

Evaluation of a Predictive Model for Upstream Fish Passage Through Culverts



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Resident Stream Fish Also Have Passage Needs



- Reproduction
- Colonize available habitat
- Seek thermal and chemical refuge
- Use available food sources

Effects of Culverts

Fragment:

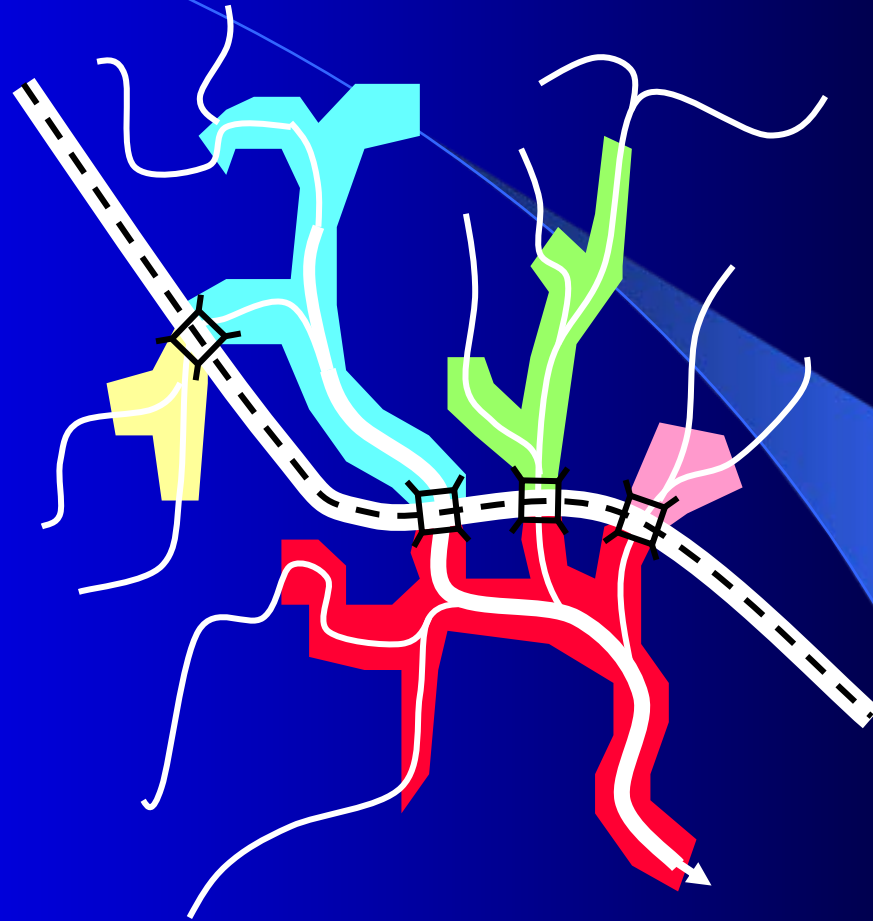
- habitat
- populations

Disrupt:

- gene flow

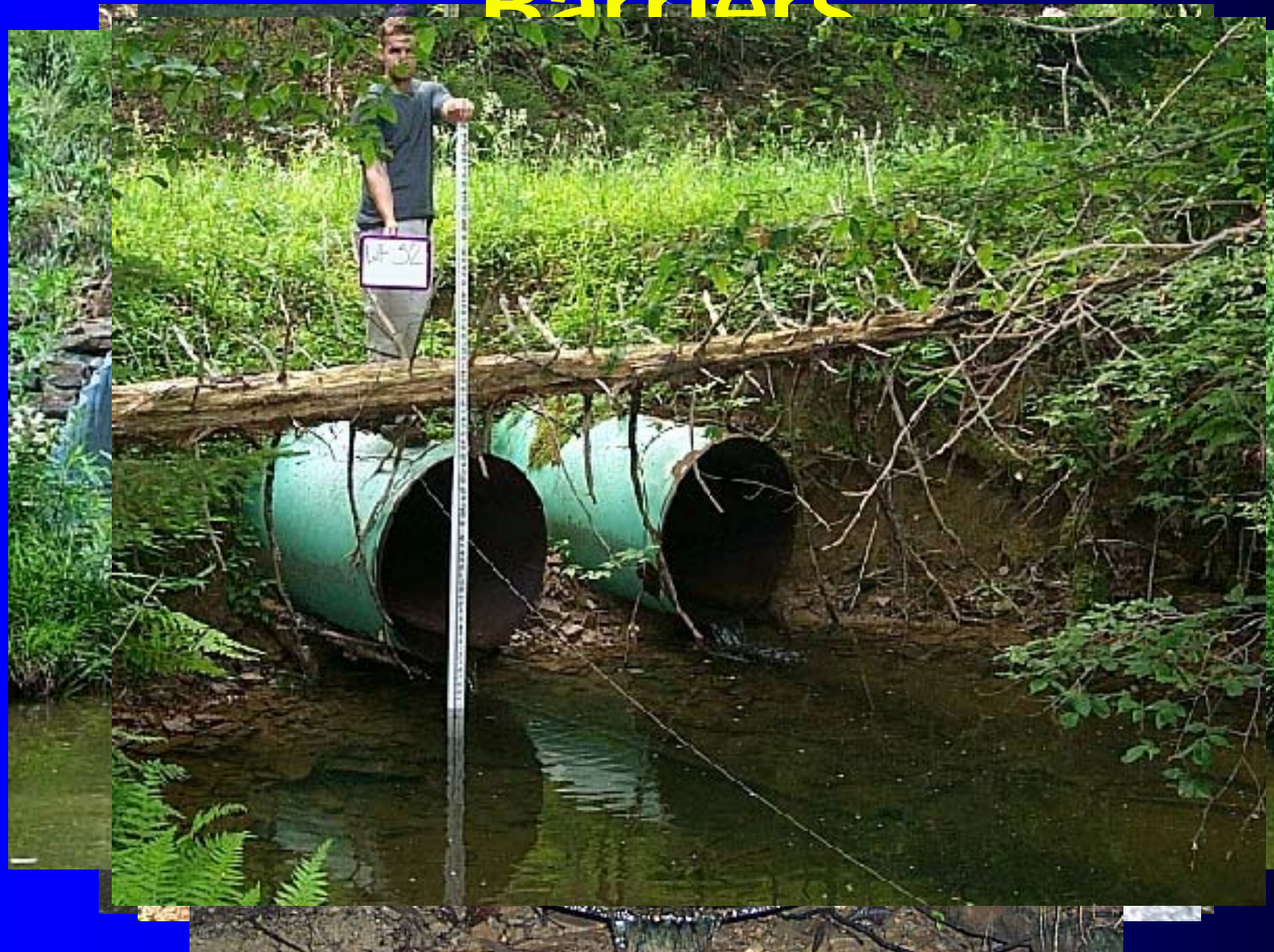
and

- recolonization dynamics after local extirpations



North Rhineland Barriers

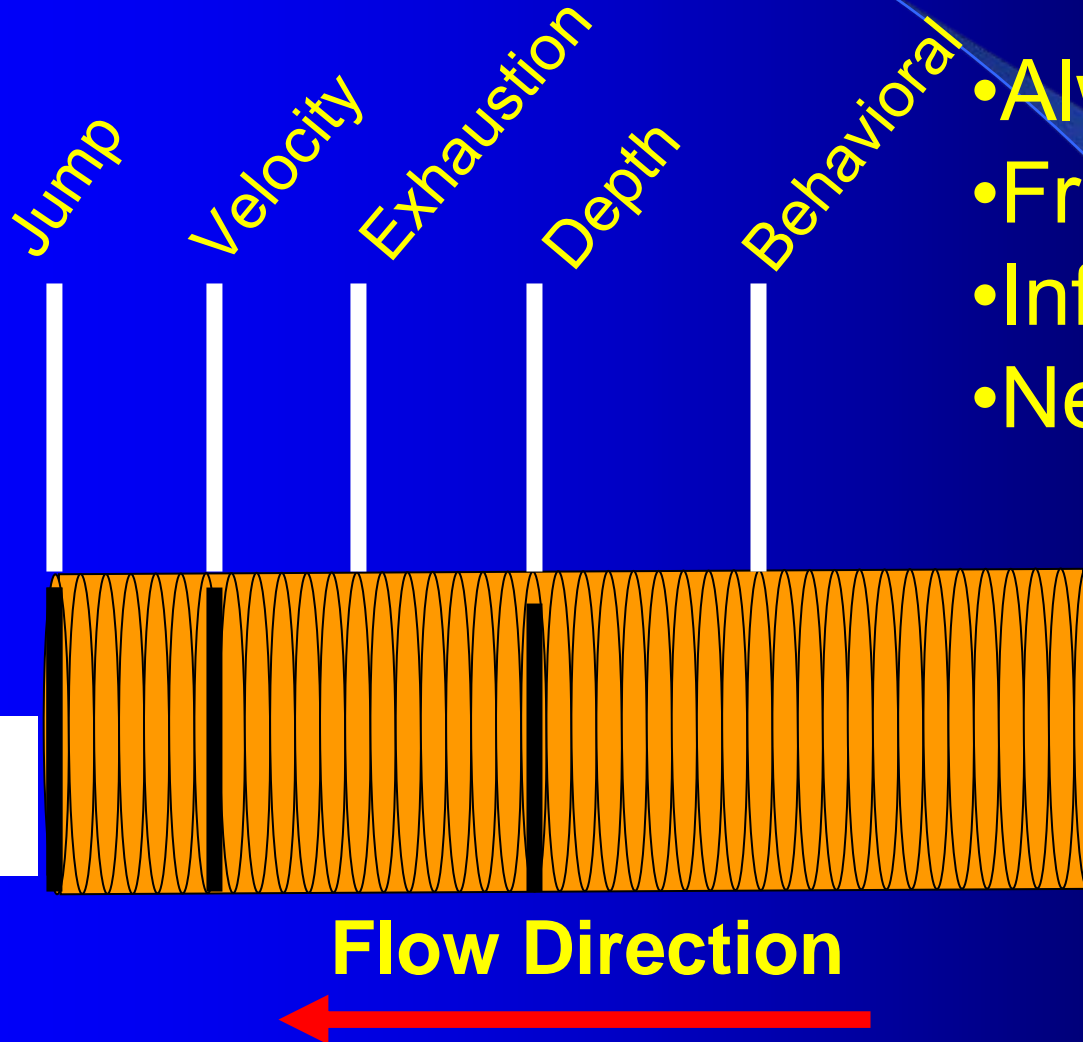
Barriers



Passage Gates

Passage requirements are:

- Always met
- Frequently met
- Infrequently met
- Never met



Study Objectives

1. Develop predictive models for upstream fish passage through culverts
2. Validate those models in the field with biological data on fish movement
3. Modify and improve the models based on field data.

