

# Applying Concepts of Landscape Ecology to Rivers

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# Applying Concepts of Landscape Ecology to Rivers

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- Evolution of instream flow issues since 1975
- Paradigm shifts 1990 – present
- Technological advances 1990 – present
- Example of patch dynamics applied to management
- Concluding remarks

# Instream Flow Issues

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- 1975 – 1985 Complete dewatering of rivers

# Minimum Flow Methods 1975 - 1985

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- Purpose – to identify a (low flow) discharge that provided adequate protection for biological resources, below which injury to resources would be accelerated.
- Often enforced as a minimum reservoir release or instream flow water right.
- Hydrologic based methods – e.g., Tennant
- Hydraulic based methods – e.g., wetted perimeter

# Instream Flow Issues

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- 1975 – 1985 Complete dewatering of rivers
- 1980 – 1995 Reservoir operations/FERC re-licensing

# Incremental Methods 1980 - 1995

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- Purpose – to quantify differences in one or more decision variables resulting from alternative management scenarios.
- Habitat area is the most common decision variable, but can include temperature and water quality.
- Reservoir operations and other water management alternatives are the most common alternatives tested.

# Instream Flow Incremental Methodology (IFIM 1982 - 1995)

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- Alternatives are generated as modified flow regimes, reservoir operating rules, temperature or water quality controls, and/or channel modifications.
- Alternatives are evaluated on the basis of:
  - **Feasibility** (distinction between “it can’t be done” and “I don’t want to do it”).
  - **Effectiveness** (change in habitat area resulting from the management alternative).
  - **Risk** (when and why an alternative will fail, and what you’re going to do about it).

# Paradigm Shifts (1990 – 2005)

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- Habitat use guilds (Bain and Boltz 1989)
- Flood pulse advantage (Junk et al. 1989)
- Ecological connectivity (Ward and Stanford 1995)
- Natural flow paradigm (Poff et al. 1997)
- Habitat patch dynamics (Bowen et al. 2003)

# Instream Flow Issues

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- 1975 – 1985 Complete dewatering of rivers
- 1980 – 1995 Reservoir operations/FERC re-licensing
- 1995 – 2005+ River restoration/rehabilitation

# Habitat Modeling Enablers, Post – 1990

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- Computer technology enhancements.
- Improved GPS/remote sensing capabilities.
- Development of new 2d hydraulic models.
- Advancements in GIS capability.

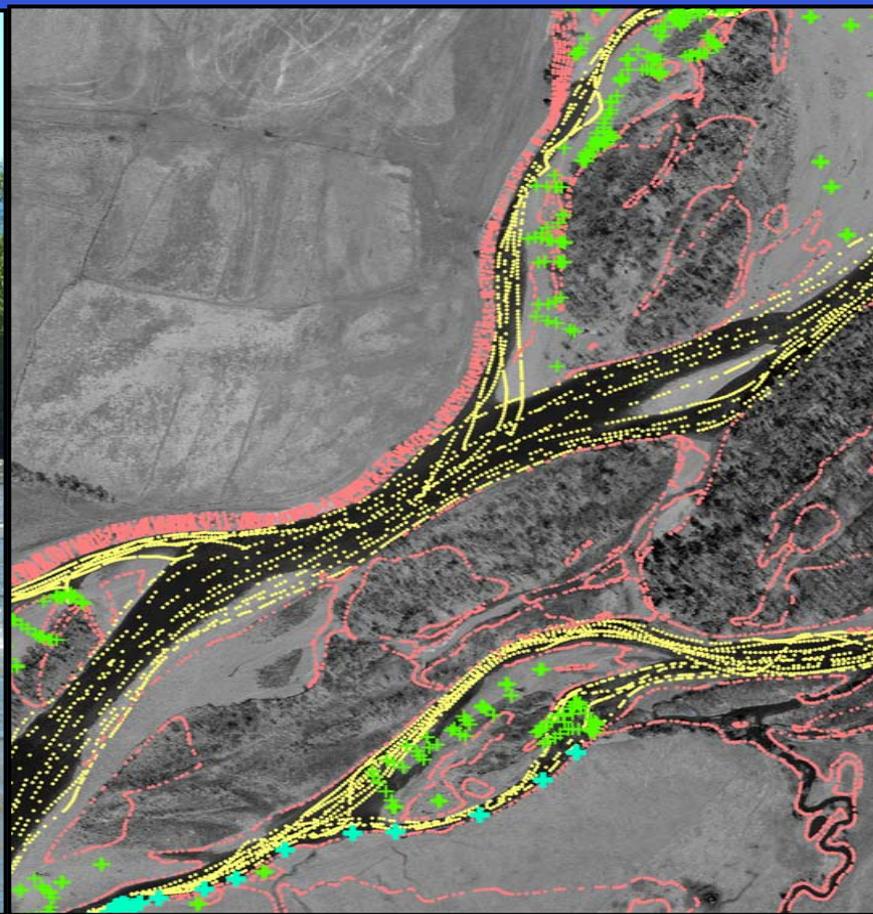
## IFIM Enablers, Post – 1990

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- Computer technology enhancements...higher speed, more memory, multiple work stations, networking.
- Do I need to elaborate?

