FACULTY OF BIOSCIENCE ENGINEERING

DEPARTMENT OF ANIMAL SCIENCES
AQUATIC ECOLOGY

IDENTIFYING HYDRAULIC PREFERENCES OF RIVERINE FISH, USING FINE-SCALE FISH TRACKS AND HYDRAULIC DATA

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RESEARCH INSTITUTE NATURE AND FOREST

RIBES

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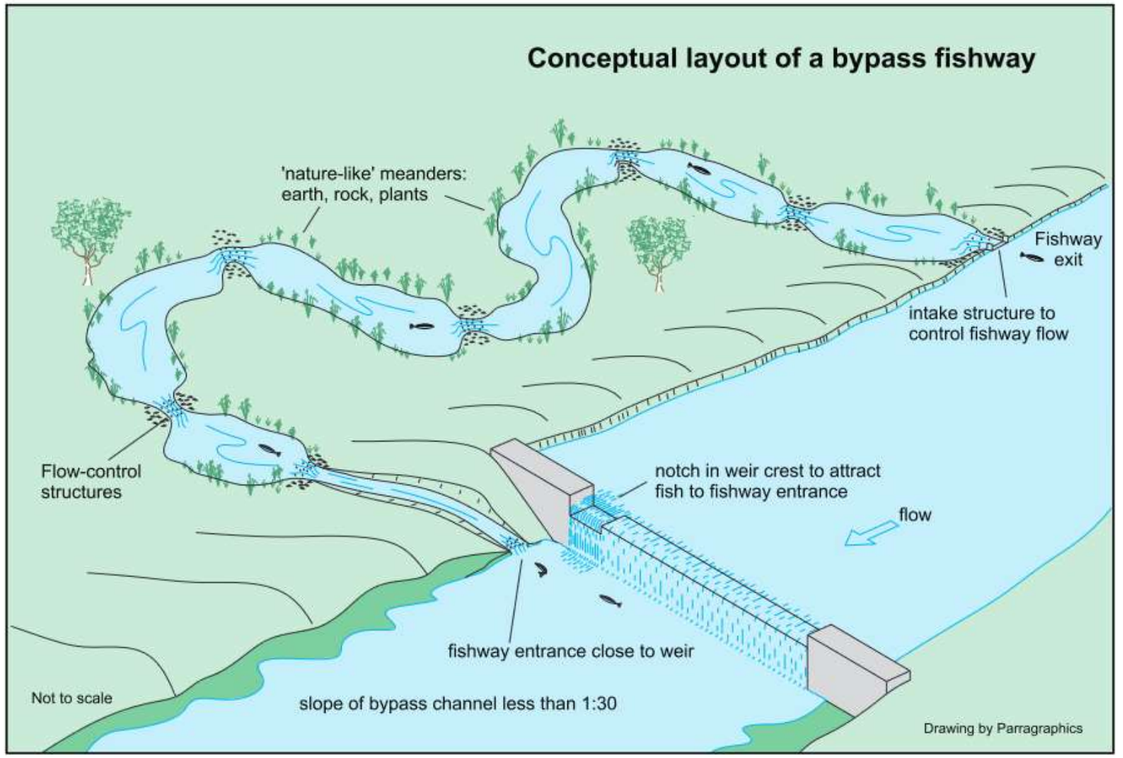
BACKGROUND

Increase in river barriers -> hinders fish migration

Rotselaar mill, Belgium

Altusried hydropower plant, Germany

Big decline in freshwater fish populations
→ fish passes as a solution
- not always great



source: Thorncraft and Harris (2000)

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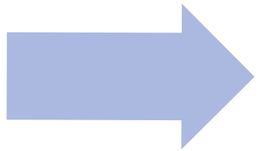
BACKGROUND

Understand fish behaviour



Better fish passage

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BACKGROUND

Are there habitat parameters and values fish prefer?

– Habitat = collection of environmental parameters describing a point in space (Aarts et al., 2008; Beyer et al., 2010)

