

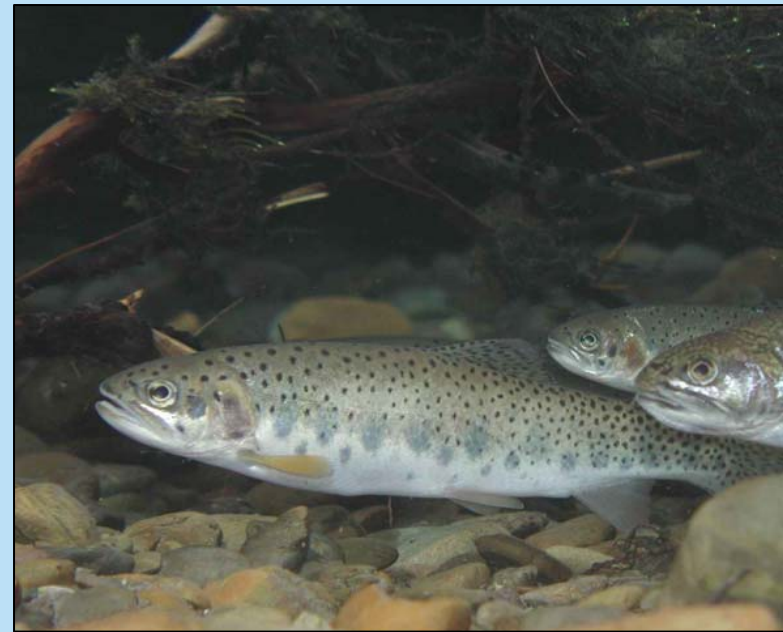
Transferability of models to predict selection of cover by coastal cutthroat trout in small streams in western Oregon, USA



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Who cares about cover?

- Least-known aspect of habitat in small streams
- Critical habitat need
- Refuge from disturbance
- Visual isolation from competitors
- Predator avoidance



What is cover?

- Habitat structure used by fish as shelter or refuge
- Often categorized as a **type** of structure
 - i.e. boulders, wood, undercut banks, etc...



Photo credit: McDowall 2006

Ask the fish...

Availability

Could a fish use it?

Use

Did a fish use it?

Selection

Use : Availability



Photo credit: J. Dunham 2006

(Johnson 1980; Manly et al. 2002)

Objectives

1. Describe characteristics of cover used by coastal cutthroat trout
2. Compare used cover and available habitat (i.e. selection) using logistic regression
3. Examine transferability of model predictions across streams

