Crown LCD Leadership Meeting Notes
November 24, 2020

Action Items (November):

What?	Who?	When?
Incorporate connectivity, intactness	Sean, Analysis Team in collaboration with Kathy Zeller, Technical Team and other subject matter experts	Throughout 2021
Continue data acquisition	Analysis Team & Kathy	On-going but ASAP
Identify Subject Matter Experts for select features	Everyone	Through January

Action Items (Prior):

What?	Who?	When?
Integrate guild approach to spatial design	Analysis Team	Through modeling effort (started - but ongoing)
Get started on Social, Cultural, Economic features (emphases on cultural sites, recreation, timber and ranching economies)	Sean and Analysis Team	ASAP
Initiate data evaluations for selected coarse features	Analysis Team and Technical Team	Ongoing
Identify Subject Matter Experts for select features	Everyone	Through January
Continue generating maps describing focal landscape features; post on website	Phil, Aubin, Sean	Ongoing; revisit monthly
Continue conceptual models for selected features; bridge to Key Ecological Attributes	Natalie and Sean	Initiated, Ongoing
Continue analytical work on cold water salmonids (and climate refugia) as a likely focal landscape feature	Analysis Team	Initiated, Ongoing
Think about how we can recruit social, cultural and economic experts	Leadership Team	Ongoing; several excellent nominees

Meeting Notes and Materials:

Recording: https://meet39041854.adobeconnect.com/pmn656mf1ii7/

Presentation Slides: Attached (Leadership_Team_call_11-24-2020.pdf)

Next Call: December 15, 2020 at 11 am

Attendees

- Alisa Wade: Alisa Wade, North Central Climate Adaptation Science Center
- Brooke Kapeller: CPAWS Southern Alberta
- Chad Willms
- Clifford Kipp (he/him/his): MT Conservation Corps
- Connie Simmons: Connie Simmons Y2Y - Alberta
- Constanza von der Pahlen: Flathead Lakers, Critical Lands Program Dir.
- Craig Harding-NCC: Craig Harding-NCC
- Erin Sexton
- Kathy Zeller: Kathy Zeller, Aldo Leopold Wilderness Research Institute
- Kelly Cooley
- Kim Pearson: Kim Pearson, Parks Canada, Waterton Lakes National Park
- Linh Hoang
- Mary McFadzen: MSU for FWS, Science Comms/Outreach
- Mary Riddle
- Phil Matson: Phil Matson, Flathead Lake Biological Station
- Richard Klafki: NCC - Canadian Rockies BC region
- Sean Finn: US Fish and Wildlife Service, Science Coordinator
- Tara Carolin
- Tom Olliff

Agenda

1. Updates mostly about data and early optimization models
2. What's Next? More data and elicit expert advice
3. Feedback / Discussion / Questions
4. Poll: Meet in December?

Updates mostly about data and early optimization models (slides 3-14)

Sean describes data acquisition processes, what we're still seeking and data management protocols. Then moved on to optimization model set up. At this point we are at the stage of both testing the modeling software with real data and exploring how the various 'dry run' parameters will work. One important early adjustment is the Analysis Team plans to start with 3 parallel analyses for MT, BC, and AB because the source data for each jurisdiction differs enough that a single analysis would violate many assumptions.

Chat box Comments:

Alisa Wade: New, so sure you've discussed this, but how will you handle anything related to connectivity given three separate models?
Alisa Wade: Sounds good!
Craig Harding-NCC: Great to hear!
Kathy Zeller: John Squires and Lucretia Olsen at RMRS are coming out with a more detailed lynx map across the Crown (and beyond). Should be published soon.
Linh Hoang: can say say waht it's suitable for? denning? forage? both?
Mary Riddle: Will John Squires and Lucretia Olsen's work include north of the border?
Alisa Wade: Is there a way to include climate refugia into this, particularly for snow-dependent spp?
Kathy Zeller: Yes, Mary
Linh Hoang: we need climate vulnerability "cost" for every one of the species
Linh Hoang: if they are just observation data - should the ranking be just yes/no? not in three ranks?
Mary Riddle: So you are scoring critical habitat less than low suitability?
Alisa Wade: Will be an interesting question to think about how current "critical habitat" might change into the future, and what that means for how it should be weighted.
Linh Hoang: @alisa - agreed

Mary Riddle: Great job Sean!
Alisa Wade: Great job, Sean!
Constanza von der Pahlen: will you overlay layers for carnivores with prey to see food chain cross roads? Sorry, I may not be using optimal modeling language.
Connie Simmons: separating species is a concern when we are working on landscape level concerns that impact different species that may be predominant concern in a certain area of the Crown. Ie: Wolverine in the Castle Parks
Linh Hoang: when the experts get together - it might be good to consider that not all of the most suitable habitat should be rated highest - as some of the moderately suitable lands may be where restoration is more needed and may benefit the species/guild more that work in the best (since it is already good habitat)
Constanza von der Pahlen: @linh good point - an optimal restoration targets map could be produced using this information.
Mary Riddle: Obviously need to focus on protecting the connections between the patches.
Mary Riddle: We have run into this before with the different management methods for species in each country.
Mary Riddle: Erin has a great slide on a grizzly bear moving around the Crown.

What's Next? More data and elicit expert advice (Slide 15-16)

Sean describes the next steps including expert solicitation and optimization model parameterization. A lot of decisions are still ahead of us. Over the next few months we will be working hard to pull in expert knowledge and incorporate as we move through model development and refinement.

Chat box Comments:

Mary Riddle: With 65% you also lose the corridors that connect the larger areas
Mary Riddle: So it seems like 65% isn't really possible. It would end up being less than that.
Constanza von der Pahlen: Can we classify lakes really as barriers?
Alisa Wade: Would be worth considering running some type of kernel/patch feature on the habitat scores as a step before the Marxan optimization. It would weight larger patches/connected patches more heavily. It would keep big areas + connected areas first. Hard to do for aquatic spp but easier for terrestrial.
Kathy Zeller: Great idea Alisa. There are even ways to run kernels for aquatic spp. Can pass on a paper if you're interested
Mary Riddle: Yes, good idea Alisa.
Alisa Wade: Thanks @Kathy - I'm pretty familiar (Dave T. was my PhD advisor :), it just gets more complex faster.
Kathy Zeller: :-) it sure does!

Feedback / Discussion (Slide 17)

Great discussion follows and is captured in the audio recording (see above) and these comments. We finish up with a poll about holding a December call. We decide to meet on 12/15/2020 at 11 am.

Chat box Comments:

Mary Riddle: One of the challenges will be taking the complexity and making it simple to understand. Our publics have little tolerance for complexity.
Connie Simmons: Thank you Sean - lots to think about and take back to my colleagues.
Constanza von der Pahlen: Great job. Thank you.
Mary Riddle: Thanks Sean and everyone else.
Alisa Wade: @Mary - great point - how best to balance copmplexity with accessibility. I would argue could do complexity as well as all the uncertainty that comes with that is well communicated (communicate uncertainty vs. complexity)
Clifford Kipp (he/him/his): Thank you!
Richard Klafki: Thanks!

