MAPPING AND ZONNING OF WILDLIFE HABITATS IN FOREST LANDSCAPES *(Rangifer tarandus L.*)

Outline

- Biodiversity losses in the intact forest landscapes due to the extensive way of forest utilization
- Balance between land use and habitats conservation

Coarse filter

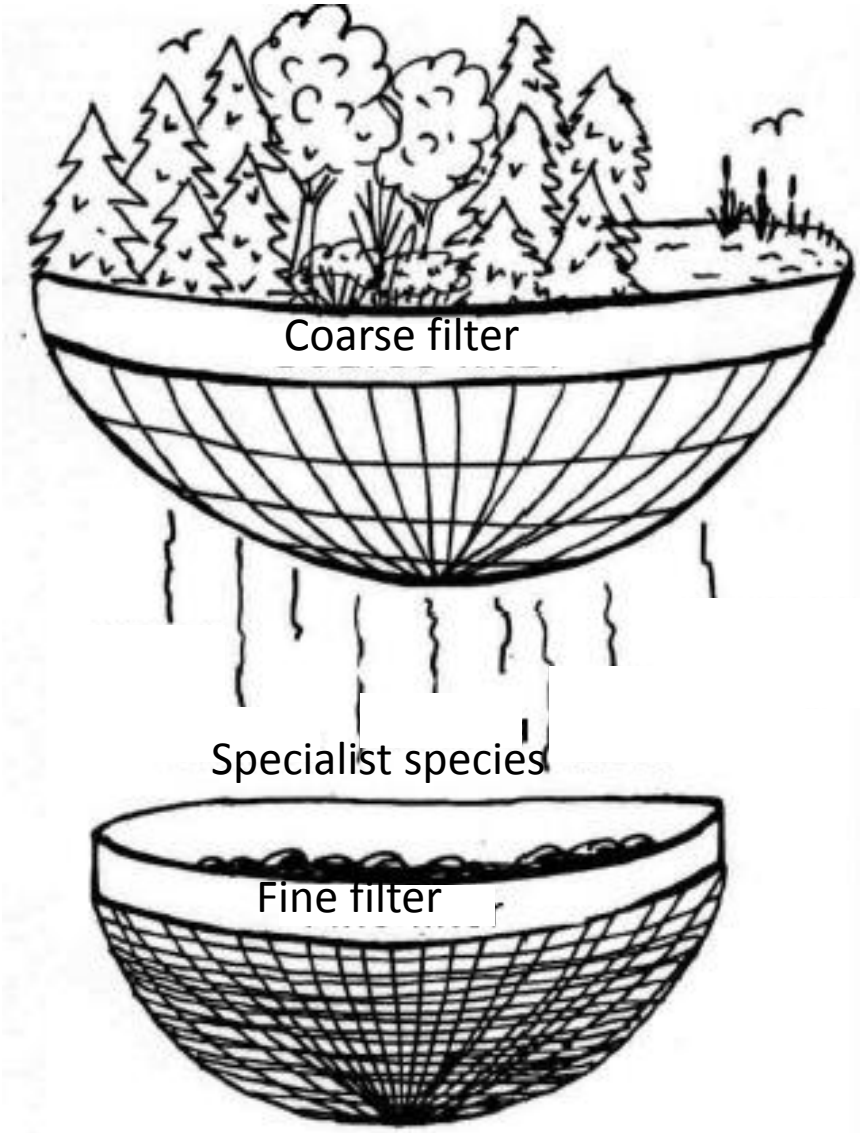
- Assessment of natural disturbance parameters
- Landscape character - habitat diversity
- Ecosystem services – bedrock, slopes, watersheds, soil, erosion, carbon

Fine filter

- Habitat inventory
- Red list species habitats as a fine filter
- Habitat assessment as an instrument of decision making

Coarse and fine filter strategies in sustainable management

Habitat diversity



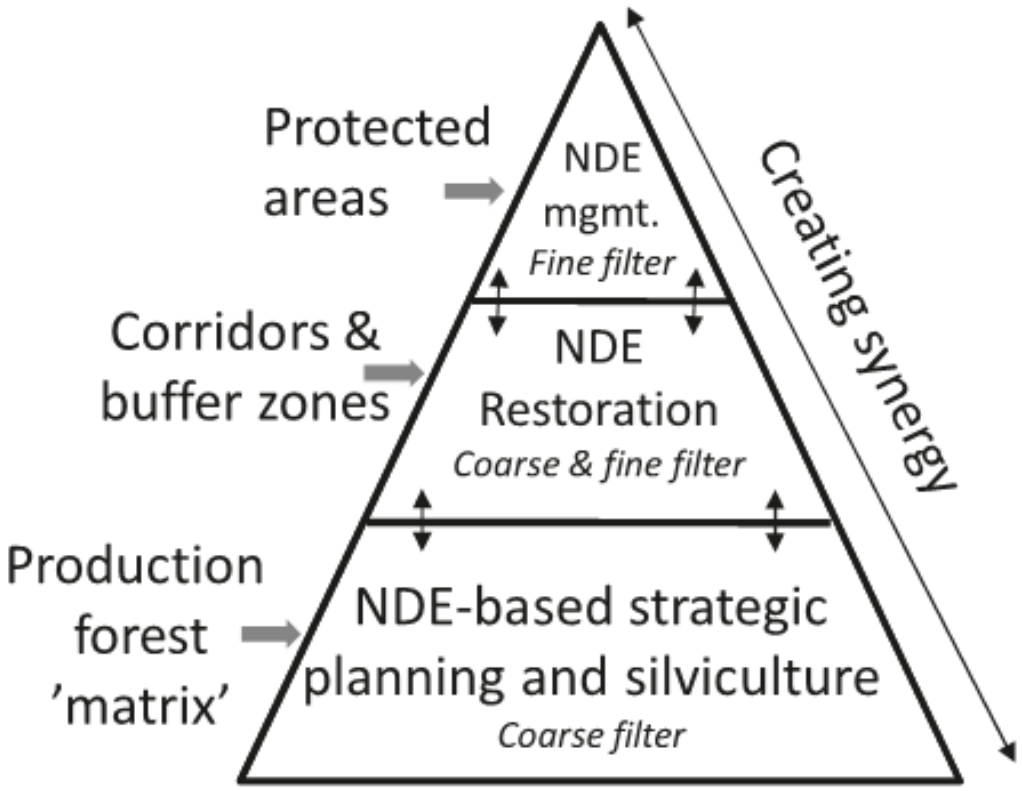
Natural like habitats maintain the main part of biodiversity and ecological functions

Species autecology

The protection area network is needed for specialized species .

Hunter ym. 1988

Approaches to biodiversity conservation



Main threat – loss of habitats

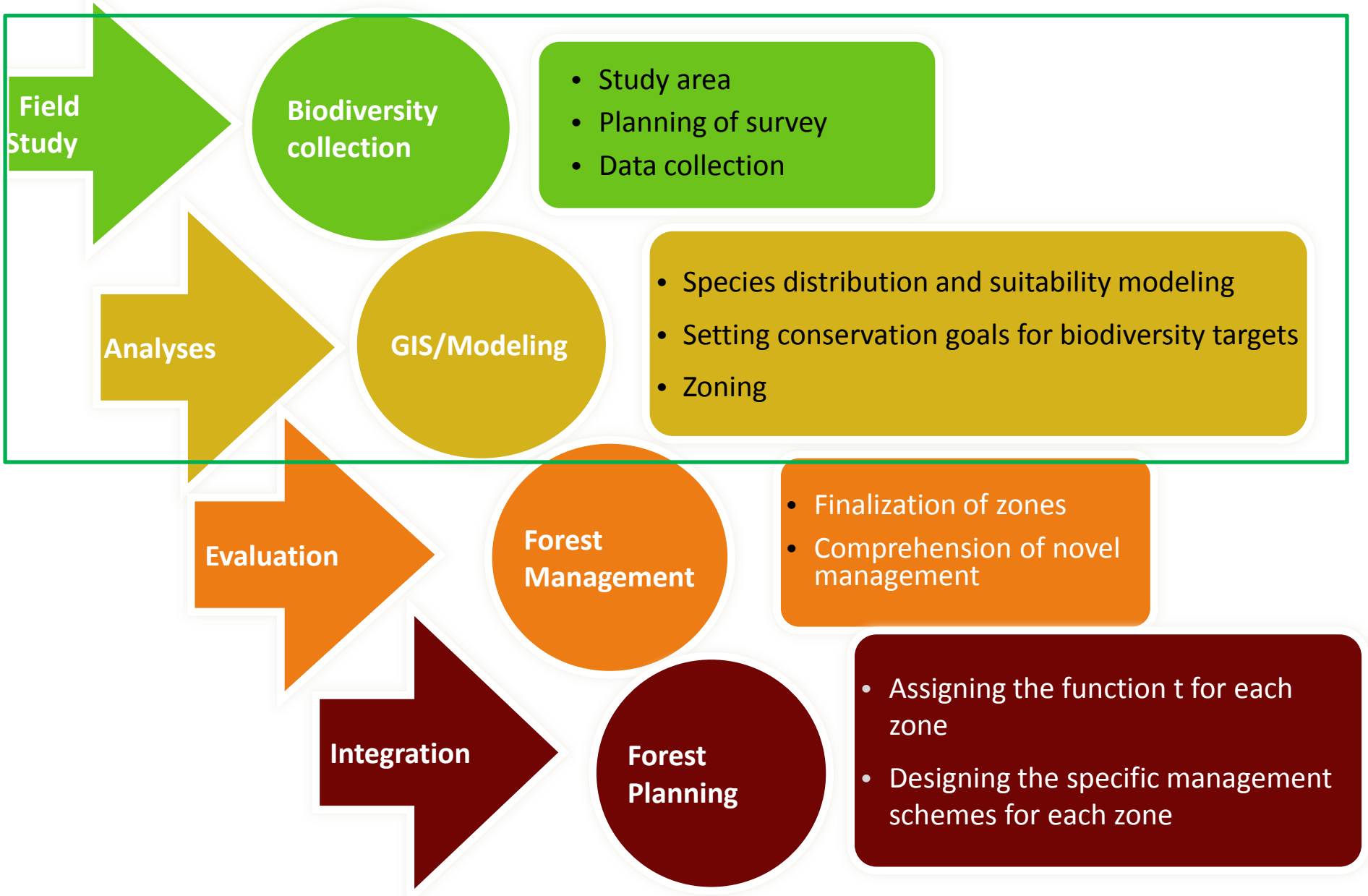
Aim – maintaining and restoration of structural and dynamic complexity and biodiversity on different levels

