

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>
Ecological systems 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 within Park boundaries; secondary domain SRE	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, Dan Binkley	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; Domain w/Park; secondary domain SRE	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?	Are seral stages available for RMNP???
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; primary around park	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; primary around Park; secondary SRE	SERGoM	Historical trends (1950 to 2000)	What outside land uses will influence park management? What land use will affect viewsheds?	
Landscape connectivity			Domain Park, SRE, westwide	Forest carnivore (target species: bighorn summer to winter use areas, puma, lynx, wolves)	Cleland, North Carolina. Plant species movement P. Gonzalez (forthcoming in Climate Change report) for climate change (climate niche space)	How are changes in habitat and connectivity related to bighorn sheep? Possible introduction of wolves? Role of park for Lynx? See Judy Viste's comments	

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, lake and wetland types	National Hydrography Data 1:24k	National Hydrography Data 1:24k	Grain 10 m; primary Park; secondary SRE	Find reach catchment areas; Generate channel type	Experts: K. Fausch, L. Poff, D. Cooper	Relationship of threats to condition; what lakes are disconnected; which are at risk to climate change?	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; primary Park; secondary SRE	Threats such as road, crossings,	Experts: K. Fausch, L. Poff, D. Cooper	Relationship of threats to condition; invasion of trees into wetlands?	
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; Colorado Riparian Vegetation dataset; NWI	Grain: 10 m; primary Park; secondary SRE	Predictive model of suitable habitat for beaver; water <8 ha; streams <15%; riparian veg <200 m	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>
Extent of invasive plants	NIIS (Stohlgren's group)		primary Park; secondary SRE				

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	Links to P. didymo? Mud snail?	Data on culverts, diversions, dams?

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; primary park, secondary SRE	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; primary park, secondary SRE		Constructed from literature, remote areas of world, and hindcasting	Wet and dry deposition	What are trends in deposition of pollutants to park?

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IV. Ecological processes							
Carbon cycling (LOWER PRIORITY)							
<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; primary SRE	Century? Some modeling needed to scale plot data up	From literature – Veblen and others	Biological integrity, vegetation structure and cover; hotspots of carbon storage	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 only; 1:24k hydro		3 or 4 gauged historical analysis of hydrograph; not spatially-explicit	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 disturbance-dependent vegetation (lodgepole, spruce/fir, aspen)	Vegetation; Slope soils	Beetle-kill locations from USFS aerial survey;	Analyze by sub-watershed; primary park, secondary SRE	Calculate RUSEL using tree; Jeff Hicke model of potential for outbreak	Experts: Kashian (Forest)	Potential for massive erosion; priority areas to monitor for invasion? Model potential for invasion of beetles?	
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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 built on an accessibility model – 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.