



Bighorn Sheep: Risk of Contact Tool

BLM-Royal Gorge Field Office

Background

- Epizootic pneumonia of bighorn sheep results in die-offs in free ranging populations¹
- Transmission of the bacteria from domestic sheep and goats to free ranging bighorn sheep does occur²
- Bacteria transmitted when they come into direct contact³

¹ Besser et al 2012

² Lawrence et al. 2010

³ Besser et al 2012a, Lawrence et al. 2012, Schommer and Woolever 2008

Background

- One interspecies contact can result in transmission and negative impacts to bighorn sheep herds.
- Domestic sheep and bighorn sheep are attracted to one another.
- Bighorn sheep carry out occasional long-distance exploratory movements (aka 'forays').

Purpose

- Methodology for calculating probability and rates of contact between bighorn sheep and domestic sheep allotments
- Predicting areas of potential disease transmission
- Appropriate for land use and project level planning

Development

- Tool was created jointly between Forest Service and BLM
- Reference values were derived from a robust dataset of bighorn sheep locations near Hells Canyon, Idaho.



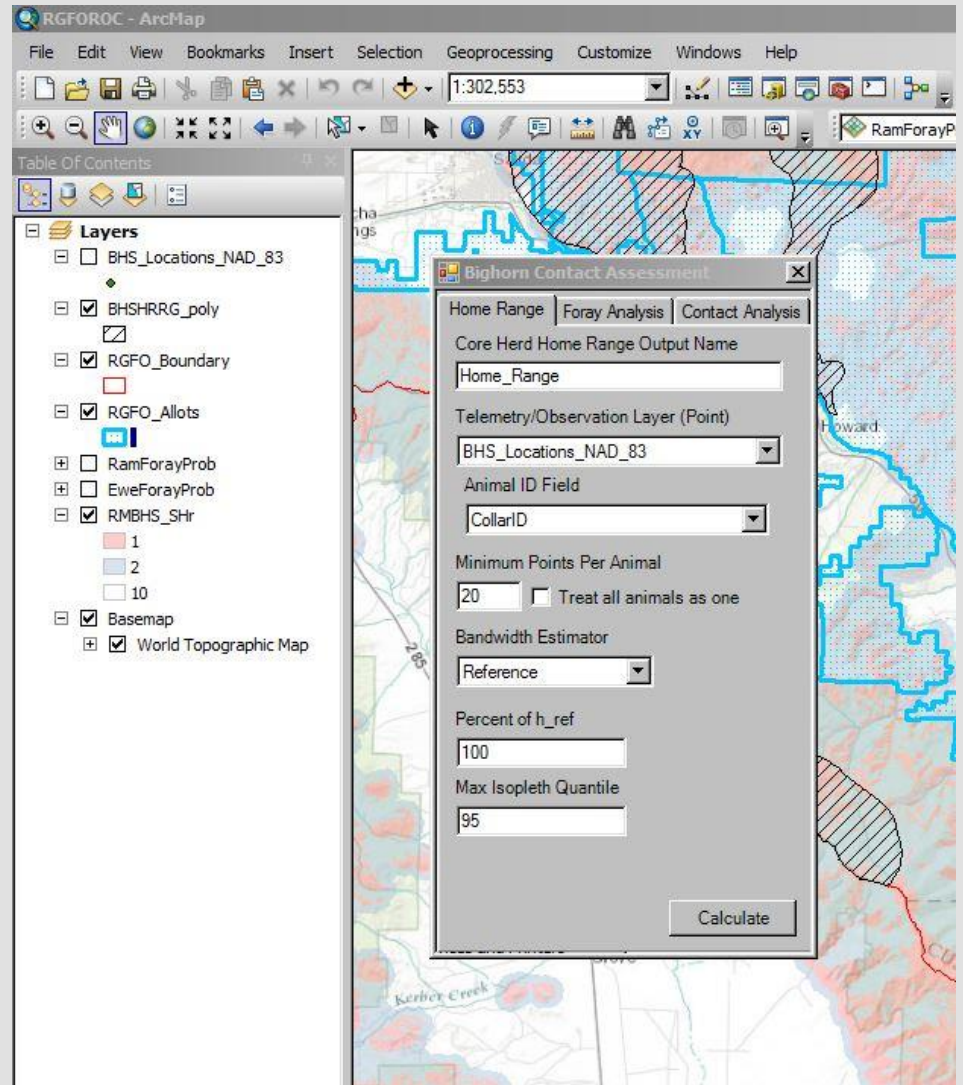
Conceptual Model

- Foray probability model has four components:
 - Estimate of herd home range
 - Frequency of forays
 - Distance distribution of forays
 - Estimate of habitat selection

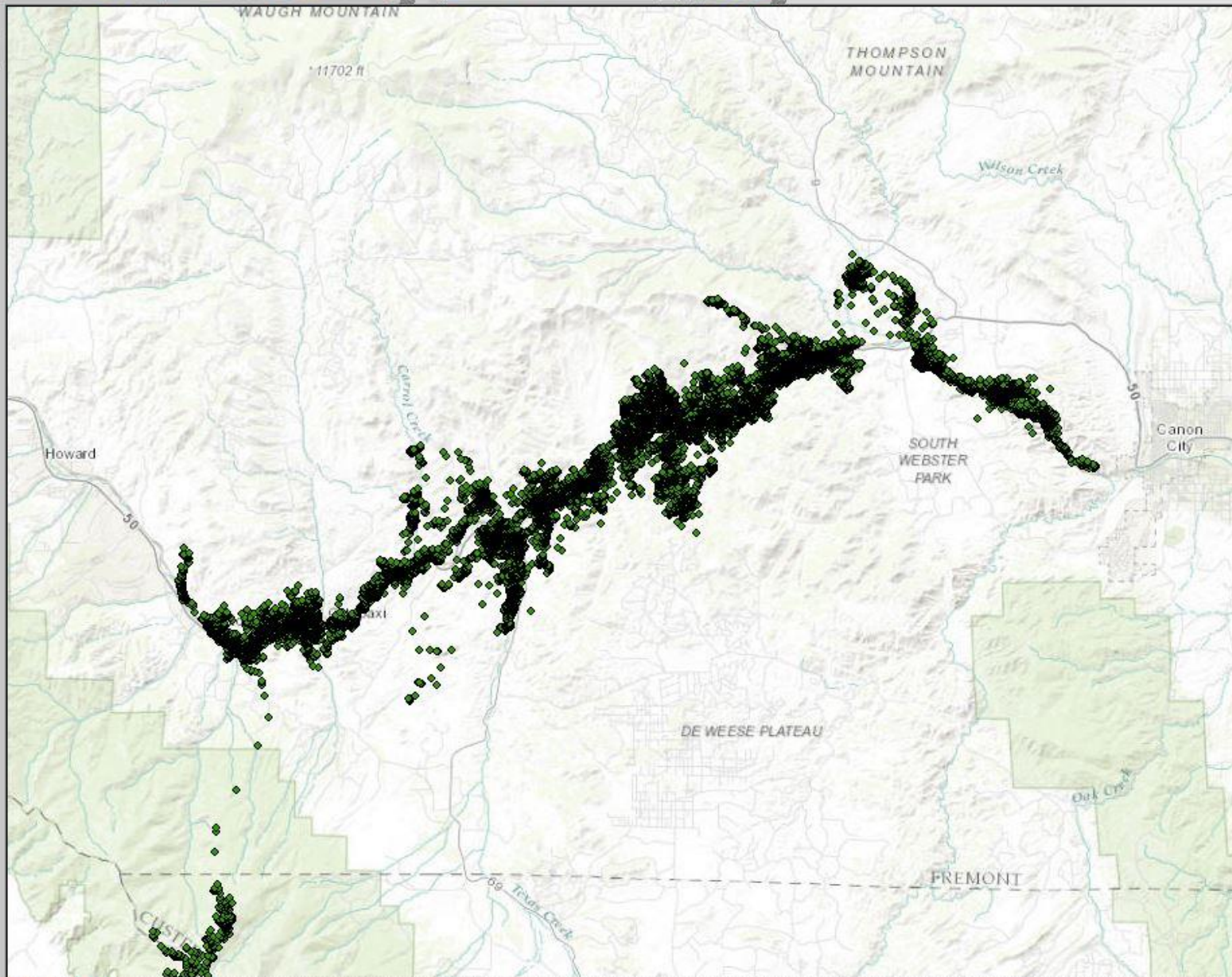


Home Range: Inputs

- Only if using point data (e.g. telemetry, GPS)
- Creates home range polygon based on locations
 - Approximates 95% of space use



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 - ☐ RGFO_Boundary
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 - ☐ RGFO_Allots
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 - ☐ C:\Users\mrustand\ROC\RGFOF
 - ☐ RamForayProb
 - ☐ EweForayProb
 - ☐ C:\Users\mrustand\ROC\RGFOF
 -  AllotmentResults.csv
 - ☒ World Topographic Map