Focal Species

- Coastal cutthroat trout (*Oncorhynchus clarkii clarkii*) >100mm



Photo credit: D. Leer

Study Streams

Trask River Basin

Gus Creek

Pothole Creek

Rock Creek

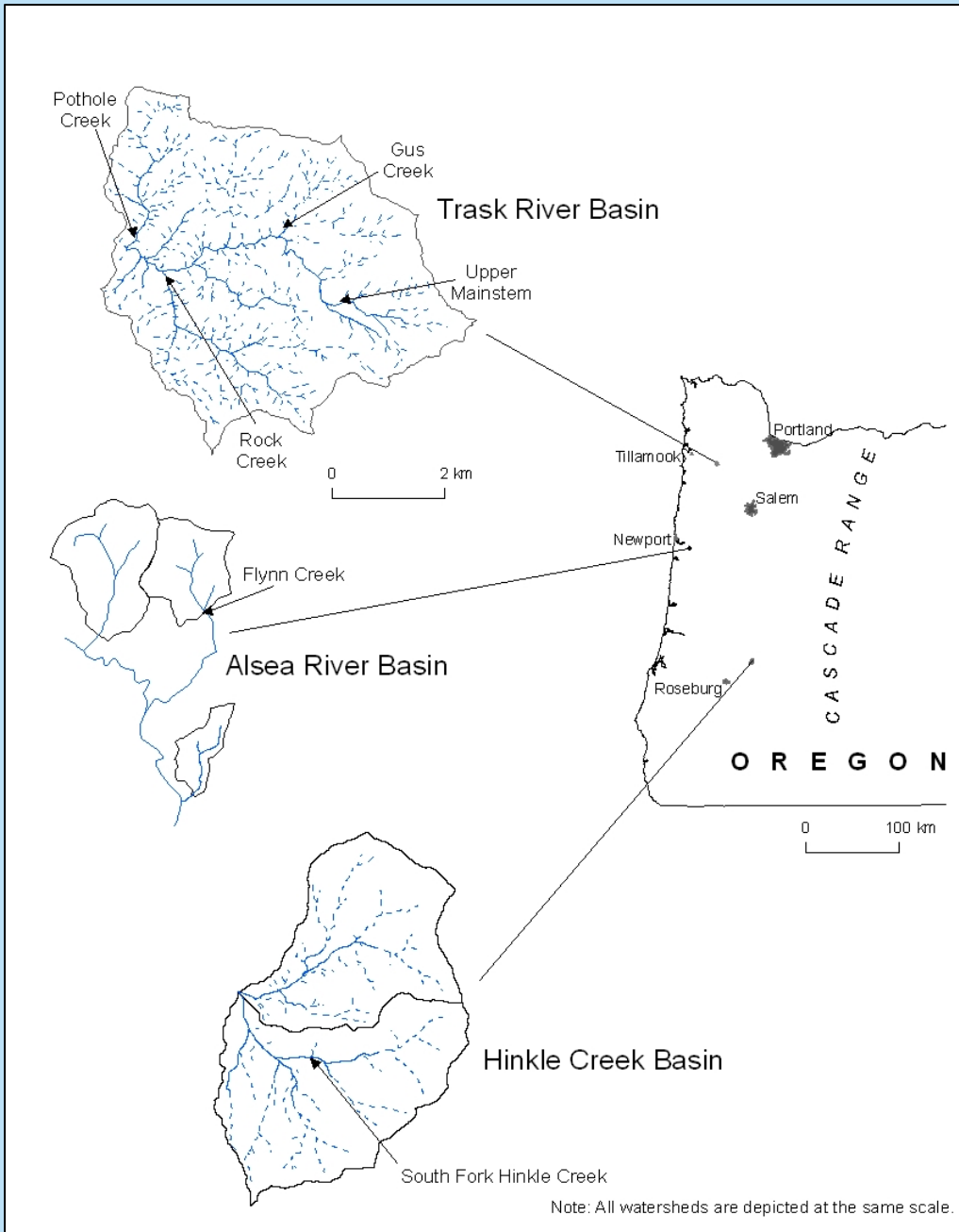
Upper Mainstem

Alsea River Basin

Flynn Creek

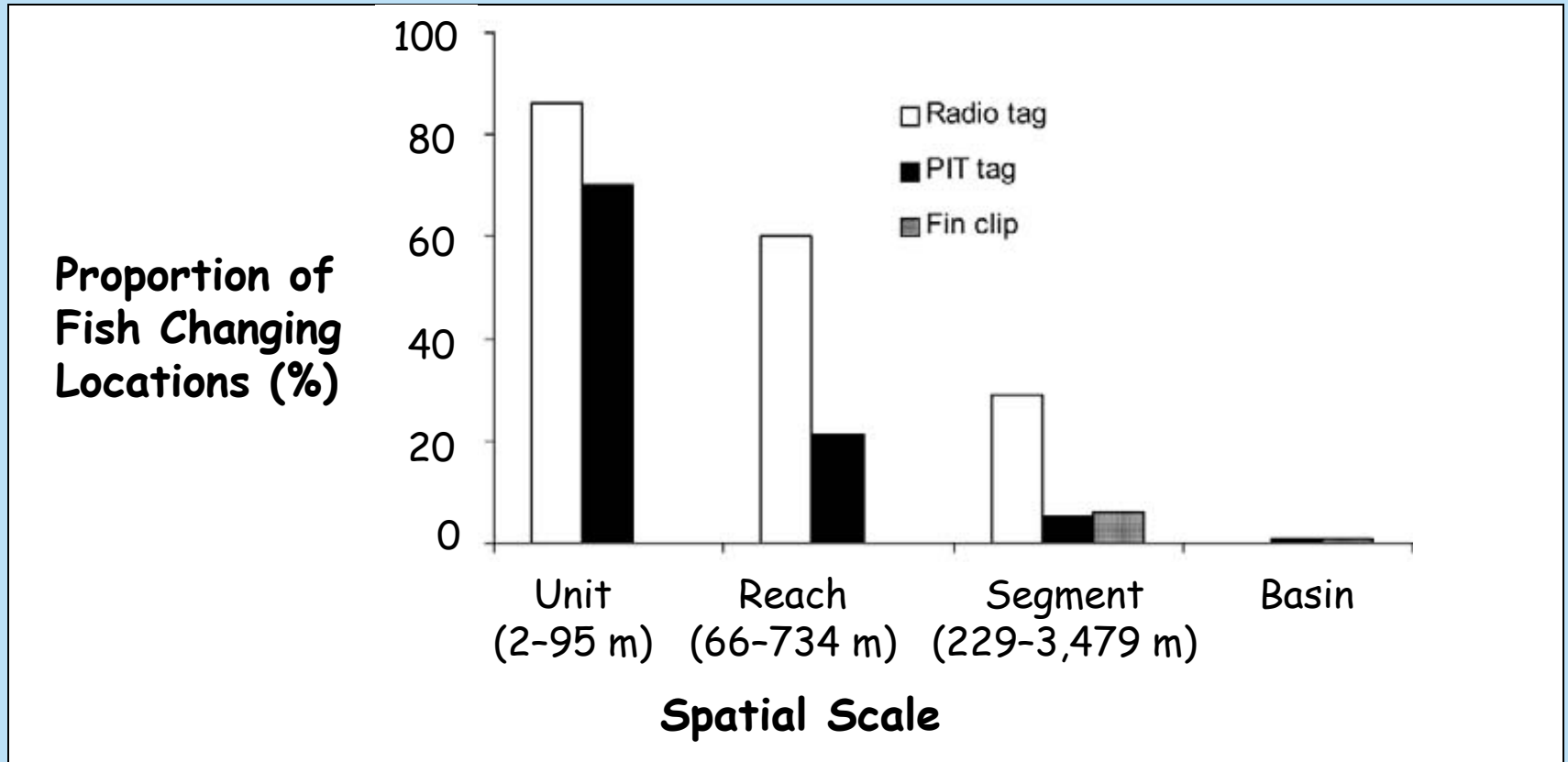
Hinkle Creek Basin

South Fork Hinkle



Spatial Scale

- 200-500 m reaches
- Based on summer movement patterns
- Number of fish detections

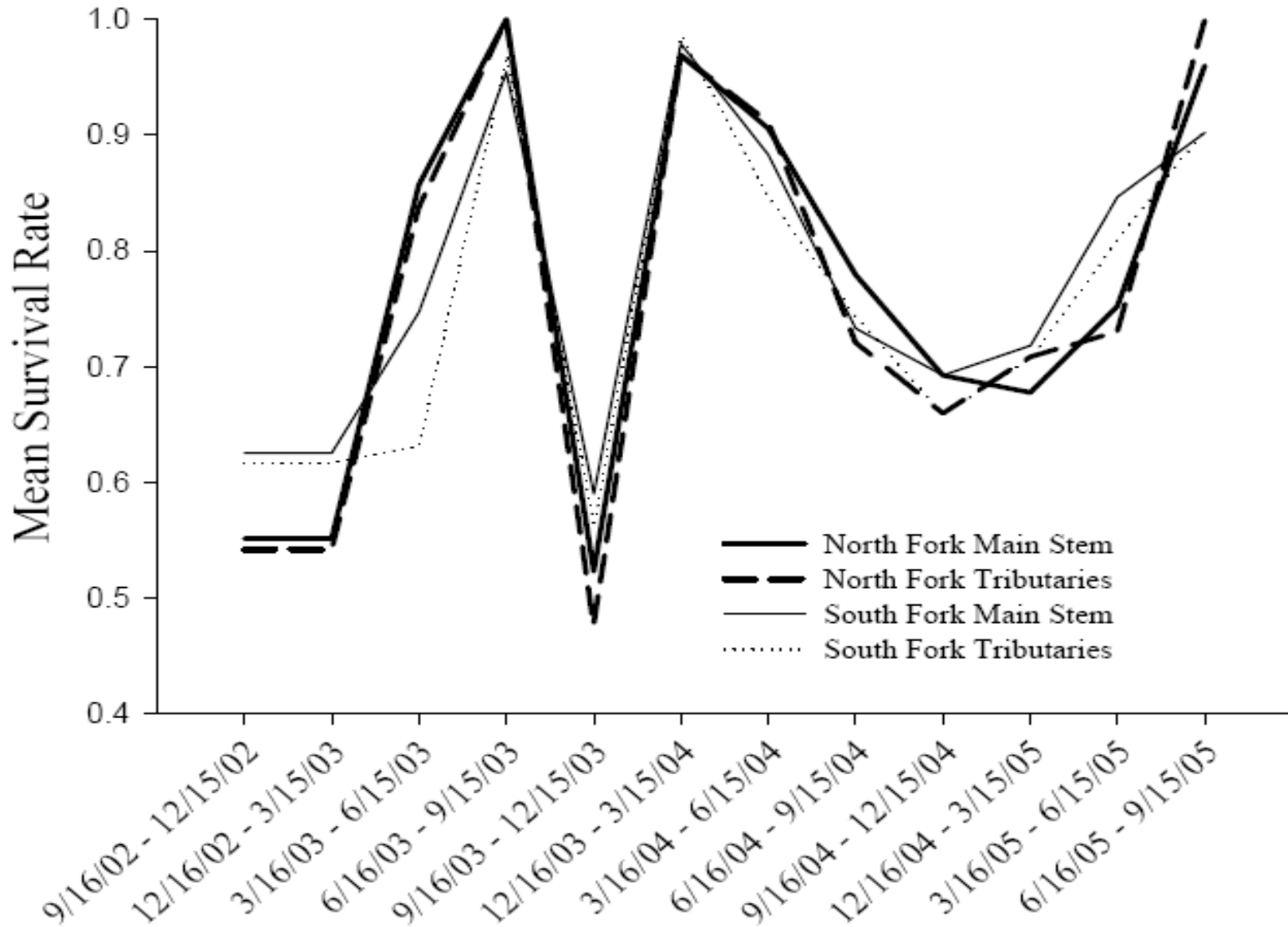


Study Period

- Summer low flow
- August 1- September 15
 - Cover is most limiting
 - Critical period for survival
 - Large fish vulnerable to predators