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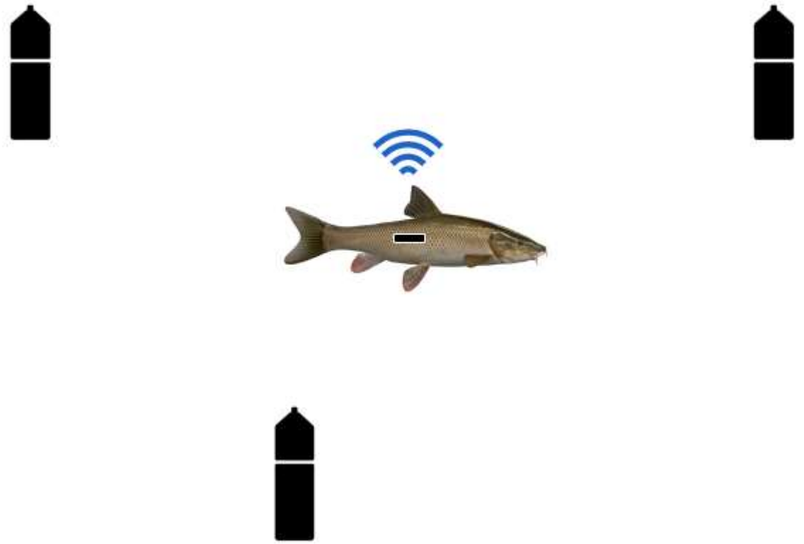
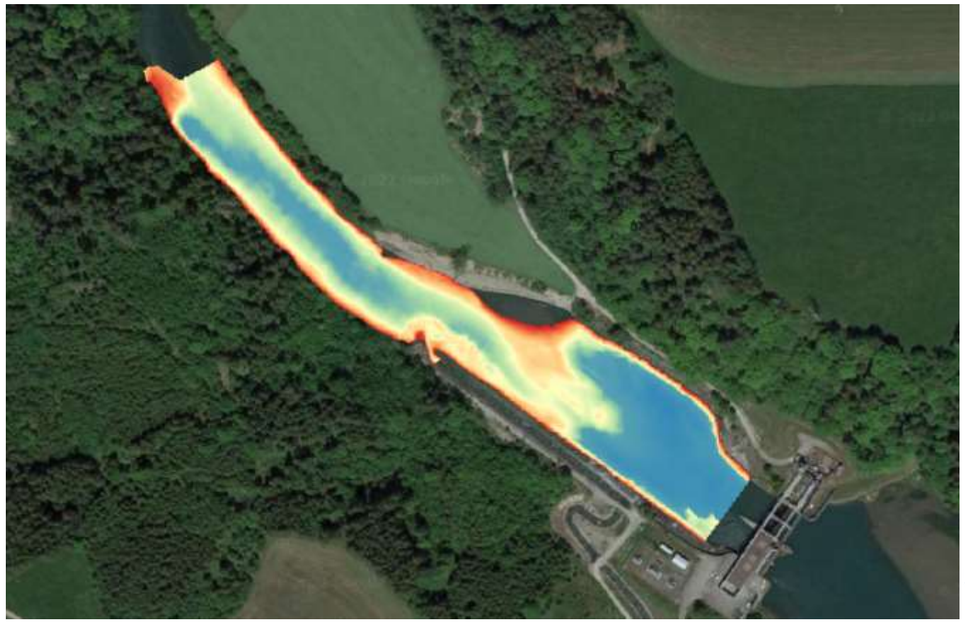
HABITAT PREFERENCE - DATA

- Fish positions
  - Via 2D acoustic telemetry
- Habitat data
  - Hydraulic models -> hydraulic parameters
  - Substrate
  - Vegetation/vegetation cover
  - Temperature





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HABITAT PREFERENCE

- “disproportionate usage of habitat relative to availability”

$$\text{Preference} \sim \frac{\text{Usage}}{\text{Availability}}$$

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HABITAT PREFERENCE

Habitat values
at fish positions

$$\text{Preference} \sim \frac{\text{Usage}}{\text{Availability}}$$

?

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HABITAT PREFERENCE: TOOLS

- Resource selection function (RSF)
- Step selection function (SSF)

Habitat values
at fish positions

$$\text{Preference} \sim \frac{\text{Usage}}{\text{Availability}}$$

?

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HABITAT PREFERENCE: TOOLS

- Resource selection function (RSF)
- Step selection function (SSF)

Habitat values
at fish positions

$$\text{Preference} \sim \frac{\text{Usage}}{\text{Availability}}$$

?