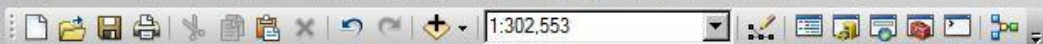
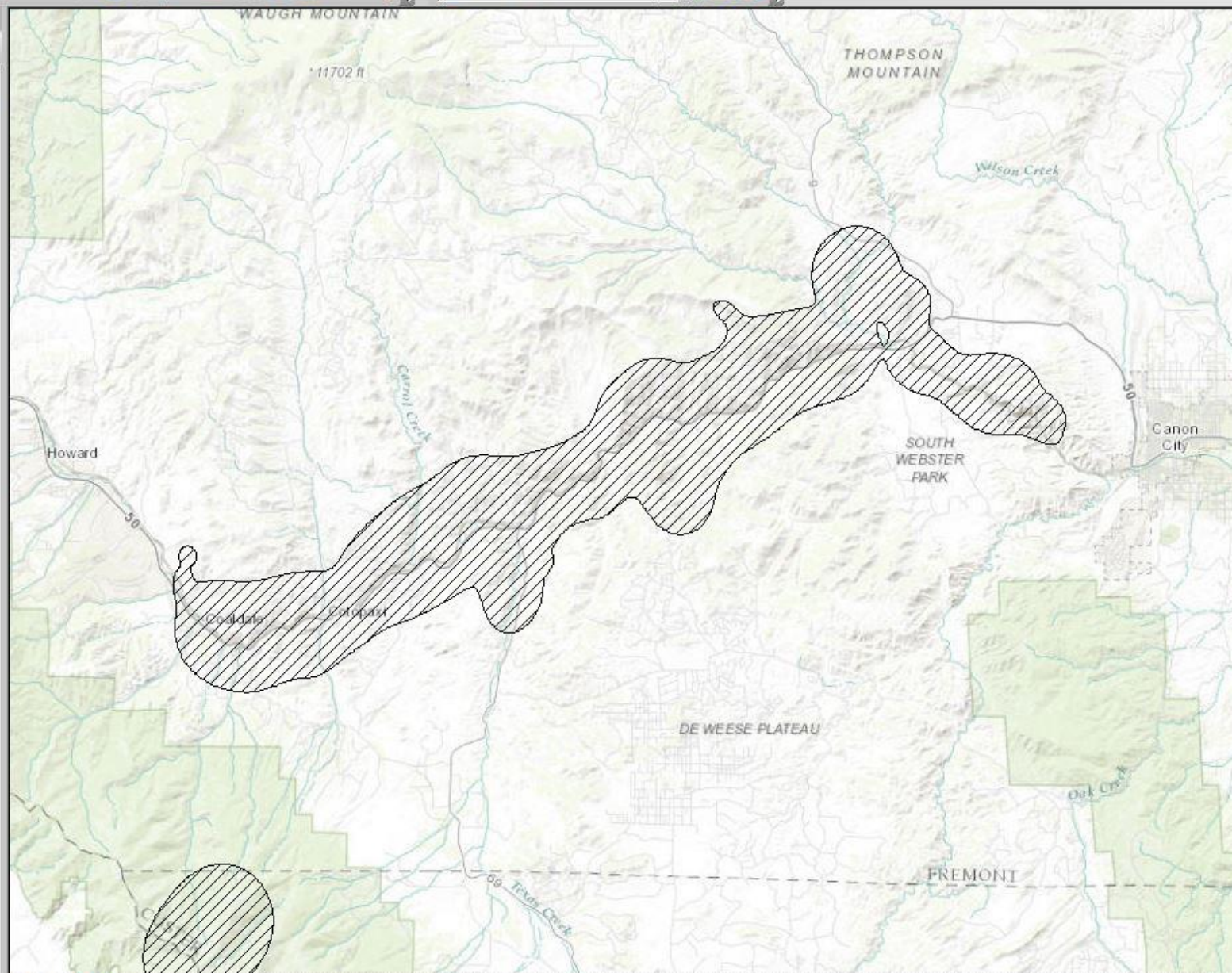


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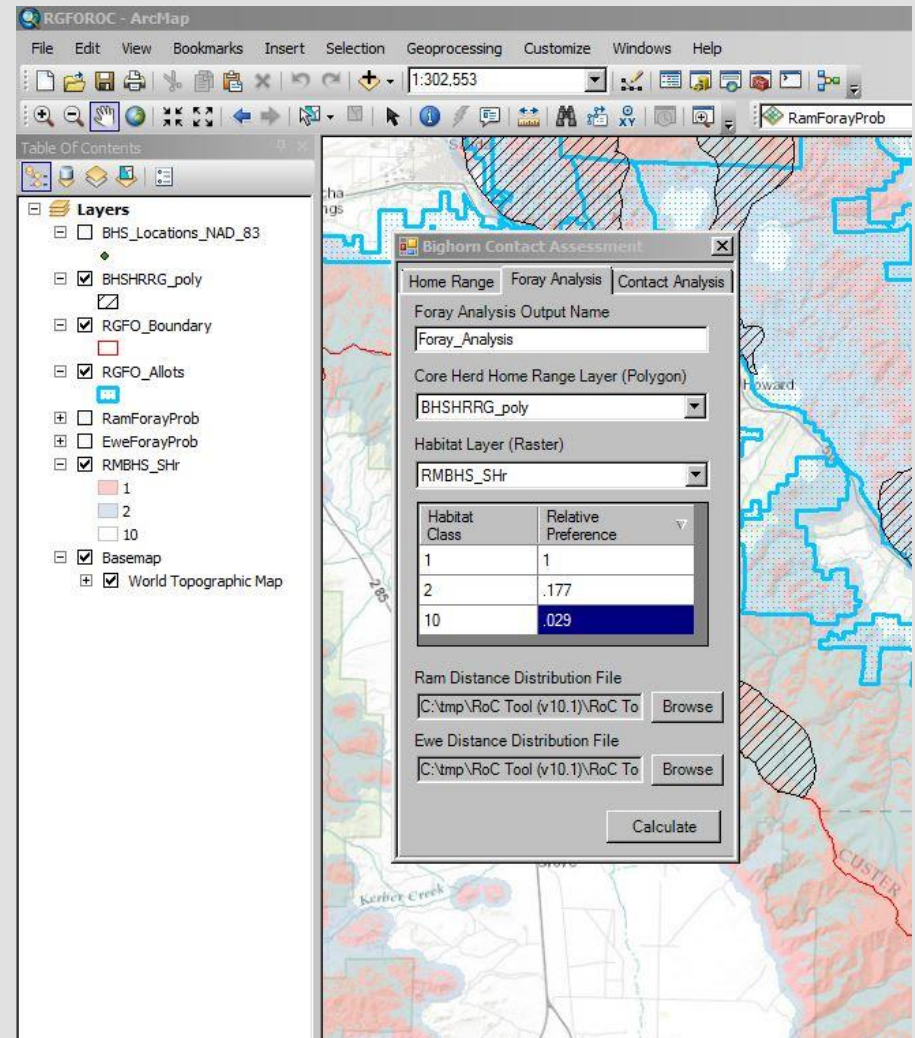


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 - ☐ RamForayProb
 - ☐ EweForayProb
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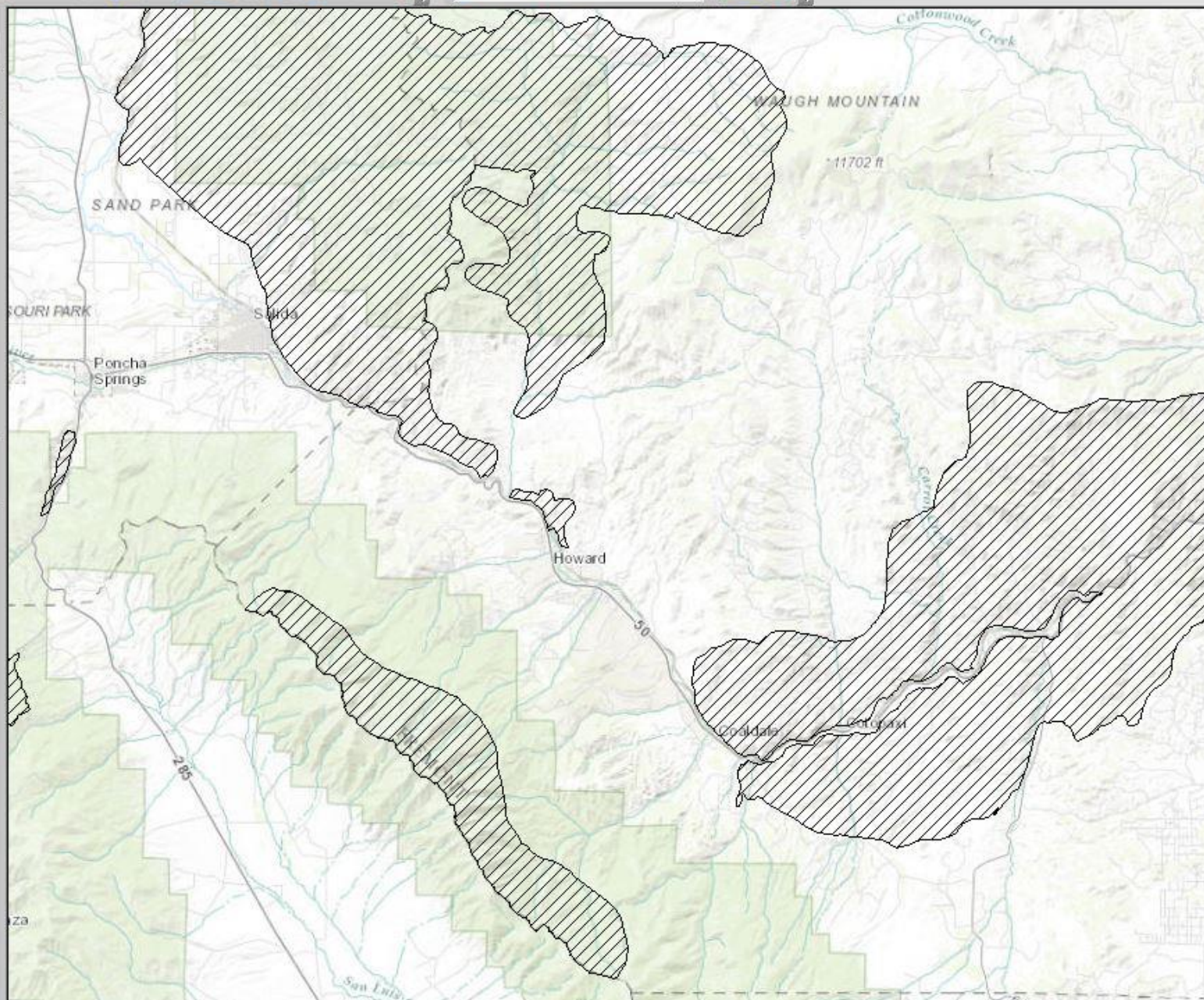


