Identification of ecological flow regime related to fish community: A quantitative ecology approach

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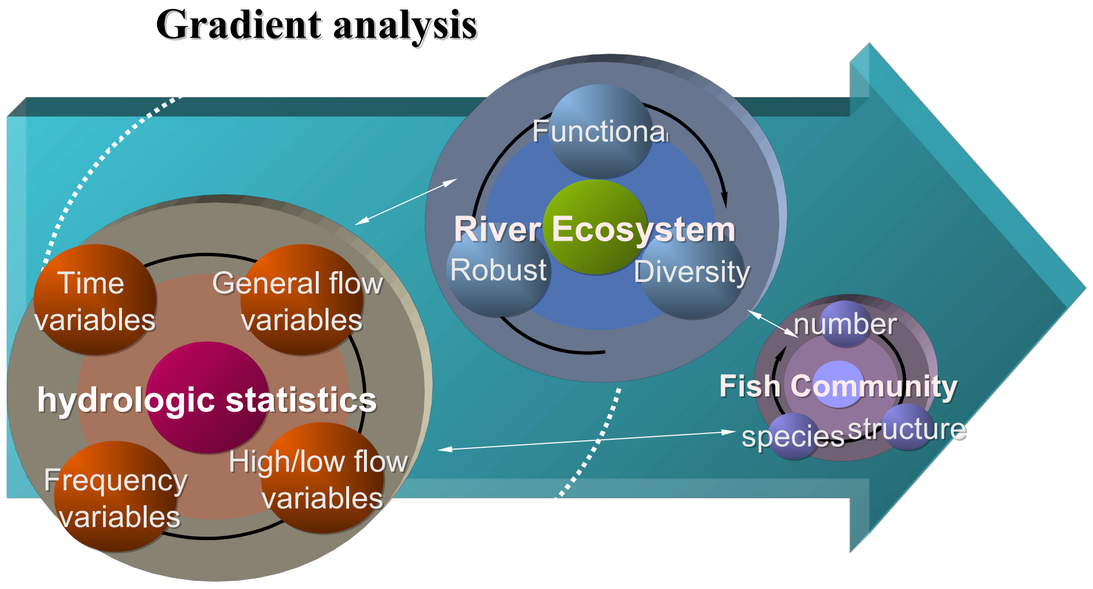
Introduction

❑ A quantitative ecology approach connect ecohydrology with fish communities



The pivotal difficulty in developing ecological flow regime is how to take into account the interaction and relation between flow regime and river ecosystem.

In this study we propose a framework of considering the relation between ecological flow regime and fish communities based on the gradient analysis technique used in quantitative ecology theory. Dummy variables for representing synthetic environment gradient could be used to identify ecohydrological niche of each specific fish species.

Methods

❑ Taiwan Ecohydrologic Indicator System (TEIS)

The TEIS provides a means to integrate hydrological, ecological, and human management influences using a new synthesis of hydrologic statistics, and provides a useful tool for the ecosystem-based water resources management in Taiwan (Chang et al., 2008) . The TEIS includes hydrologic statistics for magnitude, frequency, duration, rate of change, and timing.

* Chang, F.J., Tsai, M.J., Tsai, W.P. and Herricks, E.E., 2008. Assessing the ecological hydrology of natural flow conditions in Taiwan. Journal of Hydrology, 354(1-4): 75-89.

❑ The Gradient analysis (Ordination)

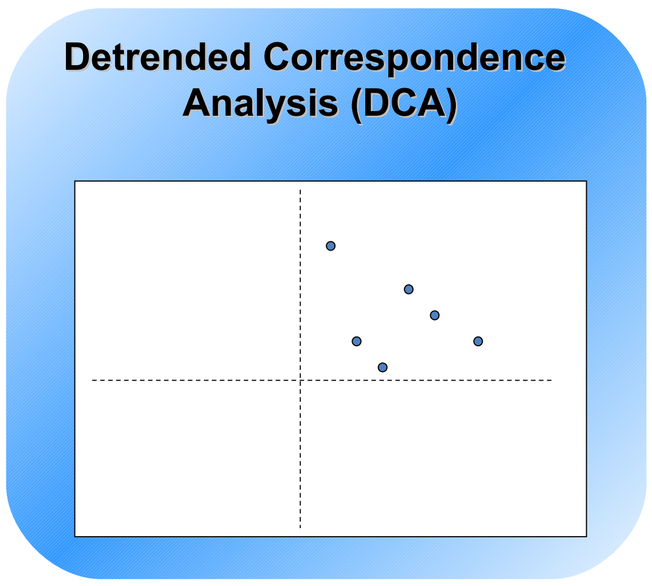
The gradient analysis (ordination) is a quantitative ecological approach for the interpretation of field data on plant and animal assemblages and their environment, and achieve an effective data reduction, expressing multi-dimensional relationships into low-dimensional data.