- Sample points in space to provide a measure of habitat availability

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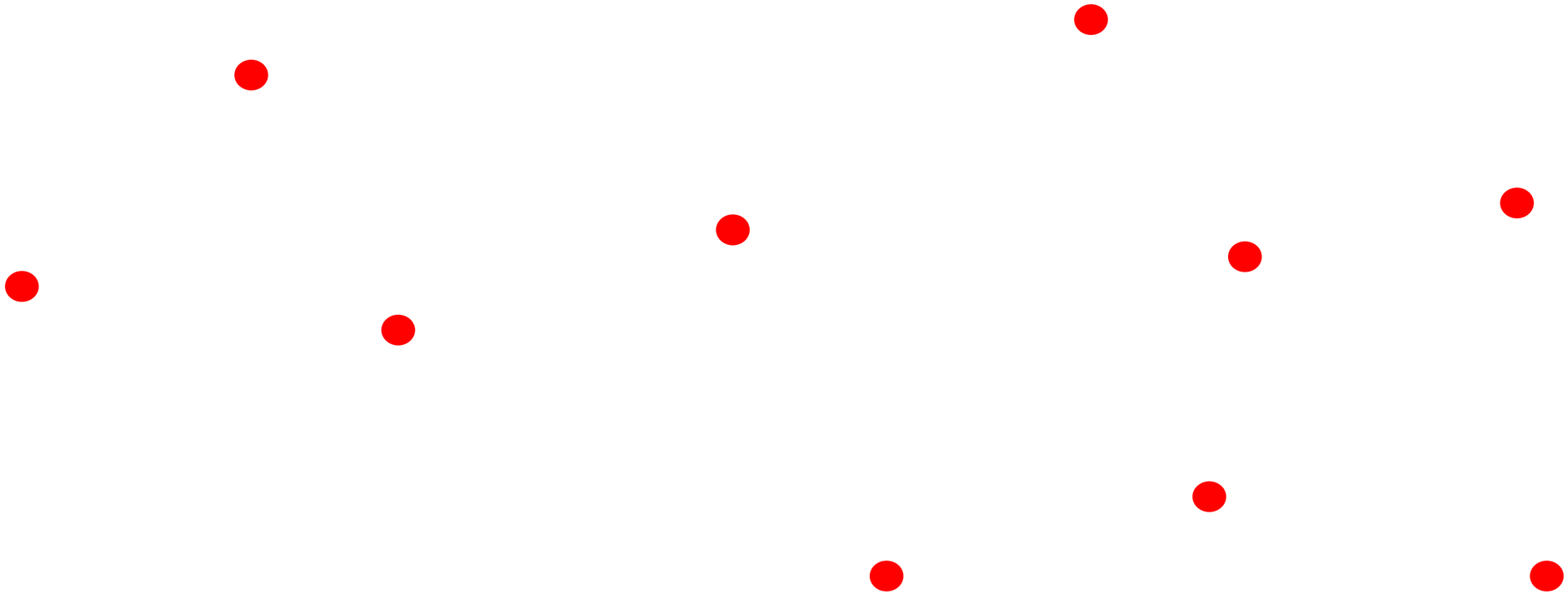
RESOURCE SELECTION FUNCTION



Fish detections

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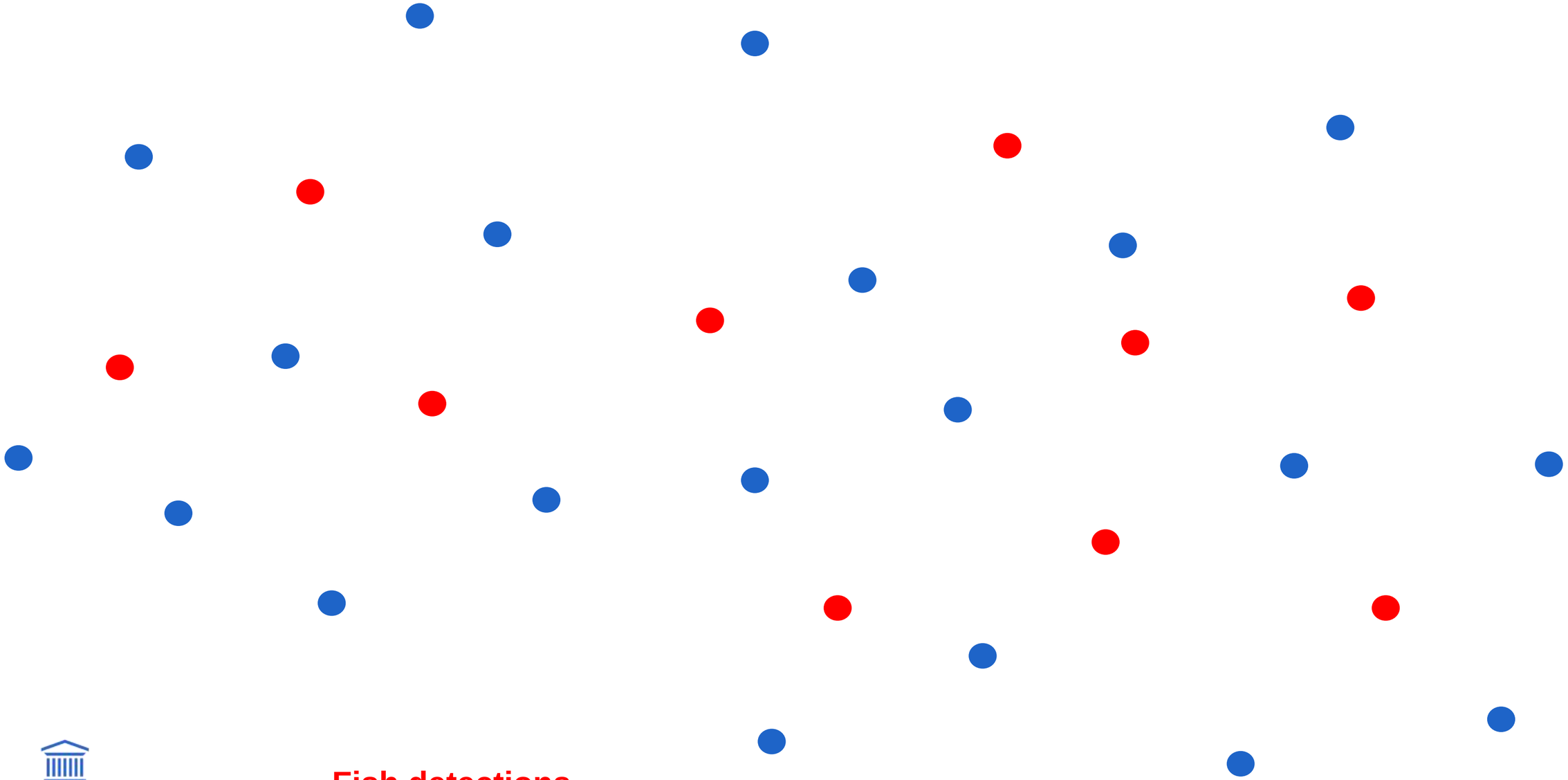
RESOURCE SELECTION FUNCTION



