

Preliminary selected indicators for ROMO/FLFO

I. Landscape condition							
Vegetation composition, structure & soils (about biotic condition)							
<i>Measure</i>	<i>Data (park)</i>	<i>Data (ecoregion)</i>	<i>Scale</i>	<i>Modeling</i>	<i>Reference condition</i>	<i>Link to DM & Vital signs</i>	<i>Questions</i>
Ecosystem types: extent and proportion of major ecosystem types (dominance, evenness, etc.)	Vegetation. Soils: SSURGO; 10 m DEMs; aerial photos; wetlands? RNA plots; Fuel treatment	Veg: Landfire existing veg types; or SW ReGap (30 m); or NLCD 2001 (30 m). Soils: SSURGO, STATSGO; DEMs 10/30 m	Grain: 30 m Aggregate to sub-watersheds	Potential riparian zones, wetlands/fens Major aquatic types (a la TNC freshwater)	Construct potential natural vegetation from abiotic factors (topography, soils); Experts: T. Veblen, M. Kaufmann, B. Romme, B. Baker, D. Cooper	Are RNAs useful for reference condition?	Decide on major ecosystem types; Maps of wetlands/riparian areas? Can park vegetation be reliably cross-walked to Use Landfire or NLCD data?
Extent and proportion of ecosystem structure/seral stages	Vegetation; fuel treatments; Fire perimeters	USFS Common veg unit; FIA Beetle kill Forest fire perimeters Forest treatments?	Grain 30 m	Model old growth forest in ecoregion based on accessibility?	Compare to late 1800s Experts: T. Veblen, M. Kaufmann, B. Romme, B. Baker, D. Cooper	Where are forest fuels? What watersheds are most susceptible to beetle kill/fire/erosion cycle?	
Landscape dynamics (broader landscape changes)							
<i>Measure</i>	<i>Data (park)</i>	<i>Data (ecoregion)</i>	<i>Scale</i>	<i>Modeling</i>	<i>Reference condition</i>	<i>Link to DM & Vital Signs</i>	<i>Questions</i>
Degree of land use changes (housing density, impervious surface)	Zones; Park boundary	Zoning & master plans from nearby counties/cities	Parcel level	Build-out analysis for adjacent areas? Model highly visible adjacent lands?	Historical trends: 1950 to 2000, 2050?	Have/will general ecotone change w/climate change? Effect of WUI – related treatments on other park resources?	How to define ecological boundaries around park
Housing density change (number of housing units)	None	SERGoM housing density 100 m	1 ha resolution	SERGoM	Historical trends (1950 to 2000)	What outside land uses will influence park management? What land use will	

						affect viewsheds?	
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II. Biotic condition

Freshwater & wetland communities (at watershed scale)

<i>Measure</i>	<i>Data (park)</i>	<i>Data (ecoregion)</i>	<i>Scale</i>	<i>Modeling</i>	<i>Reference condition</i>	<i>Link to DM & Vital signs</i>	<i>Questions</i>
Extent of major stream and wetland types	National Hydrography Data 1:24k	National Hydrography Data 1:24k	Grain 10 m	Find reach catchment areas; Generate channel type	Experts: K. Fausch, L. Poff, D. Cooper	Relationship of threats to condition	Settle on wetland classification
Connectivity/isolation of freshwater system types	National Hydrography Data 1:24k; Diversions, culverts	National Hydrography Data 1:24k; Diversions, culverts	Grain 10 m	Threats such as road, crossings,	Experts: K. Fausch, L. Poff, D. Cooper	Relationship of threats to condition	

Beaver habitat (dams, suitability model)

<i>Measure</i>	<i>Data (park)</i>	<i>Data (ecoregion)</i>	<i>Scale</i>	<i>Modeling</i>	<i>Reference condition</i>	<i>Link to DM & Vital Signs</i>	<i>Questions</i>
Extent of suitable habitat for beavers	National Hydrography Data 1:24k ?historical survey of beaver dams? Historical aerial photo interp of dams	National Hydrography Data 1:24k	Grain: 10 m	Predictive model of suitable habitat for beaver	Historical numbers of beaver? Experts?	How many beaver could RMNP support? Where would their habitat be and importance for elk/willow dynamics.	? how large of a patch is needed?

Invasive terrestrial plants

<i>Measure</i>	<i>Data (park)</i>	<i>Data (ecoregion)</i>	<i>Scale</i>	<i>Modeling</i>	<i>Reference condition</i>	<i>Link to DM & Vital Signs</i>	<i>Questions</i>
Number and presence/absence of invasive plant	?						

Invasive aquatic biota

<i>Measure</i>	<i>Data (park)</i>	<i>Data (ecoregion)</i>	<i>Scale</i>	<i>Modeling</i>	<i>Reference condition</i>	<i>Link to DM & Vital Signs</i>	<i>Questions</i>

Extent and proportion of non-native fish		DOW & USFS occurrence data	1:100K, 1:24k		Experts: Fausch, Poff		Data on culverts, diversions, dams?
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III. Chemical and physical characteristics

Water chemistry

<i>Measure</i>	<i>Data (park)</i>	<i>Data (ecoregion)</i>	<i>Scale</i>	<i>Modeling</i>	<i>Reference condition</i>	<i>Link to DM & Vital signs</i>	<i>Questions</i>
Condition of alpine lakes	Water quality parameters of headwater lakes in each basin (major ions, pH, ANC, DOC)	Water quality parameters from headwater lakes (EPA, FS, USGS, States data sets – major ions, pH, ANC, DOC)	Individual lakes could be mapped at subwatershed	DayCent-Chem for detailed modeling, or simple ratios: DIN:TP or Henricksen's nomogram	Constructed from distribution of regional high elevation lake chemistry: lowest quartile of measured nitrate concentrations for eutrophication; reference ANC based on parent material	Water chemistry, invasive aquatic species, aquatic biota: benthos and algae, freshwater communities	Sampling frequency, how do RMNP lakes compare with other southern Rocky Mountain lakes?

