

Aquatic species as example for the modeling

Connectivity Analysis of Riverine Landscapes - CARL

ECONNECT - final conference

Berchtesgaden

27 September 2011

WP 5 - UIBK



Andrea BOU-VINALS, Leopold FÜREDER
River Ecology and Invertebrate Biology
Institute of Ecology, University of Innsbruck, Austria

Content

- o Introduction
- o Focal species
- o Methodology
- o Results
- o Conclusions



Introduction

Fragmentation

Caused by

- Streets
- Railways
- Power lines
- Settlement
- Land use



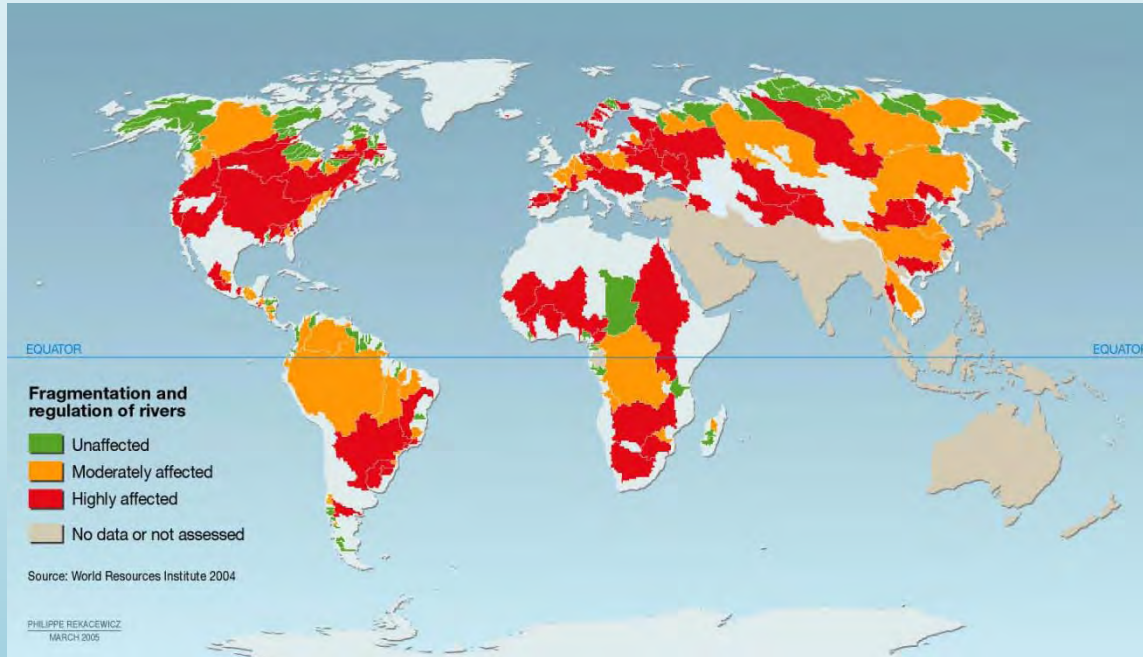
Effects

- habitat quantity and quality
- Barriers for migrating animals
- Isolation of populations
- Loss of species



Introduction

Freshwater Fragmentation



227 rivers assessed
37% were strongly affected by fragmentation and altered flows
23% were moderately affected
40% were unaffected

University of Umea and the World Resources Institute (2004)



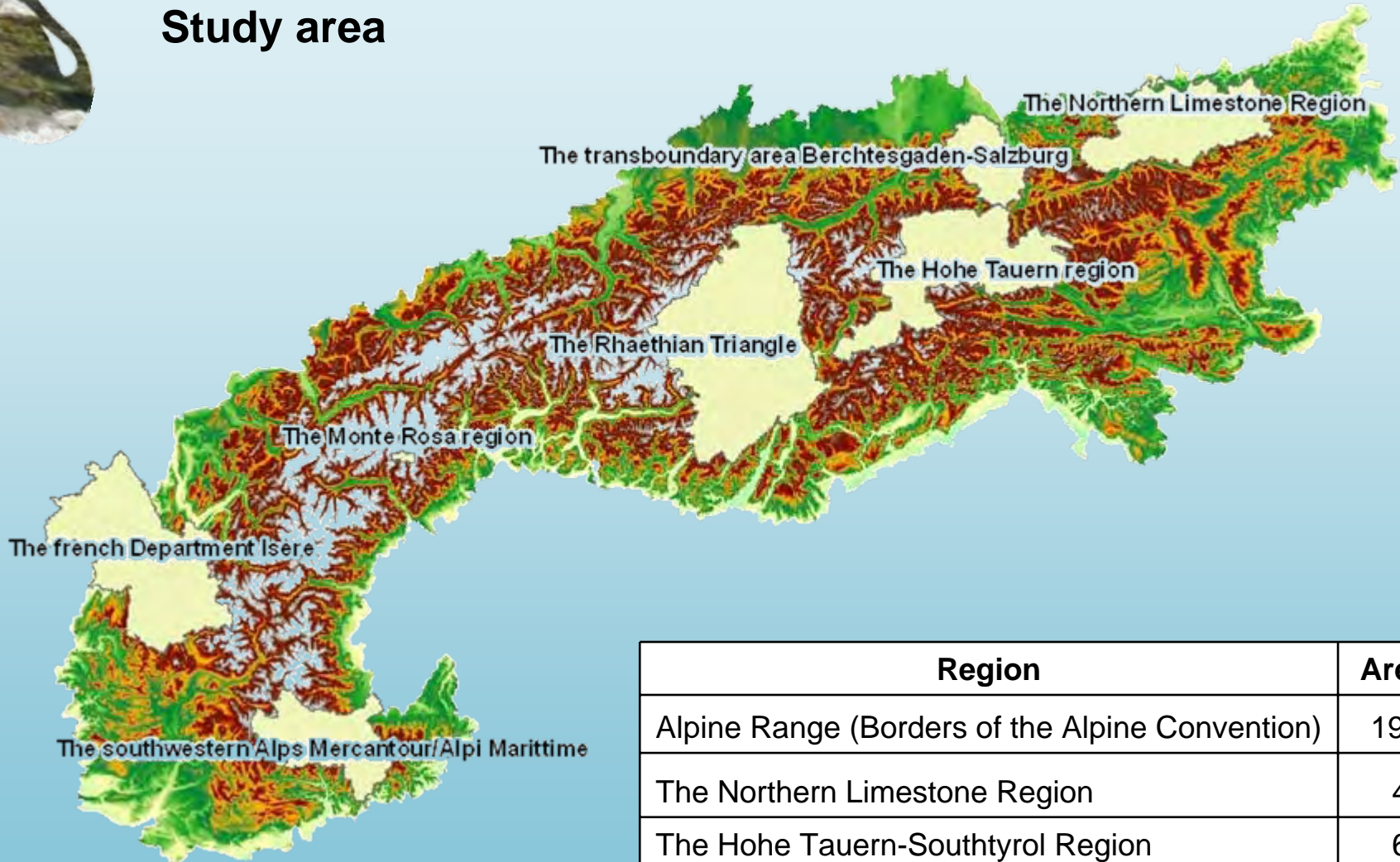
Introduction

Aims:

1. the analysis and identification of typical habitats and typical riverine species
2. the analysis and identification of barriers being effective in the longitudinal, lateral, vertical and temporal dimensions of river systems
3. analysis of the potential to increase connectivity and decrease barrier effects and fragmentation

Introduction

Study area



Focal species

- Mammals (6 species)
- Fish (8 species)
- Amphibians (6 species)
- Reptiles (2 species)
- Birds (9 species)
- Crayfish (3 species)
- Insects (3 species)
- Plant (1 species)



species	english
<i>Chondrostoma nasus</i>	Common Nase
<i>Phoxinus phoxinus</i>	Minnow
<i>Salmo salar</i>	Salmon
<i>Salmo trutta fario</i>	Brown trout
<i>Thymallus thymallus</i>	Grayling
<i>Salvelinus alpinus salvelinus</i> (L.)	Arctic char
<i>Cottus gobio</i>	Bullhead
<i>Barbus barbus</i>	Barbel
<i>Bombina variegata</i>	Yellow-bellied Toad
<i>Bufo bufo</i>	Common Toad
<i>Hyla arborea</i>	Common Tree Frog
<i>Rana temporaria</i>	Grass Frog
<i>Triturus alpestris</i>	Alpine Newt
<i>Triturus vulgaris</i>	Smooth newt
<i>Carabus clathratus</i>	Carabus clathratus
<i>Aeshna caerulea</i>	Azure Hawker
<i>Cordulegaster boltonii</i>	Golden-ringed Dragonfly
<i>Austropotamobius pallipes</i>	White-clawed crayfish
<i>Astacus astacus</i>	European crayfish
<i>Austropotamobius torrentium</i>	Stone crayfish

species	english
<i>Charadrius dubius</i>	Little Ringed Plover
<i>Actitis hypoleucos</i>	Common Sandpiper
<i>Ardea cinerea</i>	Grey Heron
<i>Alcedo atthis</i>	kingfisher
<i>Cinclus cinclus</i>	Dipper
<i>Motacilla alba</i>	White Wagtail
<i>Motacilla cinerea</i>	Grey Wagtail
<i>Acrocephalus palustris</i>	Marsh Warbler
<i>Acrocephalus schoenobaenus</i>	Sedge Warbler
<i>Cervus elaphus</i>	Red Deer
<i>Lutra lutra</i>	European Otter
<i>Myotis daubentonii</i>	Daubenton's Bat
<i>Neomys anomalus</i>	Miller's Water Shrew
<i>Neomys fodiens</i>	Water Shrew
<i>Castor fiber</i>	European Beaver
<i>Natrix natrix</i>	Grass Snake
<i>Emys orbicularis</i>	European Pond Turtle
<i>Myricaria germanica</i>	German false tamarisk



