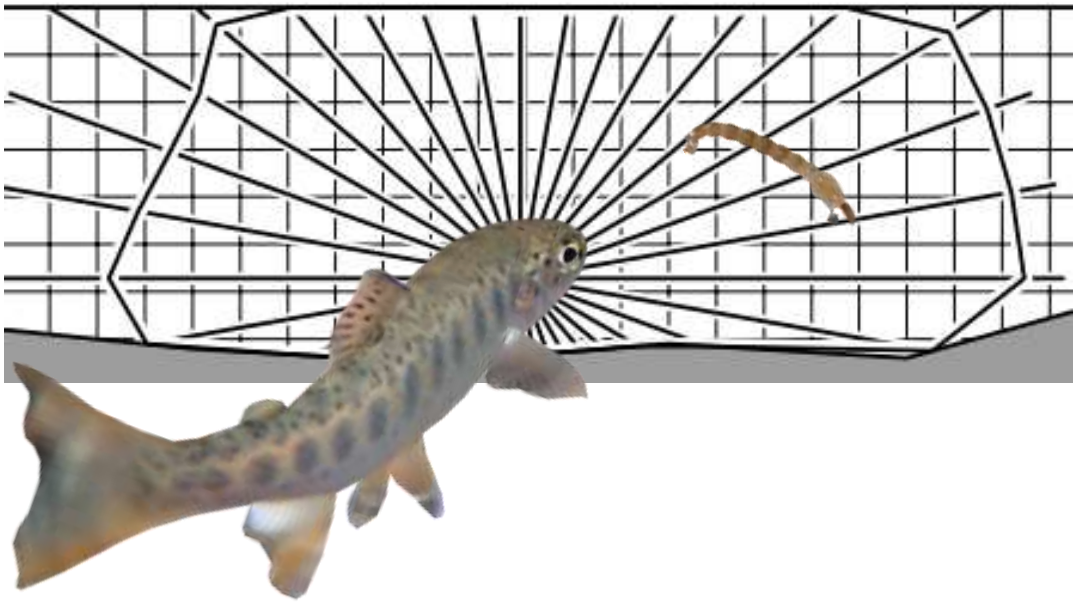
Comparing correlative and bioenergetic habitat suitability models for stream salmonids



