Long term monitoring of vegetation resources in Denali National Park & Preserve

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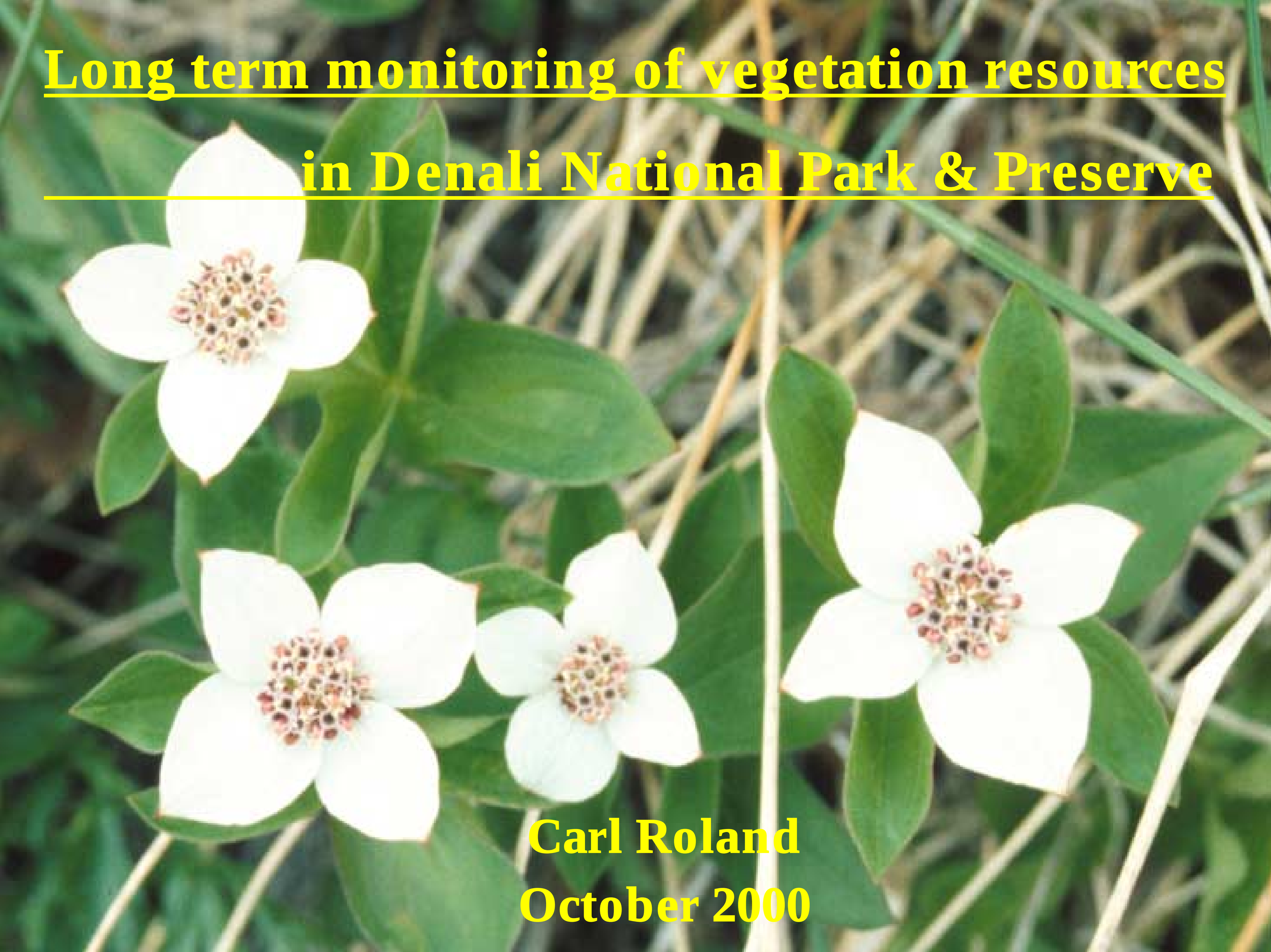

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Outline

A. Brief overview of initial vegetation monitoring design:

(Rock Creek watershed studies 1992 -2000)

- examples of data collected since 1992

B. Overview of emerging vegetation monitoring design -

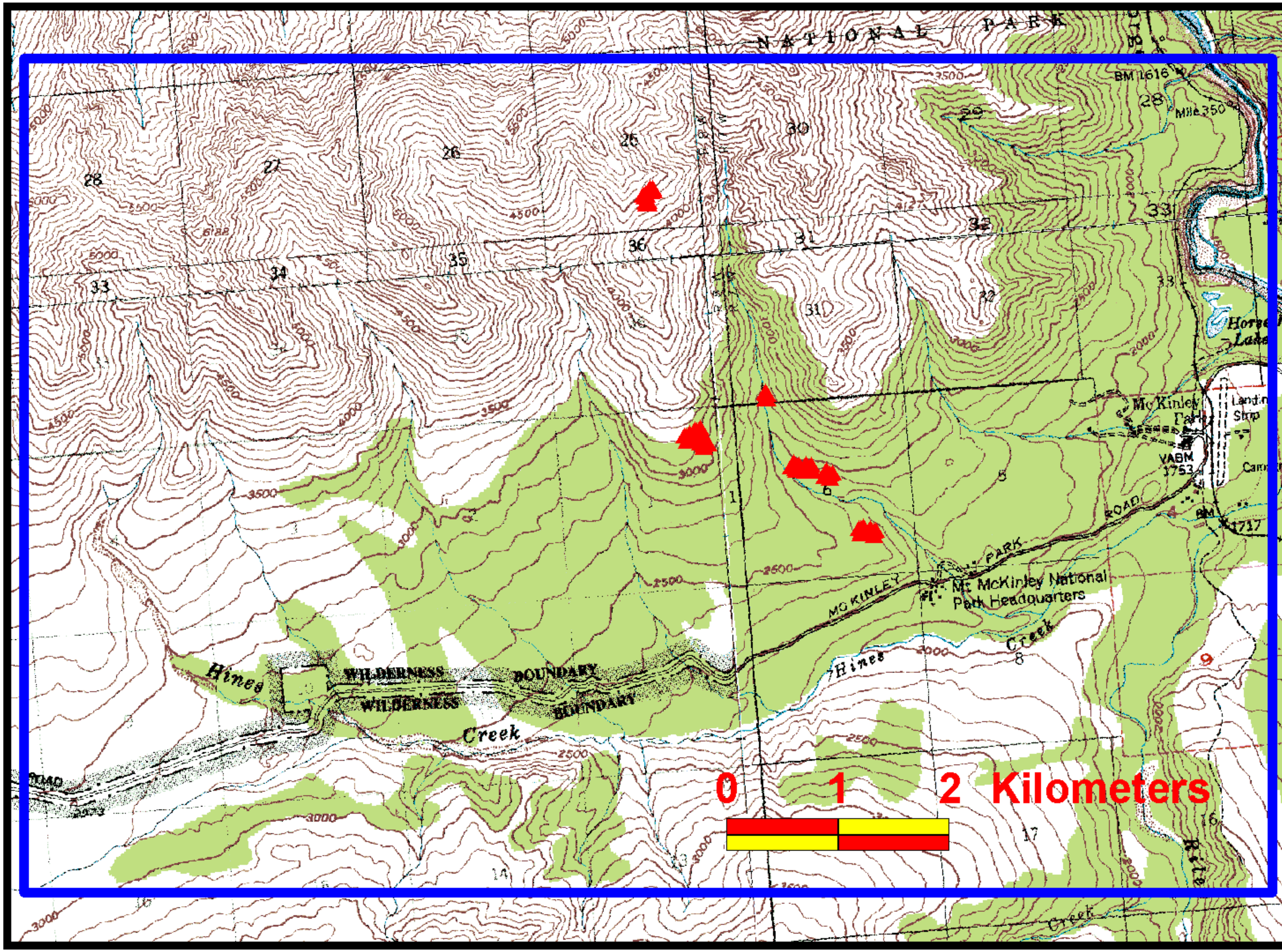
- monitoring objectives
- spatial scales for meeting objectives