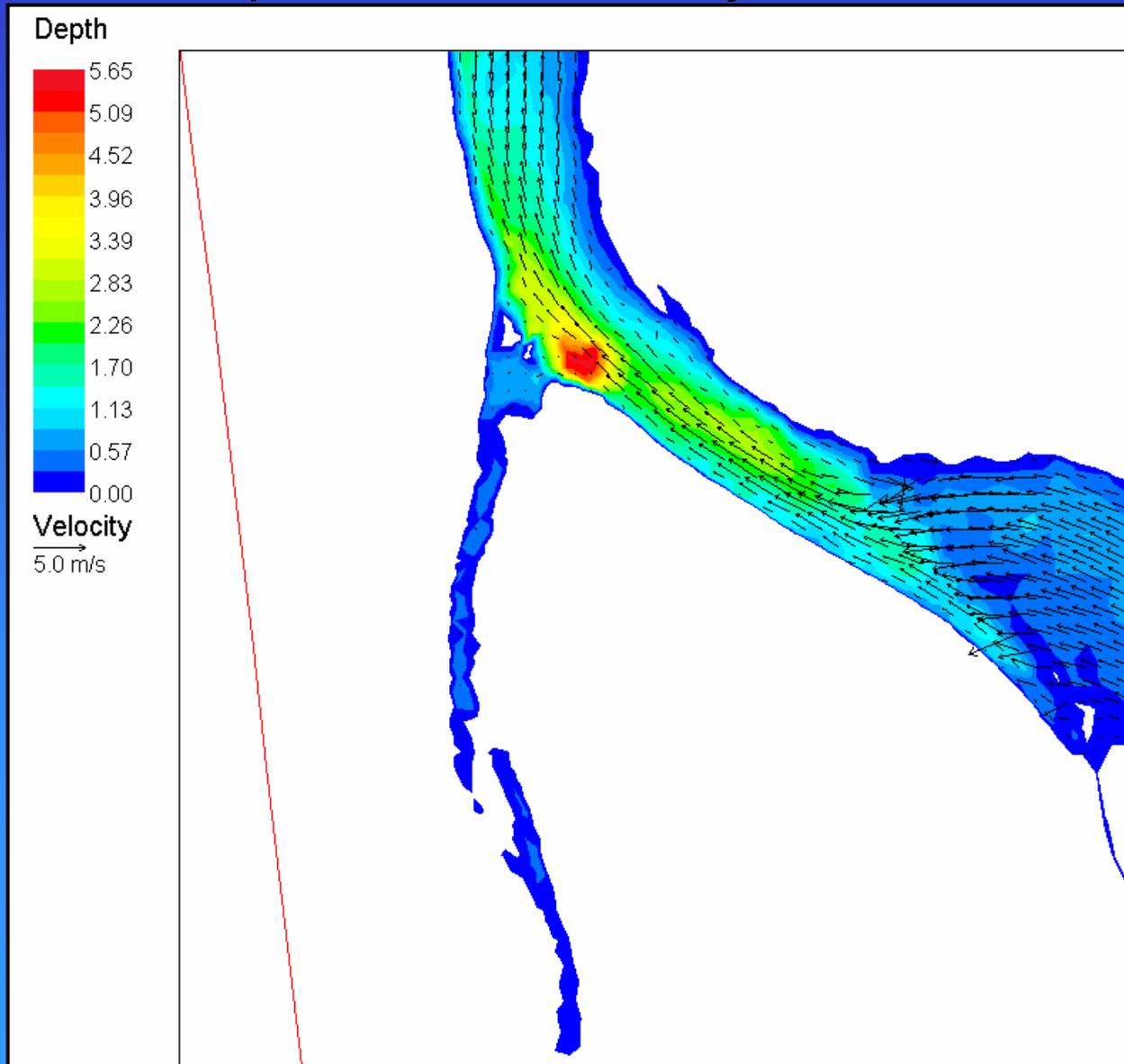
# IFIM Enablers, Post – 1990

- Improved GPS/remote sensing capabilities, allowing high density data bases for structural