Developing biological indices of water quality in intermittent agricultural streams in western Oregon

William Gerth[1], Randy Colvin[1], Alan Herlihy[1], Guillermo Giannico[1], Remegio Confessor, Jr.[2], Gerald Whittaker[2], Stephen Griffith[2]

[1]Oregon State University, Dept. of Fisheries and Wildlife, Corvallis, OR [2]USDA-ARS National Forage Seed Production Research Center, Corvallis, OR.

Objective

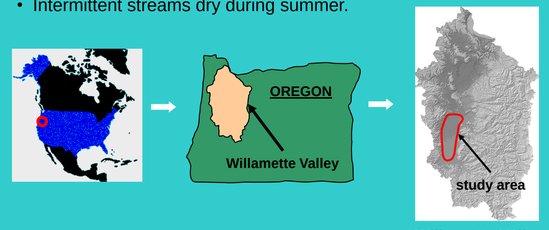
- Relate biological indicators of stream condition to disturbance gradients.

Approach

- After adjusting for natural gradients, relate biological indicators to Soil & Water Assessment Tool model (SWAT) disturbance variables.
- Relationships between biological indicators and SWAT output will be used in an integrated model to optimize the implementation of conservation practices with agricultural profits.

Location

- Low relief area in the southern Willamette Valley, Oregon, USA.
- Intermittent streams dry during summer.



Study sites

- 100m long intermittent stream sections.
- Watershed areas <1 – 22 km^2, dominated by agricultural land-use.
- Stream substrate composed of hard clay with varying amounts of rooted vegetation.

Methods

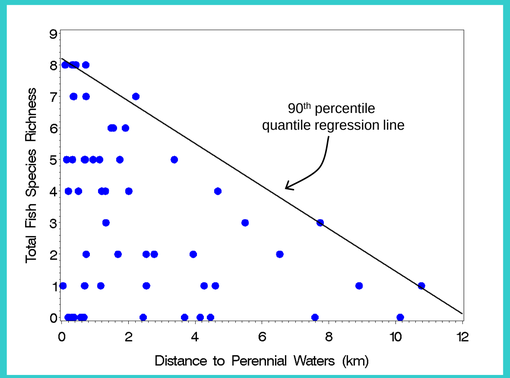
- Composite fish and macroinvertebrate database assembled
  - Fish data from 5 years of sampling, 53 sites
  - Macroinvertebrate data from 2 years of sampling, 30 sites
- Biological community metrics calculated:
  - diversity
  - abundance
  - pollution tolerance
- Quantile regression used to adjust for distance to perennial water
- Metrics (or residuals from quantile regressions) related to SWAT disturbance variables with multiple regression using Akaike's Information Criteria for model selection.

Fish and invertebrates in intermittent agricultural streams

Fish: 14 species (10 native species)
99% of individuals were native species

Macroinvertebrates: 55 taxa collected

Most biological metrics adjusted for distance to perennial water by quantile regression.



In these cases, distance corrected values (residuals from quantile regressions) were used to develop relationships with SWAT disturbance variables

Relationships between biological and SWAT disturbance variables

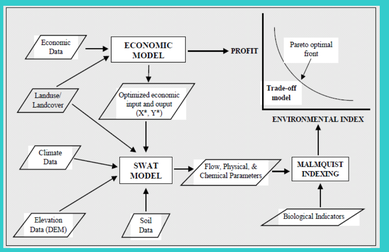
metric	distance corrected	regression equation	R^2
Fish Shannon Diversity	Yes	= – 0.315 – 0.459 Log(PO_4late) – 0.455 Log(NH_4)	0.39
Fish Caught With Minnow Trap (sticklebacks excluded)	Yes	= 3.463 – 8.00 Log(PO_4early)	0.17
Macroinvertebrate Taxa Richness	Yes	= – 5.15 – 4.22 Log(NO_3) – 3.02 Log(NH_4)	0.24
% Non-insect Macroinvertebrates	Yes	= – 0.3233 – 0.161 Log(NO_3) – 0.204 Log(NH_4) – 0.0013 * % VegSubstrate	0.27
Log Total Macroinvertebrate Density	No	= 3.17 – 1.05 Log(NO_3) + 3.02 Log(TSS) + 0.0126 * % VegSubstrate	0.56

Conclusions

- Intermittent agricultural streams provide habitat for many fish, amphibian, and macroinvertebrate species.
- Biological condition metrics were most strongly related to a natural environmental gradient; distance to perennial water.
- After adjusting for natural distance to perennial water gradient, biological metrics were related to water quality variables (NO_3, NH_4, PO_4, and TSS).

Integrated Model Development

Relationships between biological condition and water quality variables will be used to parameterize one component of an integrated economic-water quality model which optimizes agricultural profit and environmental condition.



Next Steps

- Add amphibian and bird data and develop relationships with SWAT variables.
- Run the integrated model to find balance of conservation and agricultural profits.

Acknowledgments

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