Sean Naman
University of British Columbia

Jordan Rosenfeld
BC Ministry of Environment

Jason Neuswanger
South Fork Research

Eva Enders
Fisheries and Oceans Canada

Brett Eaton
University of British Columbia

Instream flow management trade-offs

Flow allocation

Sustaining fish populations

Conservation of threatened populations

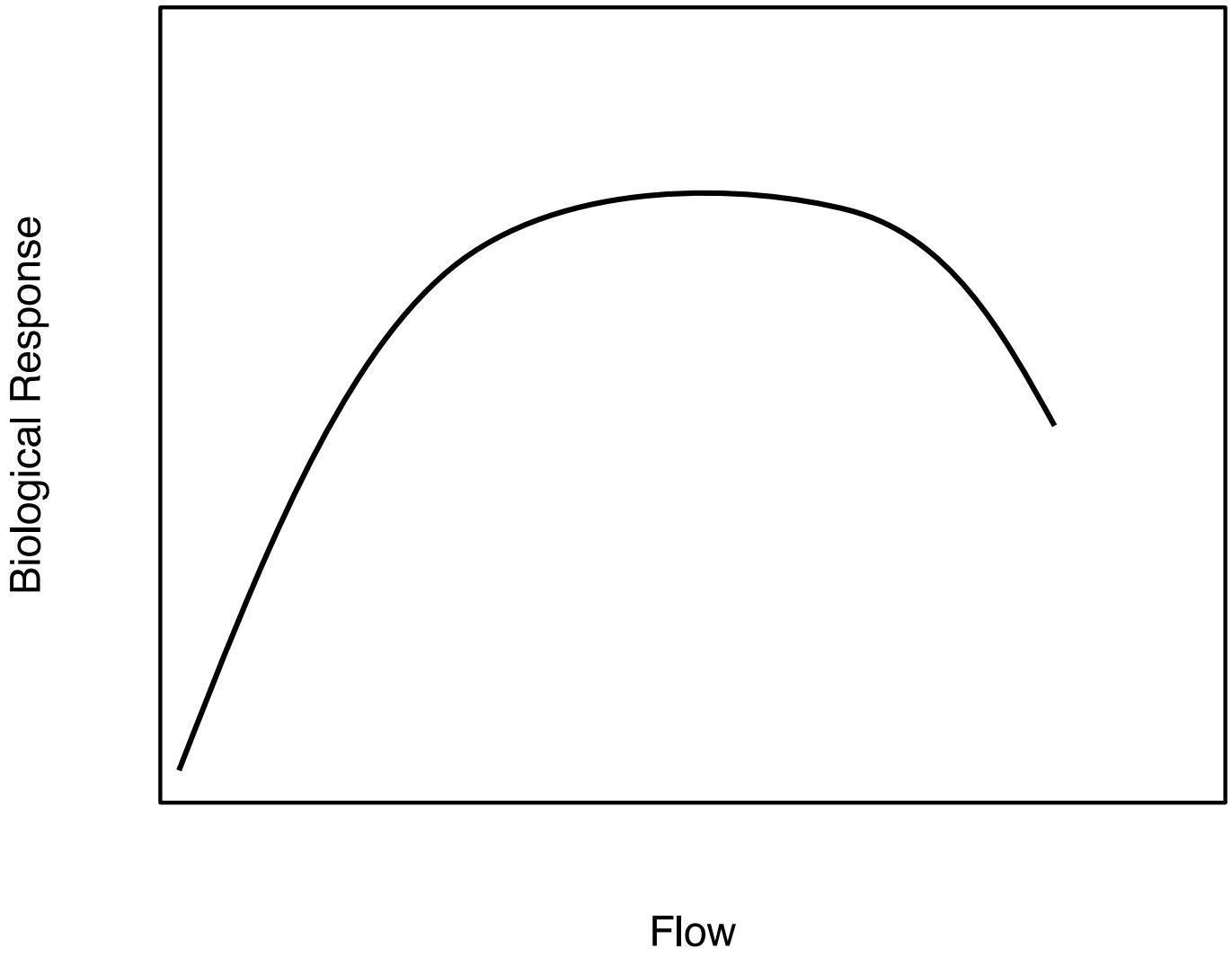
Commercial and recreational fisheries

Water for human use

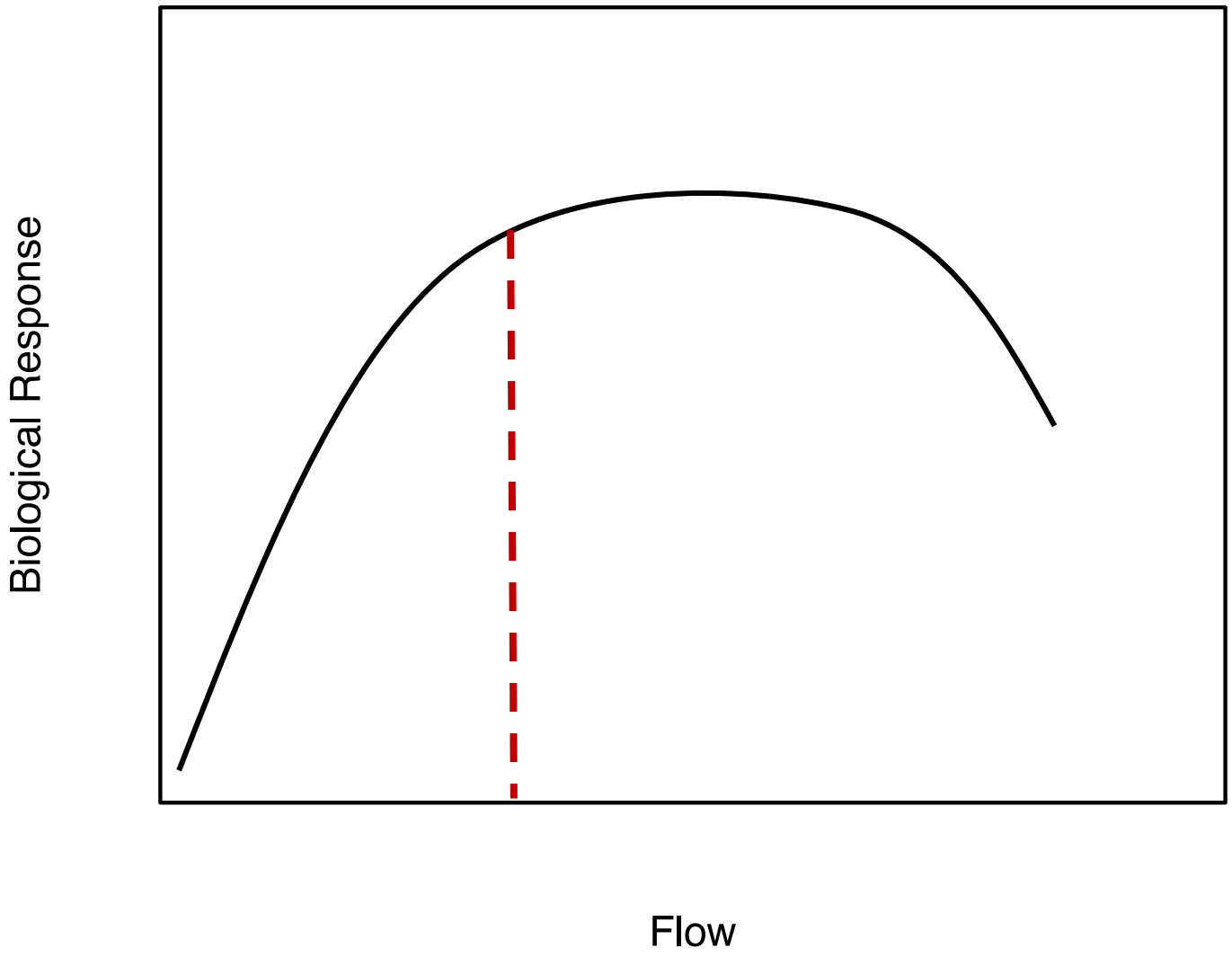
Societal requirements for freshwater

Industrial freshwater use

Flow-ecology relationships



Flow-ecology relationships



Management approaches: physical habitat simulation model (PHABSIM)

Physical Habitat Model

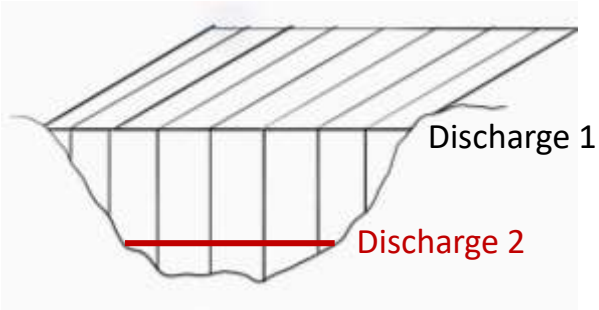
Biological Model

Habitat Availability Index

Management approaches: physical habitat simulation model (PHABSIM)

Physical Habitat Model

Link flow to habitat conditions



Biological Model

Habitat Availability Index

Management approaches: physical habitat simulation model (PHABSIM)

Physical Habitat Model

Biological Model

Define suitability of habitat conditions for fish

Habitat Availability Index

Management approaches: physical habitat simulation model (PHABSIM)

Physical Habitat Model

Biological Model

Habitat Availability Index

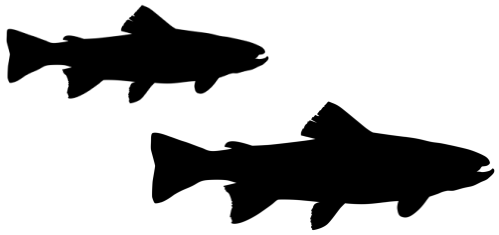
Link flow to fish habitat availability

Set management guidelines

Management approaches: physical habitat simulation model (PHABSIM)