Predictive Models

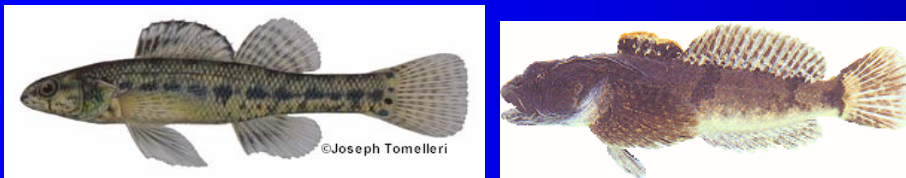
Model A: Adult Salmonidae



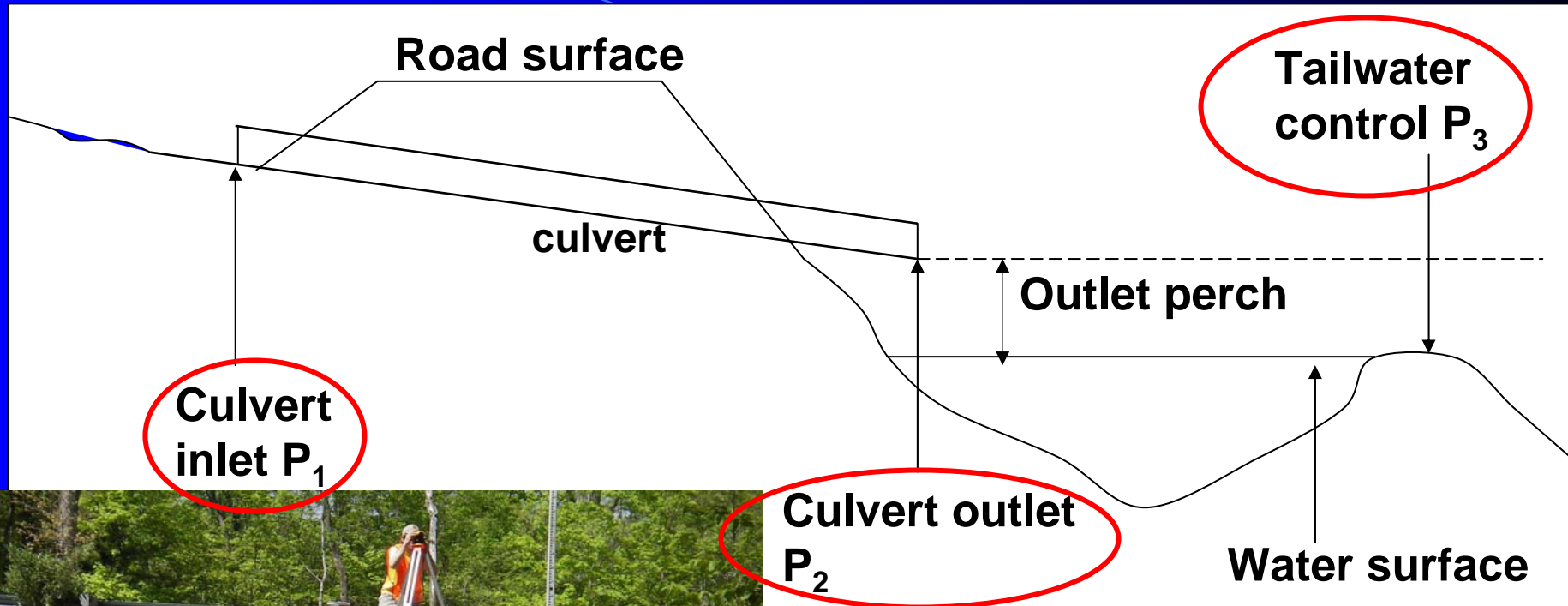
Model B: Cyprinidae/YOY Salmonidae



Model C: Percidae and Cottidae



Field Measurements



Modified from Clarkin et al. 2003

Pipe fully backwatered or 100% of pipe bottom covered by substrate

Model B



Yes

No

< 8 in

≥ 8 in

< 3.0%

≥ 3.0%

≤ 25

> 25 & < 150

≥ 150

PASSABLE

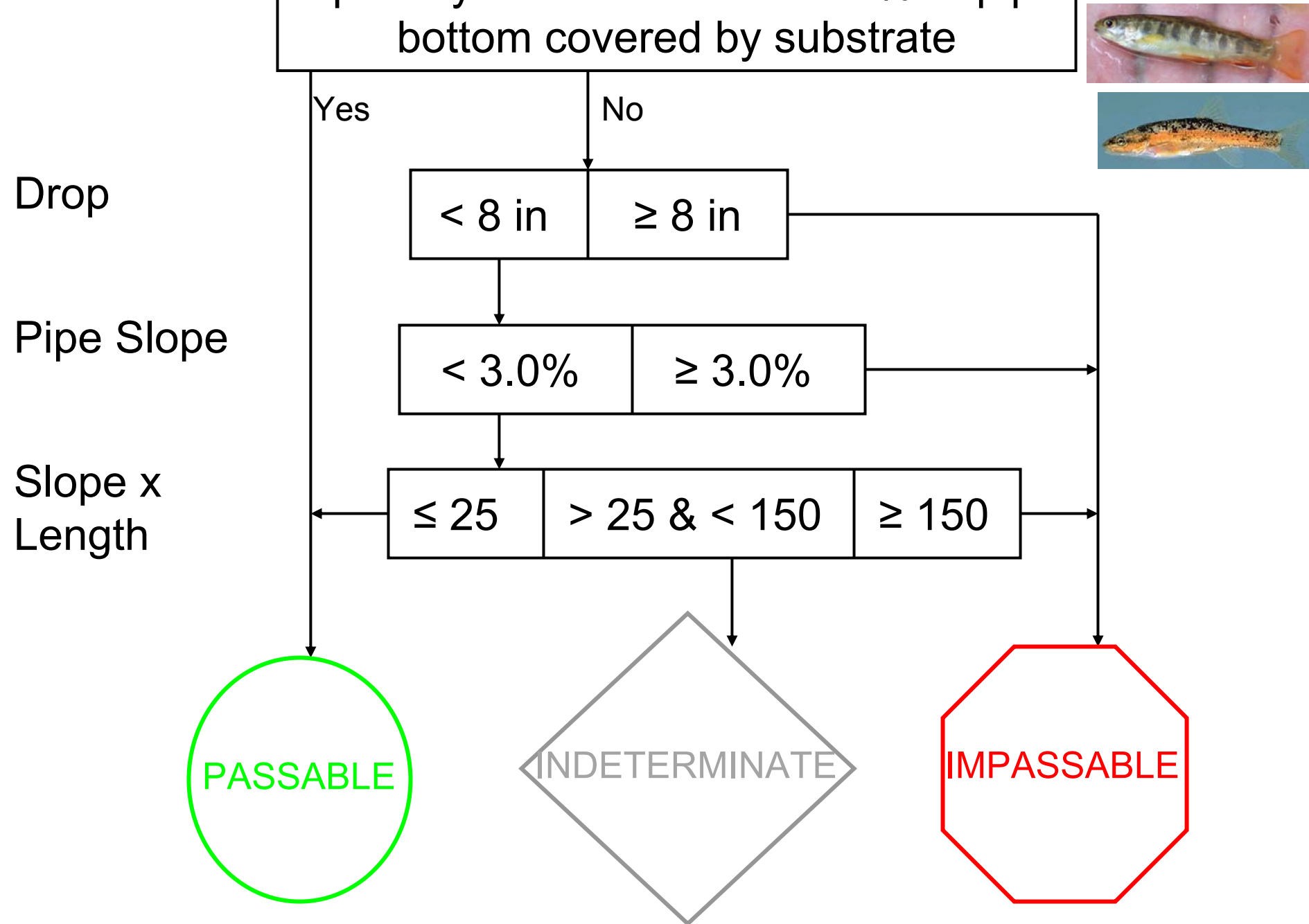
