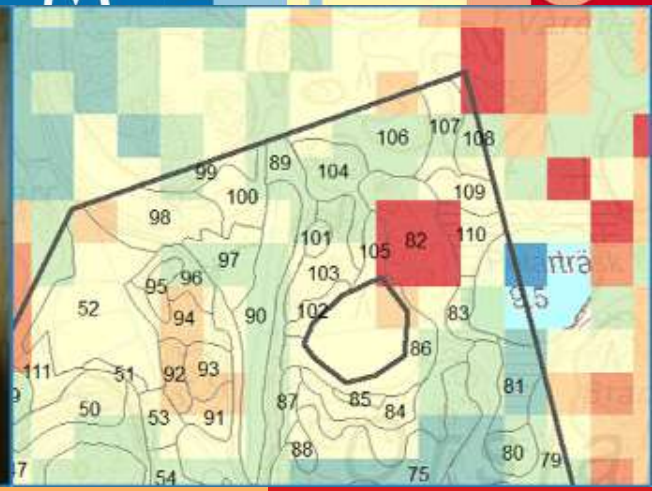
ECOLOGICAL DECISION ANALYISIS
IN SUPPORT OF SOCIETAL DECISION MAKING

METSO



Zonation
Land use prioritization
(for biodiversity conservation)

METSO Forest Biodiversity

Current issues in forest conservation and biodiversity 14.11.2019

Coordinator Ninni Mikkonen, Finnish Environment Institute (SYKE)

More information and this presentation: http://tiny.cc/Zonation_Mikkonen

10 years together with Zonation

Biologist, ecologist

Zonation analysis coordinator since 2010

Forest conservation since 2012

Interdisciplinarity!

SYKE METSÄHALLITUS UNIVERSITY OF HELSINKI UNIVERSITY OF JYVÄSKYLÄ metsäkeskus TAPIO

METLA

Why Zonation?

Why are spatial conservation prioritization tools needed?

How Z works?

Cases from FIN

1.
Spatial conservation prioritization

Smart use of resources


Wood
Money
People
Food
CRISIS
Resources are limited
Yield
Water
Peat
Area for living
Time
Energy
Prioritization needed

Why to use resources wisely?

Value: Sustainable development

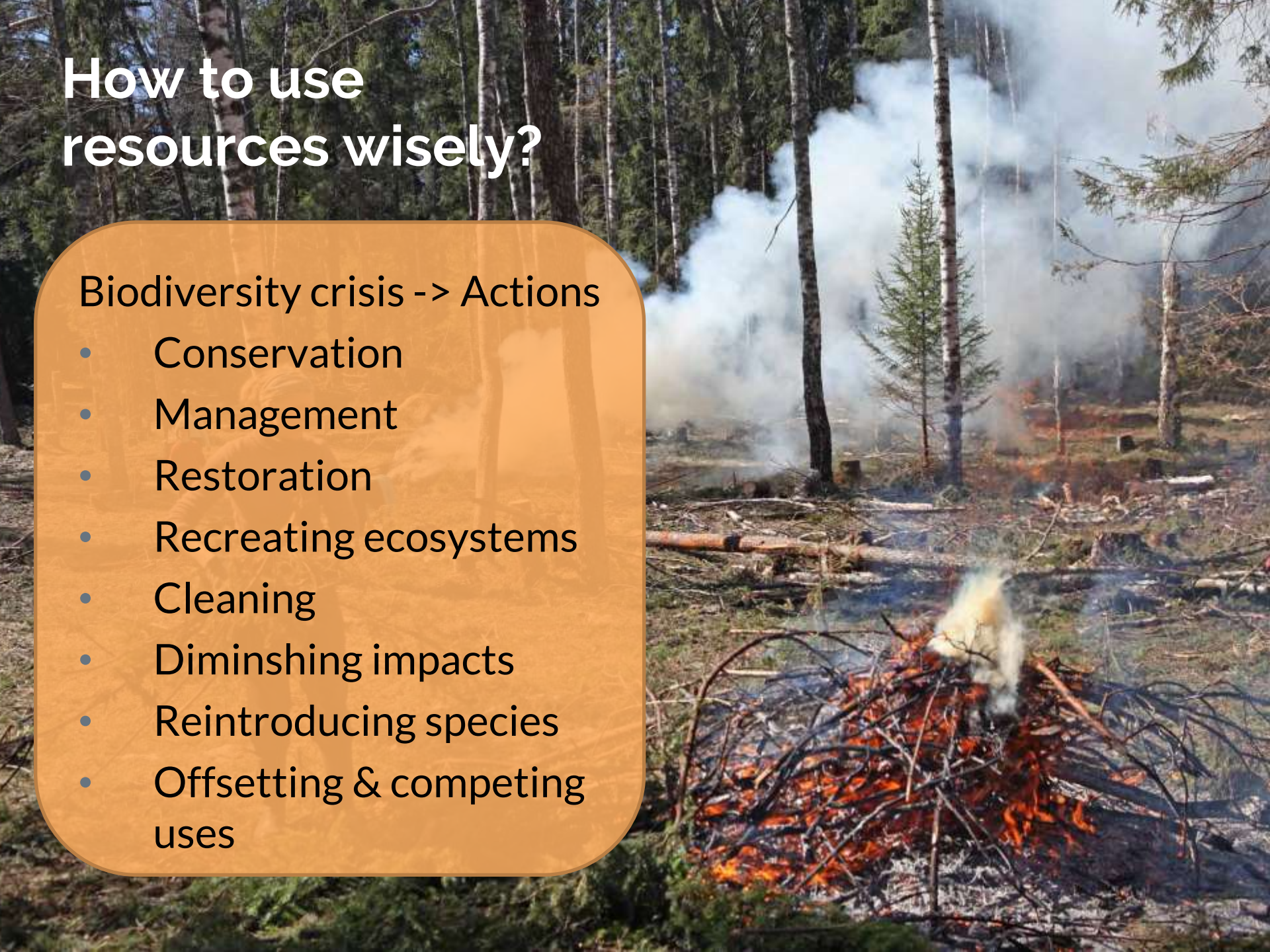
Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
(World Commission on Environment and Development, 1987)

1) Economic and 2) social development and 3) environmental protection

How to use resources wisely?

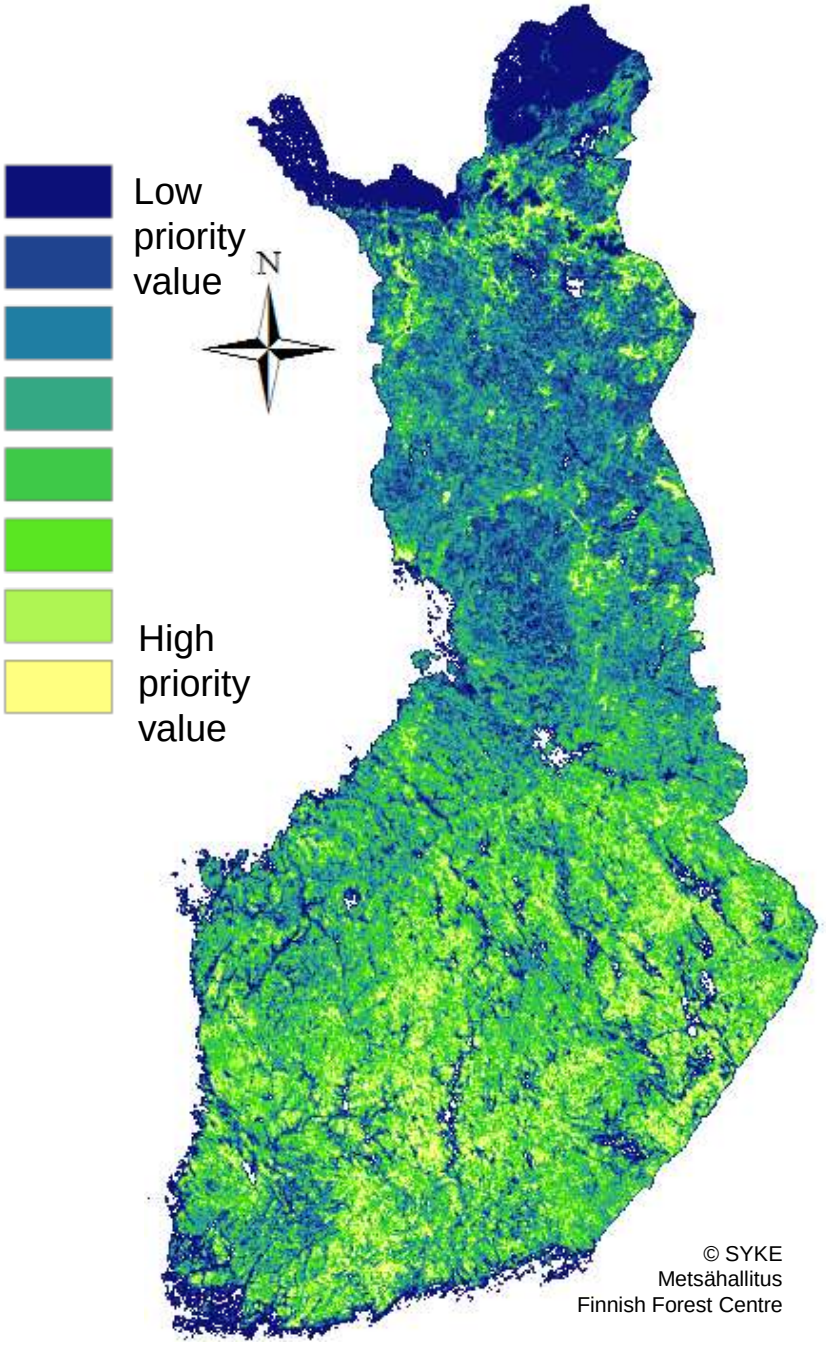
Biodiversity crisis -> Actions

- Conservation
- Management
- Restoration
- Recreating ecosystems
- Cleaning
- Diminshing impacts
- Reintroducing species
- Offsetting & competing uses

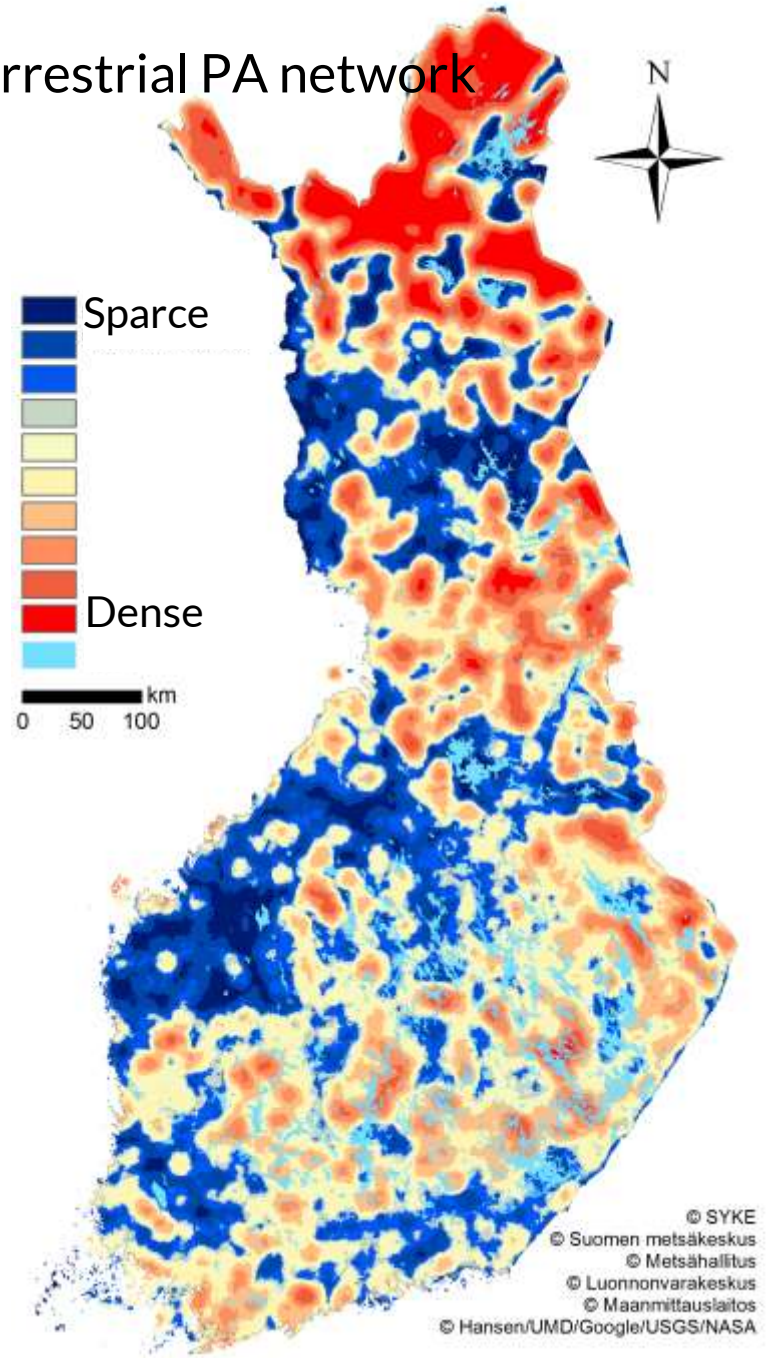


The most difficult question – where?

