Montana Mitigation System Habitat Quantification Tool

Version 1.0

HQT: the scientific method to evaluate vegetation and environmental conditions related to quality and quantity of habitat

76-22-103(9), MCA

- A GIS model: calculates functional (Fx) acres
- Answers the questions:
  - How many functional acres are gained from conservation?
  - How many functional acres are lost due to development?

What goes into the HQT

Basemap

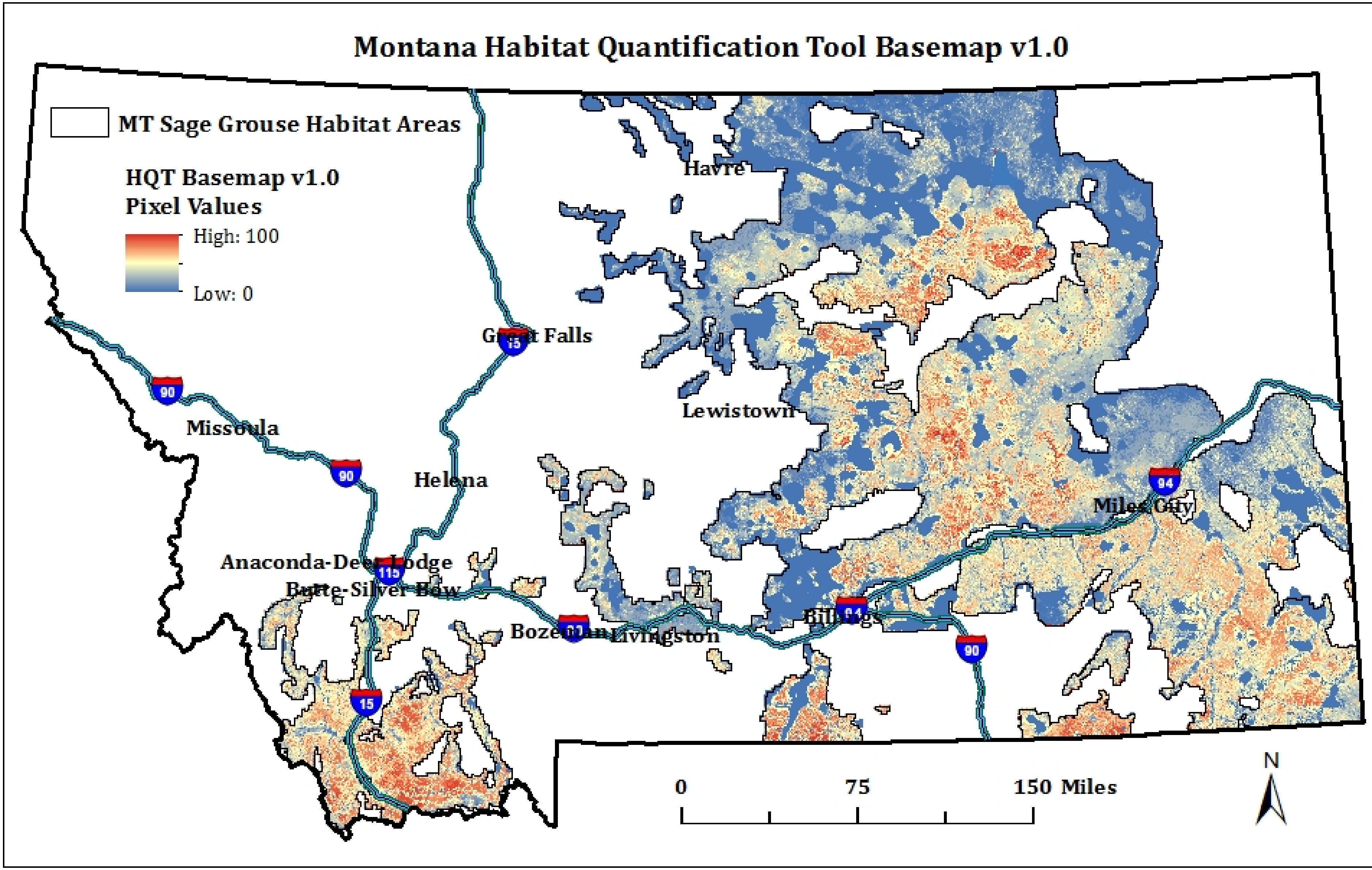
- **Habitat Variables**
  - **Averaging**
    - What data is included?
    - Where does the data come from?
    - How often is the data updated (FWP lek data, density model, MLRC LULC)
- **Anthropogenic Scores –Existing Disturbances**
  - **Multiplicative**
    - Spatial Resolution
    - Project Geometry

How the HQT is Calculated

HQT Model

- **Project direct footprint**
  - Indirect Impacts
  - Reclamation

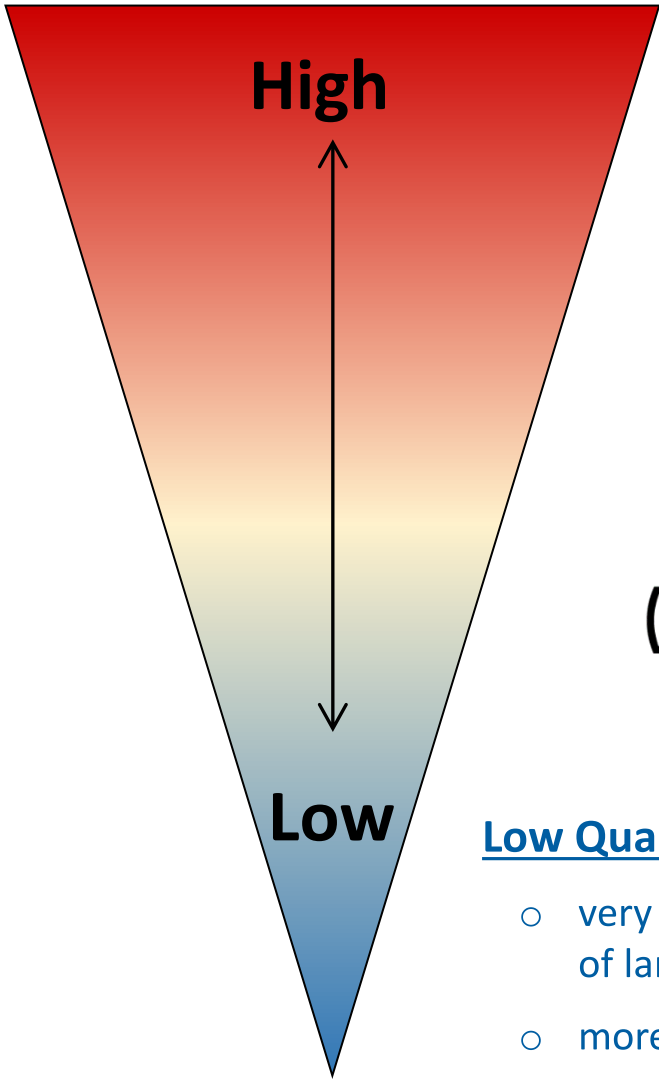
= HQT RAW SCORE



Note about Red Areas:

- *match up well with Core Areas – areas of highest priority for conservation*
- *more birds, higher quality vegetation, less existing disturbance*

Habitat Quality



High Quality Habitat:

- very high number of functional acres for each physical acre of land
- more and darker red per unit area
- many leks, high bird numbers
- lots of sagebrush, riparian areas
- low levels of existing disturbance

Each cell on the basemap: (0-100)

representing "pre-project" habitat quality

- vegetation, birds, existing disturbance

Low Quality Habitat:

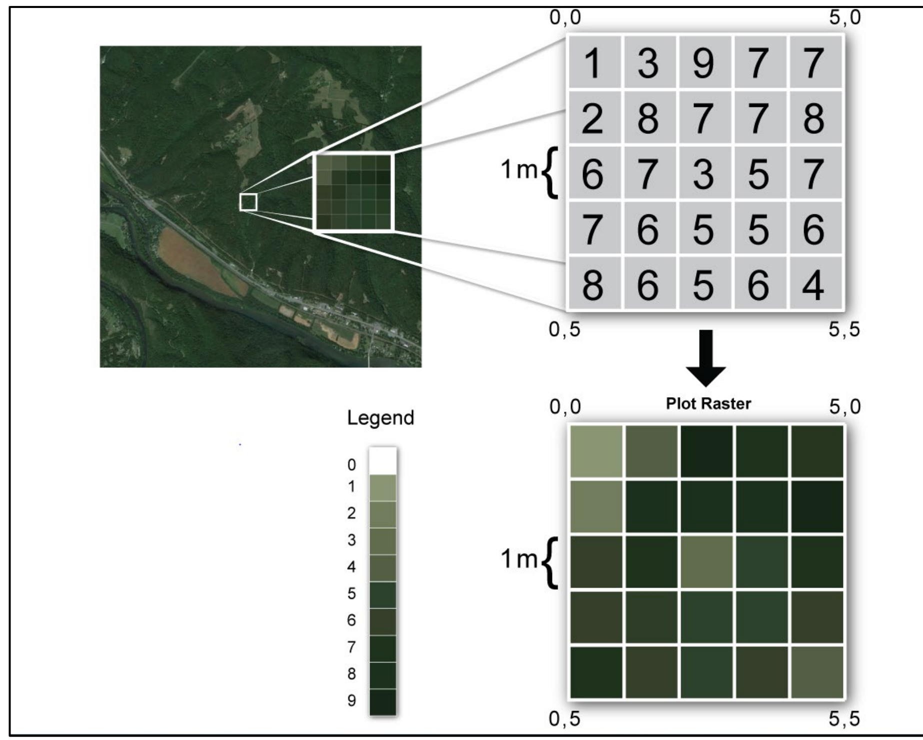
- very low number of functional acres for each physical acre of land
- more and darker blue per unit area

Statewide Basemap:

Spatial Data Fundamentals

“Raster”-based Methods

- Represent maps as a grid of values, like graph paper
- Each “pixel” represents a specific geographic location
- Values can be:
  - Continuous (Elevation)
  - Categorical (Land cover)