Foray Analysis: Inputs

- Home range polygon (calculated or known)
 - Polygon used is bighorn sheep overall range provided by Colorado Parks and Wildlife

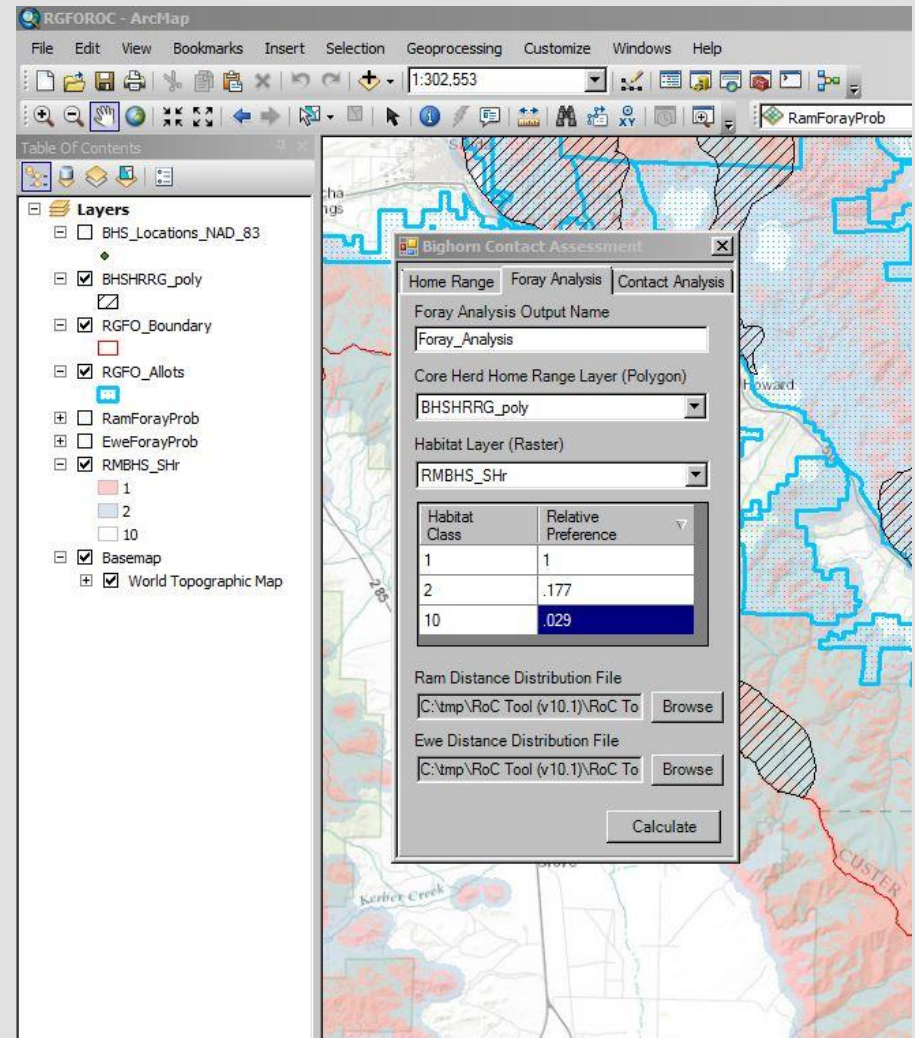


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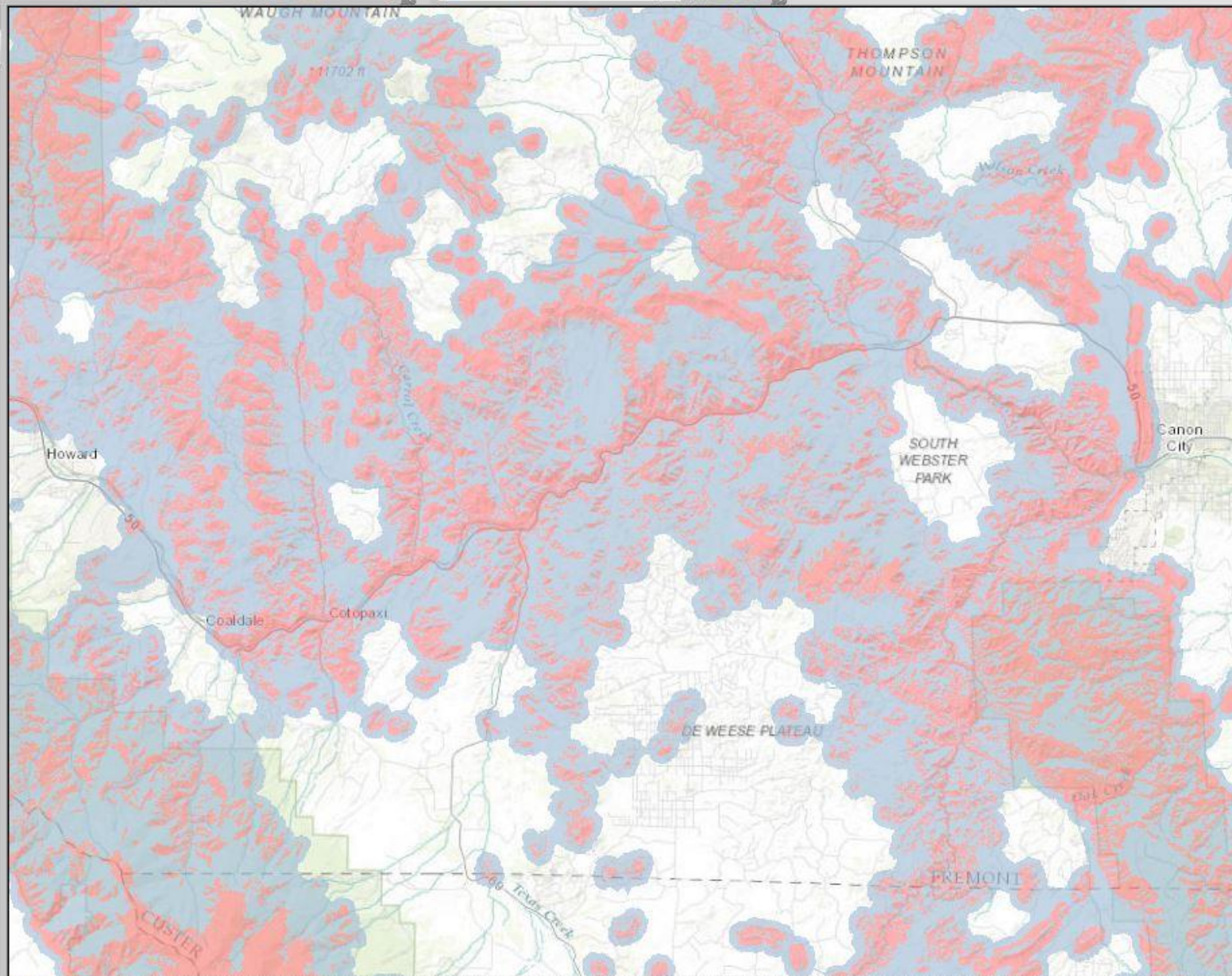


Foray Analysis: Inputs

- Home range polygon (calculated or known)
- Habitat preference
 - Layer provided by CPW
 - 1 = suitable,
 - 2 = connective habitat (within 350 meter of suitable),
 - 10 = non-habitat
 - Preference calculated from Hells Canyon, ID herd