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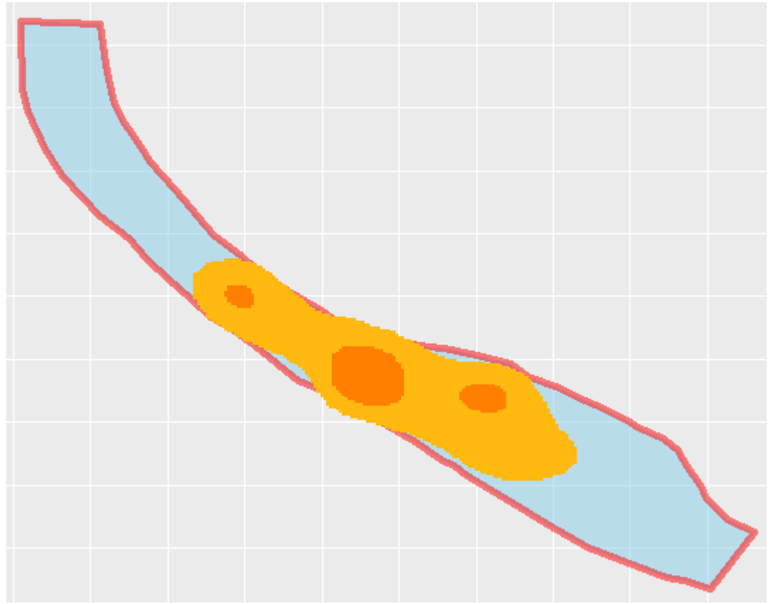
Fish detections

Random locations

DEFINING HABITAT AVAILABILITY

Study site



Within home range

- Of studied population
- Of individual

Within defined range of real positions

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DEFINING HABITAT AVAILABILITY

- Crucial step!

$$\text{Preference} \sim \frac{\text{Usage}}{\text{Availability}}$$

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RESOURCE SELECTION FUNCTIONS

- Not always appropriate, especially for fine scale data
- Assumptions
  - Data is independent
  - Availability is available

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RESOURCE SELECTION FUNCTIONS

t = n

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RESOURCE SELECTION FUNCTIONS