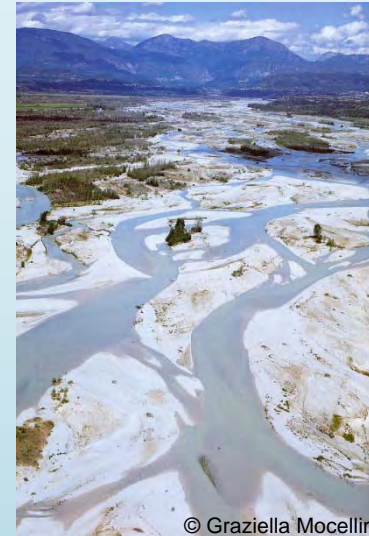
Methodology

A) Definition of the Riverine Landscapes

B) Fragmentation and Connectivity

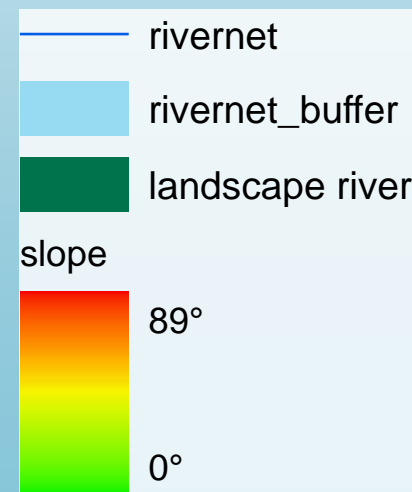
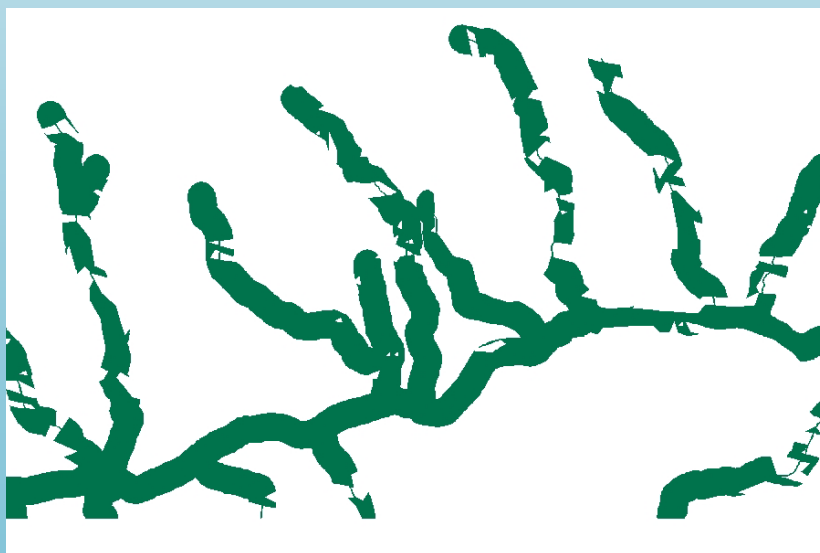
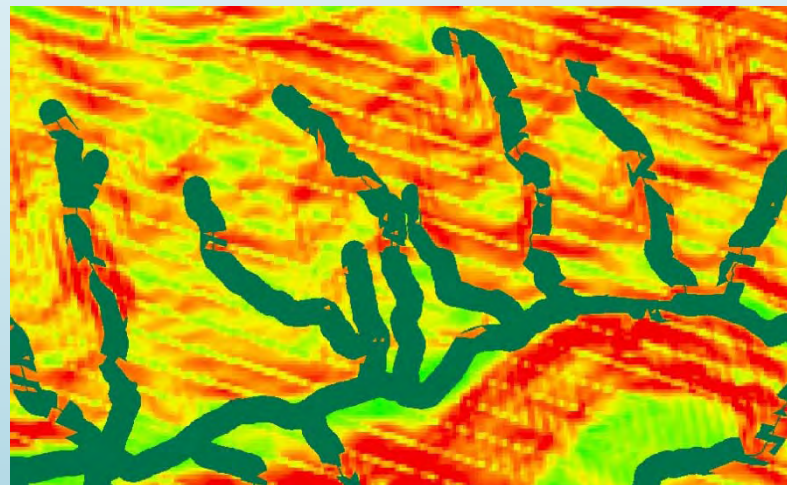
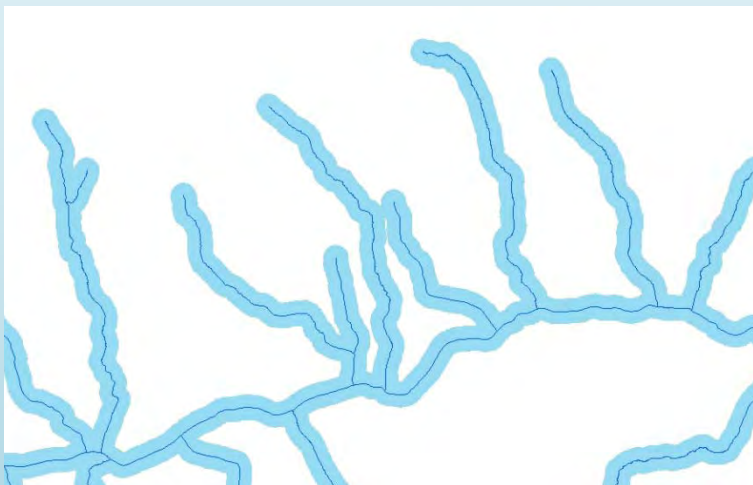
3 Foci:

1. Spatial analysis of **fragmentation**
2. **Habitat suitability model** and characterization of **barriers** for the focal species
3. Analysis of **connectivity** and **corridors**



Methodology

Definition of riverine landscapes



Focus 1: Fragmentation

Quantification of the fragmentation by indices in ArcGis 9.3.1.

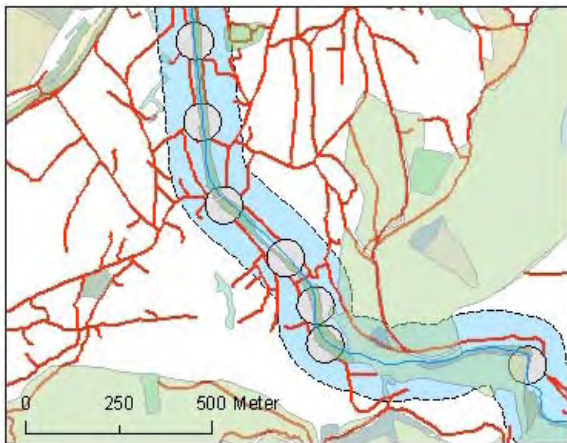
Effective Mesh Size

indices landscape (river and riparian area) division			
splitting index S	$LDI = \frac{\sum_{i=1}^n P_i}{2 \sqrt{\pi A_i \sum_{i=1}^n A_i}}$	$(1-\infty) m^2$	Jäger_2000, Lang_2007
Splitting density s	$A_i \sum_{i=1}^n \frac{1}{A_i^2}$		Jäger_2000
degree of coherence C	$c = \sum_{i=1}^n \left(\frac{A_i}{A_r}\right)^2$	(0-1) %	Jäger_2000, Lang_2007
degree of landscape division	$D = 1 - \sum_{i=1}^n \left(\frac{A_i}{A_r}\right)^2$	(0-1) %	Jäger_2000, Lang_2007
effective mesh size (meff)	$m = \frac{A_r}{S} = \frac{1}{A_r} \sum_{i=1}^n A_i^2$	(0-A)	Jäger_2000
Net product N	$N = \sum_{i=1}^n A_i^2$		Jäger_2000
edge-effect (TE, ED)			Lang_2007

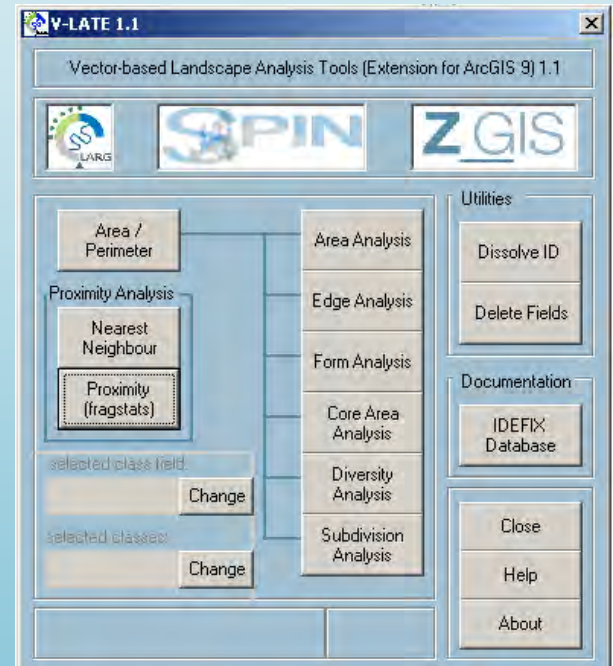
Methodology

Focus 1: Fragmentation

Calculating “effective Mesh Size” (meff) in ArcGIS with the extension of ArcGIS “V-Late 1.1” (LANG, S., TIEDE, D., 2003)



- river Ziller
- biotop mapping
- street
- power station
- riverine landscape Buffer 100m



Focus 2: Habitat suitability model (e.g. Fishotter)

Literature:

Kofler (1980); Ruiz-Olmo (1998);
 Kranz (2000); Schmutz et al. (2003);
 Medgyesy (2007); Cho et al. (2009);
 Loy et al. (2009); Mirzaei et al. (2009);
 Clavero et al. (2010)

ArcGIS tool “Corridor Designer”
 (Majka et al., 2007)

Used Parameter

- Distance to freshwater
- Occurrence of fish (Elevation, slope)
- Land use (CLC 2000)



Parameter	Gewichtung	Kategorien	Eignungswert
Nähe zu Gewässern [m]	30	0-100	100
		101-200	80
		201-300	60
		301-400	50
		401-500	40
		501-600	30
		601-700	20
		701-800	10
Seehöhe [m ü.N.N.]	30	801-1000	0
		406-2000	100
		2001-2600	40
Hangneigung [°]	30	2601-3656	0
		0-9	100
		9,01-35	20
CLC (2000)	10	35,01-83	0
		1.1.2. nicht durchgängig städtische Prägung	0
		1.2.1. Industrie/Gewerbeflächen	0
		1.2.2. Straßen/Eisenbahnnetze	0
		1.3.1. Abbauflächen	0
		1.4.2. Sport/Freizeitanlagen	20
		2.1.1. Nicht bewässertes Ackerland	40
		2.3.1. Wiesen und Weiden	40
		2.4.2. Komplexe Parzellenstruktur	40
		2.4.3. Landwirtschaftlich genutztes Land mit natürlicher Vegetation	80
		3.1.1. Laubwälder	100
		3.1.2. Nadelwälder	100
		3.1.3. Mischwälder	100
		3.2.1. Natürliches Grünland	80
		3.2.2. Heiden und Moorheiden	100
		3.2.4. Wald/Strauch	80
		3.3.2. Felsflächen ohne Vegetation	20
		3.3.3. Flächen mit spärlicher Vegetation	20
		3.3.5. Gletscher/Dauerschneegebiet	0
		4.1.1. Sumpfe	100
4.1.2. Torfmoore	100		
5.1.1. Gewässerläufe	100		
5.1.2. Wasserflächen	100		

Key species

Focus 2: Characterisation of Barriers (e.g. Bullhead)



- o Movement hindrance
+ Artificial barrier
+ Natural barrier
- o Habitat deterioration