Atmospheric deposition and air quality

<i>Measure</i>	<i>Data (park)</i>	<i>Data (ecoregion)</i>	<i>Scale</i>	<i>Modeling</i>	<i>Reference condition</i>	<i>Link to DM & Vital signs</i>	<i>Questions</i>
Wet and dry atmospheric deposition, including mercury	CO98, 98CO, CO19 NADP sites, CASTNET	NADP regional isopleth maps (produced annually), or finer resolution maps produced by us using regional concentrations and PRISM	30 m best because of topographic complexity		Constructed from literature, remote areas of world, and hindcasting	Wet and dry deposition	What are trends in deposition of pollutants to park?

IV. Ecological processes

Carbon cycling

<i>Measure</i>	<i>Data (park)</i>	<i>Data (ecoregion)</i>	<i>Scale</i>	<i>Modeling</i>	<i>Reference condition</i>	<i>Link to DM & Vital Signs</i>	<i>Questions</i>
Above- and belowground biomass	Land cover, vegetation maps, FIA data	Land cover, vegetation maps, FIA data	30m	Century? Some modeling needed to scale plot data up	From literature – Veblen and others	Biological integrity, vegetation structure and cover	What is role of RMNP in regional carbon sequestration?

V. Hydrology and geomorphology

Surface water dynamics

<i>Measure</i>	<i>Data (park)</i>	<i>Data (ecoregion)</i>	<i>Scale</i>	<i>Modeling</i>	<i>Reference condition</i>	<i>Link to DM & Vital signs</i>	<i>Questions</i>
Monthly and annual discharge in streams	Gauged data; 1:24k hydro	PRISM, montly precip	1:24k, park's watersheds	Develop CART estimate of stream flow	Precip data from 1970-2000; Experts: L. Poff; D. Merritt	Possible changes in timing and amount of discharge under climate change?	

VI. Natural disturbance regimes

Fire regime (beetle, wildfire dynamics)

<i>Measure</i>	<i>Data (park)</i>	<i>Data (ecoregion)</i>	<i>Scale</i>	<i>Modeling</i>	<i>Reference condition</i>	<i>Link to DM & Vital signs</i>	<i>Questions</i>
Extent of sensitive cover types (lodgepole)	Vegetation; Slope soils	Beetle-kill locations from USFS aerial survey	Analyze by sub-watershed				

Avalanche paths

<i>Measure</i>	<i>Data (park)</i>	<i>Data (ecoregion)</i>	<i>Scale</i>	<i>Modeling</i>	<i>Reference condition</i>	<i>Link to DM & Vital Signs</i>	<i>Questions</i>
Extent and location of run-out paths	Aerial photography	30 or 10 m DEM	w/in park	Topographic modeling of slope and fetch (cornices)			

VII. Socio-ecological systems

Visitor use

<i>Measure</i>	<i>Data (park)</i>	<i>Data (ecoregion)</i>	<i>Scale</i>	<i>Modeling</i>	<i>Reference condition</i>	<i>Link to DM & Vital signs</i>	<i>Questions</i>
Visitor Use Accessibility – one-way travel time (minutes) from trailheads	GPS trails Trail heads Roads # of parking spaces at trailhead lots Bus transit	DEM 30 m, 10 m Land cover	1:24k inside park	Using van Wagtendonk or Imhof's hiking model;	Compare to different visitor use levels (1970 to 2000)	People At OneTime (PAOT) Wilderness Encounters	Incorporate known (or modeled) destination areas such as climbing, fishing (lakes) What types of resources are within different accessibility ranges? Or recreation opportunities.
Soundscape	GPS trails Trail heads Roads Other visitor use destinations, Use acoustic monitoring devices along visitor use areas to collect acoustic data	DEM 30 m, 10 m Land cover	1:24k inside park	Noise Model Simulation (NMSim), overlaid with access or visitor use simulation models	Use standards based on research on acoustic indicators.	Sound Pressure Level (dBA) % time human sounds audible, noise free intervals, % time natural sounds audible	What is the relationship between use and dBA? What is the relationship between use and % time human sounds audible? What is the relationship between use and noise free interval? How do the above indicators affect wildlife?

Analytical units

Define management zones

Data gaps

Process/modeling gaps

Appendices

The key to distinguishing characterization vs. assessment is explicit representation of reference condition. Reference condition is used as the standard or benchmark against which current conditions are compared. Here we examine the reference condition as a

distribution of possible values. Reference condition should be reserved for referring to the naturalness of the biota and that naturalness implies the absence of significant human disturbance or alteration.

There are a number of sub-types of reference condition:

- Minimally disturbed condition
 - Historical condition
 - Least disturbed condition
 - Best-attainable condition
- These are generated through methods such as: reference-site approach; best professional judgment; interpretation of historical condition; extrapolation of empirical models; evaluation of ambient distributions