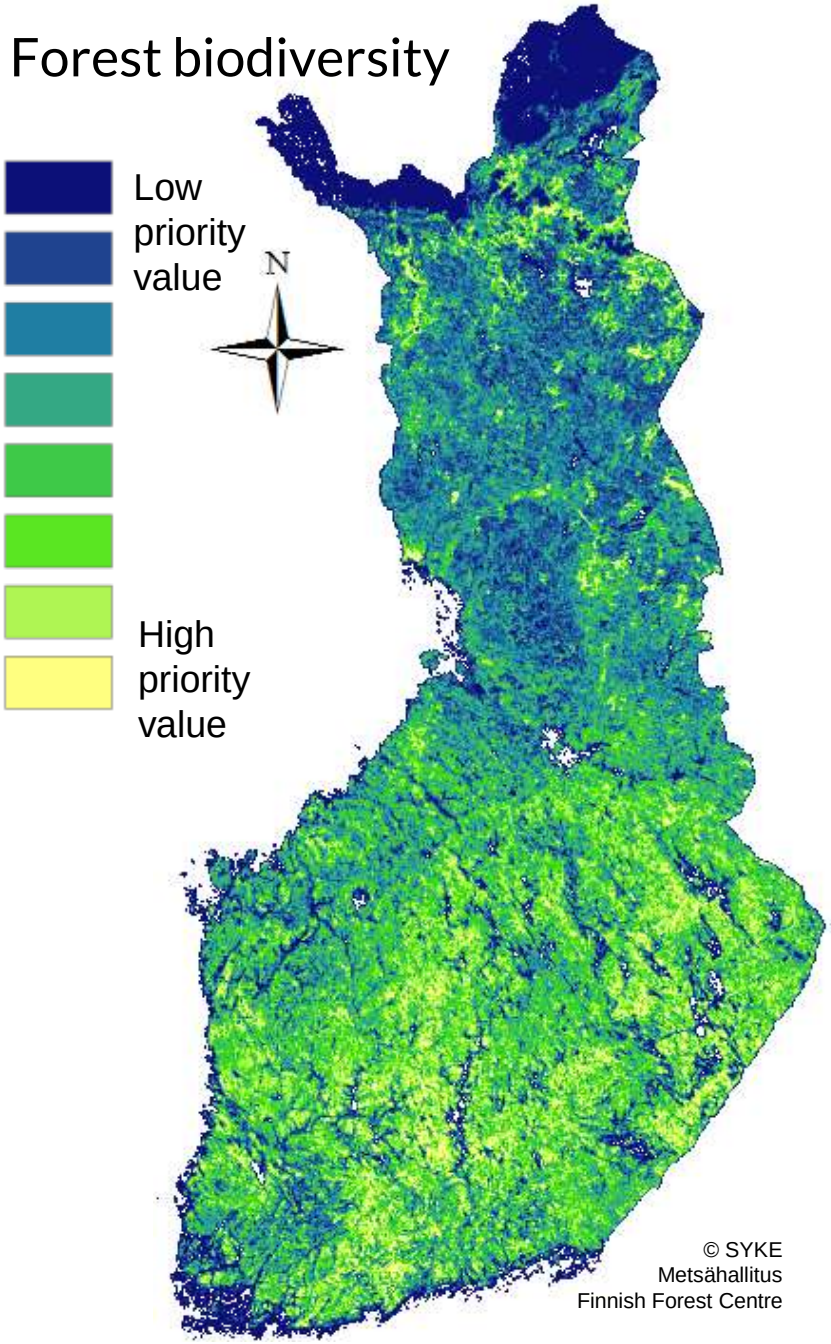
- For spatial questions -> Spatial conservation planning
- Even more difficult:
  - Which actions?
  - Interactions?
  - Consequences?



Terrestrial PA network

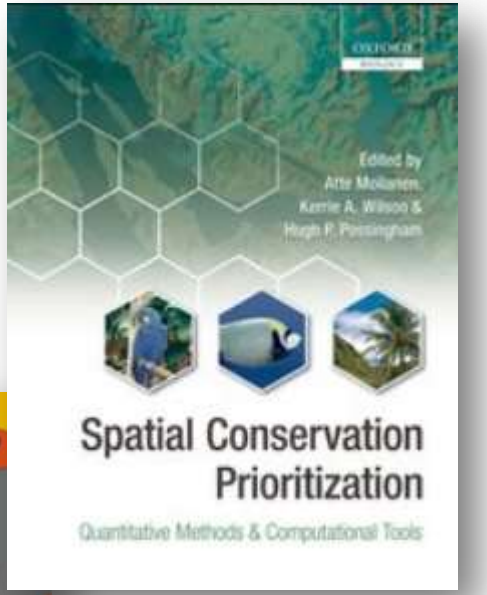


Forest biodiversity

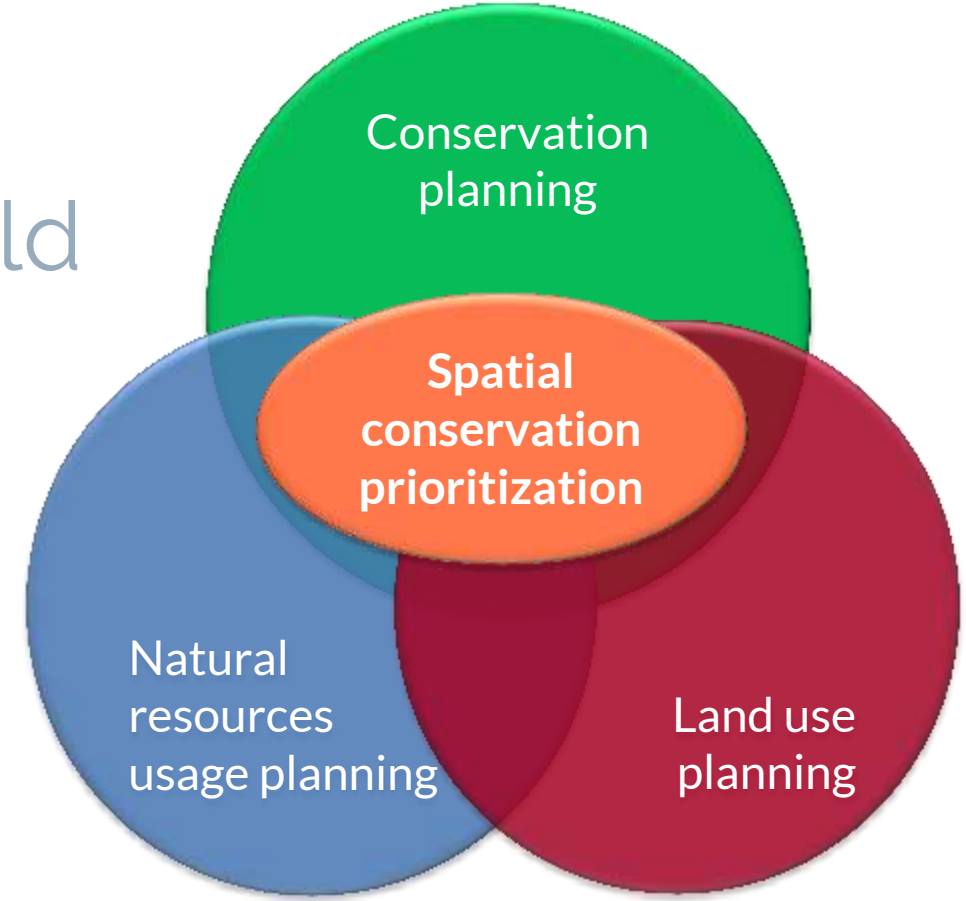


WHY + HOW + WHERE =

Ecological decision making
= structural problem analyzing possible,
but not necessarily gives answers



If the world would be perfect..



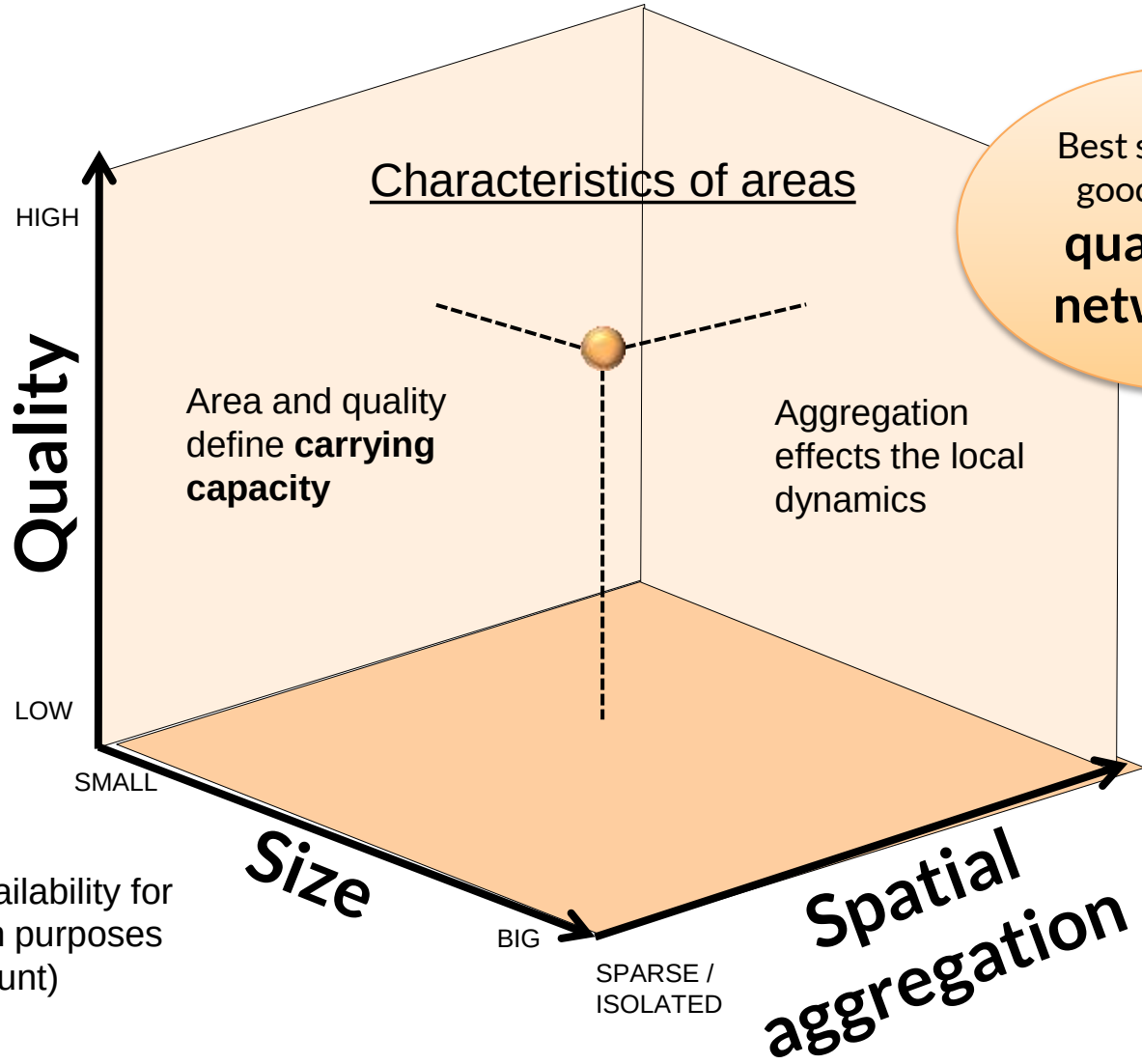
Land use decisions are a balancing act

Ferrier & Wintle 2009: *Quantative approaches to spatial conservation prioritization: matching the solution to the need*. --- **in Moilanen, Wilson, Possingham, *Spatial conservetion prioritization, quantataive methods & computational tools***

Objective:
*Best possible **long term** conservation outcome (persistence)*

"The holy trinity" of conservation planning

aka "Fundamental quantities of spatial population biology"



Resource density (e.g., mirco-climate, nestig places, food, prey)

Best solutions are good in both: in **quality** and in **network** view.

Habatitat availability for conservation purposes (spatial amount)

The spatial (network) structure of the habitat

Original picture: Joona Lehtomäki

Decision making needs spatial and good quality information

Garbage in – garbage out!