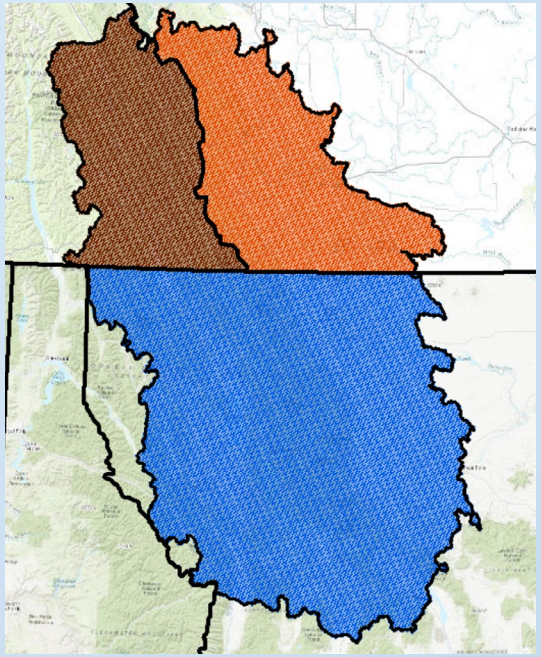
Poll for next meeting

Would you join a Crown LCD Leadership Team call on 22 December 2020?

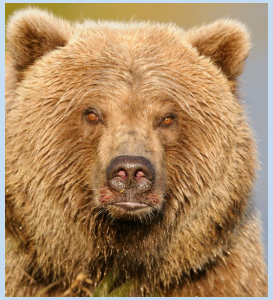
○	YES! I love these live Adobe Connect monthly updates!	25%	(3)
○	I would like a live update in December, but let's do it on the Tuesday December 15th instead.	42%	(5)
○	No time for a web meet up - I would rather get a written update.	8%	(1)
○	I will be someplace warm (or skiing, or sitting by the fire). Let's skip December and reconvene on 26 January. Happy Holidays everyone!	25%	(3)
◉	No Vote		

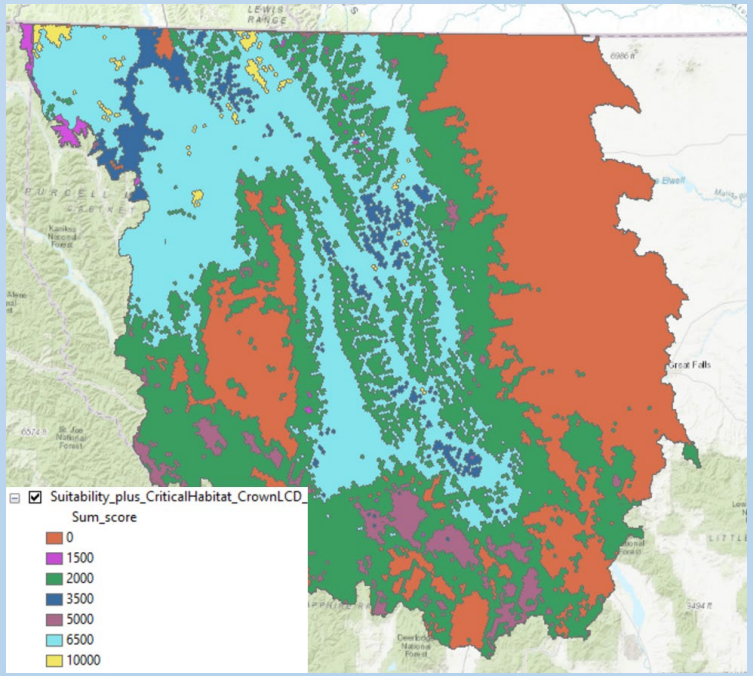
☑ Broadcast Results

Crown of the Continent Landscape Conservation Design



$$\underbrace{\sum_{PUs} Cost}_{1} + \text{BLM} \underbrace{\sum_{PUs} Boundary}_{2} + \underbrace{\sum_{Con.Targ.} SPF \times \text{Penalty}}_{3} = \text{Marxan Score}$$





Leadership Team call

November, 24 2020

Outline:

- Welcome back!
- Updates mostly about data and early optimization models
- What's Next? More data and elicit expert advice
- Feedback / Discussion / Questions
- Poll: Meet in December?

Crown LCD data, data, data

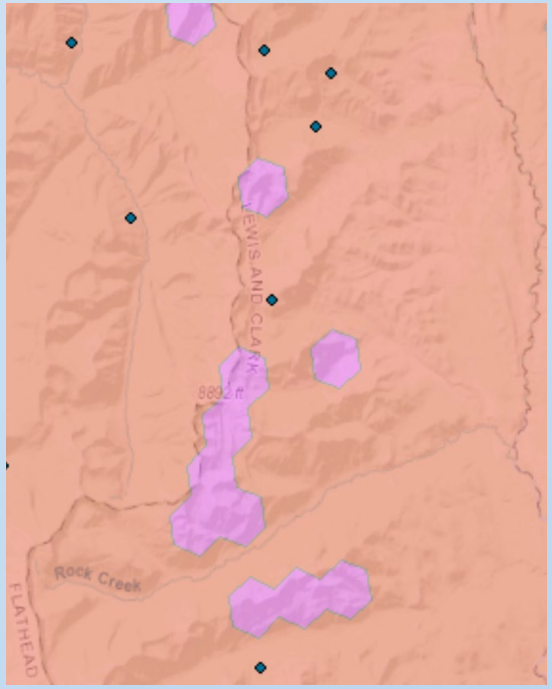
	MT	AB	BC	Waterton NP	CMP
		Weaver? ?			
Whitebark Pine (Natalie)	Observations Species Occurrence[1] Suitable habitat models		Known Locations	presence / absence, and also a habitat model	CMP Hi5 group Predicted and potential range models (nearing end of development)
Rocky Mountain Elk (Phil)	MTNHP Observations Suitable habitat models FWP Elk Distribution MTFWP 'Ungulate Data' from Aubin	Elk Wintering ABMI - not whole AB area Key Wildlife and Biodiversity Zones Mineral licks considered important habitat for ungulates by AB	Winter range data	presence	CCE_BC_Elk CCE_BC_WinterElk CCE_MT_Elk RMEF Ung_merge - BC and AB ungulate landuse.
Mule Deer (Phil)	MTNHP Observations Suitable habitat models FWP Mule Deer Distribution MTFWP 'Ungulate Data' from Aubin	ABMI - not whole AB area Key Wildlife and Biodiversity Zones Additional source pending Danielle - request is sent - North American Layer	Winter range data	presence (basically everywhere)	Ung_merge - BC and AB ungulate landuse.

- Fantastic support from Technical Team – direct source & contacts
- Crown Managers Partnership data and contacts
- Chad Willms, Kris Tempel, Danielle Pendlebury, Adam Collingwood, Bryce Maxwell, Aubin Douglas, Trevor Reid, Peggy Holroyd, Phil Matson, Alexis McEwan, Brandon Burkholder, Craig Johnson, Jason Fisher, Nikki Heim, Ken Sanderson, Christian Gostout, Anne Carlson, Hi5 Working Group and others I'm forgetting

But there is still room for more data:

Priority Ecological Features:

- Bull Trout
- Westslope Cutthroat Trout
- Grizzly Bear
- Wolverine
- Canada Lynx
- Elk
- Mule Deer
- Whitebark Pine
- **Forest**
- **Riparian**
- **Wetlands**
- **Grasslands**
- **Shrublands**
- **Aquatic (Lakes, Large Rivers)**
- **Connectivity**



Data Gaps:

- **British Columbia!**
- Trout observations or models
- Ungulates

Seeking:

- **Observation/Presence**
- **Presence/Absence**
- **Habitat Suitability Models**
- **Also ‘Cost’ data … but costs related to specific features so ask is still uncertain.**