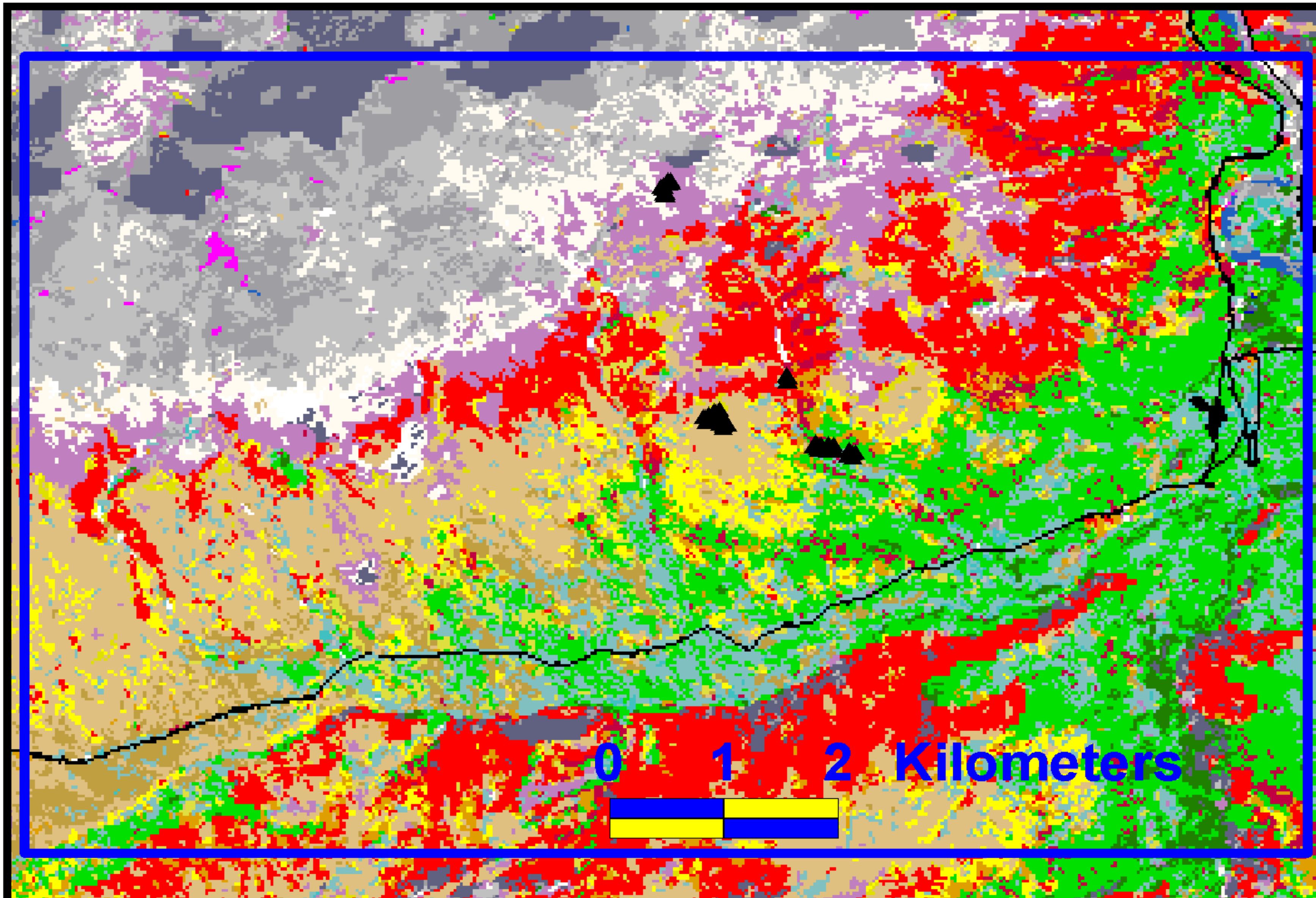
Rock Creek watershed vegetation study design:

There are three primary study sites established on an elevation gradient:

- **tundra (1480 m)**
- **treeline (1050 m)**
- **forest (650 m)**

Each of these sites consists of three replicate plots within which vegetation measurements are taken; the mean response of three replicates represents the mean for the site.


NATIONAL PARK
Mt McKinley National Park Headquarters
McKinley Park
MC KINLEY PARK ROAD
Hines Creek
WILDERNESS BOUNDARY
Horseshoe Lake
Landing Strip
VABM 1753
BM 1616
BM 1717
Mile 350
0 1 2 Kilometers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Parameters measured in Rock Creek permanent vegetation plots:

1) White spruce growth and reproduction (annual measurements)

- cone counts of sample trees
- dendrometer-band readings for incremental growth
- seed-traps to quantify number of seeds and seed viability
- seed germination trials on spruce seeds collected in traps