2.

a tool for spatial conservation prioritization

…for his extraordinary contributions to **ecologically** based, **computational** methods to **support conservation solutions** that successfully **tradeoff** biodiversity values, costs and alternative land-uses and **conservation resource allocation**.

ZONATION
Conservation planning software

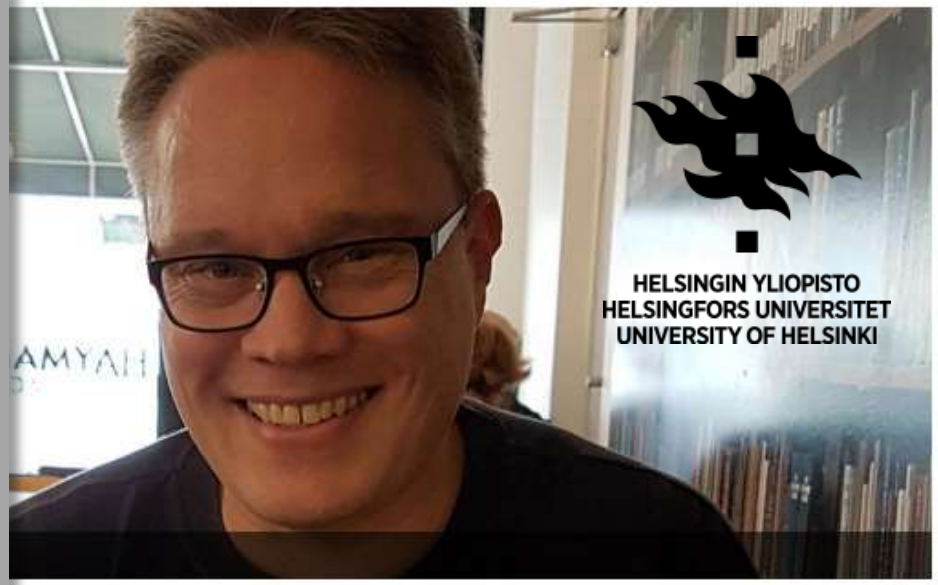
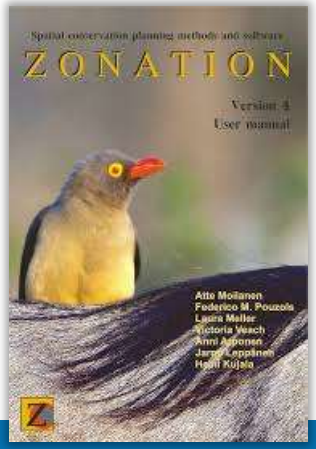


PHOTO: YUNG EN CHEE



RESEARCH /

Atte Moilanen receives Distinguished Service Award from the Society for Conservation Biology

Zonation since 2006

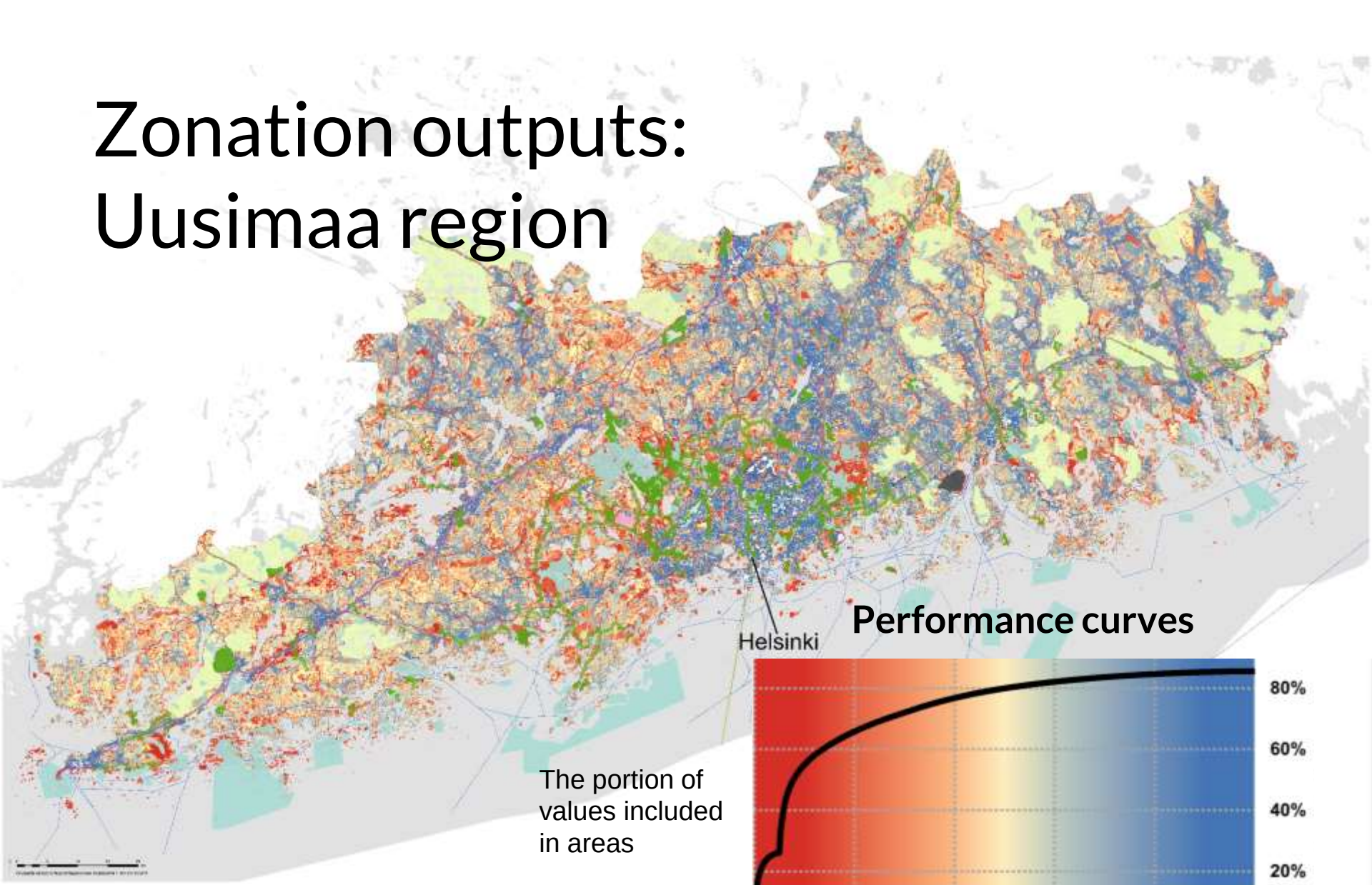
- Freely available www.syke.fi/zonation/en
- Can use big datasets simultanously

There are no jobs on a dead planet!

Atte Moilanen,
the creator of Zonation software

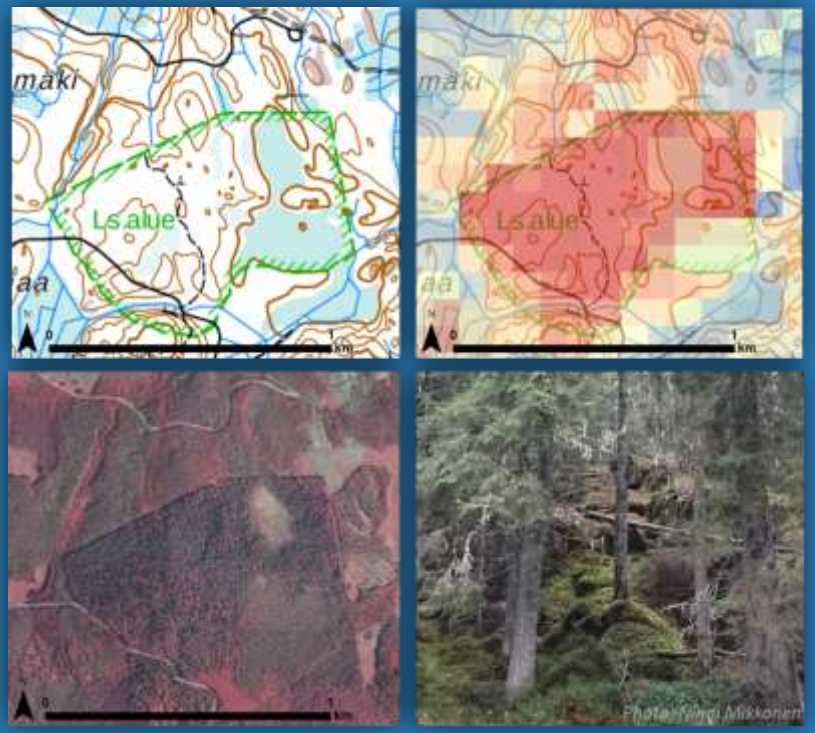
What is the difference between Z and GIS?

Zonation outputs: Uusimaa region



© Joel Jalkanen, University of Helsinki
Joel.jalkanen@helsinki.fi

What is the difference between Z and GIS



Simultaneously:

1. **<u>Complementarity</u> of areas (irreplaceability)**
2. Balanced solution between input features
3. Prioritization of the whole research area (vs. targets)
4. Distribution: rarity
5. Connectivity, interactions…
6. Weights between
7. Replacement cost analyses
8. Costs, penalties, threats, uncertanties
9. …

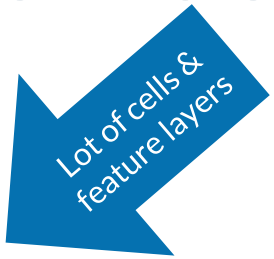
WHEN to use Zonation?

- **When expertise is not enough!**
  - Big areas
  - Interdisicplinarity needed
  - Subjectivity needs to be reduced
  - Connectivity is needed
  - GIS is not enough

- **When you have resources, not just an idea**
  - When experts, time, money and datas are available –Not a modelling tool

Everything has two sides…

Strenghts of Z



- Z can process very **big data sets** and take into account very difficult factors such as connectivity
- Planning process is transparent which reduces subjectivity
- Z is effective and easily repeatable approach IF datas are ready
- Easy to take advantage of excisting datas and focus ideas on creating new ones

Weaknesses of Z

- SLOW if prepaired data is not available
  - Expensive in the beginning
- If you have quality problems with data
- One can never have everything essential in one analyisis
- Might seem complicated from a perspective of interest groups

ZONATION
Conservation planning software

Zonation – what is it for?

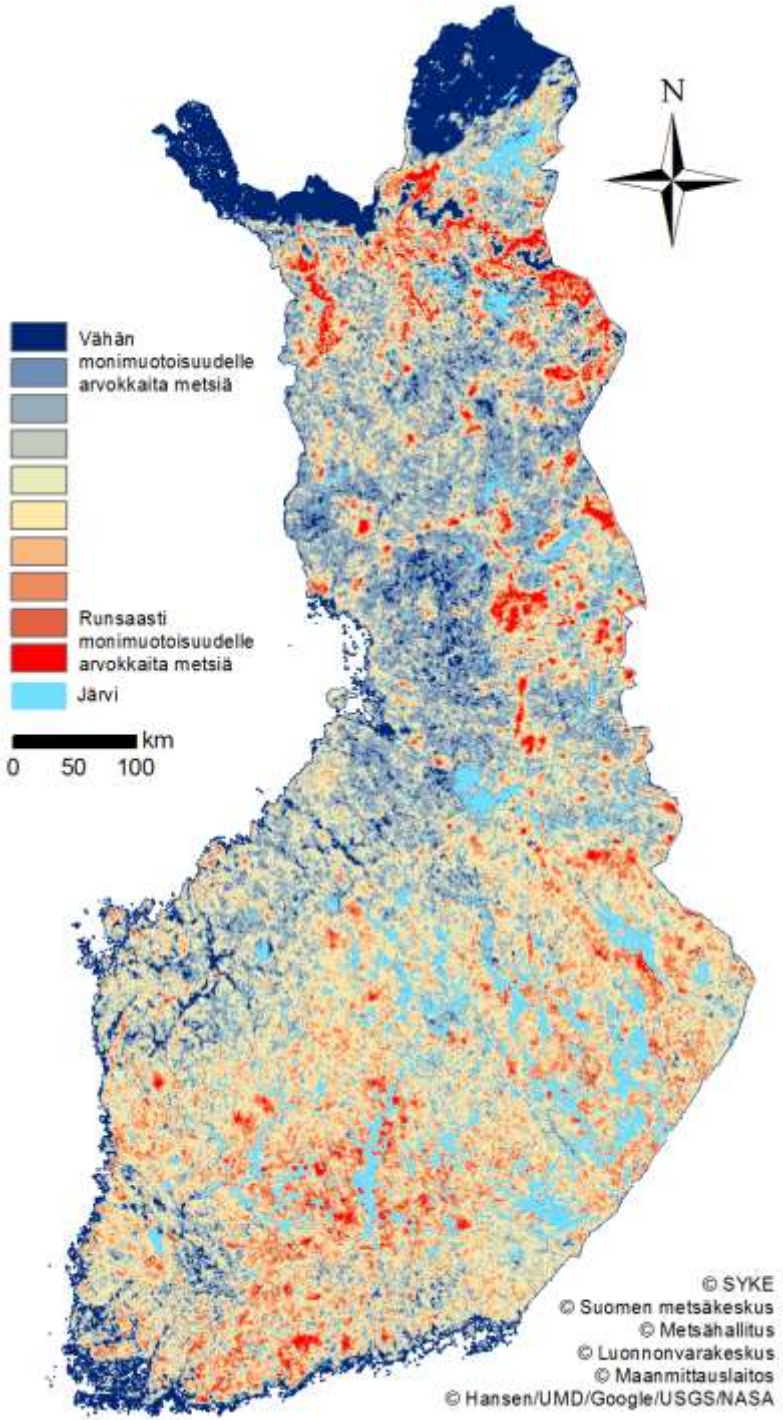
1	Identifying ecologically most valuable areas
2	Identifying ecologically least valuable areas
3	Assessing excisting nature conservation network
4	Expanding (developing) nature conservation network

ZONATION
Conservation planning software

Zonation – what is it for?