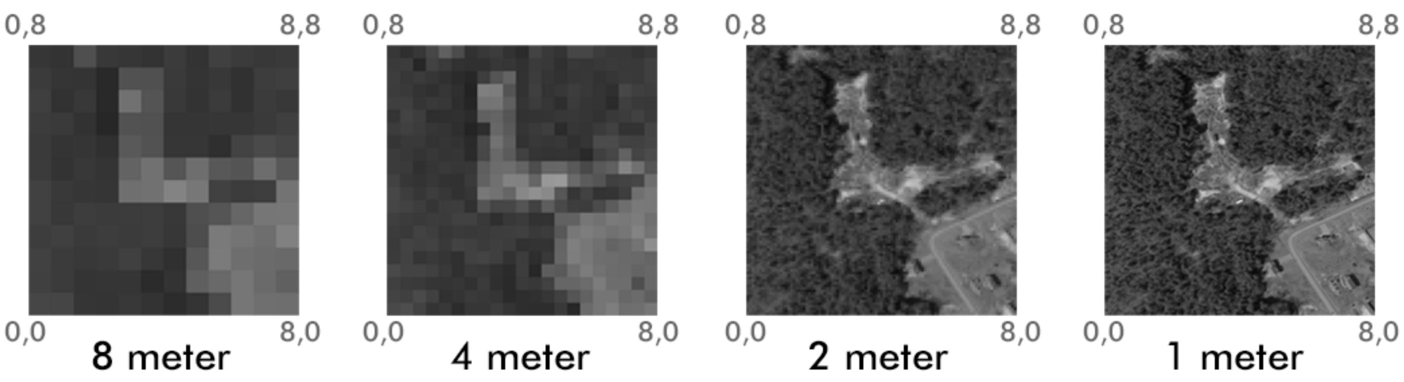
Source: National Ecological Observatory Network (NEON)

Statewide Basemap:

Spatial Data Fundamentals

“Raster”-based Methods

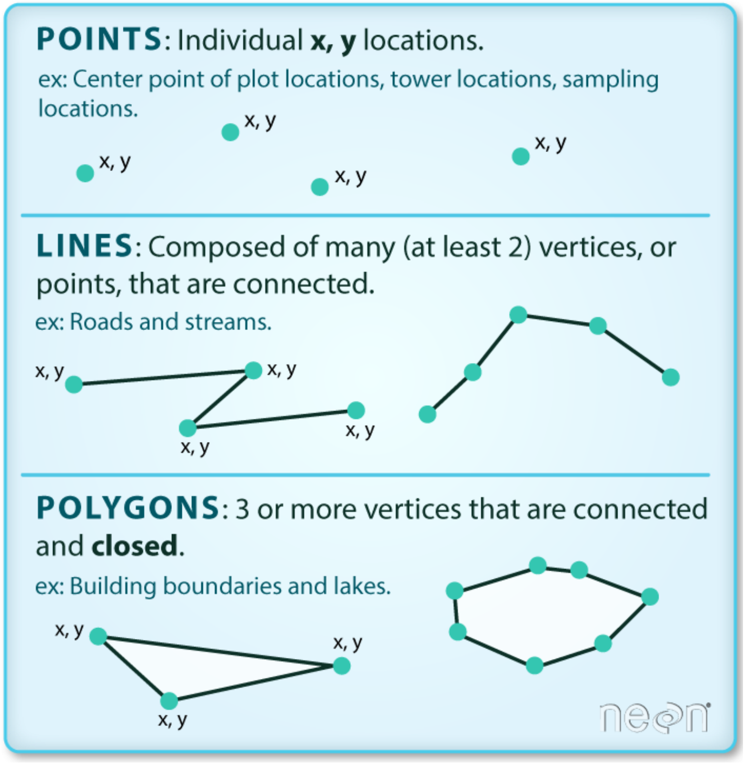
- Resolution
  - The area on the ground that each pixel covers
- Raster over the same physical area (extent) at different resolutions:



Source: National Ecological Observatory Network (NEON)

Statewide Basemap:

Spatial Data Fundamentals



Source: National Ecological Observatory Network (NEON)

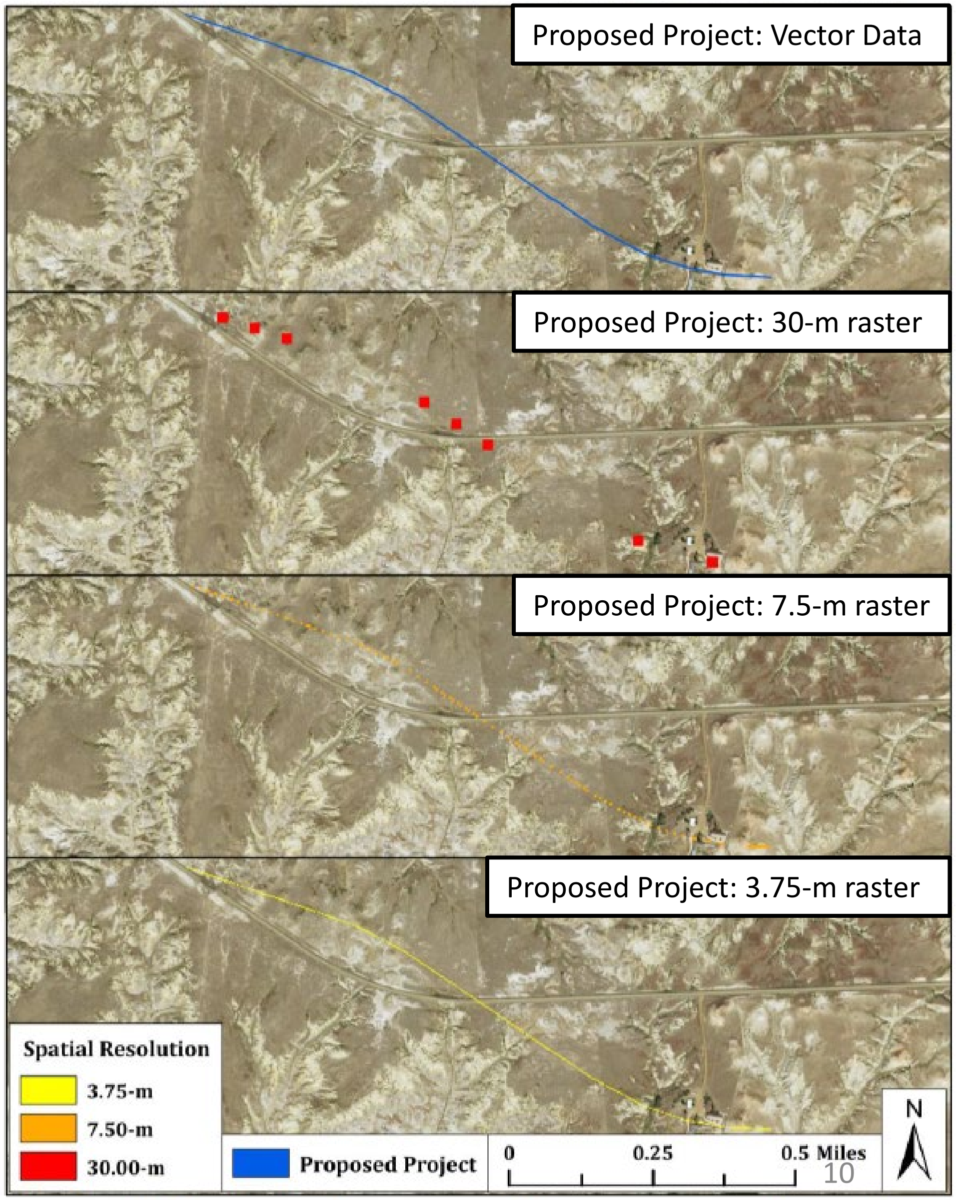
Proposed Projects: "Vector" data

- Represent features with specific geographic locations
  - Points
    - (ex: survey plots, water supply wells)
  - Lines
    - (ex: roads)
  - Polygons
    - (ex: gravel pit, building)

Statewide Basemap:

- Source data available at different degrees of resolution
  - Most source data at 30-m resolution
- Proposed project data
  - Vector converted to Raster
  - Finer resolution, more detailed data required to accurately capture project footprint
- Comparison of
  - 30-m, 7.5-m, 3.75-m resolution basemap
  - Statewide Basemap
    - All processing at 30-m resolution
    - Final Resolution = convert to 3.75-m
    - Least error when converting proponent data from vector to raster
    - Most Direct Impact of project footprint
    - Least are outside the actual project footprint included in Direct Impact going forward to HQT analysis

Spatial Resolution



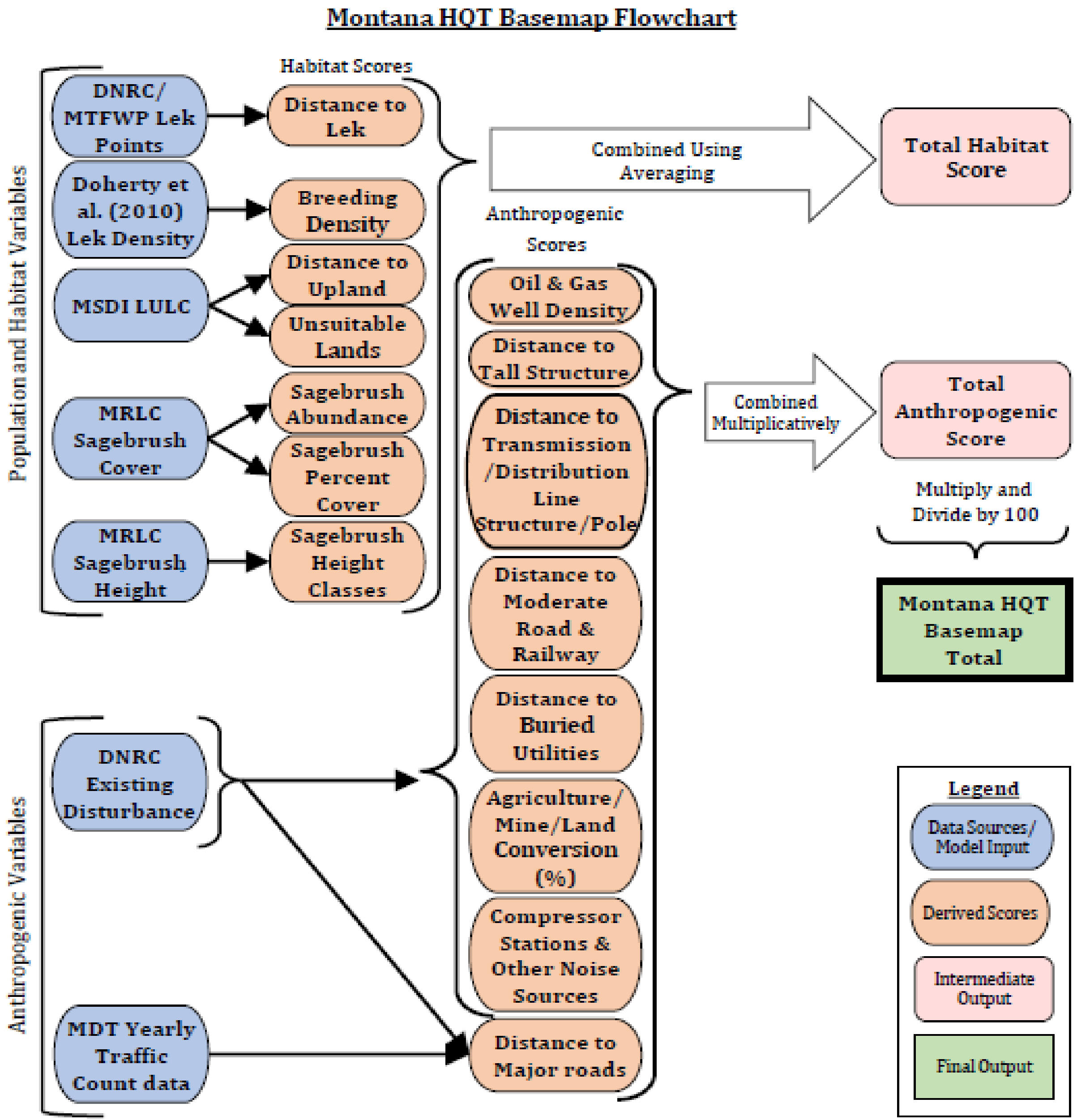
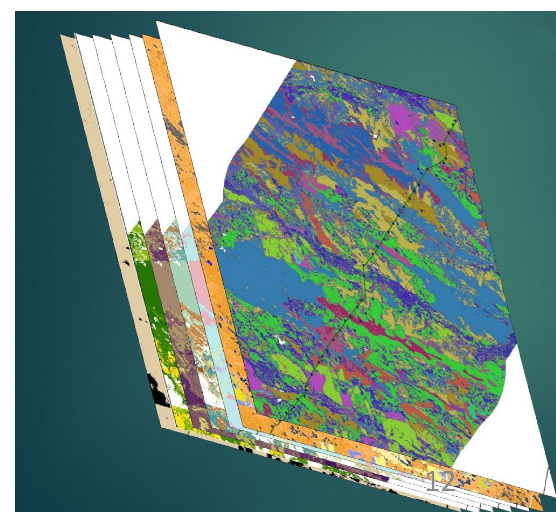