Methodology

Focus 3: Connectivity and Corridors



Legend

- Fließgewässer_Tirol
- ▨ Riparian Forests
- - - Lech Korridor Buffer 200m

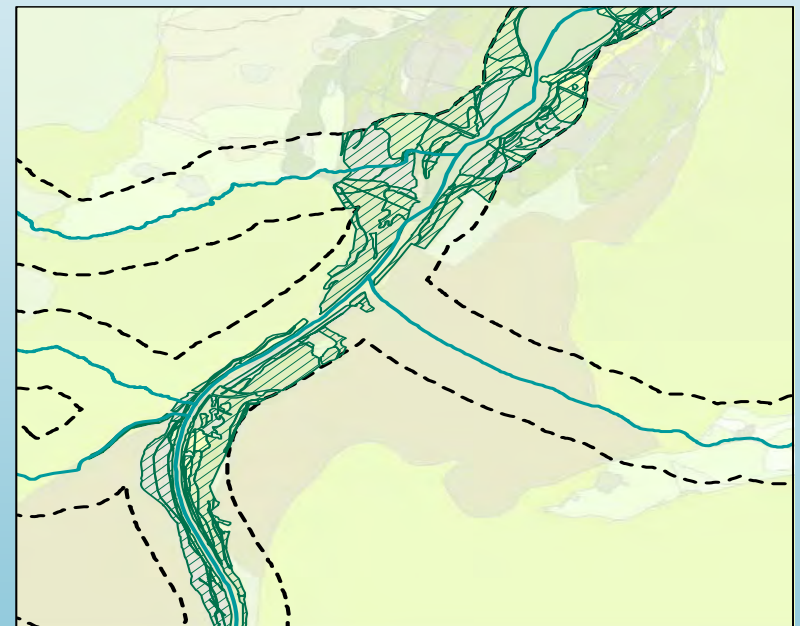
Intersection of
habitat suitability model and **barriers**



Connectivity analysis with ArcGis tool
“Corridor designer” (Majka et al. 2007)



Permeability / Corridor

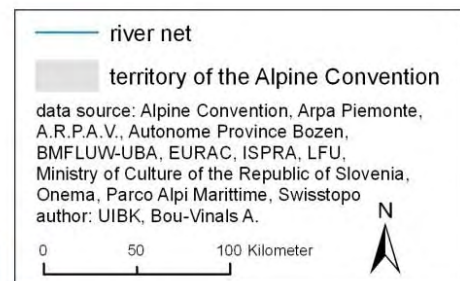
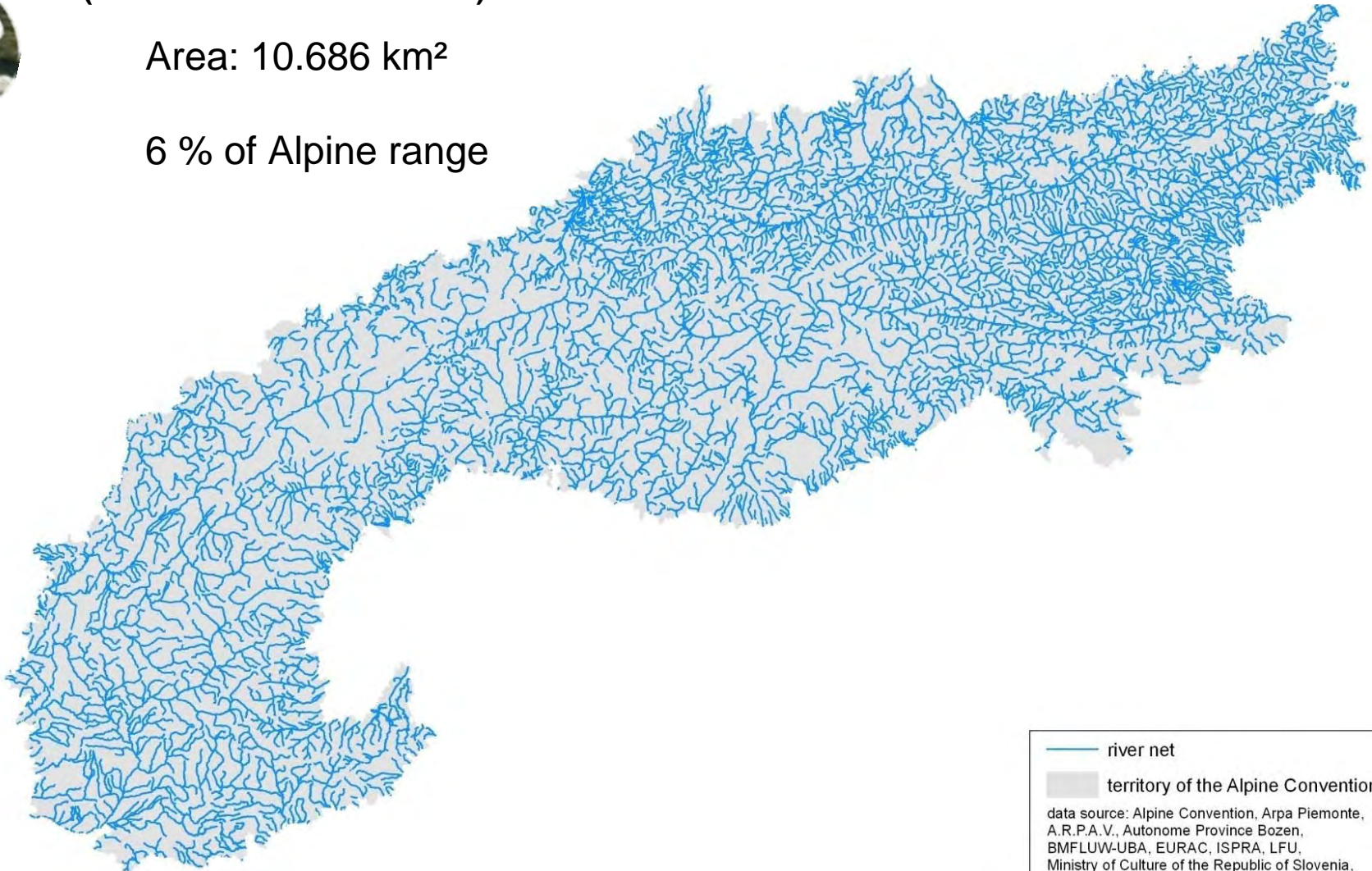


Results

Potential riverine landscape (main rivers and tributaries)

Area: 10.686 km²

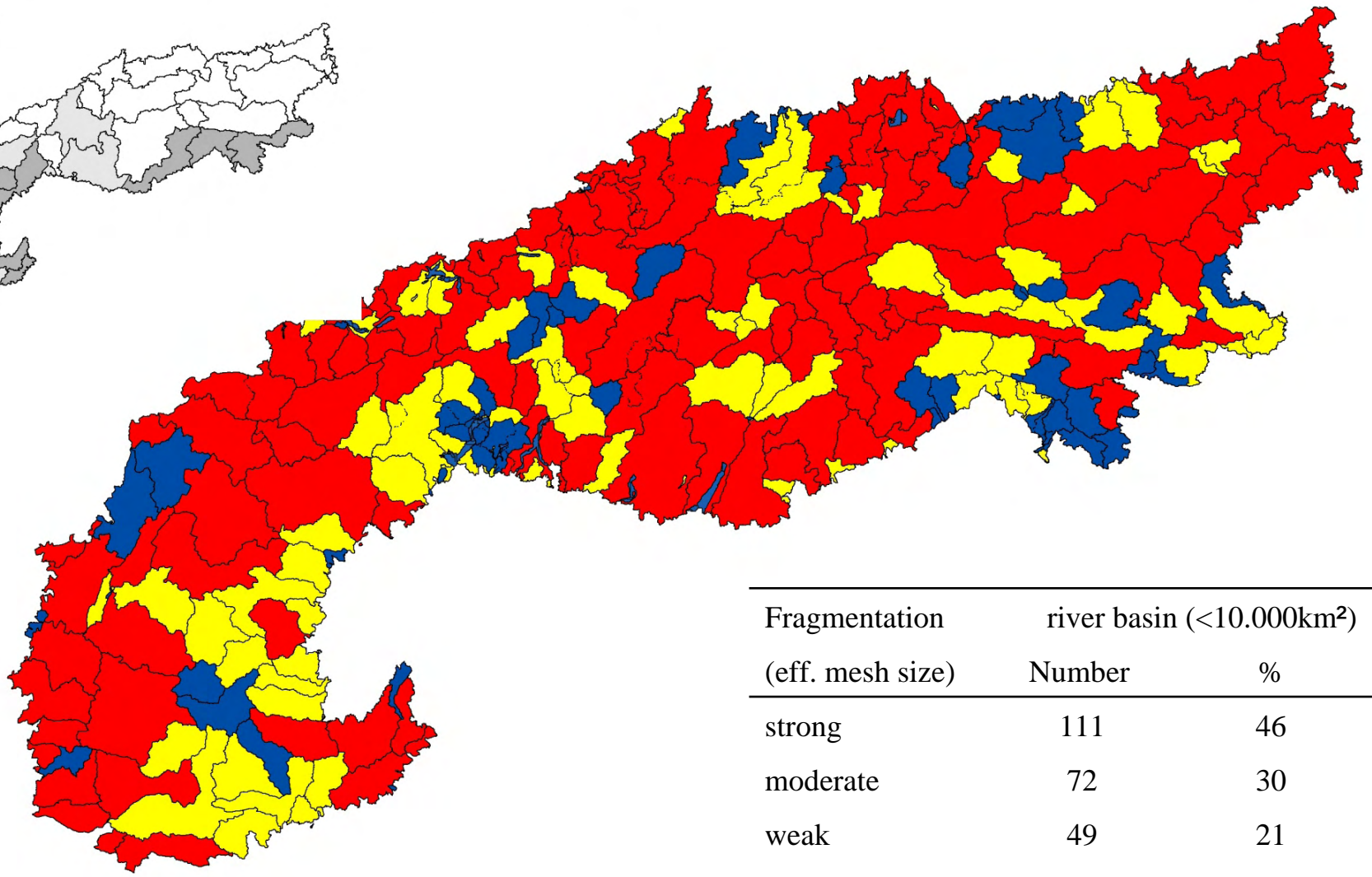
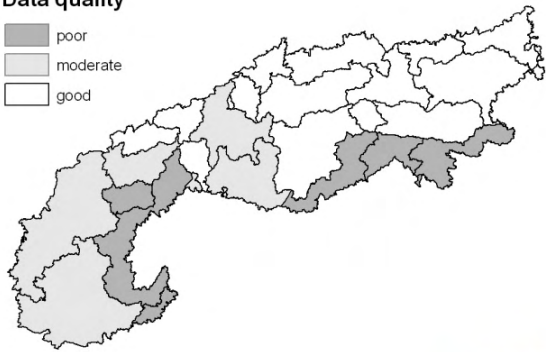
6 % of Alpine range



