# The Effects of Habitat Fragmentation on Fish Developmental Stability

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## What Is Stream Habitat Fragmentation?

- lack of connectivity between upstream and downstream populations or sites

which occurs when:

1) the longitudinal continuum is disrupted
2) when lateral connections are severed between the stream channel and adjacent wetlands or riparian zones

## How Are Streams Fragmented?

- By land-use changes such as:
  - Deforestation of riparian and floodplain areas
  - Urban development
  - Livestock grazing
  - Conversion of floodplain and riparian areas into cropland for agricultural use

70% loss of natural landscape in Illinois

## Outcome of Habitat Fragmentation

- Land use practices can cause stream habitat fragmentation along both a lateral and longitudinal gradient, which can lead to:

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The creation of distinct good and poor patches within a stream system

## Within Poor Patches

The possible abiotic changes that occur due to Habitat Fragmentation are:

- increased sedimentation
- increased water temperature
- decreased dissolved oxygen levels
- decreased habitat diversity

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These abiotic changes may cause:
Increased habitat stress within poor patches

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Leading to:

A disruption in an organism's development processes

or

Decreased Developmental Stability

## How is Developmental Stability Measured?

Fluctuating Asymmetry

- Is the most widely utilized index of developmental stability
- The pattern of bilateral variation in a sample where the asymmetry values are distributed around a mean of zero
  - The further the value from zero the more fluctuating asymmetry there is in an individual organism

## Objectives

To Determine if:

- Abiotic Factors differ between sites with different habitat quality (good/bad).
- Developmental stability (Fluctuating Asymmetry) of fish differ between sites of varying habitat quality.
- Fluctuating Asymmetry values could be used as an indicator of stream integrity.

## Methods

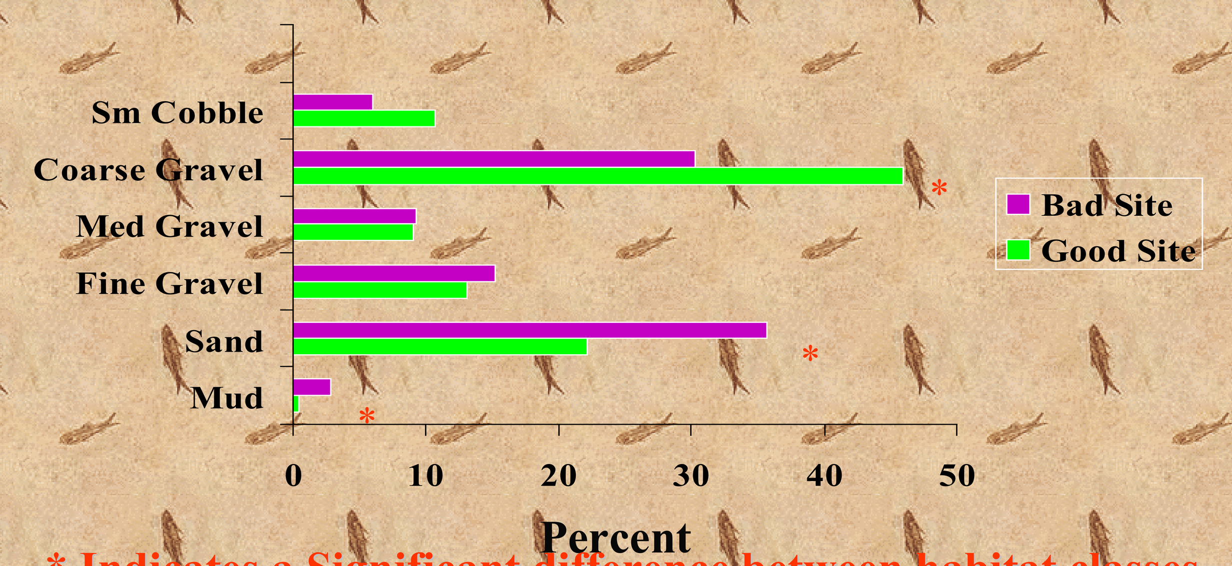
- Seven sites along Polecat Creek were analyzed for habitat quality using the Stream Habitat Assessment Procedure (SHAP)
- SHAP determines habitat quality based on fifteen metrics in the following three categories
  - Channel Hydrology and Morphology
  - In-stream Habitat
  - Riparian and Bank Use

The Seven Sites were Classified into Four Good & Four Bad Sites as Determined by SHAP

## Methods for Abiotic Analysis

- Substrate Composition: was determined by use of a eckman dredge, 2 samples were taken per site and % composition determined for six substrate size classes.
- Water Temperature: was measure by temperature probes (Hobo Loggers) for a period of four months (June – September) and the mean, min and max determined for both habitat classes.