Figure 3. 4. The flowchart for the development of the Montana HQT Basemap.



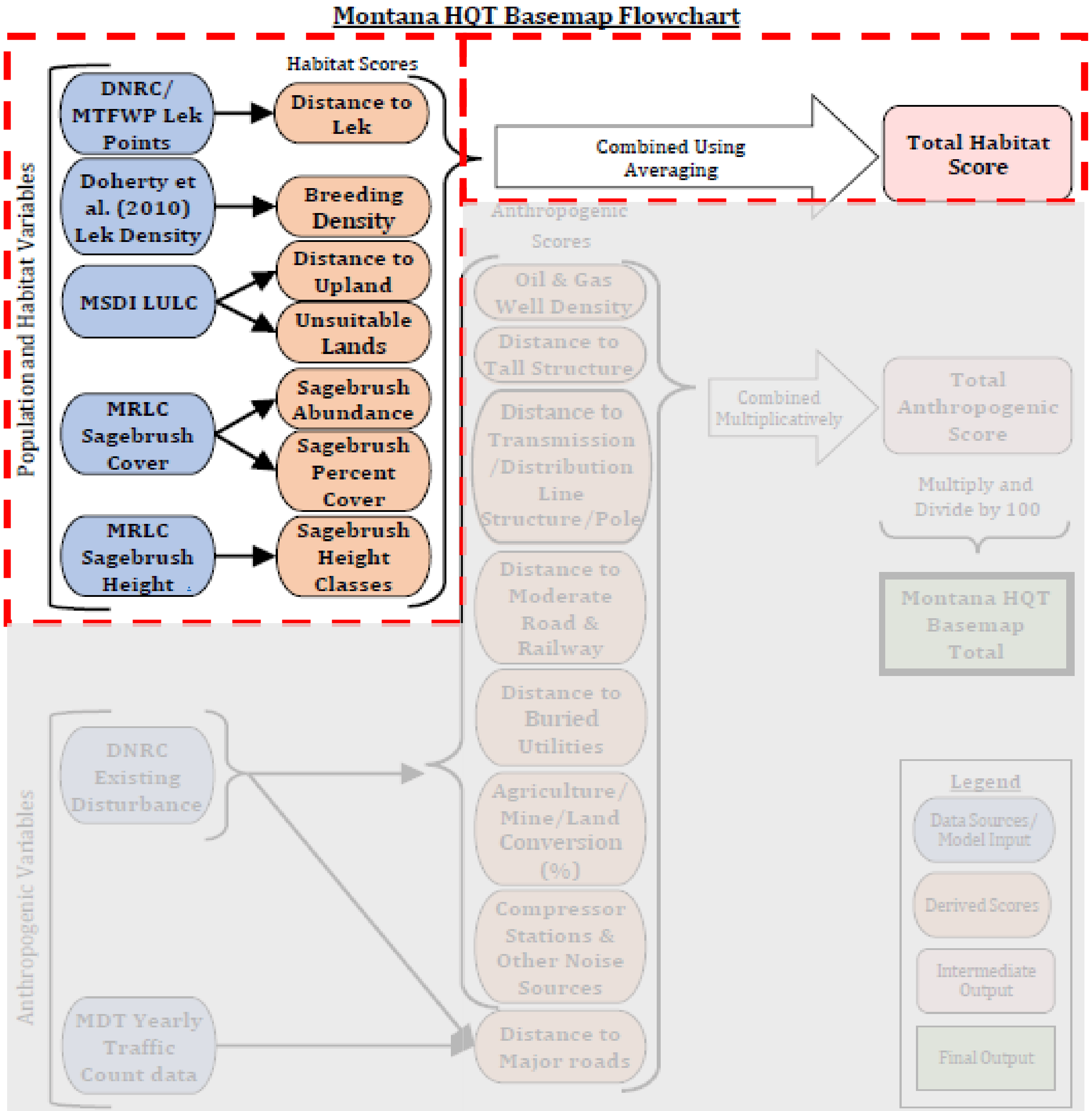
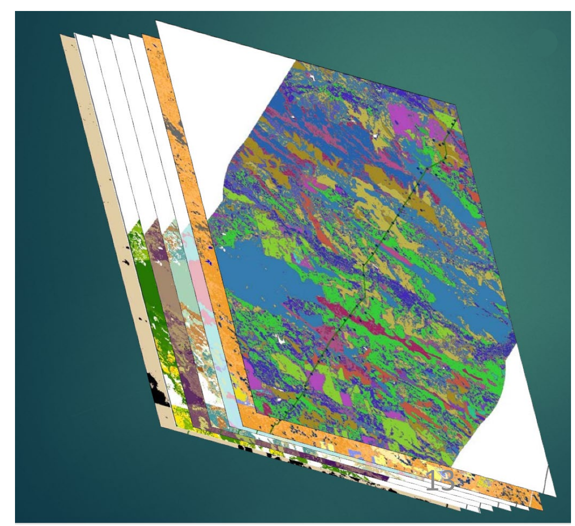
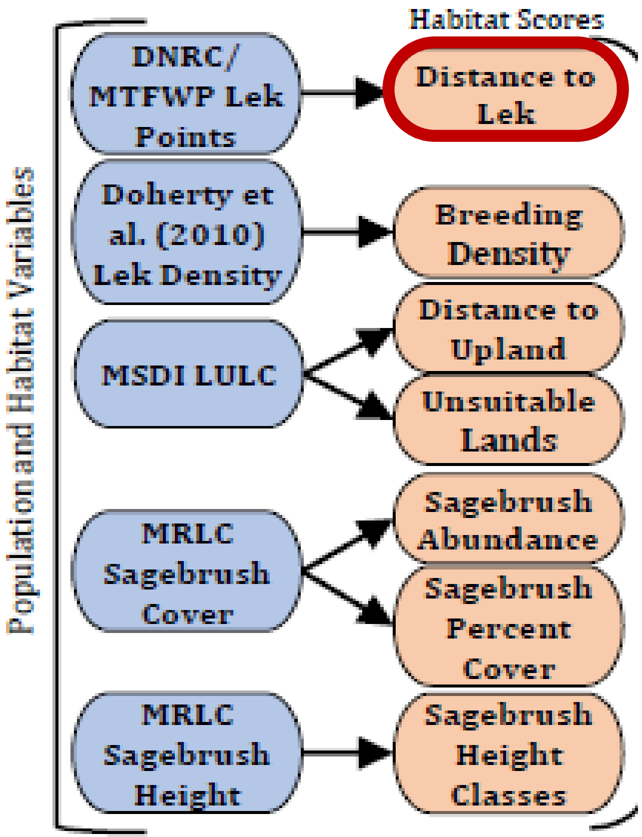


Figure 3. 4. The flowchart for the development of the Montana HQT Basemap.

How the Habitat Score is Calculated





Distance to Lek

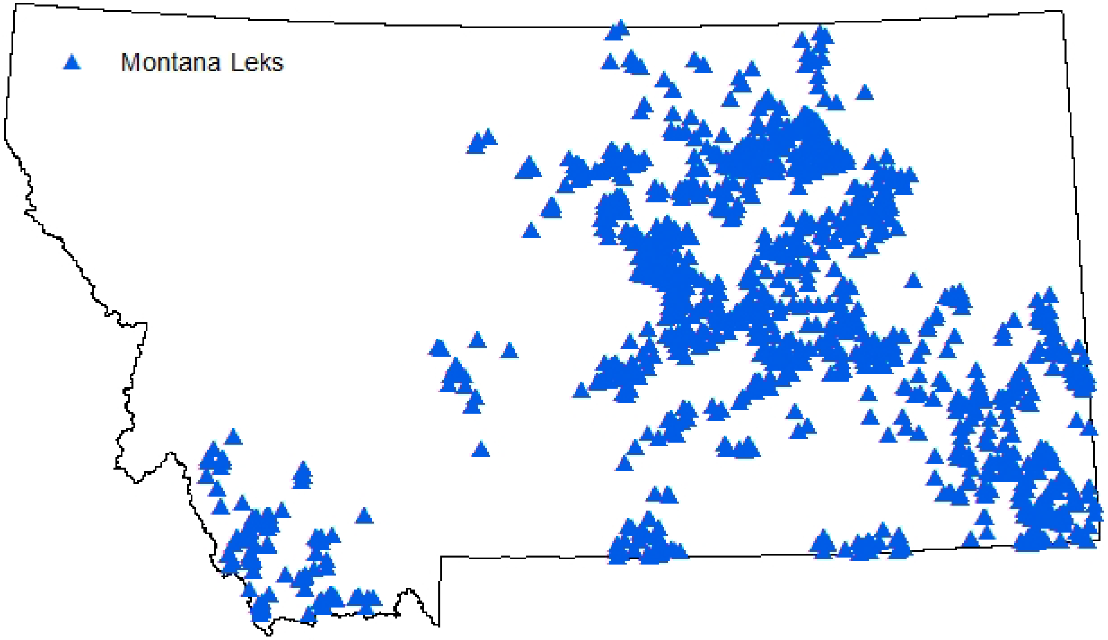
- Important nesting habitat within 3.2-km (1.98 miles) of leks