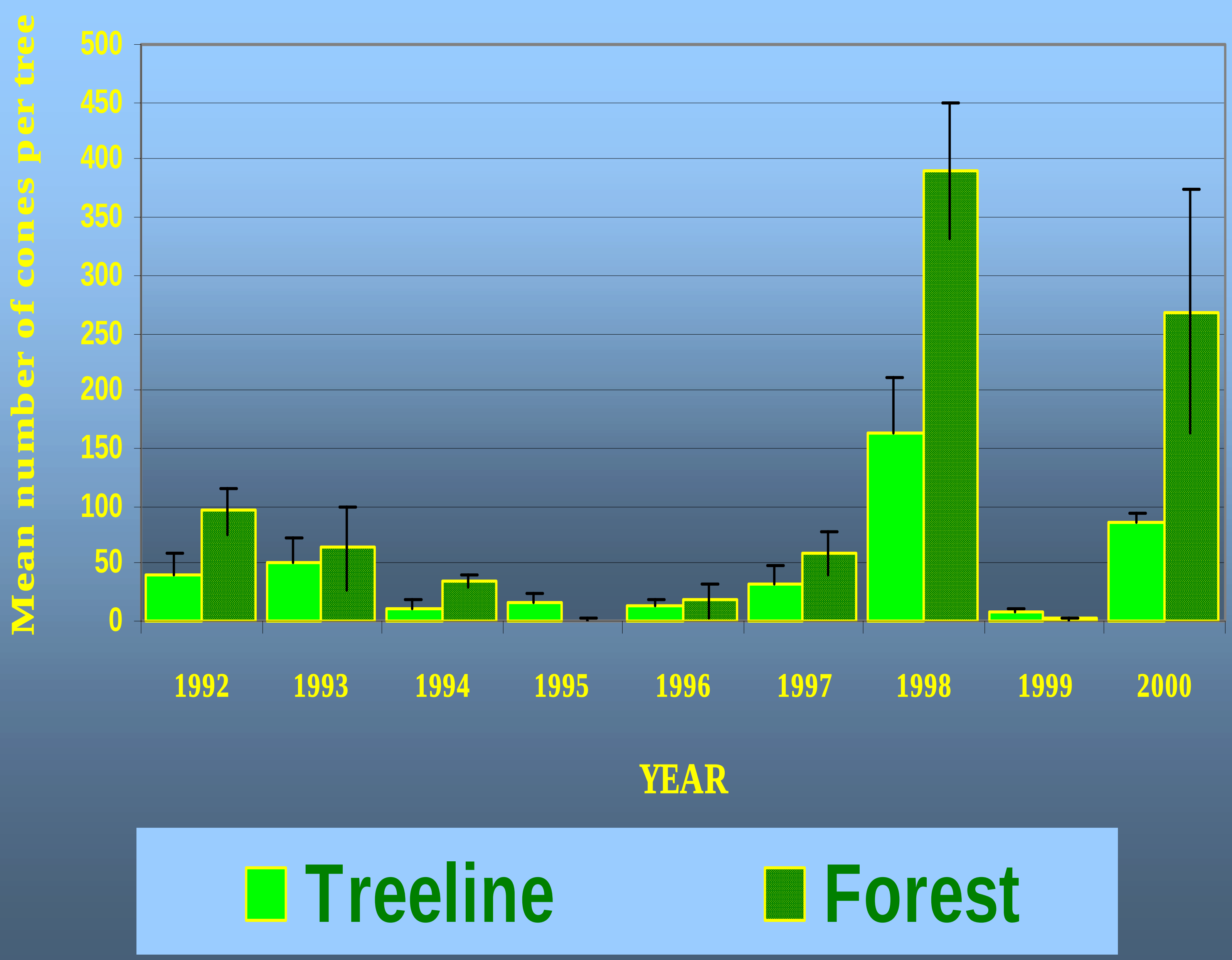
2) Vegetation structure & composition: (8 year remeasurement cycle)

- cover, by species, of all taxa present (including vascular plants, mosses & lichens)
- density and diameter of tree and shrub species

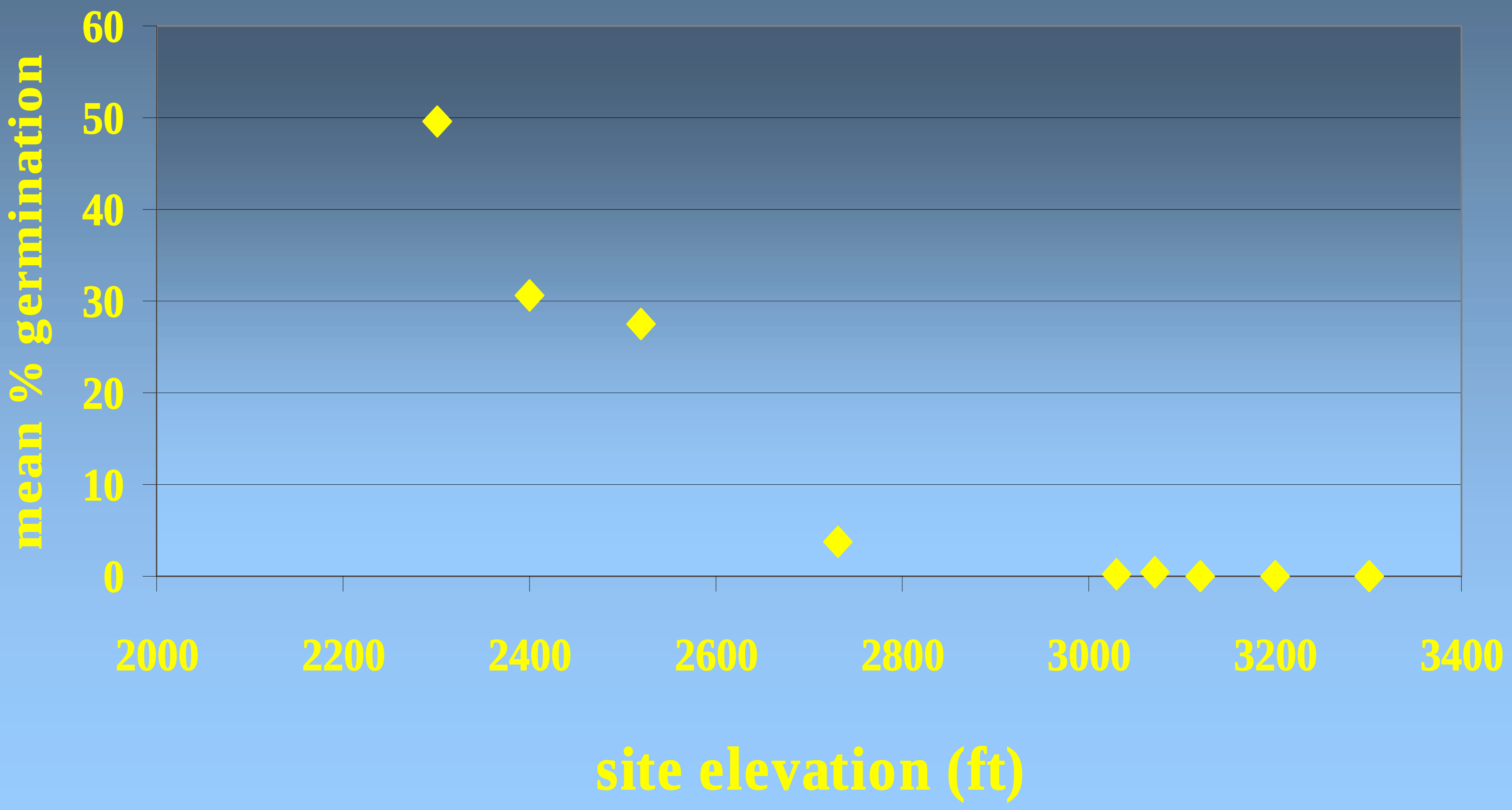
** Discontinued elements of the initial protocol include phenology and berry production

Some examples of data from Rock Creek vegetation studies…………..