t = n - 1

t = n

Data is not independent

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RESOURCE SELECTION FUNCTION

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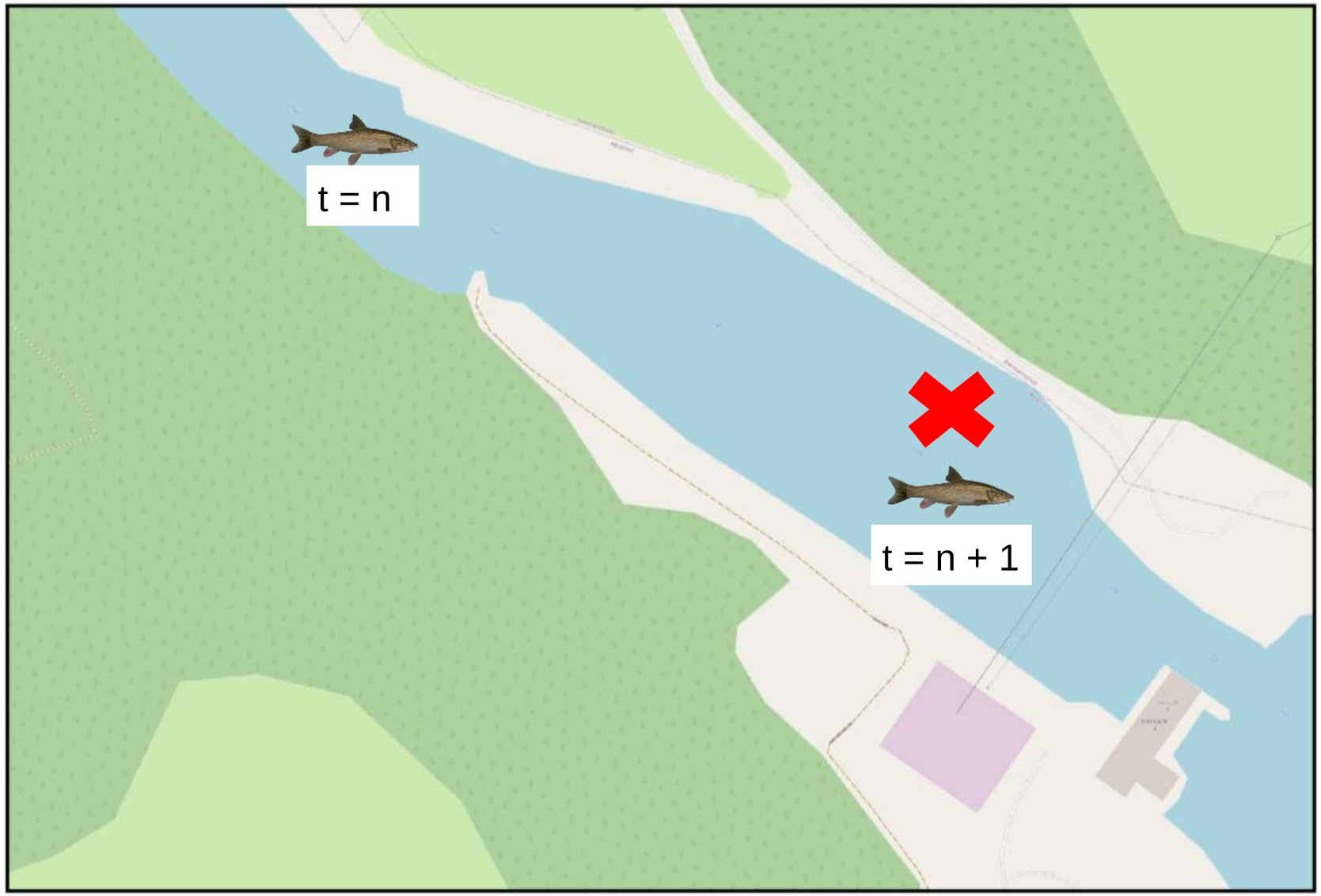
RESOURCE SELECTION FUNCTION



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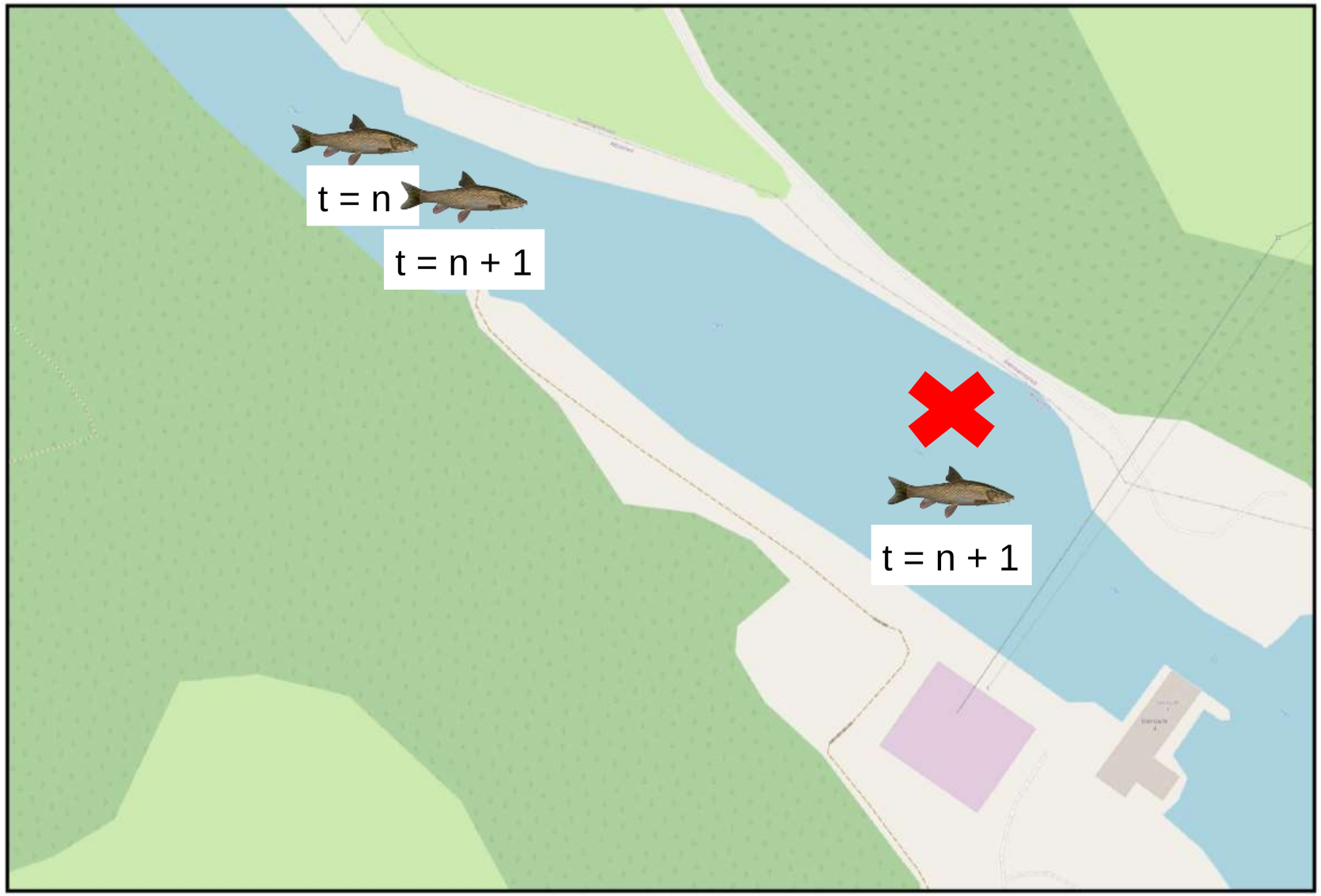
RESOURCE SELECTION FUNCTION