Survival decreased during the summer low flow period in the Hinkle Creek Basin



Overview of Methods

Capture/tag/release fish

Detections of fish using cover

Randomly available habitat

Data Analysis

Objective 1 -

Used cover

- Descriptive statistics
- Wilcoxon rank sum tests

Objective 2 -

Selection

- Spearman rank correlation
- Logistic Regression

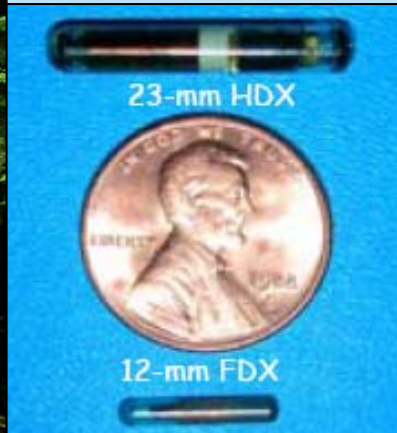
Objective 3 -

Transferability

- Cross validation
- Cohen's kappa statistic
- ROC curves

Captured, tagged and released fish

- Coastal cutthroat trout $>100\text{mm}$
- 23mm half-duplex PIT tags



Relocated fish with mobile antennae

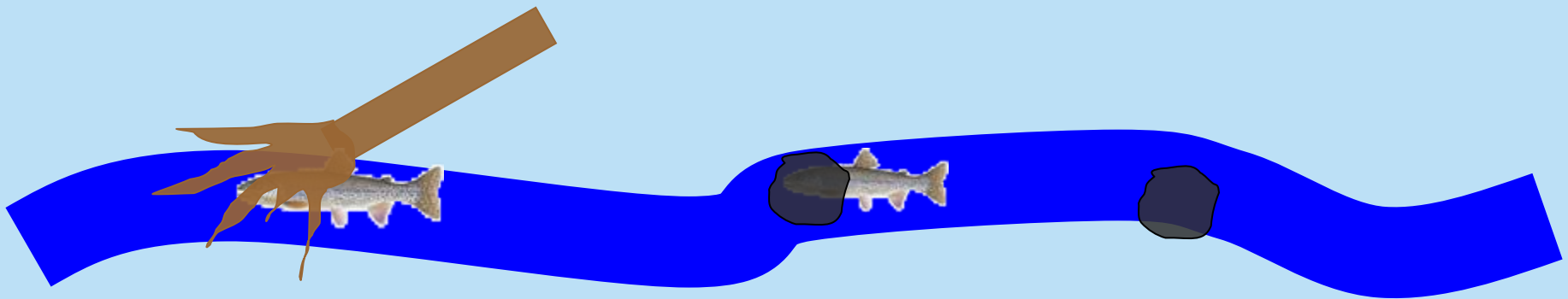


- Two mobile antennae
- Detection radius
 - 0.5m
 - 10cm



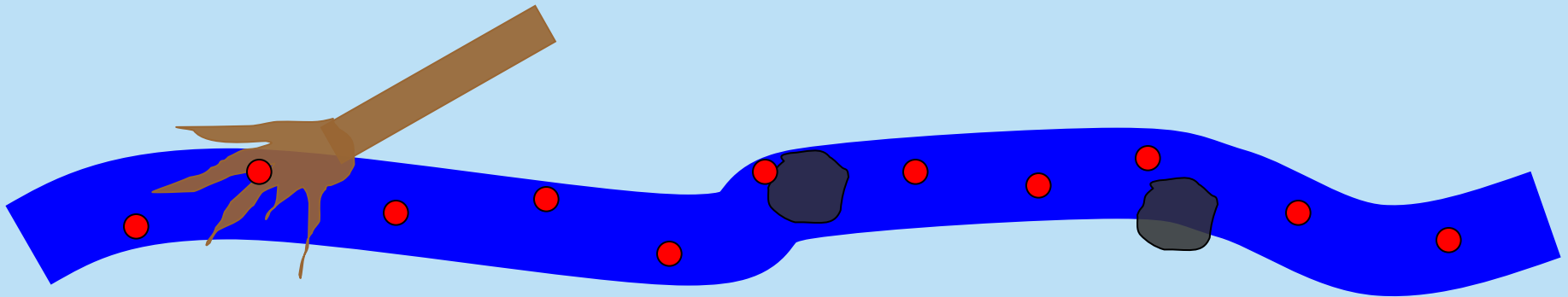
For fish using cover

- Measured characteristics of used cover
 - Depth, surface area, b-axis of boulders/cobble/gravel, proximity to depth >20cm, type of cover



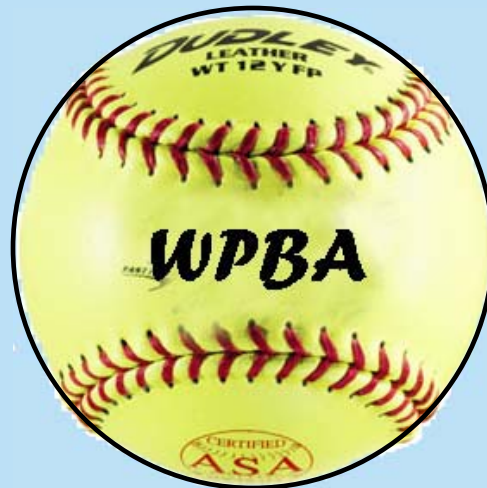
Available Habitat

- Measure characteristics of available habitat
 - Random point every 2m in each stream
 - Used the same measurements as those recorded for used cover



More on available habitat...

- Classified all available points as a cover type
- Some points were not large enough to conceal a 100mm fish
- Classified these points as "not cover"



Sample Sizes

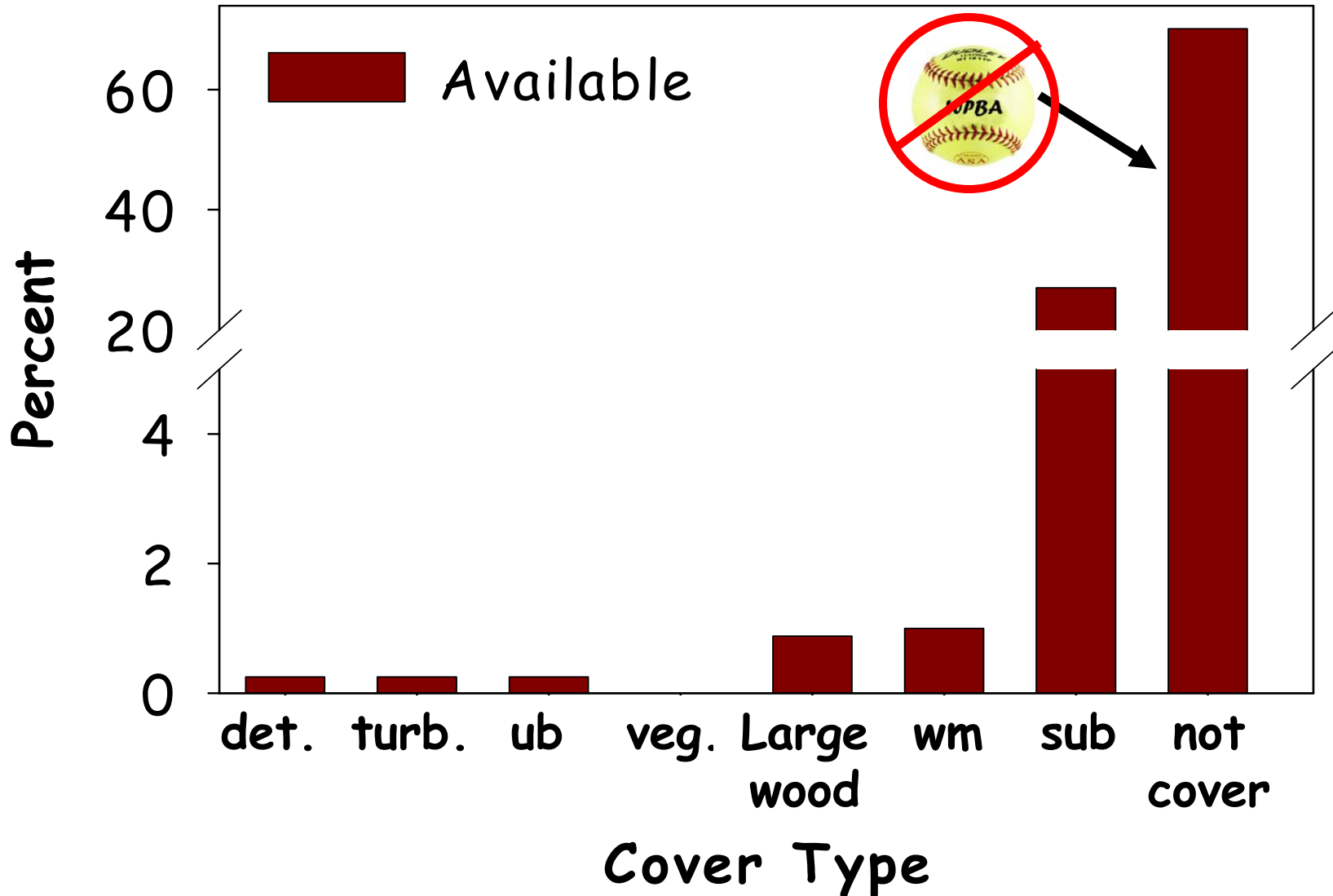
- PIT Tagged 1036 cutthroat trout
 - Mean fork length 121 ± 20
- Collected habitat characteristics for:
 - **285** fish using cover
 - **797** randomly available habitat points