Physical Habitat Model

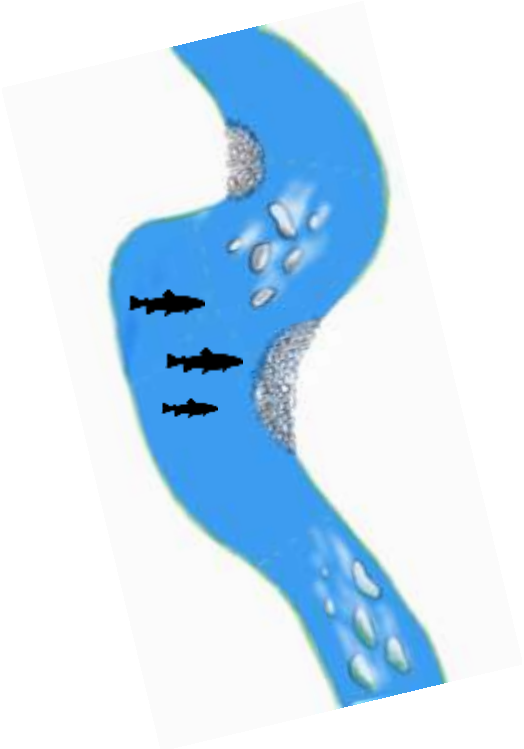
Biological Model



Habitat Availability Index

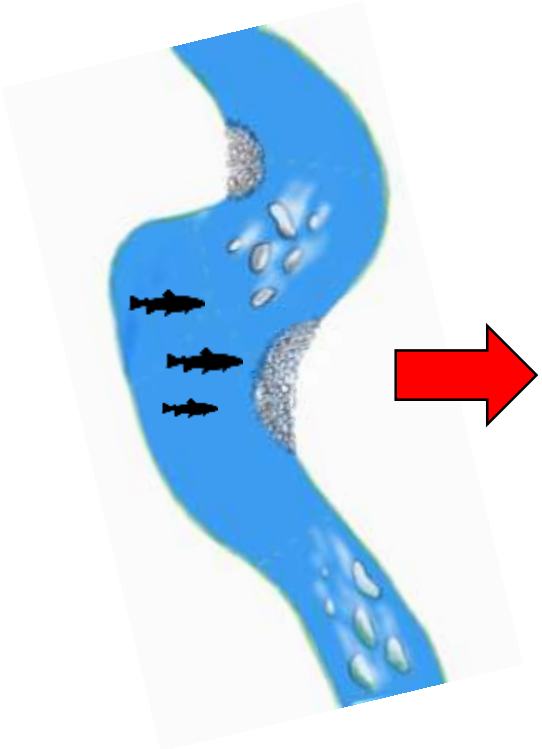
Correlative habitat suitability models

Observed habitat use/preference



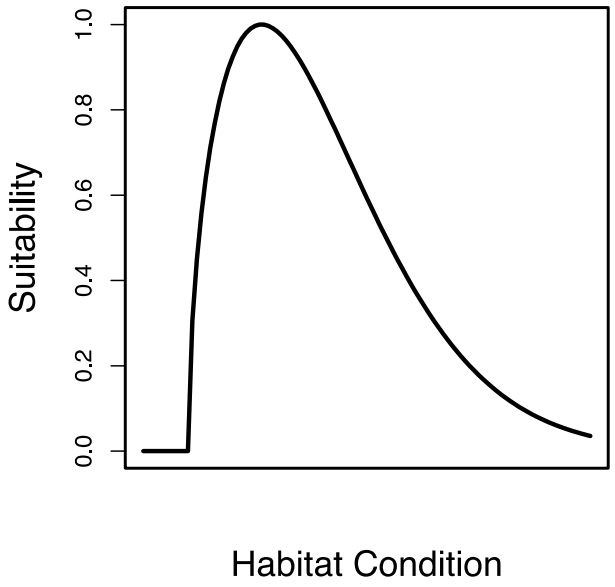
Correlative habitat suitability models

Observed habitat use/preference



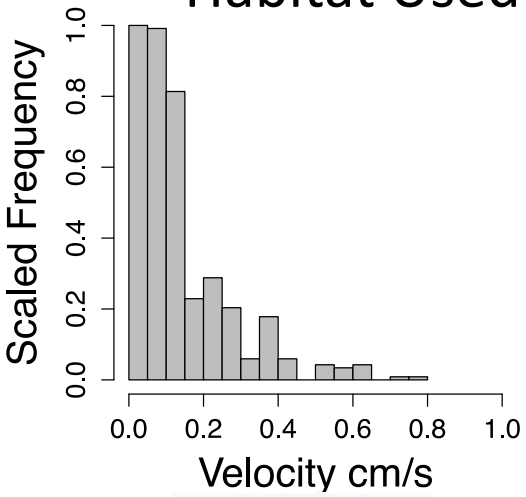
Statistical Model

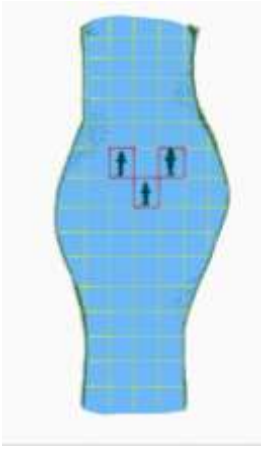
Habitat suitability index



Habitat suitability curves

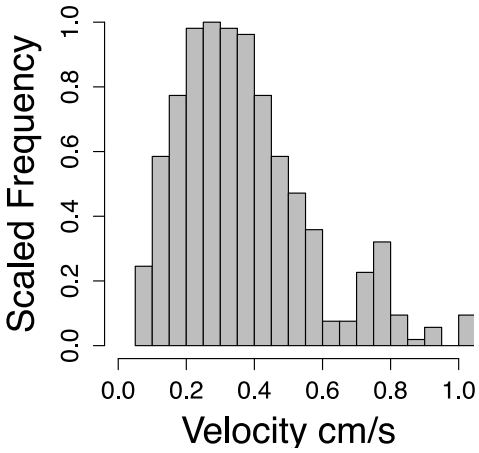
Habitat Used

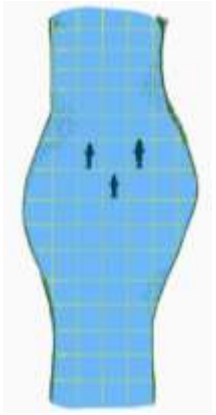