characteristics of channel and floodplain.



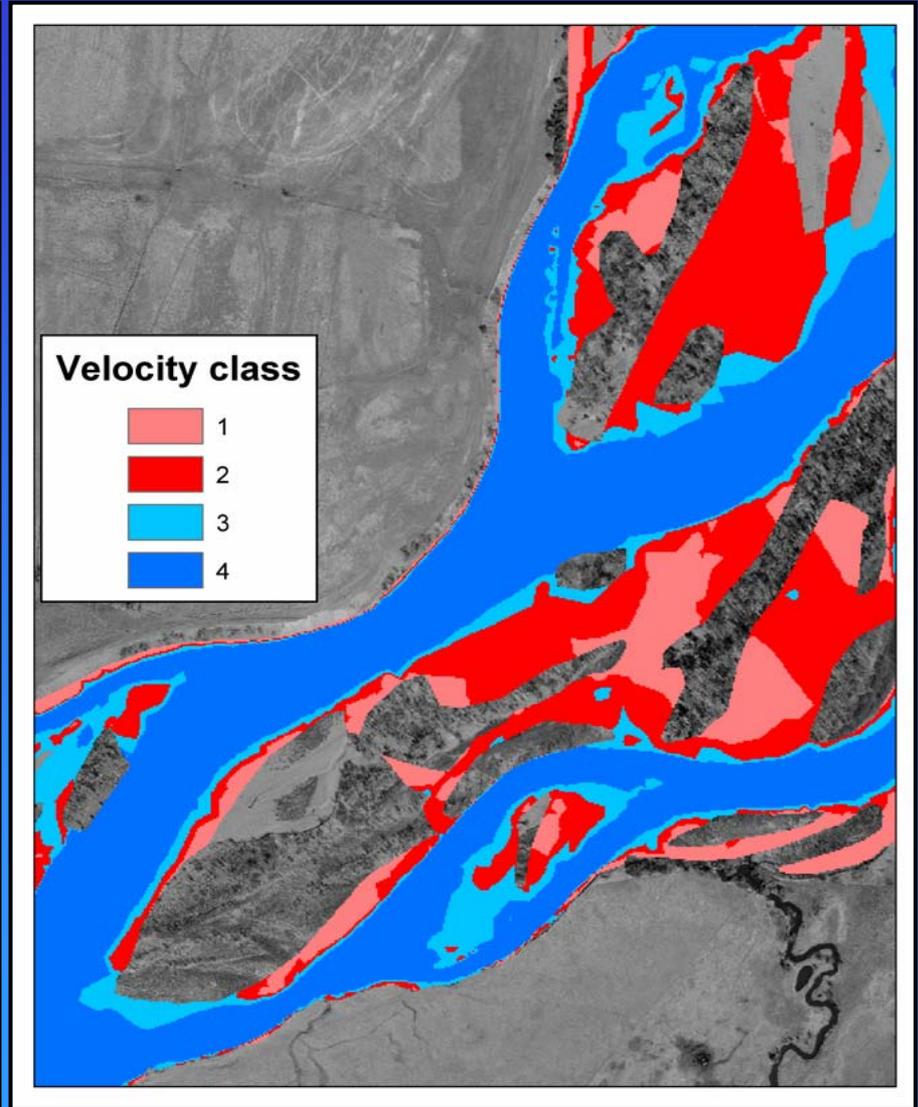
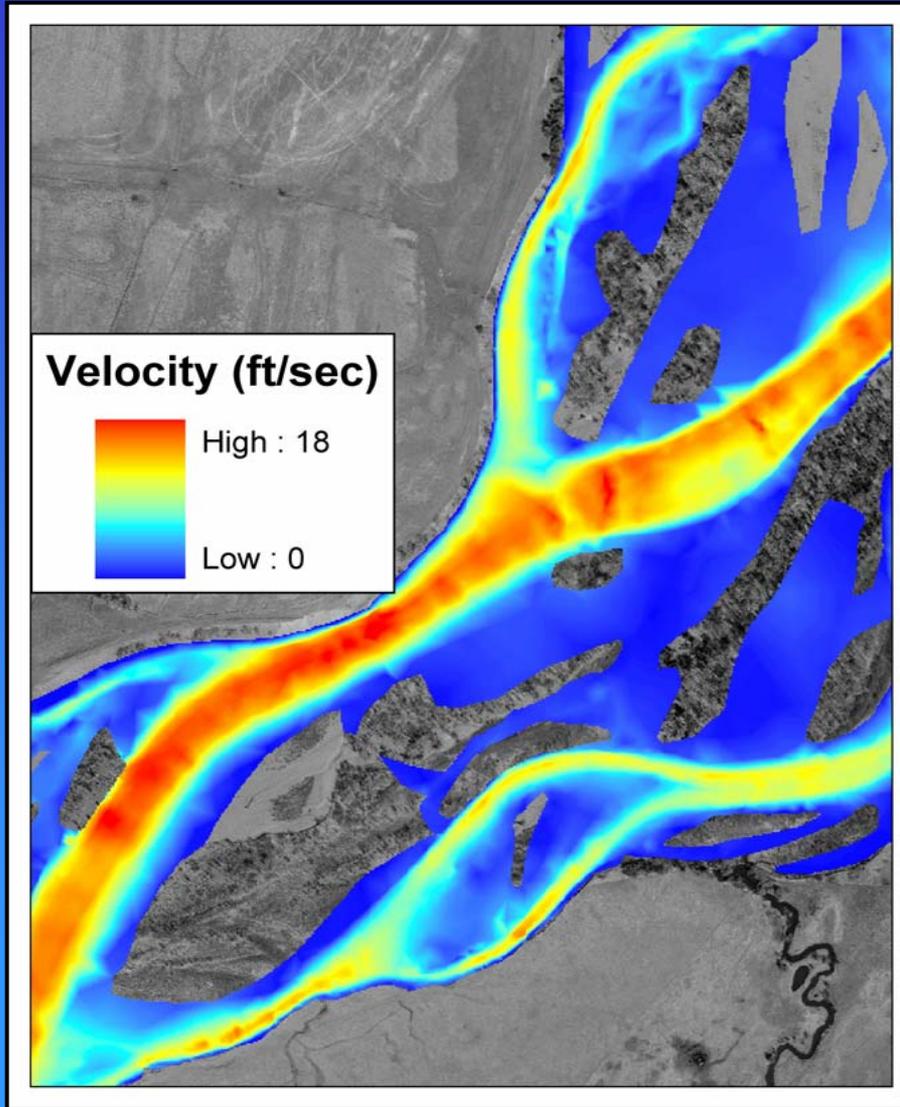
# IFIM Enablers, Post – 1990