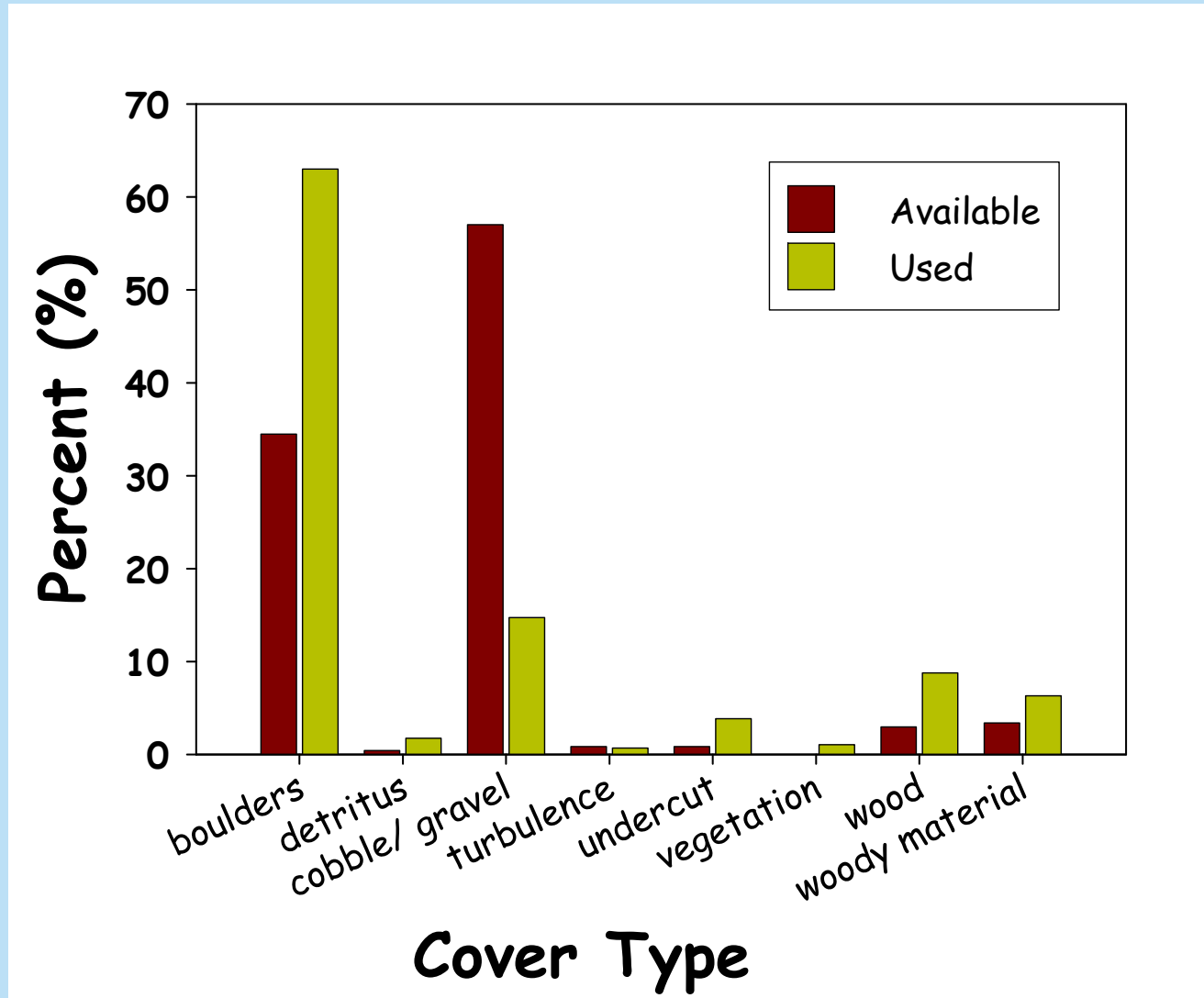
Objectives

1. Describe characteristics of cover used by coastal cutthroat trout
 - Descriptive statistics
 - Wilcoxon rank sum test

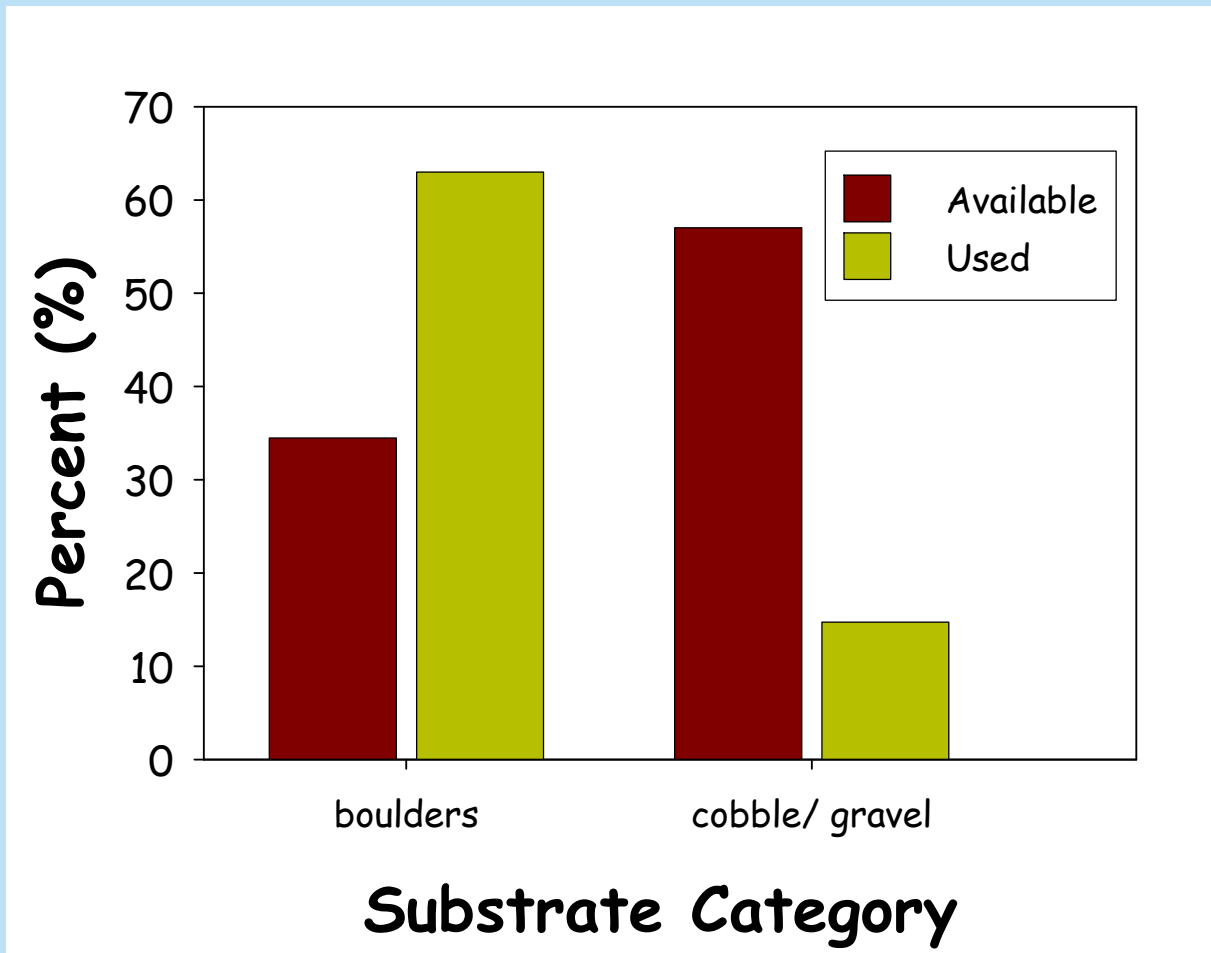
Available cover was rare



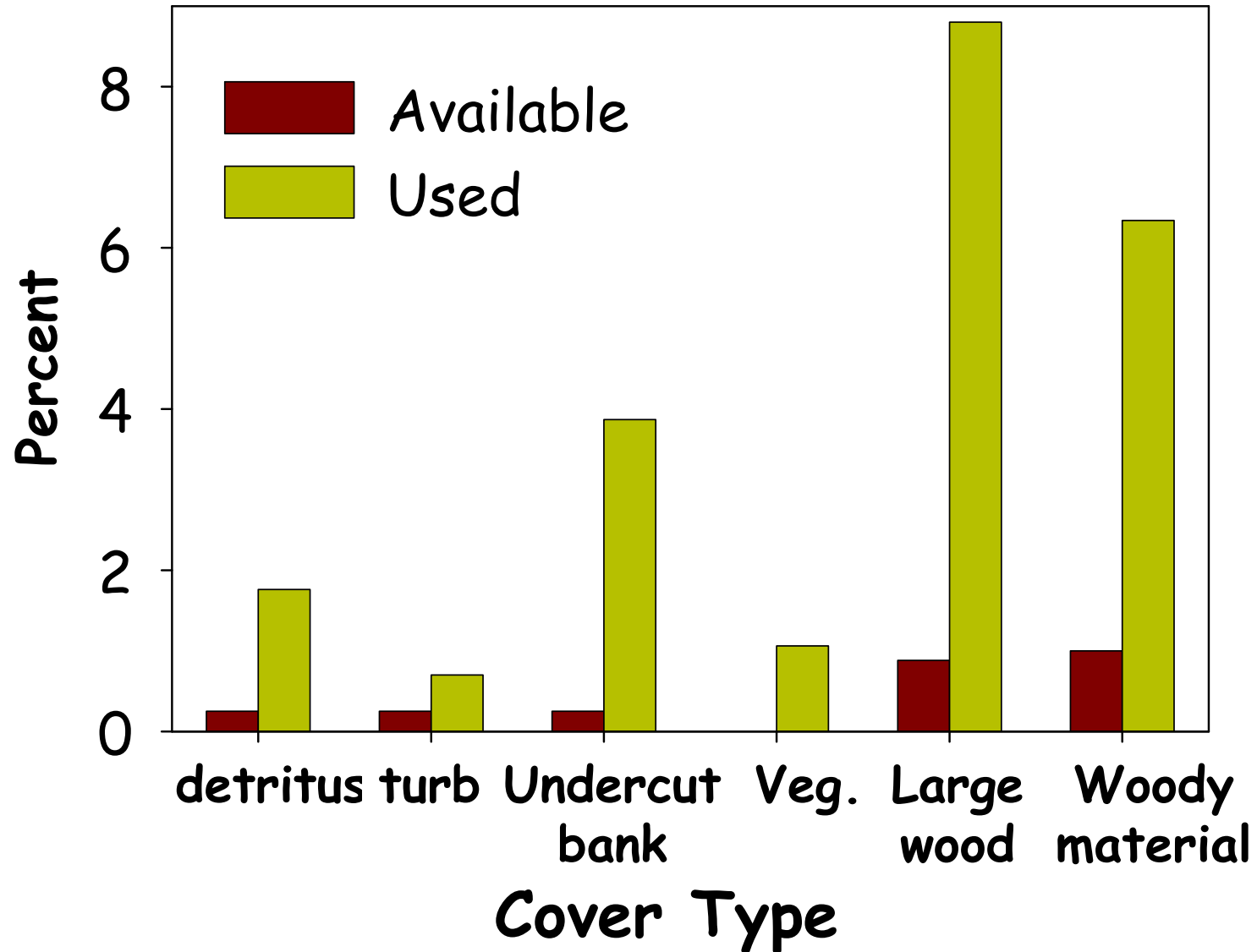
Substrate was the dominant cover type used by fish