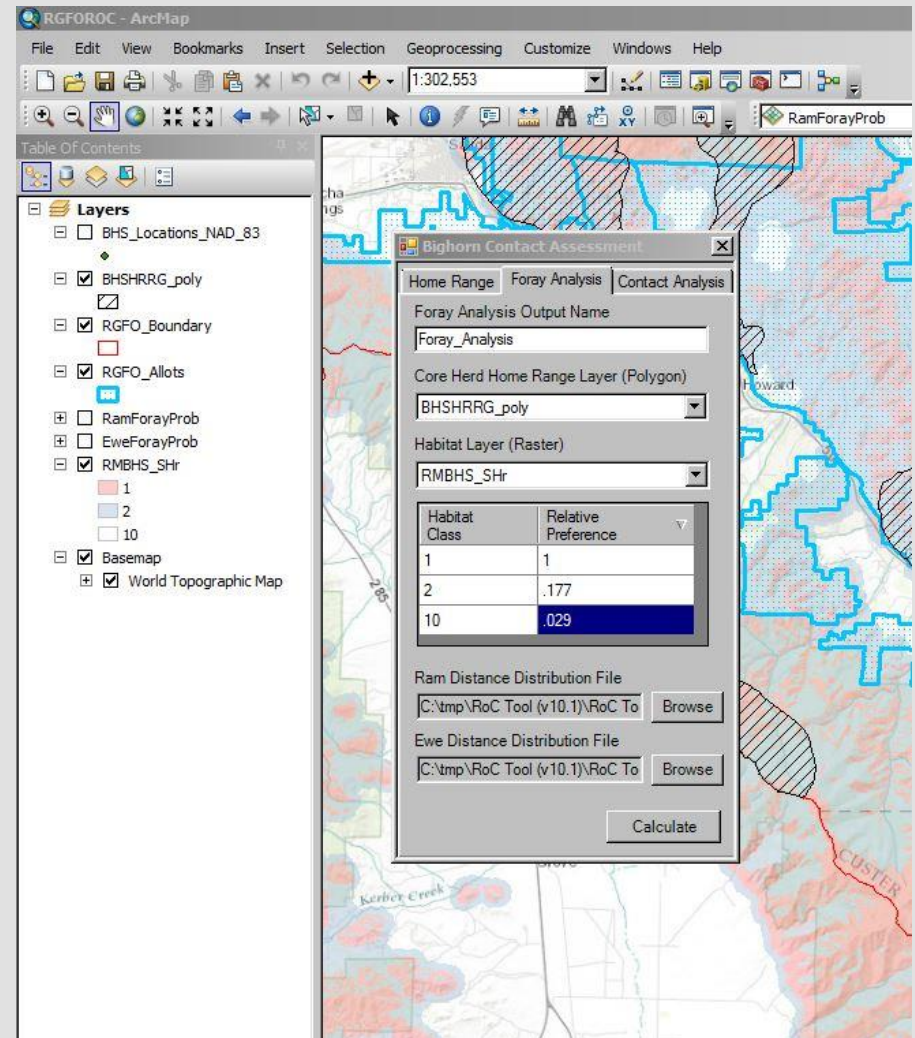


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Foray Analysis: Inputs

- Home range polygon (calculated or known)
- Habitat preference
 - Probability of forays at one kilometer intervals

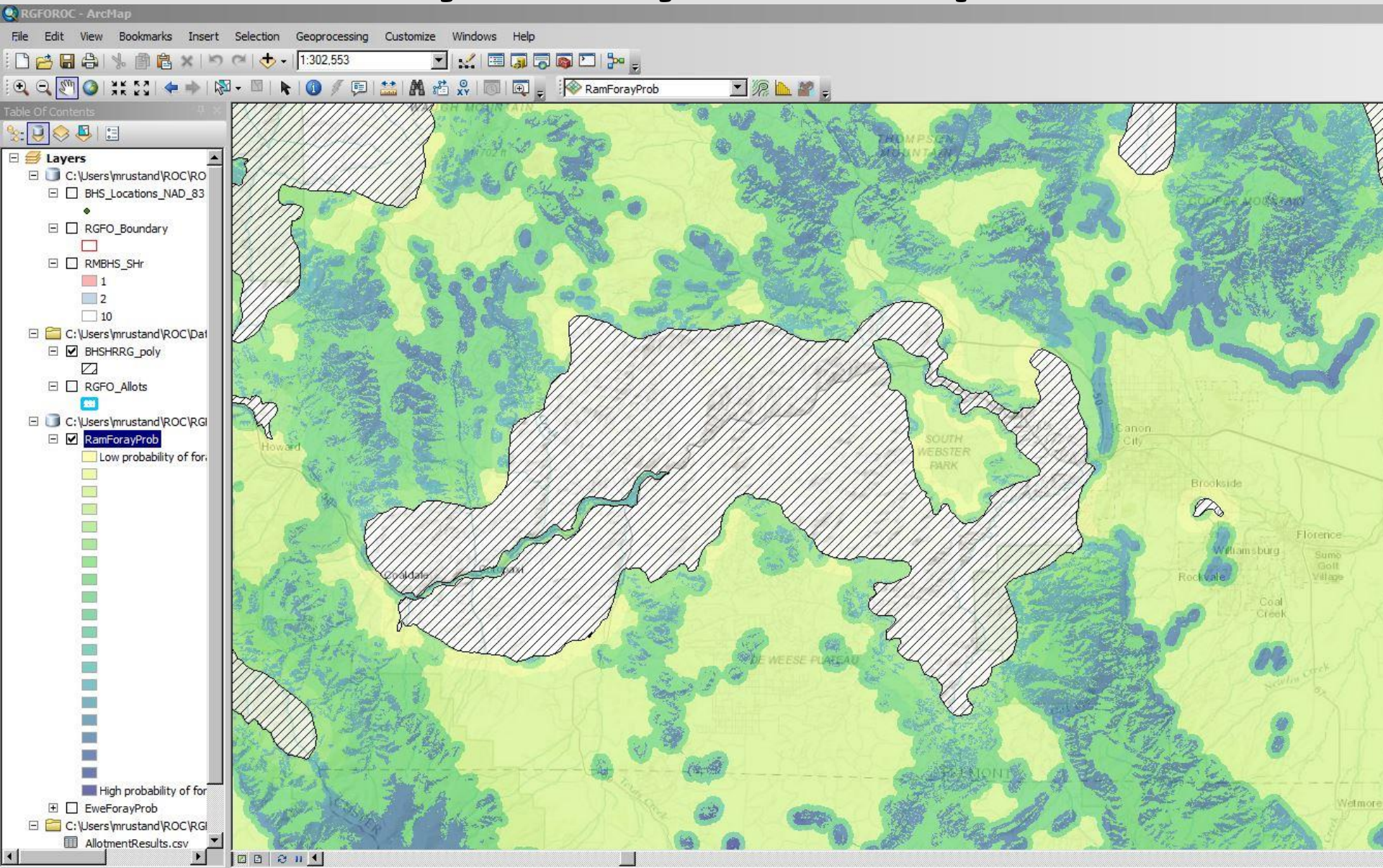


Foray Analysis: Inputs

- Home range polygon
(calculated or known)
- Habitat preference
- Foray distance
distribution
 - Data from Hells
Canyon, ID herd

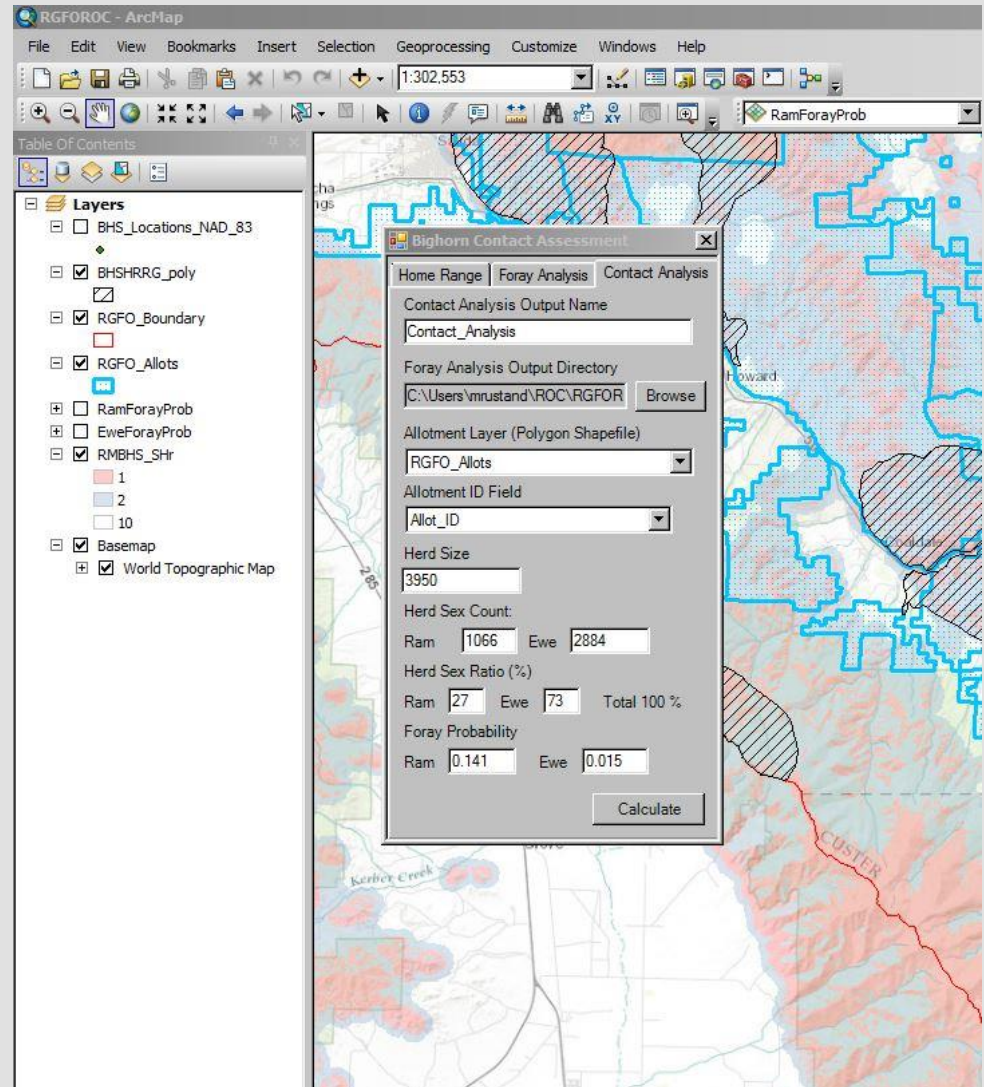
	A	B
1	Distance	ForayProb
2	1	1
3	2	0.951151
4	3	0.901913
5	4	0.851967
6	5	0.801174
7	6	0.749647
8	7	0.697794
9	8	0.646302
10	9	0.596065
11	10	0.548045
12	11	0.503117
13	12	0.461911
14	13	0.424703
15	14	0.391374
16	15	0.361445
17	16	0.334169
18	17	0.308666
19	18	0.284067
20	19	0.25966
21	20	0.234989
22	21	0.209924
23	22	0.184658

