# Great Lakes Coastal Wetlands Monitoring Plan: Application to Monitoring Lake Ontario Coastal Wetlands

Don Uzarski
Central Michigan University

GLCWC Program Manager – J. Schneider and K. Rodriguez (US EPA GLNPO)
GLCWC Facilitator – J. Hummer and R. Lawson (GLC)

# Presentation Outline

- Introduce Great Lakes Coastal Wetlands Consortium
  - Developed Monitoring Plan over last 7 Years
- Briefly Discuss Protocols For:
  - Statistical Design D.G. Uzarski & S. Otieno
  - Covariates D.G. Uzarski, T.M. Burton, & J.J.H. Ciborowski
  - Invertebrates D.G. Uzarski, T.M. Burton, J.C. Brazner, & Jan J.H. Ciborowski
  - Fish D.G. Uzarski, T.M. Burton, J.C. Brazner, & J.J.H. Ciborowski
  - Plants D.A. Albert
  - Birds G.P. Grabas, T.L. Crewe, & S.T. A. Timmermans
  - Amphibians S.T. A. Timmermans, T.L. Crewe, & G.P. Grabas
  - Landscape L.L. Bourgeau-Chavez, R.D. Lopez, A. Trebitz, T. Hollenhorst, G.E. Host, B. Huberty, R.L. Gauthier, & J. Hummer
  - Cost M. Meixler
- See Also
  - Data Management System S. Eddy & R. D. Garcia
  - Partnerships for Implementation T.L. Collin, J. Hummer, K. Holmes, & R. W. Archer

# About the Great Lakes Coastal Wetlands Consortium

- GLNPO RFP for $1.2 million (+600K Supplemental) in 2000
  - In response to SOLEC 96' and 98'
    - Indicators of ecosystem health
  - Develop Bi-national Standardized Monitoring Program Based on SOLEC Indicators
    - Few, if any, SOLEC indicators were developed

# The Great Lakes Coastal Wetlands Consortium

- 2000 Consortium was formed
- Joint facilitation GLC and GLNPO
  - 150 + Participants
    - 50 organizations (Federal, State/Provincial, Academic, NGOs)
- 2000 Consortium put out an RFP
  - Develop and evaluate metrics and protocols for measuring ecosystem health

# The Great Lakes Coastal Wetlands Consortium

- Development and Evaluation Process had to Consider:
  - Cost
  - Measurability
  - Basin wide applicability
  - Data availability
  - Sensitivity to change
  - Endpoint levels
  - Statistical approach.

- Six proposals were selected by peer review.

# The Great Lakes Coastal Wetlands Consortium

- Six proposals

- Conducted Pilot Studies 2002
  - Bain et al. (Ontario)
  - de Szalay et al. (Erie)
  - Ingram et al. (Ontario)
  - Timmermans et al. (Erie)
  - Uzarski et al. (Michigan & Huron)
  - Wilcox et al. (Michigan)

# The Great Lakes Coastal Wetlands Consortium

- Six proposals

- Conducted Pilot Studies 2002
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  - Timmermans et al. (Erie)
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  - Wilcox et al. (Michigan)

Combined data

+ Uzarski et al. Superior data

# The Great Lakes Coastal Wetlands Consortium

- During the Metric Development Phase
  - Parallel project with different goals
    - Great Lakes Environmental Indicators (GLEI) group

- GLEI goal:
  - To develop an integrated set of environmental indicators that can be used to assess the condition of the coastal margins of all five Great Lakes.

# The Great Lakes Coastal Wetlands Consortium

- 2007 Duluth, MN- Consortium and GLEI
  - Ensure the best possible product

- Still considering
  - Cost
  - Measurability
  - Basin wide applicability
  - Data availability
  - Sensitivity to change
  - Endpoint levels
  - Statistical approach
  - …and specific to wetlands

# The Great Lakes Coastal Wetlands Consortium

- Consortium Submitted Final Product to US EPA March 2008.

- http://www.glc.org/wetlands/

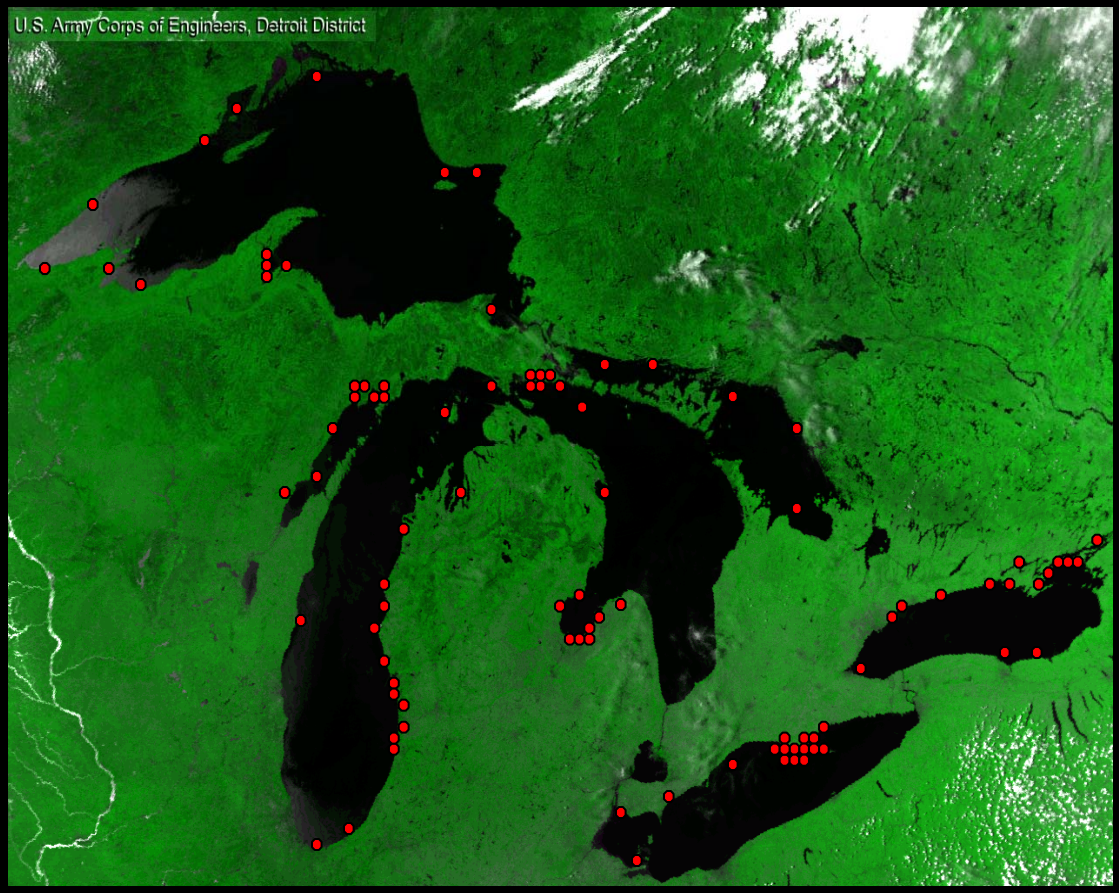
# Statistical Design

**Urquhart, N. S., S.G. Paulsen, and D.P. Larsen. 1998. Monitoring for policy-relevant regional trends over time. Ecological Applications 8(2): 246-257.**

- Urquhart et al. evaluates designs
  - maximize efficiency in detecting both
    - Status
    - Trends
- Status and Trends are conflicting goals