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OTHER OPTIONS?

- Step selection functions
  - Relax assumptions due to non-independence
  - Better defines availability
  - Links consecutive points into steps

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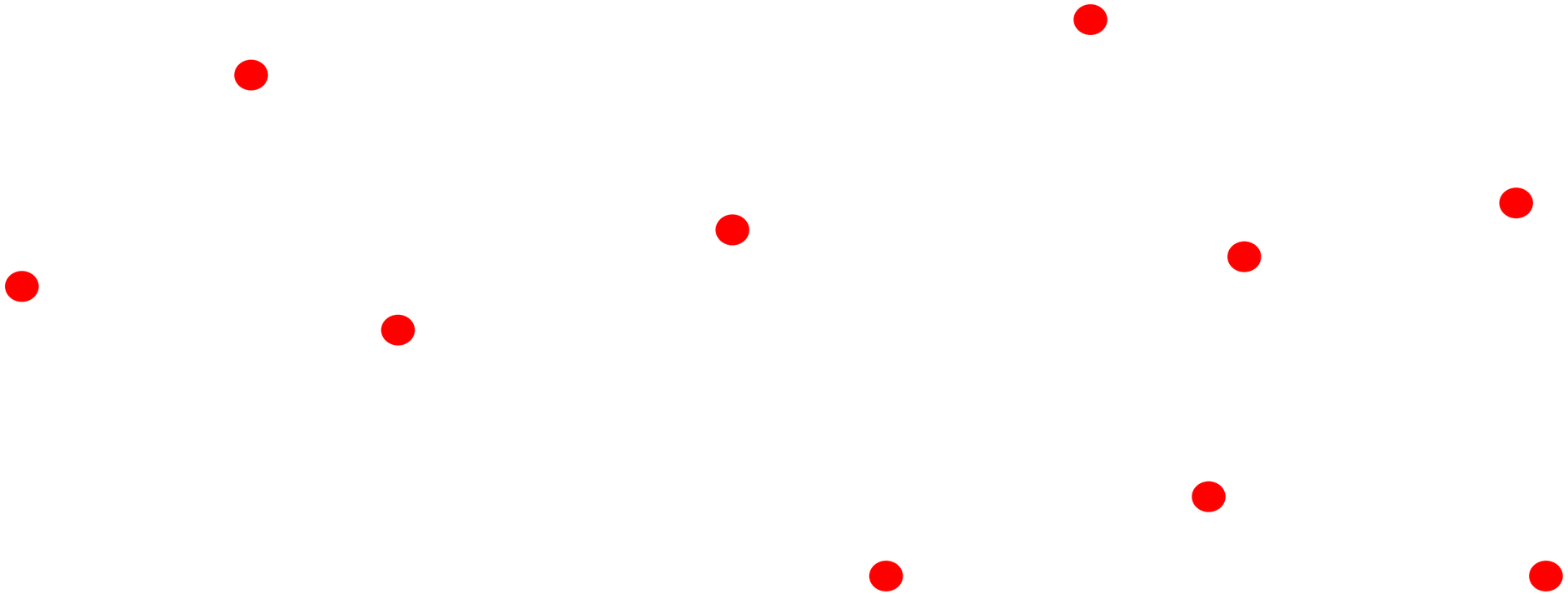
STEP SELECTION FUNCTION