1

Identifying ecologically most valuable areas

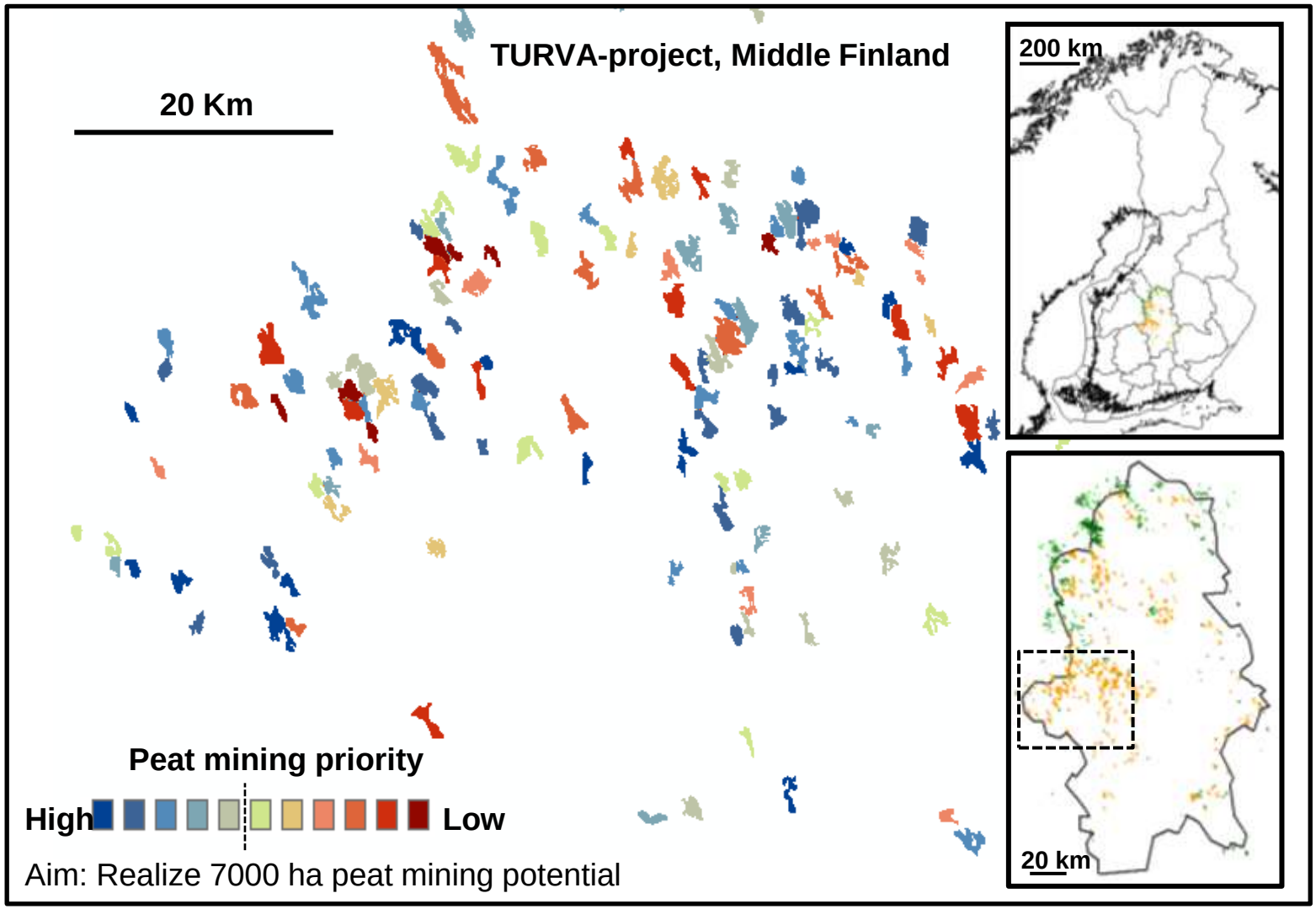


ZONATION
Conservation planning software

Zonation – what is it for?

1	Identifying ecologically most valuable areas
2	Identifying ecologically least valuable areas

7000 ha peatland for mining – Which should be saved?

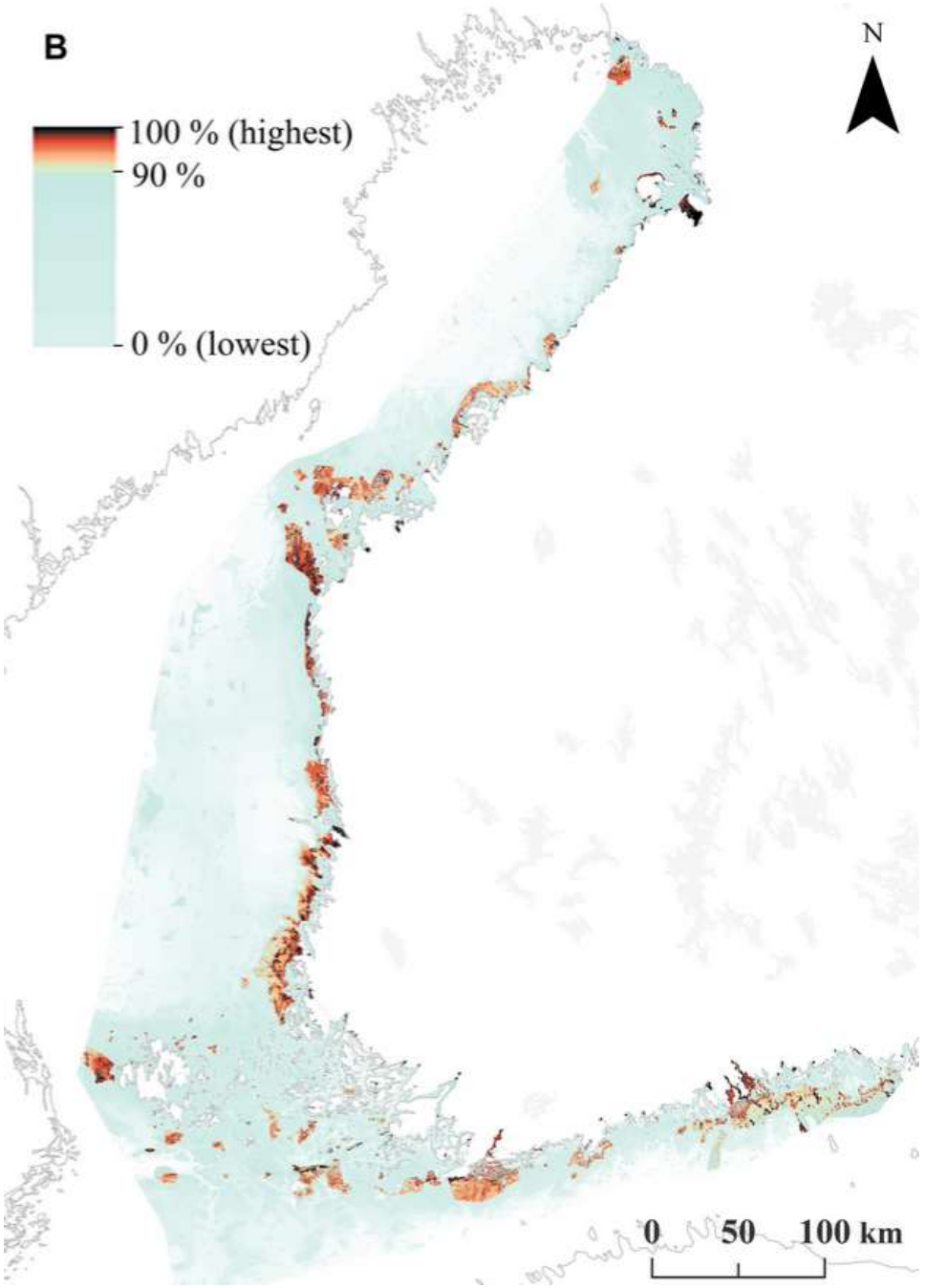


ZONATION
Conservation planning software

Zonation – what is it for?

1	Identifying ecologically most valuable areas	2	Identifying ecologically least valuable areas
3	Assessing excisting nature conservation network	4	Expanding (developing) nature conservation network

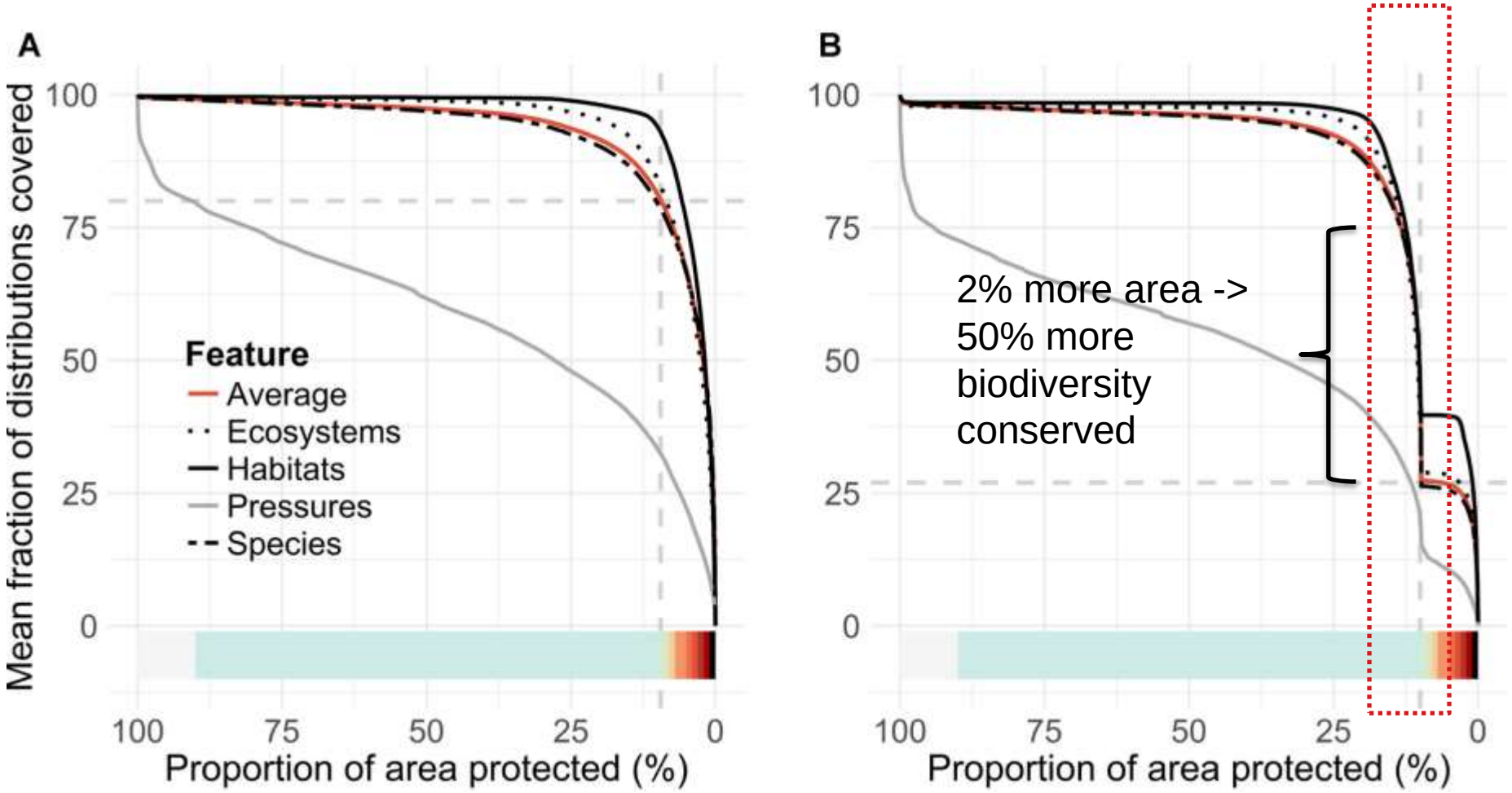
Evaluation, Gap Analysis, and Potential Expansion of the Finnish Marine Protected Area Network