  (Foster et al. 2014; Woodward 2006)

- 95% of nesting activity occurs within 10-km (6.2 miles) of leks (Doherty 2008).
- Habitats within 3.2 km (1.98 miles) get a Habitat Score of = 100
- Decreasing values with increasing distance from leks based on averaging values within distance bins

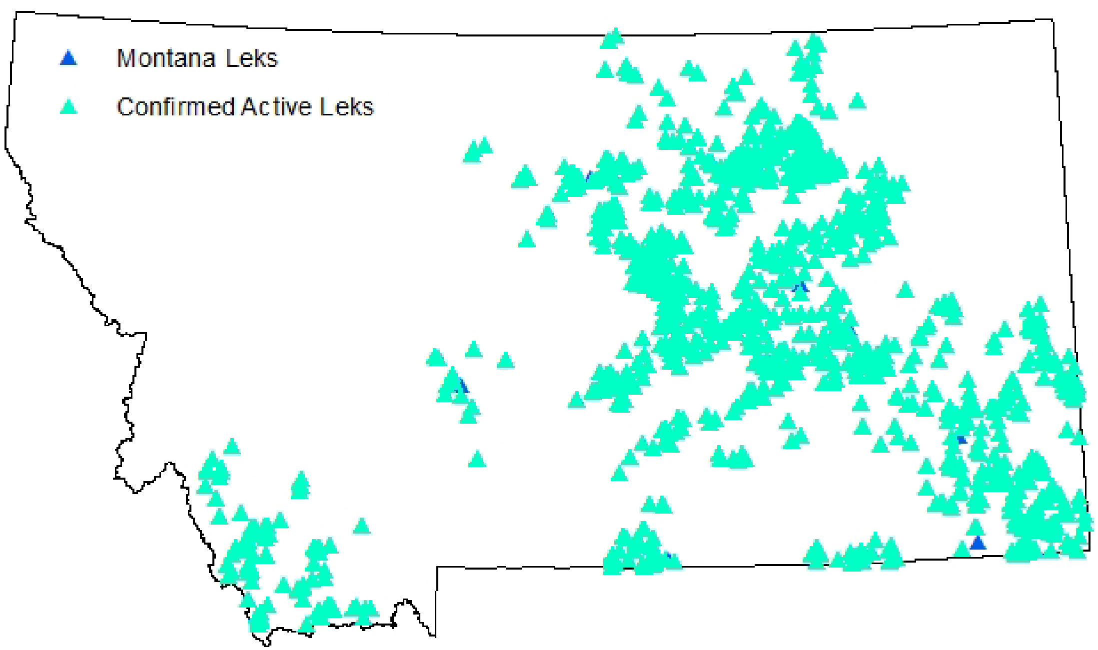
See HQT Technical Manual section *3.2.2 Population and Habitat Variables Used to Create the Montana HQT Basemap* pg. 34-38 and *Appendix A: Population and Habitat Variables* pg. 84-101 for discussion of this and other habitat score variables.

Distance to Lek



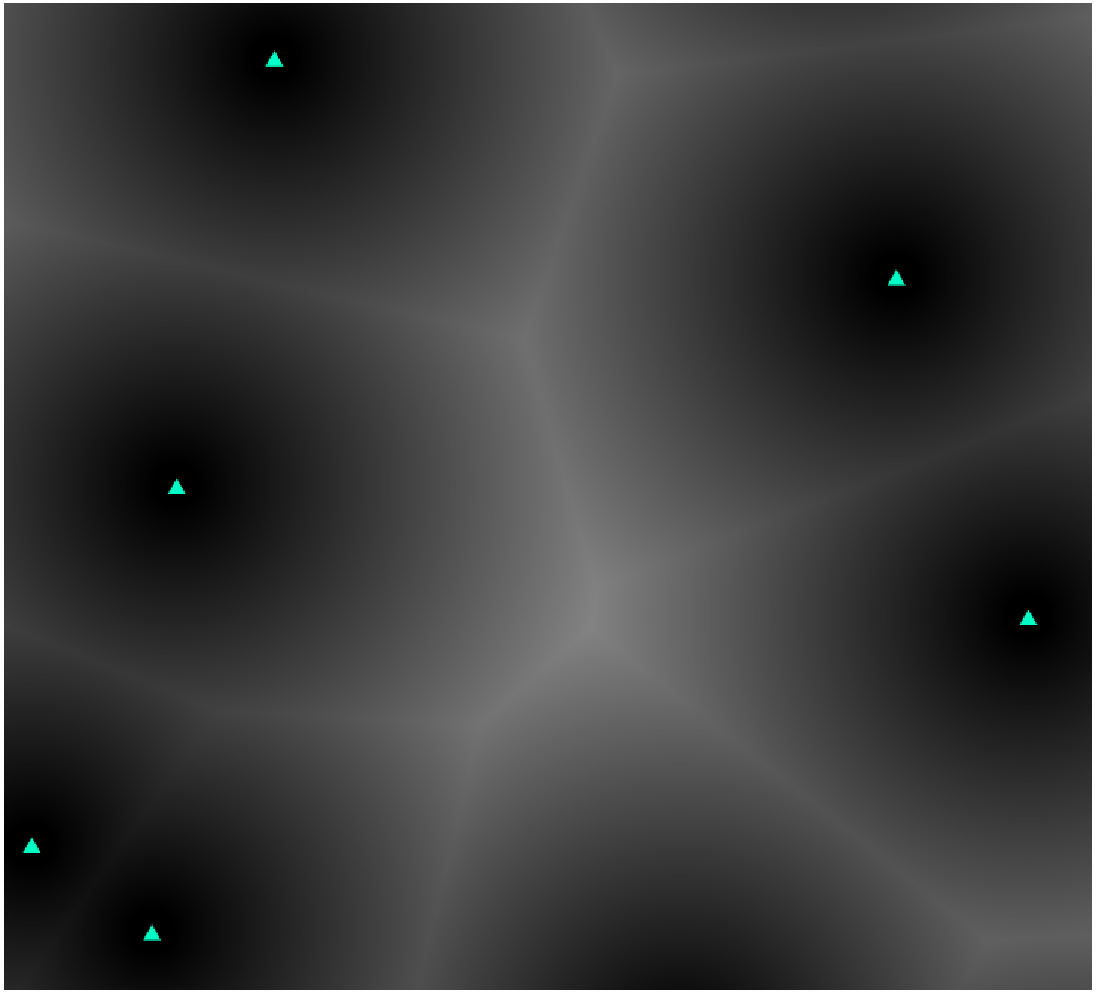
Distance to Lek

- Select active leks from Montana statewide lek data
  - "Confirmed Active" = 1 year with 2+ males lekking on site followed by evidence of lekking within 10 years



Distance to Lek

- Calculate the distance from each active lek to each grid cell within 20-km

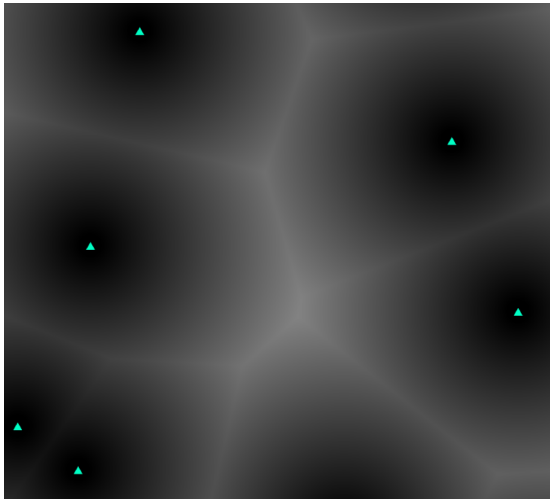


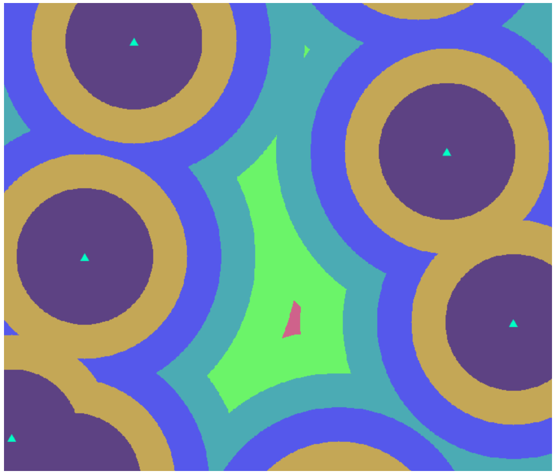
Distance to Lek

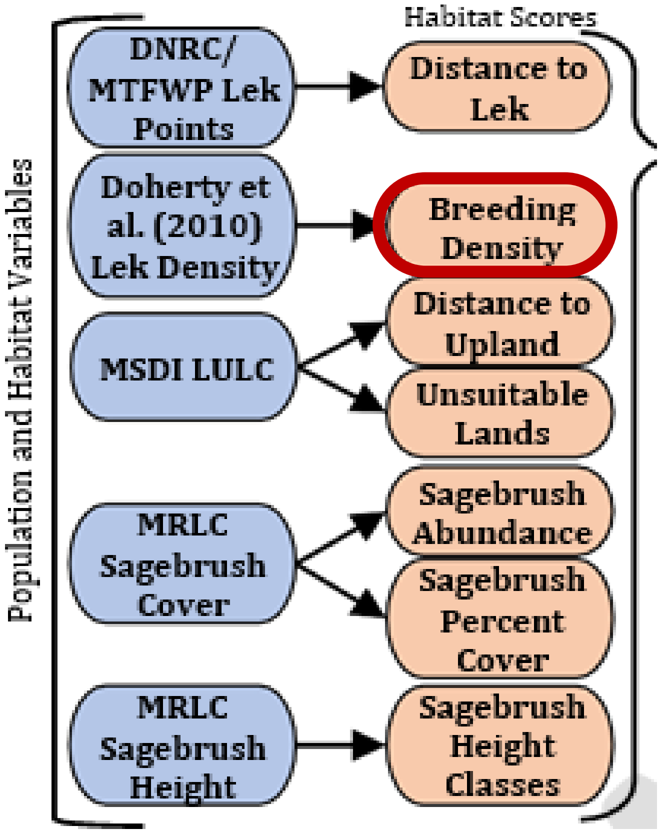
- Translate distance from active leks to a Habitat Score
  - higher habitat values closer to leks

Table A.3 (MT HQT Manual, page 87)

Distance from Lek (km)	Habitat Score
0.0 - 3.2	100
>3.2 - 4.8	80
>4.8 - 6.4	50
>6.4 - 8.0	20
>8.0 - 10.0	10
>10.0 - 20.0	5
>20.0	0