Fish detections

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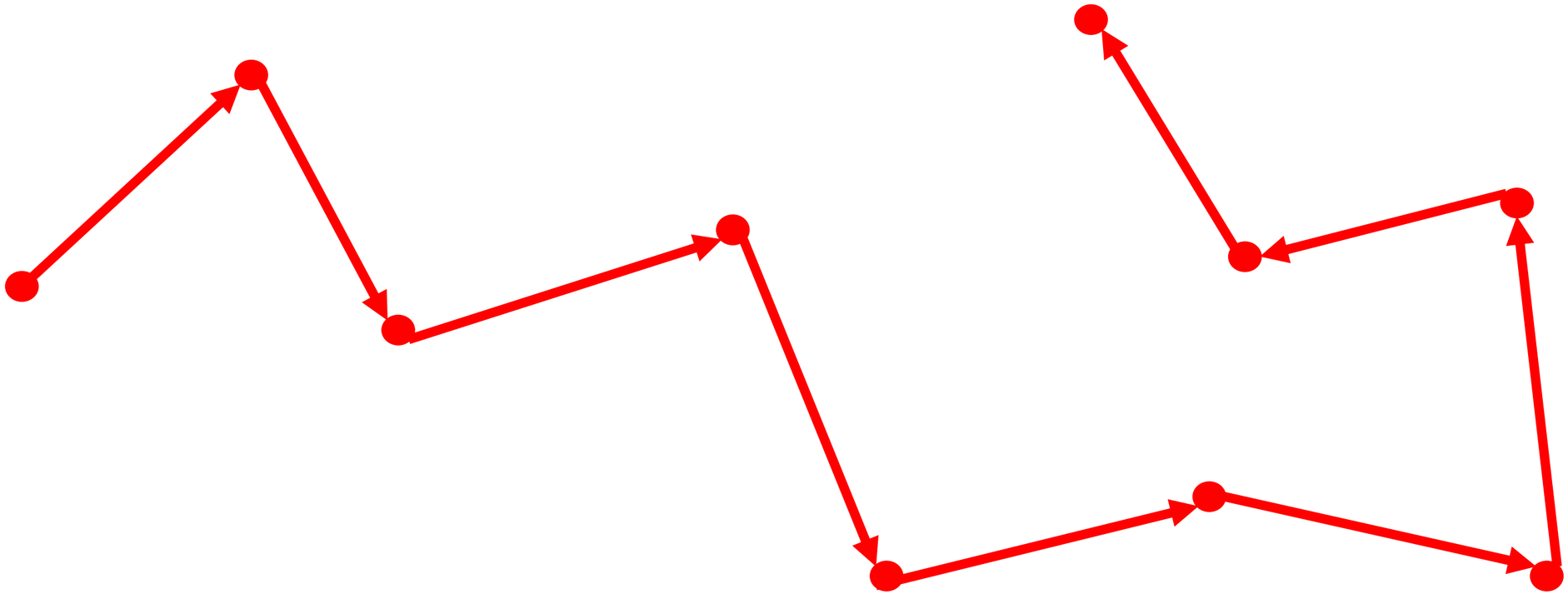
STEP SELECTION FUNCTION