Effective mesh-size River Basins (<10.000km²) - Alpine Range

Data quality

- poor
- moderate
- good

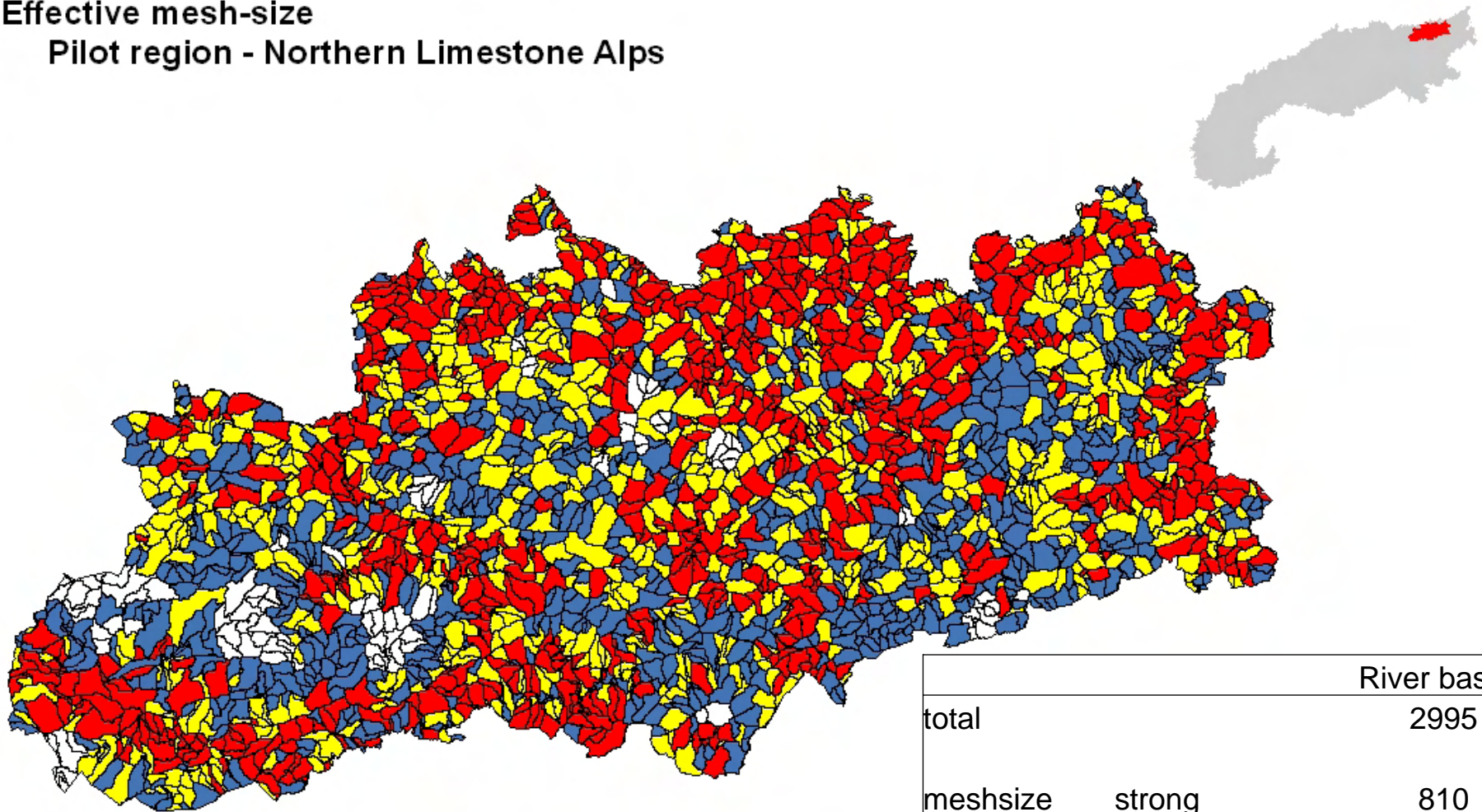


Fragmentation (eff. mesh size)	river basin (<10.000km ²)	
	Number	%
strong	111	46
moderate	72	30
weak	49	21
no running waters	7	3
Sum	239	



Effective mesh-size

Pilot region - Northern Limestone Alps



		River basins
total		2995
meshsize	strong	810
	moderate	969
	weak	991
	no running waters	225



River Ecology and Invertebrate Biology
Institute of Ecology, University of Innsbruck

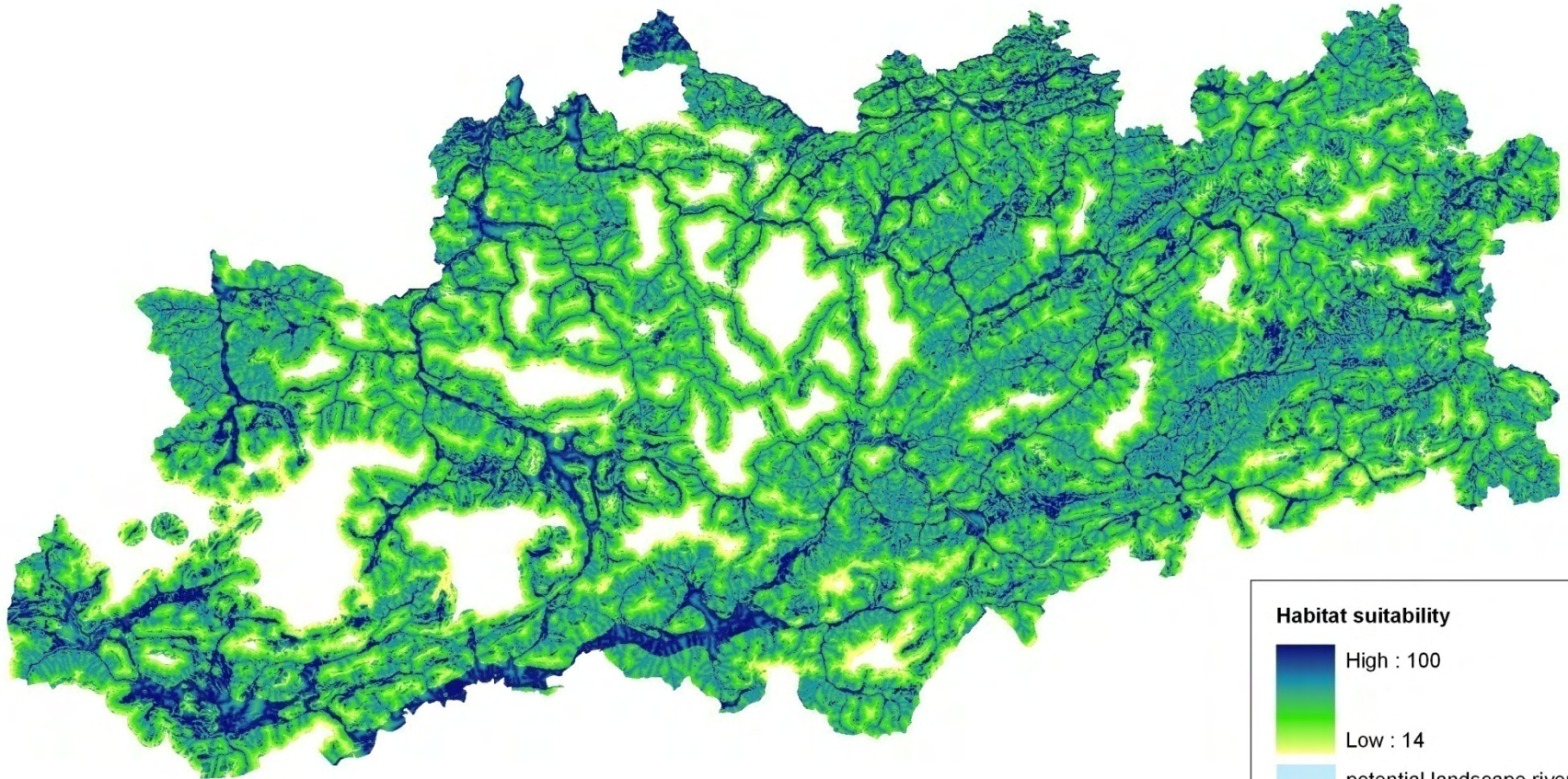


data source: Umweltbundesamt
author: Andrea Bonaloni@uibk.ac.at
date: September 2010

0 5 10 Kilometer



Habitat Suitability Model - Fishotter *Lutra lutra* Pilot region - Northern Limestone Alps



Habitat suitability

High : 100

Low : 14

potential landscape river

data source: Aster, Corine Land Cover, Teleatlas,
Land Niederösterreich, Land Oberösterreich,
Land Steiermark, Umweltbundesamt
author: andrea bou-vinals@uibk.ac.at
date: May 2011

0 3,75 7,5 Kilometer



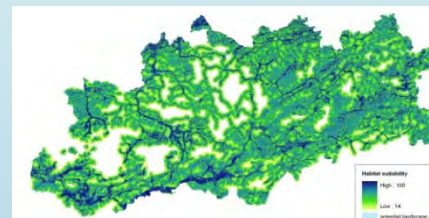
River Ecology and Invertebrate Biology
Institute of Ecology, University of Innsbruck



Results

How good is the Habitat Suitability Model?

Check with occurrence data



? Species occurrence ?