Habitats occupied by fish

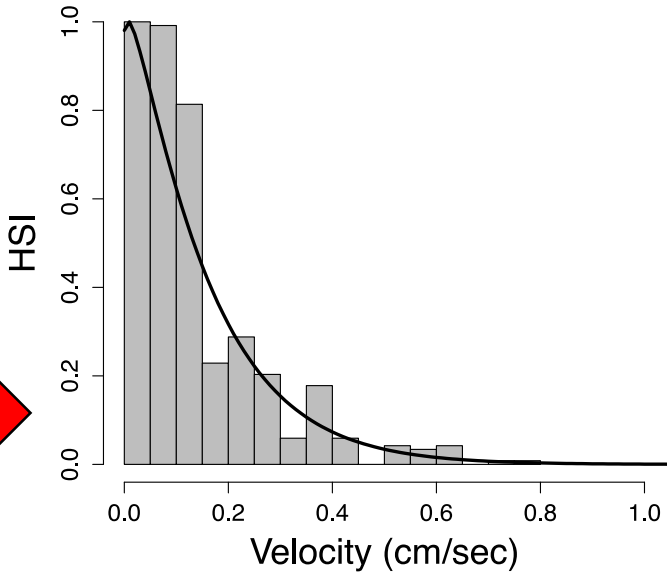
Habitat Available



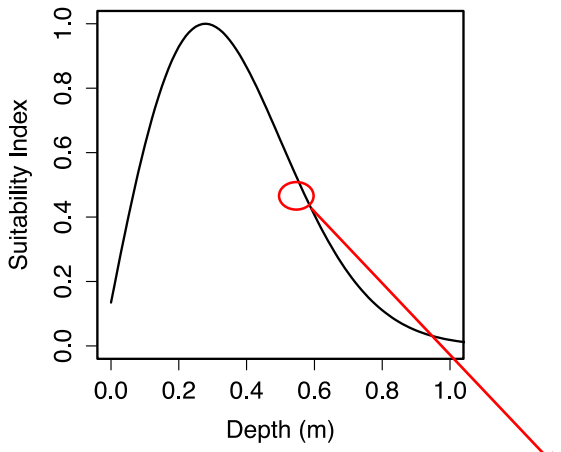


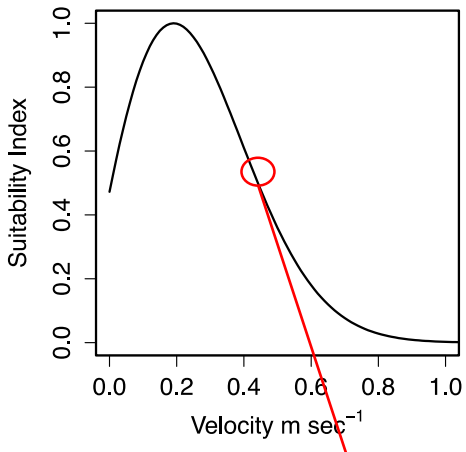
Ambient habitat availability

Habitat Suitability Curve

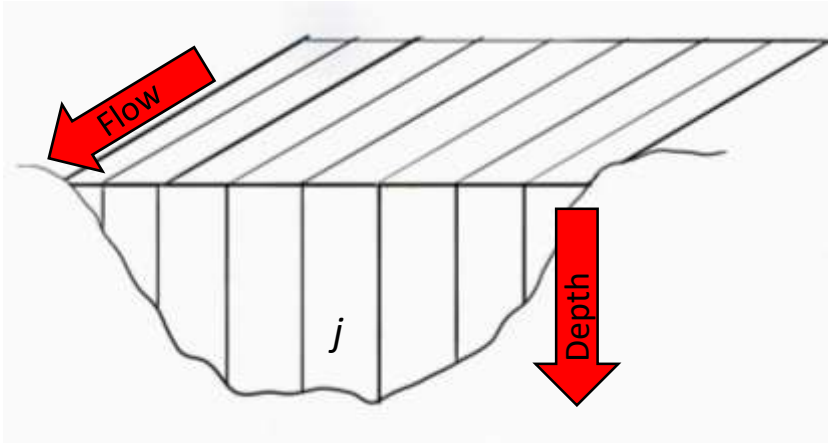


Habitat use relative to availability



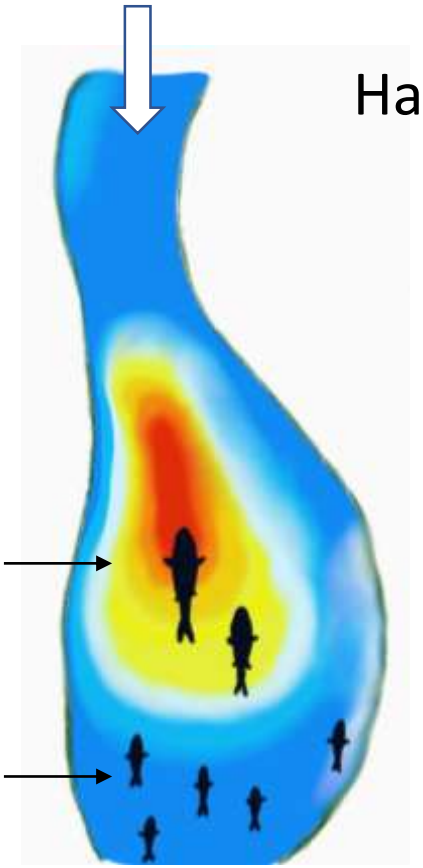


Habitat Suitability Index$_j$ = HSI_{Depth} x $HSI_{Velocity}$ x HSI_n



Stream channel cross section

Criticisms of correlative suitability models



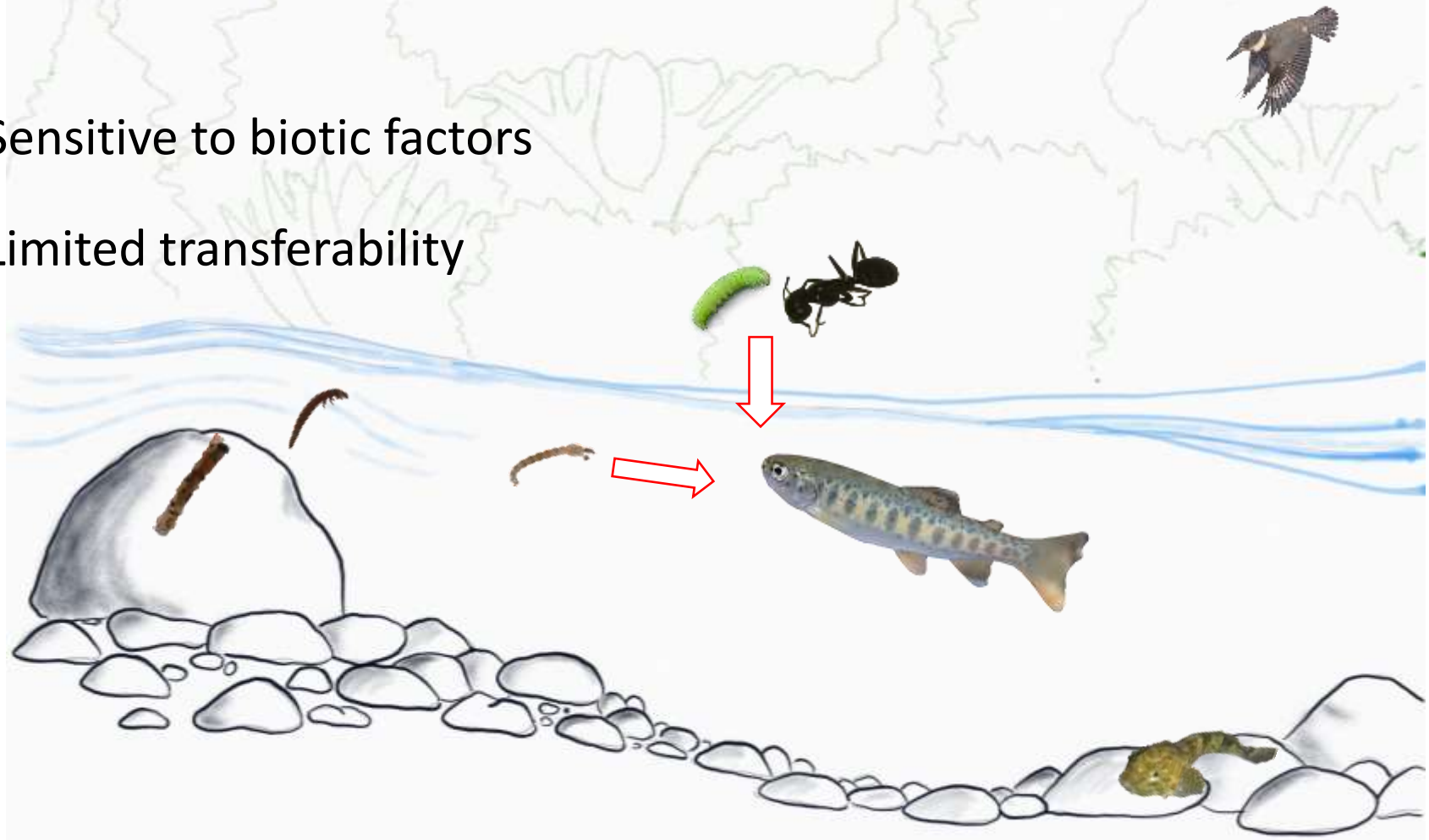
Habitat ***use*** may not reflect habitat ***quality***