Task – to define the proportion and allocation of ecological constraints

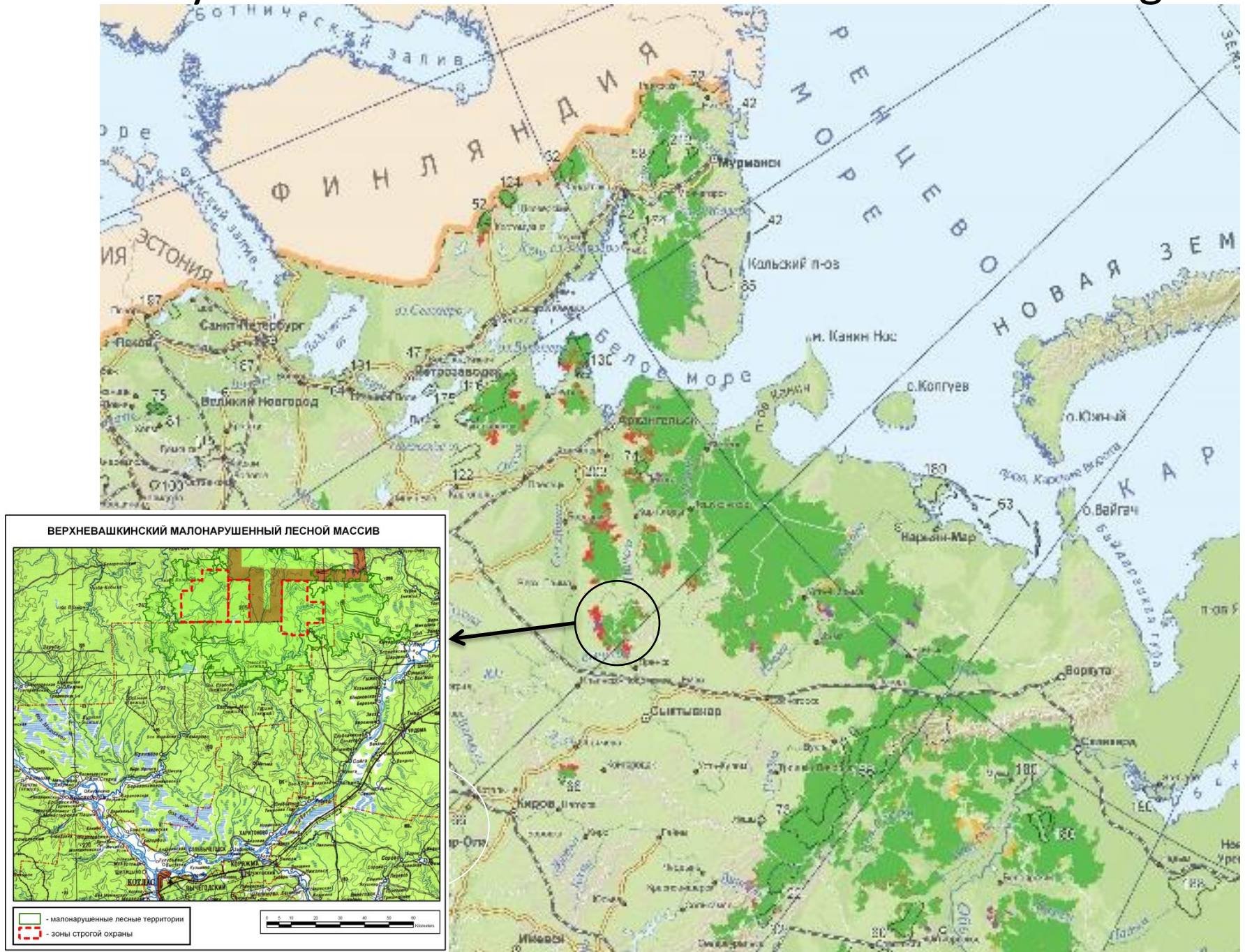
Patch-corridor-matrix model breaks the forest area down into three zone types: - Strictly protected areas (the fine filter), - Corridor / buffer areas (mixed zone), - Production forest matrix (the coarse filter)

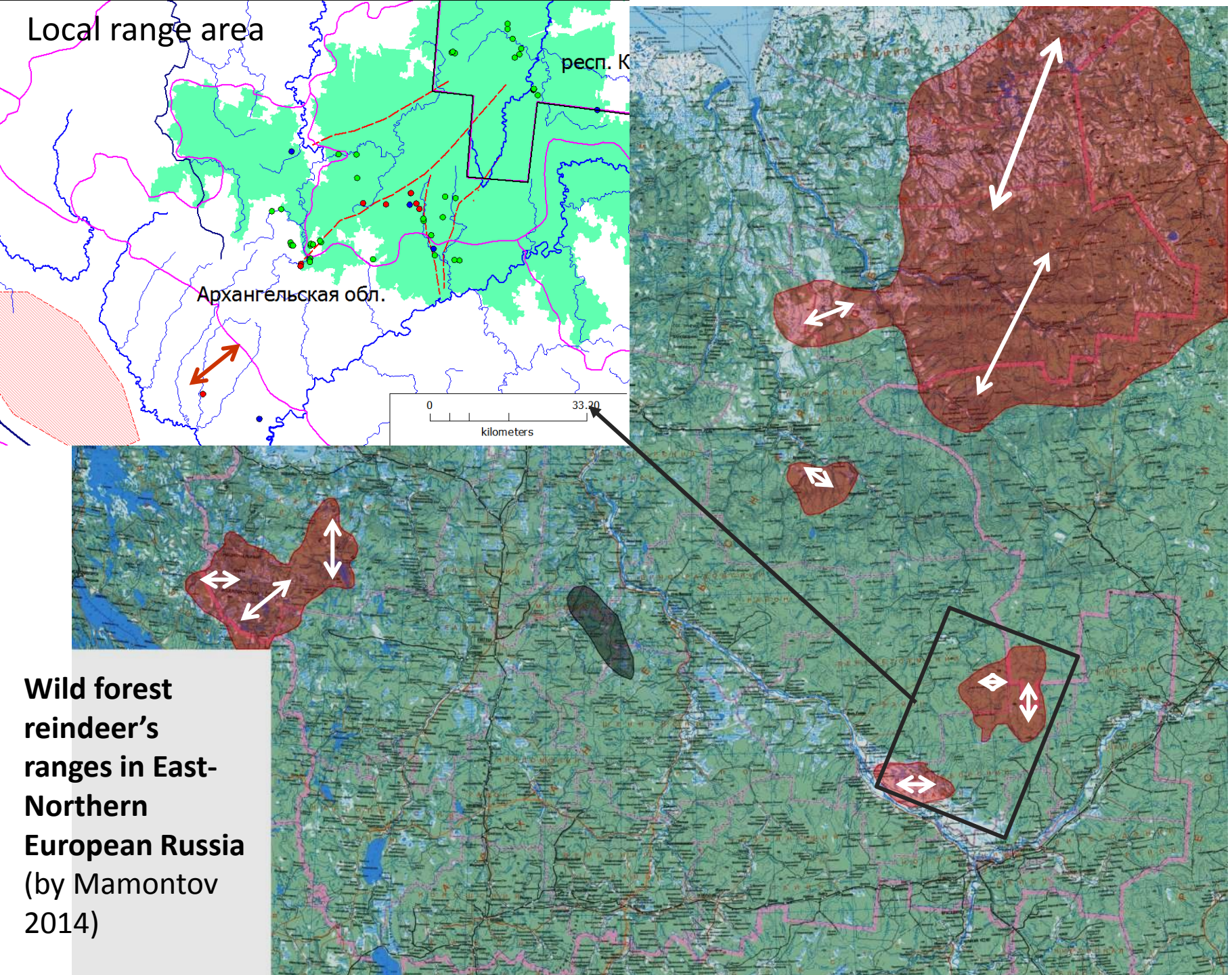
Kuuluvainen & Grenfell 2012

Work flow


Field Study
Biodiversity collection
Study area
Planning of survey
Data collection
Analyses
GIS/Modeling
Species distribution and suitability modeling
Setting conservation goals for biodiversity targets
Zoning
Evaluation
Forest Management
Finalization of zones
Comprehension of novel management
Integration
Forest Planning
Assigning the function t for each zone
Designing the specific management schemes for each zone

Study area – zone with intact forests in Barents region





Wild forest reindeer's ranges in East-Northern European Russia (by Mamontov 2014)

Fine filter – focal species: wild forest reindeer

Risk factors

- Industry (clearcuts and habitats destruction)
- Climate change
- Predators
- Infrastructure (roads)
- Cumulative effects

- Focal vulnerable (2(V)) species, the population is in RF red list (2020)
- One of the boreal species most sensitive to land use change
- The range of a reindeer population is often thousands of square km
- Factors that influence population persistence act at the range scale
- Require large expanses of mature coniferous forests and do not generally occupy younger forests
- Females have low reproductive rates
- Individuals are long-lived, such that population-level responses may lag behind landscape change by up to10-30 y.