Data Management

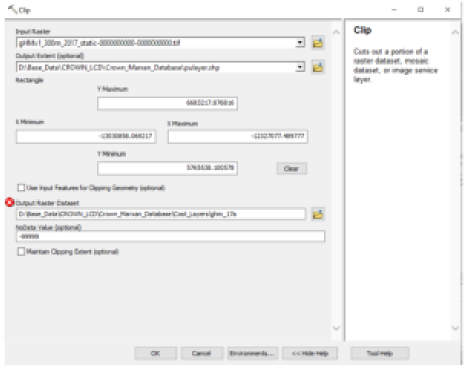
#	Layer	Source	Attributes/Summary	Geography	TechTeam Comments	Link to Dataset	Stakeholder c-	Re
90								
91	**LANDCOVER/VEGETATION**							
92	Historic (potential natural) vegetation	LANDFIRE			Selected Landfire Biophysical Settings	http://www.landfire.gov/version_comparison.php?mosaic=Y		
93	Landscape permeability	human modification and connectivity to adapt to climate change		Montana				
94	TopoClimate							
95	Land Facets (latitude-adjusted elevation)	AdaptWest	100 m resolution	North America		https://adaptwest.databasin.org/pages/adaptwest-landfacets		
96	Topo Facets (latitude-adjusted elevation)	AdaptWest	100 m resolution	North America		https://adaptwest.databasin.org/pages/adaptwest-landfacets		
97	Landforms	AdaptWest	100 m resolution	North America		https://adaptwest.databasin.org/pages/adaptwest-landfacets		
98	Heat Load Index	AdaptWest	100 m resolution	North America		https://adaptwest.databasin.org/pages/adaptwest-landfacets		
99	**Land cover types**	LANDFIRE v1.3	Existing Vegetation Types and land cover types; 6 v	Montana		https://www.landfire.gov/version_comparison.php		
100	**CCE Landcover (c2000)**	CMP	Land cover and land use for the Crown of the Contir	Transboundary		https://www.sciencebase.gov/catalog/item/55199de6e4b03238427832ac		
101	**Land Use/Land Cover c2015**	CMP	shows the Land-Use/ Land-Cover of the Crown of the Continent with a 50km buffer.			https://www.sciencebase.gov/catalog/item/57a220c8e4b006cb45553dfb		Hig
102	**GlobCover Landcover**		22 cover classes; 300 m resolution	Global		http://due.esrin.esa.int/page_globcover.php		
103	ABMI Wall-to-Wall Landcover	ABMI		Alberta		https://abmi.ca/home/data-analytics/da-top/da-product-overview/Data-Archive/Land-Cover.html#:~:text=The%20ABMI		
104	**Vegetation Resource Inventory - Landcover**	BC Gov		BC				
105	**Landcover 30 m 2015 (LANDSAT and RapidEye)**	**CEC**	**land cover at a spatial resolution of 30 meters provides a harmonized view of the physical cover of Earth's surface across the continent**	**North America**		**http://www.cec.org/north-american-environmental-atlas/land-cover-30m-2015-landsat-and-rapideye/**		**Me**
106	Ecological Land Units (ELUs)	UN						
107	**GRIZZLY BEAR**							
108	BC Grizzly Bear Population Units	GNLCC	These are boundaries identifying similar behavioura	BC		https://www.sciencebase.gov/catalog/item/550b13d8e4b02e76d7593e2e		
109	Predicted Grizzly Bear Density in Western NA	NBLCC	We built regression models to relate grizzly bear der	Transboundary		https://www.sciencebase.gov/catalog/item/5771b877e4b07657d1a6c338		
110	Grizzly Bear Habitat selection	NBLCC		BC		https://www.sciencebase.gov/catalog/item/5771b868e4b07657d1a6c080		
111	GB Recovery Zones	NoRock	Grizzly bear recovery zones were established by the	US		https://www.sciencebase.gov/catalog/item/5a5fa2d9e4b06e28e9bfc454		
112	GB Connectivity Mapping	Birchdale Ecological	We sought to predict preferred linkage habitats for	Transboundary		https://www.sciencebase.gov/catalog/item/55269b68e4b026915857c66f		
113	GB Harvest Management - BC	NBLCC		BC		https://www.sciencebase.gov/catalog/item/572a2a69e4b0b13d391a0ada		
114	GB Mortality 1998-2017	NoRock	numbers of documented mortalities for independen	Montana		https://www.sciencebase.gov/catalog/item/5b06f715e4b0ac450c98b2fc		
115	Major components of GB diet	NBLCC	measured stable carbon and nitrogen isotope ratios	North America		https://www.sciencebase.gov/catalog/item/5771b8bde4b07657d1a6d0b4		
116	Collared grizzly bear data	Montana Fish, Wildlife & Parks Grizzly Bear Population Monitoring	Program	MT	Request data - used in Lost Trail CA LI	http://fwp.mt.gov/fishAndWildlife/management/grizzlyBear/monitoring.html		
117	GB RSF and Habitat State models	Danielle	RSF model identifies grizzly bear habitat along east	Alberta	can request data			
118	Grizzly bear zone	GOA	primary and secondary habitat zones for grizzly bea	Alberta		https://www.alberta.ca/wildlife-sensitivity-maps.aspx		
119	Connectivity for Grizzlies	Miistakis	connectivity for grizzly models (based on RSF), patch size, contraints - Miistakis; new		Ken			
120	**MESO CARNIVORES**							
121	Wolverine habitat	GNLCC		North America	No downloadable data, but contact for	https://greatnorthernlcc.org/gnlcc_projects/prj_report.html?PRJ_ID=375		
122	Lynx Critical Habitat	USFWS		US	Download data - used in LTR LPS	https://ecos.fws.gov/ecp/report/table/critical-habitat.html		
123	Fisher Habitat	USFWS		North America	Download data - used in LTR LPS	https://www.sciencebase.gov/catalog/item/58fa685be4b0b7ea5452587f		
124	Canada Lynx Connectivity Winter Corridors - 1 mile buffer	USFS	putative winter corridors facilitating dispersal from n	Montana		https://www.sciencebase.gov/catalog/item/54b05ab9e4b078c4c44376e4		
125	Linking climate change to population cycles of hares and lynx		by the use of historic fur harvest data, we constructe	Canada		https://www.sciencebase.gov/catalog/item/5771b886e4b07657d1a6c5f2		
126								
127	relative abundance maps for 100s species (mammals, birds, plants, lichens	ABMI	estimates of relative abundance (habitat suitability r	Alberta	raw data used to create RA maps also	https://www.abmi.ca/home/data-analytics/da-top/da-product-overview/GIS-Biodiversity-Data/Predicted-Relative-A		
128	wolverine range	COSEWIC		North America		https://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_wolverine_e.pdf		
129	Spatial and Genetic Relationships of Fishers in Boreal Mixed-Wood Forests	of Northeastern British Columbia		Canada		https://www.sciencebase.gov/catalog/item/5771b86be4b07657d1a6c0e4		
130								
131	Climate change impacts on wolverine connectivity	NC CASC		Montana				
132	Climate change impacts on Canada lynx connectivity	NC CASC						
133	Wolverine modelling data for a large area in SE BC/SW Alberta	Garth Mow						
134	ABMI Habitat Associations	ABMI						
135								
136	**WHITEBARK PINE**							
137	Five needle pine habitat suitability	Danielle (						
138	Lidar Limber Pine (and whitebark) modelling (same as above?)	GOA						
139								
140	Whitebark Pine Habitat Range	WBPEF						
141	SAR critical habitat layer for BC that includes Whitebark pine (and Limber)	Gov't BC						
142	known locations of Whitebark Pine (WB Pine polygons in the BC CDC)	BC Conse						
143	**FOREST CONDITION**							
144	Forested Areas	CMP						
145	Canopy Closure	CMP						
146	Habitat elements (incl. canopy closure, dead vegetation, soil characteristics	ABMI						
147								
148	North American Wildland Fuel Database	US Forest						
149								
150								
151								
152								
153								
154	**UNGULATES**							

Create Planning Units:

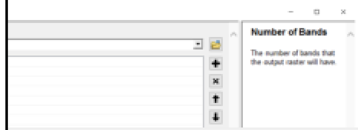
We chose to use hexagonal planning units because:

- Hexagons reduce sampling bias due to edge effects of the grid shape, this is related to the low perimeter-to-area ratio of the shape of the hexagon. A circle has the lowest ratio but cannot tessellate to form a continuous grid. Hexagons are the most circular-shaped polygon that can tessellate to form an evenly spaced grid.
- Hexagons are preferable when your analysis includes aspects of connectivity or movement paths

Arc Toolbox > Data Management Tools > Sampling > Generate Tessellation settings:



Raster:



Grizzly Bear Data Sources, Data Selection and Process Steps

Montana – Scenario #1

Source data with comments

MTNHP_Predicted_Habitat_Suitability_GBear.shp – covers entire MT portion of Crown LCD project area; 4 suitability classes (including 'unsuitable') created using Maximum Entropy software (Phillips et al. 2006, Ecological Modeling 190:231-259); Montana Natural Heritage Program. 2019. Grizzly Bear (Ursus arctos) predicted suitable habitat models created on September 12, 2019.Montana Natural Heritage Program, Helena, MT. 16pp.

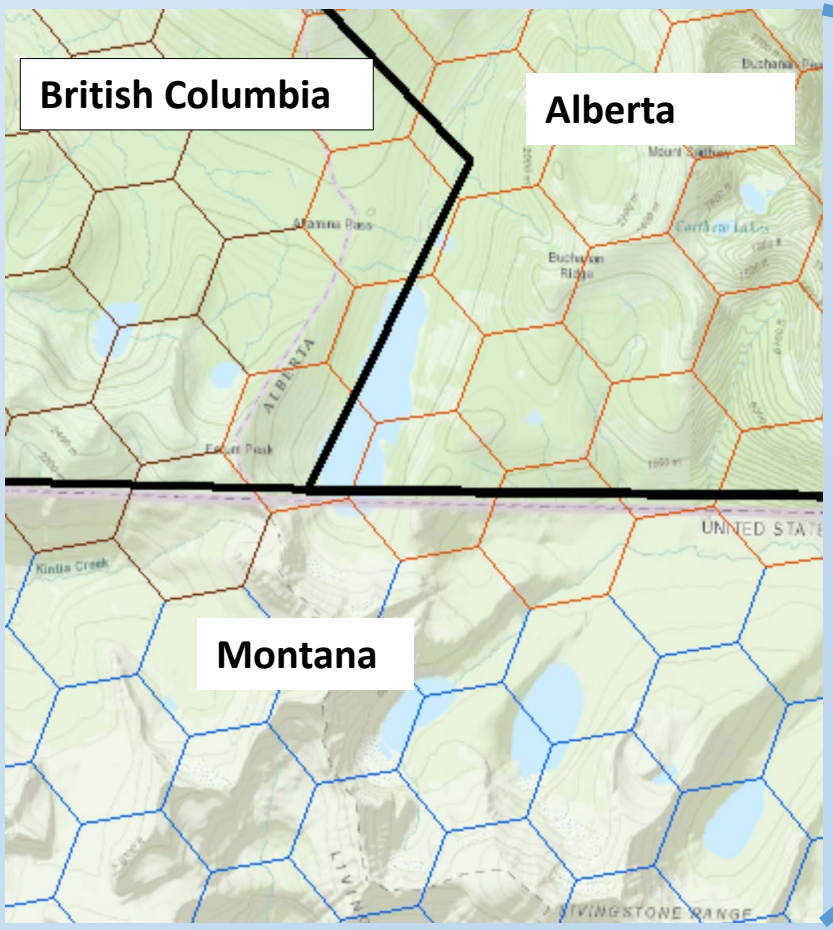
MTNHP_ObsData_GBear.shp – The Montana Natural Heritage Program (MTNHP) maintains point observation data for plant and animal species in Montana. These databases include information on the location, status, characteristics, and dates of observation.

CMP Report on Estimating Grizzly Bear Occupancy (CMPGBMar21.shp; dated 21 March 2013); Grizzly bear detections were defined from taken hair traps to provide consistent coverage across the CCE and sampling methodology. Hair trap stations (at least those reported here) were constrained by the CMP spatial definition of the Crown of the Continent Ecosystem (CCE). NO data was reported for the peripheral areas of the Crown LCD project area.

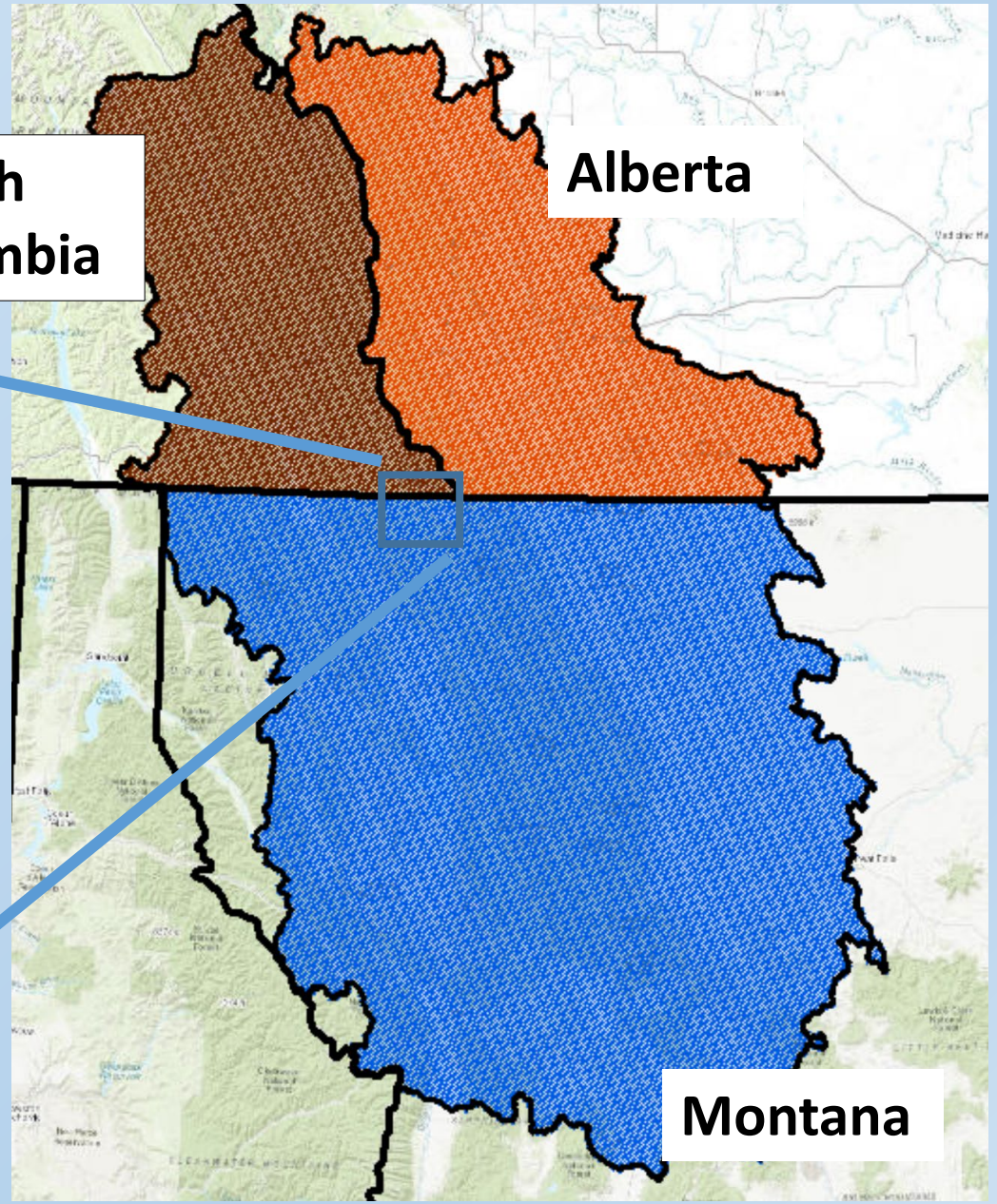
Project Area & Planning Units

For optimization modeling, we divide the Project Area into sub-units called Planning Units