Lower quality habitats more frequently used

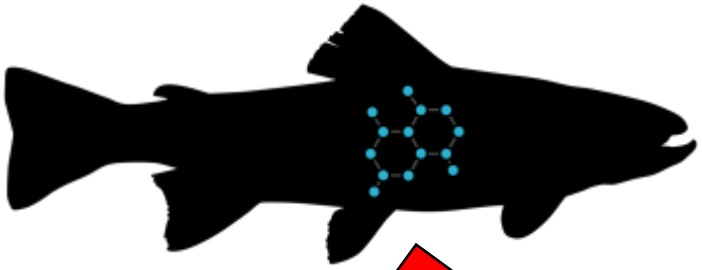
Criticisms of correlative suitability models

Sensitive to biotic factors

Limited transferability

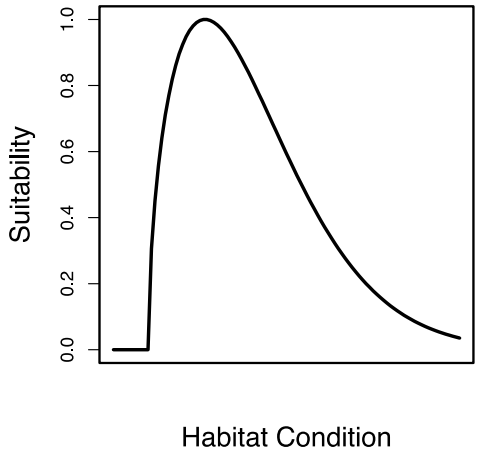


Mechanistic habitat suitability models



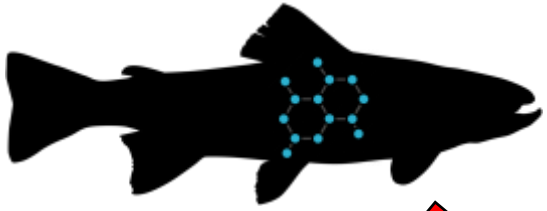
Fundamental knowledge of physiology and behaviour of a target species

Mechanistic model of energy balance, growth, survival etc.