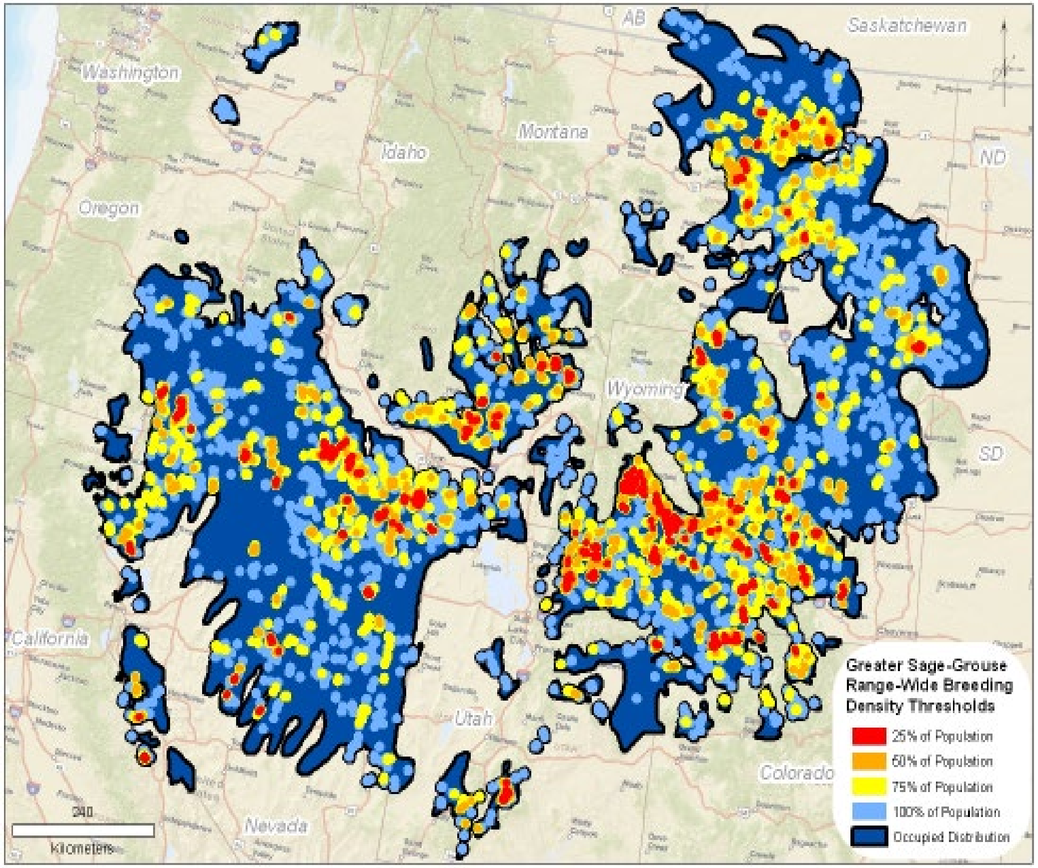
Breeding Density

- The Doherty et al. (2010a) model provides a spatially explicit, continuous variable that identifies breeding density across the range of the species.
- 95% of nesting activity occurs within 10-km (6.2 miles) of leks (Doherty 2008).
- The model output is a grouping of nesting areas that represent the smallest areas necessary to contain 25, 50, 75, and 100 percent of the nesting GRSG populations.
- Areas outside of the breeding density model (modeled breeding density of 0) receive a score of 0

See HQT Technical Manual section *3.2.2 Population and Habitat Variables Used to Create the Montana HQT Basemap* pg. 34-38 and *Appendix A: Population and Habitat Variables* pg. 84-101 for discussion of this and other habitat score variables.

Breeding Density

- Doherty Breeding Density Model
  - Range-wide sage-grouse breeding density
  - Spatial locations representing percentage of known breeding population:
    - 25% - highest density of displaying males, closer to leks
    - 50%
    - 75%
    - 100% - lower density, have to go farther from leks to get 100% of the population

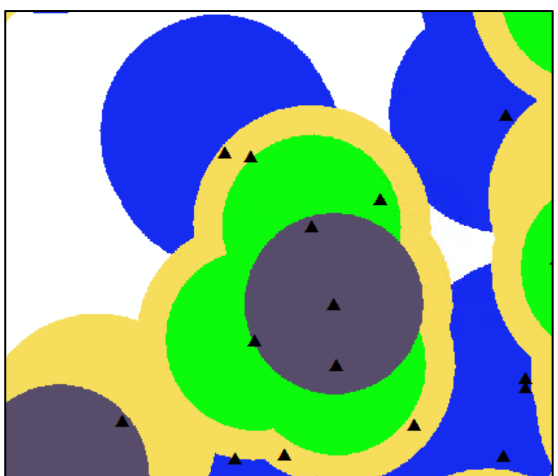


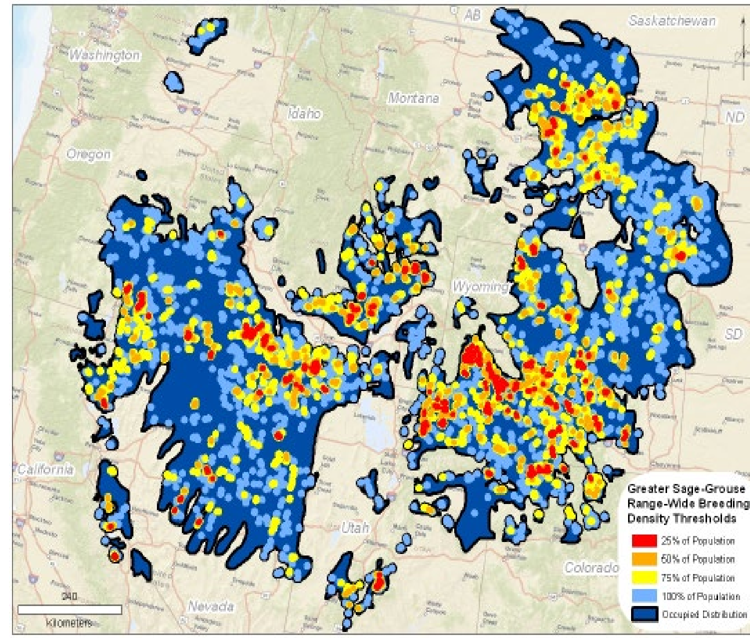
Breeding Density

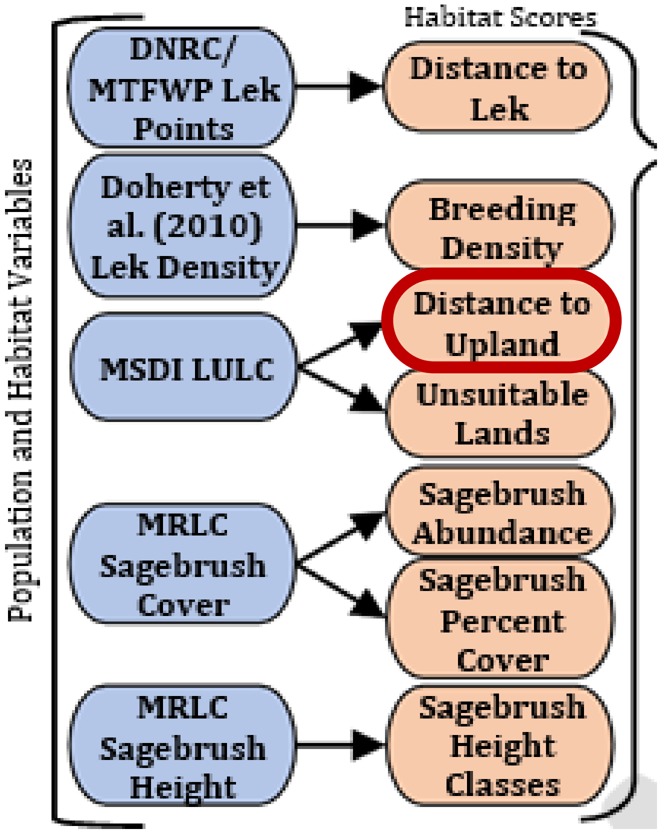
Classify the Doherty Breeding Density model for sage-grouse habitat in Montana

Table A.4 (MT HQT Manual, page 89)

Breeding Density (%)	Habitat Score
25	100
50	75
75	50
100	25
0 (outside model)	0





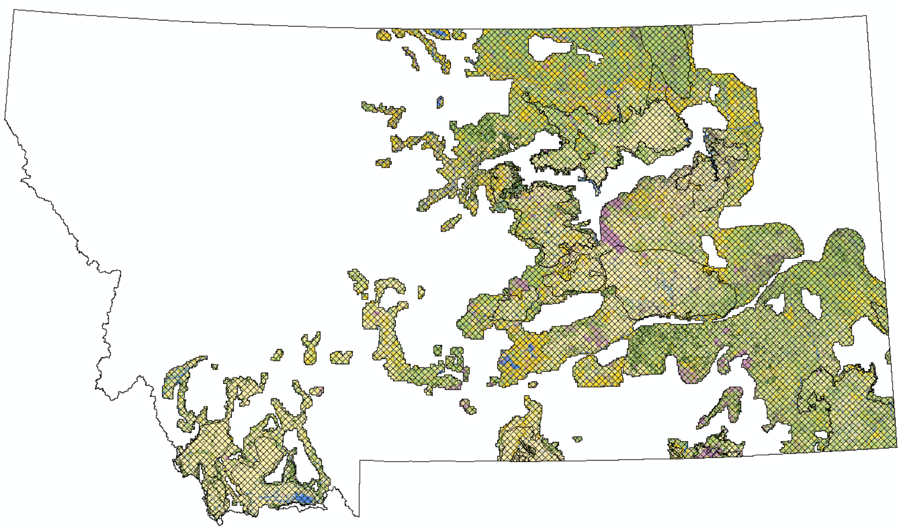


Distance to Suitable Upland Habitat

- The mosaic of upland and mesic habitat is important to support populations of GRSG (Connelly et al. 2000, Schreiber et al. 2015)
- Upland is defined as high or hilly habitat having unique plant species not generally found in mesic habitats.
- early and late summer brood-rearing habitats that are specific to mesic (riparian) landscapes
- Mesic (riparian) habitats within 50.0-m and 100.0-m of upland habitat receive higher variable scores.

See HQT Technical Manual section *3.2.2 Population and Habitat Variables Used to Create the Montana HQT Basemap* pg. 34-38 and *Appendix A: Population and Habitat Variables* pg. 84-101 for discussion of this and other habitat score variables.