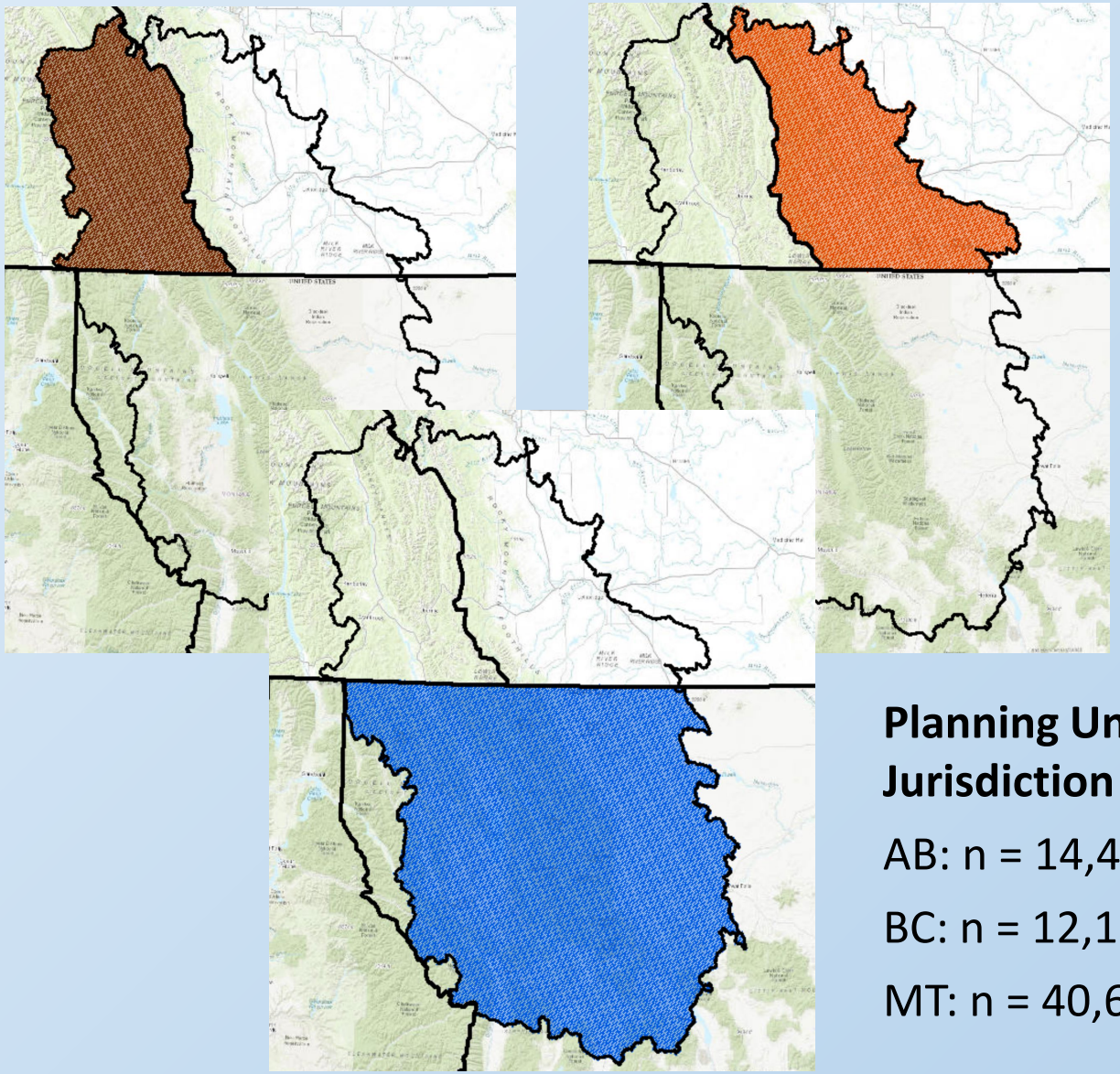
Planning Unit: 2km² each



Crown LCD Project Area



Three Parallel Optimization Models



Planning Units by Jurisdiction

AB: n = 14,471

BC: n = 12,193

MT: n = 40,692

Why?

- Primarily disparate data & sources
- Explore data handling techniques

Benefits

- Finer resolution planning units
- More efficient iterations
- Can always ‘scale up’ when appropriate

Drawbacks

- More onerous data & processing documentation

Setting the Model Environment

Sum of selected Planning Unit Costs

Sum of Planning Unit Value for priority features

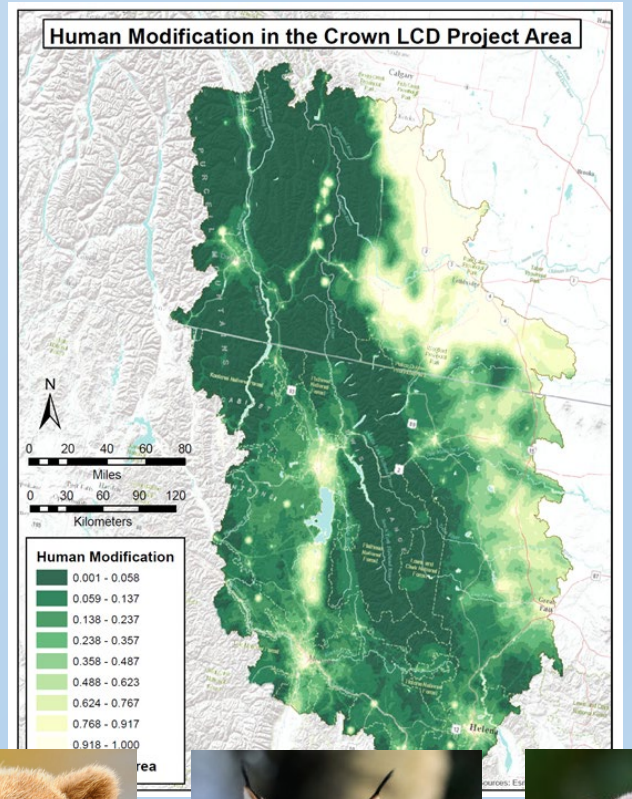
Total perimeter of selected Planning Units

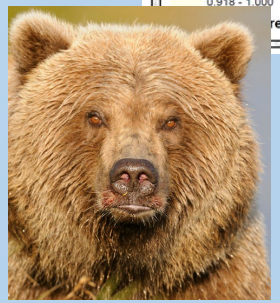
1 2 3

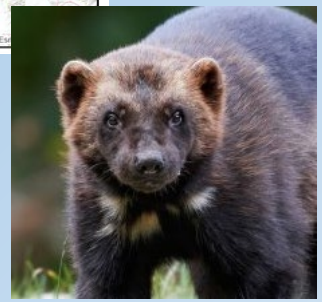
$$\sum_{PUs} Cost + \text{BLM} \sum_{PUs} Boundary + \sum_{Con.Targ.} SPF \times \text{Penalty} = \textbf{Marxan Score}$$

Example Geography: Montana portion of Crown LCD Project Area

Example Cost: Global Human Modification (Theobald et al. 2020)