Mean annual cone production by white spruce in Rock Cr.

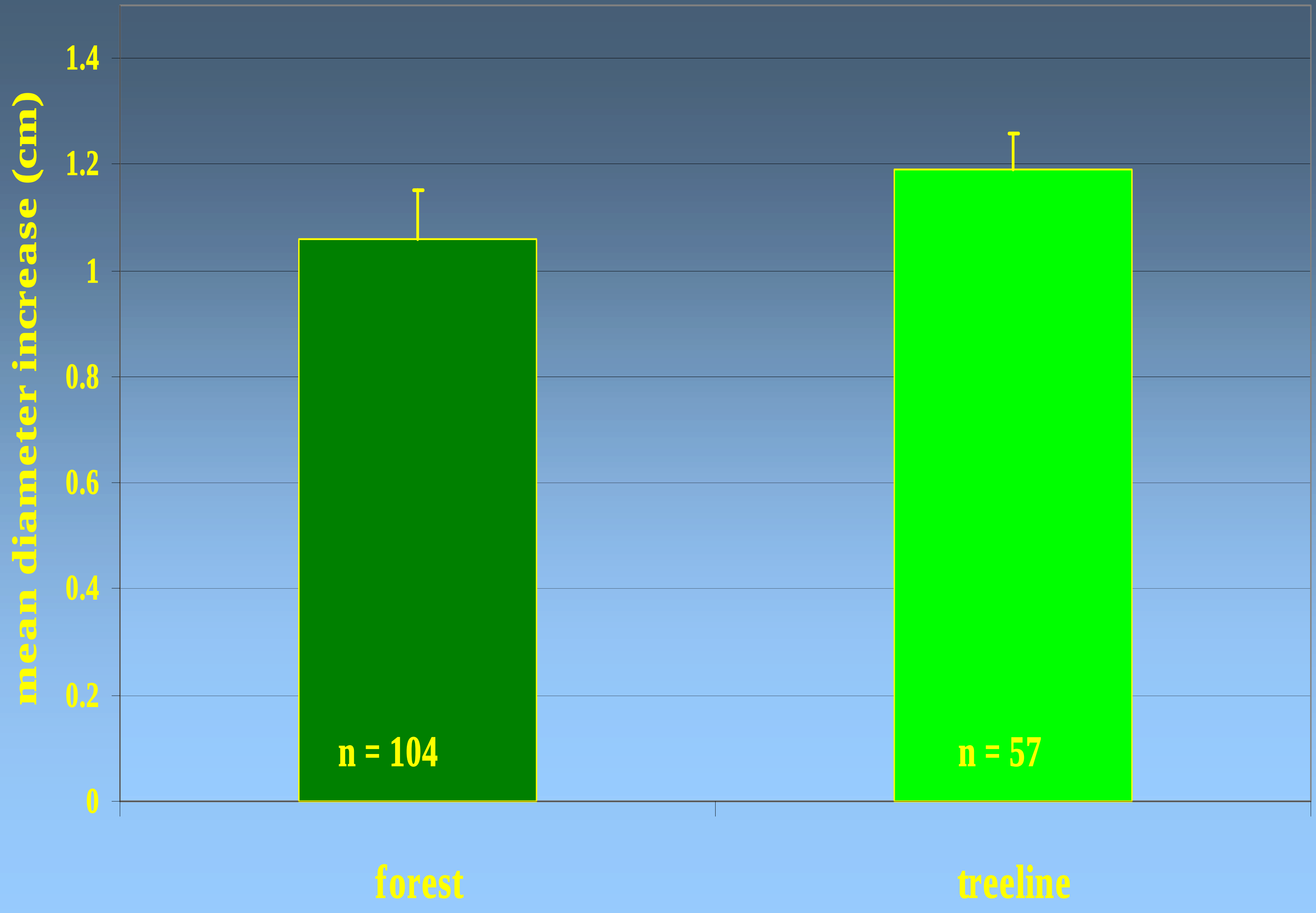


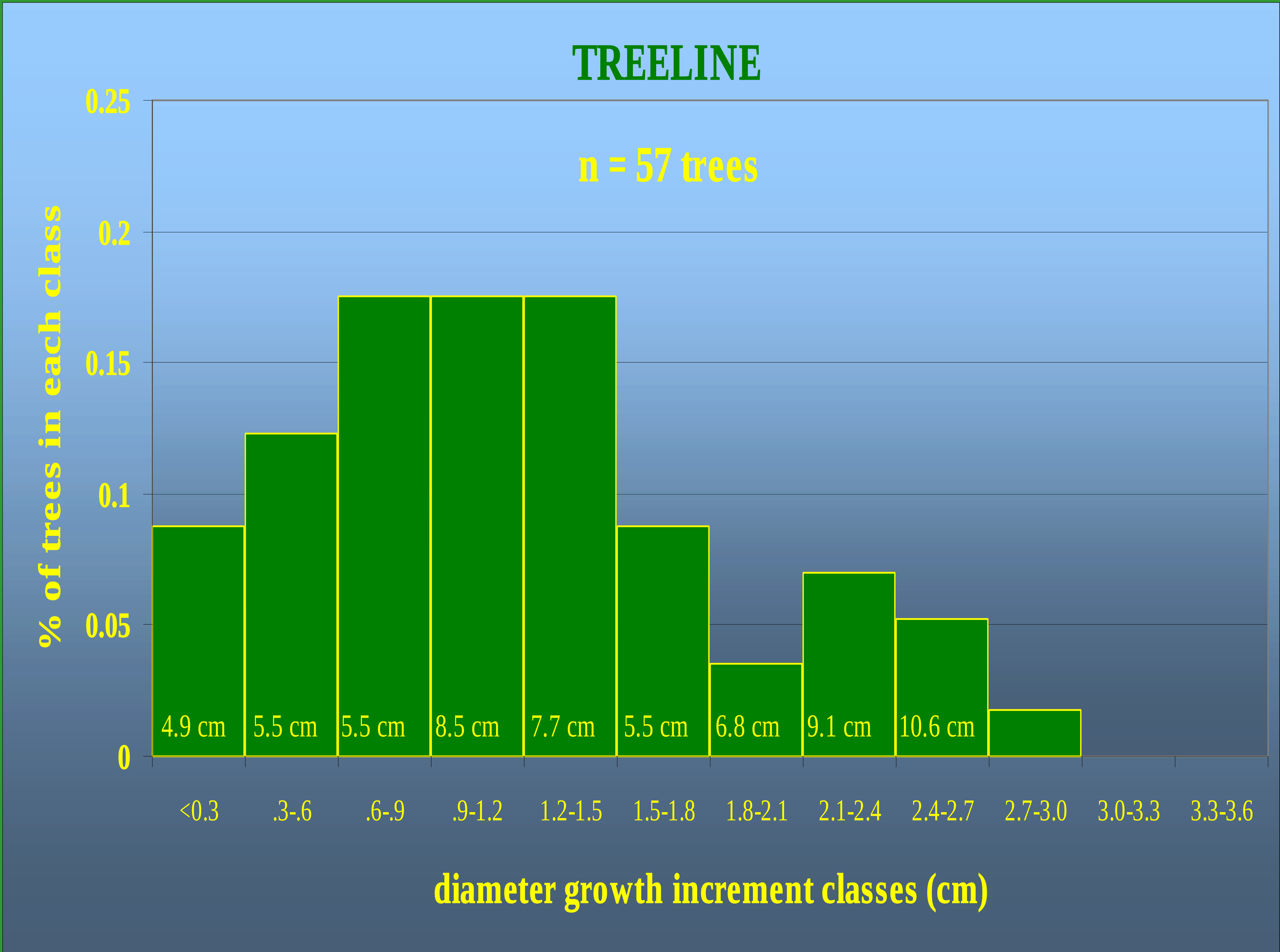
Mean % germination of *P. glauca* seeds harvested from eight sites in Denali in 1998