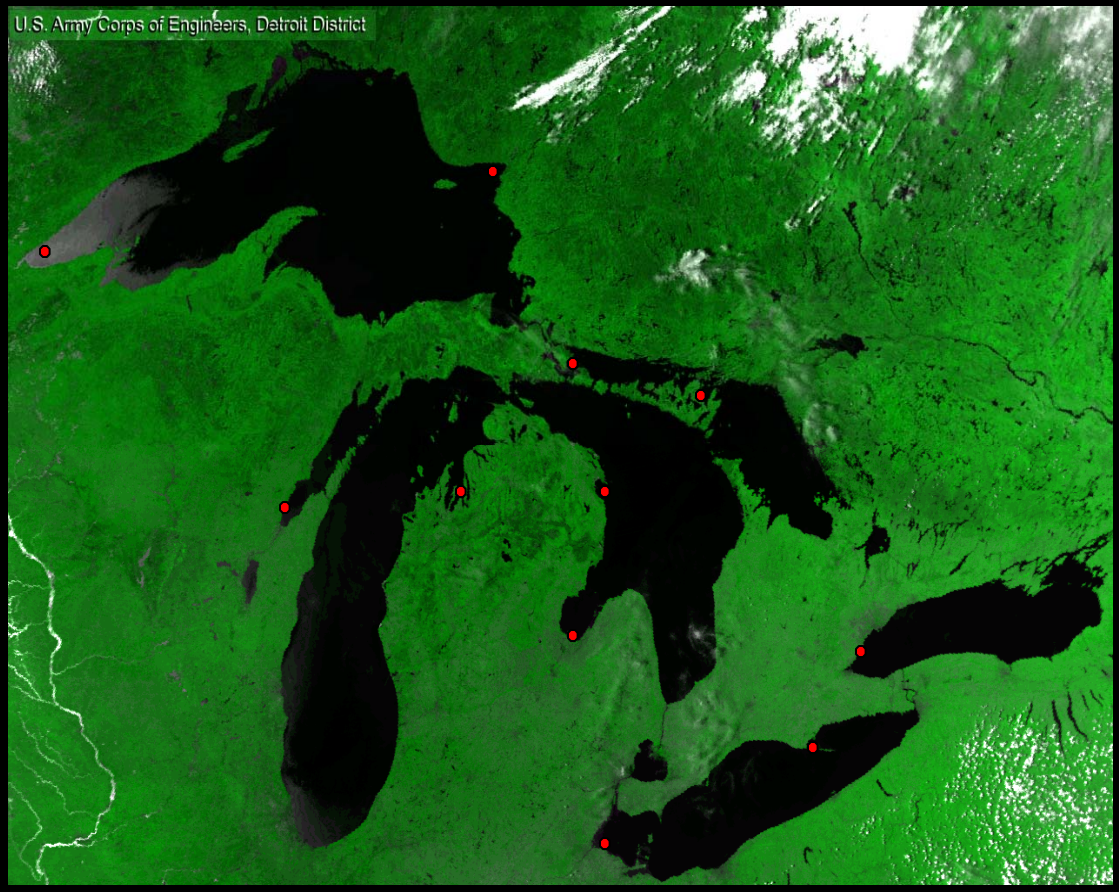
# Statistical Design

- Status = Capture Spatial Variance
- What is the status or health of (all) GL wetlands?



# Statistical Design

- Trends = Capture Temporal Variance
- How is GL wetland health changing over time?
- Sample fewer sites, repeatedly



Urquhart, N. S., S.G. Paulsen, and D.P. Larsen. 1998. Monitoring for policy-relevant regional trends over time. Ecological Applications 8(2): 246-257.

- Compared 4 designs

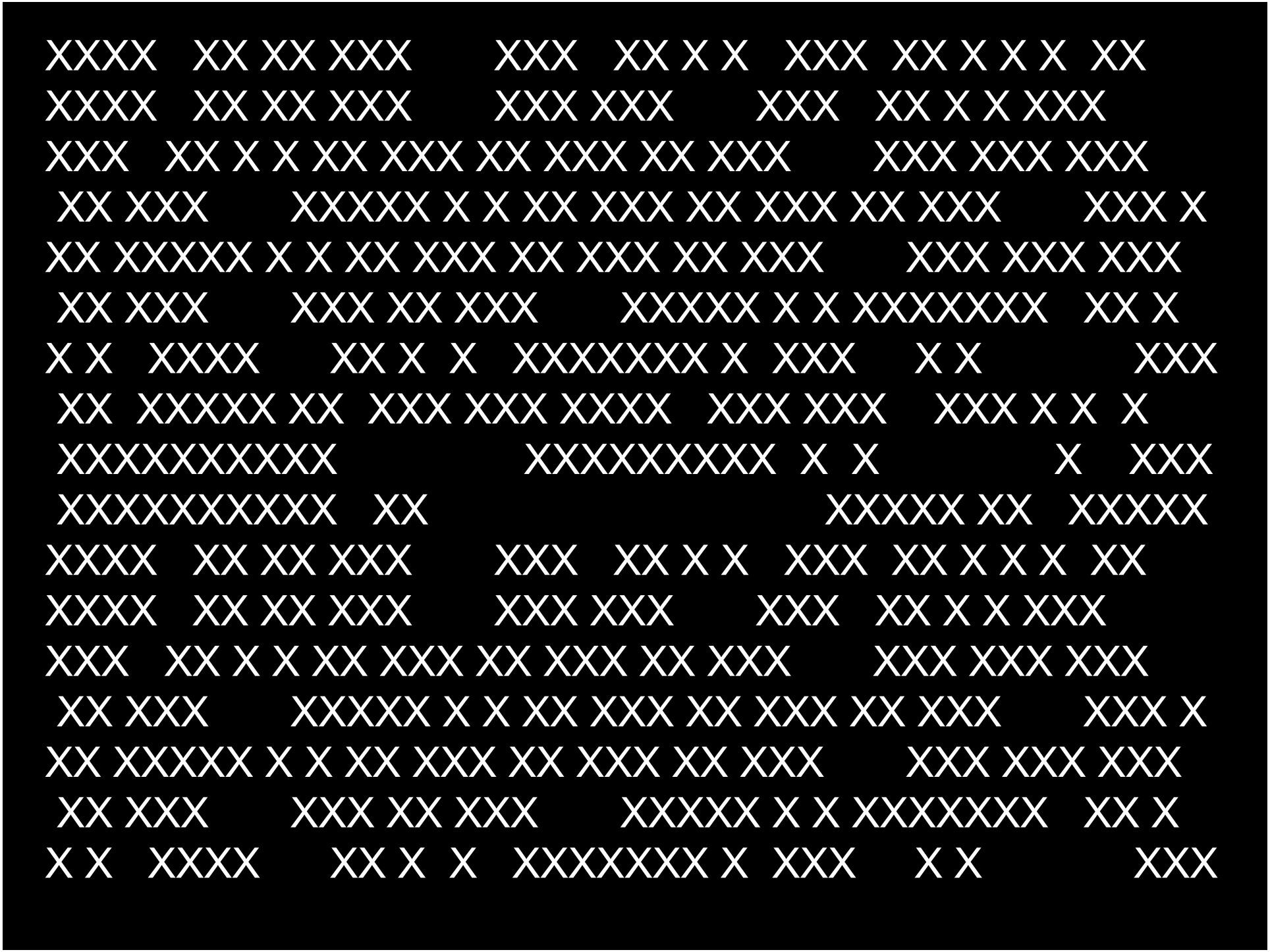
- Assume resources to sample 60 sites/yr
  - #1 – Select 60 sites to sample every year
  - #2 – Select 60 new sites to sample every year
  - #3 – Select 4 sets of 50 sites and 1 set of 10
    - Sample 1 of the 4 sets of 50 every year
    - Sample 1 set of 10 every year
  - #4 …