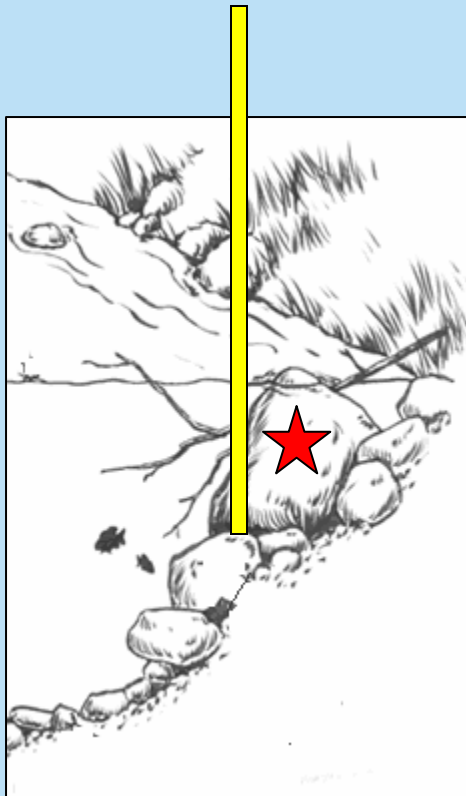
Boulders were used more often than cobble/gravel



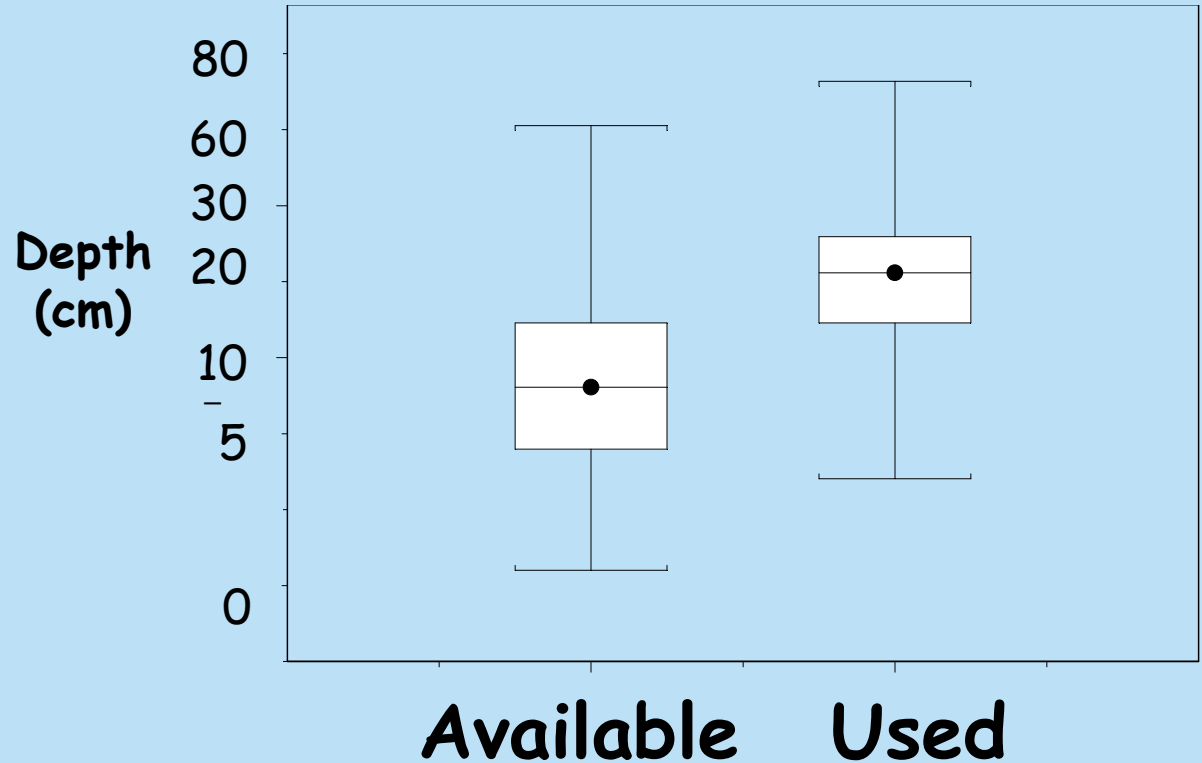
Other cover types were rare



Depth (cm)

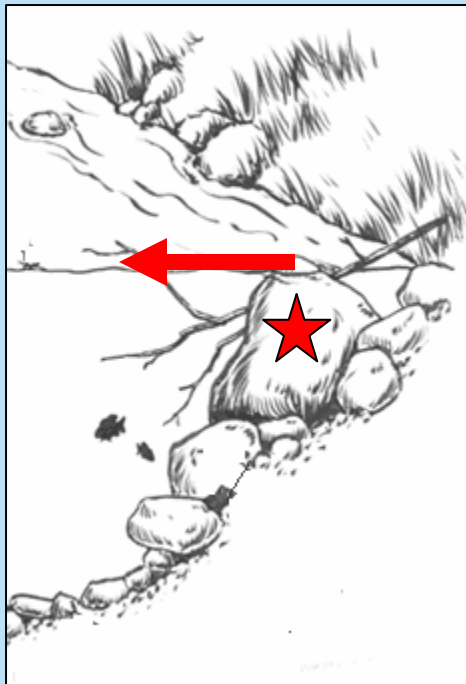


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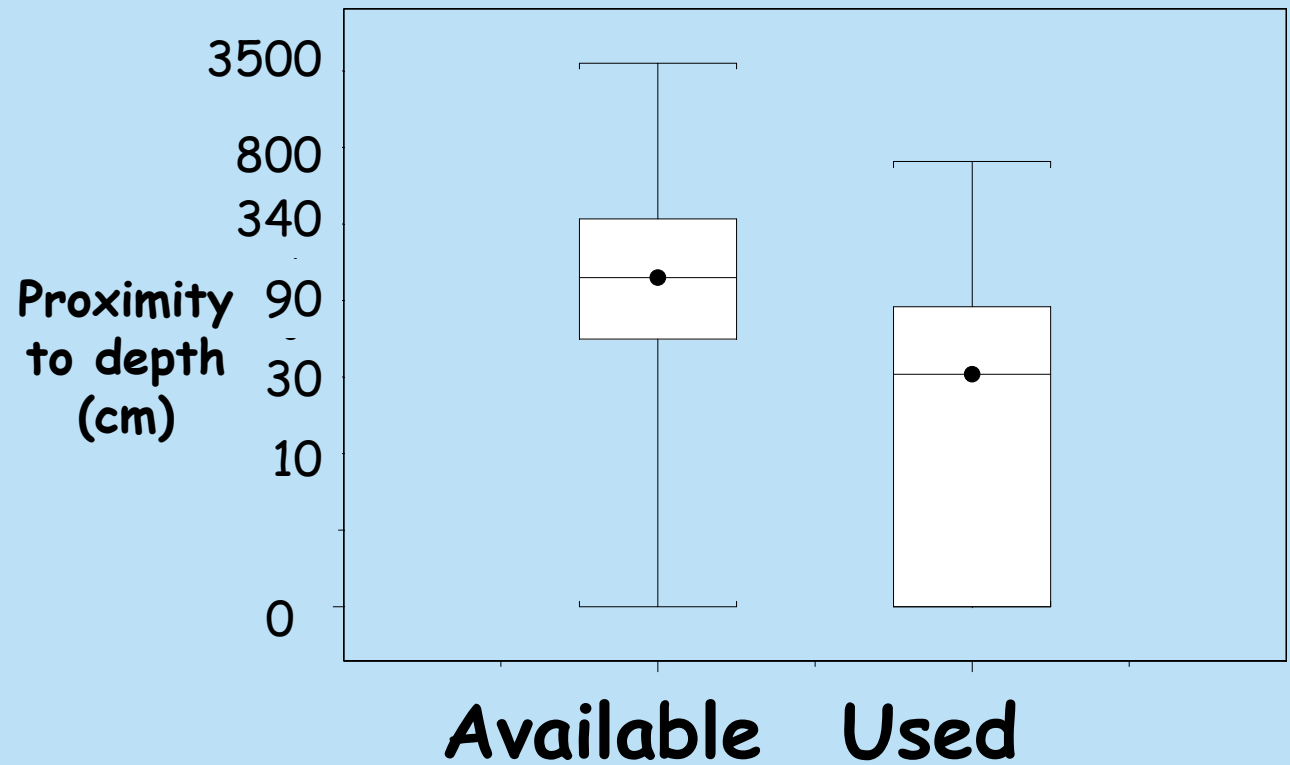