- Development of new 2d hydraulic models.



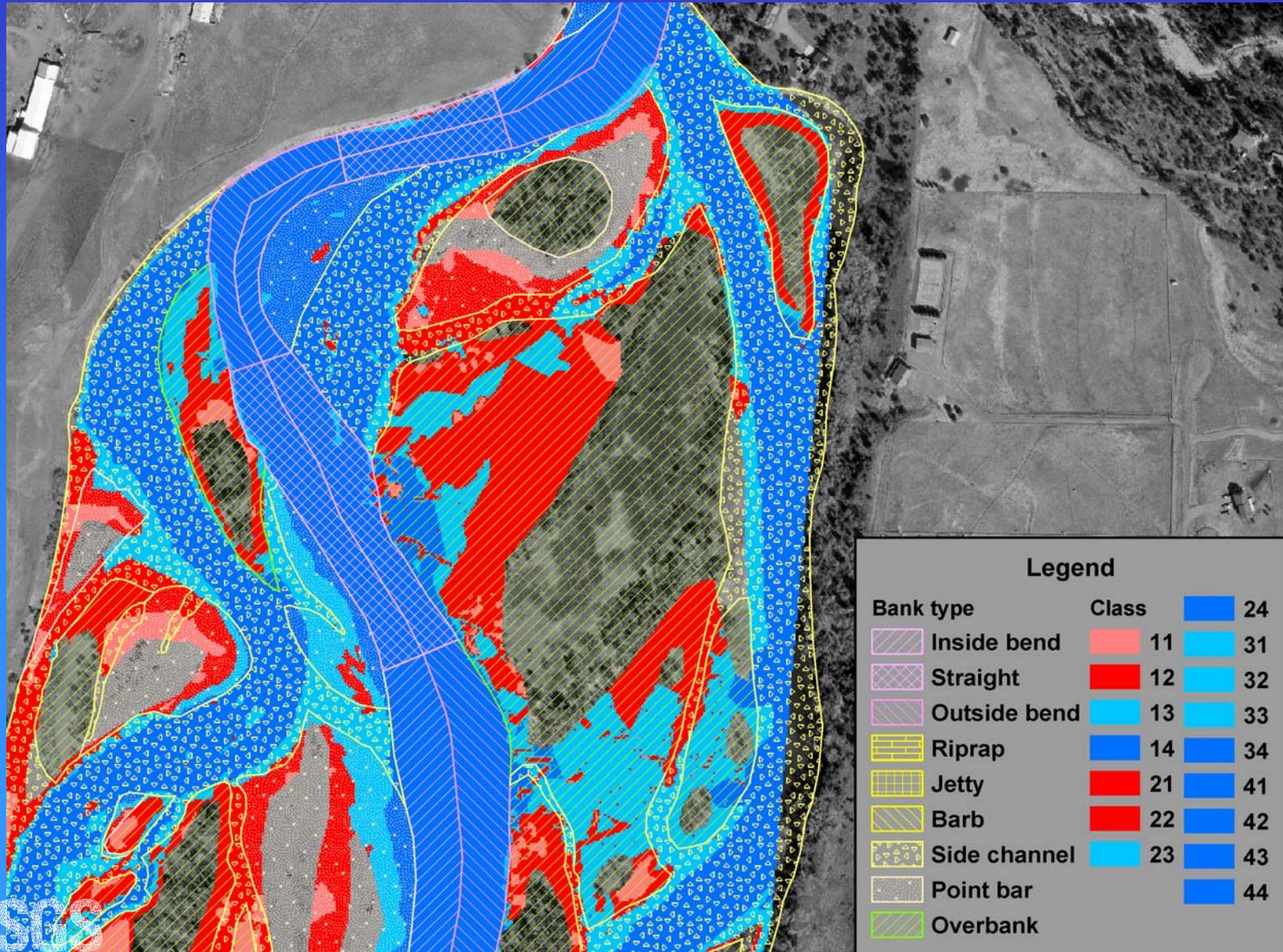
# IFIM Enablers, Post – 1990

Advancements in GIS capability.



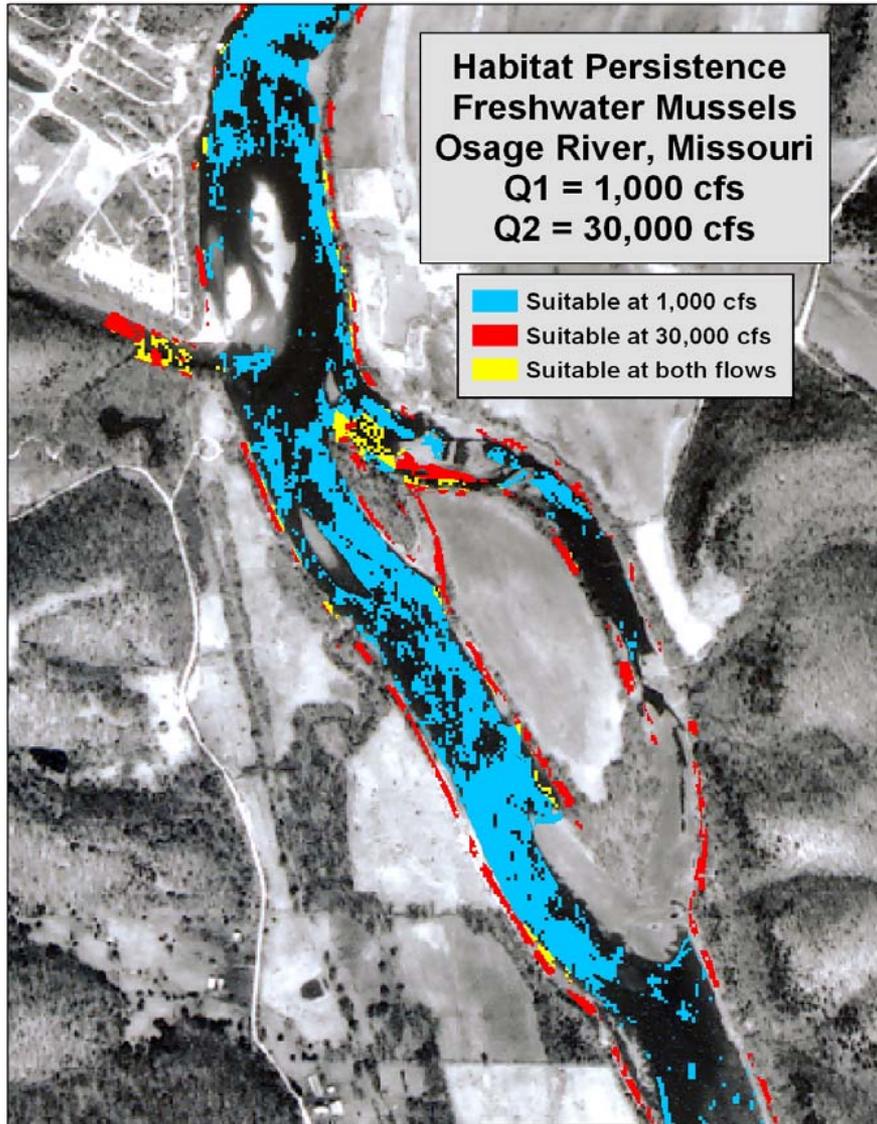
# IFIM Enablers, Post – 1990

Advancements in GIS capability.



# IFIM Enablers, Post – 1990

Advancements in GIS capability.



## **Example**

# **Application of Landscape Ecology Concepts to Instream Flow Problems**

**A comparison of patch dynamics  
In two northern Great Plains rivers**

**Yellowstone River near Savage, MT  
SSCV Habitat in Red  
Spring peak (late May - early June)**

**Patch Dynamics:  
Matching the map  
Sequence with the  
Hydrology**



**Yellowstone River near Savage, MT  
SSCV Habitat in Red  
Recession (early June)**

**Patch Dynamics:  
Matching the map  
Sequence with the  
Hydrology**



**Yellowstone River near Savage, MT  
SSCV Habitat in Red  
Recession (mid June)**

**Patch Dynamics:  
Matching the map  
Sequence with the  
Hydrology**



**Yellowstone River near Savage, MT  
SSCV Habitat in Red  
Recession (late June)**

**Patch Dynamics:  
Matching the map  
Sequence with the  
Hydrology**



**Yellowstone River near Savage, MT  
SSCV Habitat in Red  
Recession (early July)**

**Patch Dynamics:  
Matching the map  
Sequence with the  
Hydrology**



**Yellowstone River near Savage, MT  
SSCV Habitat in Red  
Recession (late July)**

**Patch Dynamics:  
Matching the map  
Sequence with the  
Hydrology**



Yellowstone River near Savage, MT  
SSCV Habitat in Red  
Recession (August - September)