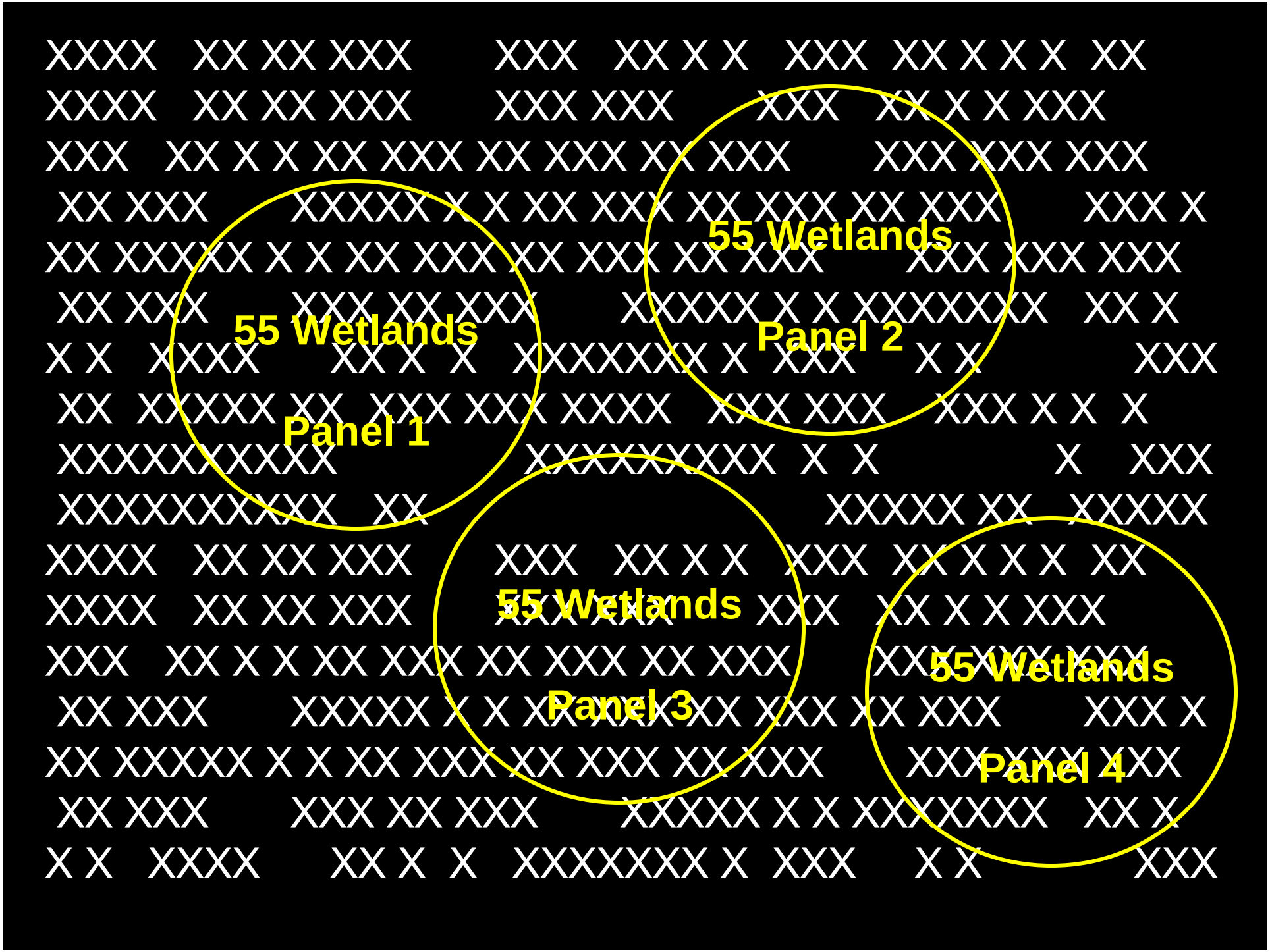
| PANEL | SIZE | TIME PERIODS (=YEARS) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | ... |
| DESIGN 1 = SAME SITES ( = LAKES) | | | | | | | | | | | | | | |
| 1 | 60 | X | X | X | X | X | X | X | X | X | X | X | X | ... |

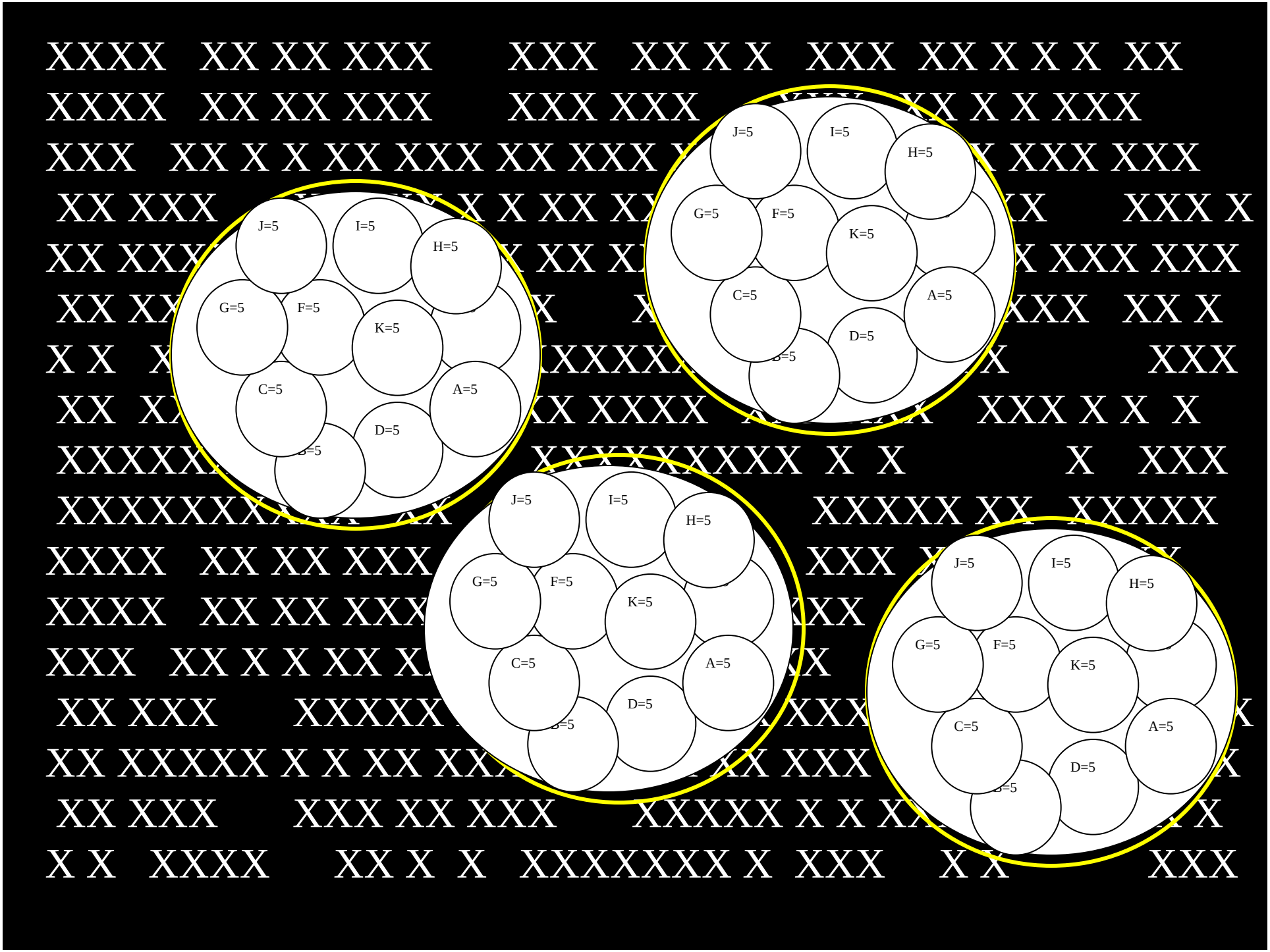
| DESIGN 2 = NEW SITES ( = LAKES) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 60 | X | | | | | | | | | | | | |
| 2 | 60 | | X | | | | | | | | | | | |
| 3 | 60 | | | X | | | | | | | | | | |
| 4 | 60 | | | | X | | | | | | | | | |
| 5 | 60 | | | | | X | | | | | | | | |
| 6 | 60 | | | | | | X | | | | | | | |
| 7 | 60 | | | | | | | X | | | | | | |
| 8 | 60 | | | | | | | | X | | | | | |
| 9 | 60 | | | | | | | | | X | | | | |
| 10 | 60 | | | | | | | | | | X | | | |
| 11 | 60 | | | | | | | | | | | X | | |
| 12 | 60 | | | | | | | | | | | | X | |
| ... | ... | | | | | | | | | | | | | ... |

| DESIGN 3 = AUGMENTED SERIALLY ALTERNATING | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 50 | X | | | | X | | | | X | | | | ... |
| 2 | 50 | | X | | | | X | | | | X | | | ... |
| 3 | 50 | | | X | | | | X | | | | X | | ... |
| 4 | 50 | | | | X | | | | X | | | | X | ... |
| COMMON | 10 | X | X | X | X | X | X | X | X | X | X | X | X | ... |

| DESIGN 4 = PARTIALLY AUGMENTED SERIALLY ALTERNATING | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 35 | X | | | | X | | | | X | | | | ... |
| 2 | 35 | | X | | | | X | | | | X | | | ... |
| 3 | 35 | | | X | | | | X | | | | X | | ... |
| 4 | 40 | | | | X | | | | X | | | | X | ... |
| 1A | 5 | X | X | | | X | | | | X | | | | ... |
| 2A | 5 | | X | X | | | X | | | | X | | | ... |
| ... | ... | | | | | | | | | | | | | ... |
| 1B | 5 | X | | | | X | X | | | X | | | | ... |
| ... | ... | | | | | | | | | | | | | ... |
| 1C | 5 | X | | | | X | | | | X | X | | | ... |
| ... | ... | | | | | | | | | | | | | ... |