Data availability

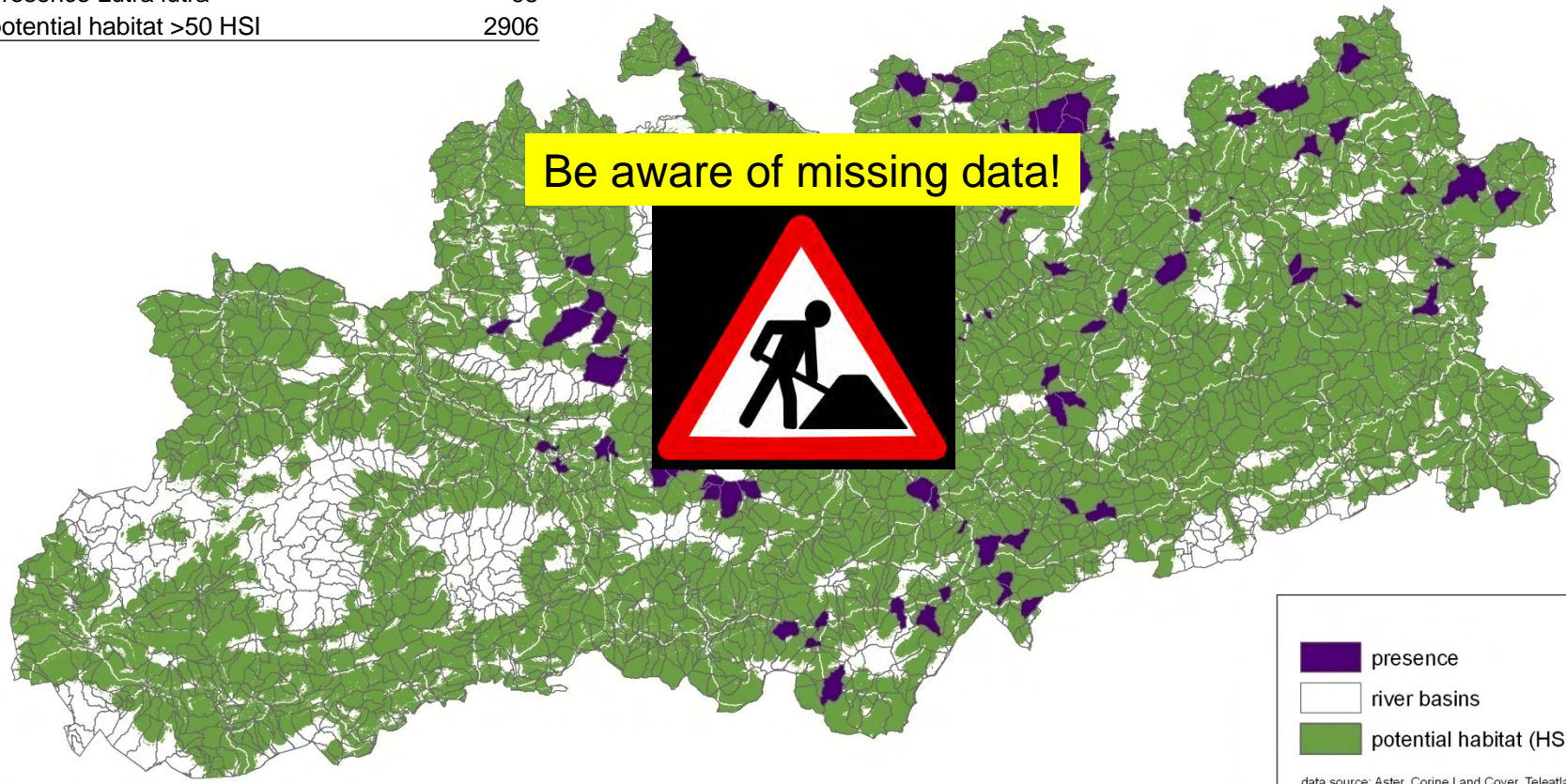
Fishotter *Lutra lutra*

Pilot region - Northern Limestone Alps



	River basins
total	2995
presence <i>Lutra lutra</i>	95
potential habitat >50 HSI	2906

Be aware of missing data!

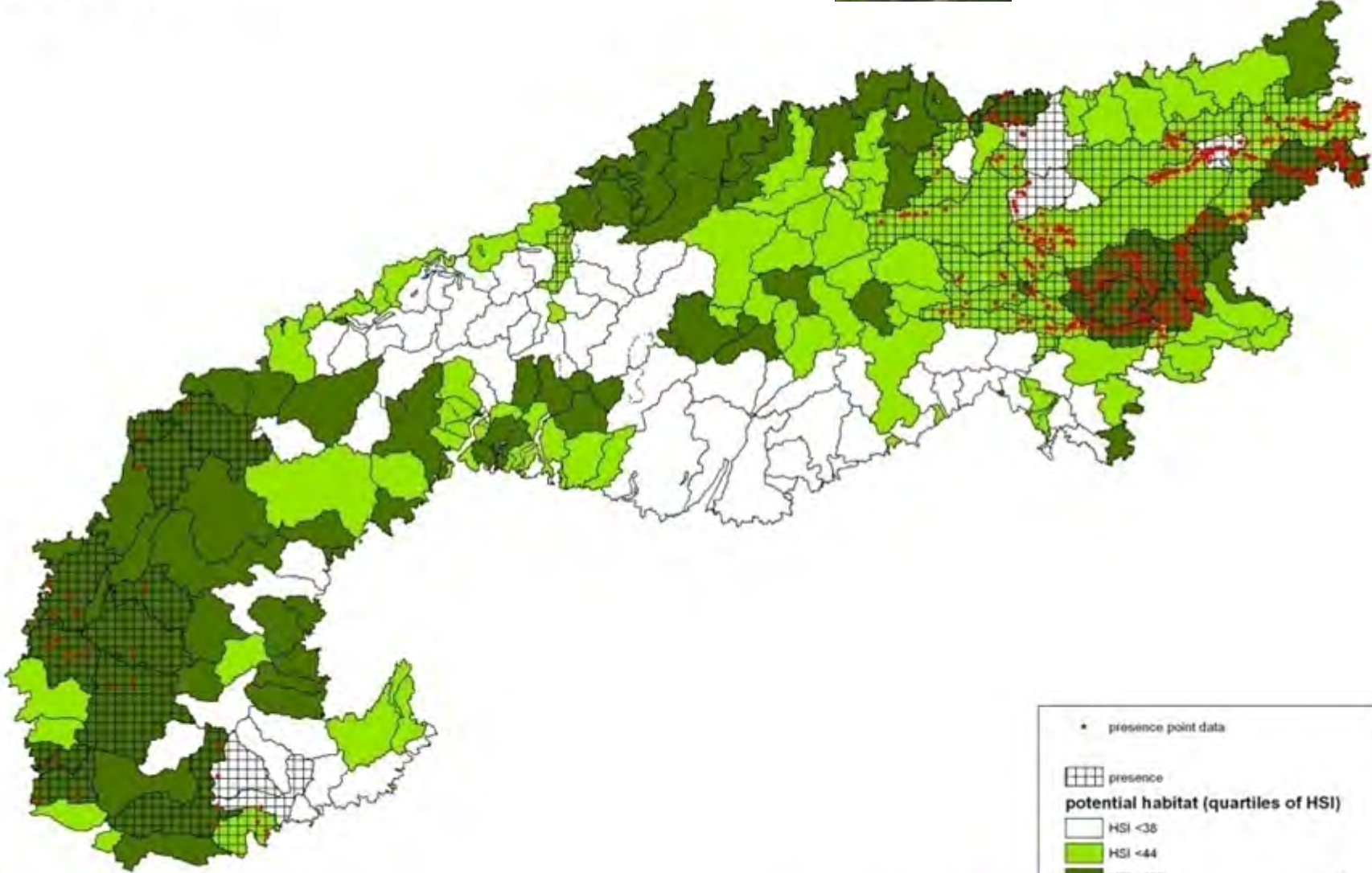


- presence
- river basins
- potential habitat (HSI>50)

data source: Aster, Corine Land Cover, Teleatlas,
 Land Niederösterreich, Land Oberösterreich,
 Land Steiermark, Umweltbundesamt
 author: andrea bou-vinals@uibk.ac.at
 date: May 2011

0 3,75 7,5 Kilometer

Fish otter (*Lutra lutra*) Alpine Range



• presence point data

presence

potential habitat (quartiles of HSI)

HSI < 36

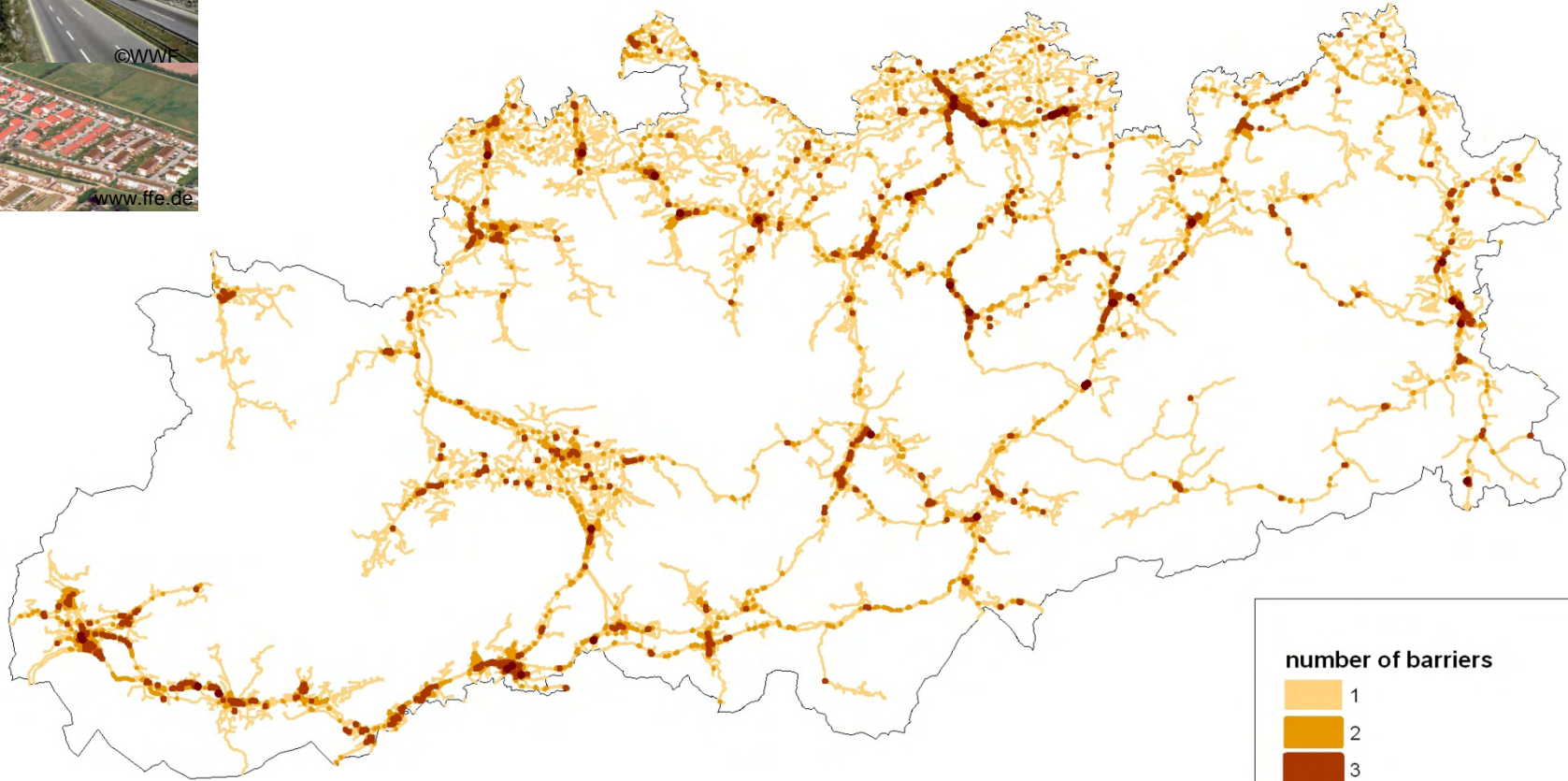
HSI < 44

HSI < 100

0 50 100 Kilometer

N

Migration barrier - Fishotter *Lutra lutra* Pilot region - Northern Limestone Alps



number of barriers



data source: Aster, Corine Land Cover, Teleatlas,
Land Niederösterreich, Land Oberösterreich,
Land Steiermark, Umweltbundesamt
author: andrea bou-vinals@uibk.ac.at
date: February 2011