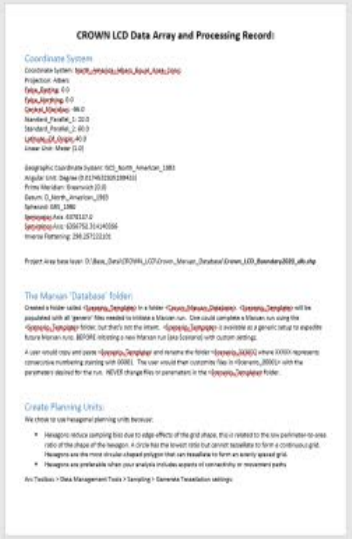






Example Features: Carnivores

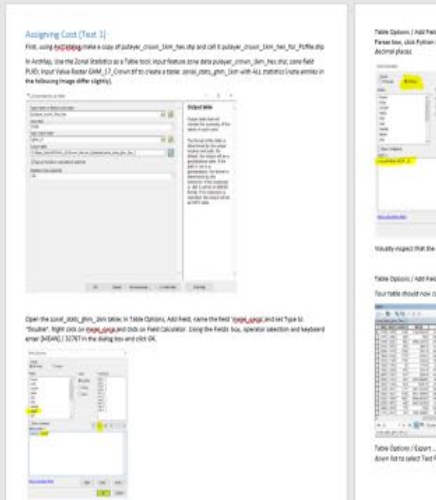
A Lot of Data Documentation!

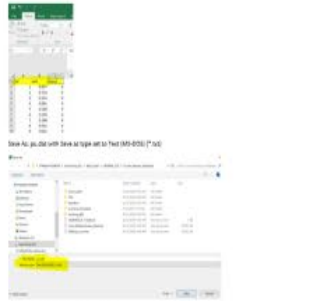

CROWN LCD Data Array and Processing Record:

Coordinate System

The Marxan 'Database' folder:

Create Planning Units:


Assigning Cost (Test 1)




Notes on Global Human Modification data

Canada Lynx Source Data in Montana

- Montana Natural Heritage Program Habitat Suitability Model

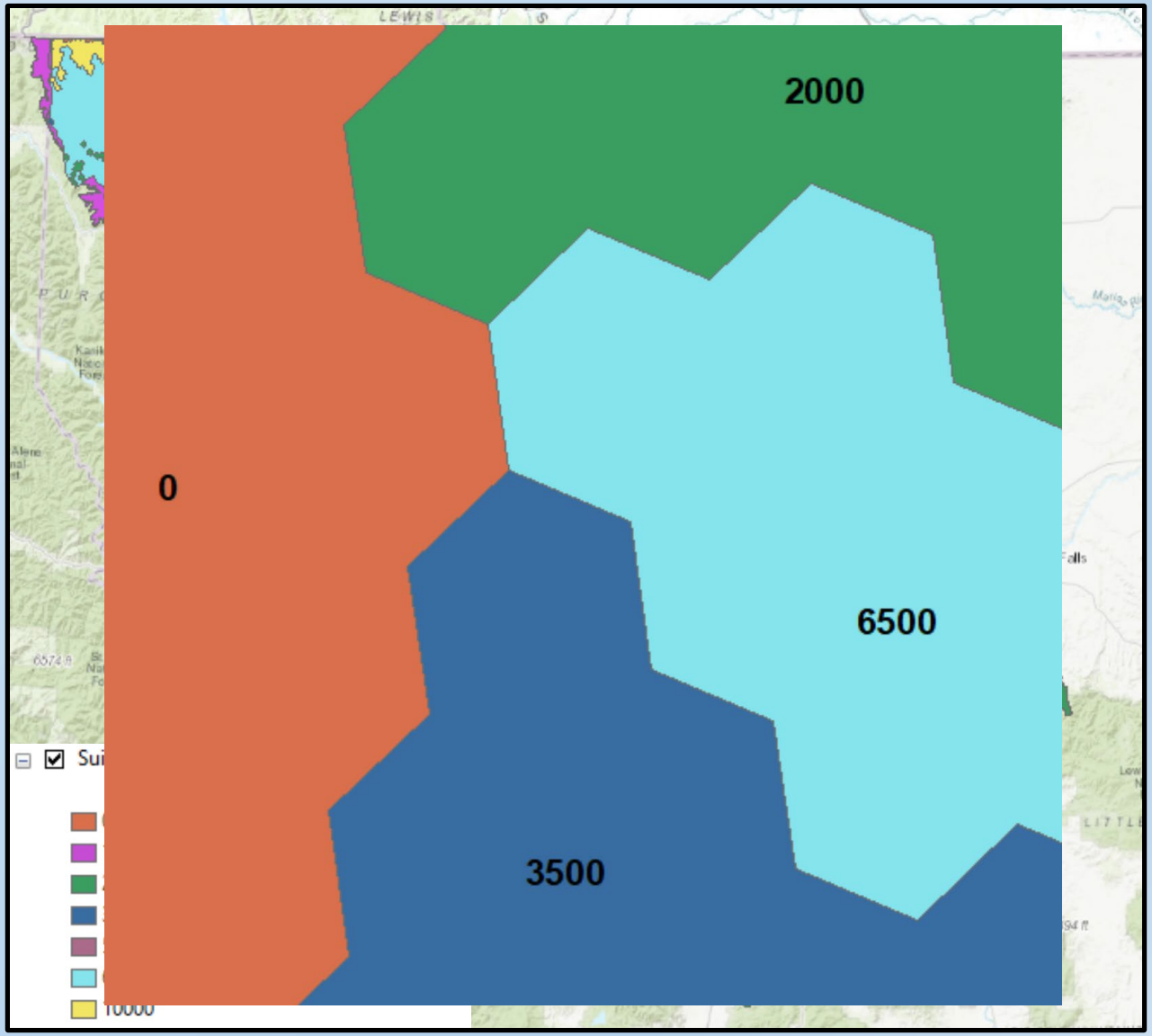
  Scoring

  - Optimal Suitability – 10,000
  - Moderate Suitability – 5,000
  - Low Suitability – 2,000
  - Generally Unsuitable - 0