Foray Analysis: Outputs



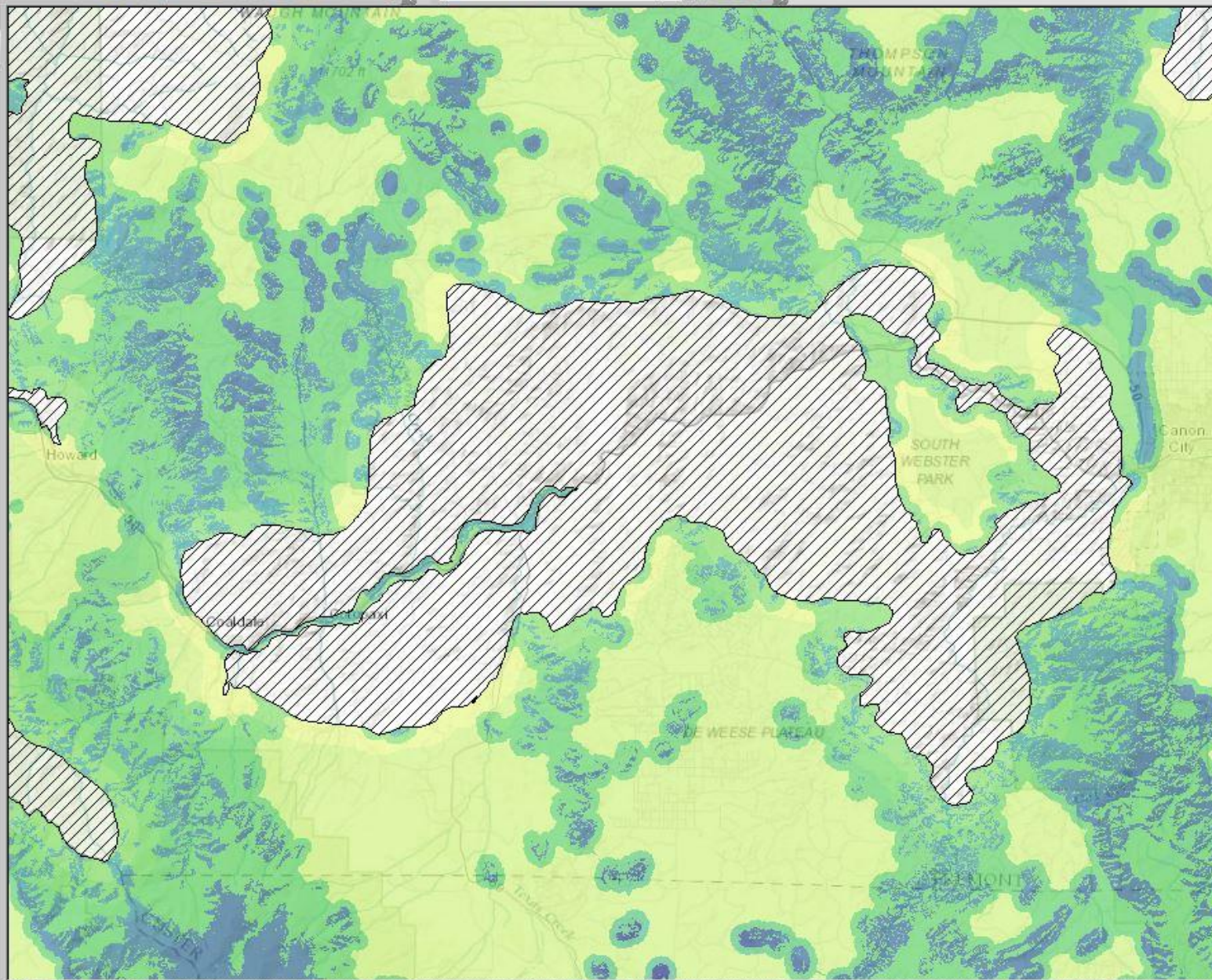
Contact Analysis: Inputs

- Foray analysis output



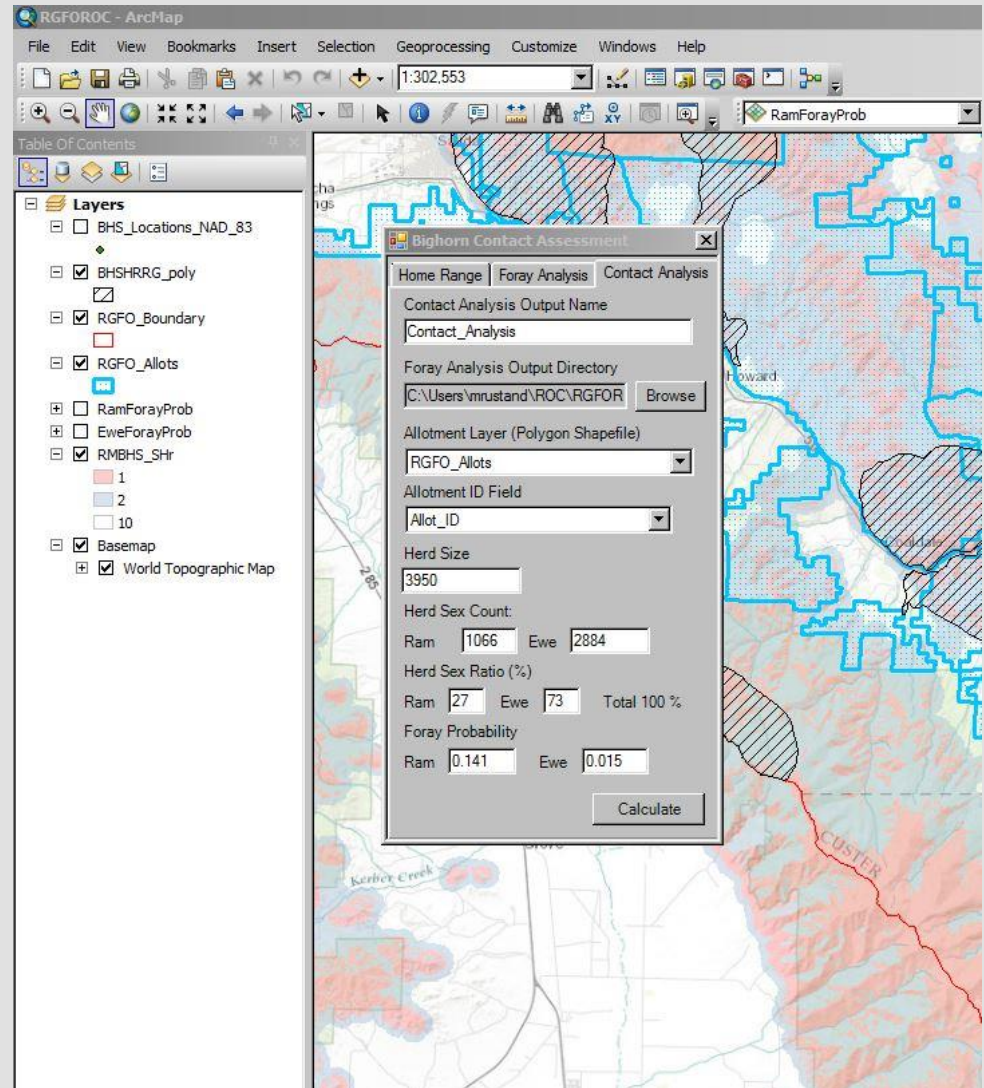
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- ☒ BSHRRG_poly
- ☐ RGFO_Allots
- ☐ C:\Users\mrustand\ROC\RG
- ☒ RamForayProb
 - Low probability of for:
 - High probability of for:
- ☐ EweForayProb
- ☐ C:\Users\mrustand\ROC\RG
- ☐ AllotmentResults.csv