Detrended Correspondence Analysis (DCA)

DCA is an eigenvector ordination technique based on CA, and it overcome the problem of "Arch effect“ (Hill and Gauch,1980).

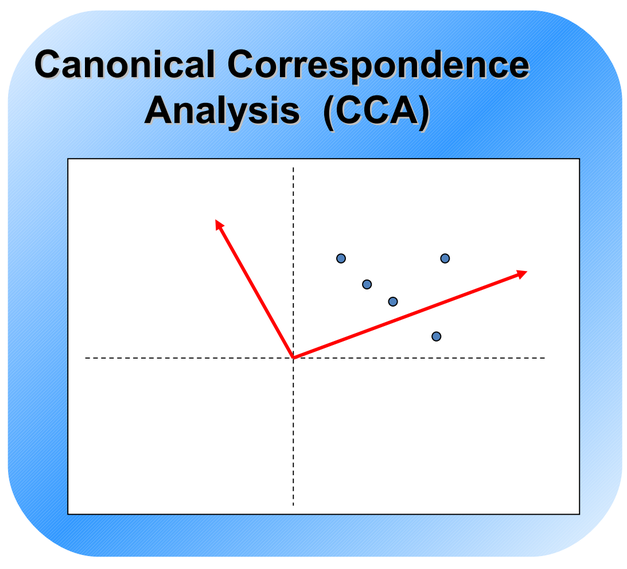
Canonical Correspondence Analysis (CCA)

CCA is a constrained ordination technique developed to relate biological assemble and environment factor variation patterms (Ter Braak,1986).



Stepwise multiple regression

Monte Carlo permutation test



Establish 14 fish species Fuzzy membership function

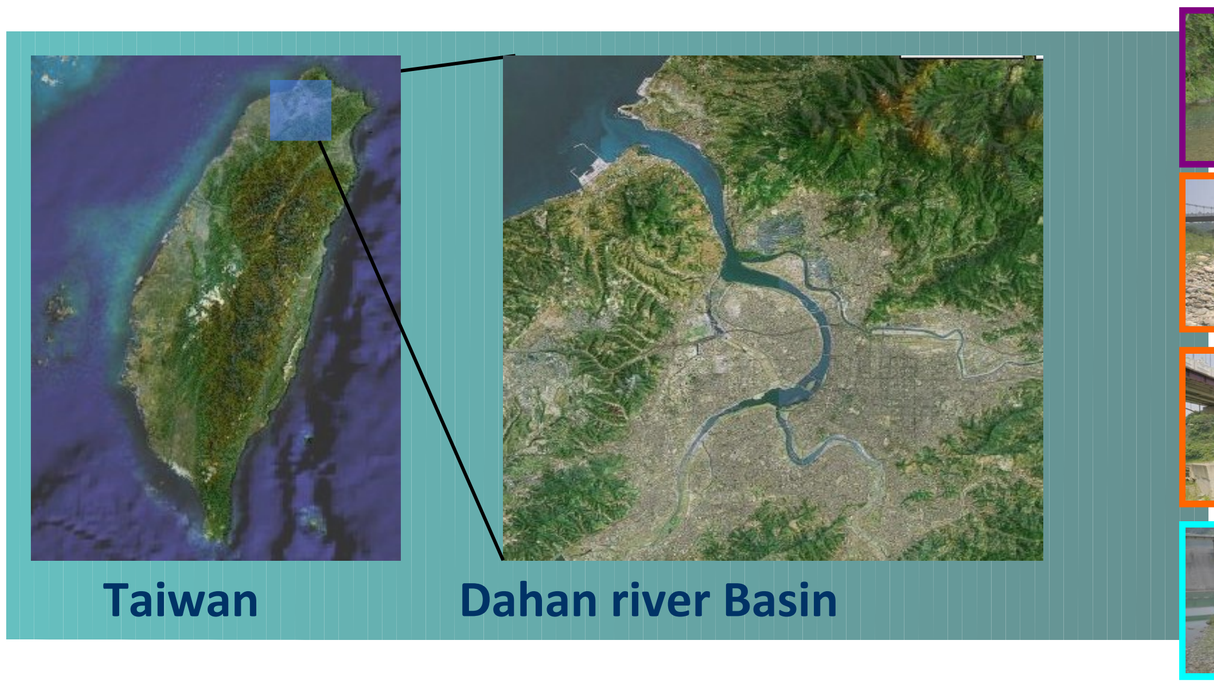
❑ Develop the Gradient analysis framework with TEIS and Fish community