- USFWS Critical Lynx Habitat Designation

  Scoring

  - Critical Habitat – +1,500



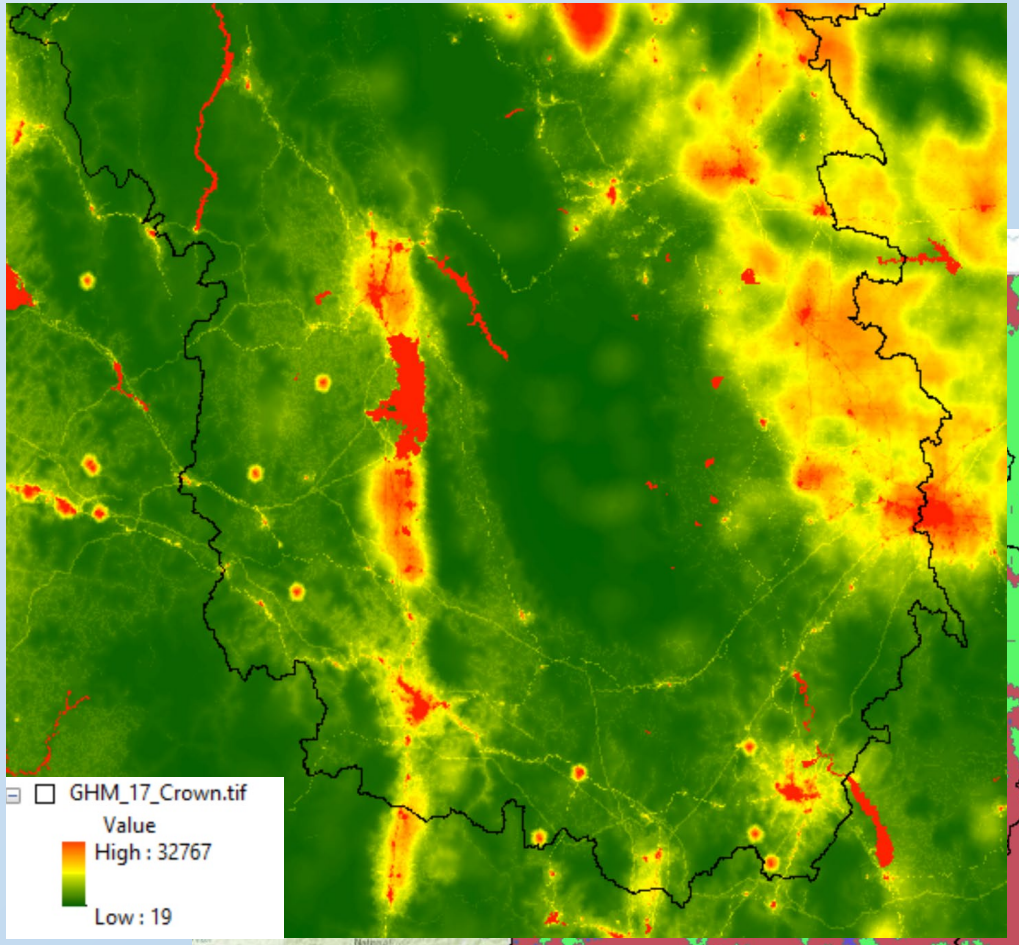
Features + Cost

Example Geography: Montana portion of Crown LCD Project Area

Example Features: Carnivores

Example Cost: Global Human Modification (Theobald et al. 2020)

Human Modification "Cost"



Grizzly Bear

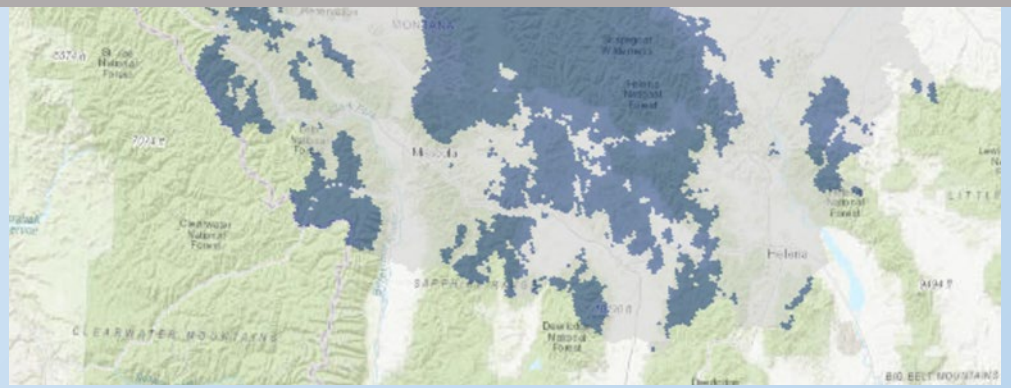
Wolverine

Canada Lynx

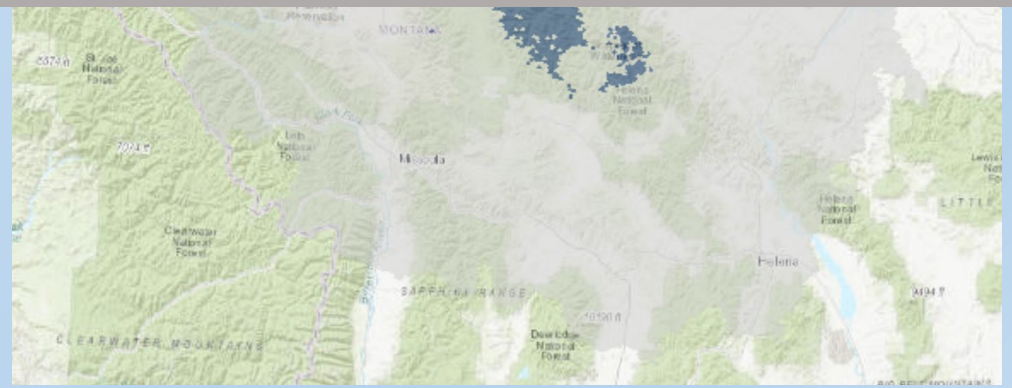
$$\underbrace{\sum_{PUs} Cost}_{1} + \text{BLM} \underbrace{\sum_{PUs} Boundary}_{2} + \underbrace{\sum_{Con.Targ.} SPF \times \text{Penalty}}_{3} = \text{Marxan Score}$$

DRAFT -- Optimal Carnivore Habitat -- DRAFT

In Montana Portion of the Crown LCD Project Area



Retain 90% of optimal habitat



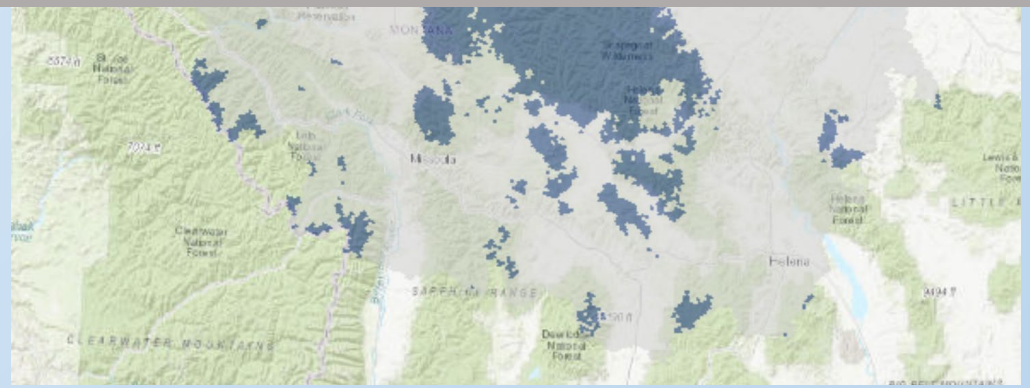
Retain 10% of optimal habitat

DRAFT -- Optimal Carnivore Habitat -- DRAFT

In Montana Portion of the Crown LCD Project Area

What kinds of questions does this generate?

- Remember, this is just 3 carnivore species



- What are ecological conditions in the optimal habitat?
- What about connections among patches?

Retain 65% of optimal habitat

DRAFT -- Optimal Carnivore Habitat -- DRAFT

In Montana Portion of the Crown LCD Project Area

- Recall we are only looking at Carnivore data inputs
- No surprise that very little of the valley bottoms are 'optimal'
  - Deer and Elk?
  - Bull Trout and Cutthroat Trout??
  - Whitebark pine??
- And recall, ecological connectivity is a feature as well

Retain 65% of optimal habitat

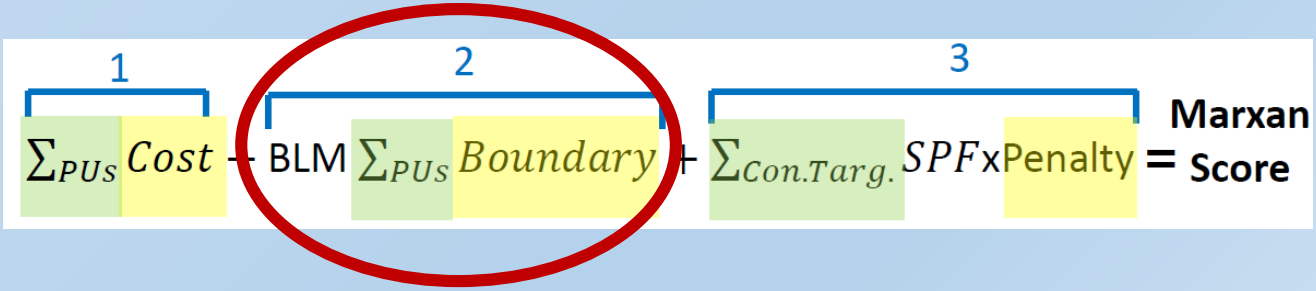
For Leadership Team consideration …

- Optimization “Targets” for each feature
  - Model inputs identify “a target amount for each feature to be included in solution”
  - May be guided by:
    - Legislation
    - Resource Planning
    - Published Literature
    - Expert Knowledge