55 Wetlands
Panel 2
55 Wetlands
Panel 1
55 Wetlands
Panel 3
55 Wetlands
Panel 4

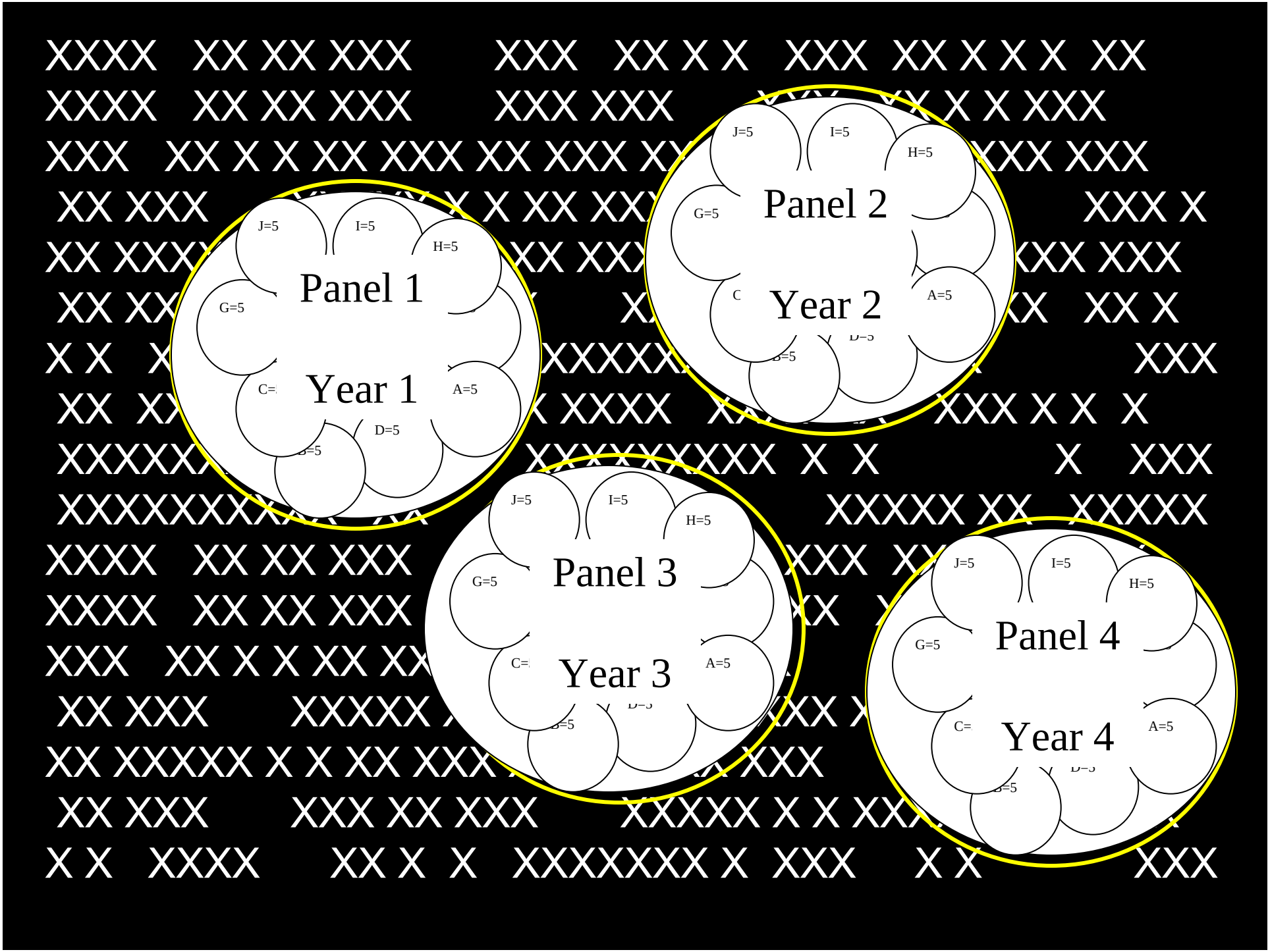

J=5
I=5
H=5
G=5
F=5
K=5
C=5
A=5
D=5
B=5
J=5
I=5
H=5
G=5
F=5
K=5
C=5
A=5
D=5
B=5
J=5
I=5
H=5
G=5
F=5
K=5
C=5
A=5
D=5
B=5
J=5
I=5
H=5
G=5
F=5
K=5
C=5
A=5
D=5
B=5

**Design 4 - Partially Augmented Serially Alternating**

1-4 = Panels

A-J = Sub-Panels

| | # OF SITES | YEAR 1 | YEAR 2 | YEAR 3 | YEAR 4 | YEAR 5 | YEAR 6 | YEAR 7 | YEAR 8 | YEAR 9 | YEAR 10 | YEAR 11 | YEAR 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 35 | X | | | | X | | | | X | | | |
| 2 | 35 | | X | | | | X | | | | X | | |
| 3 | 35 | | | X | | | | X | | | | X | |
| 4 | 40 | | | | X | | | | X | | | | X |
| 1A | 5 | X | X | | | X | | | | X | | | |
| 2A | 5 | | X | X | | | X | | | | X | | |
| 3A | 5 | | | X | X | | | X | | | | X | |
| 4A | 5 | | | | X | X | | | X | | | | X |
| 1B | 5 | X | | | | X | X | | | X | | | |
| 2B | 5 | | X | | | | X | X | | | X | | |
| 3B | 5 | | | X | | | | X | X | | | X | |
| 4B | 5 | | | | X | | | | X | X | | | X |
| 1C | 5 | X | | | | X | | | | X | X | | |
| 2C | 5 | | X | | | | X | | | | X | X | |
| 3C | 5 | | | X | | | | X | | | | X | X |
| 4C | 5 | | | | X | | | | X | | | | X |
| 1D | 5 | X | | | | X | | | | X | | | |
| 2D | 5 | | X | | | | X | | | | X | | |
| 3D | 5 | | | X | | | | X | | | | X | |


Panel 1
Year 1
J=5
I=5
H=5
G=5
A=5
D=5
Panel 2
Year 2
J=5
I=5
H=5
G=5
A=5
Panel 3
Year 3
J=5
I=5
H=5
G=5
A=5
Panel 4
Year 4
J=5
I=5
H=5
G=5
A=5

**Design 4 - Partially Augmented Serially Alternating**

1-4 = Panels

A-J = Sub-Panels

| | # OF SITES | YEAR 1 | YEAR 2 | YEAR 3 | YEAR 4 | YEAR 5 | YEAR 6 | YEAR 7 | YEAR 8 | YEAR 9 | YEAR 10 | YEAR 11 | YEAR 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 35 | X | | | | X | | | | X | | | |
| 2 | 35 | | X | | | | X | | | | X | | |
| 3 | 35 | | | X | | | | X | | | | X | |
| 4 | 40 | | | | X | | | | X | | | | X |
| 1A | 5 | X | X | | | X | | | | X | | | |
| 2A | 5 | | X | X | | | X | | | | X | | |
| 3A | 5 | | | X | X | | | X | | | | X | |
| 4A | 5 | | | | X | X | | | X | | | | X |
| 1B | 5 | X | | | | X | X | | | X | | | |
| 2B | 5 | | X | | | | X | X | | | X | | |
| 3B | 5 | | | X | | | | X | X | | | X | |
| 4B | 5 | | | | X | | | | X | X | | | X |
| 1C | 5 | X | | | | X | | | | X | X | | |
| 2C | 5 | | X | | | | X | | | | X | X | |
| 3C | 5 | | | X | | | | X | | | | X | X |
| 4C | 5 | | | | X | | | | X | | | | X |
| 1D | 5 | X | | | | X | | | | X | | | |
| 2D | 5 | | X | | | | X | | | | X | | |
| 3D | 5 | | | X | | | | X | | | | X | |

- Revisits
  - Year 2 revisit sub-panel 1A
  - Year 3 revisit sub-panel 2A
  - Year 4 revisit sub-panel 3A
  - etc.