INDETERMINATE

IMPASSABLE

Drop

Pipe Slope

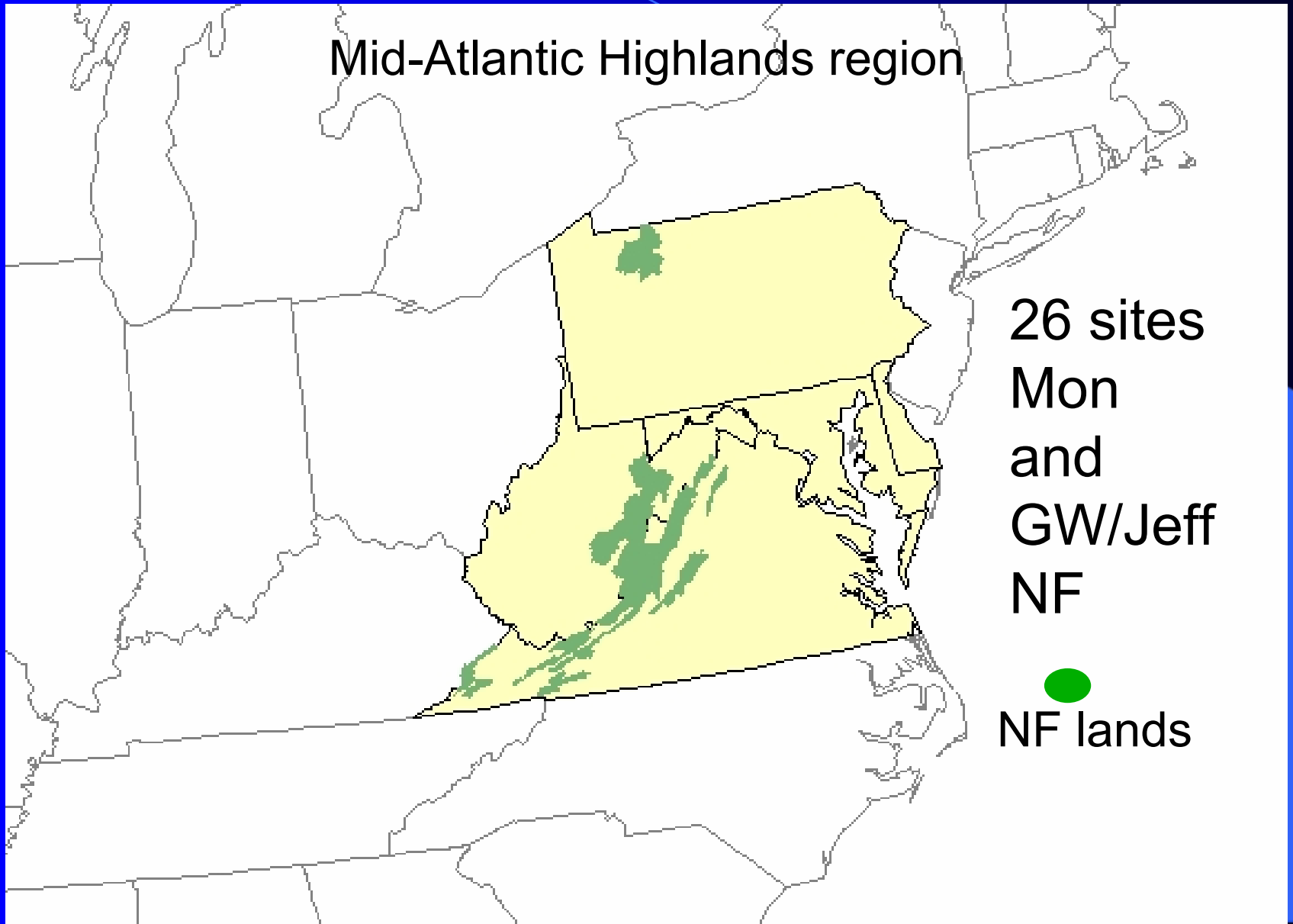
Slope x Length



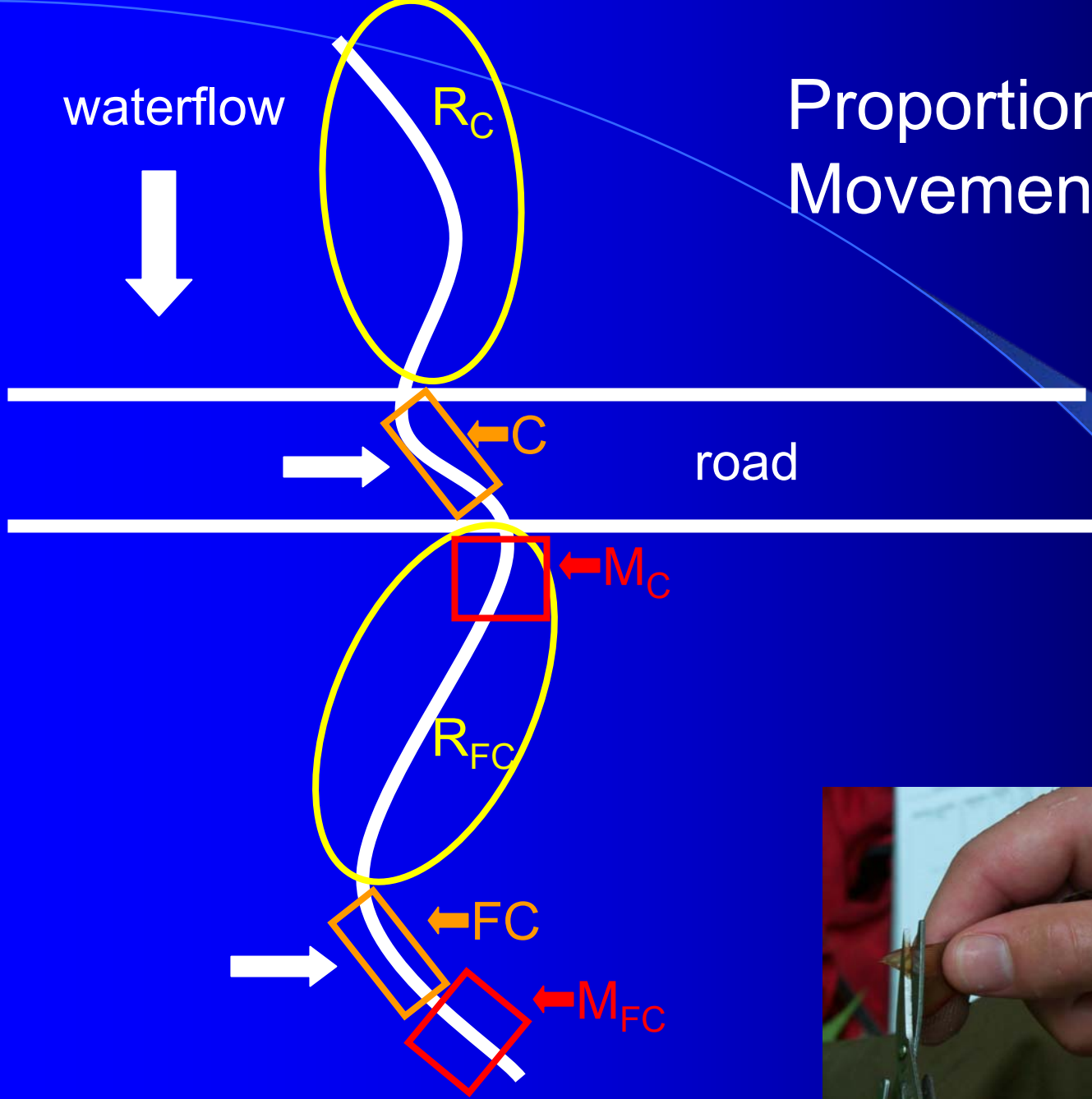
Validating the Model



Study Area



Proportional Movement



Results



Movement Through Culverts



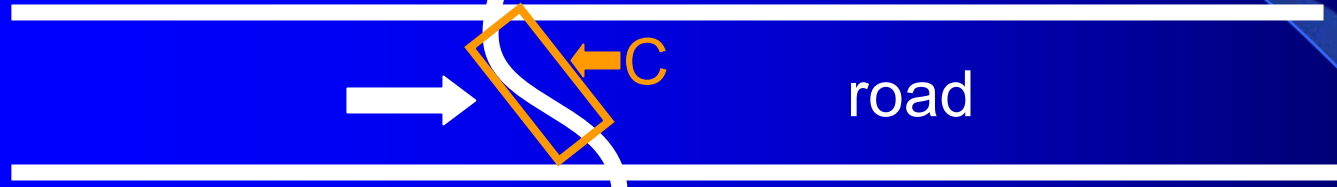
Summer: 3/10 impassable

10/14 passable

Fall: 1/11 impassable

9/14 passable

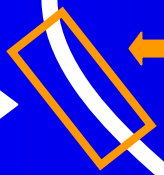
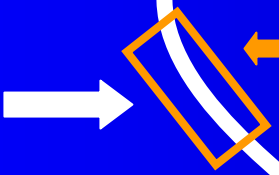
waterflow