Elina Virtanen, Finnish Environment Institute
elina.a.virtanen@ymparisto.fi
https://doi.org/10.3389/fmars.2018.00402

Evaluation of all marine areas

Evaluation of PA area effectivity

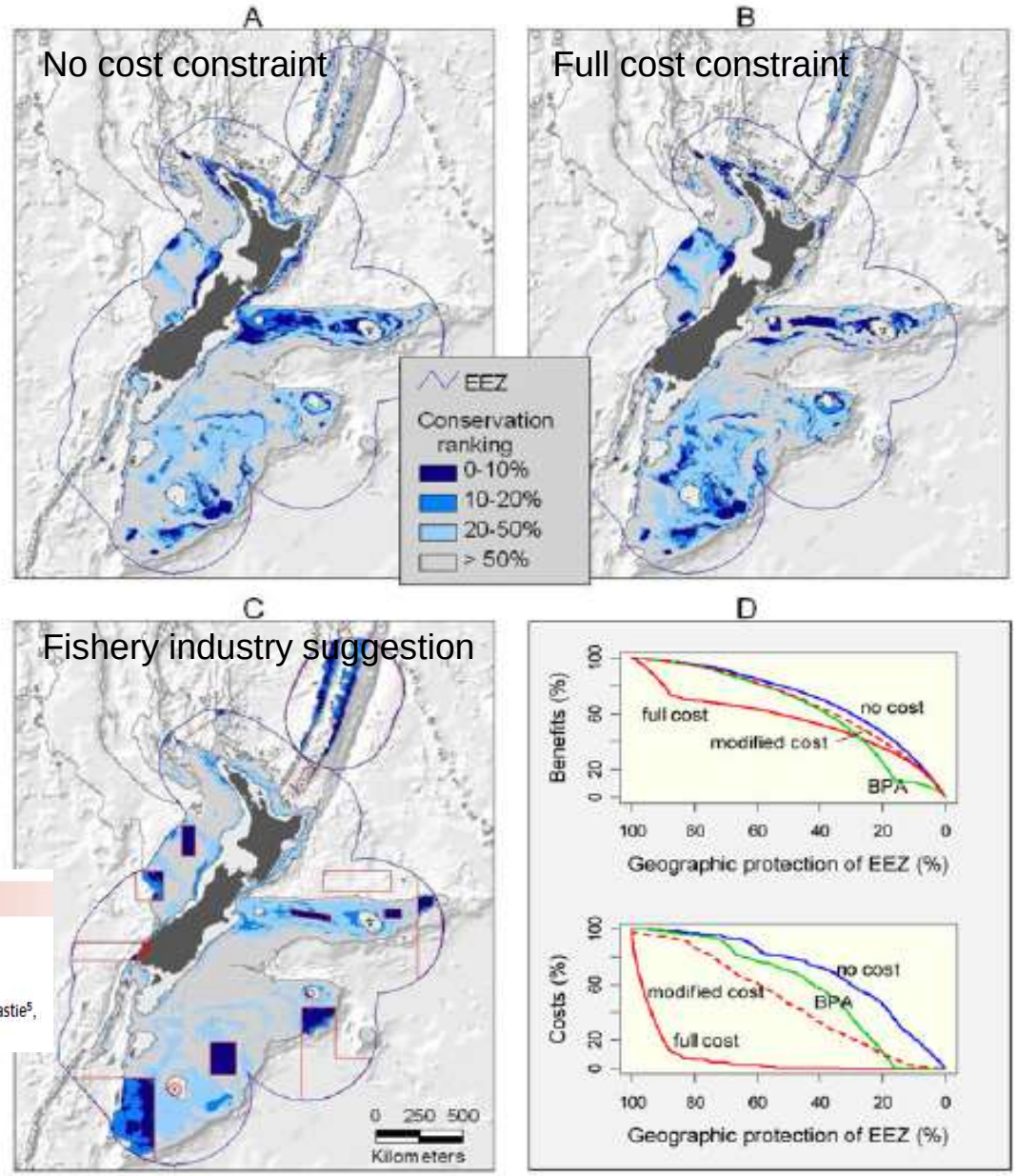


ZONATION
Conservation planning software

Zonation – what is it for?

1	Identifying ecologically most valuable areas	2	Identifying ecologically least valuable areas
3	Assessing excisting nature conservation network	4	Expanding (developing) nature conservation network

Where to establish marine conservation areas that are ecologically and economically sustainable?



LETTER

Novel methods for the design and evaluation of marine protected areas in offshore waters

John Leathwick[1], Atte Moilanen[2], Malcolm Francis[3], Jane Elith[4], Paul Taylor[1], Kathryn Julian[1], Trevor Hastie[5], & Clinton Duffy[6]

Figure 3 Zonation scenarios for marine protected areas in waters of trawlable depth in New Zealand's Exclusive Economic Zone, given varying constraints; highest conservation priorities are associated with low ranking scores. A. Initial "no cost constraint" analysis with weighting of endemic species and allowance for fragmentation effects; B. "full cost constraint"—as for A, but using a fishing intensity layer to constrain site selection; C. "BPA"—as for A, but cells falling within Benthic protection areas (boundaries shown in red) were retained until all other grid cells had been removed; D. mean benefits (top) and costs (bottom) as a function of geographic protection of waters of trawlable depth in the Exclusive Economic Zone for four Zonation scenarios.

No costs for
fishing opportunities
but more than 20 % more
biodiveristy values

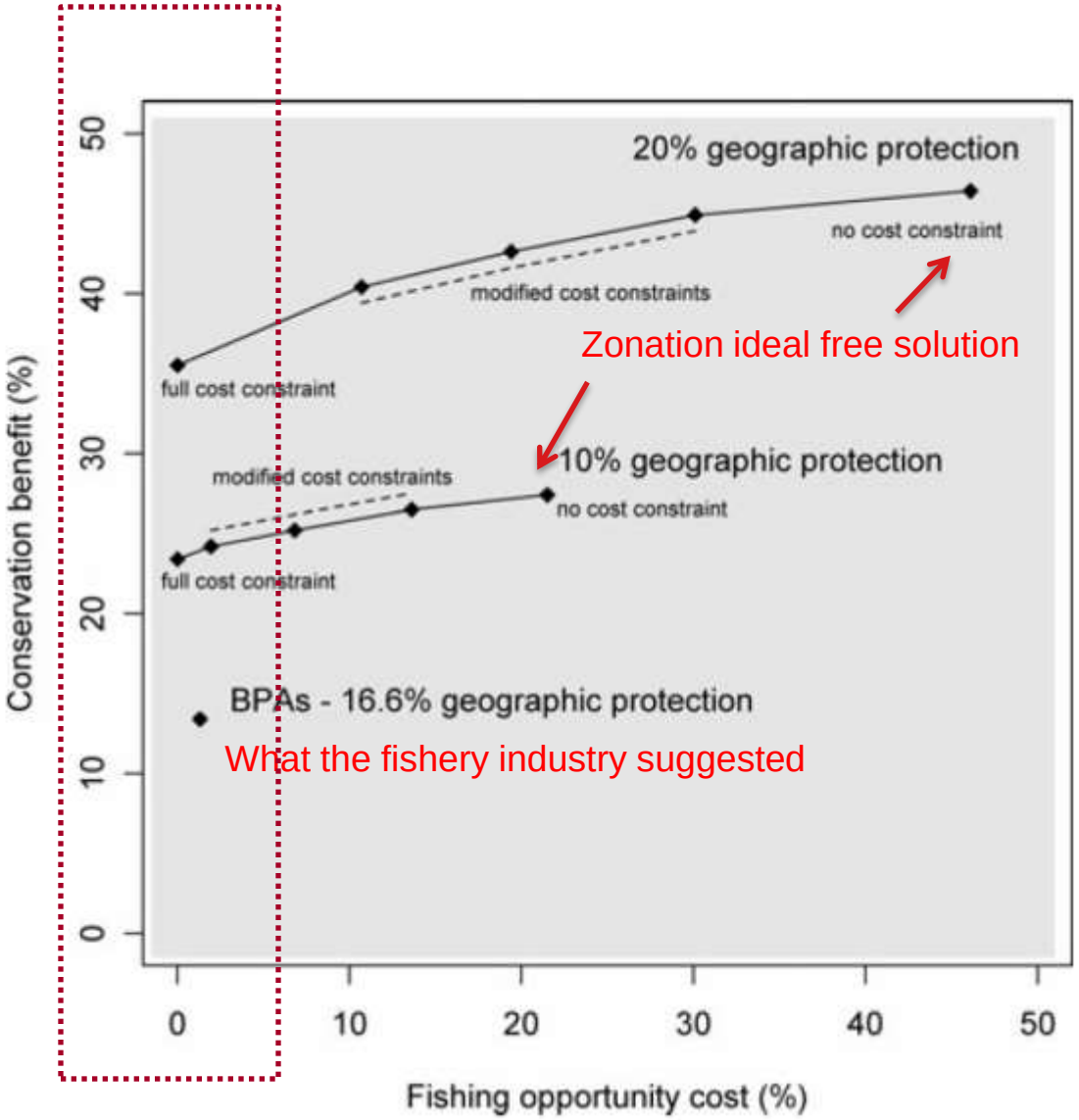


Figure 5 Costs and benefits of defining MPAs based on five Zonation scenarios in which cell selection was influenced to varying degrees by data describing spatial variation in fishing intensity during 2005. Cost–benefit curves are shown for 10% and 20% levels of geographic protection of waters with trawlable depths, with symbols indicating results from particular scenarios. The costs and benefits of reserves proposed by the New Zealand fishing industry (BPAs) are shown for comparison.

Case 1.
Forest conservation prioritization

Zonation process is an analogue of baking a cake

When 18-year-old apprentice chef Franz Sacher created the Sacher Torte at the court of Prince Metternich in 1832, little did he know the impact his cake would have on chocolate lovers worldwide. The recipe for the Original Sacher-Torte is a well-kept secret, known only to confectioners at Hotel Sacher in Vienna.

Sacher Torte recipe

How to make it:

- Melt the chocolate slowly (ideally in a bain-marie). Meanwhile, mix the butter with the icing sugar and vanilla sugar until creamed. Gradually stir in the egg yolks. Pre-heat the oven to 180 °C. Grease a cake tin with butter and sprinkle with flour. Whip up the egg whites with a pinch of salt, add the crystal sugar and beat to a stiff peak. Stir the melted chocolate into the paste with the egg yolks and fold in the whipped egg whites alternately with the flour. Fill the dough into the tin and bake for around 1 hour.
- Remove the cake and leave to cool off (to achieve a flat surface turn the cake out on to a work surface immediately after baking and turn it again after 25 minutes).
- If the apricot jam is too solid, heat it briefly and stir until smooth, before flavouring with a shot of rum. Cut the cake in half crosswise. Cover the base with jam, set the other half on top, and coat the upper surface and around the edges with apricot jam.
- For the glaze, break the chocolate into small pieces. Heat up the water with the sugar for a few minutes. Pour into a bowl and leave to cool down until just warm to the taste (if the glaze is too hot it will become dull in appearance, but if too cold it will become too viscous). Add the chocolate and dissolve in the sugar solution.
- Pour the glaze quickly, i.e. in a single action, over the cake and immediately spread it out and smooth it over the surface, using a palate knife or other broad-bladed knife. Leave the cake to dry at room temperature.