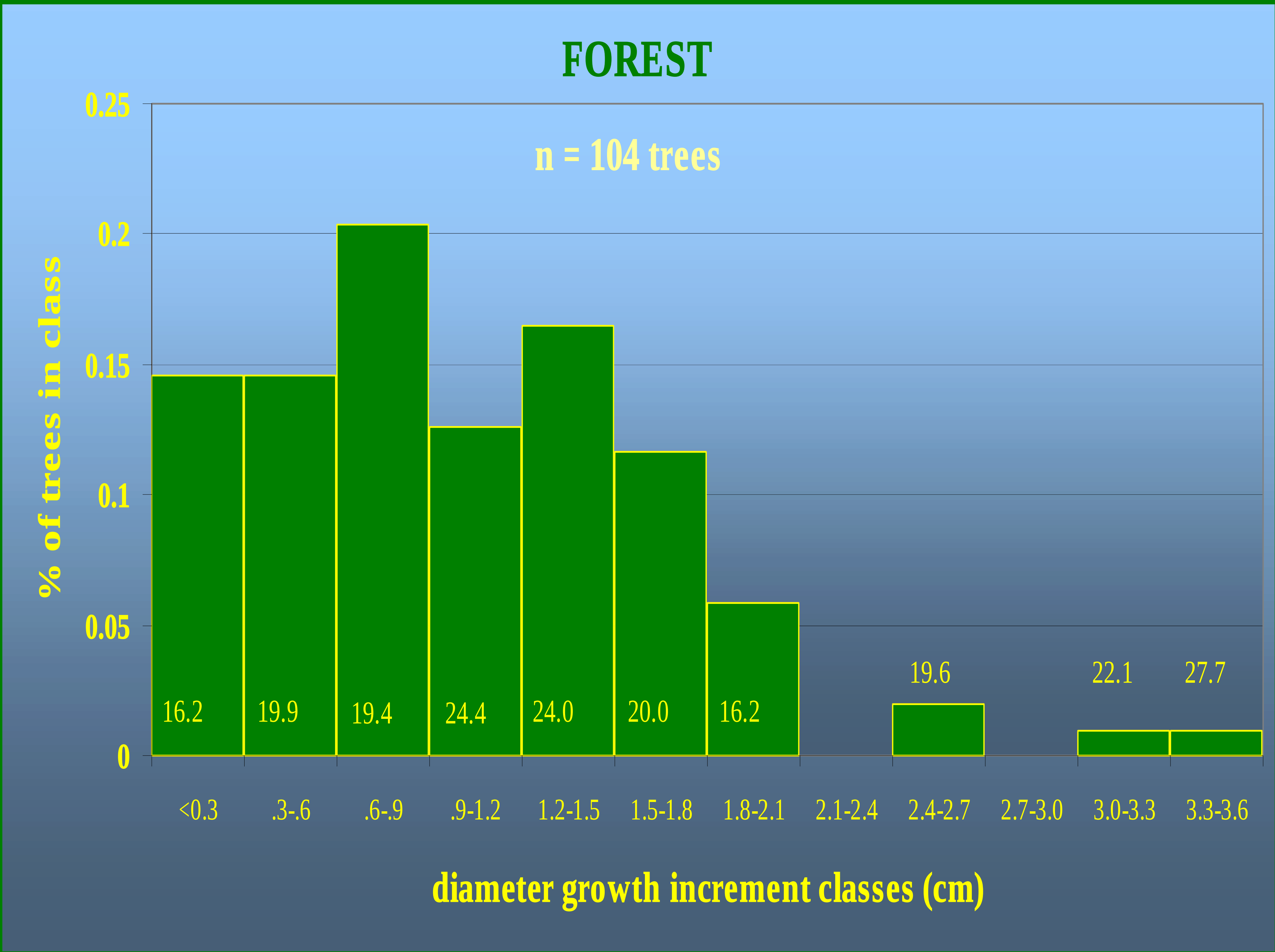



Mean annual bole growth of white spruce in Rock Creek study area
(as measured by dendrometer bands)
Mean annual diameter growth (cm)
0.6
0.5
0.4
0.3
0.2
0.1
0
1994
1995
1996
1997
1998
1999
YEAR
Forest
Treeline

Mean white spruce growth between 1993-2000 (per tree)