# Chosen Design

- Randomly Selecting Wetlands to Sample
  - Re-sample Subset Two Consecutive Years
- Stratify by Region by Lake
- Design Superior to Others
  - Good Estimate of Variation in Wetland x Year Interaction.
  - Eventually Sample Many Different Sites
  - Less Impact on Wetland from Over Sampling
    - Sampling Year after Year = Disturbance

# Covariates – Future Analyses

- **Flora/Fauna**
  - Plants
  - Invertebrates
  - Fish
  - Etc.

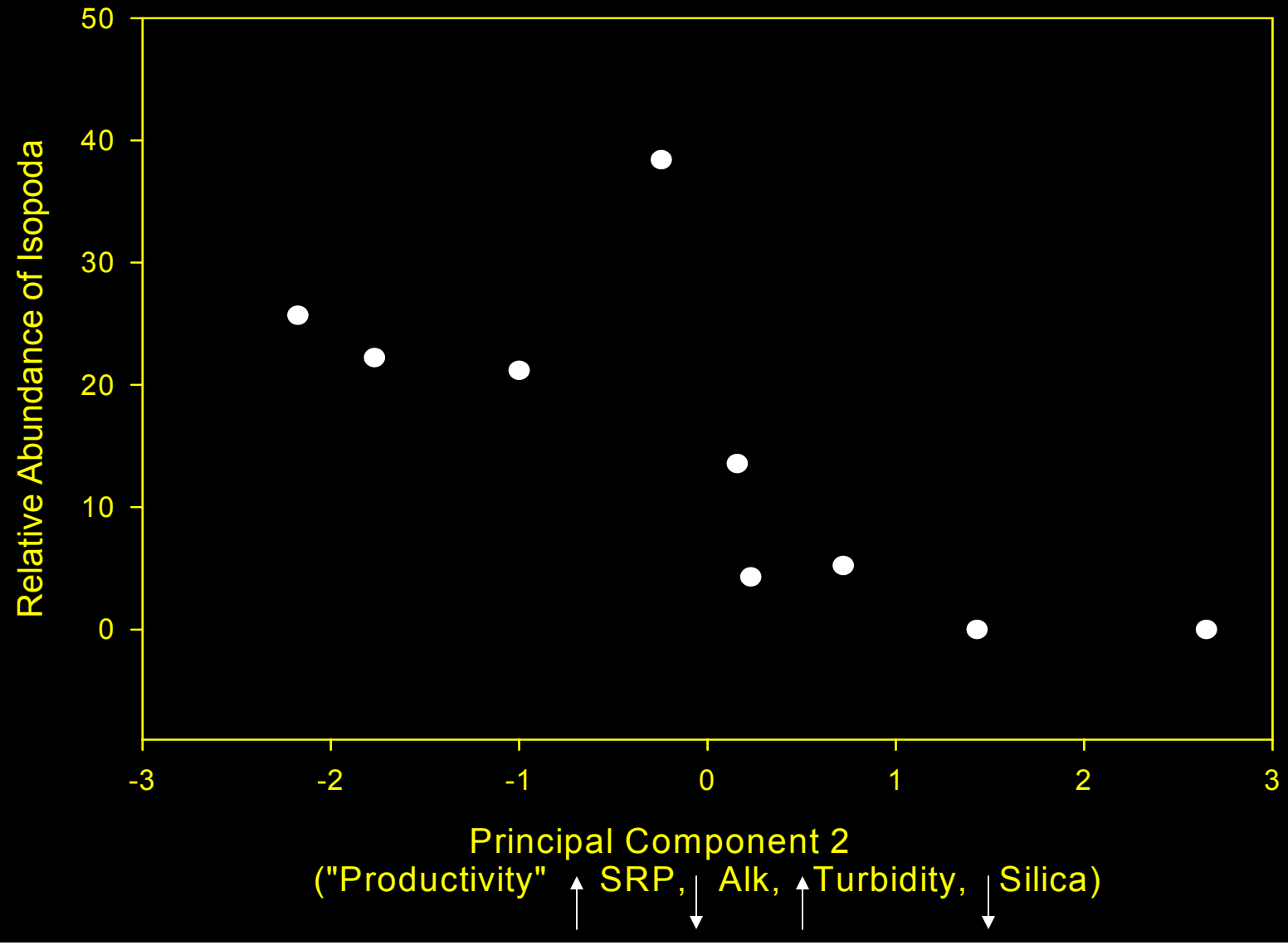
- **Chemical / Physical**
  - –SRP, $NH_4$ $NO_2$/$NO_3$, SO4, Cl, DO
  - –Temperature
  - –Turbidity
  - –Chlorophyll
  - –Sp. Conductance
  - –pH
  - –Alkalinity
  - –Redox Potential

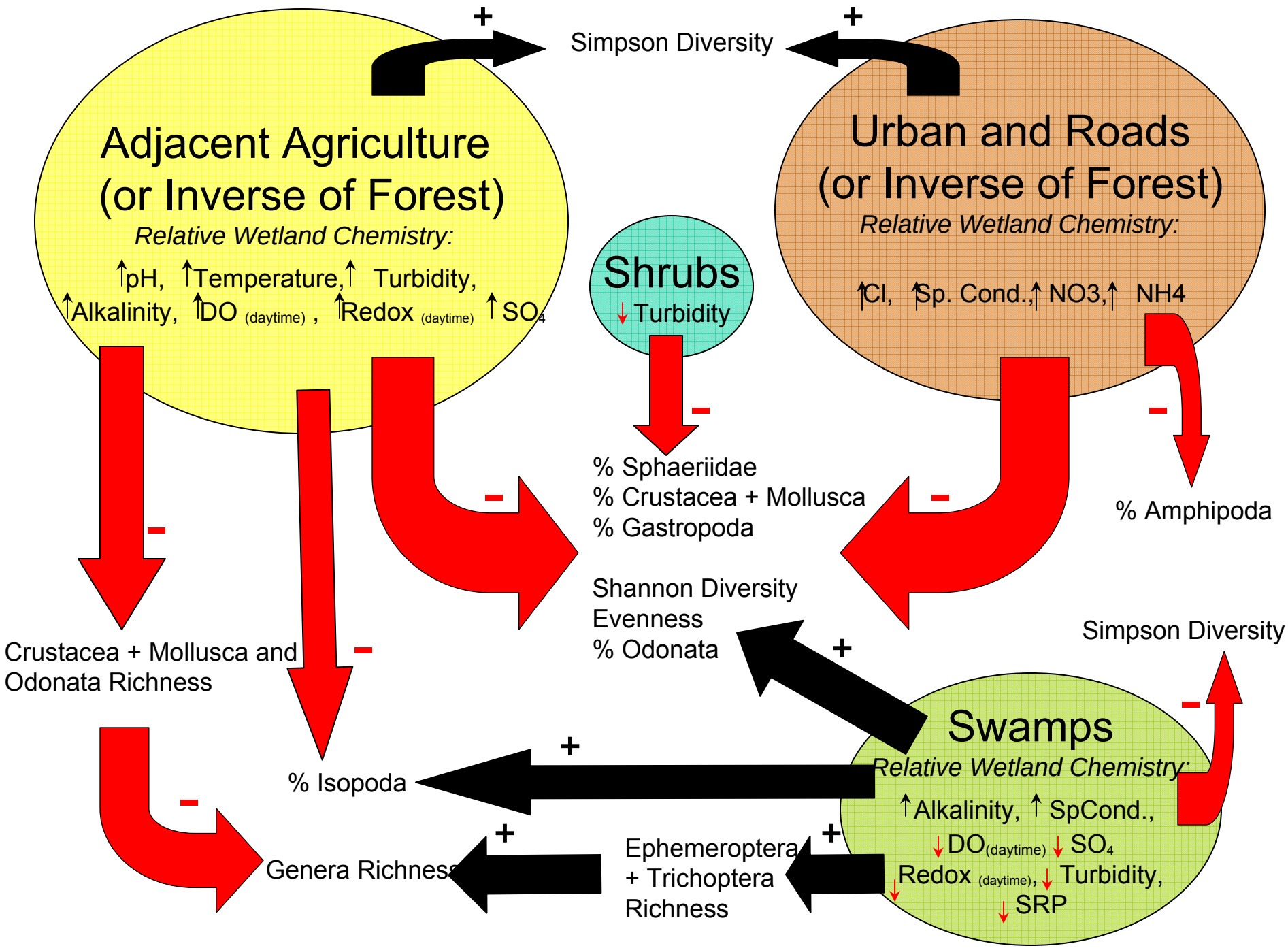
- **Vegetation**
  - Vegetation type
  - Stem density
- **Sediment**
  - Organic (muck) depth
  - Particle size
  - Organic content