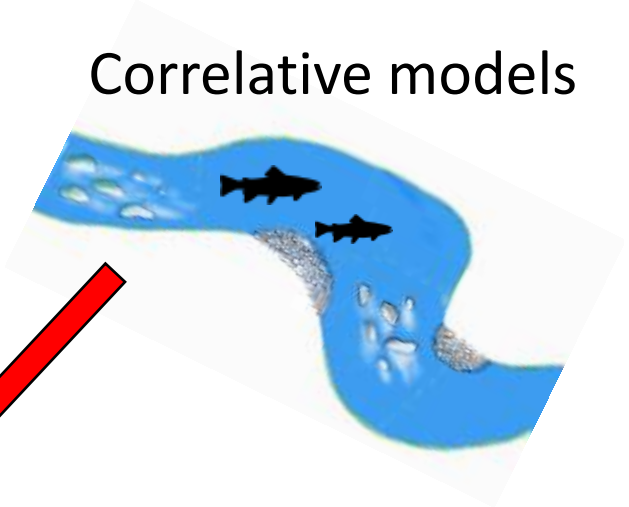


Correlative vs. mechanistic habitat suitability models

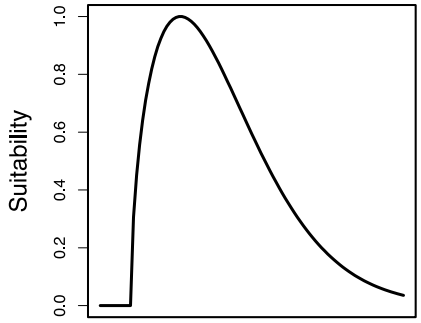
Mechanistic models



Correlative models

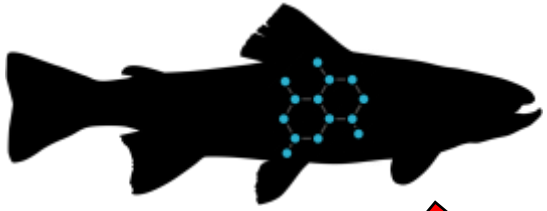


Habitat suitability

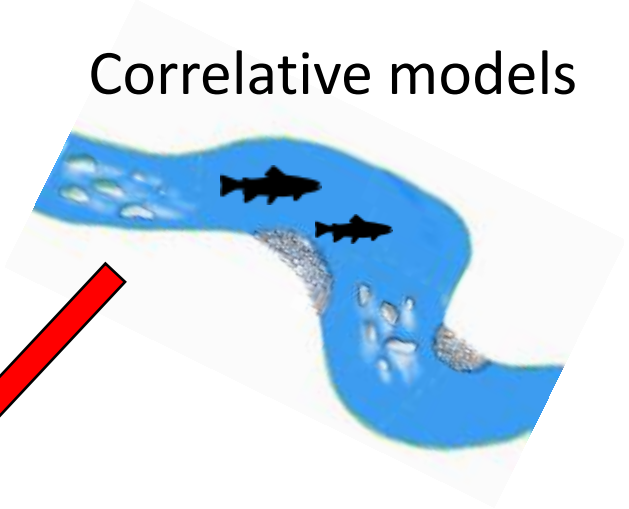


Correlative vs. mechanistic habitat suitability models

Mechanistic models

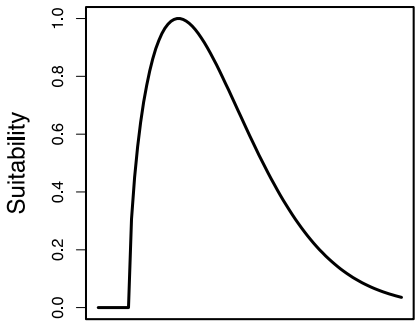


Correlative models



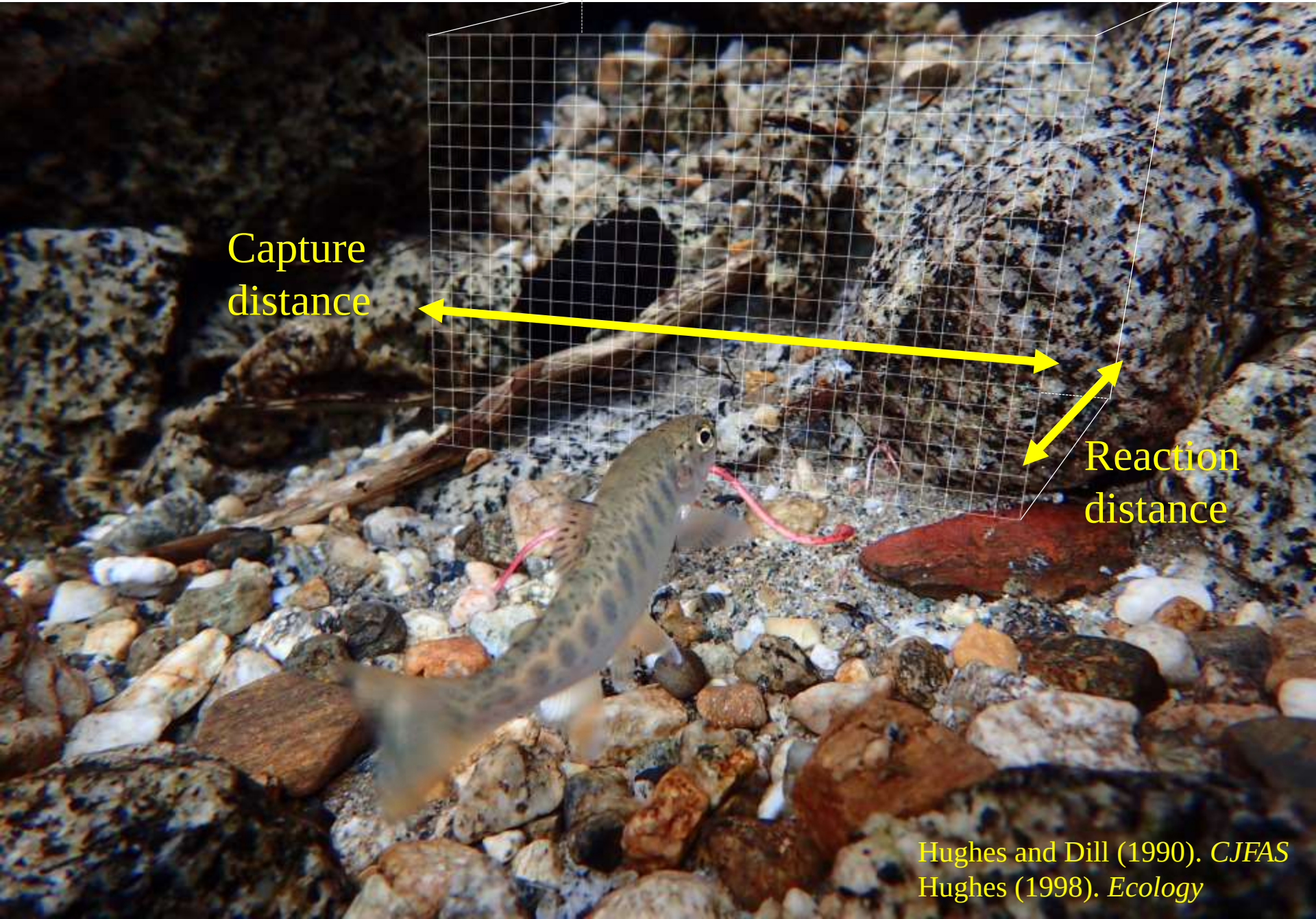
More biologically realistic but complicated

Habitat suitability



Simple to apply but conceptually flawed

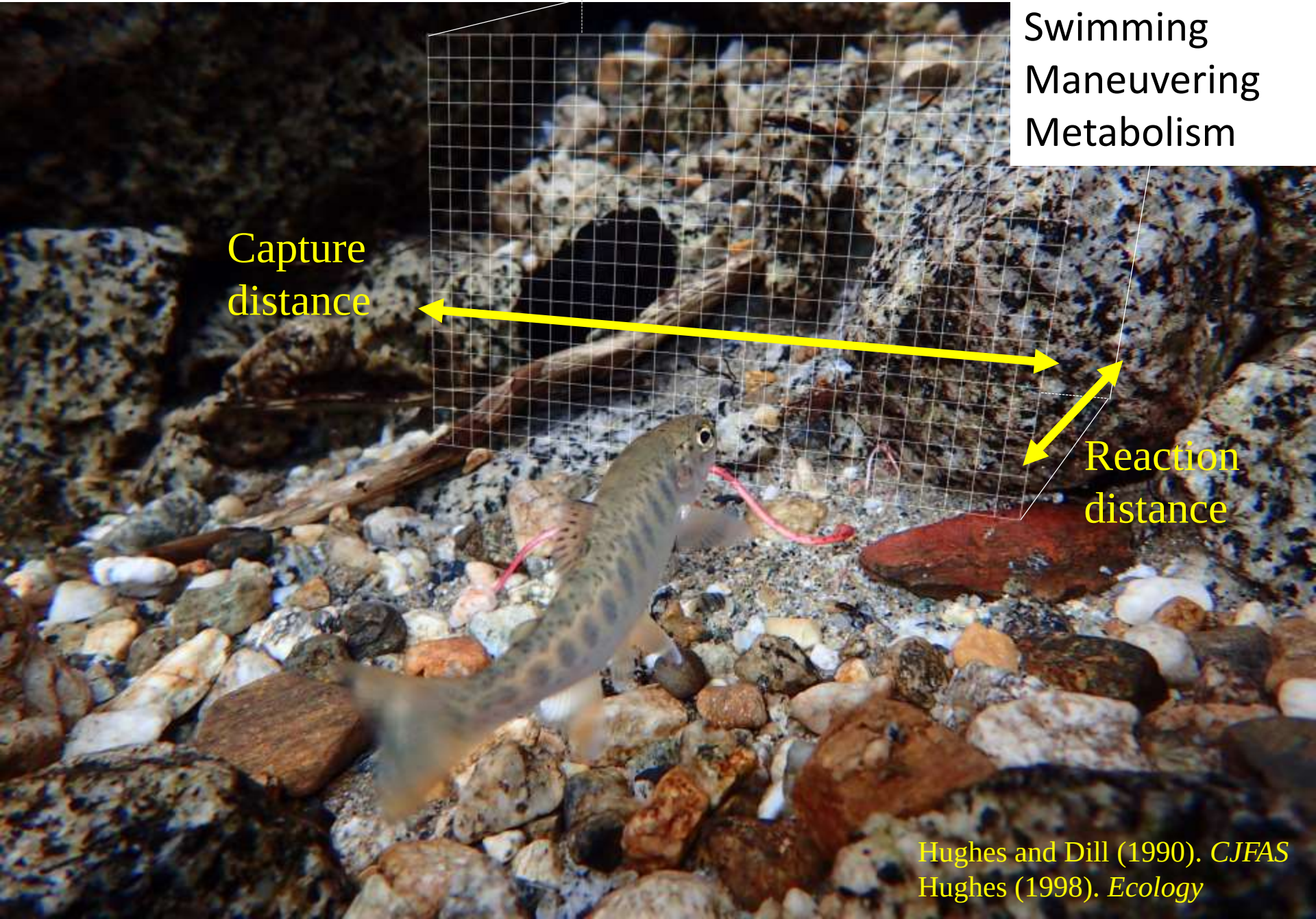
Net Energy Intake (J sec^{-1}) = Gross Energy Intake – Energy Costs