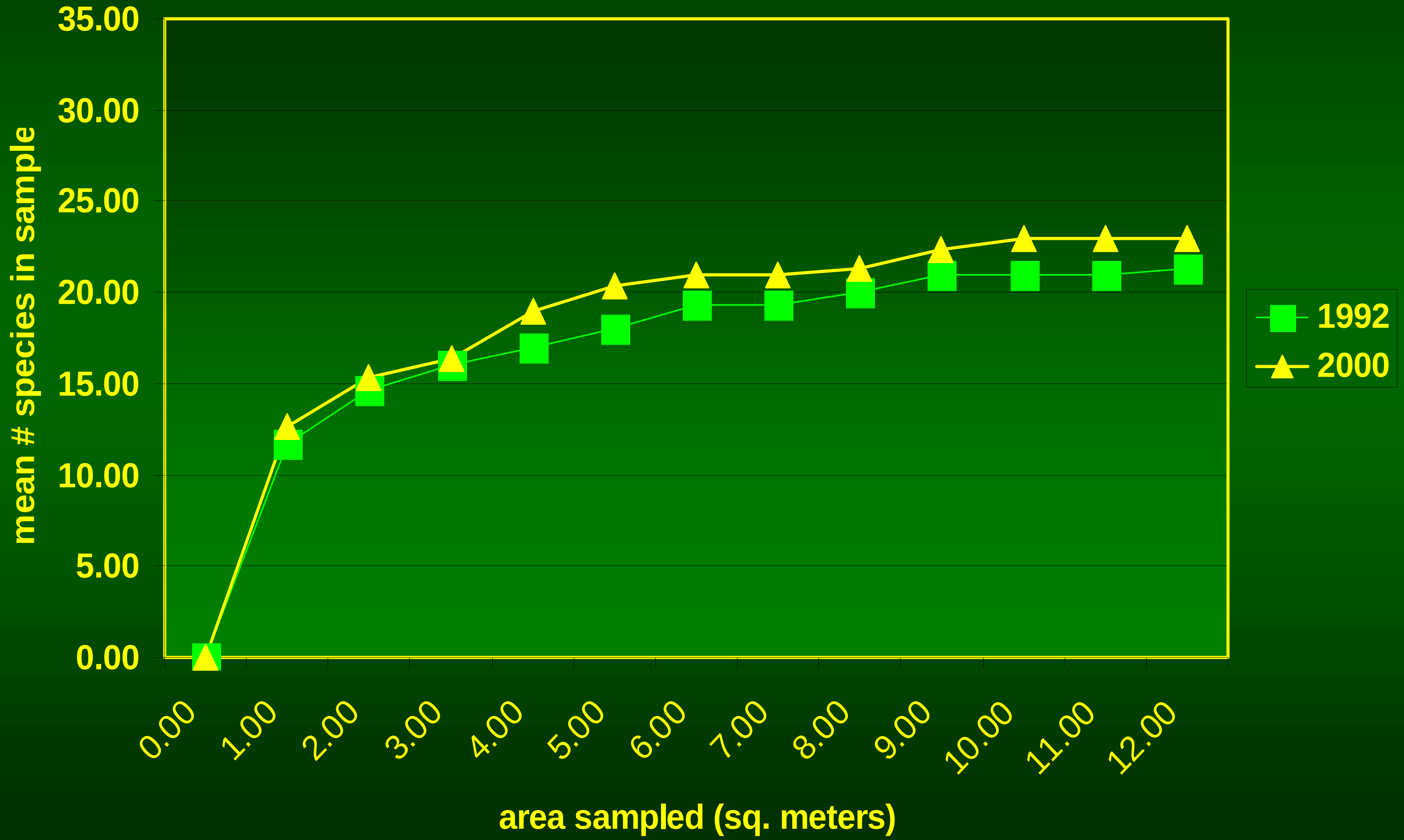



TREELINE
n = 57 trees
% of trees in each class
0.25
0.2
0.15
0.1
0.05
0
4.9 cm
5.5 cm
5.5 cm
8.5 cm
7.7 cm
5.5 cm
6.8 cm
9.1 cm
10.6 cm
<0.3
.3-.6
.6-.9
.9-1.2
1.2-1.5
1.5-1.8
1.8-2.1
2.1-2.4
2.4-2.7
2.7-3.0
3.0-3.3
3.3-3.6
diameter growth increment classes (cm)



FOREST
n = 104 trees
% of trees in class
0.25
0.2
0.15
0.1
0.05
0
16.2
19.9
19.4
24.4
24.0
20.0
16.2
19.6
22.1
27.7
<0.3
.3-.6
.6-.9
.9-1.2
1.2-1.5
1.5-1.8
1.8-2.1
2.1-2.4
2.4-2.7
2.7-3.0
3.0-3.3
3.3-3.6
diameter growth increment classes (cm)

Mean species area curves for Rock Creek Forest replicates in 1992 and 2000 sampling events

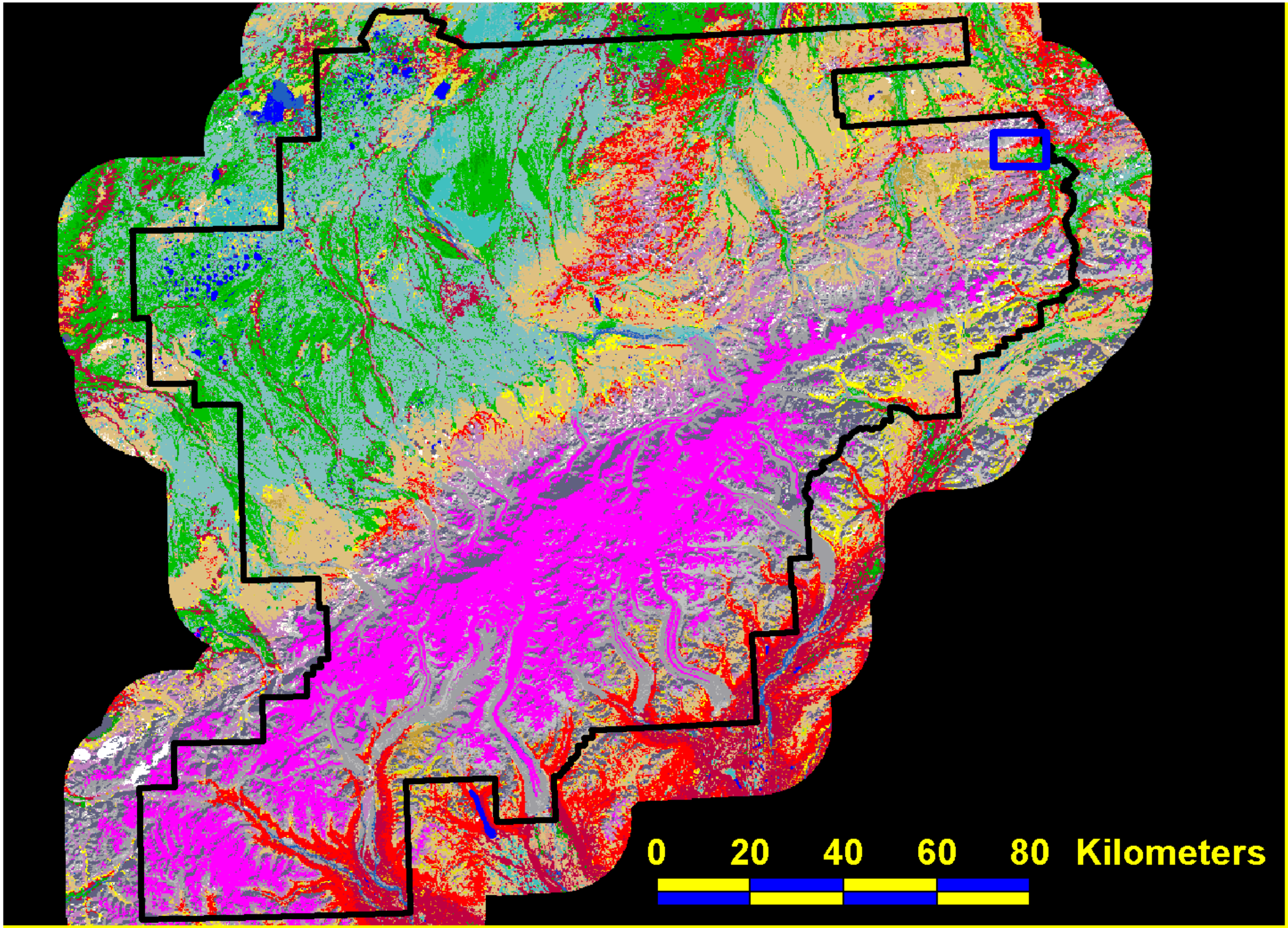


Conclusions from Rock Creek study area data

We observed large inter-annual variations in tree growth, and cone and seed production in white spruce during the period 1992-2000

