# Introduction

## Background

Large swathes of the South and West Queensland are categorized as arid and semi-arid areas according to the Bureau of Meteorology classifications (Bureau of Meteorology, 2007). Such habitats are characterised by either low rainfall throughout the year, or by wet summers and low rainfall winters. Dryland rivers, which are a critical aquatic habitat in this region, experience cyclic conditions of “booms” in productivity due to episodic floods and “bust” periods after the waters recede, leaving behind perennial and semi-perennial waterholes. These waterhole refugia play a central role in shaping ecological dynamics of these intermittent riverine ecosystems, governing critical mechanisms and processes such as growth and resilience in species that inhabit such environments (Marshall et al., 2016). Natural phenomena such as droughts and flooding create key disturbance events in these ecosystems, that have been shown to significantly impact the magnitude of the role such refugia play. This project aims to look at the impact of various hydrological factors on growth of golden perch (*Macquaria ambigua*), Bony bream (*Nematalosa erebi*) and Common carp (*Cyprinus carpio*) populations found in dryland rivers in the region that experience flow intermittency. Otolith biochronology will be used as a means of understanding the impact of hydrological factors on incremental growth rate in these three species across 11 rivers in the Northern Murray-Darling Basin.

## Product Overview

The final products will include a comprehensive analytical script prepared with the programming language R that tidies, prepares for analysis and thoroughly explores the dataset to examine the impact of various hydrological factors such as drought, flooding and flood in/out conditions, flow days, degree days, bankfull flow status and any other factors pertinent to annual flow regimes (independent variables), on the annual growth (dependant variable) of the three species. Following visualisation of raw data and observation of descriptive statistics that will help better inform the modelling process, the data will be explored using a number of methods. This investigation will be based on growth readings for year of age 1-2, as derived by cohort year, for all specimens sampled and the modelling process will be methodologically iterative, including the following model types:

Multiple Linear Regression:

* Overview: A foundational method to quantify and model the relationship between growth and one or more of the independent variables.
* Implementation: The lmer() function from the ‘lmer4’ package will be used to estimate model parameters, starting with a base model and iteratively adding potential predictors.
* Evaluation: Model diagnostics such as residual plots, QQ-plots, and the variance inflation factor (VIF) will be employed to check the assumptions and fit of the model. The R-squared value will provide insight into the explanatory power of the model.

Mixed Effects Models:

* Overview: These models will consider both fixed and random effects and are predicted to be especially useful where data is in the form of catchments nested within sites.
* Implementation: Using the lmer() function from the ‘lme4’ package in R, fixed effects of predictors will be analysed while accounting for the random variations across catchments and sites.
* Evaluation: Model fit will be evaluated using likelihood ratio tests, and AIC and BIC criteria. As before, model assumptions will be checked via residual plots.

Generalized Linear Models (GLMs):

* Overview: These models will extend linear regression to allow for response variables that have error distributions other than a normal distribution.
* Implementation: The glm() function will be employed, and Gaussian GLMs will be the primary focus, but the project will explore variations, adjusting fixed and random effects, and trying different link functions based on data distribution.
* Evaluation: Deviance and residuals will be the key evaluation metrics. The goodness of fit will be evaluated using the AIC and BIC.

Random Forest:

Overview: TBA

Implementation: TBA

Evaluation: TBA

Artificial Neural Networks (ANNs):

Overview: TBA

Implementation: TBA

Evaluation: TBA

The data will be retrieved from a Power BI dashboard managed by the Queensland Department of Environment and Science, DES. Furthermore, the research findings and methodology will be published in the form of a report.