Patch Dynamics:  
Matching the map  
Sequence with the  
Hydrology



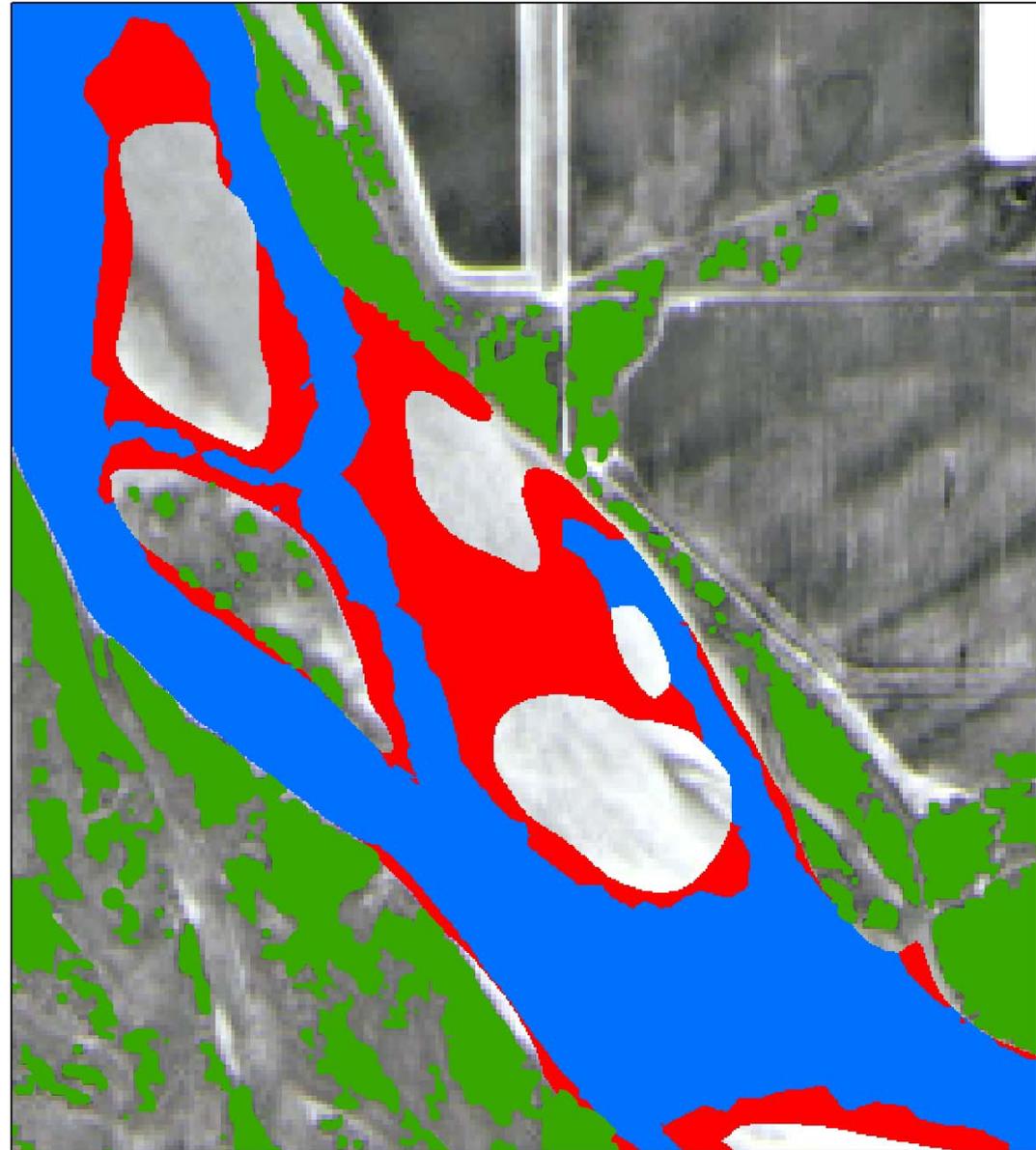
**Yellowstone River near Savage, MT  
SSCV Habitat in Red  
Base flow (October)**

**Patch Dynamics:  
Matching the map  
Sequence with the  
Hydrology**



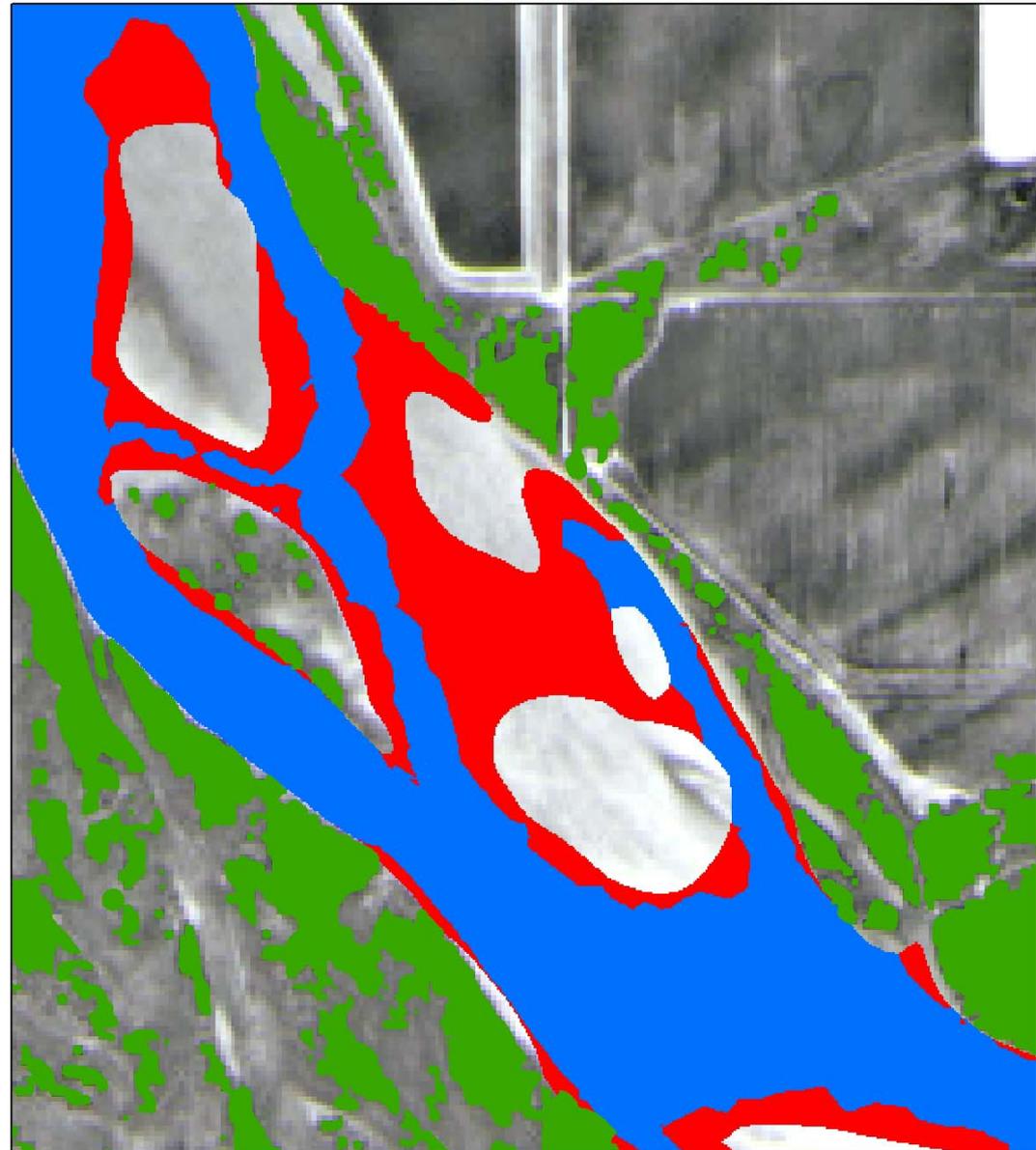
Missouri River near Culbertson, MT  
SSCV Habitat in Red  
Spring Peak (May)