# Example of IBI Development (use of covariates)

- Combine covariates using multivariate analyses.
- Essentially taking 18 dimensions (or variables)
  - Combining them into 1 or 2 dimensions
- Relate biology to chemical/physical/land use
- Establish a predictive model
  - Use to develop IBI


## Relative abundance of Isopoda vs. Principal Component 2 (Pearson correlation r = -0.734, p = 0.024)

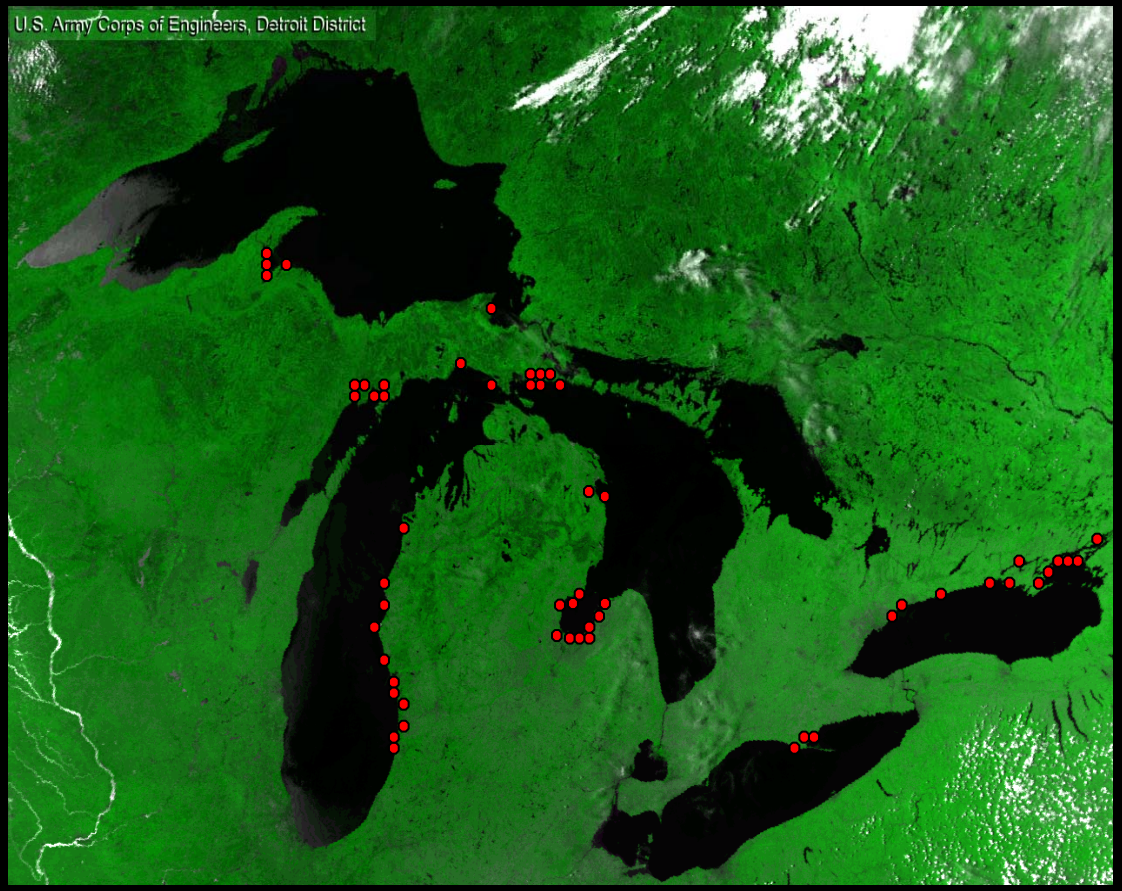



Simpson Diversity
Adjacent Agriculture
(or Inverse of Forest)
Relative Wetland Chemistry:
↑pH, ↑Temperature, ↑ Turbidity,
↑Alkalinity, ↑DO (daytime) , ↑Redox (daytime) ↑SO4
Urban and Roads
(or Inverse of Forest)
Relative Wetland Chemistry:
↑Cl, ↑Sp. Cond., ↑NO3, ↑ NH4
Shrubs
↓Turbidity
% Sphaeriidae
% Crustacea + Mollusca
% Gastropoda
% Amphipoda
Shannon Diversity
Evenness
% Odonata
Crustacea + Mollusca and
Odonata Richness
% Isopoda
Genera Richness
Ephemeroptera
+ Trichoptera
Richness
Simpson Diversity
Swamps
Relative Wetland Chemistry:
↑Alkalinity, ↑ SpCond.,
↓DO(daytime) ↓ SO4
Redox (daytime), ↓ Turbidity,
↓ SRP

# Macroinvertebrates

- Identify inundated monodominant vegetation zones.
- 3 replicates from each zone.
  - Use a dip net (0.5 mm mesh).
  - Field pick 150 organisms per replicate
    - Timed count (catch per unit effort)
- Identify to LOTU

# Invertebrate IBI Tested Extensively




- 1997 – 2002

(fringing wetlands)

- From high water levels to near record lows.
- Other investigators have also tested the IBI

# IBI for Fringing Wetlands

***Metrics used in each plant zone***

1. **Odonata richness**
2. **% Odonata**
3. **Crustacea + Mollusca richness**
4. **Total Genera richness**
5. **% Gastropoda**
6. **% Sphaeriidae**
7. **Total taxa richness**
8. **Evenness**
9. **Shannon diversity index:**
10. **Simpson index:**

# ***Additional Metrics Specific to plant zones***

**Inner *Schoenoplectus* Zone :**

11. **Ephemeroptera + Trichoptera richness**
12. **% Crustacea + Mollusca**
13. **Relative abundance Isopoda**
14. **Relative abundance Amphipoda (Increases with intermediate disturbance)**

Outer *Schoenoplectus* Zone :

11. **Total number of families**
12. **% Crustacea plus Mollusca**

# Category Scores

- Extremely Degraded: (0 to 15% of possible score)
- Degraded: (>15 to 30% of possible score)
- Moderately Degraded: (>30  to 50% of possible score)
- Moderately Impacted: (>50 to 70% of possible score)
- Mildly Impacted: (>70% to 85% of possible score)
- Reference Conditions: (>85 to 100% of possible score)

# IBI Development and Testing

- Published in Peer Reviewed Journals:


Burton T.M., D.G. Uzarski, J.P. Gathman, J.A. Genet, B.E. Keas and C.A. Stricker. 1999. The development of an index of biotic integrity for Great Lakes coastal wetlands of Lake Huron. Wetlands. 19(4): 869-882.

**Uzarski**, D.G., T.M. Burton and J.A. Genet. 2004. Validation and performance of an invertebrate index of biotic integrity for Lakes Huron and Michigan fringing wetlands during a period of lake level decline. Aquatic Ecosystem Health & Management. 7(2): 269-288.

# Alternative Protocols for Invertebrates

- Using either Activity Traps or Artificial Substrates.
  - No established IBIs for these protocols
  - Highly Recommend Dip-Net Protocol

# Fish

- 3 Fyke nets/zone (4.8 mm mesh) for 1 net-night

- Sampled all major inundated plant zones.


# IBI Development

- Published in Peer Reviewed Journal:

Uzarski, D.G., T.M. Burton, M.J. Cooper, J. Ingram, and S. Timmermans. 2005. Fish Habitat Use Within and Across Wetland Classes in Coastal Wetlands of the Five Great Lakes: Development of a Fish Based Index of Biotic Integrity. Journal of Great Lakes Research 31(supplement 1): 171-187.