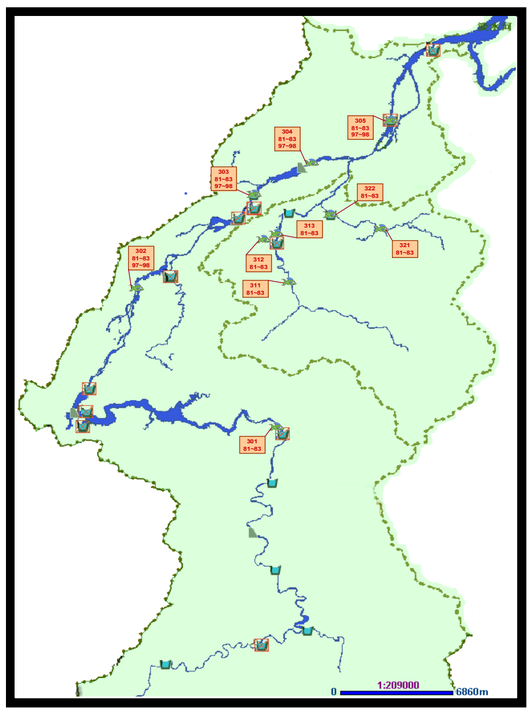
This ecological flow regime approach will focus on a gradient method of analysis to establish optimal habitat conditions related to Taiwan ecohydrological indicators (TEIS). A model of ecological response will be developed and use modified flows to species response in the habitat gradient axis of hydro-ecological location.

Study area & Data

Taiwan's land area is approximately 36,000 km2 with mountains reaching 3952 m. In this relatively small area, hydrologic monitoring has been conducted for over 50 years.

We collect historical records of fisheries data available from bioassessments and identification of flow recording locations that can be related to fish sampling locations in Dahan river Basin. TEIS hydrologic statistics calculated for the location and the sampling period are organized.



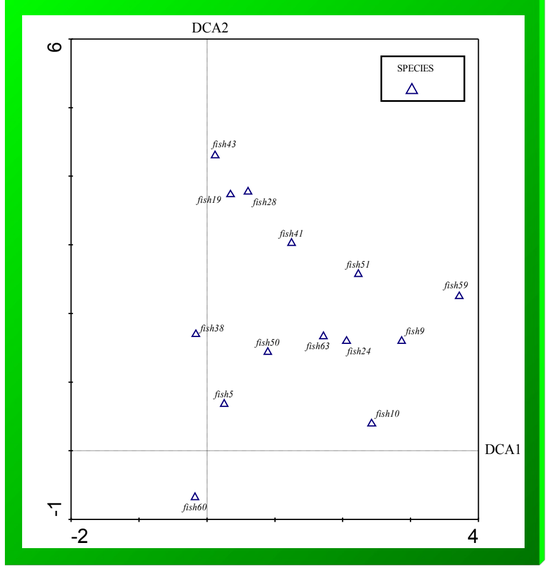


Result

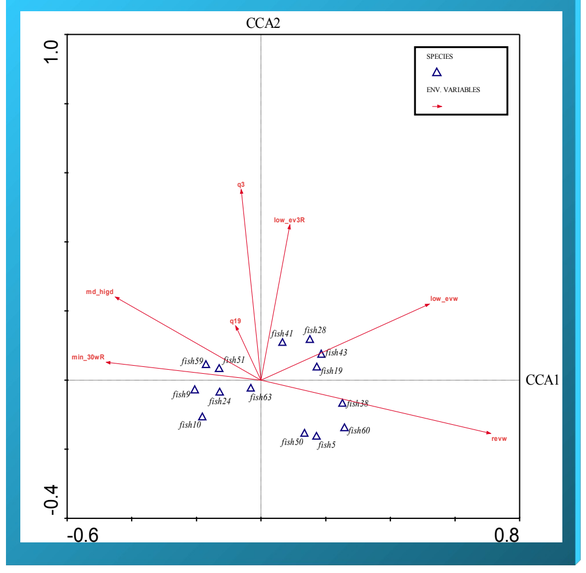
❑ Developing Fish fuzzy menbership function on synthetic gradient of TEIS

The development of fish fuzzy membership functions that effectively integrates hydrologic regimes and the state and condition of ecosystems uses a gradient method to evaluate the distribution of species, explore the relationship between indicators of TEIS, identify fish communities in relation to habitat, and assess ecological response to hydrological factors .