- **Habitats** are used differently by seasons

Suitable winter habitats

- Dry pine forests on sands, oligotrophic bogs near White See, edges of open bogs and spruce forests, old-growth spruce forests with gaps

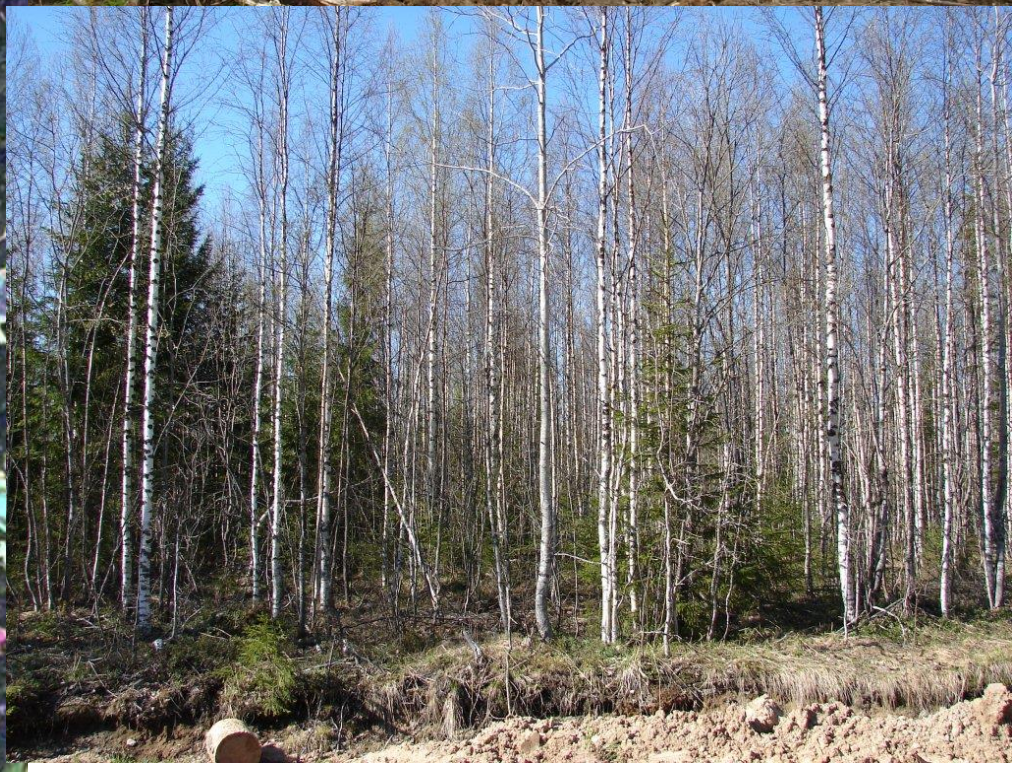
Suitable summer habitats

- Minerotrophc swamps, riparian sites, herbaceous wet pine and spruce forests old-growth spruce forests with gaps





Unsuitable habitats

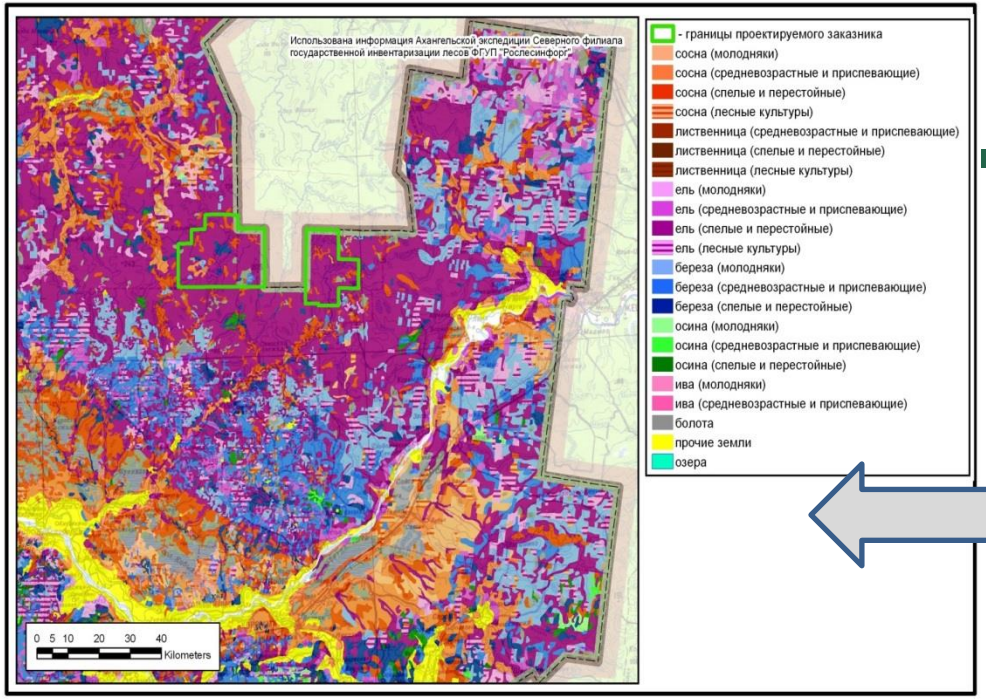


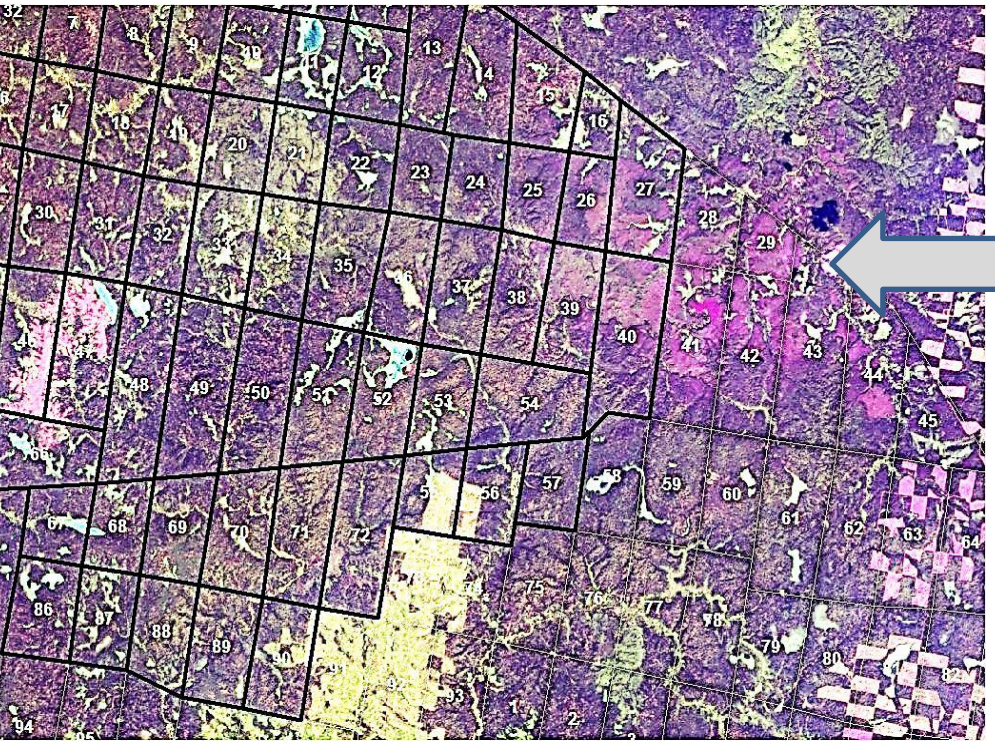
Requirements to forestry management in range

- An assessment of the status of the population in the range, supplemented by information on the status of the population in the Management Unit;
- An assessment of the habitat, including current habitat condition, critical habitat
- and disturbance levels;
- Identification of important habitat or landscape features, including continuous
- tracts of undisturbed habitat, known calving areas, and travel corridors;
- Habitat management measures that will support self-sustaining caribou populations and protect critical habitat;
- At least 65% undisturbed habitats in the range should be achieved or maintained over time;
- Monitoring of habitats

(by Canadian FSC standard 2018)

Levels of zonning





To develop the basis for decision making in forest use we made resource maps on two spatial levels:

Landscape resource basic map – for whole local range

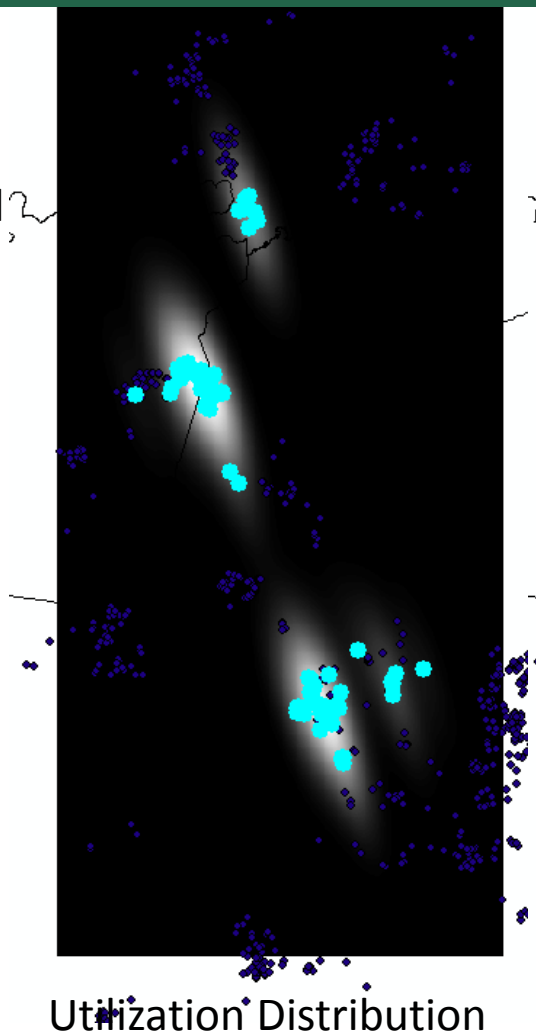
- Resource (habitat) mapping with general vegetation classification, disturbances and Infrastructure based on suitability modelling (RSPF)

Forestry units of question

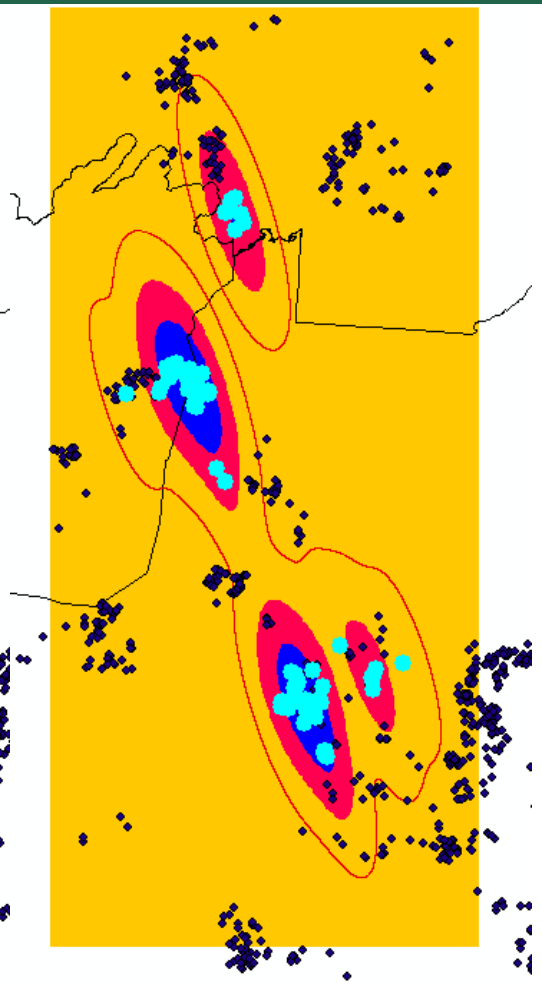
- Habitat mapping based on detailed vegetation and disturbances + known calving areas and travel corridors

Landscape resource map -selection and utilization distributions

- Habitat models to quantitatively predict habitat occupancy
- Habitat use across space was estimated using statistical kernel methods applied to GPS point data
- The continuous utilization distributions was binned into three categories: high use (above 90th percentile, moderate use (90th – 50th) and low use (below 50th)
- Allows to integrate habitats and point data (telemetry etc.)

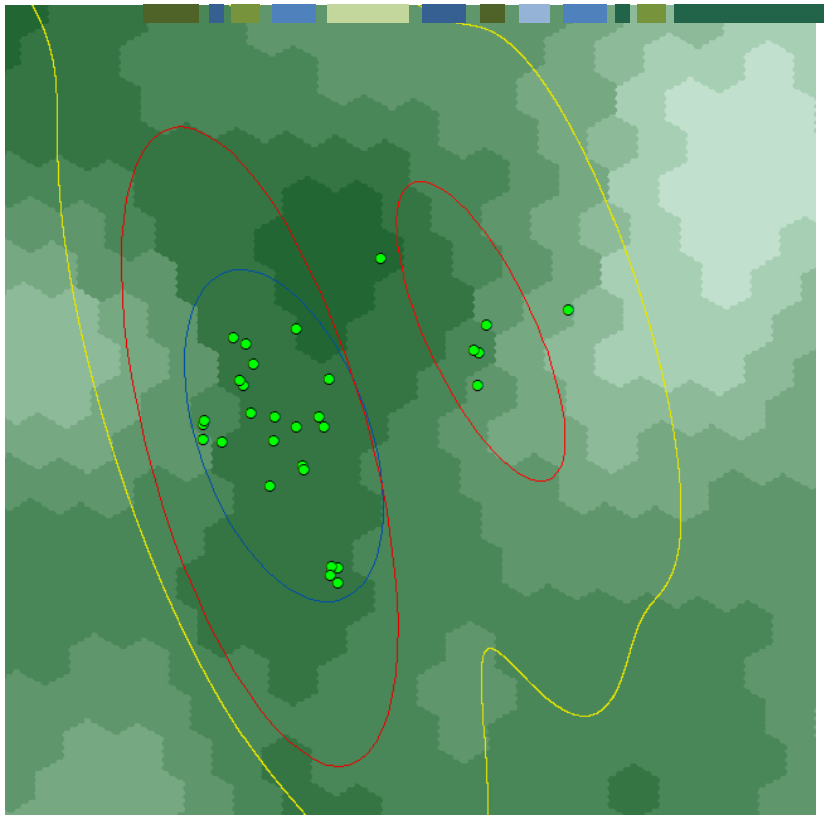


Utilization Distribution (UD)



Resource-Use Categories

Resource Selection Probability Function (RSPF)

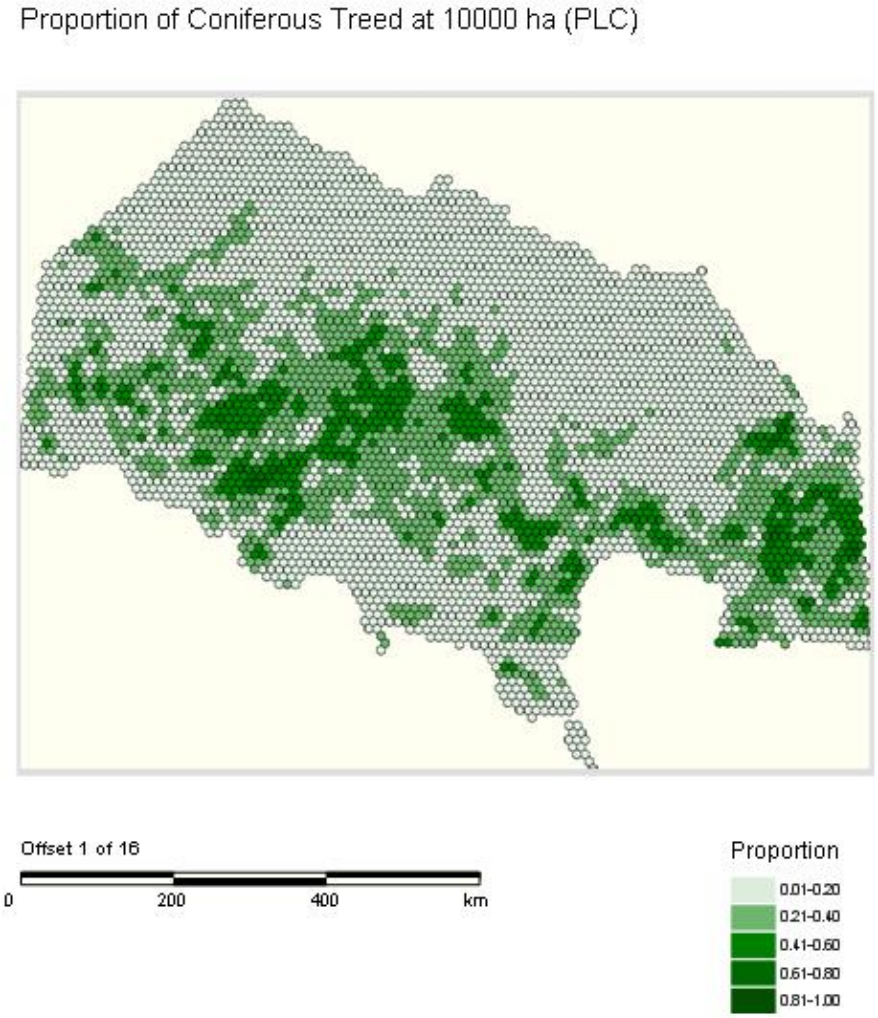


- Modern conservation planning often uses a particular type of habitat model - a resource selection function (RSF) or Resource Selection Probability Function (RSPF) based on Bayes logistic regression.
- These functions can estimate the probability that a particular piece of land will be selected for use by the species of interest.
- The models can be used to estimate changes in expected patterns of use based on forecast changes to the landscape (cuttings, fires etc.).
- **RSPF Data Requirements**
- *Resource selection* - the probability that a *resource unit* (of some specified *resource type*) is selected for use, when encountered.
- *Resource unit* is the area surveyed within a specified distance and of a specified resource type. The landscape context of a resource unit can be characterized at multiple scales (e.g., 10-10000 ha).
- Resource use and selection - within a seasonal range, we can assign a resource unit as *selected* or *not selected* and probability of use