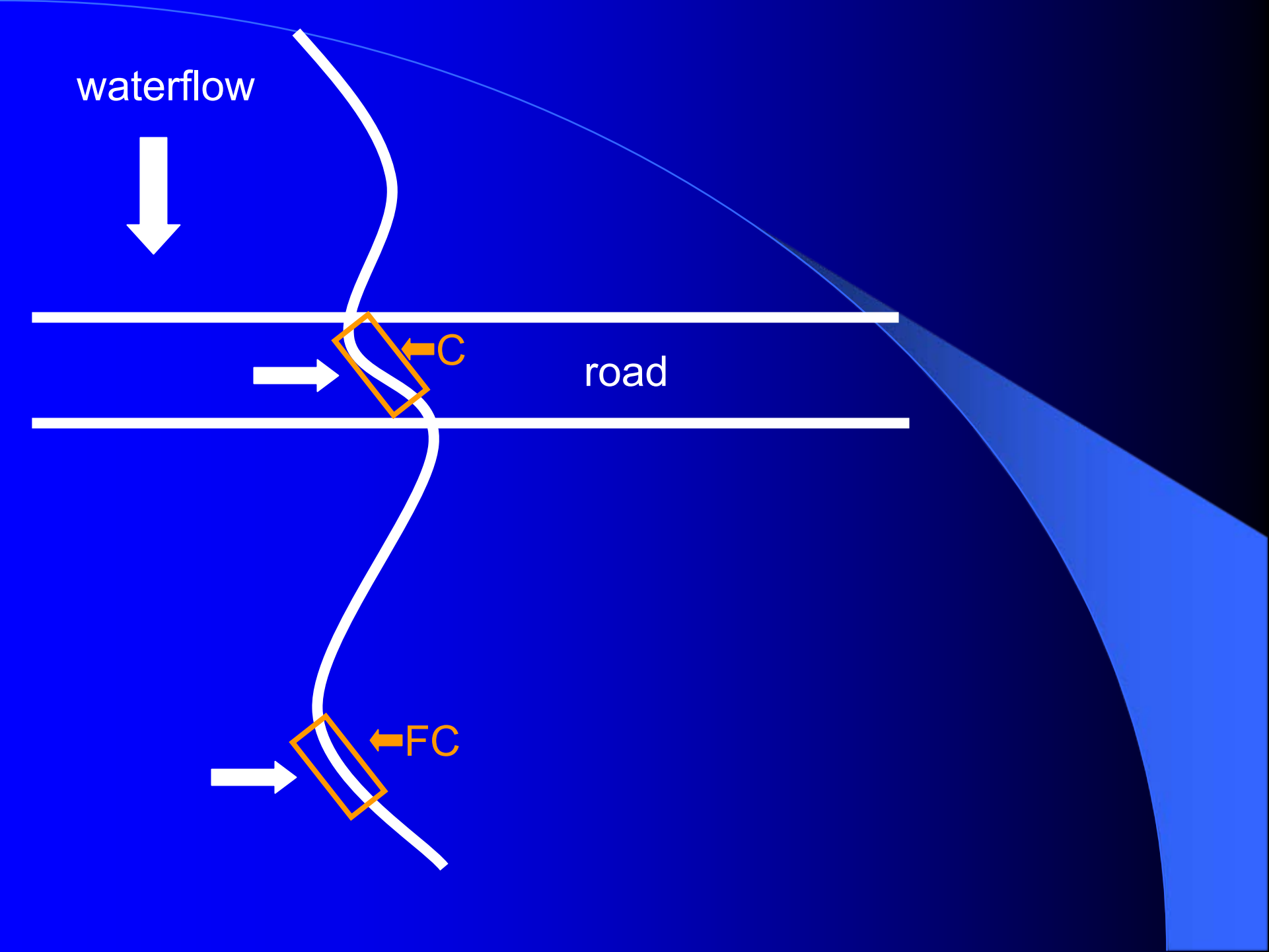
road



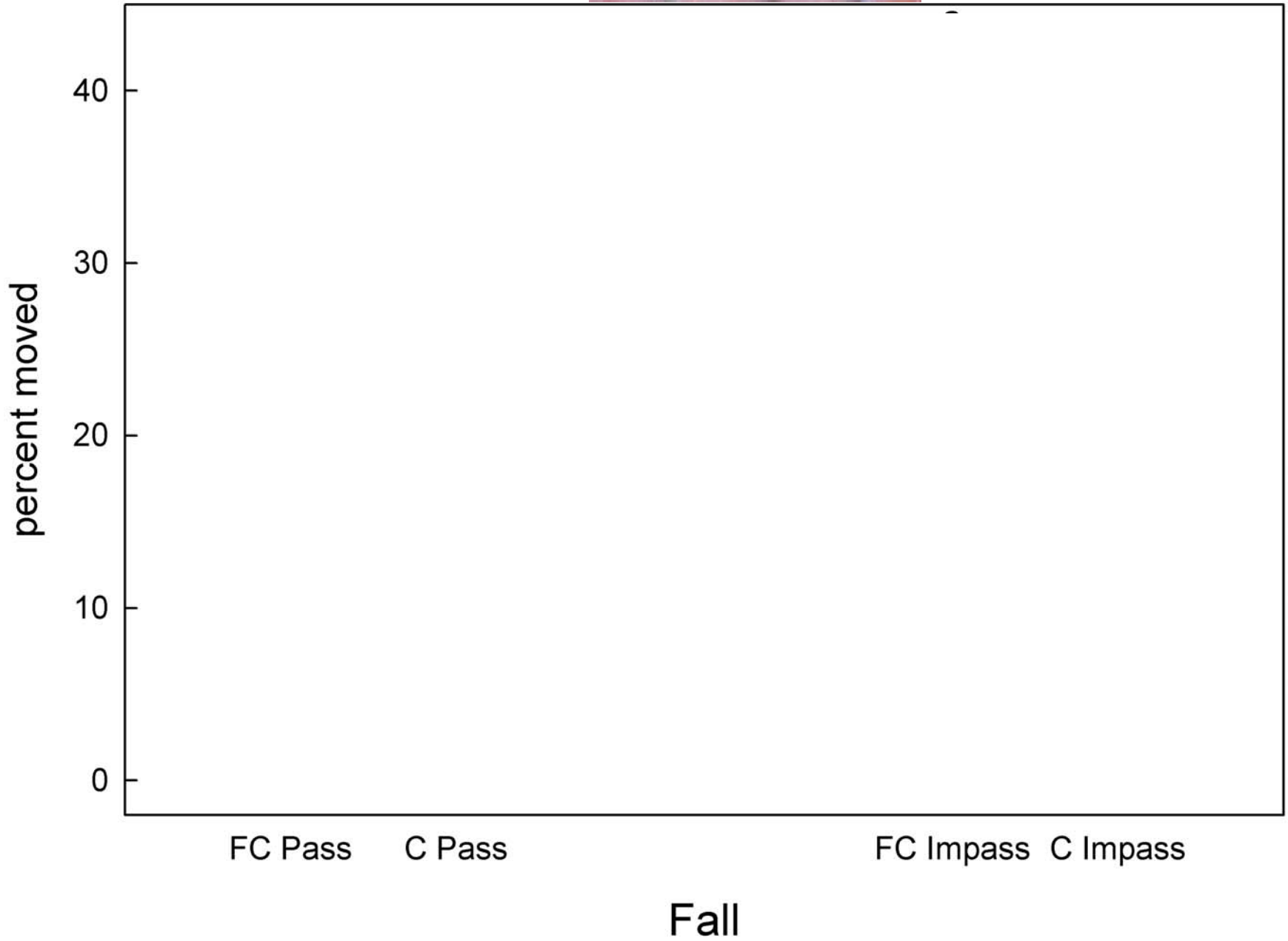
C



FC



Group B



ANOVA RESULTS

3 Levels:

Group (A, B, or C)

Classification (Passable or Impassable)

Section (FC or C)