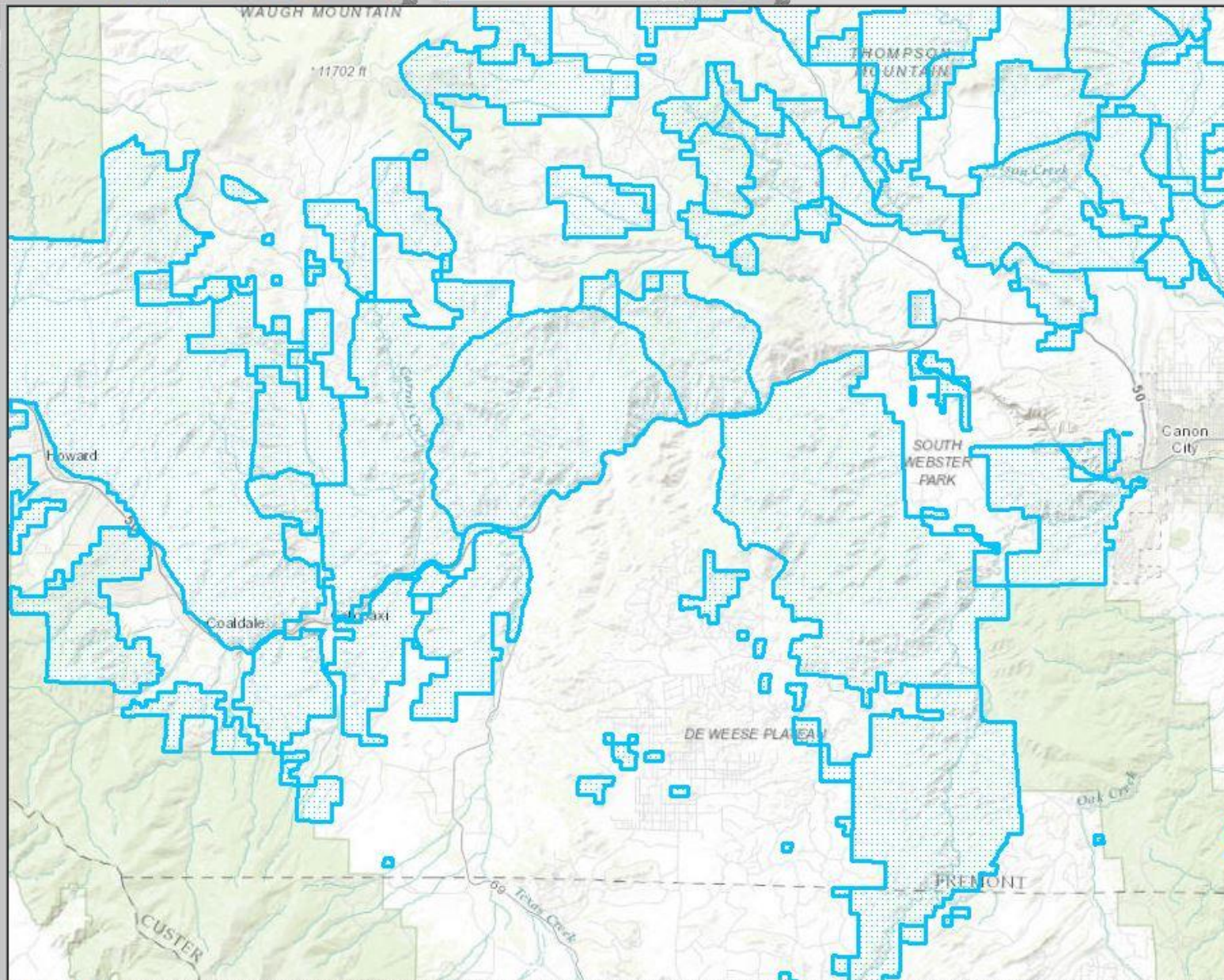
Contact Analysis: Inputs

- Foray analysis output
- Range allotments
 - Allotments consisting of multiple polygons were exploded (single polygon to multiple polygons)



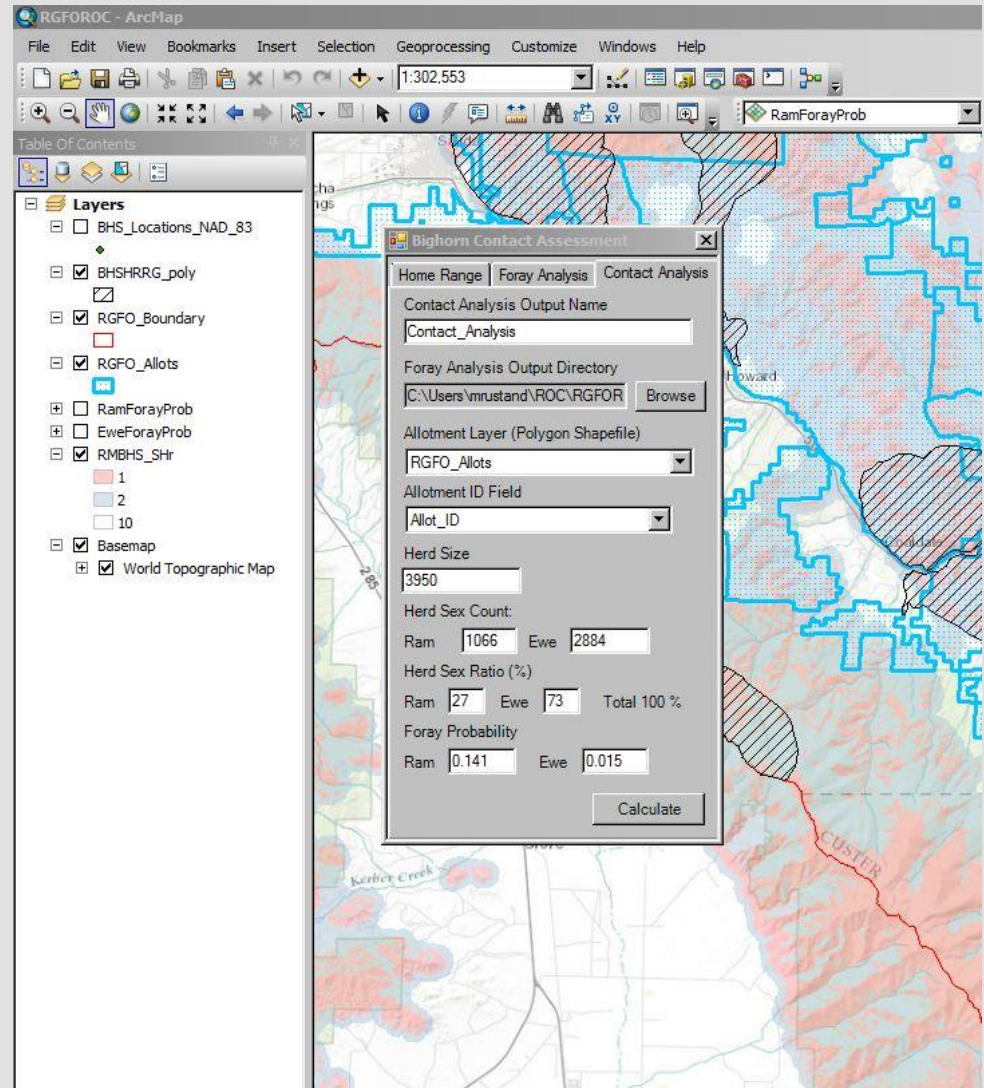
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Contact Analysis: Inputs

- Foray analysis output
- Range allotments
- Bighorn sheep population statistics
 - Herd Size
 - Sex ratio/percentage
 - Sex foray probability