Resource type and unit

- High RSPF - old growth conifer and wooded swamps cover
- Low RSFP- deciduous forests and areas with high linear feature density and zones around clearcuts

Result - IFL resource mapping (LSL script - OMNR©)



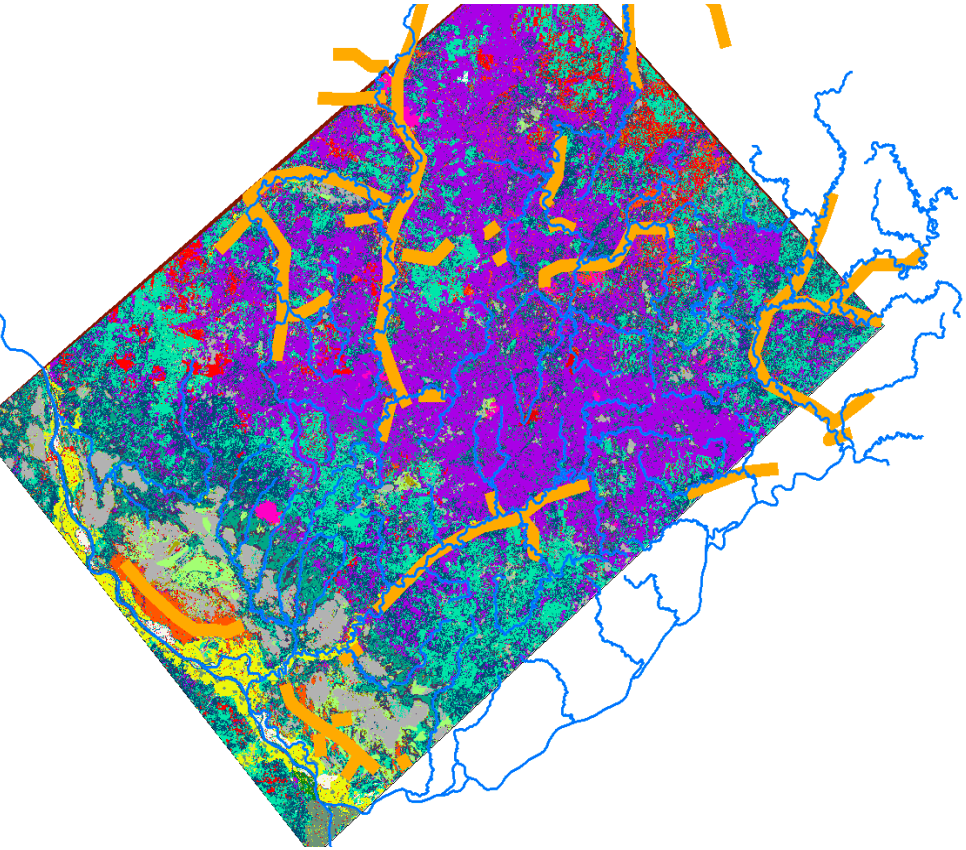
Specialized spatial analysis program to characterize resource types by hexagon based spatial analysis units (Kushneriuk and Rempel 2011).

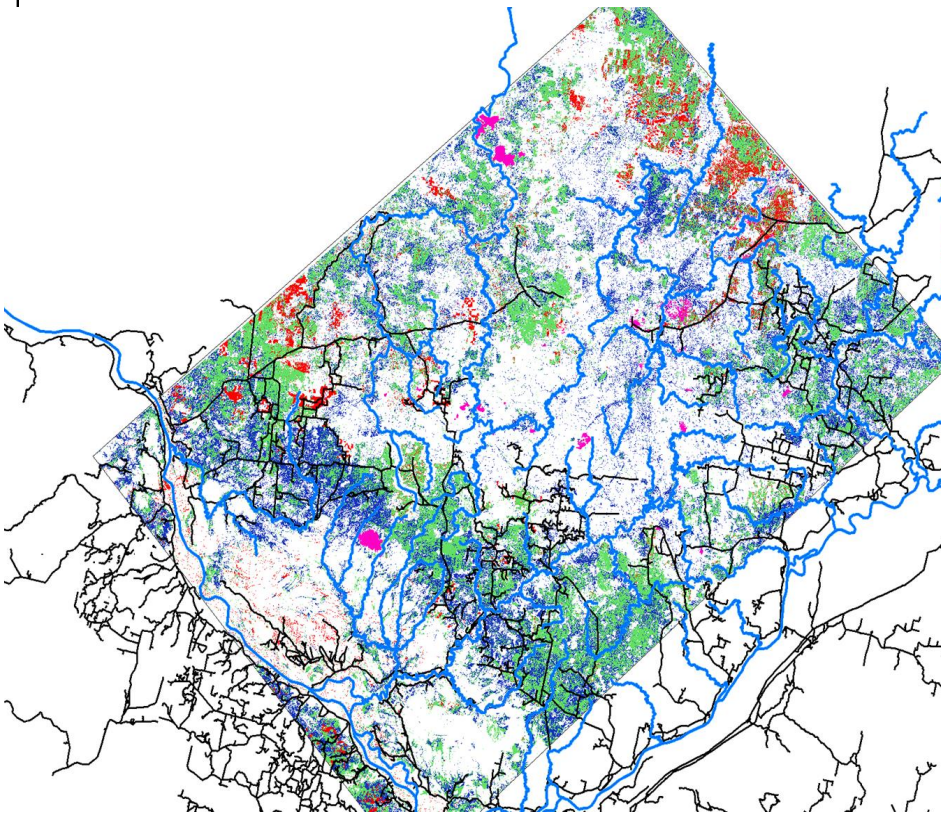
This results in hexagon-based maps and associated attribute tables used in the regression model.

Resource units using a grid of hexagon cells at scales of 16, 1000, 5000 and 10000 ha.

Within resource units, we characterized most resource types as the proportion of hexagon area that was comprised of a specific forest type (Hornseth and Rempel 2015).

Input data: vegetation map, disturbances map, infrastructure, RSPF for landscape



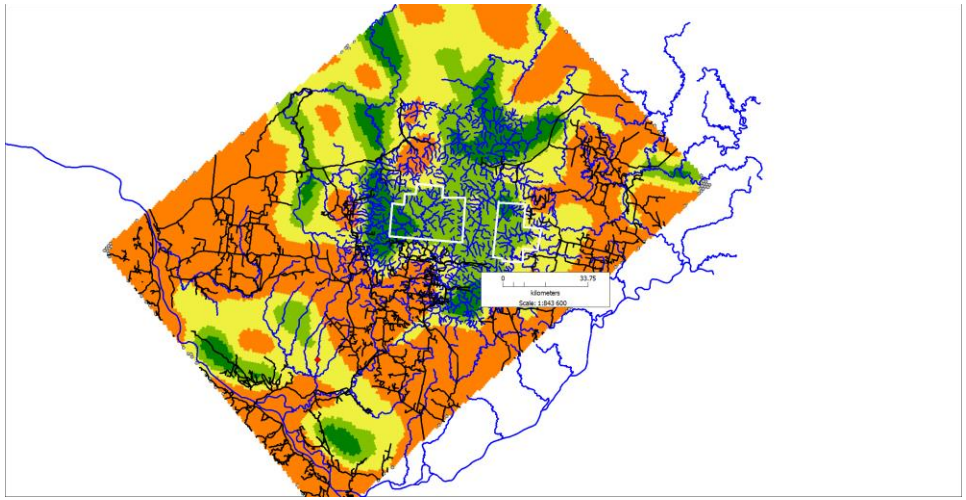


Spruce
Aspen
Birch
Pine, eskers
Disturbances
Open wetlands

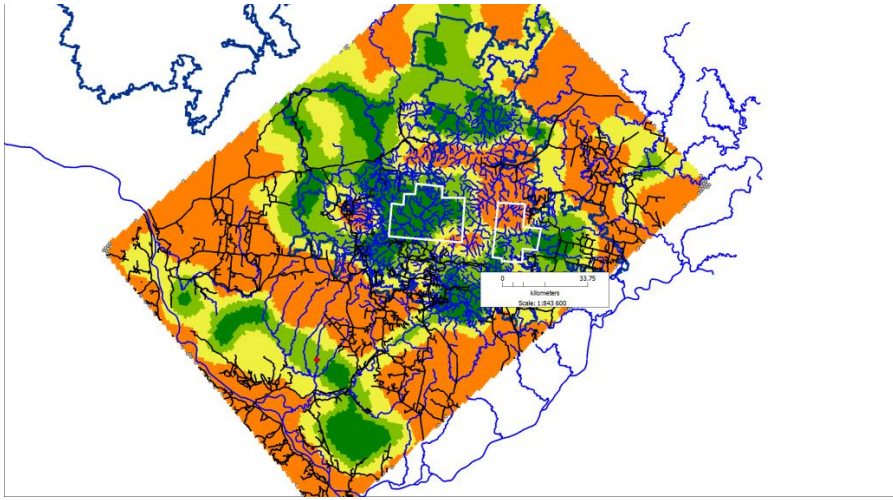
Birch recruitment
Fires
Disturbances
Asoen recruitment