Wilcoxon t-test P-value <.0001

Proximity to depth of 20cm

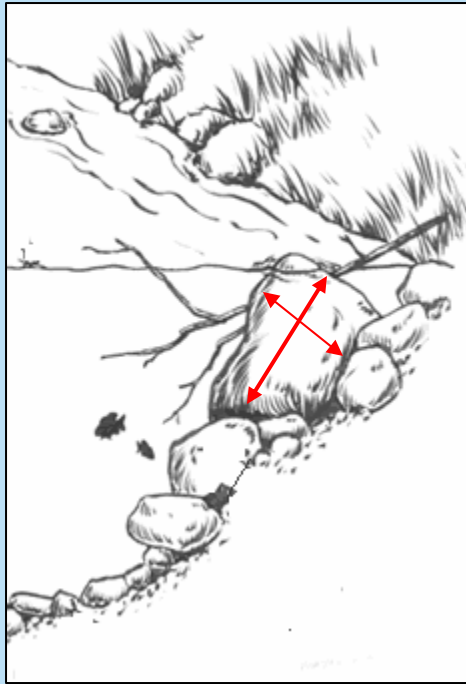


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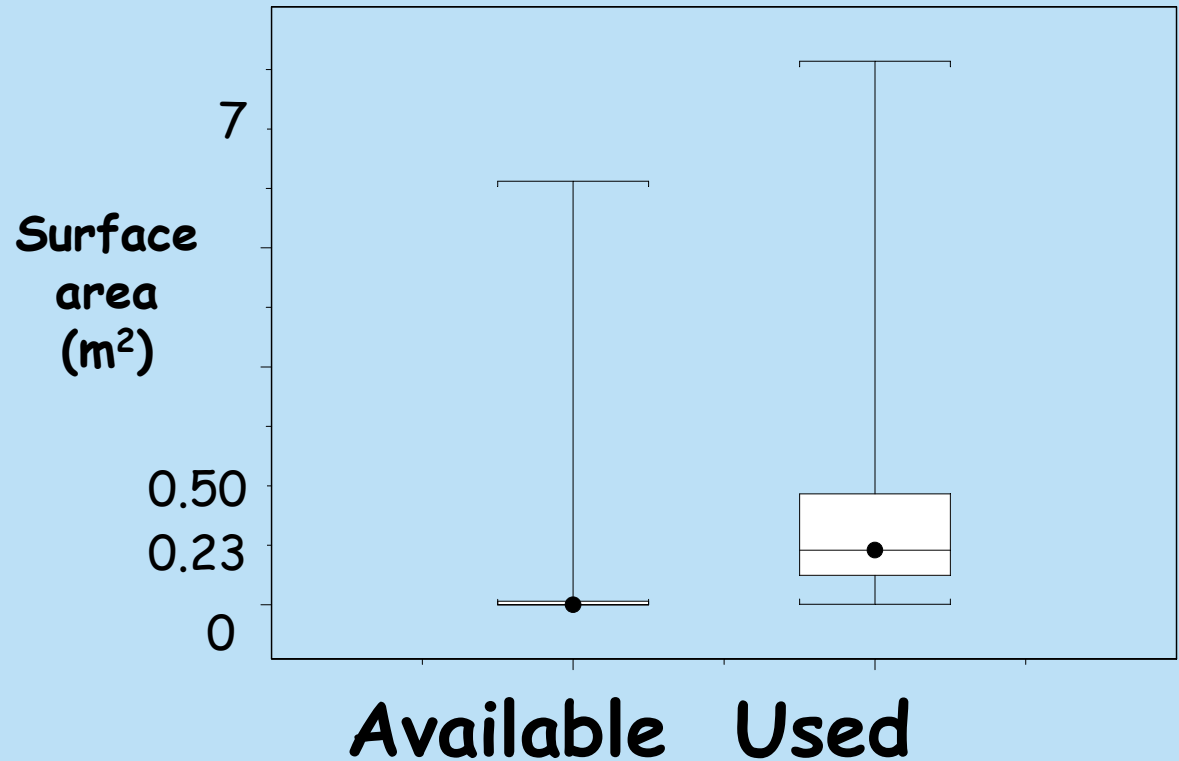


Wilcoxon t-test P-value <.0001

Surface area of cover (m²)

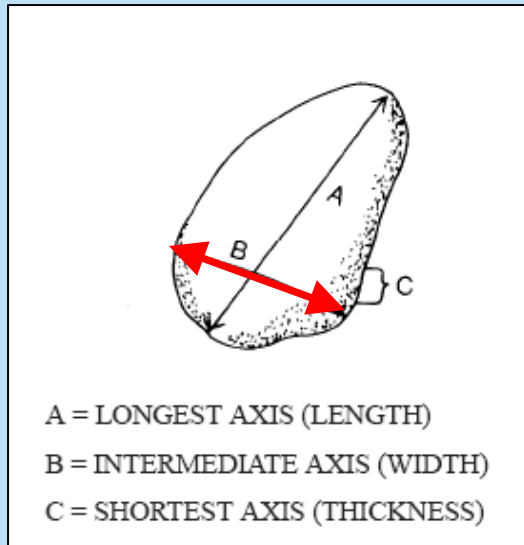


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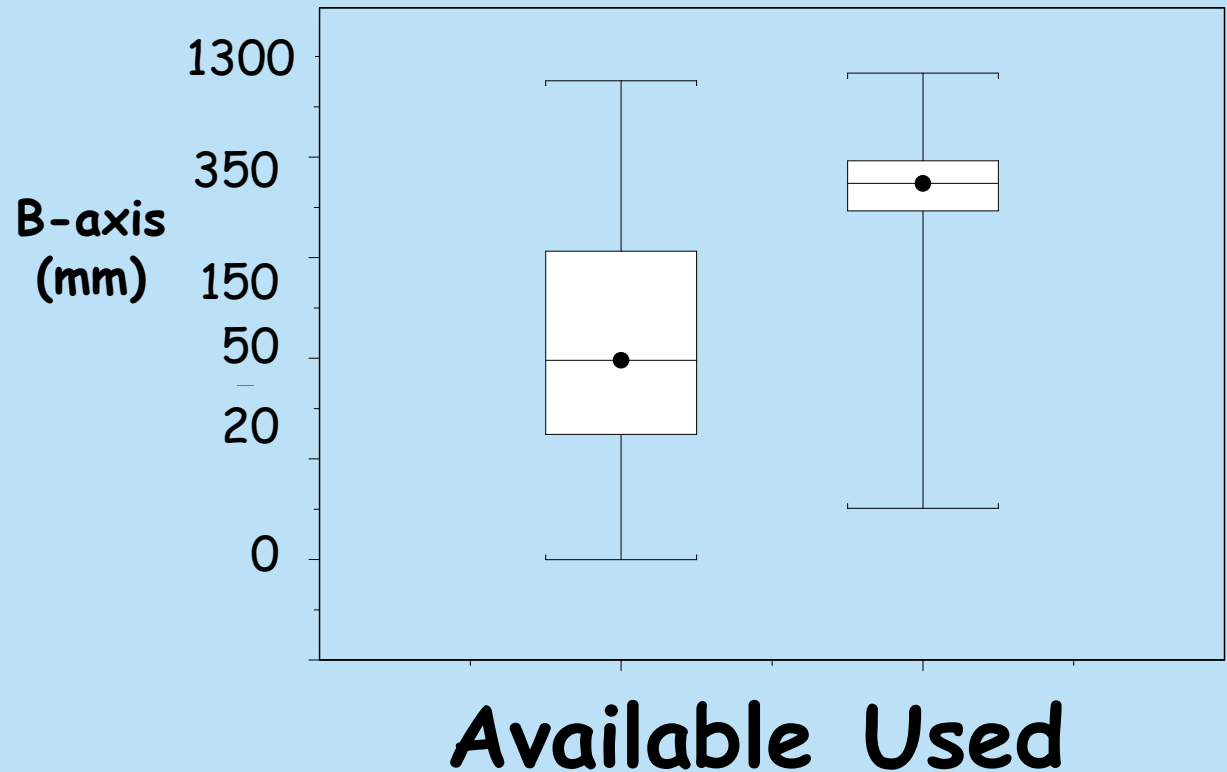