## *Fish Metrics - Schoenoplectus Zone:*

1. Mean catch per net-night:
   <10 score = 0 | 10-30 score = 3 | >30 score = 5
2. Total richness:
   <5 score = 0 | 5 to <10 score = 3 | 10 to 14 score = 5 | >14 score = 7
3. Percent non-native richness:
   >12% score = 0 | 7 to 12% score = 3 | <7% score = 5
4. Percent omnivore abundance:
   >70% score = 0 | 50 to 70% score = 3 | <50% score = 5
5. Percent piscivore richness:
   <15% score = 0 | 15 to 25% score = 3 | >25% score = 5
6. Percent insectivore abundance:
   <20% score = 0 | 20-30% score = 3 | >30% score = 5
7. Percent insectivorous Cyprinidae abundance:
   <1% score = 0 | 1-2% score = 3 | >2% score = 5
8. Percent carnivore (insectivore+piscivore+zooplanktivore) richness:
   <60% score = 0 | 60-70% score = 3 | >70% score = 5
9. White sucker (*Catostomus commersoni*) mean abundance per net-night:
   0 score = 0 | >0 to 0.4 score = 3 | >0.4 score = 5
10. Black bullhead (*Ictalurus melas*) mean catch per net-night:
    0 score = 0 | >0 to 3 score = 3 | >3 score = 5
11. Rock bass (*Ambloplites rupestris*) mean catch per net-night:
    0 score = 0 | >0 to 4 score = 3 | >4 score = 5
12. Alewife (*Alosa psuedoharengus*) mean catch per net-night:
    >11 score = 0 | 1 to 11 score = 3 | <1 score = 5
13. Smallmouth bass (*Micropterus dolomieu*) mean catch per net-night:
    0 score = 0 | >0 to 5 score = 3 | >5 score = 5
14. Pugnose shiner (*Notropis anogenus*) mean catch per net-night:
    0 score = 0 | >0 to 5 score = 3 | >5 score = 5

## *Fish Metrics: Typha Zone:*

1. Percent insectivore abundance:

<40% Score = 0 | 40 to 80% score = 3 | >80% score = 5

2. Insectivorous Cyprinidae richness:

0 to 1 Score = 0 | >1to 3 score = 3 | >3 score = 5

3. Percent Centrarchidae abundance:

0-30 score = 0 | >30 to 60 score = 3 | >60 to 80 score 5 | >80 score = 7

4. Centrarchidae richness:

0 to 1 score = 0 | >1 to 3 score = 3 | >3 score = 5

5. Mean Shannon Diversity Index:

<0.2 score = 0 | 0.2 to 0.7 score = 3 | >0.7 score = 5

6. Mean evenness:

<0.2 score = 0 | 0.2 to 0.6 score = 3 | >0.6 score = 5

7. Longnose Gar (*Lepisosteus osseus*) abundance per net-night:

0 score = 0 | >0 to 0.5 score = 3 | >0.5 to 2 score = 5 | >2 score = 7

8. Largemouth bass (*Micropterus salmoides*) abundance per net-night:

0 to 2 score = 0 | >2 to 30 score = 3 | >30 score = 5

9. Rock Bass (*Ambloplites rupestris*) abundance per net-night:

0 to 1 score = 0 | >1 to 5 score = 3 | >5 score = 5

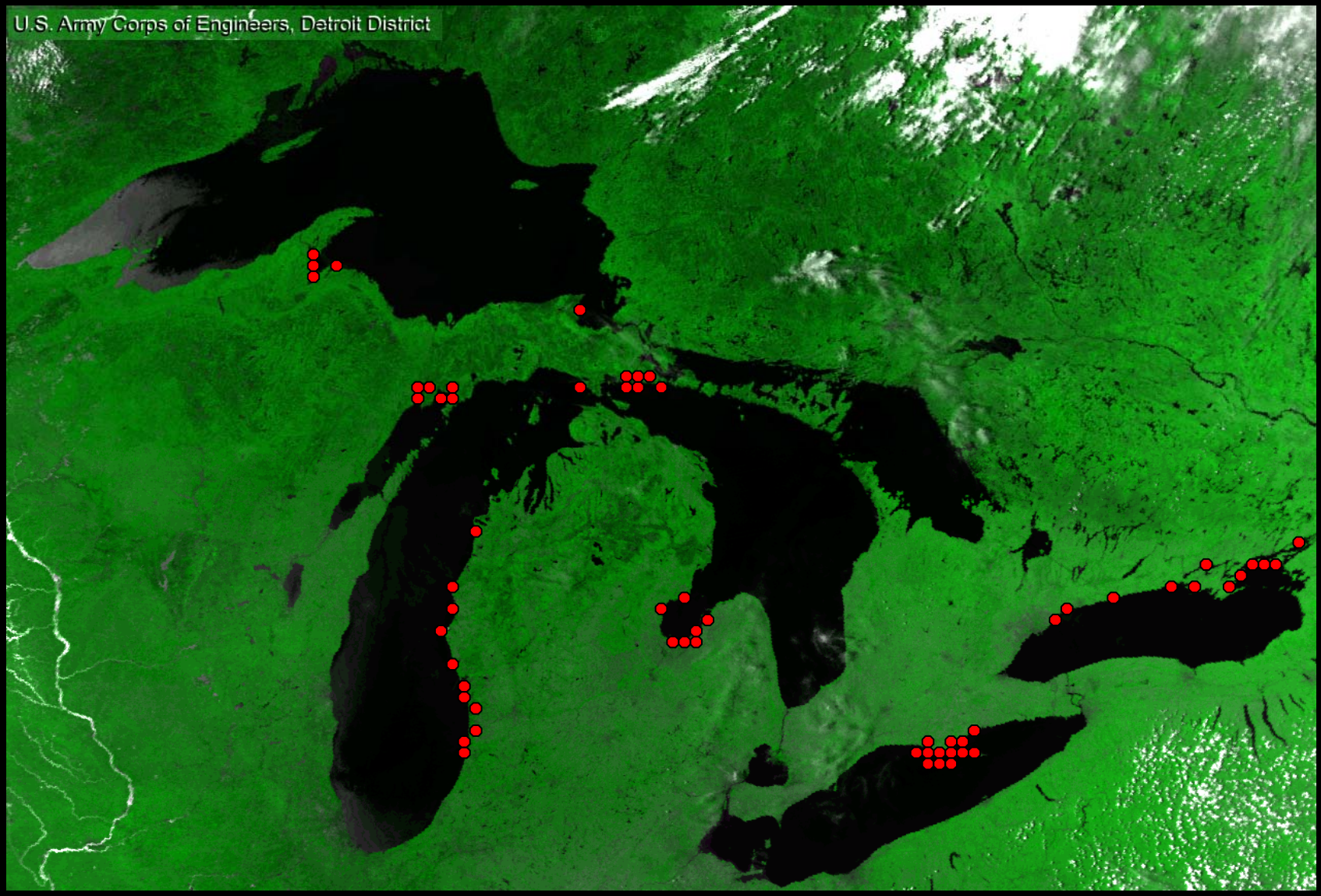
10. Bluegill (*Lepomis macrochirus*) abundance per net-night:

0 to 3 score = 0 | >3 to 20 score = 3 | >20 to 30 score = 5 | >30 score = 7

11. *Lepomis* abundance per net-night:

0 to 5 score = 0 | >5 to 20 score = 3 | >20 to 50 = 5 | >50 score = 7


# GLCWC Fish IBI Developed




# Tested at GLEI Sites

Bhagat et al. (2007) Concluded IBI valid


# Alternative Protocols for Fish

- Using Electroshocking Gear
  - No established IBI for this protocol
  - Highly Recommend Fyke Net Protocol

# Plant Protocols

- Using Aerial Photos
  - Map Wet Meadow and Emergent Zones
  - Map patches of invasives (or GPS in field)

- Sample July or August

- Overlay Random Grid in Each Zone
  - or
- Select Three Transects that Cross Each Zone.