50 km

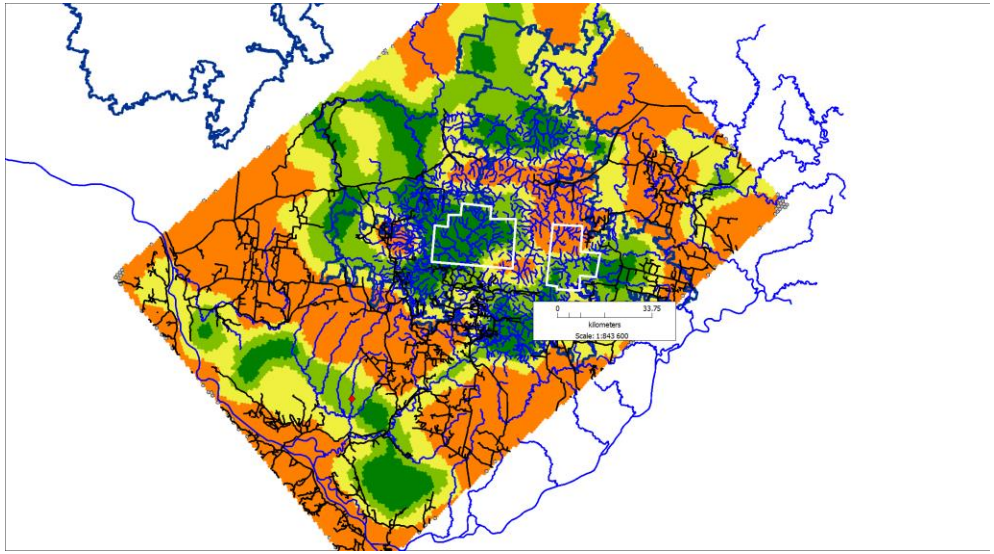
Output data: Seasonal resource maps



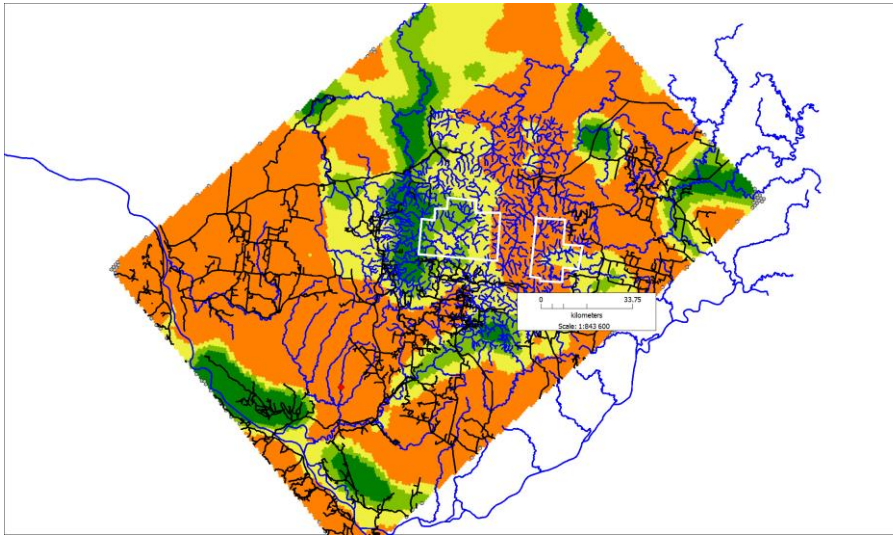
Winter



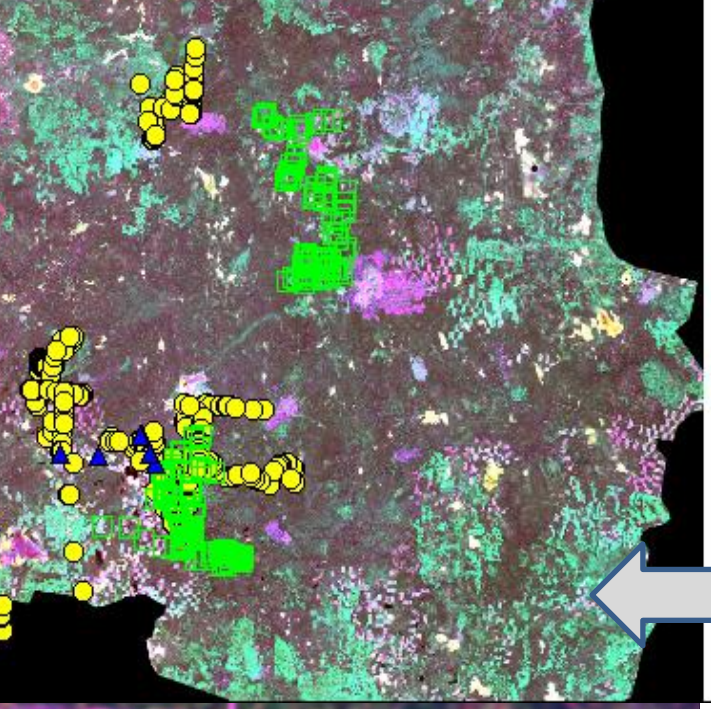
Spring

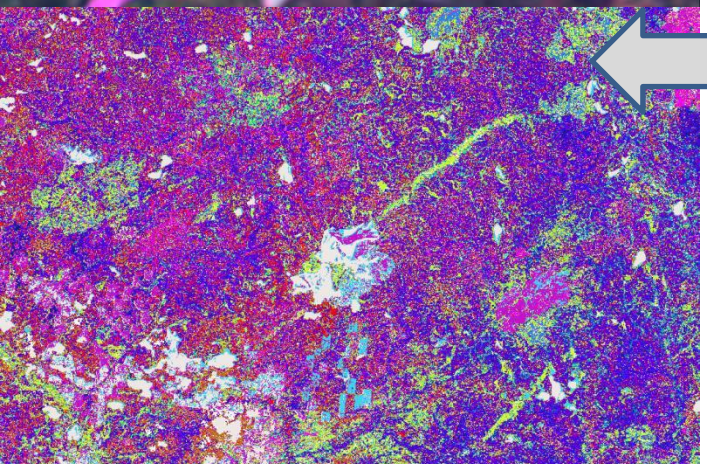


Summer



Fall





Forestry units mapping

Input data: classification of satellite imagery

1) High-resolution remote sensing imagery Sentinel2 , Landsat 8, forestry maps

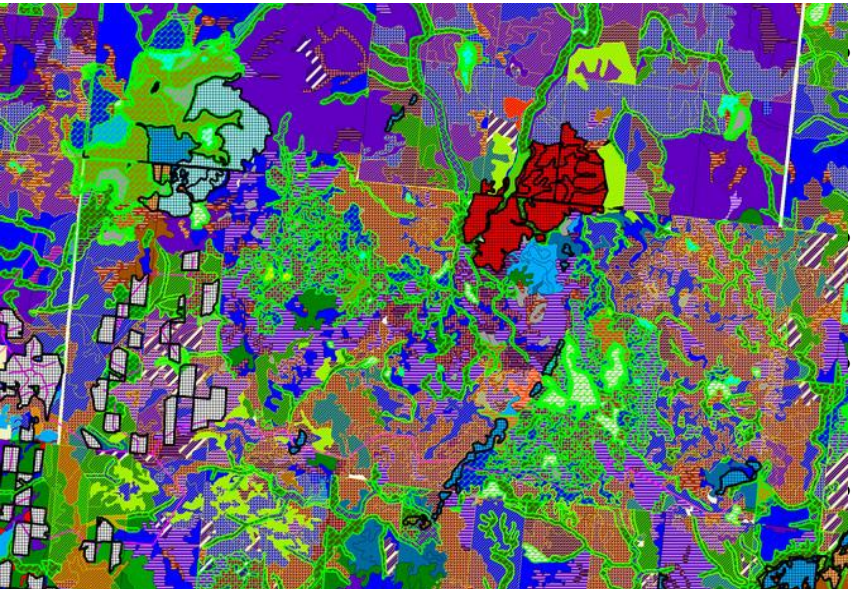
2) Series of field data (~400 GPS points) with vegetation description for training and validation.