Fish detections

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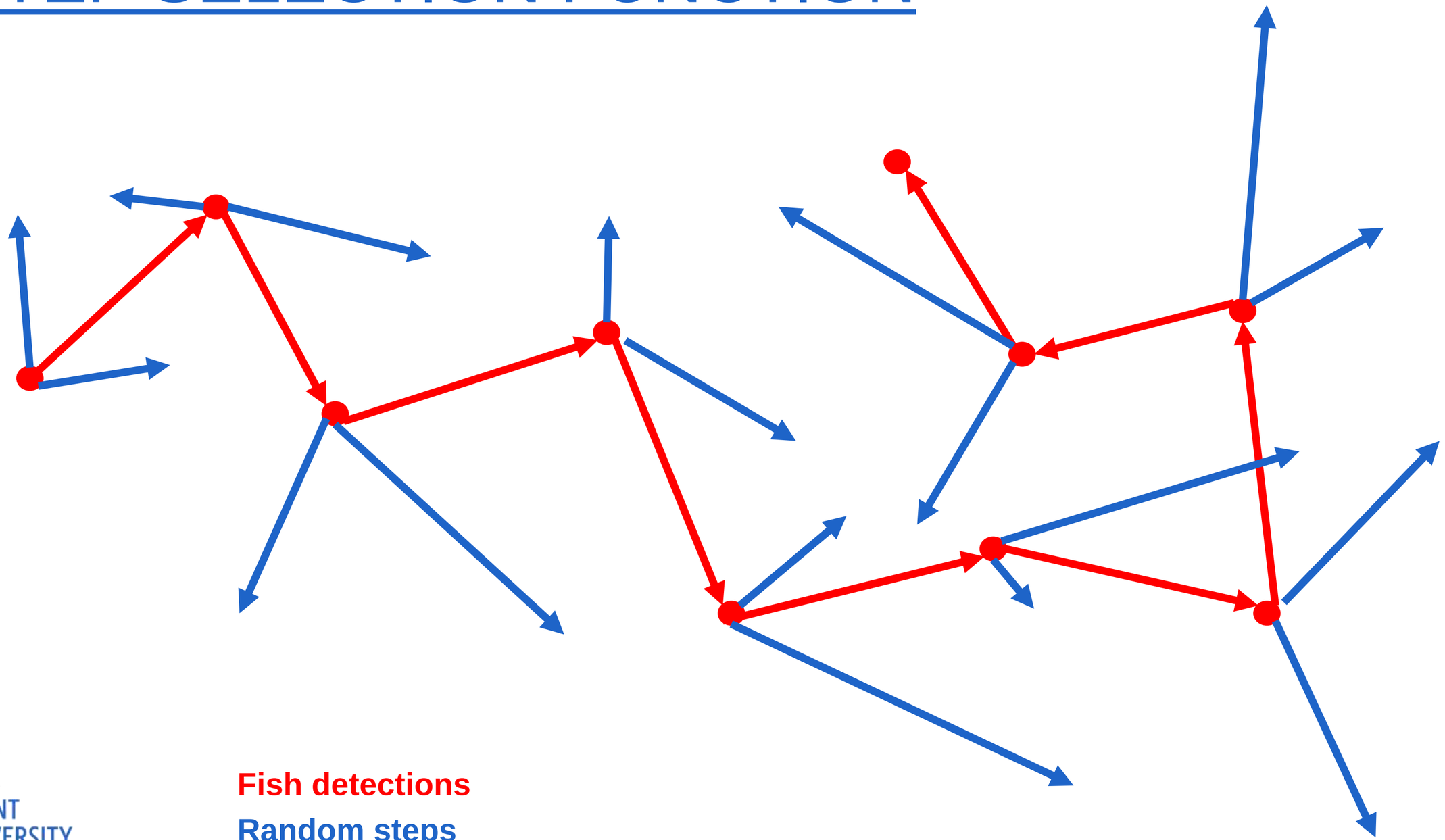
STEP SELECTION FUNCTION



Fish detections

Random steps

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STEP SELECTION FUNCTIONS: BENEFITS

- Relaxes assumptions independence
- Availability specific to locations
- Accounts for movement
  - Can model movement

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RESOURCE + STEP SELECTION FUNCTIONS

- Output?

$$w(x) = \exp(\beta_1 \mathrm{X}_1 + \beta_2 \mathrm{X}_2 + \cdots + \beta_n \mathrm{X}_n)$$

w(x) = relative probability of using a location in space

X_n = value of habitat parameter at the location

β_n = preference estimate

- Estimates β for each habitat parameter
  - Positive β -> preference
  - Negative β -> avoidance
  - Magnitude -> strength of effect

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OUTPUT

- Direct
  - Map predicted usage
  - Simulate movement, with SSF
- Indirect
  - Habitat suitability curves
  - Inform other models e.g. IBMs

$$w(x) = \exp(\beta_1 \mathrm{X}_1 + \beta_2 \mathrm{X}_2 + \cdots + \beta_n \mathrm{X}_n)$$

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EXISTING APPLICATIONS TO RIVERINE FISH

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DATABASE SEARCH

Database search

- Resource, step or habitat selection
- Freshwater, riverine, rive
- Telemetry or acoustic

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DATABASE SEARCH

Database search

- Resource, step or habitat selection
- Freshwater, riverine, rive
- Telemetry or acoustic

48 papers

- Retained if
  - Study species = fish
  - Study site = river(s)
  - Positional data via telemetry
  - Analyse via RSF/SSF

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DATABASE SEARCH

Database search

- Resource, step or habitat selection
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48 papers

- Retained if
  - Study species = fish
  - Study site = river(s)
  - Positional data via telemetry
  - Analyse via RSF/SSF

2 papers

- Both RSFs
- **No applications of SSFs**

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EXISTING APPLICATIONS

Study	Species	Environmental variables	Telemetry + tracking type	Temporal scale	Availability
Capra et al. (2017)	• Barbel (Barbus barbus) • Chub (Squalius cephalus) • Wells catfish (Silurus glanis)	• Hydraulic parameters • Substrate • Temperature	Acoustic Passive	3s to 5 minutes	10 points within 1km of each detection
Gerig et al. (2014)	• Humpback chub (Gila cypha)	• Habitat type • Hydraulic type • Water depth • Substrate	Acoustic Active	Surveys twice daily, morning and afternoon	Randomly in study site, equal number to real detections

CONCLUSIONS

- RSFs + SSFs little used with fish telemetry + hydraulic model outputs
  - Despite growing amount of data
- Fine scale -> SSFs may be better suited, but not yet applied in literature
  - Growing applications of SSFs in other contexts may assist use in freshwater systems

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