## Substrate Composition Results




* Indicates a Significant difference between habitat classes

## Temperature Results


## Habitat Conclusions

Poor Patches - Set up a stressful environment with

Increased sedimentation

Large temperature fluctuations

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Which may lead to loss of Developmental Stability

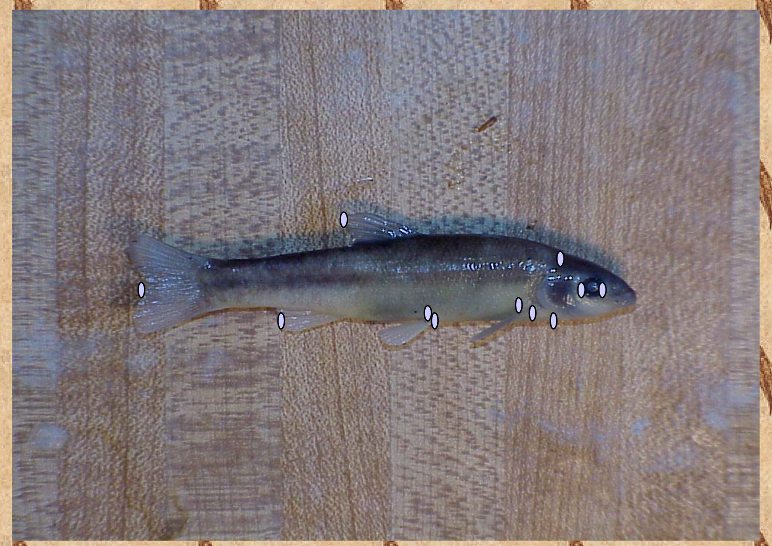
## Methods for Determining Developmental Stability

### Fish Sampling

- Fish Sampled from a 300-500 ft. length of stream in each site
- Both end were blocked off to prevent fish from entering or exiting sample area. The area was sampled with a 30 ft. electric seine powered by a single phase, 110 V A.C., 3000 W generator for a minimum of 30 minutes.
- fish (Stonerollers and Striped shiners) were collected with dip nets and placed in buckets for preservation for later analysis

## Procrustes Method of Shape Analysis

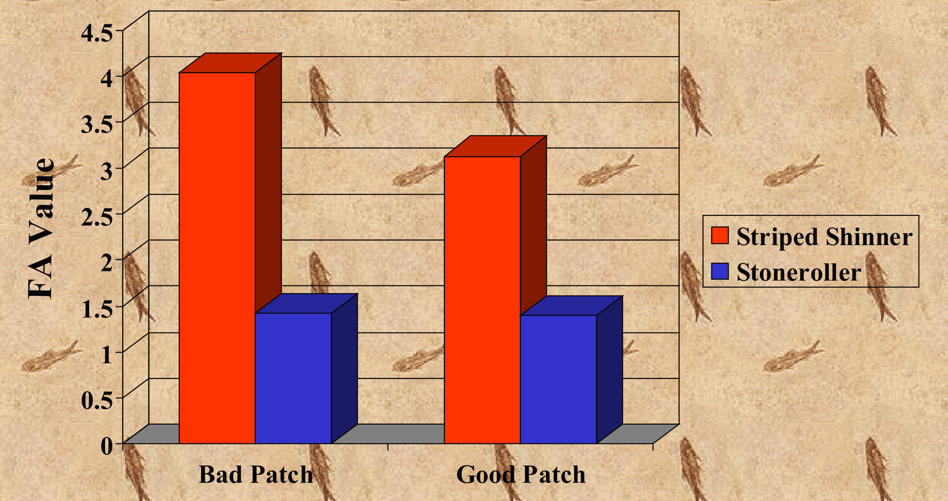
### The Fish Landmarks



- Landmarks: anterior and posterior most part of eye, dorsal and ventral tip of operculum, anterior and posterior insertion points of pectoral and pelvic fins, dorsal fin ray four, anal fin ray three, and ray nine of caudal fin.
- In addition to these eleven landmarks, Striped Shiners also were landmarked at ends of the lateral line.

- Procrustes Method:
  - Reflect the landmark configuration of one body side to its mirror image
  - Scale the configurations to unit centroid size
  - Superimpose the left and right configurations so they have the same centroid size Rotate the configurations to achieve optimal fit
  - Giving a consensus configuration as the mean coordinates of landmarks, the new set of variables that contain the complete shape information = Fluctuating Asymmetry

## Results




- Levens Test indicated that there was no significant difference in shape between sites for both fish.

## What is a B.L.U.P.?

- Best Linear Unbiased Predictor
  - Random effect analog to a fixed effect mean
  - Each individual value is regressed to the group mean as a function of the distance from the group mean and the variance components of the mixed model effects

- Used to remove observer error

## Results (Using BLUP's)

Common Stonerollers:

- F-max Test: indicated a significant difference in FA among sites ($p < 0.05$)
- Bonferroni Test: illustrated that sites 7 and 2 (both good sites) had significantly lower FA values as compared to the other sites.

Stripe Shiner:

- F-max Test: indicated a significant difference in FA among sites ($p < 0.05$)
- Bonferroni Test: illustrated that sites 1 (good site) and 5 (bad sites) had significantly higher FA values as compared to the other sites.

## Conclusions

- Abiotic factors differ between good and bad sites with bad sites having increased sedimentation and temperature fluctuation, and a decreased habitat variability.
- No significant difference for FA values between good and bad sites for either stripe shiner's and common stonerollers.
- Significant differences in FA values were observed for both species among sites.
  - Common Stoneroller's from good sites (7, 2) having lower FA values.
  - Striped shiner's showed no trend related to habitat type
- Thus, FA showed only moderate success as an indicator of habitat quality in this study.