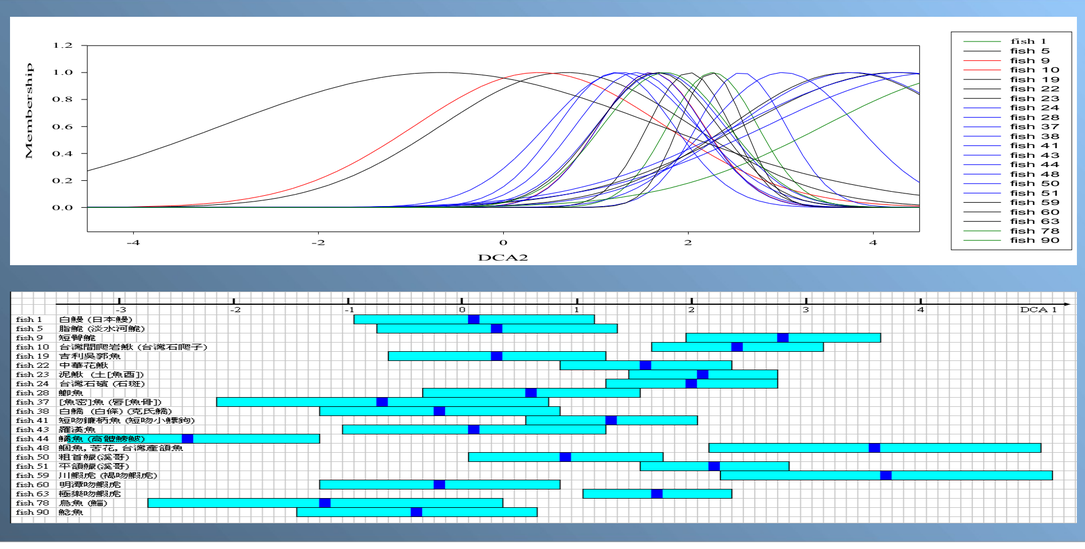
DCA Biplot Diagram



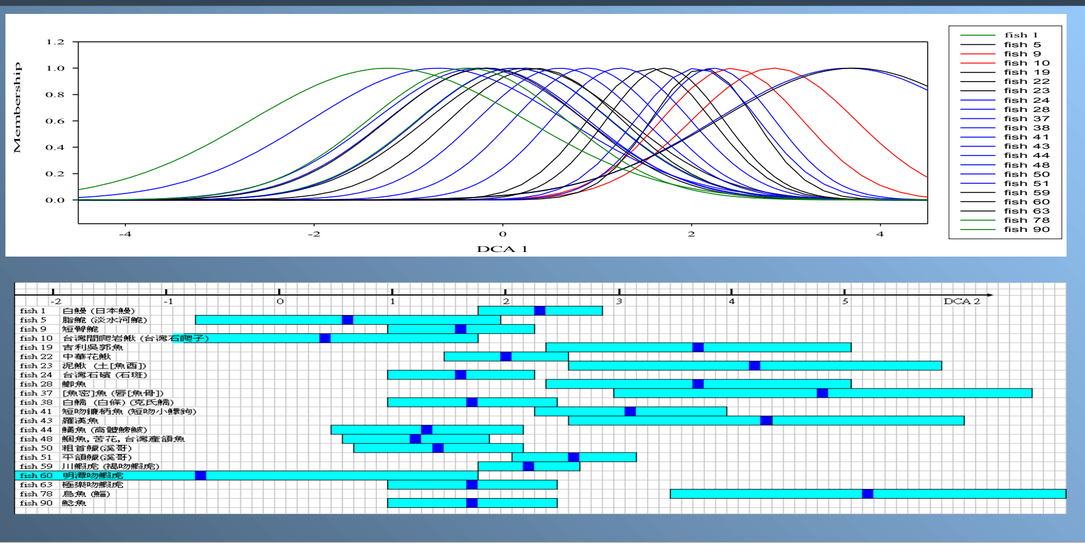
CCA Biplot Diagram



Fish fuzzy membership function on first synthetic gradient (CCA1)



Fish fuzzy membership function on Second synthetic gradient (CCA2)



Future Application

❑ Integrating gradient analysis results in Multi-Objective water Resources Management

The future work of this research will identify approaches to meet human and ecosystem needs achieving the joint goals of establishing a management framework applicable to the Shihmen Reservoir while modifying operational schemes to meet ecological objectives. We expect to provide rule curves that modify procedures for reservoir storage capacity and the control of reservoir discharges. We will use the historical reservoir operations and establish new operational rules based on ecological objective functions and constraints.