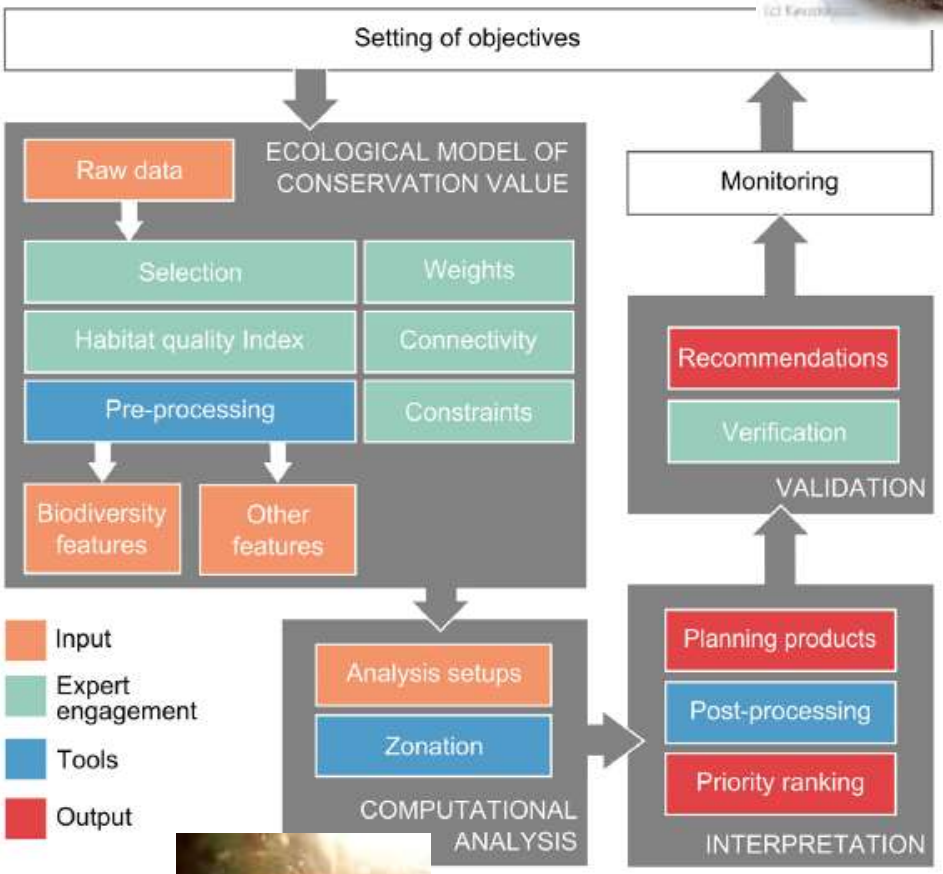
Serve with a garnish of whipped cream. If possible, do not store the Sacher Torte in the fridge, as it will "sweat".

For the Sacher Torte

- 7 egg yolks
- 150 g softened butter
- 125 g icing sugar
- 200 g dark chocolate
- 1 packet (8g) vanilla sugar
- 7 egg whites
- 125 g crystal sugar
- A pinch of salt
- 150 g flour
- Butter and flour for the mould
- 150 – 200 g apricot jam, for spreading
- Rum, if desired
- Whipped cream to garnish

For the glaze

- 200 g dark chocolate coating or cooking chocolate
- 250 g sugar
- 150-170 ml water



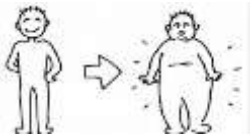
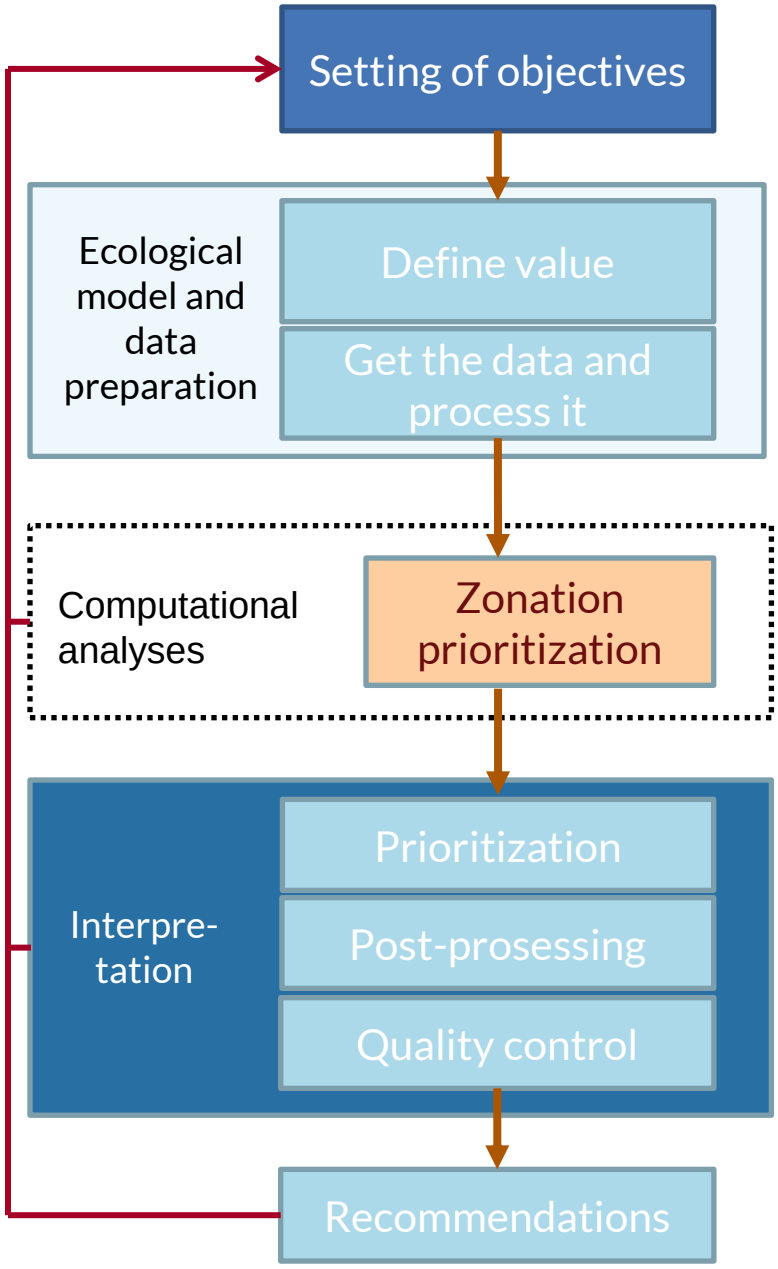


Figure 4. A schematic of ...ration prioritization process (adapted from V). Groups defined by the gray background ...evel stages in Figure 1. Orange color indicates inputs to other stages of the process. Li... ...ve operations, that include engaging with experts. Blue color indicates stages, where co... ...ed. Red color indicates outputs from other stages of the process.

Original picture: Joona Lehtomäki



Where are the most valuable not conserved forest areas in Finland?

- *Species and habitats assessments show that they are declining!!*

***Get** the data (find + contracts)*
***Decide** ecological model*
***Model** dead wood potential based on tree stand data*
***Define** penalties for negative actions*
***Get** species observations*
***Define** connectivities*

Execute the analysis step by step

Visualize the results
Interpret
Identify valuable areas
Prepare user manuals

PRINCIPAL DATA:
DEAD WOOD POTENTIAL

Tree stand data on every stratum

- Tree species
- Diameter
- Volume
- Fertility class

Modelling dead wood potential (DWP) for each site

- MOTTI-program
- 168 DWP functions
- Tree stand data converted to DWP with DWP-functions

UPDATING AND SUPPLEMENTING DATA

PENALTY based on forestry operations with negative impact on biodiversity

1. Forest declarations & satellite IM
2. Mineral and peatland drainage data

Forest area connectivity

IUCN Red Listed forest species

Connectivity

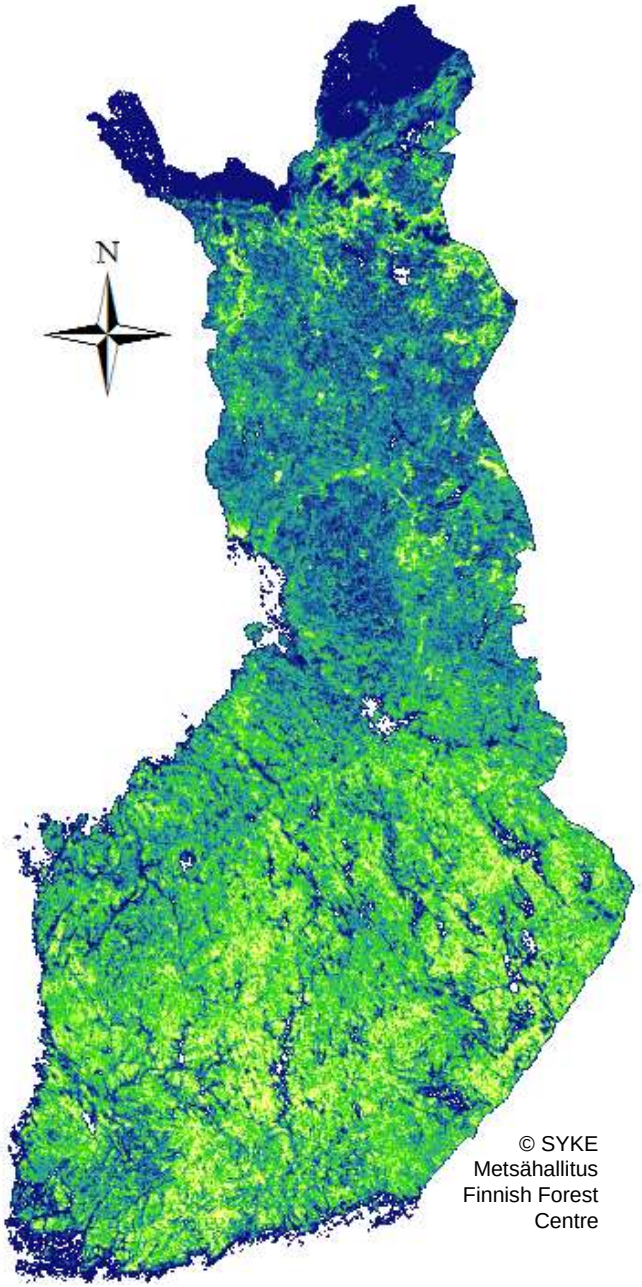
Habitats of special importance in terms of biodiversity (Forest Act 10 §)

Permanent conservation areas

Connectivity

Zonation
Spatial conservation prioritization

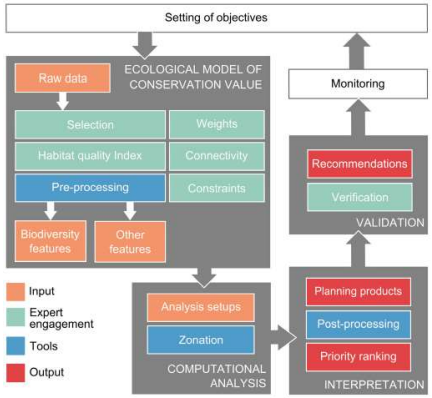
Version 1 + Version 2 + Version 3 + Version 4 + Version 5 + Version 6



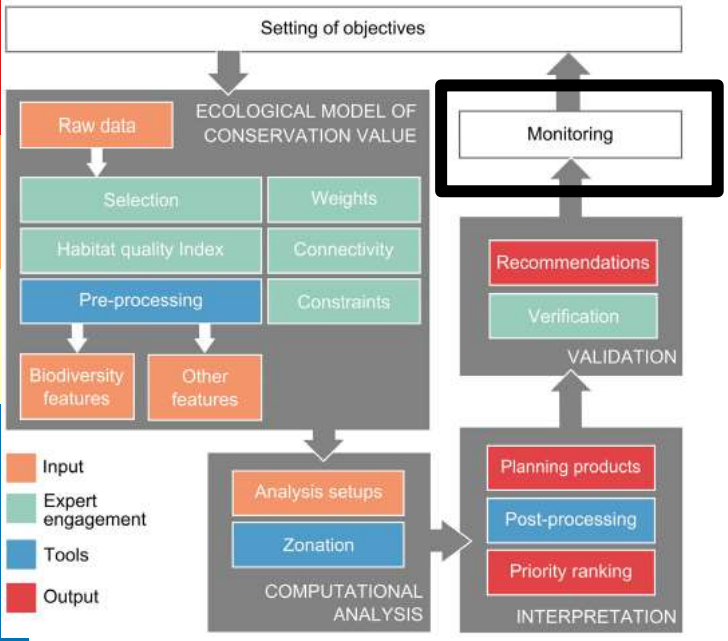
Validation

- Finnish Forest Centre:
  - Informing private landowners about forest conservation values through metsään.fi –service
  - nature management and restoration planning in private owned forests
- Metsähallitus Forestry: areal ecological network assessment
- Ministry of environment: budget planning for METSO-program
- Centre of Economic Development, Transport and the Environment: land use questions, conservation area expansion (METSO)
- Finnish Environment Institute: conservation studies, new Z-analyses
- Region Councils: land use planning