0 3,75 7,5 Kilometer

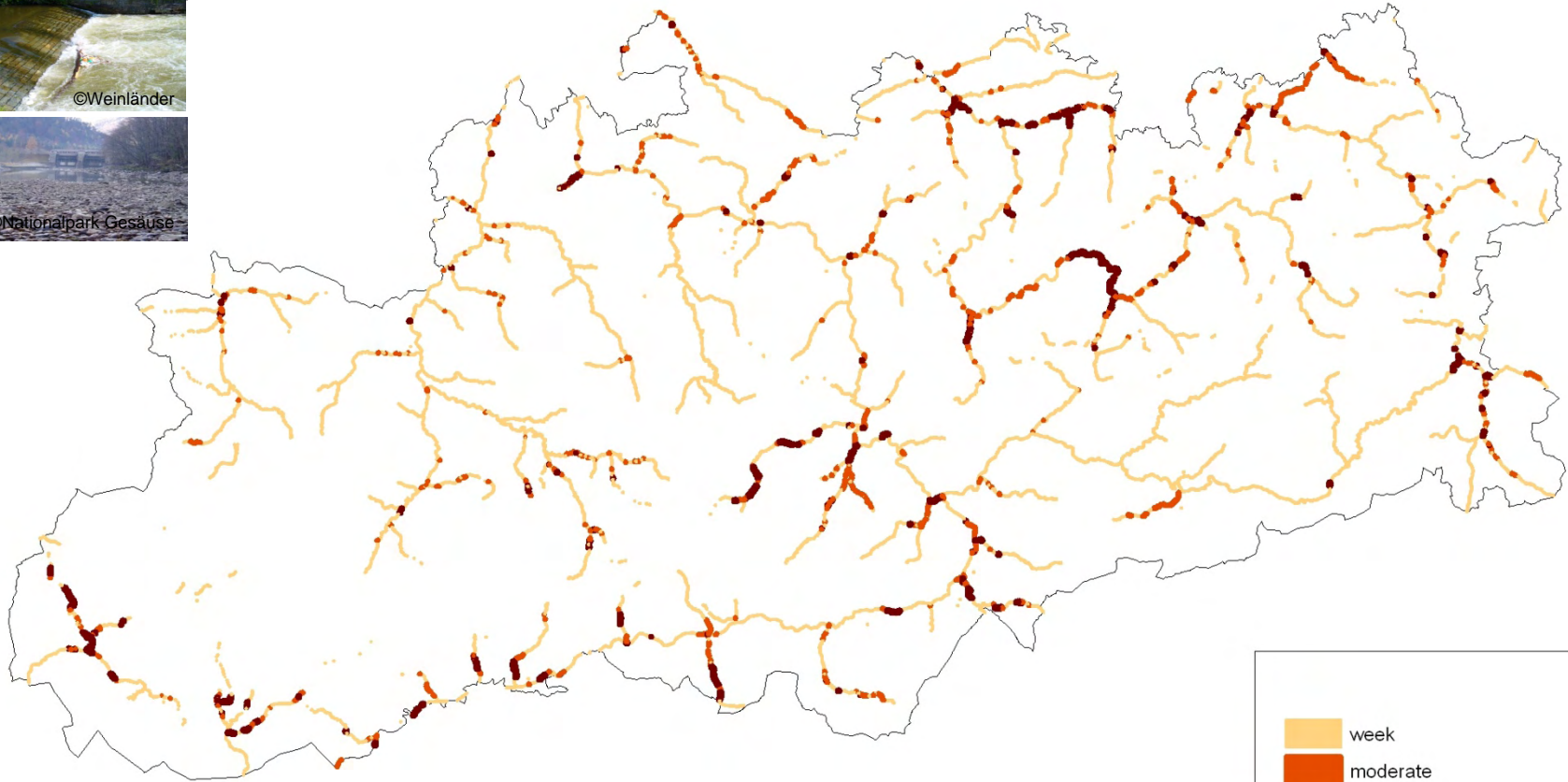


River Ecology and Invertebrate Biology
Institute of Ecology, University of Innsbruck



Habitat deterioration - Fish otter (*Lutra lutra*)

Pilot region – Northern Limestone Alps



weak
 moderate
 strong

data source: Aster, Corine Land Cover, Teledatlas,
 Land Niederösterreich, Land Oberösterreich,
 Land Steiermark, Umweltbundesamt
 author: andrea bou-vinals@uibk.ac.at
 date: February 2011

0 3,75 7,5 Kilometer

Results

Focus 3: Connectivity and Corridors

Potential habitat (Habitat Suitability Model)
+
Species specific barriers

ArcGis tool “Corridor designer”

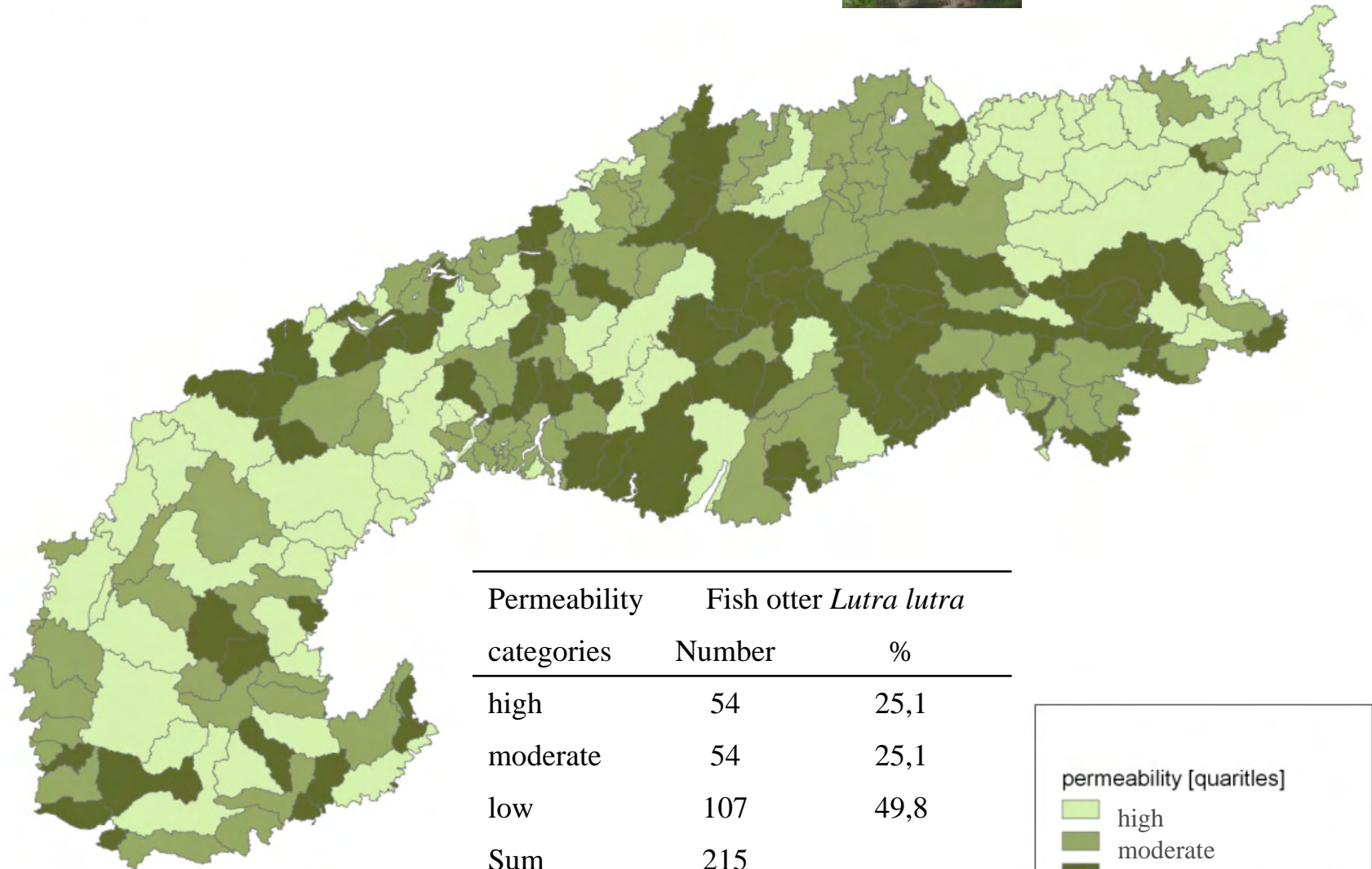


Permeability / Corridors

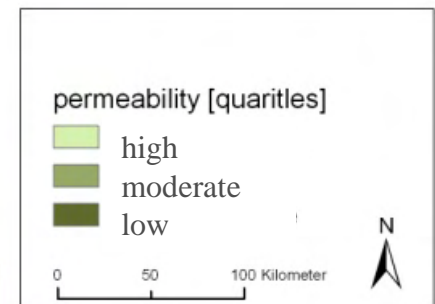
Corridor Analyse - Fish otter (*Lutra lutra*) Alpine Range



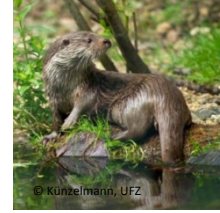
© Künzelmann, UFZ



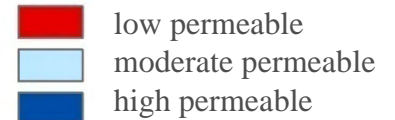
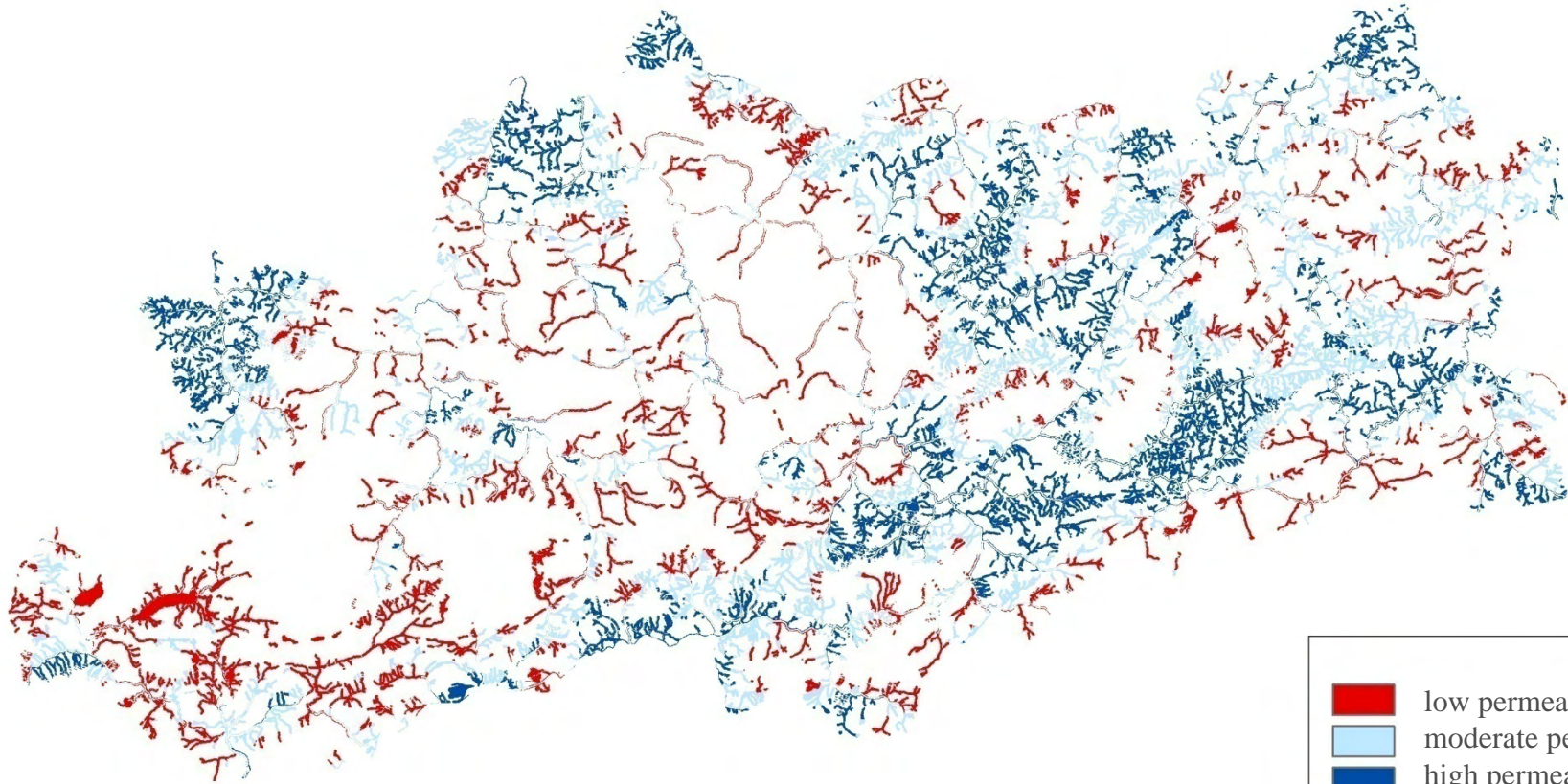
Permeability categories	Fish otter <i>Lutra lutra</i>	
	Number	%
high	54	25,1
moderate	54	25,1
low	107	49,8
Sum	215	