“spec.dat”

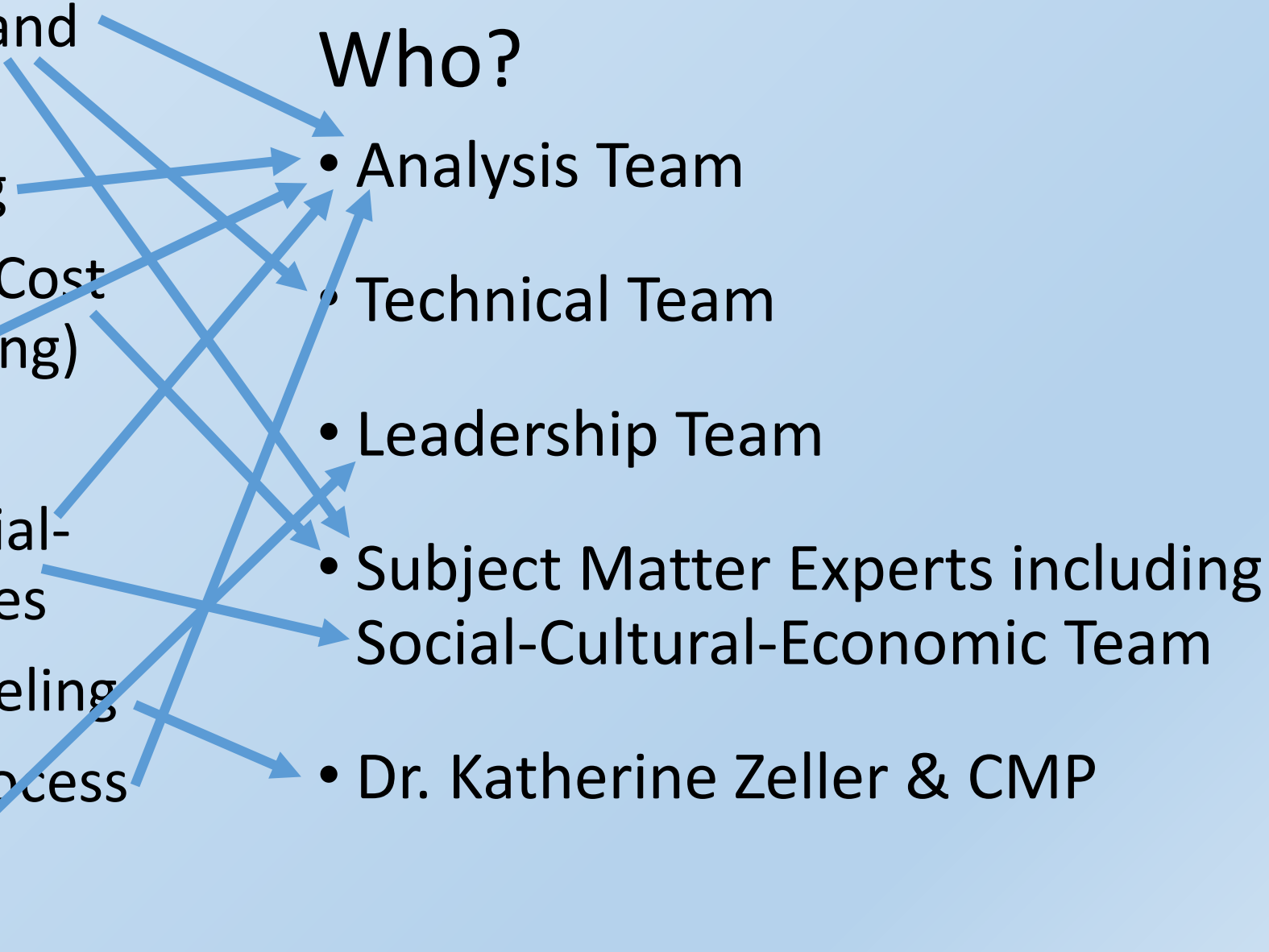
id	prop	target	targetocc	spf	name
1	0.65	0.0	0	1.0	C_Lynx
2	0.65	0.0	0	1.0	Wolverine
3	0.65	0.0	0	1.0	G_Bear

- “Boundary Limits Modifier”
  - Governs the amount of clumping in solution



What is next?

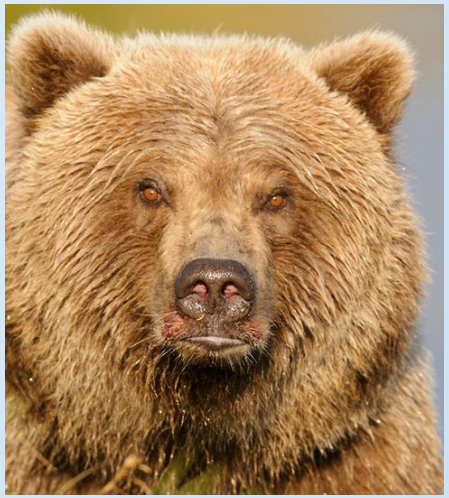
- Continue data collection and vetting
- Format Data for Modeling
- Develop Feature-Specific Cost Layers (more data gathering)
- Model Iterations
- Initiate Discussion on Social-Cultural-Economic Features
- Initiate Connectivity Modeling
- Excruciatingly detailed process documentation
- Sustain Momentum

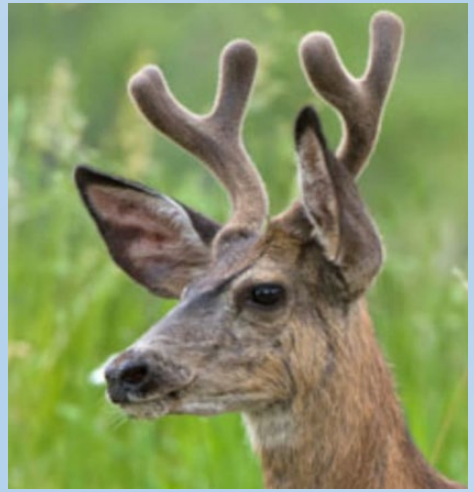


Who?

- Analysis Team
- Technical Team
- Leadership Team
- Subject Matter Experts including Social-Cultural-Economic Team
- Dr. Katherine Zeller & CMP

Feedback – Discussion -- Questions





Outline: Update on data collection, management and formatting

1. Ecological Feature Data
    1. Data seeking / sources (people and agencies) – cheers to Tech Team!
        1. What we're waiting on
        2. What's still missing
    2. Data Management
        1. Spreadsheets and Documentation
    3. Data and the project area
        1. The Marxan environment and planning units
        2. Expect we will run parallel models for the 3 jurisdictions
        3. Makes data and processing documentation all the more important
    4. Formatting
        1. Lengthy decision-rich process – required finely detailed notes
            1. What data is useful?
            2. What is redundant?
            3. Mix/Match data – again careful documentation allows us to adjust and iterate
            4. Scoring
            5. Cost layers / data