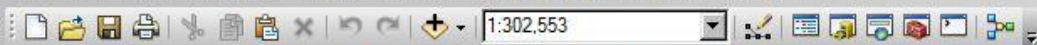
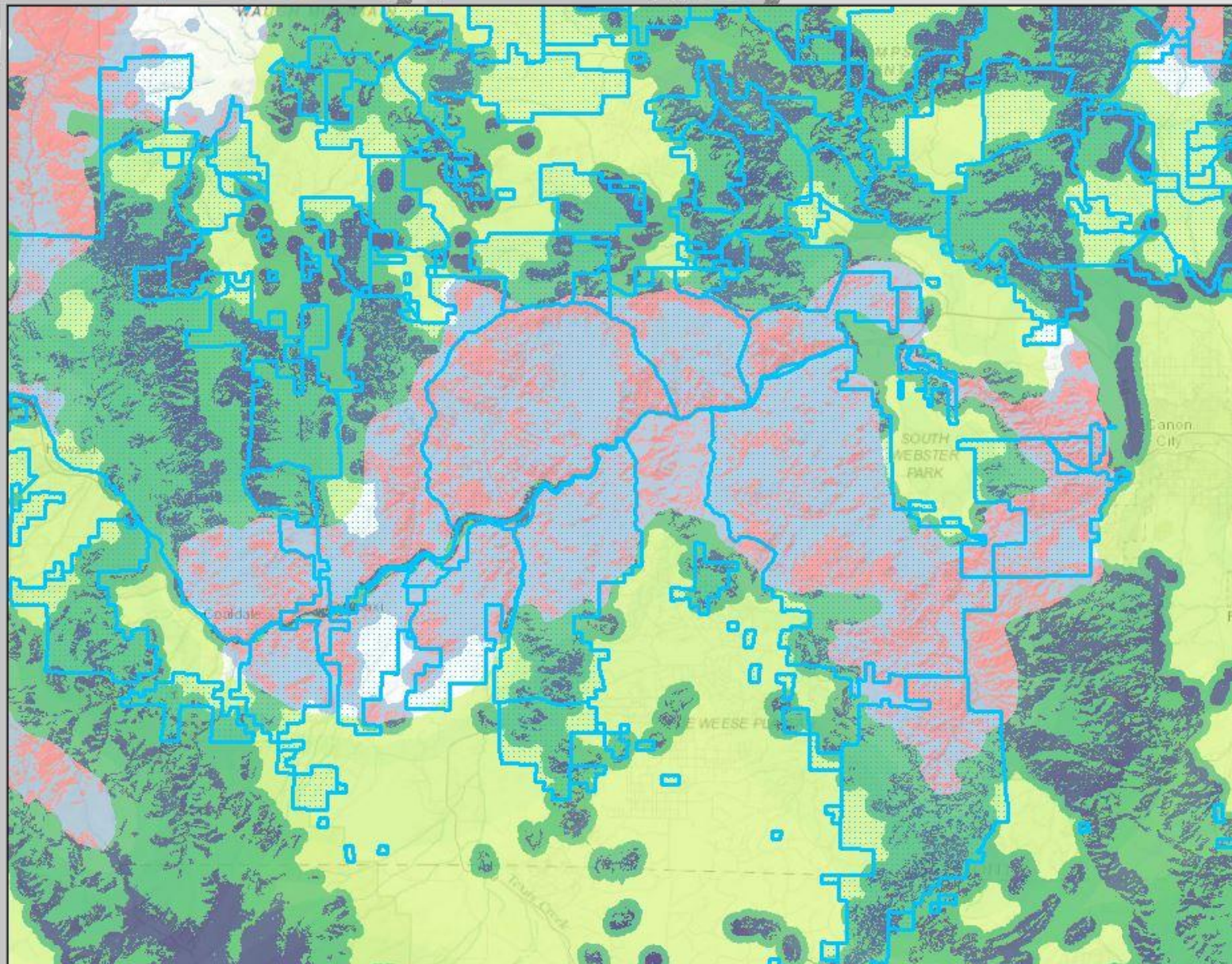


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Contact Analysis: Outputs

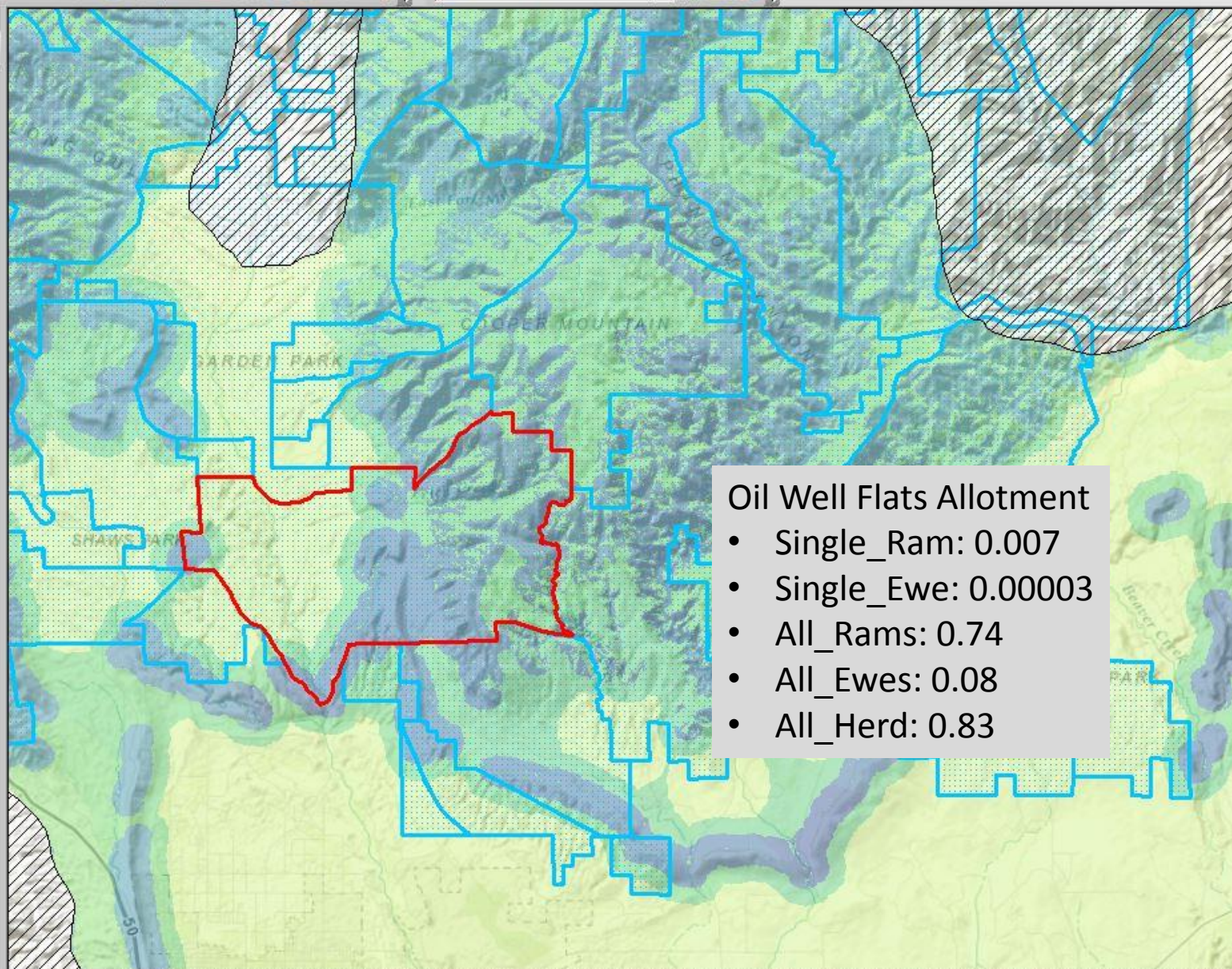
- **Single_Ram**: Probability a ram will foray outside its home range and contact the allotment
- **Single_Ewe**: Probability a ewe will foray outside its home range and contact the allotment
- **All_Rams**: Average number expected to foray outside its home range and contact the allotment per year
- **All_Ewes**: Average number expected to foray outside its home range and contact the allotment per year
- **All_Herd**: Average number of adult sheep expected to foray outside its home range and contact the allotment per year

Contact Analysis: Outputs

- Single_Ram: 0 – 0.00070
- Single_Ewe: 0 – 0.000043
- All_Rams: 0.000001 – 0.74
- All_Ewes: 0 – 0.082
- All_Herd: 0.000001 – 0.84

	Allot_ID	Single_Ram	Single_Ewe	All_Rams	All_Ewes	All_Herd	Notes
	886	0.000135	0.000007	0.14447	0.019804	0.164274	<Null>
	992	0.000136	0.000008	0.145525	0.024139	0.169665	<Null>
	557	0.000138	0.000003	0.147377	0.008983	0.15636	<Null>
	932	0.000144	0.000009	0.153986	0.025543	0.179528	<Null>
	596	0.000146	0.000009	0.155713	0.025829	0.181542	<Null>
	1000	0.000147	0.000004	0.156799	0.011362	0.168161	<Null>
	976	0.000151	0.000008	0.160671	0.022025	0.182697	<Null>
	650	0.000153	0.000008	0.163008	0.022346	0.185353	<Null>
	520	0.00016	0.000008	0.170974	0.023438	0.194412	<Null>
	694	0.000163	0.00001	0.173963	0.028856	0.20282	<Null>
	889	0.00017	0.000009	0.181726	0.024912	0.206638	<Null>
	385	0.000173	0.000011	0.185115	0.030931	0.216046	<Null>
	893	0.000179	0.00001	0.190741	0.029064	0.219805	<Null>
	916	0.000182	0.000013	0.194672	0.037417	0.23209	<Null>
	453	0.000186	0.000008	0.198291	0.021897	0.220187	<Null>
	921	0.00019	0.000017	0.202604	0.04772	0.250324	<Null>
	396	0.000192	0.00001	0.204934	0.028093	0.233027	<Null>
	702	0.000194	0.000012	0.20751	0.034421	0.241931	<Null>
	712	0.000198	0.000008	0.211005	0.023301	0.234306	<Null>
	403	0.000203	0.000012	0.216565	0.035923	0.252489	<Null>
	1001	0.000205	0.000005	0.218207	0.015812	0.234018	<Null>
	896	0.000211	0.000012	0.225267	0.03539	0.260657	<Null>
	381	0.000212	0.000005	0.226384	0.014412	0.240796	<Null>
	591	0.000213	0.000013	0.226991	0.037653	0.264644	<Null>
	947	0.000219	0.000016	0.233596	0.044899	0.278495	<Null>
	646	0.00022	0.000013	0.234466	0.038318	0.272783	<Null>
	888	0.00023	0.000005	0.244974	0.014932	0.259906	<Null>
	709	0.000244	0.000017	0.25996	0.049966	0.309927	<Null>
	649	0.000246	0.000016	0.262826	0.047038	0.309864	<Null>