Patch Dynamics:  
Matching the map  
Sequence with the  
Hydrology



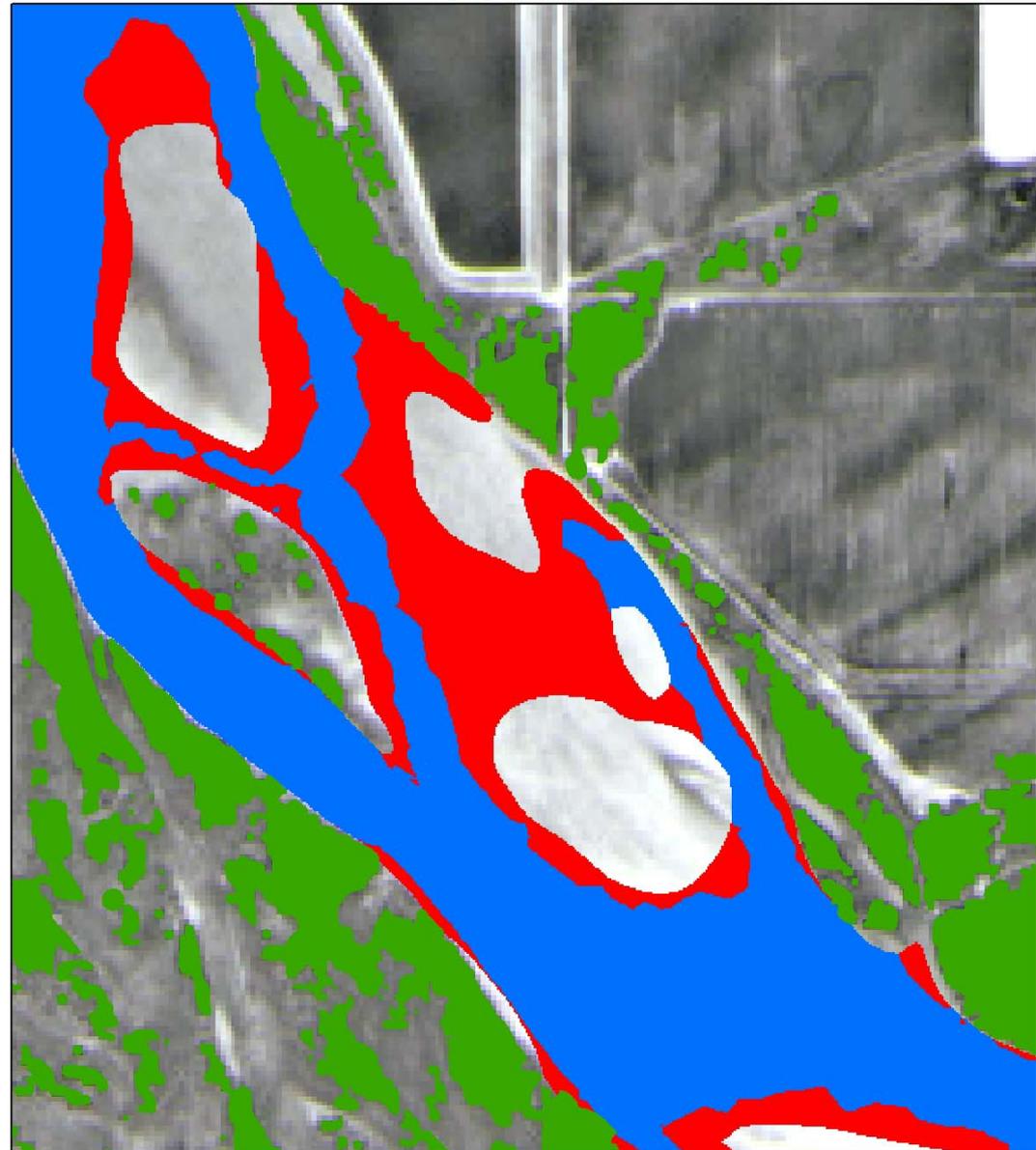
**Missouri River near Culbertson, MT  
SSCV Habitat in Red  
Recession (June)**