ANOVA RESULTS

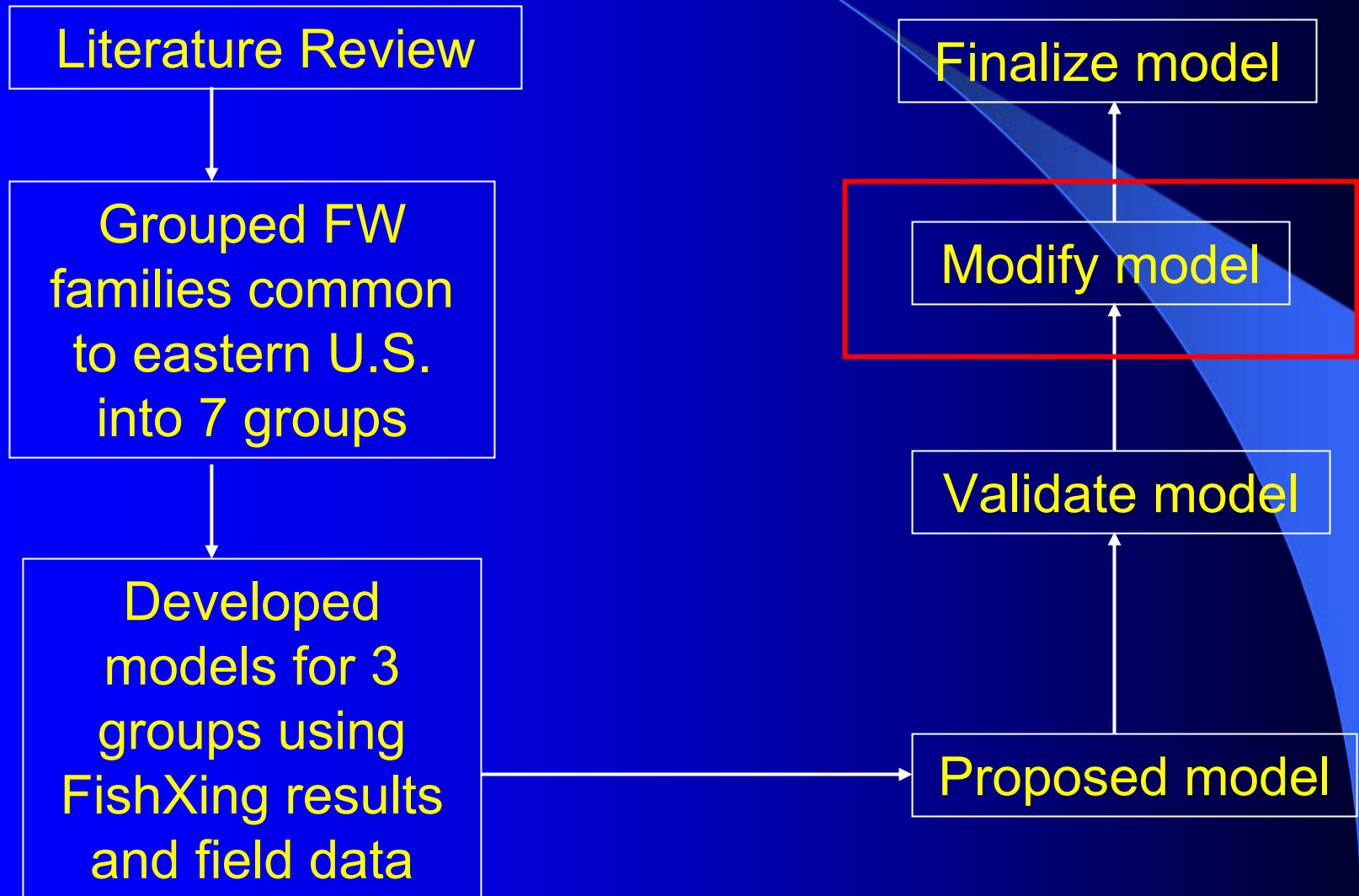
fall	Source of variation	df	F	P value
	group	2	15.69	<.0001
	class	1	0.64	0.4266
	section	1	9.52	0.0028
	group*class	2	1.74	0.1825
	group*section	2	2.61	0.0793
	class*section	1	2.55	0.1138
	group*class*section	2	0.22	0.8018

Group (A, B, or C)

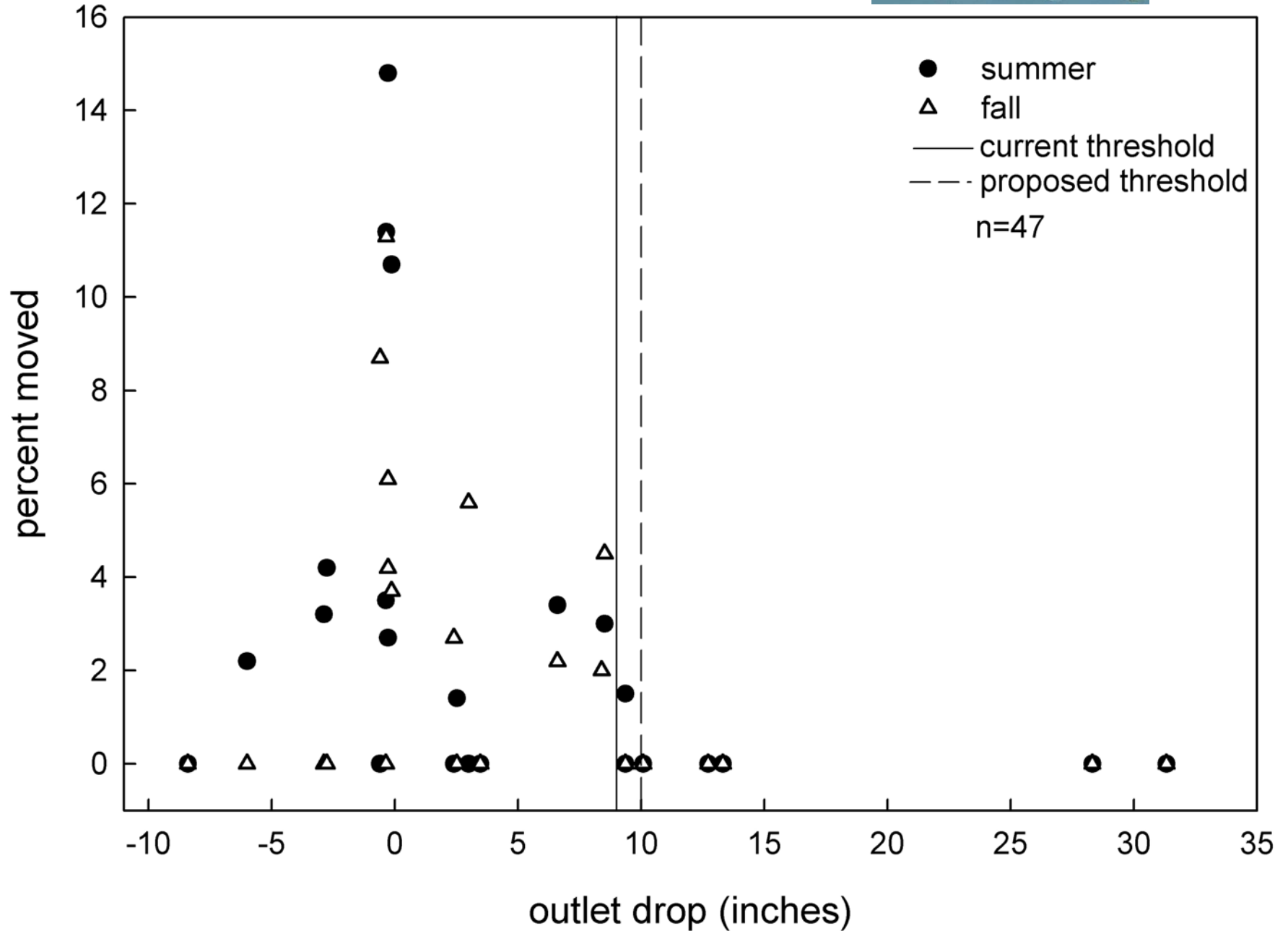
Classification (Passable or Impassable)