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Low probability of for
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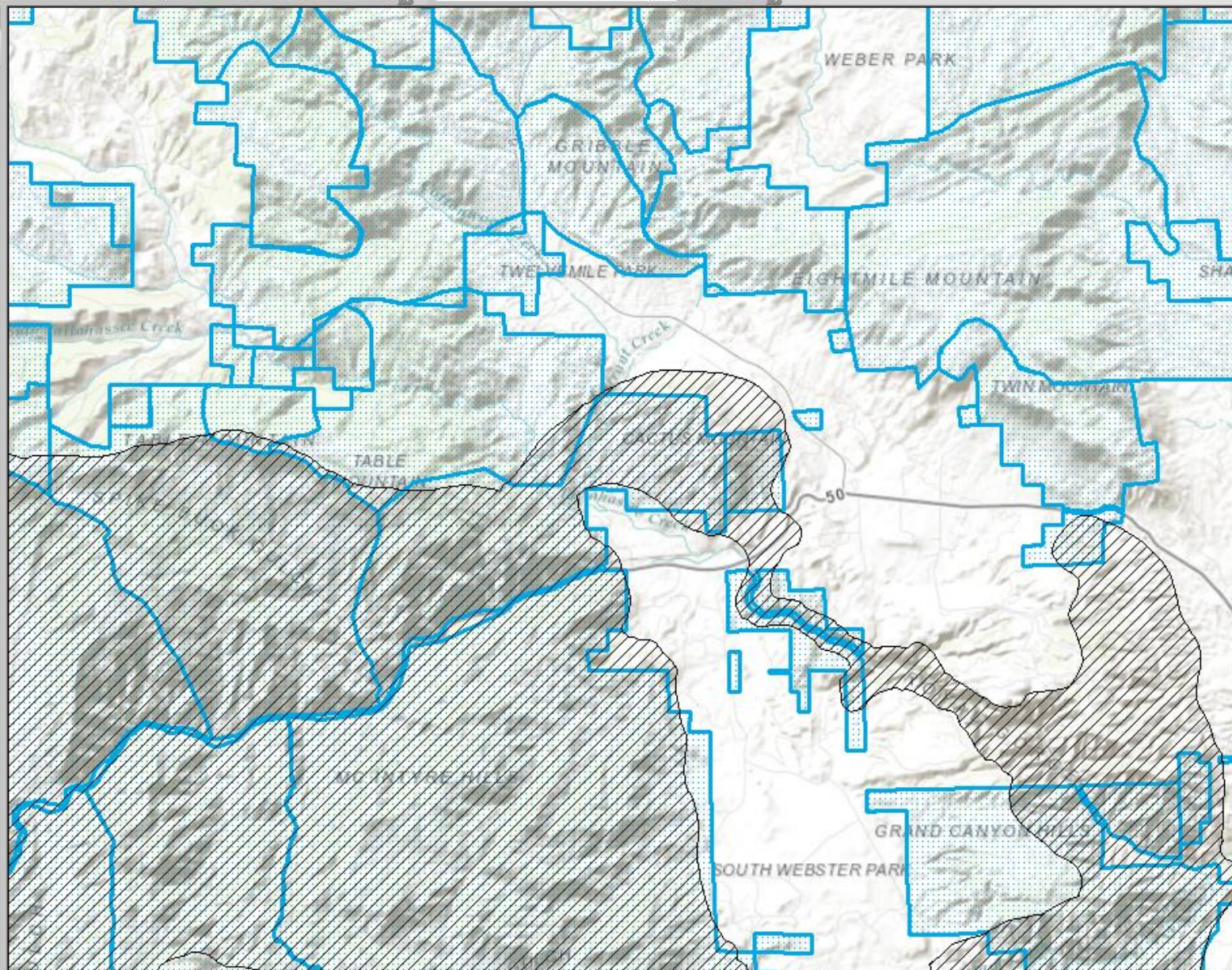


Results

- Assumptions . . .
 - The Payette National Forest analysis states contact rates >0.04 annually were unacceptable (USFS 2010)
 - Based on disease return intervals and impacts to long term herd viability; however, the number is arbitrary
 - Disease event occurring within a herd every 25 years or less creates:
 - High risk to long term viability (USFS 2013)
 - Low probability of population persistence (USFS 2013)
 - All allotments are grazed by sheep
 - Not realistic, but for purposes of land use plan analysis

Results

- 179 allotment polygons intersected the core herd home range
 - Assumed contact between domestic and bighorn sheep



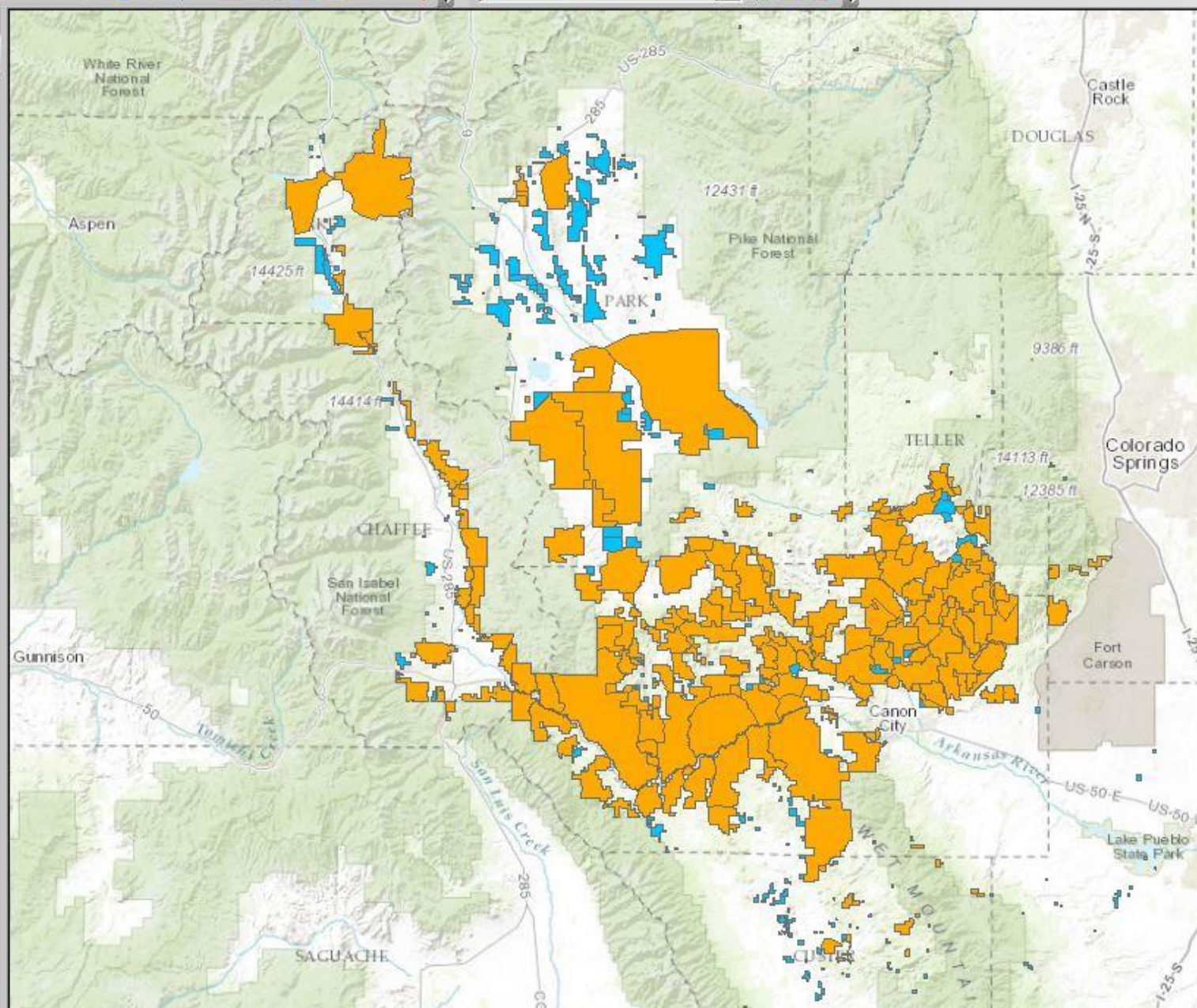
Results

- 179 allotment polygons intersected the core herd home range
 - Assumed contact between domestic and bighorn sheep
- 143 of the remaining 712 allotment polygons had contact rates > 0.04

Results

- Royal Gorge Field Office has 1,404,255 total acres within allotment boundaries (private and public acres)
- 593,000 acres in allotments that touch a bighorn sheep home range polygon
- 391,650 acres in allotments with a contact rate >0.04
- 984,650 acres (or 70% of total acres) in allotments at risk for contact between domestic and bighorn sheep

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 - ☐ RamForayProb
 - Low probability of for



Discussion

- Not a final output for the Royal Gorge Field Office
 - Refine core herd home range polygons with assistance from CPW terrestrial biologist
 - Calculate habitat preference and foray distance values from available point data
 - Run model for each bighorn sheep herd (management unit) to better reflect local populations

Discussion

- The tool calculates probability of contact and rate of contact, not disease transmission
- May conduct seasonal analysis if data is available
- The model does not account for stray or privately raised domestic sheep or goats

Questions?