Hughes and Dill (1990). *CJFAS*
Hughes (1998). *Ecology*

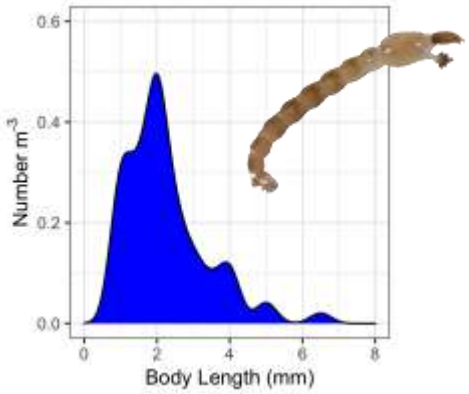
Net Energy Intake (J sec^{-1}) = Gross Energy Intake – Energy Costs

Swimming
Maneuvering
Metabolism



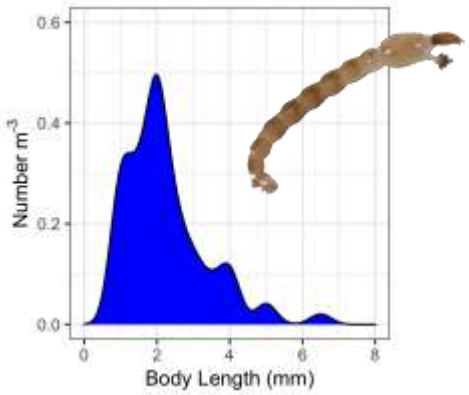
Hughes and Dill (1990). *CJFAS*
Hughes (1998). *Ecology*

Drift concentration, Size distribution

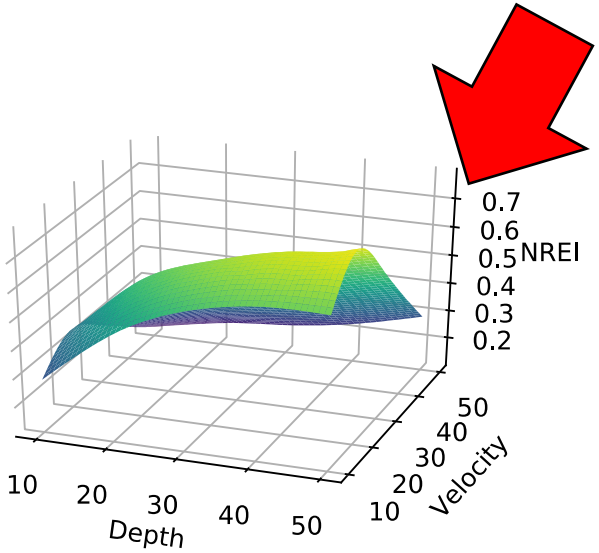


Fish size, Temperature

Drift concentration, Size distribution

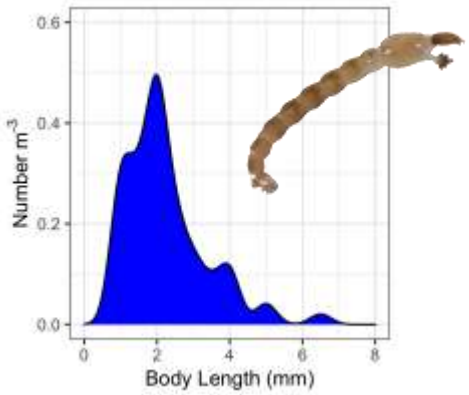


Fish size, Temperature

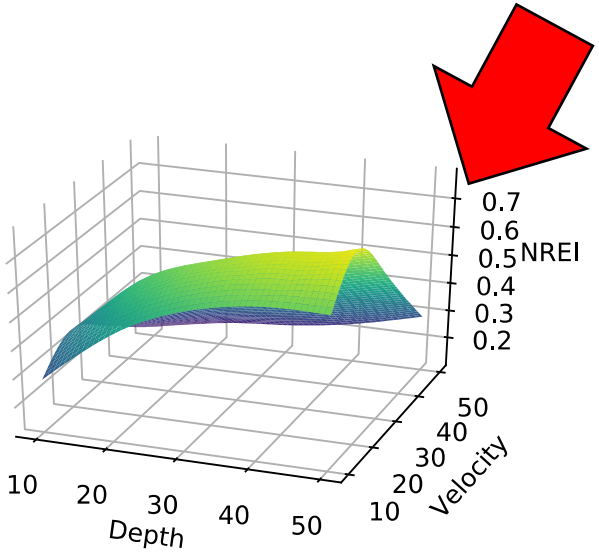


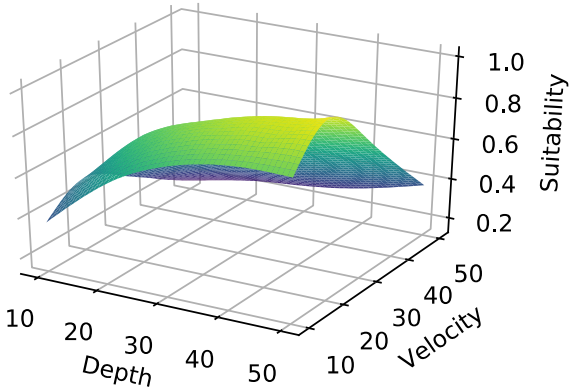
Net energy intake across depth and velocity ranges