Section (FC or C)

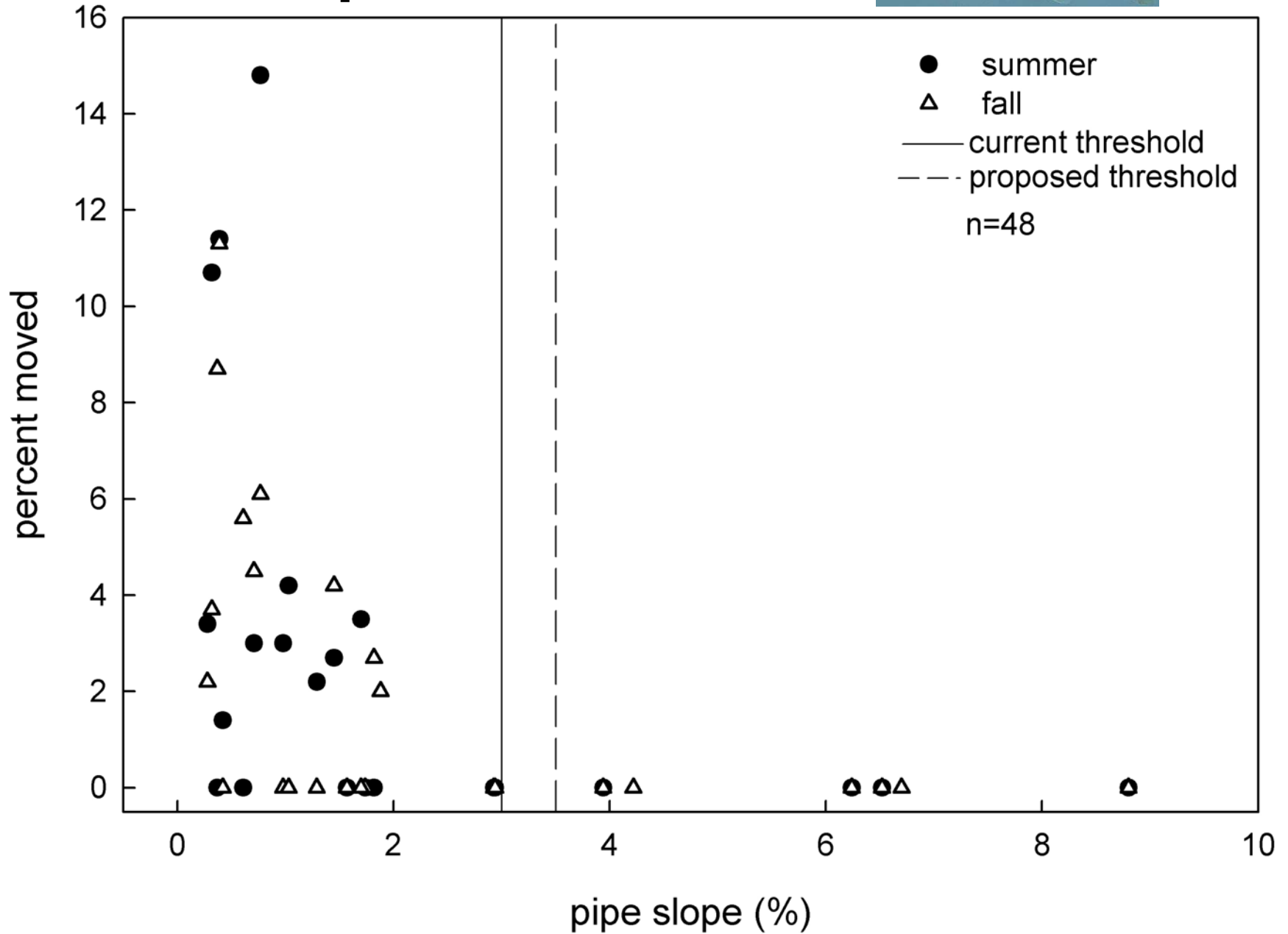
Predictive Model Development



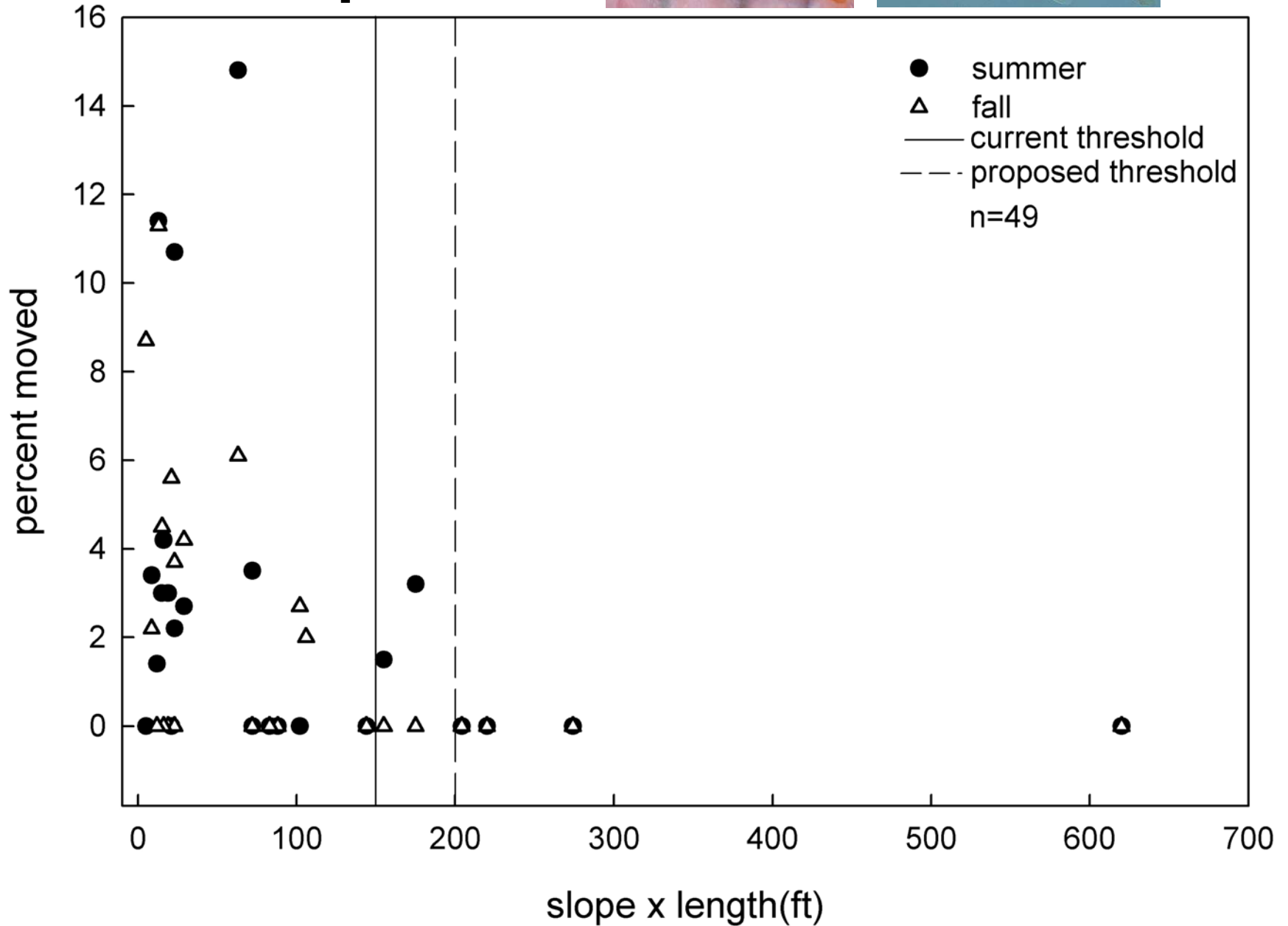
Group B



Group B



Group B



Pipe fully backwatered or 100% of pipe bottom covered by substrate



Yes

No

Drop

< 10 in

≥ 10 in

(8in)

Pipe Slope

< 3.5%

≥ 3.5%

(3.0%)

Slope x Length

≤ 25

> 25 & < 200

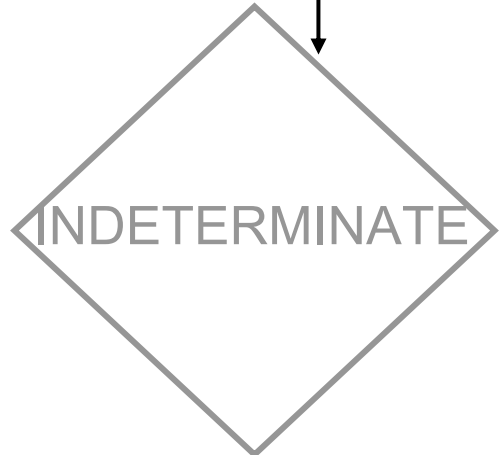
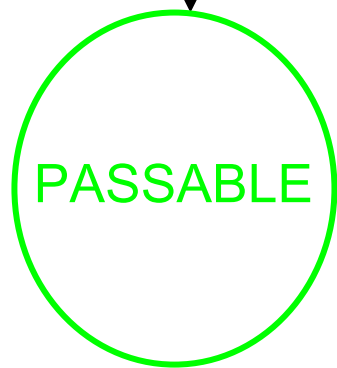
≥ 200

(150)

PASSABLE

INDETERMINATE

IMPASSABLE



Conclusions

Greatest fish movement occurred at culverts with:

- outlet drop < 4 inches
- culvert slope < 2.0%