Corridor Analysis - fishotter *Lutra lutra* Pilot region - Northern Limestone Alps




© Kunzelmann, UFZ



data source: Aster, Corine Land Cover, Teleatlas,
Land Niederösterreich, Land Oberösterreich,
Land Steiermark, Umweltbundesamt
author: andrea bou-vinals@uibk.ac.at
date: May 2011

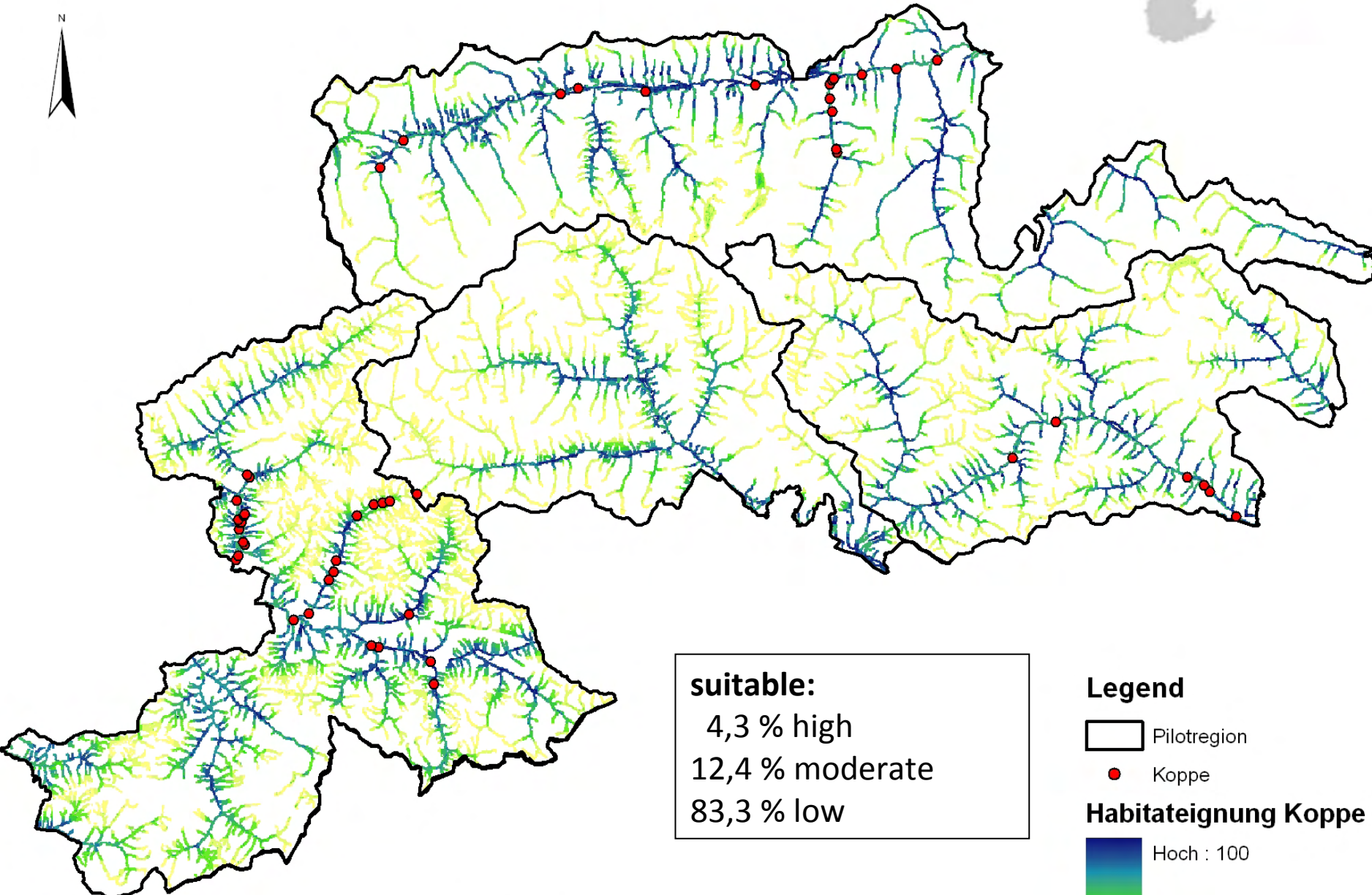
0 3,75 7,5 Kilometer



River Ecology and Invertebrate Biology
Institute of Ecology, University of Innsbruck



Habitat suitability for bullhead (*Cottus gobio*) The Hohe Tauern – Southtyrol Region



suitable:
4,3 % high
12,4 % moderate
83,3 % low

Legend

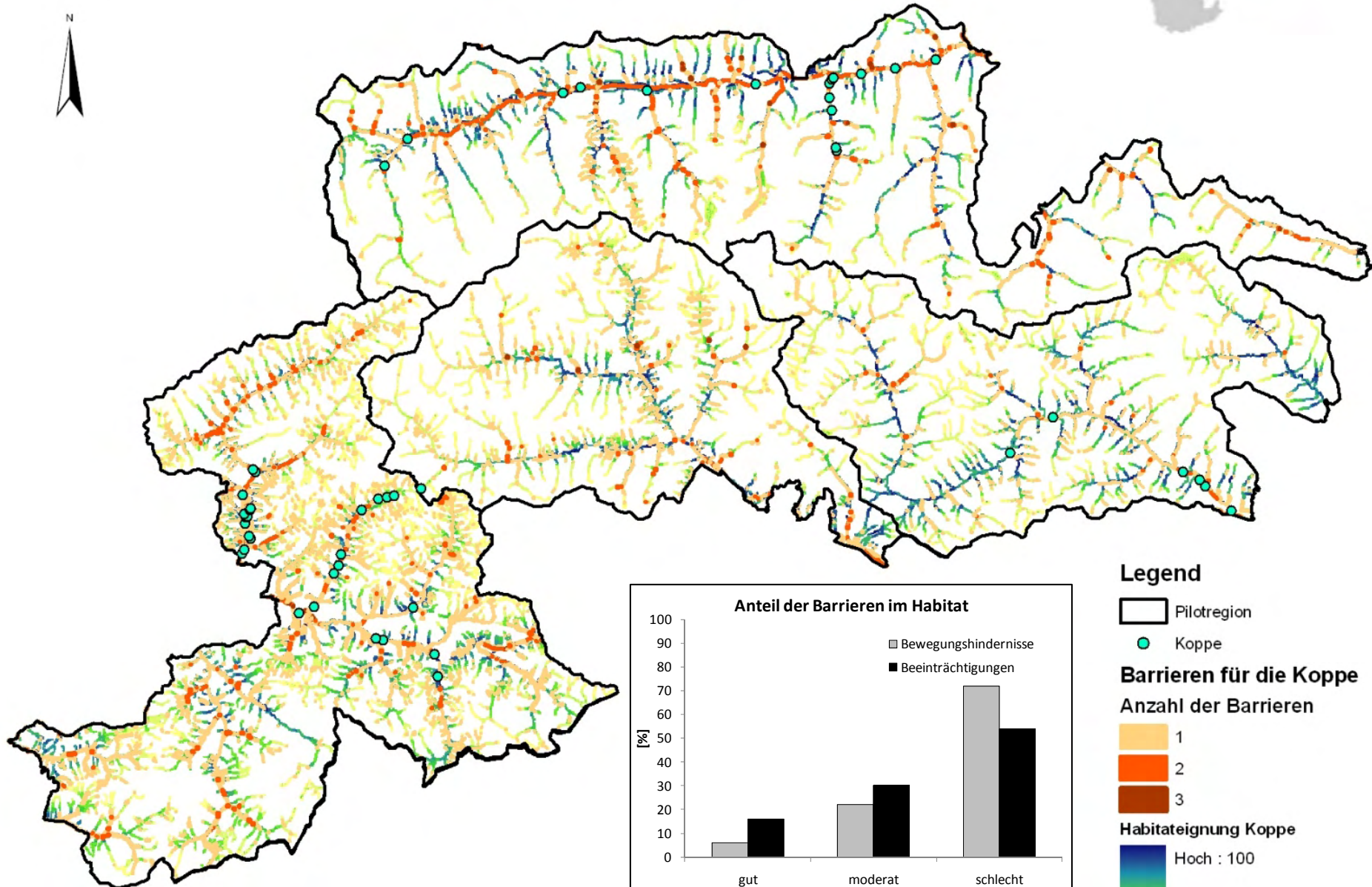
-  Pilotregion
-  Koppe

Habitateignung Koppe

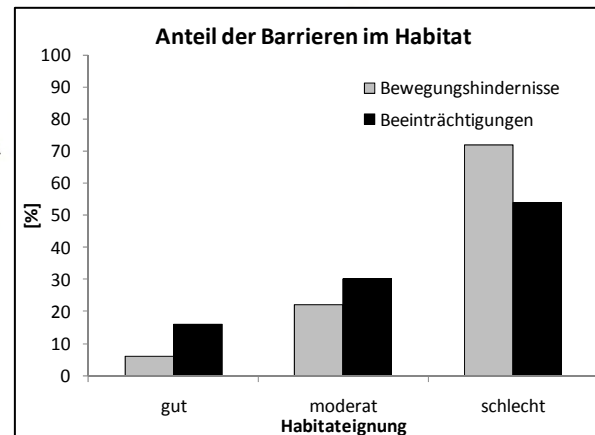


Hoch : 100
Niedrig : 40

Barriers and obstacles for bullhead (*Cottus gobio*) The Hohe Tauern – Southtyrol Region