Drift concentration, Size distribution



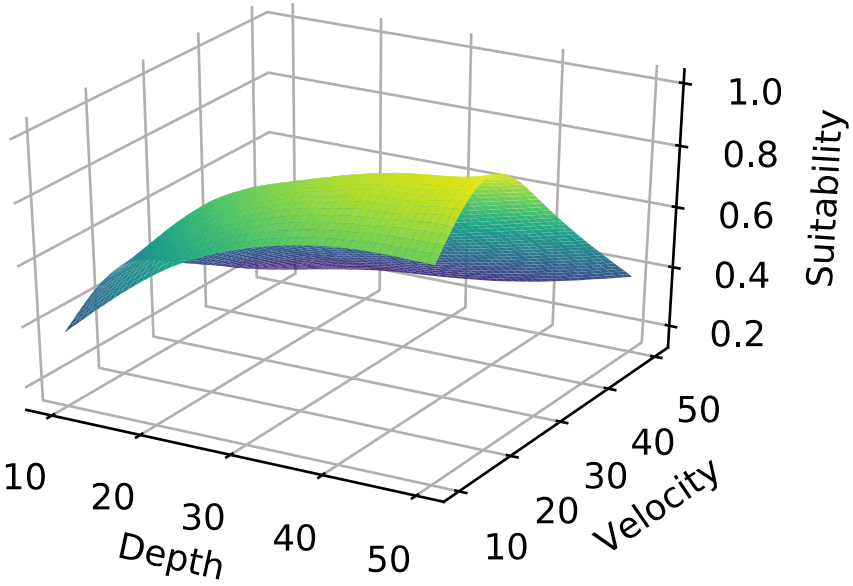
Fish size, Temperature



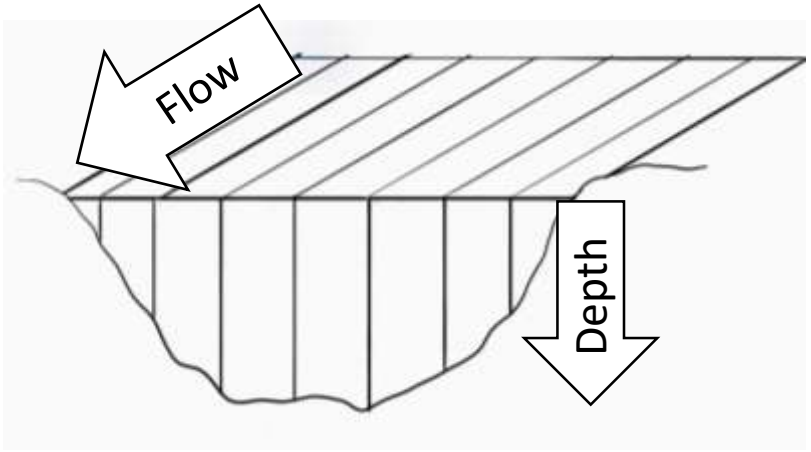


Net energy intake across depth and velocity ranges

Standardized bioenergetic habitat suitability curve



Standardized bioenergetic habitat suitability curve

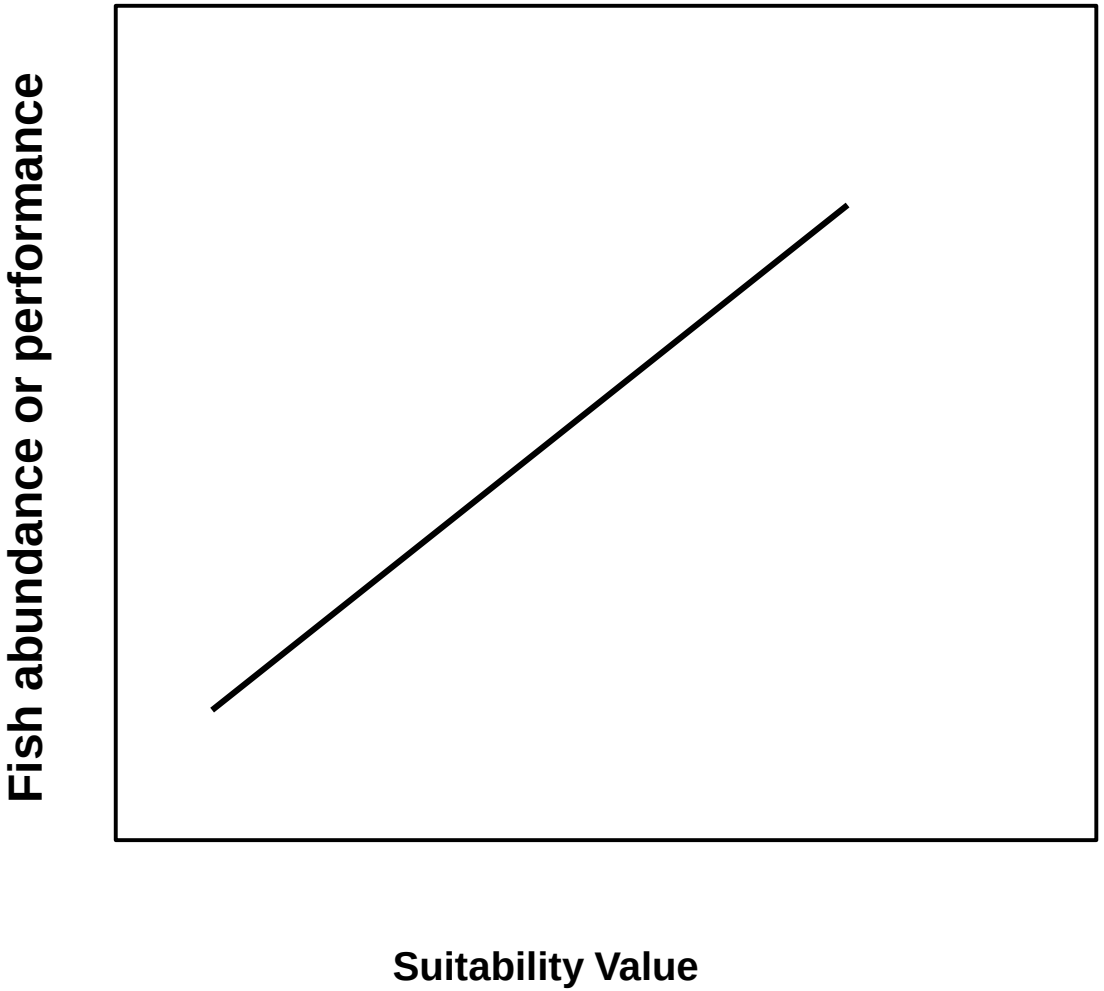


Hydraulic habitat data

Cell	Depth	Velocity	Suitability
1	0.22	0.1	0.6
2	0.2	0.15	0.7
...*n*	...*i*	...*i*	...*i*

Habitat suitability predictions

How well do suitability models perform?



Objectives

- Compare correlative vs. bioenergetic model *predictions*