- slope x length value < 82



Management Implications

Final models can be a tool for natural resource managers

Watershed prioritization

- Native species conservation
- Invasive species control



Acknowledgements

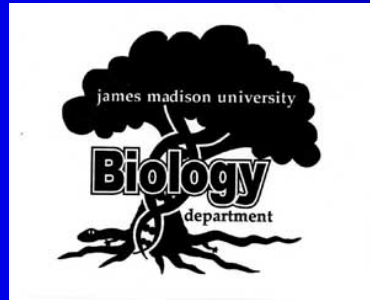


Fish & Aquatic
Ecology Unit

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Lee RD

Greenbrier RD



Committee:

Mr. M. Hudy

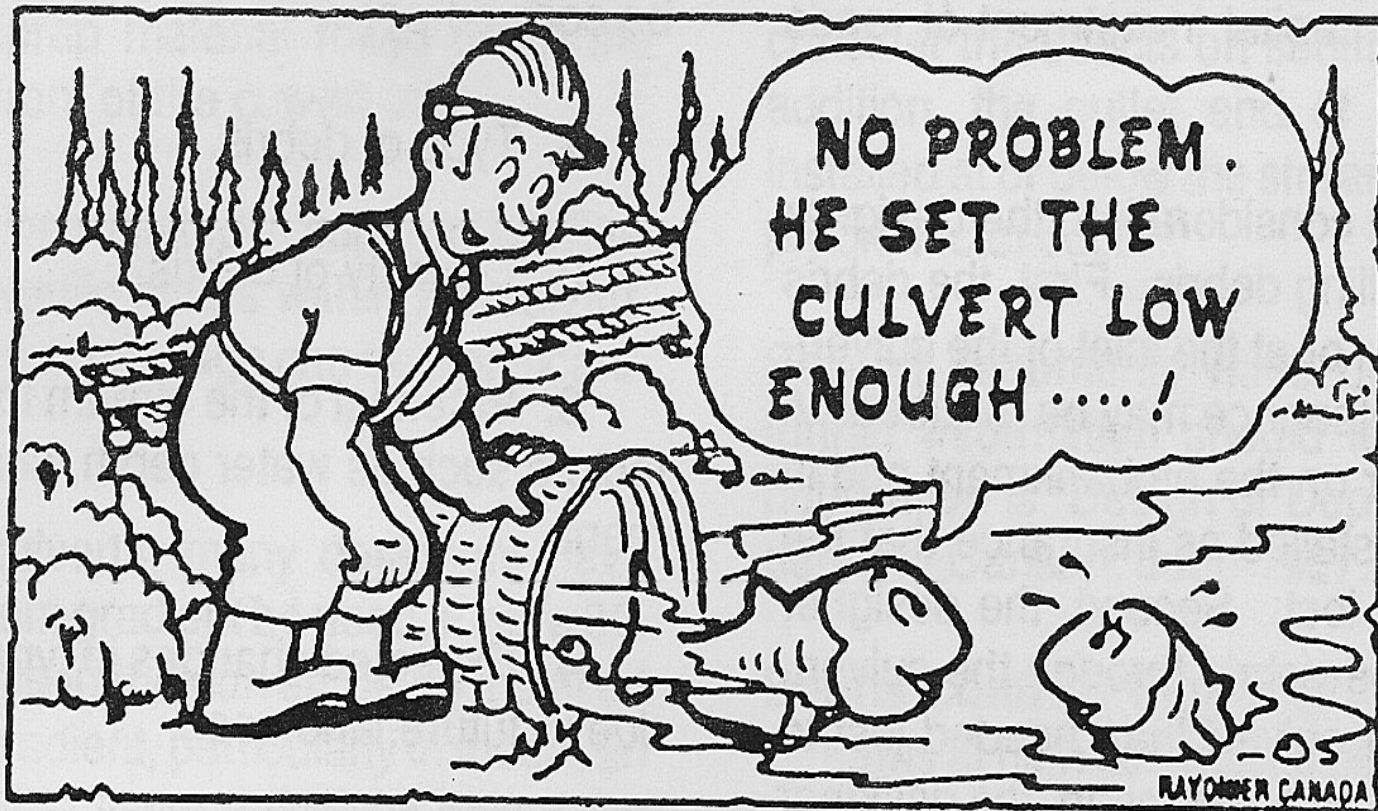
Dr. K. Simon

Dr. R. Harris



Field Crews:

Aaron, Allison,
Kyle, Jeremy, Arlis,
Paul, Tom



**CULVERTS MUST BE LAID
SO FISH MAKE THE GRADE**

Figure 33.