**Patch Dynamics:  
Matching the map  
Sequence with the  
Hydrology**



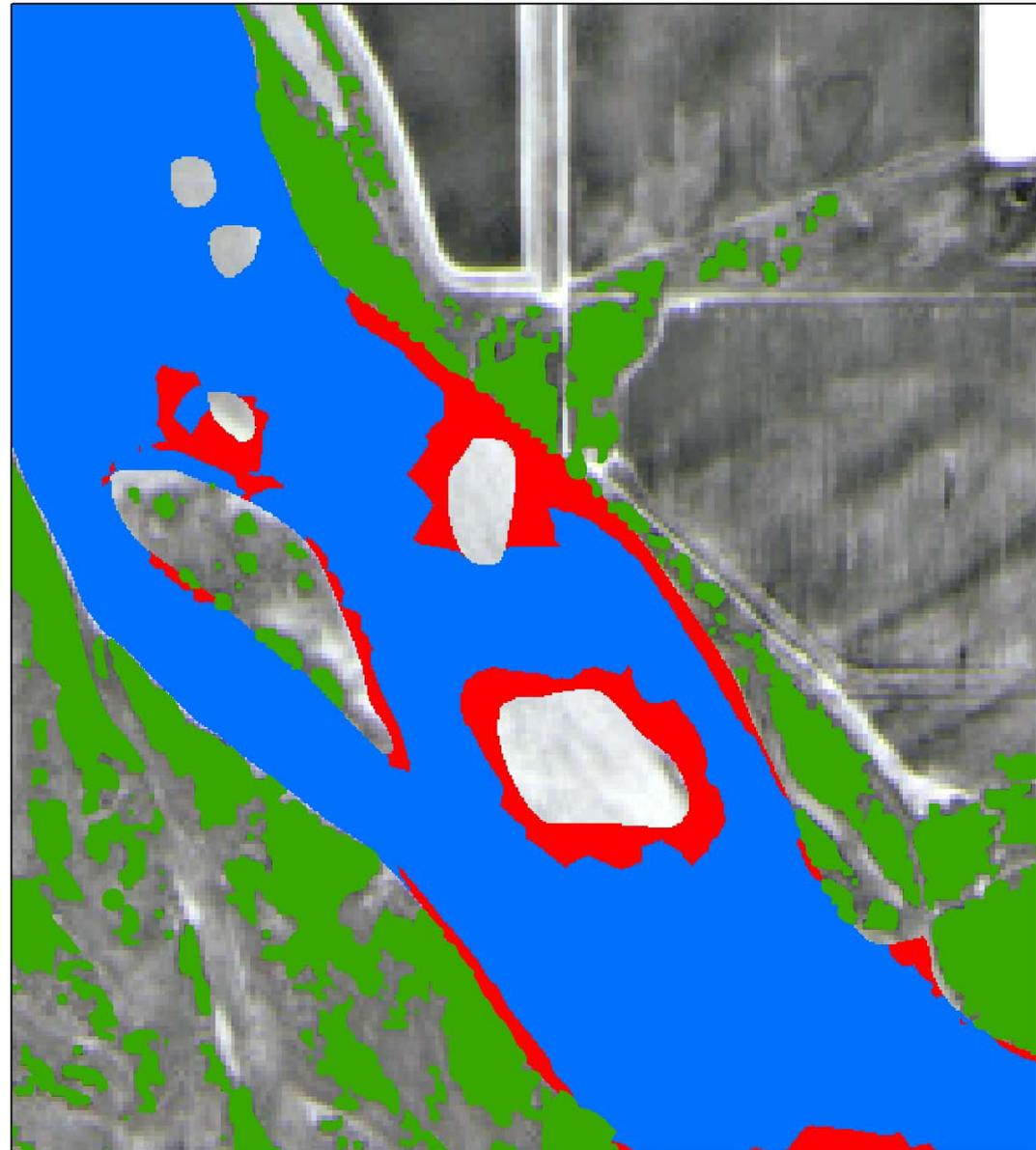
**Missouri River near Culbertson, MT  
SSCV Habitat in Red  
Recession (July)**

**Patch Dynamics:  
Matching the map  
Sequence with the  
Hydrology**



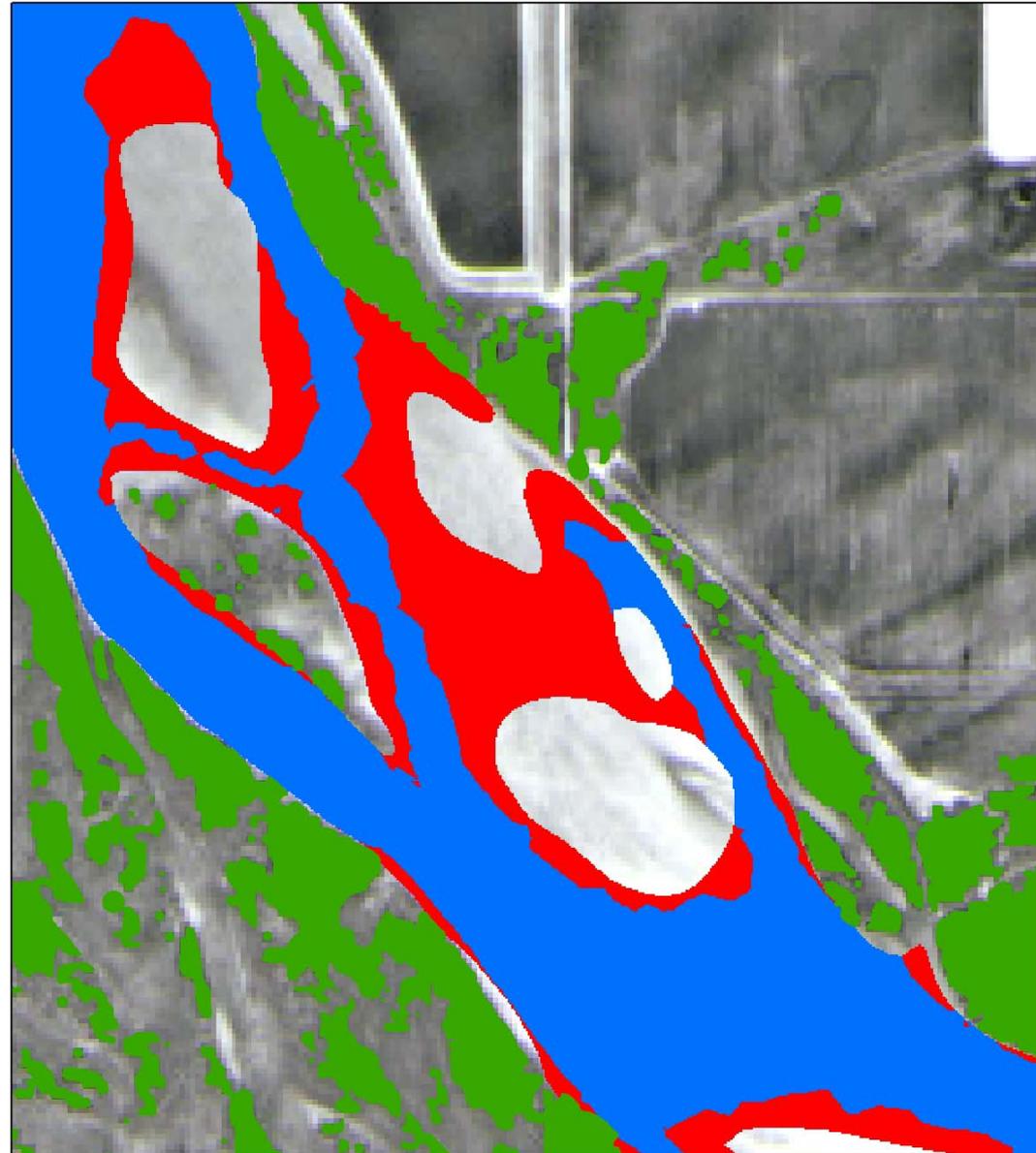
Missouri River near Culbertson, MT  
SSCV Habitat in Red  
Recession (August)