Validation



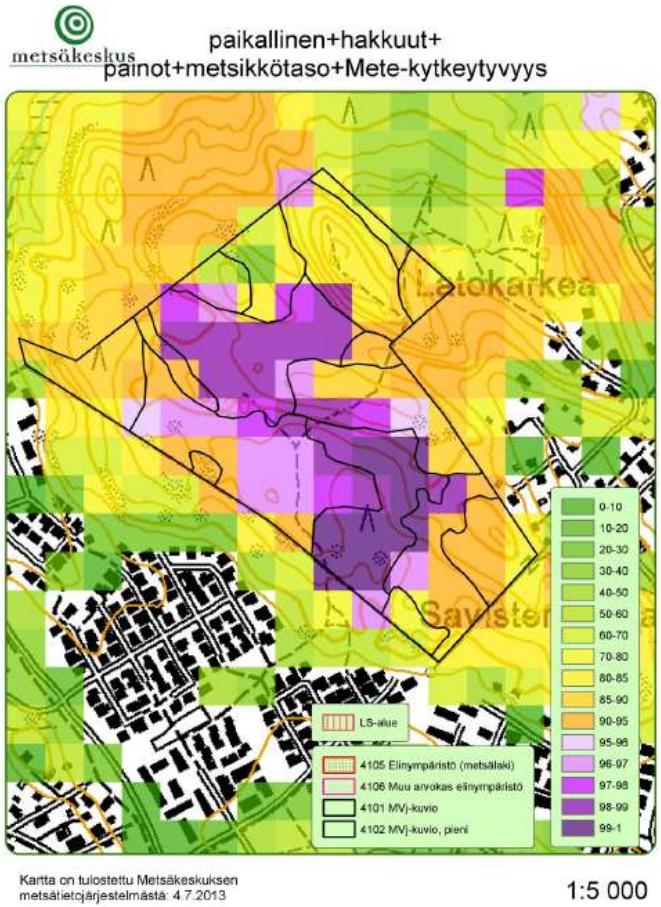
- **Challenges for utilizing the results:**
  - Data user don't understandt how how they were made
  - Data user does not agree with the need or the technique used
  - Data user has too much work – no time for new things, no capability
  - Data user has no will to learn new things
  - People have their old habits
  - ICT-skills need improvement
  - GIS-skills need improvement



Monitoring

- the effects of conservation actions
  - Conservation area network assessment
  - Has the biodiversity loss decreased?
    - RL assessments
    - Habitat assessments
    - Has the connectivity within the conservation network improved?
      - How to measure that?

From results to conservation



- Decisionmakers have active role
- Clear objectives
- Clear benefits
- Clear action plan
- Put effort on result discussion and user training, don't spoil with bad GIS equipment etc.
- Clear roles inside process
- Remember: Garbage in – garbage out

Other Z-analyses within (at least some) forest conservation issues

The wicked problem: where to conserve?

Forest biodiversity decline

Areas important for forest biodiversity can be identified

- Years of expert knowledge
- Threats well known
- Good assessments of species and habitats
- Spatial help available

Climate change escalation

Areas important for climate change mitigation under survey

- Trees are one of the most effective carbon sequesters and storages
- Trees ≠ forest
- CO_2 Sequestration rate + amount of storage + rate of decomposition

Land owner values

Conserving areas is a question of values

- Voluntary
- Political
- Need for compensation
- METSO program & C permium
- Too little, too late or enough, just in time?

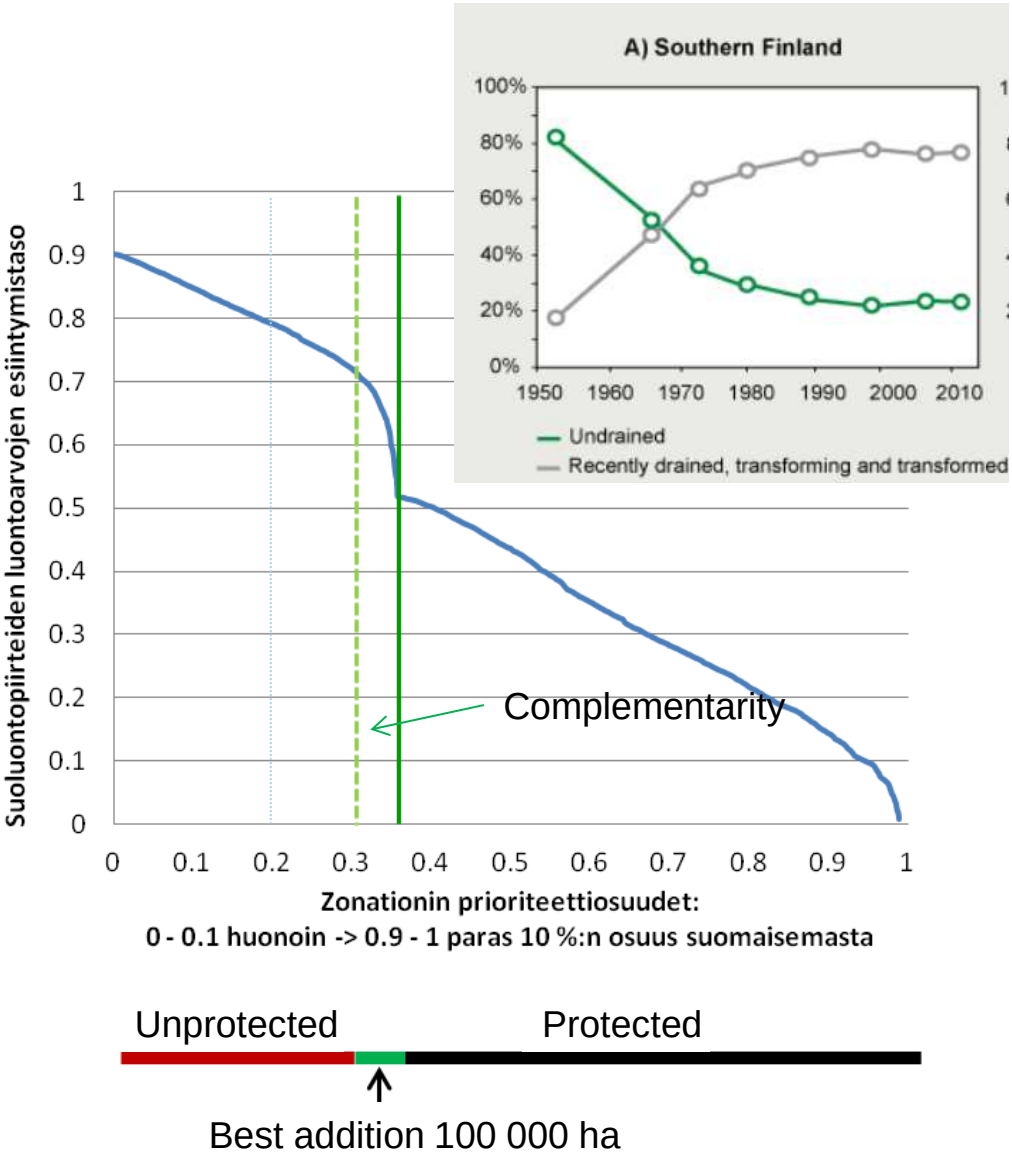
In short:

- Conservation prioritization analyses with Zonation-software
- Where are forest areas important for forest biodiveristy, carbon sequestration and storages, or both?
- IBC-Carbon = Integrated Biodiversity Conservation and Carbon Sequestration in the Changing Environment

strategicRESEARCH

Mire conservation complementary program –
Which mires would be most effective addition to our recent network?

- Politicians had decided to complement mire conservation network
- BD is suffering e. g. 50 % of Finnish peatland has been ditched specially on the 1970's
- Zonation was used to help experts to choose between mires
- Effective = smallest possible amount of land with the biggest possible addition for biodiversity
- Target Approx. 100 000 ha
- Miretypes, ecosystems, species, geological entities
- € Value for burning peat to heat
- The Right who were in power, decided not to finish the program just before finishing line and changed it into voluntary based program
- 2. version: land owners willingness to conserve



One modelling example

- Important game bird that has suffered strongly from forestry
- Forest structure and species characteristics were prioritized to identify lekking sites
- Results were used succesfully on capital area

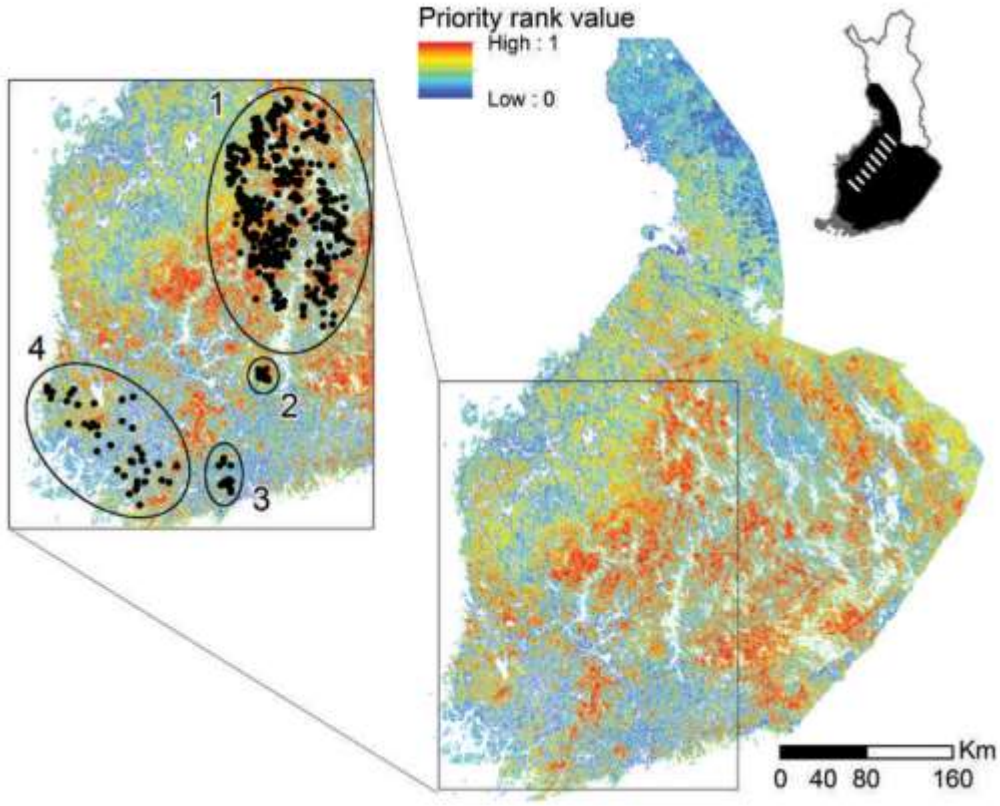
Wildl. Biol. 18: 337-353 (2012)
DOI: 10.2981/11-073

www.wildlifebiology.com

Current management

Defining spatial priorities for capercaillie *Tetrao urogallus* lekking landscape conservation in south-central Finland

Saija Sirkiä, Joona Lehtomäki, Harto Lindén, Erkki Tomppo & Atte Moilanen



Balancing alternative land uses in conservation prioritization

Atte Moilanen,[1,9] Barbara J. Anderson,[2] Felix Eigenbrod,[3,4] Andreas Heinemeyer,[5] David B. Roy,[6] Simon Gillings,[7] Paul R. Armsworth,[3,8] Kevin J. Gaston,[3] and Chris D. Thomas[2]

- Different land uses have different prioritizations for their values
- Combination these in Z and using weighting could help.
  - But only to certain level
- Compare this and Uusimaa-region green infrastructure: sometimes it's better not to add everythinig to same Z-analysis

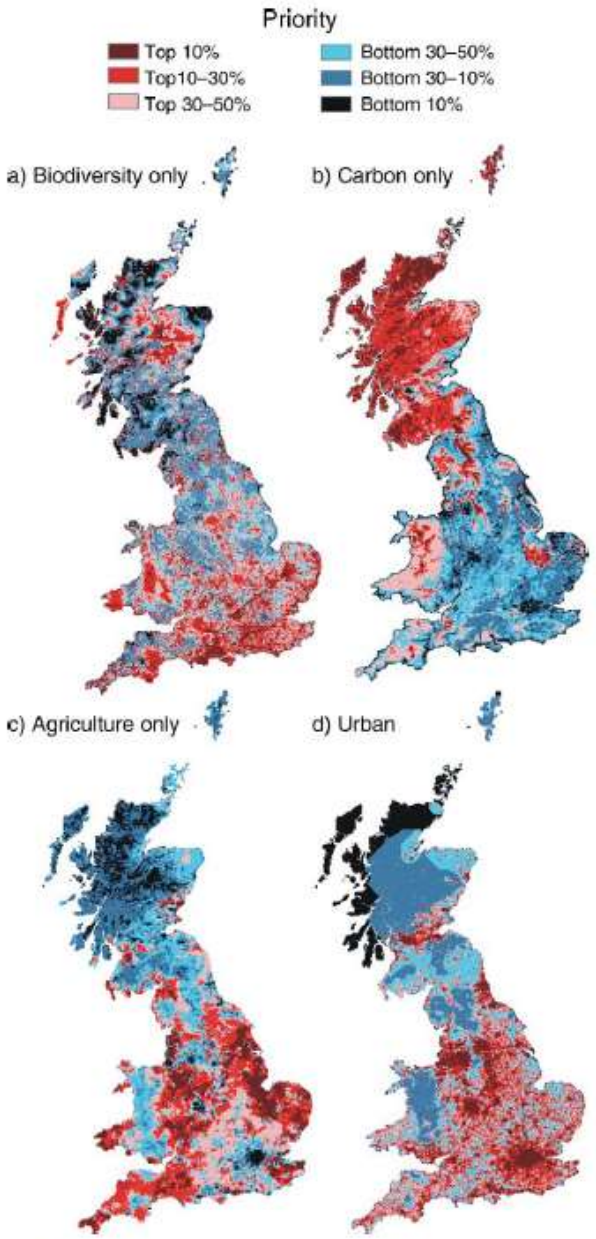


Fig. 1. Priority maps for Britain based on single-criterion Zonation analyses: (a) biodiversity (400 Biodiversity Action Plan species) only; (b) carbon storage only; (c) agricultural value only; and (d) urban use only.