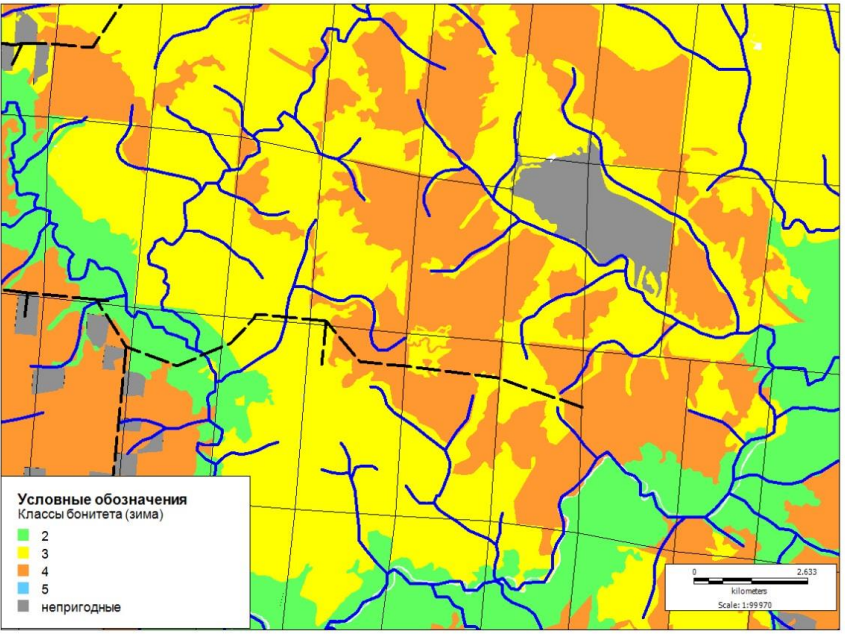
3) Training (reference) sampling points (> 1000) which was taken from high resolution imagery + field data

4) Classification of satellite imagery on the base of reference sampling with random forest algorithm (Belgiu, Drogut, 2016):

5) Validation of results with forestry maps and field GPS ground data

Output data: Habitat map/winter zonation(fragment)





Within forest compartments we characterized most resource types as the proportion of area that was comprised of a specific types of pixels

Accordingly the types' proportion habitat classes was produced

Habitat map is the basis to estimate the capacity (suitability) of the land of interest

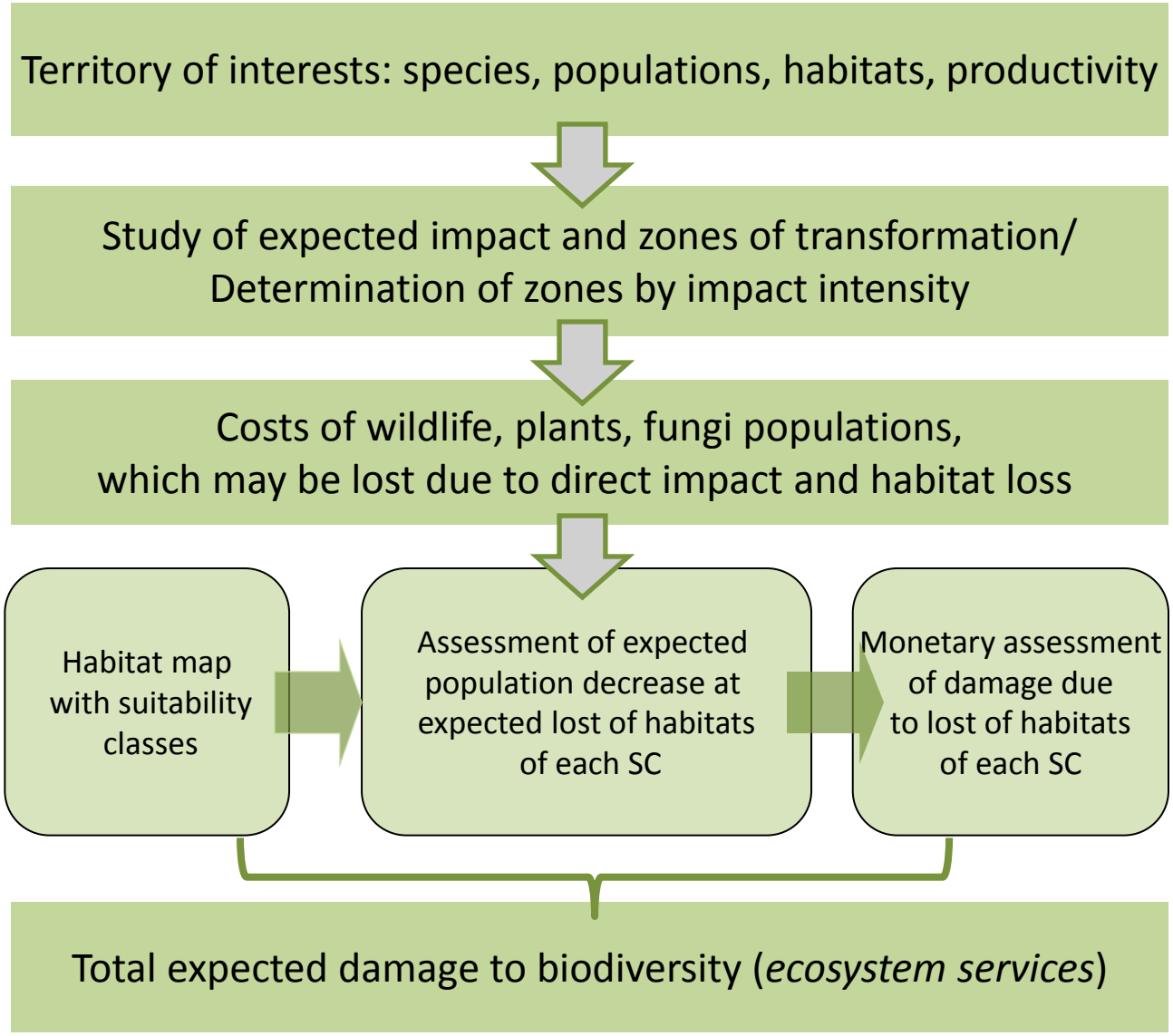
Data of telemetry where used for capacity assessment - 5 classes of habitat capacity + unsuitable (Mamotov, 2009)

Roads reduces the habitats quality along them (up to 200 meters) by 1 class, and clearcuts in use – by 2 classes

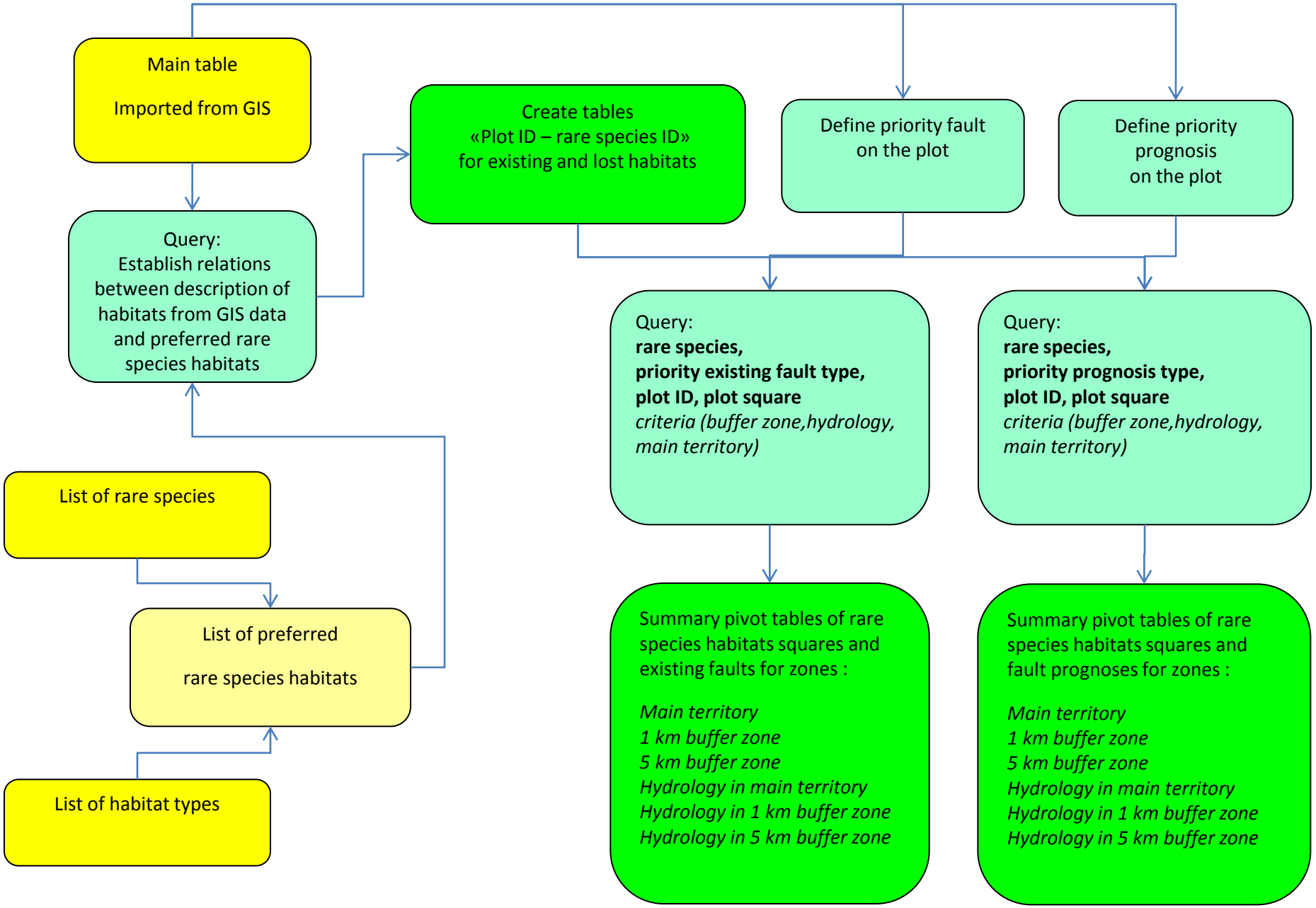
Reindeer uses large (~ 1000 ha) clasters of unfragmented habitats of high capacity

Capacity zonation is the base for monetary habitat estimation and forecasts under different forestry scenaria