Wilcoxon t-test P-value <.0001

B-axis of substrate particles (mm)



Harrelson et. al. 1994



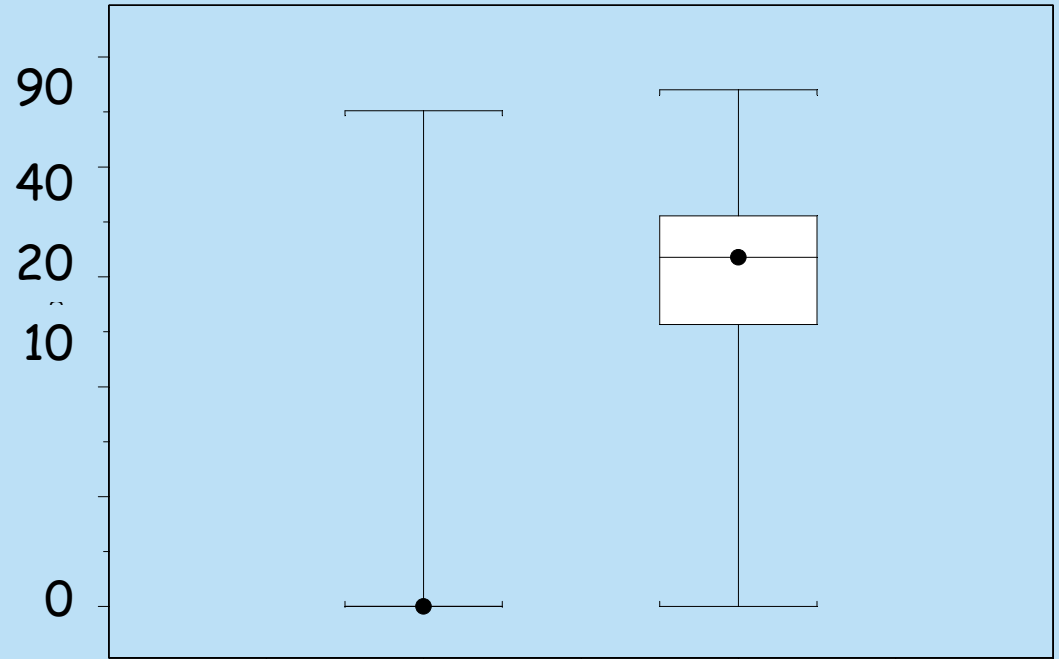
Wilcoxon t-test P-value <.0001

Distance under substrate (cm)



www.mostreamteam.org

Distance
under
boulder
(cm)



Available Used

Wilcoxon t-test P-value <.0001

Take home message...

- Substrate was the dominant cover type
- All other cover types were rare
- Used cover and available habitat were different

Objectives

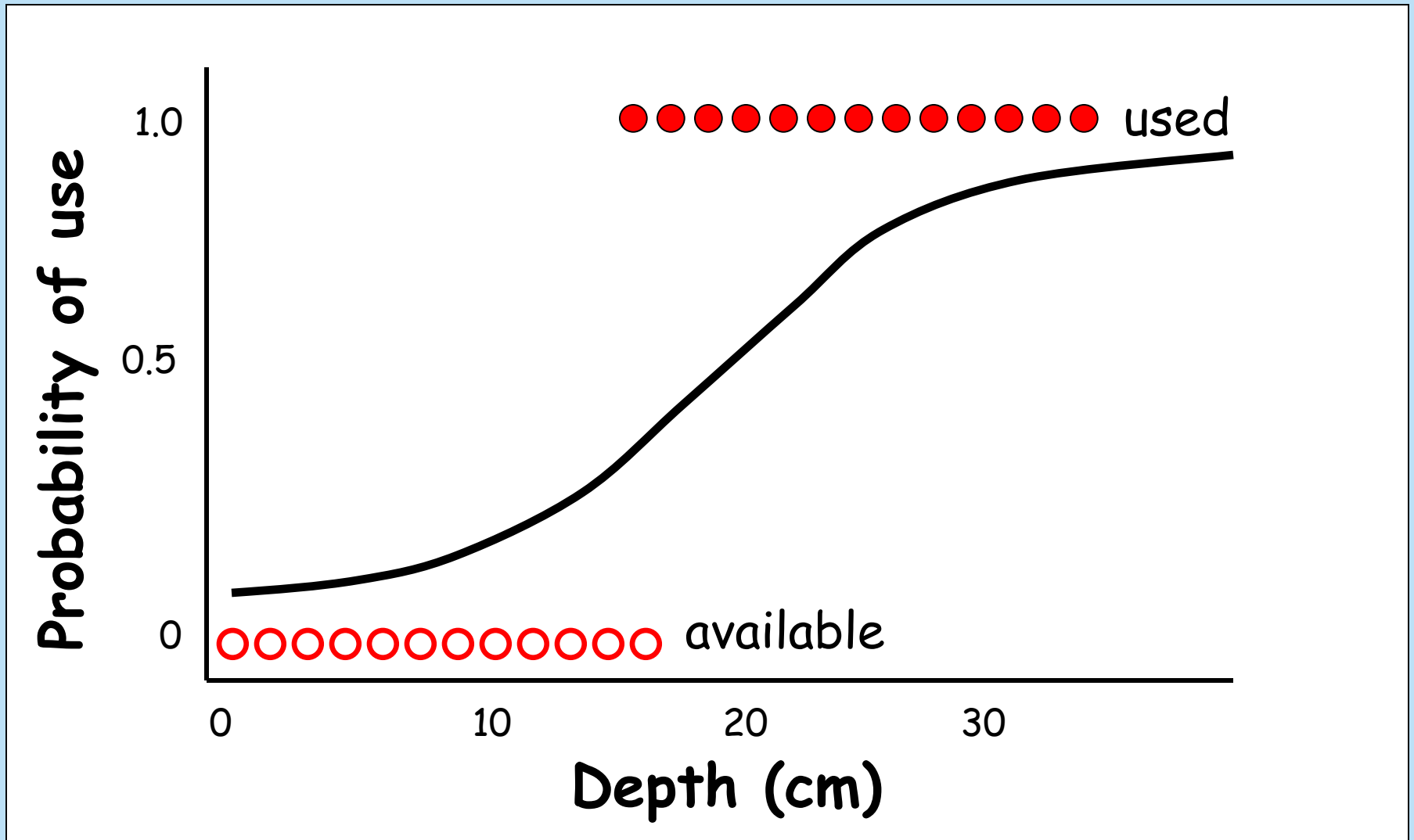
2. Compare used cover and available habitat (i.e. selection) using logistic regression

Manly et al 2002 -Design II

- Used information is collected for known individuals
- Available habitat is collected for the population of the target species in the study area

Logistic Regression -

a model to predict the probability of use



Logistic regression model for all streams

Probability of use =
depth + surface area - (depth*surface area)

Variable	Estimated Coefficient (β)	SE	Wald chi-square	p-value
Intercept	-7.79	0.84	85.33	<0.0001
Log (surface area of cover)	6.41	1.79	12.85	0.0003
Log (depth)	2.97	0.32	84.88	<0.0001
Log (depth) x log (surface area)	-1.82	0.64	8.12	0.004

Take home message...

- Probability of use increased with bigger cover
- Probability of use increased with deeper water
- Surface area of cover was larger when depth was shallow