Contents lists available at SciVerse ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Improving conservation planning for semi-natural grasslands: Integrating connectivity into agri-environment schemes

Anni Arponen [a,*], Risto K. Heikkinen [b], Riikka Paloniemi [c], Juha Pöyry [b], Jukka Similä [c], Mikko Kuussaari [b]

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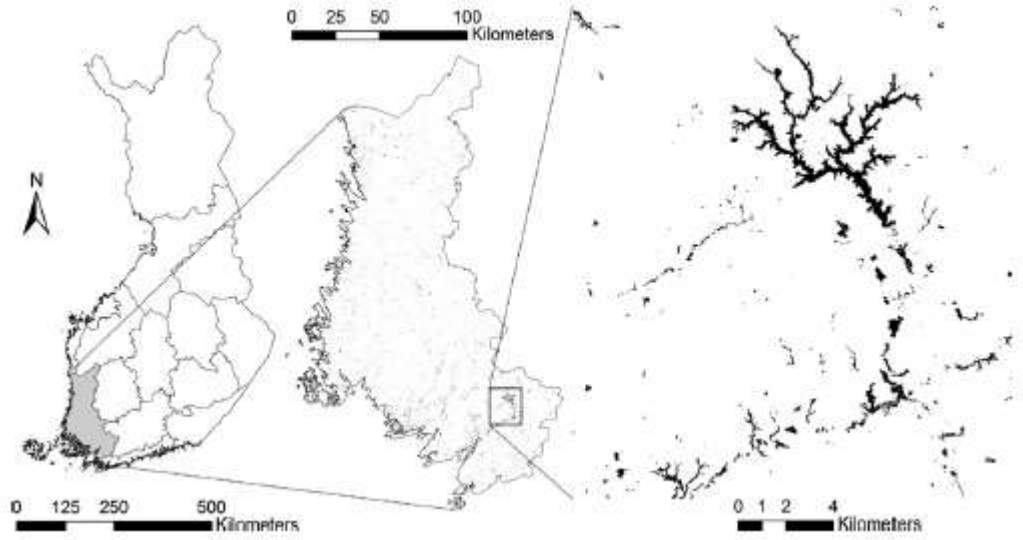

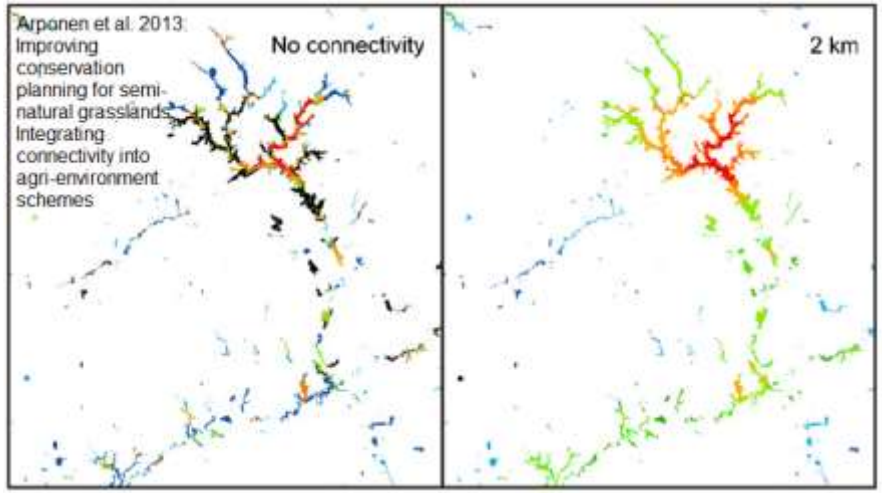

LETTER

Global protected area expansion is co
projected land-use and parochialism

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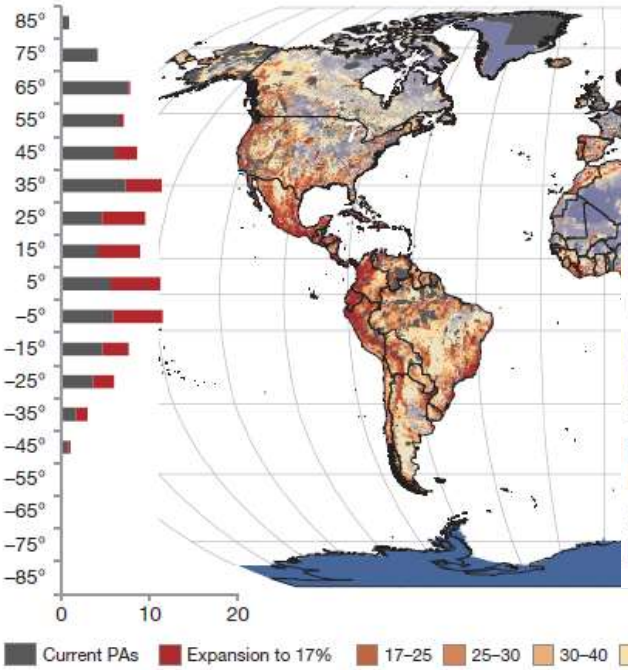

Figure 1 | Global priority map for the expansion of the PA system. Prioritization of the global PA network expansion, taking future (2040) projected land-use into account. The bars on the left show the distribution of current (grey) and proposed (red) expansion areas by latitude bins. Currently designated PAs are quite evenly distributed across latitudes (55% of global PAs are in latitudes $\geq -30^\circ$ and $\leq 30^\circ$), whereas the expansion effort would be concentrated in the tropics to maximize coverage of species and ecoregions (75% of the expansion areas are between latitudes -30° and $+30^\circ$). Analysis data sources: International Union for the Conservation of Nature (IUCN), World Database on Protected Areas (WDPA), and Database of Global Administrative Areas (GADM).

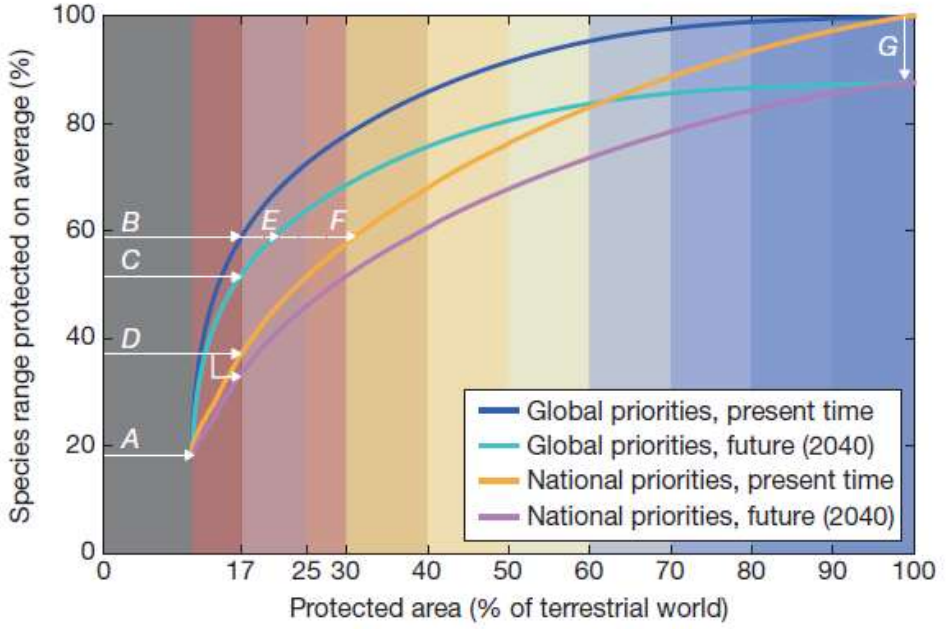

Figure 2 | Cumulative average coverage of species ranges in different fractions of terrestrial land. Terrestrial land fractions are listed in priority order, from current PAs (grey) to 17% expansion (red), and over entire terrestrial land. Background colours match the priority map (Fig. 1). The present PAs cover ~19% of species ranges (*A*). Expansion to 17% could increase coverage to ~61% (*B*) or ~56% with 2040 land use (*C*). National priorities perform much worse (*D*). A further expansion would be required to compensate land-use change (to 21%, *E*) and/or national-scale planning (to 32%, *F*). Globally, land-use change may cause over ~12% species' range loss (*G*).

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Matches and mismatches between national and EU-wide priorities: Examining the Natura 2000 network in vertebrate species conservation

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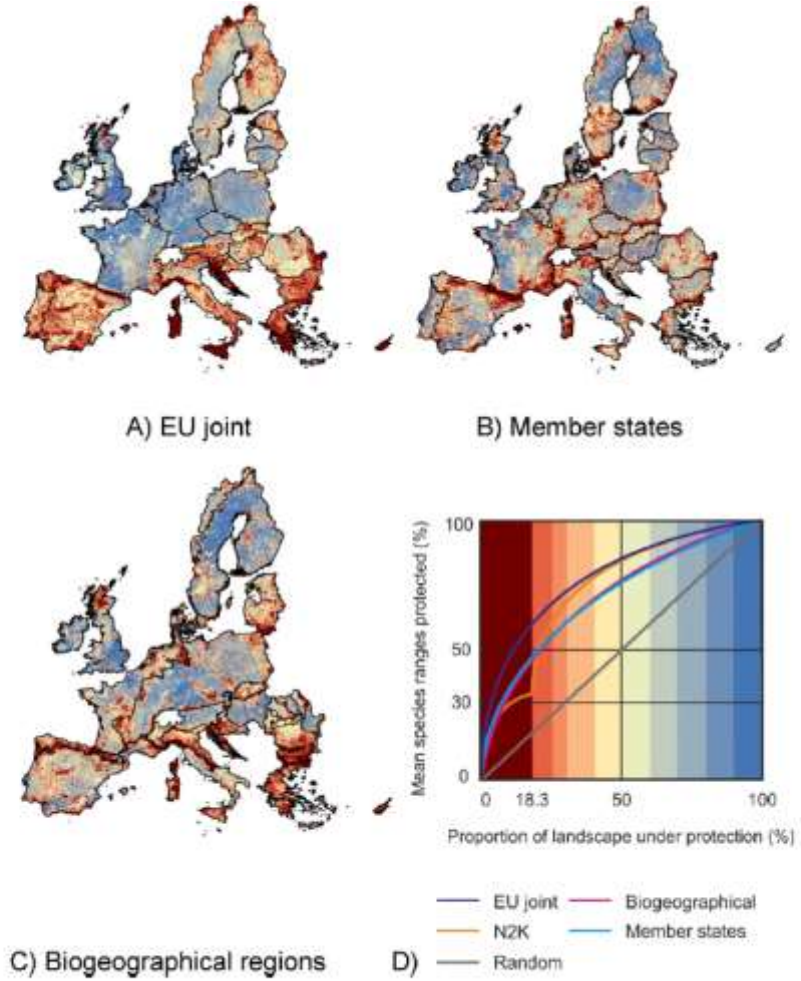

Fig. 1. Priorities for all vertebrate directive species are presented for each hypothetical administrative planning scenario (A, B, or C) with the same color scale (D). Here, areas have been zoned to graded colors based on their priority rank, with highest priorities (top 18.3% of EU area) shown in red. Performance curves (D) are presented for all five prioritization scenarios and they report the mean proportion of vertebrate directive species' ranges at different stages of the landscape ranking. For example, when 18.3% of land is under protection in the N2k scenario, on average 34% of species ranges are covered, while the EU joint scenario can on average cover 60% of species ranges with the same 18.3% of land.

Zonation is a decision support tool for conservation planning

It doesn't do anything itself.

The results are as good as…

… the datas that are used
… the expert decisions that are made
… the ecological model that is built

In future

Repeatable forest analyses with new BD surrogates

Include climate change

Integrate forests, peatlands, semi-natural grasslands, rocky areas, fresh and marine waters

Thank you!

Questions?

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