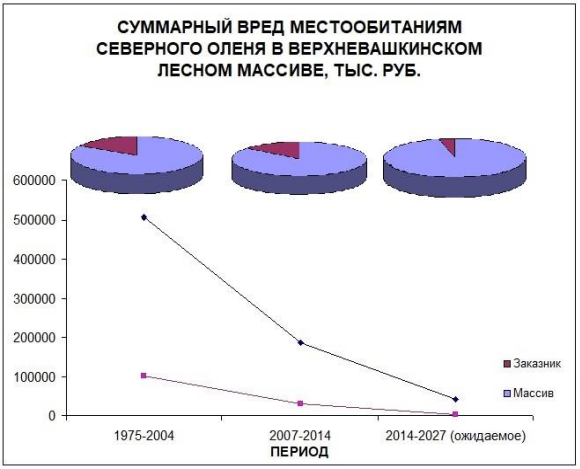
Algorithm of potential damage monetary assessment

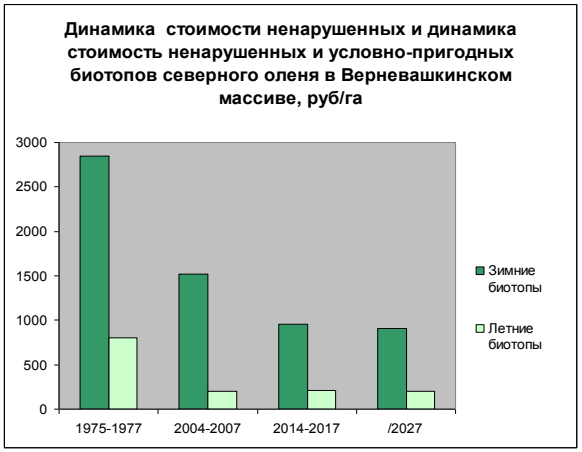


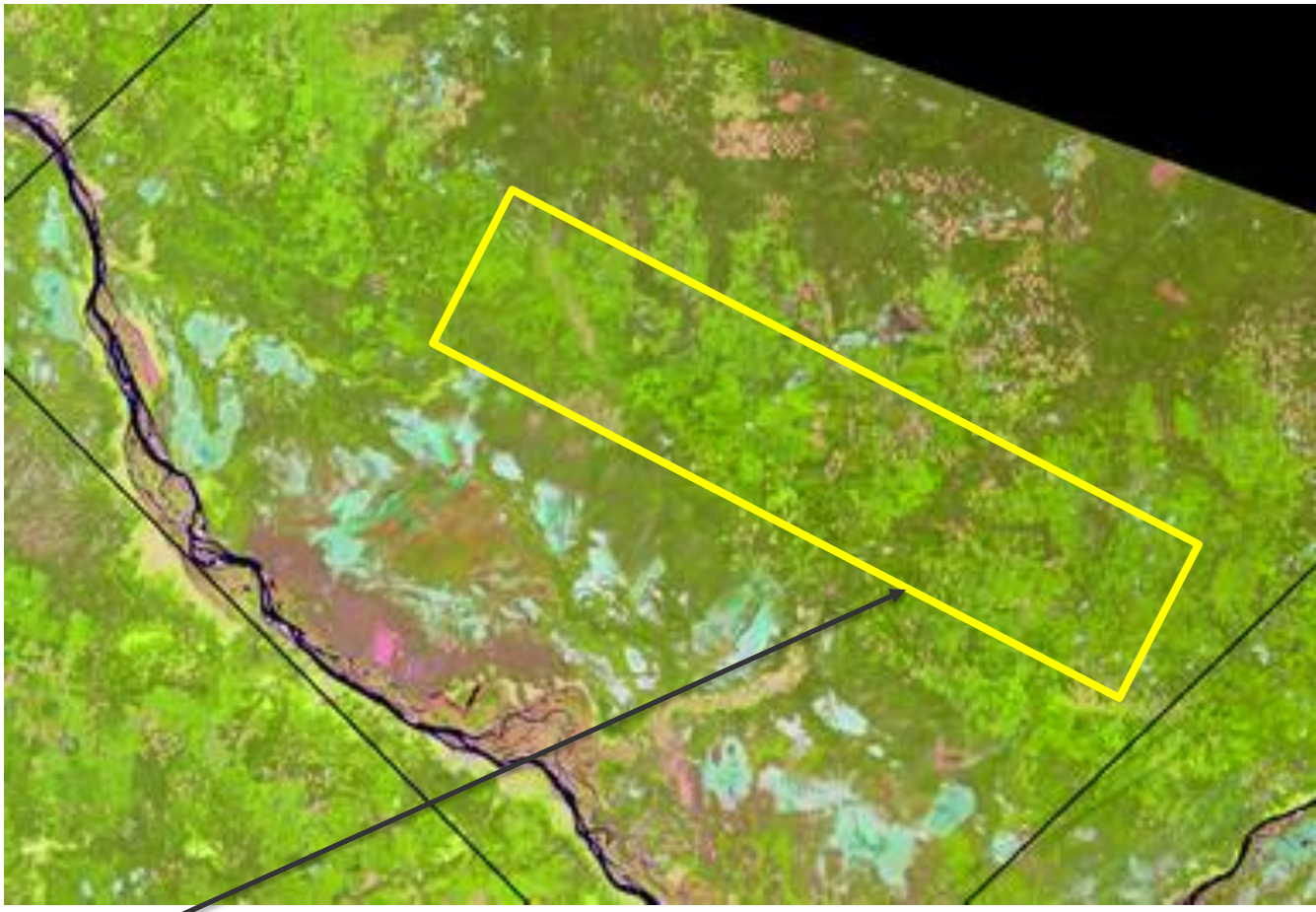
Structure of database for economical assessment of habitats (for zonation and forecast)



Monetary damage for wild forest reindeer range under forestry influence (for the periods since 1970s)







Zone of extensive 1980th clearcuts (with aspen and birch regeneration).
Clearcutting rates have been strongly declined during the economic crisis of the 1990s and have been increased since 2000th (*by Angelstam P. …Zagidullina A. et al. 2020*)

Summary

- Habitat selection and movement patterns of wild forest reindeer vary by seasons and landscapes types. However, a common theme across Barents region is that populations require large areas of suitable habitats (presumably, unfragmented old growth coniferous forests and wetlands). So, under current forestry based on large clearcuts the forecast for studied reindeer ranges for the next 10 year is negative.
- Therefore, urgent habitat management measures are needed that will support self-sustaining populations and protect critical habitat. Particularly, an extending of existing protected areas and preserving of large (700-1000 ha and more) clusters of high quality seasonal habitats, migration corridors, nursery areas) etc.
- As a component of conservation plans for wild forest reindeer, the concept of zonation is a highly relevant approach to bridge forest use and maintaining biodiversity. RSPF models can be used to estimate changes in expected patterns of use based on forecast changes to the landscape (cuttings, fires etc.). Resource mapping is an efficient tool for decision making support.
- Study (monitoring) of population state in different ranges is necessary. F.e. zonation needs supplementary field data about critical habitats (migration corridors , nursery area) additional telemetry.

Acknowledgements

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Abstract

Wild forest reindeer conservation is an example of such a scenario where complex cumulative effects exist at the core of the conservation dilemma. We try to develop approaches to preserve habitats of wild forest reindeer (*Rangifer tarandus L.*) at range scale. To minimize the impact of their activities and contribute to reindeer conservation, companies can limit the extent and distribution of habitat loss. Because of vast area of range, collaborating between forest users is needed.

Habitat loss is globally a threat to biodiversity and in managed boreal forests a loss of habitats is the most common factor affecting diversity. Intact forests of Barents region are home to one of the last and the most southern remaining populations of listed wild forest reindeer and other vulnerable and protected species. Wild reindeer conservation is an example of such a scenario where complex cumulative effects exist at the core of the conservation dilemma. The species is one of the most sensitive to forestry, climate changes and big disturbances (fires). The range of its population is often thousands of square kilometers. To minimize the impact of their activities and contribute to reindeer conservation, forestry companies can limit the extent and distribution of habitat loss. Because of vast area of range, collaborating between forest users is needed. We try to develop approaches to preserve habitats of wild forest reindeer at range scale.

To prepare maps for wildlife habitat assessment we mapped vegetation cover, disturbances, sandy soils and roads. Classification of vegetation cover was carried out on the base of remote sensing, forestry maps and big series of field data. To assign the classes for the selected Landsat 8 pixels, we used the following data. GPS ground data series were available for different years. This information was used jointly with high-resolution images Sentinel2. To classify the LC8 imaging the random forest algorithm (QGis) was used on the base of big training series. To generalize the vegetation map LSL tool was used (Kushneriuk, Rempel, 2011). Modern conservation planning often uses a particular type of habitat model called a resource selection probability function (RSPF). These functions can estimate the probability that a particular piece of land will be selected for use by the species of interest. The models can be used to estimate changes in expected patterns of use based on forecast changes to the landscape. With using of habitat map, field datasets and PSFP of wild forest reindeer we made seasonal habitat assessment for wildlife. This assessment became the basis of 1) conservation zoning of the area 2) monetary estimation of expected damage for wild forest reindeer population under different scenario of forest use. It is scientific basis for the decision making in land use.

By: Zagidullina A. et al. 2020 MAPPING AND ZONING OF WILDLIFE HABITATS IN PRIMARY FOREST LANDSCAPES // IALE-Russia «Landscape Science and Landscape Ecology: Considering Responses to Global Challenges, September, Moscow