Distance to Suitable Upland Habitat

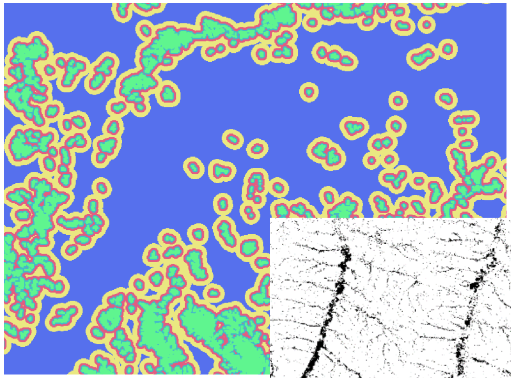


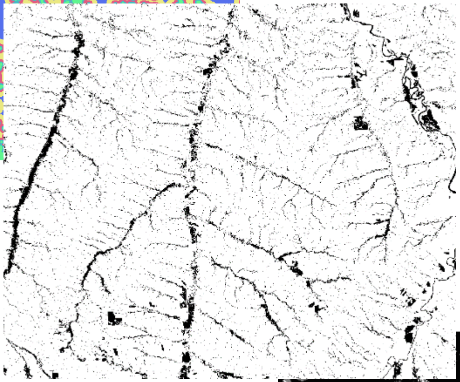
- Three habitat inputs
  - Montana Natural Heritage Program Landcover
  - Montana Natural Heritage Program Wetland/Riparian Areas
  - USFWS National Wetlands Inventory

- Select all sagebrush habitats

Distance to Suitable Upland Habitat

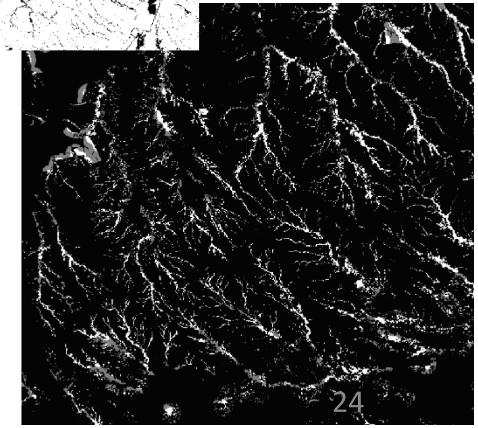
- Calculate distance to sagebrush habitats and assign habitat scores
- Only include wetland/riparian habitats



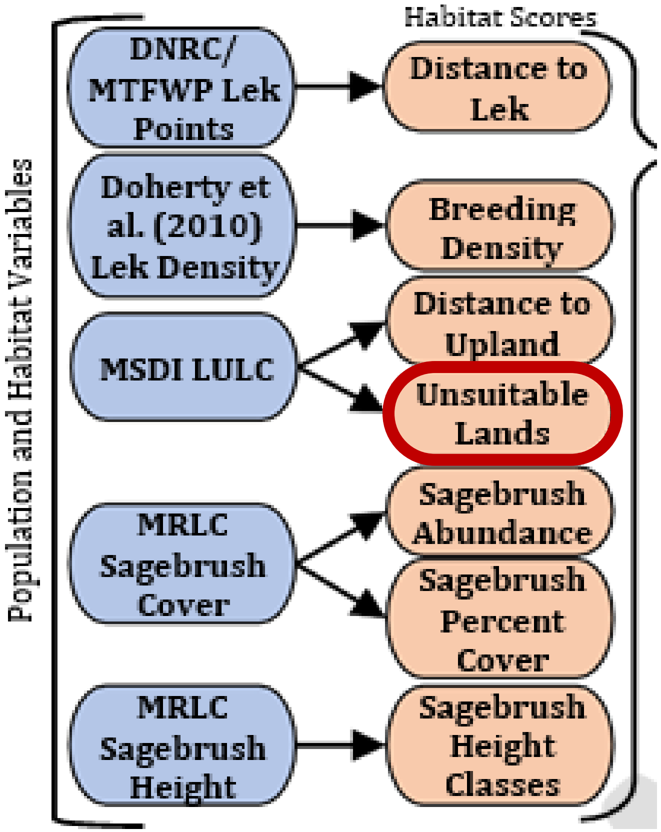


Wetland /riparian habitats

Distance to Suitable Upland Habitat (m)	Habitat Score
0 – 50	100
>50 – 100	75
>100 – 200	50
>200 – 400	25
>400	0



Distance to Suitable Upland Habitat



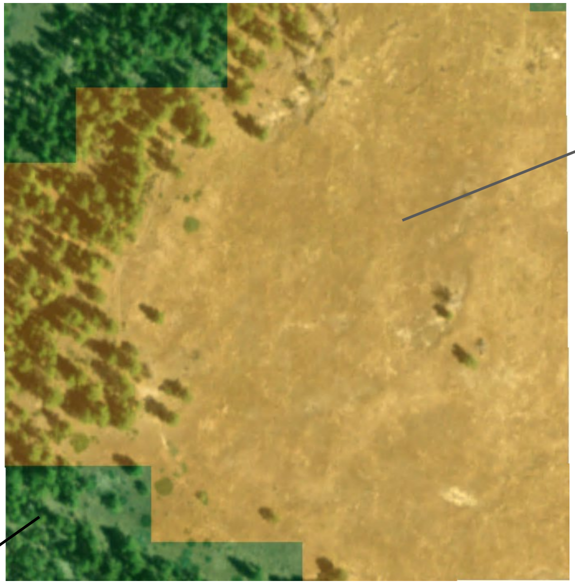
Unsuitable Habitat

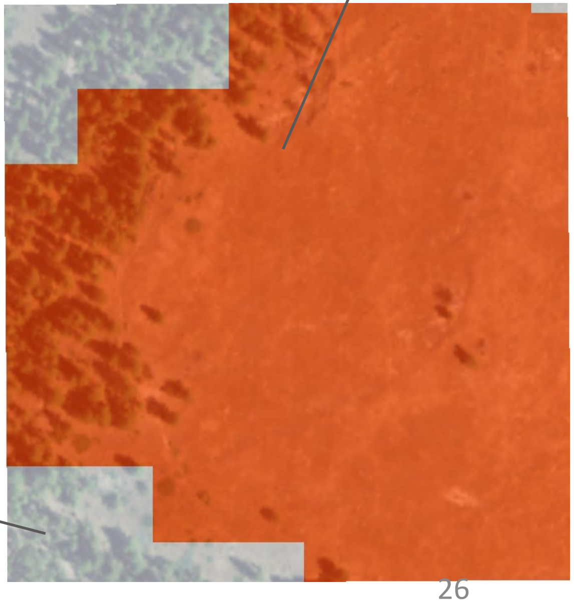
- The EO defines unsuitable habitat as "land within the historic range of sage grouse that did not, does not, or will not provide sage grouse habitat due to natural ecological conditions such as badlands or canyons"
- For the purposes of the HQT, excluded unsuitable lands would also include land cover classes that do not provide basic life requisites for GRSG,
  - urban areas,
  - existing disturbance footprints,
  - recent burns) or
  - areas of high elevation or forested habitats not suitable for sage grouse.

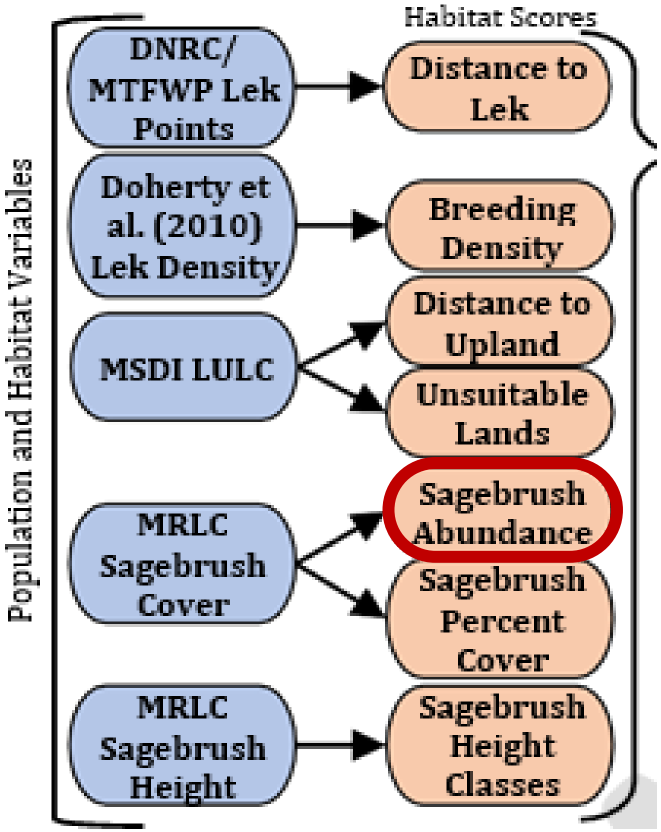
See HQT Technical Manual section *3.2.2 Population and Habitat Variables Used to Create the Montana HQT Basemap* pg. 34-38 and *Appendix A: Population and Habitat Variables* pg. 84-101 for discussion of this and other habitat score variables.

Unsuitable Habitat

- Assign a score of zero to all unsuitable habitat types







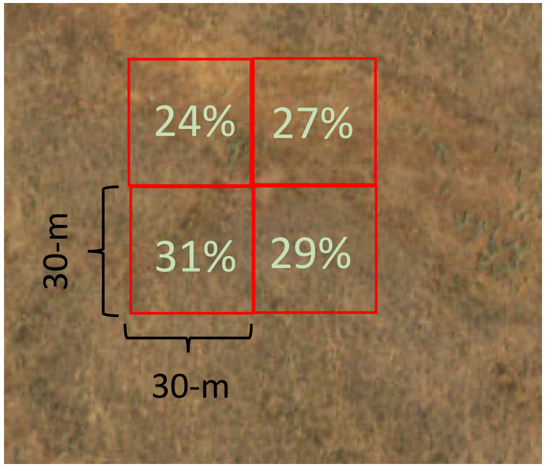
Sagebrush Abundance

- Sagebrush abundance is a strong predictor of lek persistence in Montana (Walker et al(2007)
- Average values from Doherty (2008), Walker et al. (2007) and Aldridge and Boyce (2007), were calculated and standardized to a range of values between 0 and 100.
- Sagebrush abundance of 80 to 100% = Score of 100
- 40% to 80% = Score between 75 and 90
- 20% to 40% = Score between 50 and 60
- Silver Sagebrush

See HQT Technical Manual section *3.2.2 Population and Habitat Variables Used to Create the Montana HQT Basemap* pg. 34-38 and *Appendix A: Population and Habitat Variables* pg. 84-101 for discussion of this and other habitat score variables.