- Sample 15 randomly selected 1.0 $m^{-2}$ quadrats
  - In each zone or along transects
  - Sample Dry and Flooded areas

# Plant Metrics

- Invasive Plant Cover for Entire Site (%)
  - Invasive Plant Cover for:
    - Wet Meadow zone
    - Dry Emergent zone
    - Submergent Flooded zone
    - Emergent Flooded zone
- Invasive Frequency for Entire Site (# of quadrats w invasives/# quadrates)
  - Invasive Frequency for:
    - Wet Meadow zone
    - Dry Emergent zone
    - Submergent Flooded zone
    - Emergent Flooded zone
- Mean Conservatism (Native Species) for Entire Site (total score for each species from FQI/# of species)

# Protocols for Birds


- **Based on species composition & relative abundance**
  - **Surveys from 6:00 p.m. to sunset**
  - **During breeding season (May –July)**
  - **Marshes > 10 ha in size**
- **1-8 stations/route**
  - **1 or more routes per marsh**
- **Passive visual and auditory observations**
  - **5 minutes/station for 100 m radius**
  - **Then 5 minutes of playback recordings of rails, etc. (secretive species)**
  - **Then 5 minutes of passive observations**
- **>300 m between stations**
  - **avoid overlap.**
- **Routes surveyed 3 times over breeding season**
  - **>10 days between visits**


# Bird Community Metrics

- Mean relative **a**bundance (i.e., proportion) of **N**on-**A**rial **F**oragers for the survey route.
- Mean relative **a**bundance (i.e., proportion) of **M**arsh **N**esting **O**bligates for the survey route.
- Mean species **r**ichness of **A**rea-sensitive **M**arsh **N**esting **O**bligates for the survey route.


# Amphibian Protocols

- **Frog and Toad call surveys**
  - **3 times during breeding season (April through June)**
  - **Timing based on mean night temperatures.**
- **Surveys done from 10:00 p.m. to midnight**
  - **by observers trained to identify calls.**
- **Number of surveys/wetland varies with size.**


# Amphibian Metrics

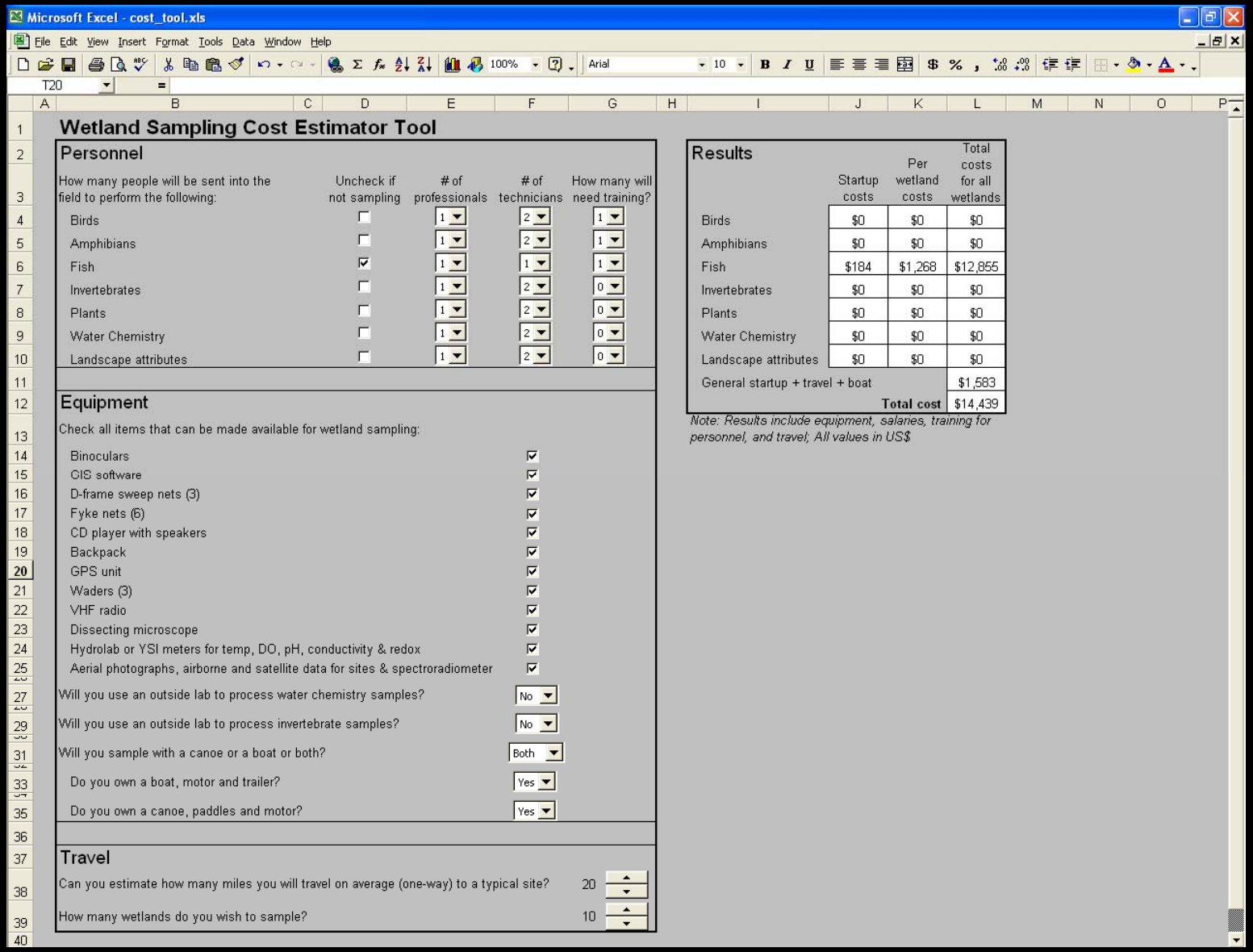
- **Total species richness.**
- **Species richness of woodland species.**
- **Probability of detecting a woodland species within the wetland.**

# Landscape Indicators

- Recommend a two-tier wetland mapping system
  - Moderate (30 m) resolution satellite-based mapping
    - Entire basin
    - every 5 Years
  - High resolution (< 1 m) airborne or satellite-based map
    - one lake basin per year
      - all are sampled every 5 yrs.
- Calculate Metrics using this data base.
- Possible Metrics
  - Gains and losses of wetland area
  - Land cover/land use for each site sampled and for basin
  - Changes in Land use/land cover
  - Area dominated by Invasives

# Cost

- Cost Estimator Tool
  - Basically check boxes
    - what you have or need.
- One site varies from $1,395 to $5,223
  - Birds, Amphibians and Plants
    - least expensive
  - Invertebrates
    - by far the most expensive indicator.
- Estimated Cost per Wetland by Indicator
  - Invertebrates ($3,241),
  - Landscape attributes ($2,222)
  - Fish ($1,029)
  - Amphibians ($160)
  - Birds ($112)
- Costs decrease if either water chemistry or invertebrate samples are sent to external labs.


Microsoft Excel - cost_tool.xls
File Edit View Insert Format Tools Data Window Help
T20
Wetland Sampling Cost Estimator Tool
Personnel
How many people will be sent into the field to perform the following:
Uncheck if not sampling
# of professionals
# of technicians
How many will need training?
Birds 1 2 1
Amphibians 1 2 1
Fish 1 1 1
Invertebrates 1 2 0
Plants 1 2 0
Water Chemistry 1 2 0
Landscape attributes 1 2 0
Equipment
Check all items that can be made available for wetland sampling:
Binoculars
CIS software
D-frame sweep nets (3)
Fyke nets (6)
CD player with speakers
Backpack
GPS unit
Waders (3)
VHF radio
Dissecting microscope
Hydrolab or YSI meters for temp, DO, pH, conductivity & redox
Aerial photographs, airborne and satellite data for sites & spectroradiometer
Will you use an outside lab to process water chemistry samples? No
Will you use an outside lab to process invertebrate samples? No
Will you sample with a canoe or a boat or both? Both
Do you own a boat, motor and trailer? Yes
Do you own a canoe, paddles and motor? Yes
Travel
Can you estimate how many miles you will travel on average (one-way) to a typical site? 20
How many wetlands do you wish to sample? 10
Results
Startup costs
Per wetland costs
Total costs for all wetlands
Birds $0 $0 $0
Amphibians $0 $0 $0
Fish $184 $1,268 $12,855
Invertebrates $0 $0 $0
Plants $0 $0 $0
Water Chemistry $0 $0 $0
Landscape attributes $0 $0 $0
General startup + travel + boat $1,583
Total cost $14,439
Note: Results include equipment, salaries, training for personnel, and travel; All values in US$

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