0 10 20 Kilometers



Legend

Pilotregion

Koppe

Barrieren für die Koppe

Anzahl der Barrieren

1

2

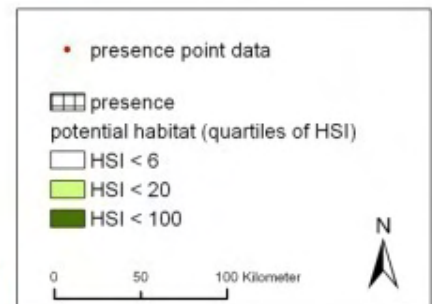
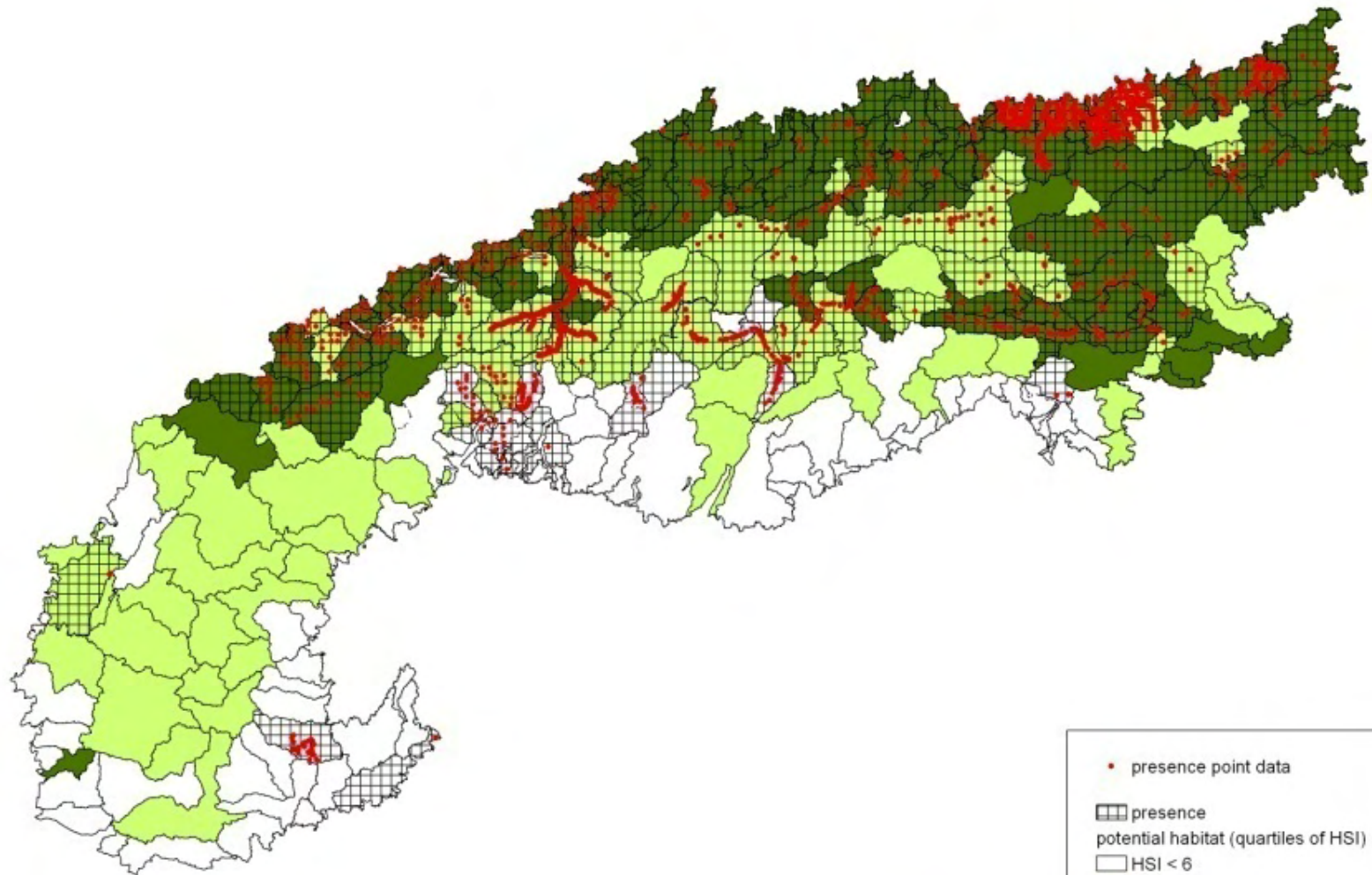
3

Habitateignung Koppe

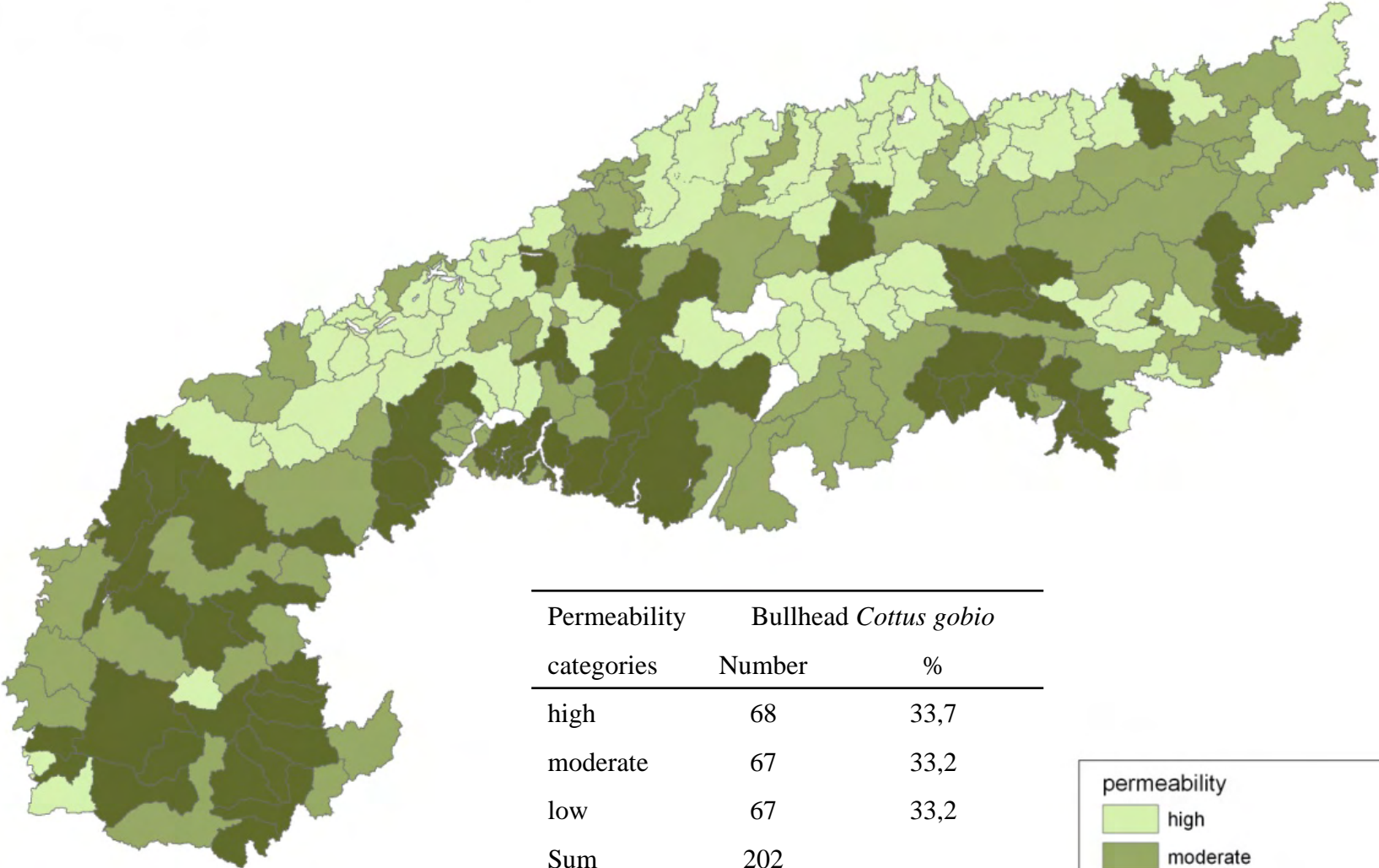
Hoch : 100

Niedrig : 40

Bullhead (*Cottus gobio*) Alpine Range



Corridor analysis- Bullhead (*Cottus gobio*) Alpine Range



Permeability categories	Bullhead <i>Cottus gobio</i>	
	Number	%
high	68	33,7
moderate	67	33,2
low	67	33,2
Sum	202	

permeability

- high
- moderate
- low

0 50 100 Kilometer

Conclusions

1. the analysis and identification of typical habitats and typical riverine species – **most parts of the potential riverine landscapes are suitable for fish otter, bullhead is limited mainly by natural circumstances**
2. the analysis and identification of barriers being effective in the longitudinal, lateral, vertical and temporal dimensions of river systems - **impacts are associated with human settlements and activities in the valleys, while higher elevated and protected areas are less affected**
3. analysis of the potential to increase connectivity and decrease barrier effects and fragmentation – **CARL is a good tool to identify fragmentation and to localise areas with less permeability for species – Problem of data availability and quality**

Data source and References



Alpine Convention
Amt für Jagd und Fischerei Südtirol
Agence de l'eau Rhône-Méditerranée et
Corse
Aster gdem - Courtesy NASA/JPL-
Caltech
Autonome Provinz Bozen/Bolzano
Autonome Provinz Trento
Arpa Piemonte
A.R.P.A.V.
BAFU
BAW
BMLFUW-UBA
CKMAP
CORINE Land Cover 2000 (CLC2000)
DIREN Rhône-Alpes
European Environment Agency
EURAC
European River Catchments dataset
version 1.01, European Environment
Agency, 2006.
GBIF data portal
Gis-Steiermark
Haus der Natur,
INATURA
ISPRA
Kagis
Kofler (2003)
Kranz A. (2000):
LFU

Medgyesy N.,
Ministry of Culture of the Republic of Slovenia
Ministry of the environment and spatial planning, Republic of
Slovenia
NASA, METI
Nationalpark Gesäuse
NLWKN (Hrsg.) (2009)
NÖGIS
Onema
Parco Alpi Marittime
Provinz Lombardia
Reuther et al. (2000)
Sagis
Swisstopo
Tele Atlas BV 2010
Tiris
Umweltbundesamt, BMLFUW
Umweltdachverband, Austria
Vogis
WIGeoGis
worldclim
ZOBODAT