARMCANZ (2000a, b) and these should be consulted.

4.3.2.2 Biological assessment

An advantage of the NT AUSRIVAS protocol is the acquisition of relative abundance information on macroinvertebrates which when analysed may be more sensitive to, and informative about, stream impacts. (The AUSRIVAS model outputs are derived from presence-absence data only.) In summary dot-point form, the following basic analyses and reporting can be conducted on the macroinvertebrate data:

- Community summaries for each site – taxa number, total abundance, the AUSRIVAS OE50 scores themselves (see section 4.3.1) – can be calculated and plotted for potentially disturbed (or 'exposed') and reference sites.
- Macroinvertebrate community structure – taxa and respective relative abundance – can be examined amongst sites using multivariate ordination (e.g. multidimensional scaling MDS) and classification methods.

- For inference about impact and its possible cause(s):
 - Statistical comparisons can be conducted of the community summaries between reference and exposed sites, before and after disturbance (e.g. BACI class of designs discussed in ANZECC & ARMCANZ (2000a)).
 - Taxa contributing to any differences observed between reference and exposed sites may assist in identifying physico-chemical stressors leading to the observations.
 - Relationships may be sought between the biological and environmental data such as to link observed biological patterns to natural or disturbance-related factors.

The PRIMER software (Clarke & Warwick 2001; Clarke & Gorley 2006) is well suited to the analysis of community data for any of the methods described above. ANZECC & ARMCANZ (2000a, chapters 3 and 7; 2000b, chapter 6) also provide useful advice on these data analysis techniques.

For reporting purposes, the raw macroinvertebrate and environmental data should be included as appendices.