Patch Dynamics:  
Matching the map  
Sequence with the  
Hydrology



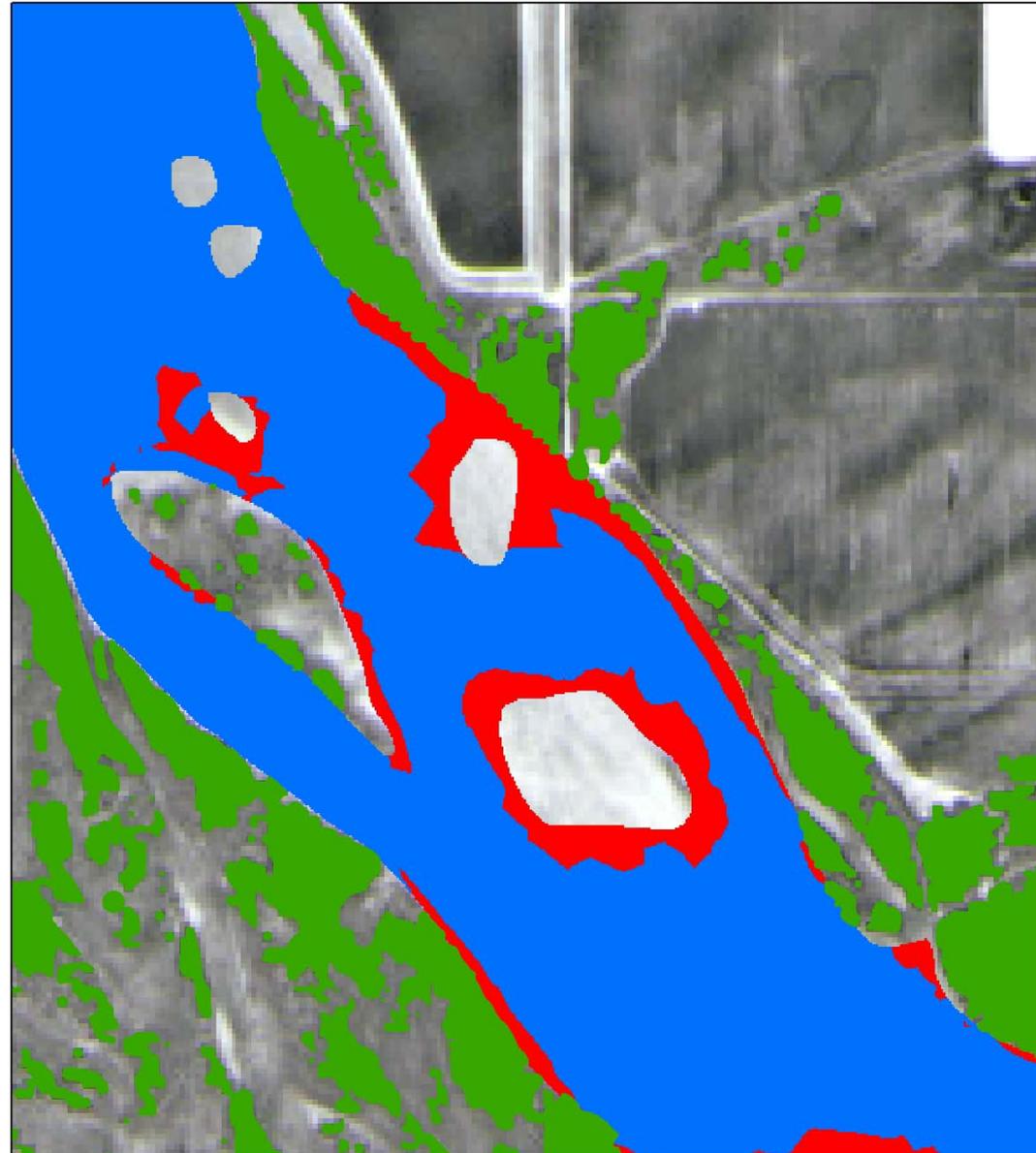
Missouri River near Culbertson, MT  
SSCV Habitat in Red  
Recession (September)

Patch Dynamics:  
Matching the map  
Sequence with the  
Hydrology



Missouri River near Culbertson, MT  
SSCV Habitat in Red  
Base flow? (October)

Patch Dynamics:  
Matching the map  
Sequence with the  
Hydrology



# Concluding Remarks

- Patch dynamics and landscape ecology concepts fit seamlessly with IFIM philosophy and procedures, but...
  - Allow habitat analysis at multiple layers,
  - At multiple scales,
  - And with more decision variables.

# Concluding Remarks

- Evolution from traditional instream flow to river restoration/rehabilitation will require...
  - Redefinition of baseline or reference conditions at least for hydrology and geomorphology.
  - Development of standard methods for defining reference conditions.

# Concluding Remarks

- Evolution from traditional instream flow to river restoration/rehabilitation may include...
  - Community/habitat use guild concepts,
    - Floodplain and riparian processes,
    - Paradigm of “Natural Patch Dynamics,”
    - Water management to control invasives.

# Concluding Remarks

- Basic IFIM concepts of feasibility, effectiveness, and risk analysis are still valid, regardless of the application.

# References

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