There were significant differences in spruce seed viability between forest and treeline sites due to negligible seed viability at treeline; (for example, the very large cone crop of 1998 produced no viable seeds in treeline sites)

Vegetation composition (cover and diversity) of study sites has not changed significantly between 1993 and 2000 (although analysis of 2000 data not yet complete)


0 20 40 60 80 Kilometers

Problems with initial sample design (Rock Creek)

1) it deals with too narrow a range of questions/issues

- provides little data on major management concerns and issues
- monitors change across only a single environmental gradient
- sample design includes sites in only three (of more than twenty) major vegetation types in the Park

2) the spatial scale of the study design is inadequate

- area of inference does not extend beyond the watershed
- does not provide information on the status and trends of vegetation at a landscape-scale

A proposed solution:

Landscape-scale study design for vegetation monitoring!

Design attributes of emerging vegetation monitoring protocol:

1) design is based on a Park-wide systematic grid with random start

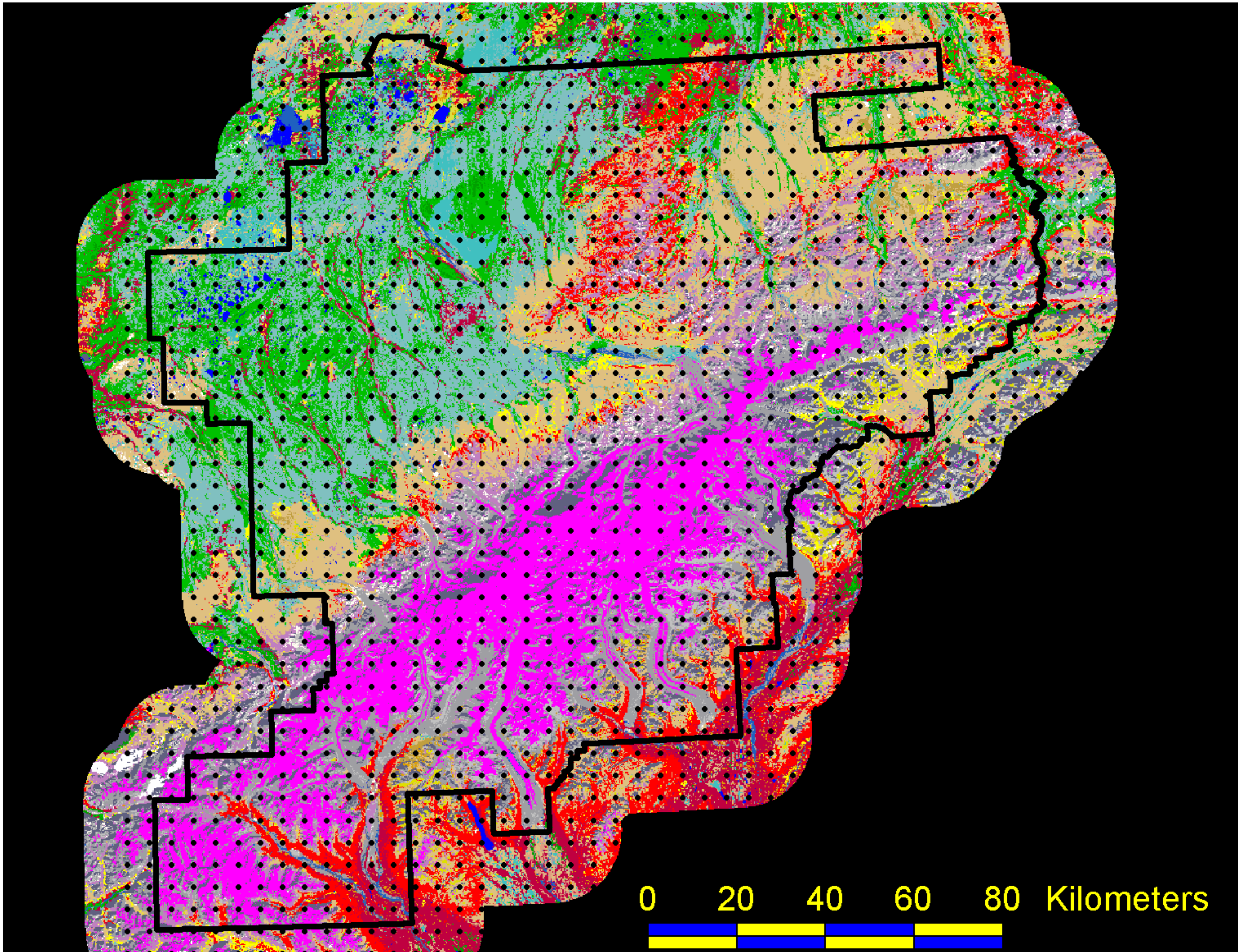
2) a nested, spatially integrated sampling design -

   Different questions will be asked at different spatial scales, which will vary from remotely sensed data (most inclusive scale), to “intensive” monitoring sites, of which there will be relatively few.

   Information collected at each scale will allow us to “scale-up” ; that is, make projections or estimates concerning processes occurring at larger spatial scales using a modeling approach.