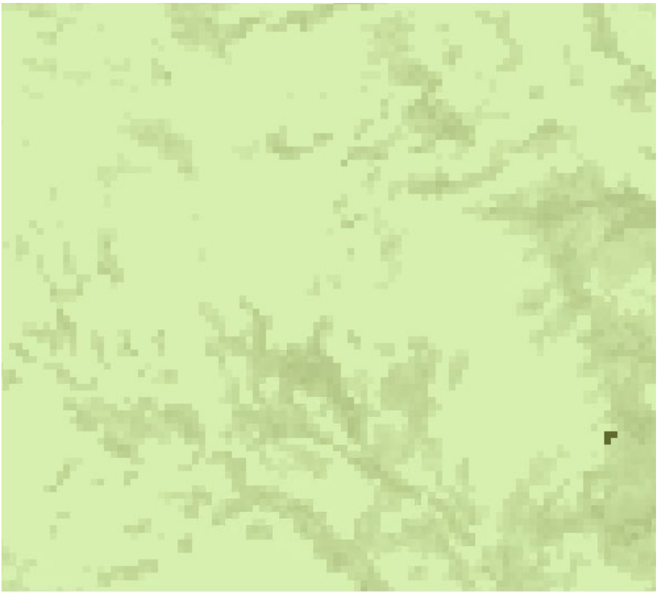
Sagebrush Abundance

- Multi-Resolution Land Characteritix (MRLC)
- Sagebrush Rangeland Cover
  - Produced by USGS & BLM
  - Western US:
    - Percent sagebrush cover for each 30-m pixel
    - Based on satellite imagery and field-verification



Sagebrush Abundance

- Determine areas with:
  - > 2% sagebrush cover = 1
  - <= 2% sagebrush cover = 0



Sagebrush Abundance

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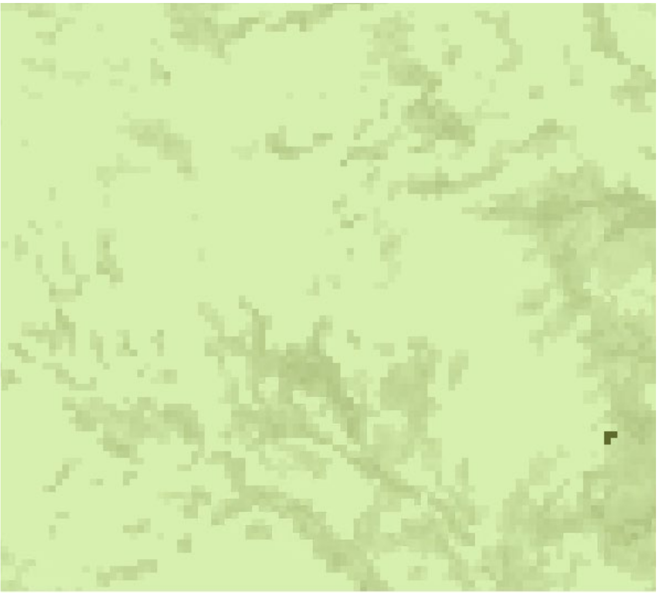
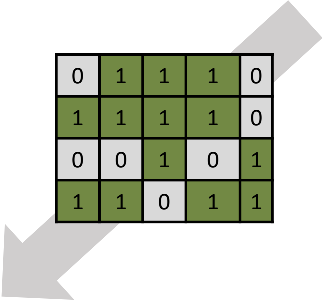
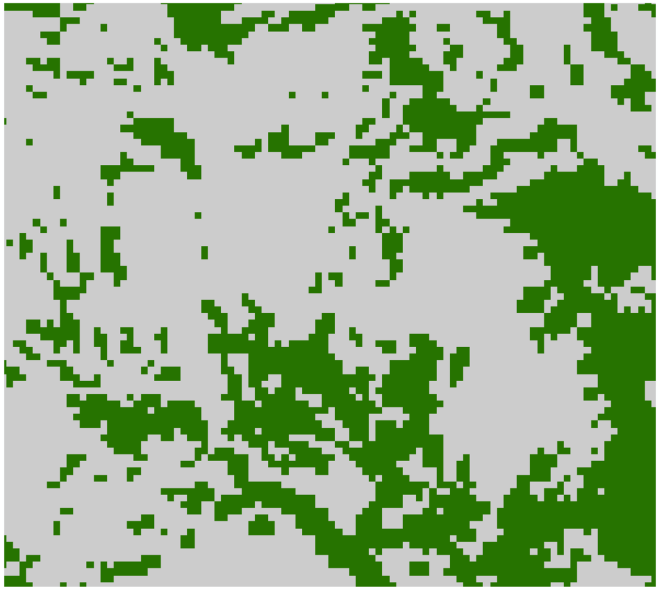
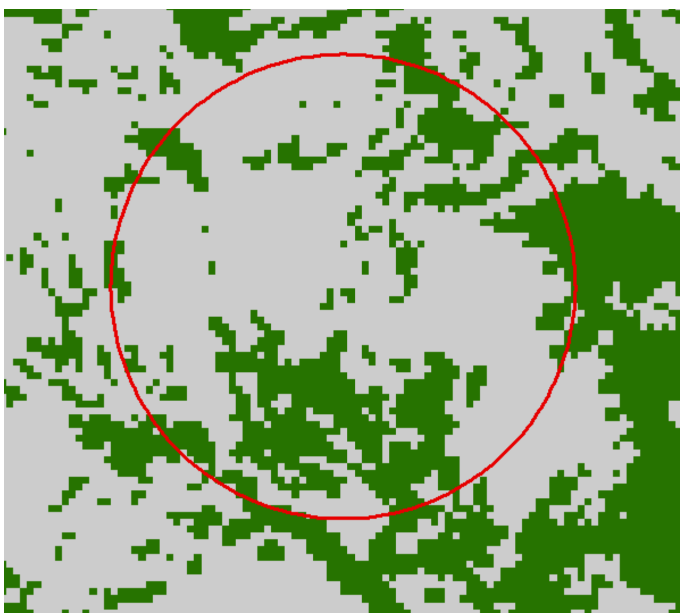


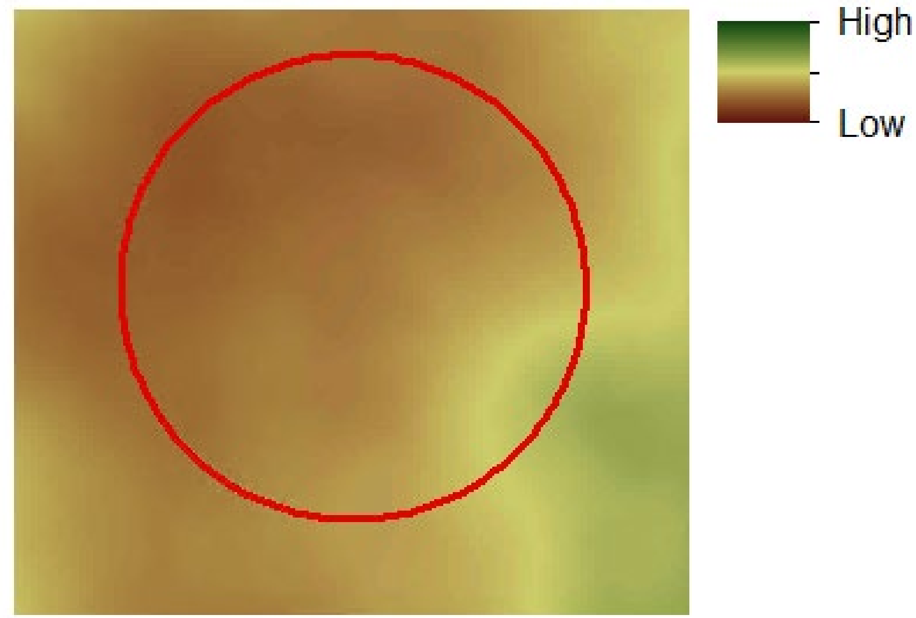




Sagebrush Abundance

- Calculate percent of sagebrush habitat within a 1-km radius circle



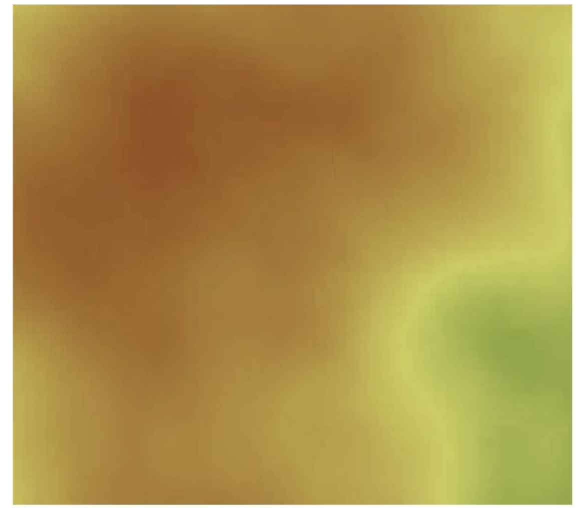


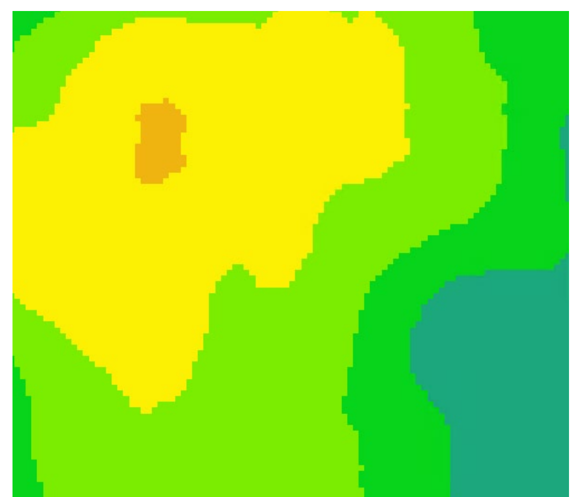
Sagebrush Abundance

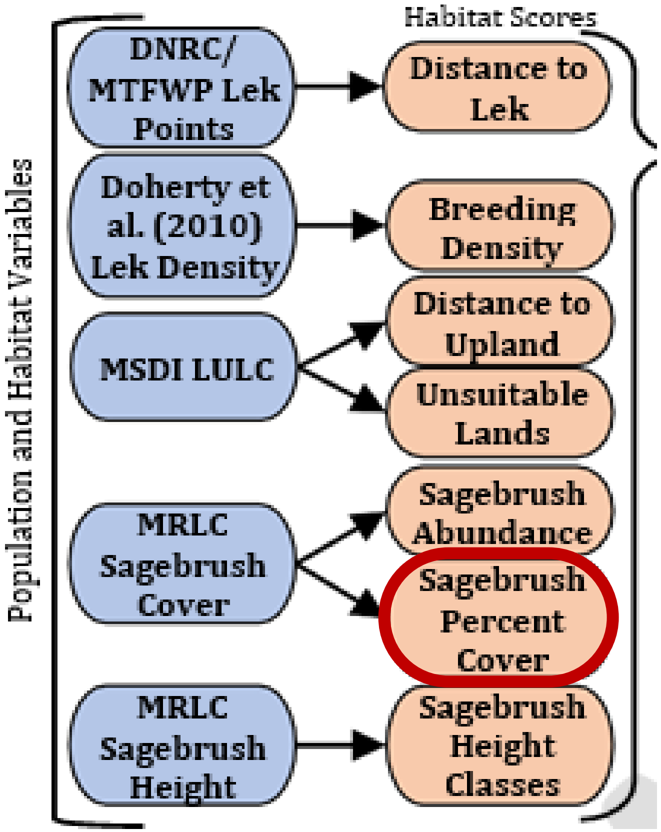
Reclassify the Percent of Sagebrush Cover to get final Sagebrush Abundance