Objectives

3. Examine transferability of model predictions across streams

Transferability

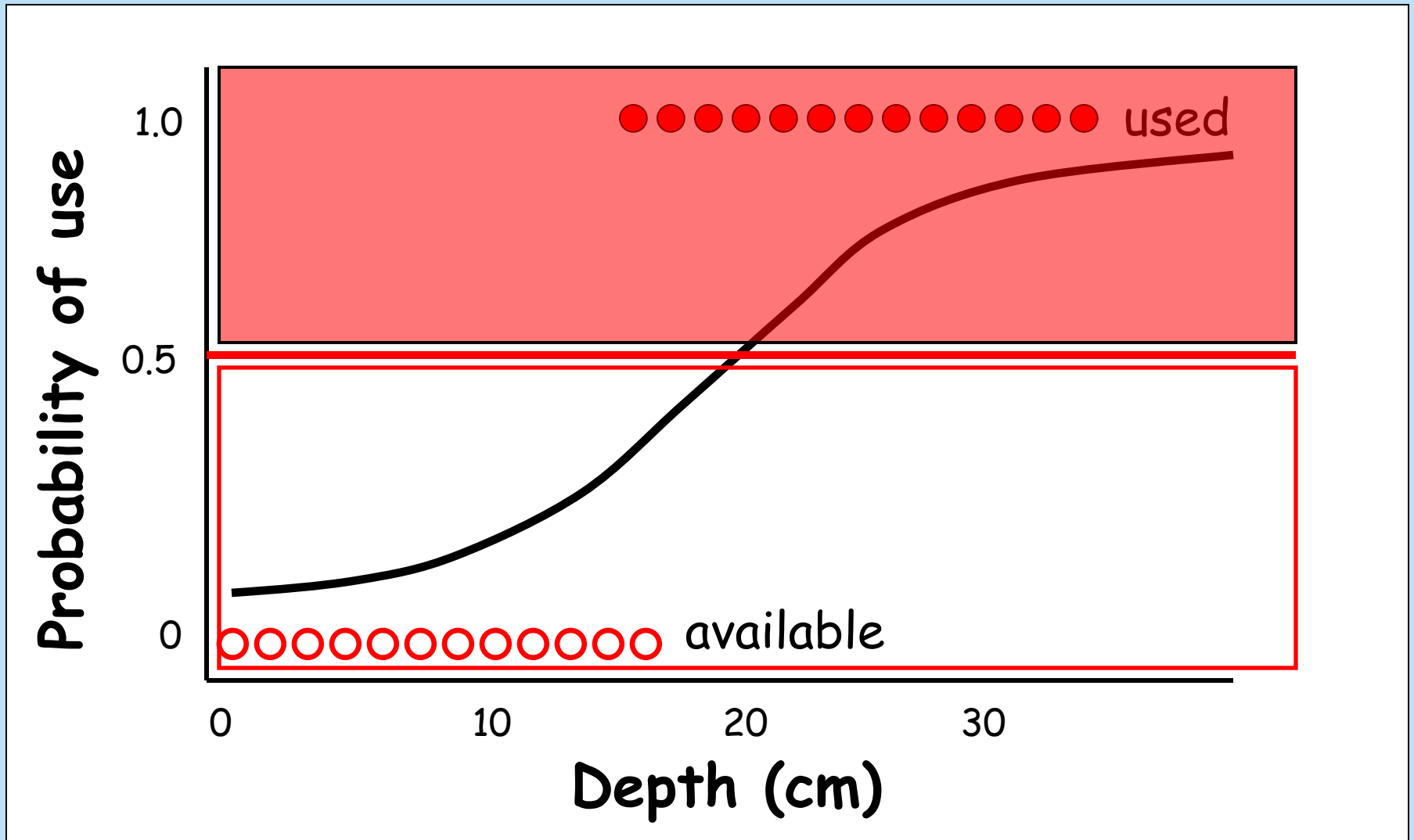
- Ability of a model to accurately predict independent events across locations



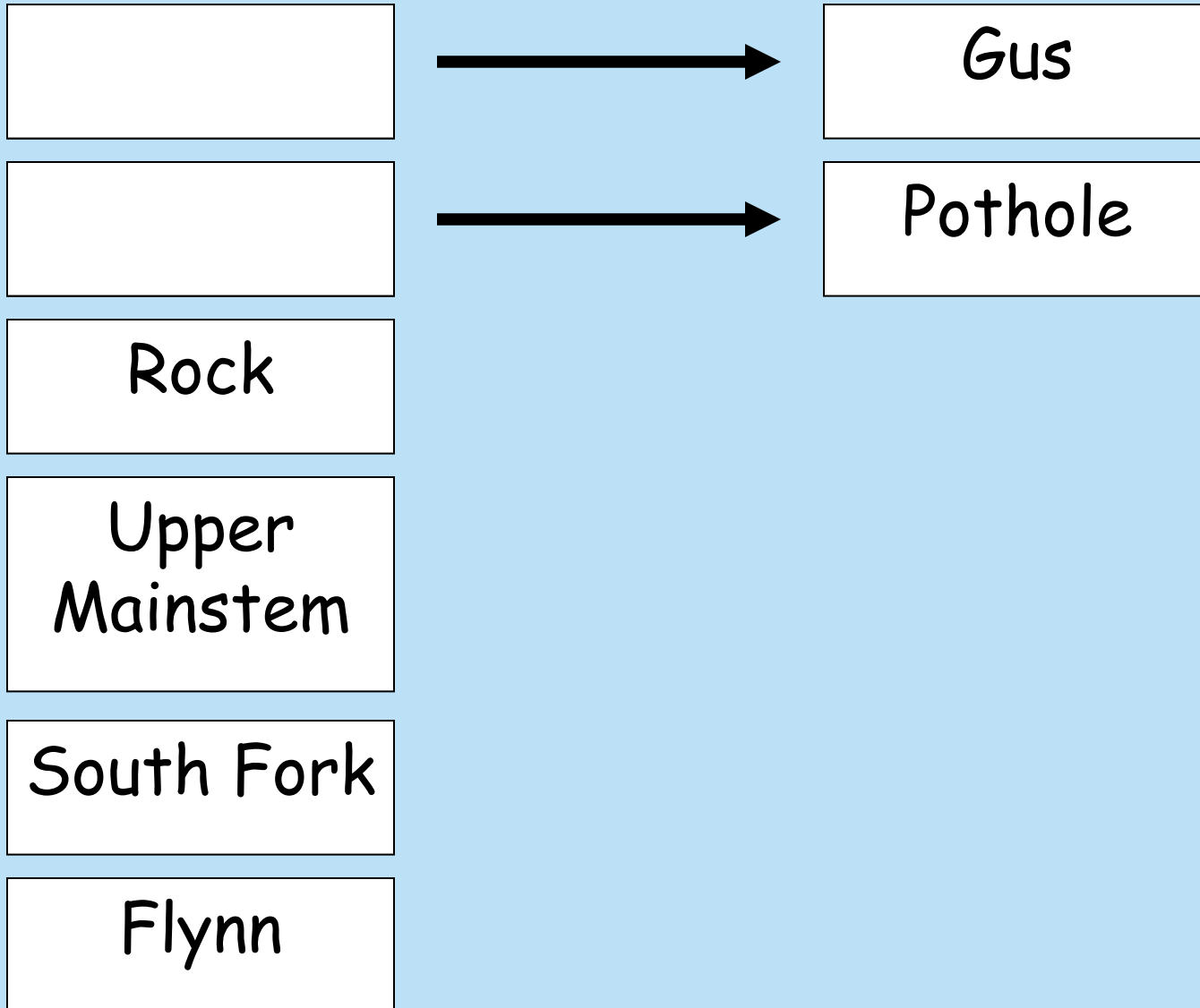
Methods to analyze transferability

1. Cross validation
 - Based on a user specified threshold
2. Cohen's kappa statistic
 - Based on an optimal threshold
3. Receiver operator characteristic curves (ROC)
 - Threshold independent

What is a threshold?



Cross Validation



Model Transferability

Method	Range of values
Cross validation	77% to 80%
Cohen's kappa	0.58 to 0.60
Receiver operator characteristic curves	0.84 to 0.86

Cohen's kappa values from 0.4 to 0.75 = good transferability

ROC values ≥ 0.8 = good transferability

Take home message...

- Regardless of the statistical method, our models transferred well across six streams in three different watersheds
- The models transferred well despite major differences in biotic and abiotic characteristics of the streams

What did we learn?

- Cover was rare in our streams
- Substrate was the dominant cover type used by coastal cutthroat trout
- Used cover and available habitat characteristics were different
- Depth, surface area, their interaction were significant predictors of cover use
- Our models transferred well across 6 streams in 3 different watersheds

Implications

- Improved understanding of habitat requirements for coastal cutthroat trout
- Measure of cover for headwater streams
- Method for examining impacts of land management practices and restoration on habitat in headwater streams

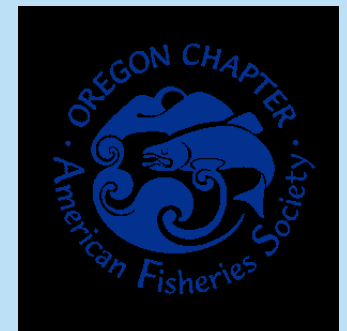
Future study

- Mechanisms of cover use
 - Predation
 - Competition
 - Velocity refuge
- Impact of cover on survival
 - Evasion vs. concealment
- Different seasons, sizes of fish



Funding

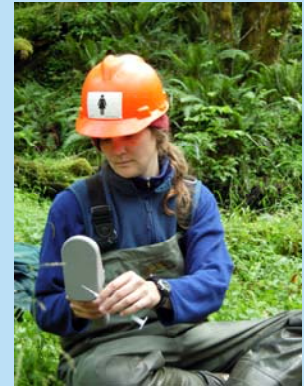
- OSU Forest Research Laboratory - College of Forestry
 - Fish and Wildlife Habitat in Managed Forests Research Program
- OSU Department of Fisheries and Wildlife
- OSU Department of Biology
- USGS - Forest Rangeland and Ecosystem Science Center
- USDA Forest Service - Olympic National Forest
- Oregon Chapter - American Fisheries Society
- Washington County Fly Fishers
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Contamination