3) spatially explicit - the area of inference for each vegetation parameter sampled is clearly defined (area of inference will vary among parameters based on cost vs. precision evaluations)

4) design will allow us to to make statistically rigorous, area-based statements concerning change occurring on a large spatial scale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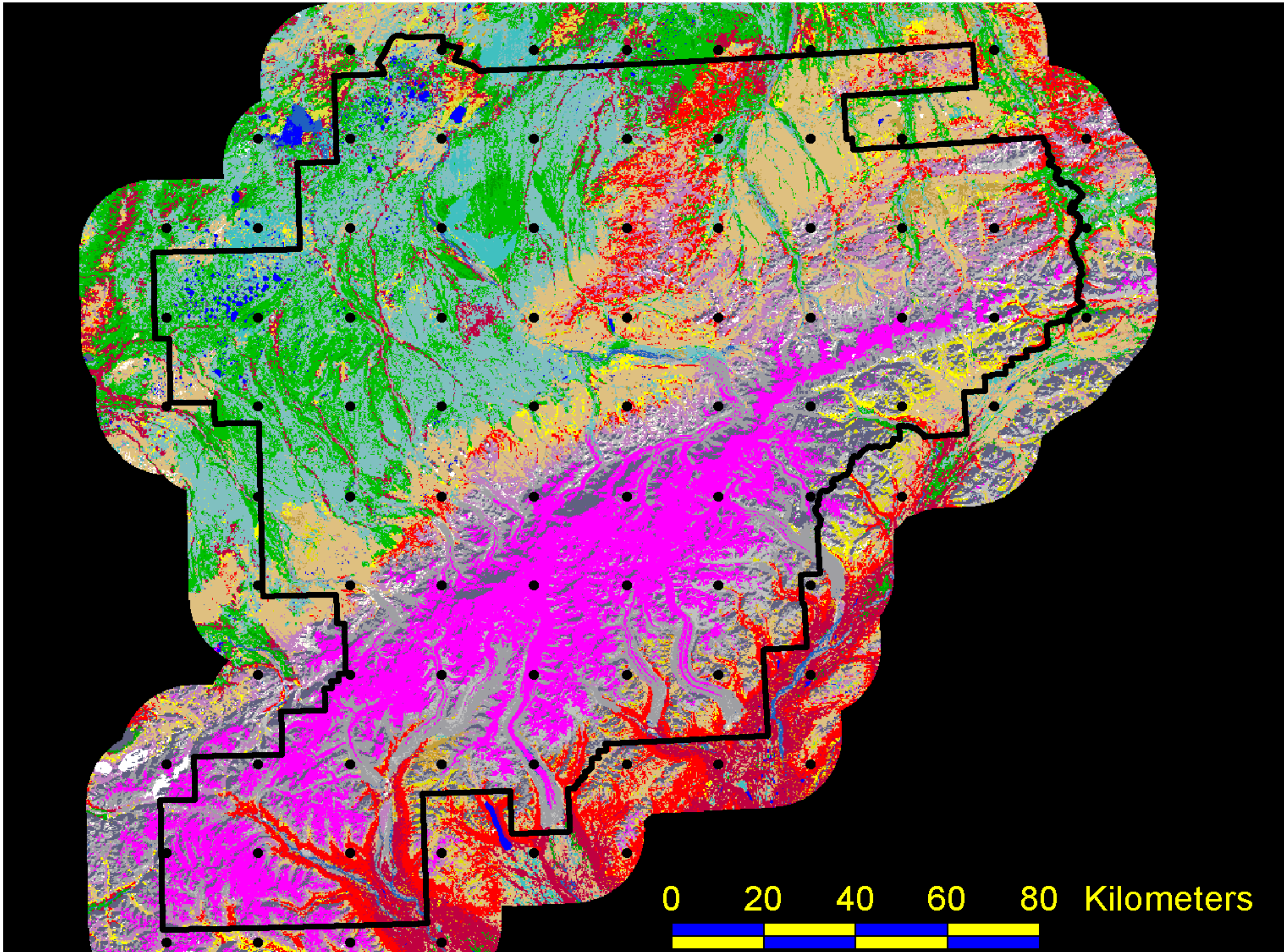
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Principal objectives of landscape-scale sampling design

- detect changes in the structure of the vegetation cover of the Park and in the distribution of major landcover types
- detect change in the species composition and species diversity (species-area relations) of the vegetation cover of the Park.
- detect changes in the distribution and character of fuels (particularly down woody debris) on the landscape of the Park
- detect changes in the evidence of human use of the landscape of the Park, and impacts to vegetation resources of the Park
- detect changes in the distribution and abundance of lichen species in the Park, particularly key indicators of air quality
- detect inter-annual variation and long term trends in the timing and character of key phenological events on the landscape of the Park
- detect changes in the degree, extent and distribution of activity of selected forest insect species in the Park

Spatial scales of inquiry for vegetation monitoring:

- **Foundation of the systematic grid concept is the base grid (100m? 1 km?)**

  Monitoring at this fine scale of resolution will be restricted to remote sensing applications: (monitoring of landscape phenology, major landcover classes, etc…)

  Another function of the base grid is to serve as a "ready made" georeferenced sampling frame within which to allocate all other vegetation research/monitoring in the Park; it is fine enough to link together all research and monitoring activities

- **A network of extensive-scale field monitoring sites will be established on a (10 km ?) grid subsample of the base grid**

  These sites will be the primary source of data concerning landscape-scale vegetation processes: species diversity, fuel loading, distribution of vegetation types, etc...

- **A much smaller network of intensive monitoring sites will be selected in order to monitor parameters that are too expensive to monitor at finely resolved spatial scales (1 cluster per ecoregion?)**

  Growth, reproduction and other process variables that are too costly to monitor at numerous sites will be studied in a few selected sites that are inexpensive to access, but are broadly representative of important Park ecosystems

Remotely-sensed vegetation parameters:

1) Land cover classes: proportion of base grid points in the following - each point assigned to one basic category at 5 year intervals:

- vegetated, barren, rock, ice, water

These data will provide areal estimates of basic elements of landscape evolution over time; deglaciation, primary succession, lake succession etc….

2) Inter-annual variation in landscape vegetation phenology (annual): - minimum Julian date assigned for each point for following events:

- snow-free date, initial green-up, peak green-ness, senescence, snow-cover date

3) Gross measures of productivity (annual):

-"greenness" (NDVI) indices assigned to each point, calibrated by more intensive sampling on the ground

Major parameters measured at "extensive-scale" plot network

1) species composition and plant diversity (species-area relationships)

2) fuel loading and down-woody debris

3) vegetation structure (cover, density, etc… by life form)

4) human impacts and evidence of use

5) density, size and condition of forest tree species; evidence of fire, disturbance or insect activity

6) presence/abundance of key indicator species - (including exotics, selected lichens for air quality,..)

Vegetation parameters measured at “intensive-scale” sites

1) relative success of different revegetation techniques (in terms of soil stabilization, cover, etc…)

2) growth and reproduction of selected species (such as white spruce studies in Rock Creek)

3) productivity variables to calibrate remote-sensing data

4) ecophysiology of selected taxa (in cooperation with University scientists)

5) specific impacts of human activities (snowmachines, trampling etc.…)

6) population dynamics or demography of species of special management concern (rare plants, exotics, etc.…)

Benefits of a nested, landscape-scale sampling design that utilizes a systematic random grid sampling frame

1) offers an unbiased method of sample site selection that removes preconceived notions of how and where change will occur

2) provides a framework for integrating all monitoring and research efforts within the Park (a "ready-made" set of randomly-allocated study locations)

3) ensures dispersion of sample sites throughout the landscape

4) allows for "scaling-up" of inferences made at successive spatial scales (using a modeling approach)

5) will allow us to make statistically rigorous, area-based statements concerning change occurring on the landscape