Table A.5 (MT HQT Manual, page 92)

Sagebrush Abundance (%)	Habitat Score
0 - 2	0
>2 - 10	15
>10 - 20	30
>20 - 30	50
>30 - 40	60
>40 - 50	75
>50 - 70	80
>70 - 80	90
>80 - 100	100







Sagebrush Canopy Cover

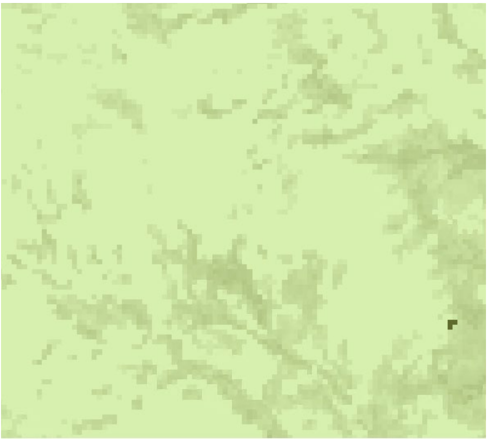
- Across all seasons, the highest reported GRSG use in Montana occurred in habitats having 15-25% cover with the lowest use occurring in areas with sparse or extremely low sagebrush canopy cover.
- Sagebrush cover is also an important attribute of brood-rearing habitat
- Sagebrush is an essential component of winter habitat because GRSG winter diets are almost exclusively sagebrush leaves.
- Seasonal canopy cover values were standardized to a range of values between 0 and 100 for habitat variable scoring purposes.
- Sagebrush percent canopy cover of 15% to 30% was assumed to provide the highest function and was assigned a score of 100

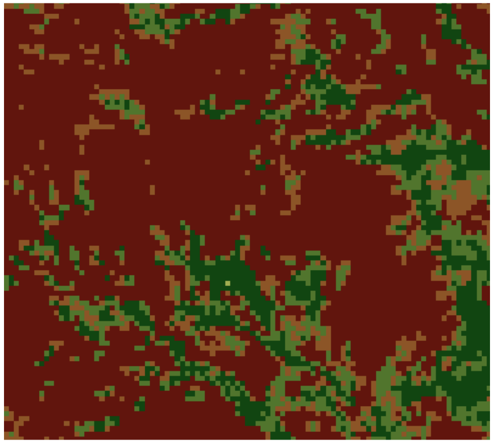
Sagebrush Canopy Cover

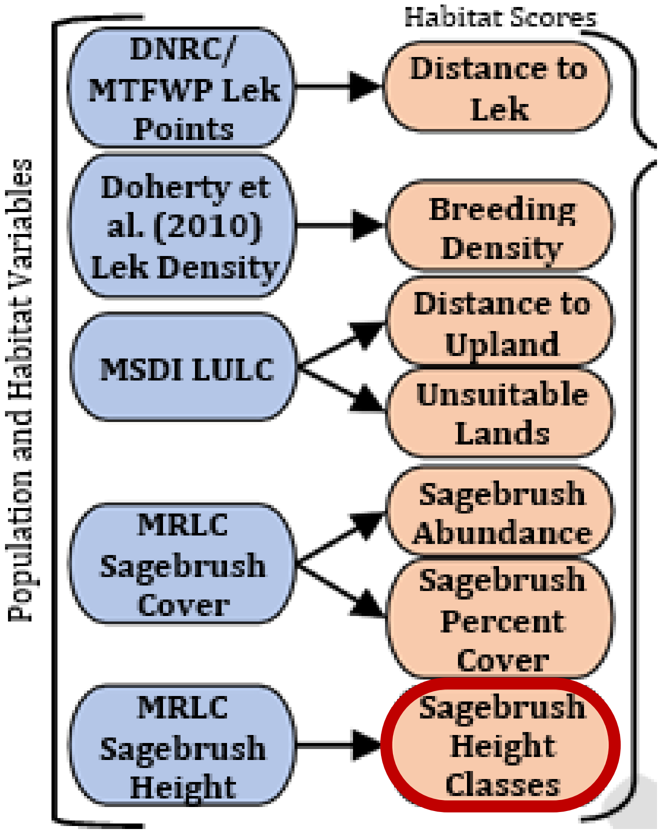
1. Sagebrush Rangeland Canopy Cover clipped to Montana Sage Grouse Habitat (from Sagebrush Abundance steps)
2. Assign Habitat Scores to get final Sagebrush Canopy Cover

Table A.7 (MT HQT Manual, page 95)

Sagebrush Cover (%)	Habitat Score
0 - <3	0
3 - <10	40
10 - <15	90
15 - <30	100
30 - <40	70
40 - <45	50
45 - <55	40
55 - <60	30
60 - <70	20
≥70	10







Sagebrush Height

- Sagebrush canopy height is an important aspect of all sage grouse seasonal habitats
- literature recommendations for sagebrush height for sage grouse habitat varies seasonally and regionally
- Montana-specific data and literature were used to evaluate height requirements during the nesting season.
- In Montana, sage grouse nesting was commonly reported in habitats having sagebrush heights between 15.0-cm and 50.0-cm (Eng and Schladweiler 1972, Lane 2005, Wisinski 2007, Woodward et al. 2011, Foster et al. 2014).
- Sagebrush height for winter use in Montana differs from range wide sagebrush communities due to differences in snowfall depths and winter conditions.

See HQT Technical Manual section *3.2.2 Population and Habitat Variables Used to Create the Montana HQT Basemap* pg. 34-38 and *Appendix A: Population and Habitat Variables* pg. 84-101 for discussion of this and other habitat score variables.

Sagebrush Height

1. Clip Sagebrush Rangeland Height to Montana Sage-Grouse Habitat
   - Similar to Sagebrush Cover, produced by USGS/BLM
   - Average sagebrush height (cm) in a 30-m pixel
2. Assign Habitat Scores to get final Sagebrush Canopy Height

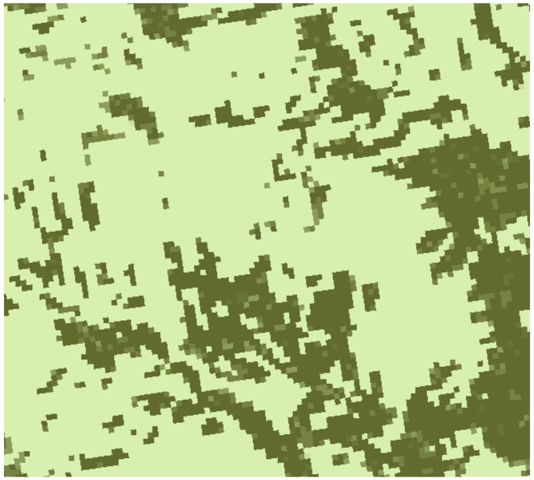
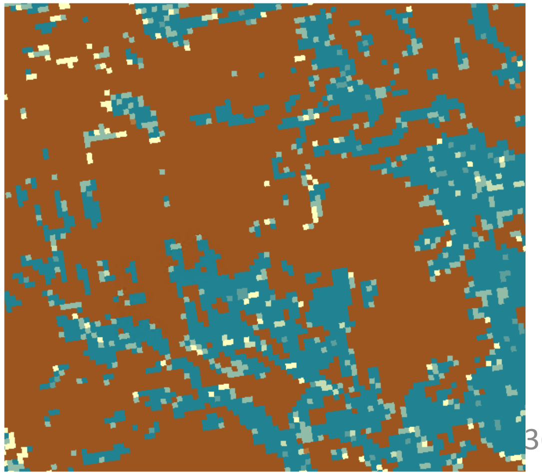


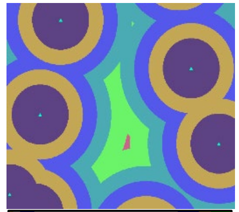
Table A.9 (MT HQT Manual, page 98)

Sagebrush Canopy Height (cm)	Habitat Score
0 - 10	0
>10 - 15	10
>15 - 20	60
>20 - 25	80
>25 - 45	100
>45 - 50	90
>50 - 60	70
>60 - 70	60
>70 - 85	30
>85	20

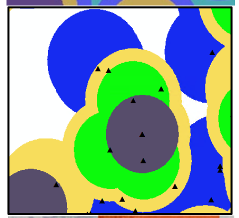
Highest values at moderate sagebrush heights. Balances sage grouse use of different habitats across seasons.



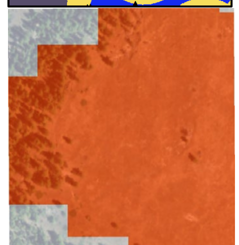
Distance to Lek



Breeding

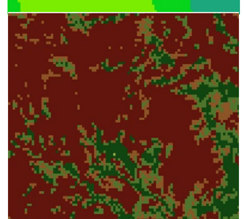


Distance to Suitable Upland

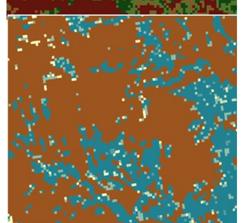


Sagebrush Abundance

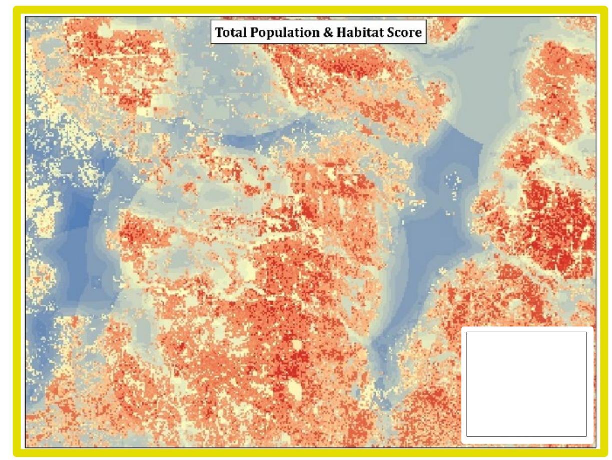
Sagebrush Percent Cover



Sagebrush Height Classes



Final Habitat Score



Montana HQT Basemap Flowchart

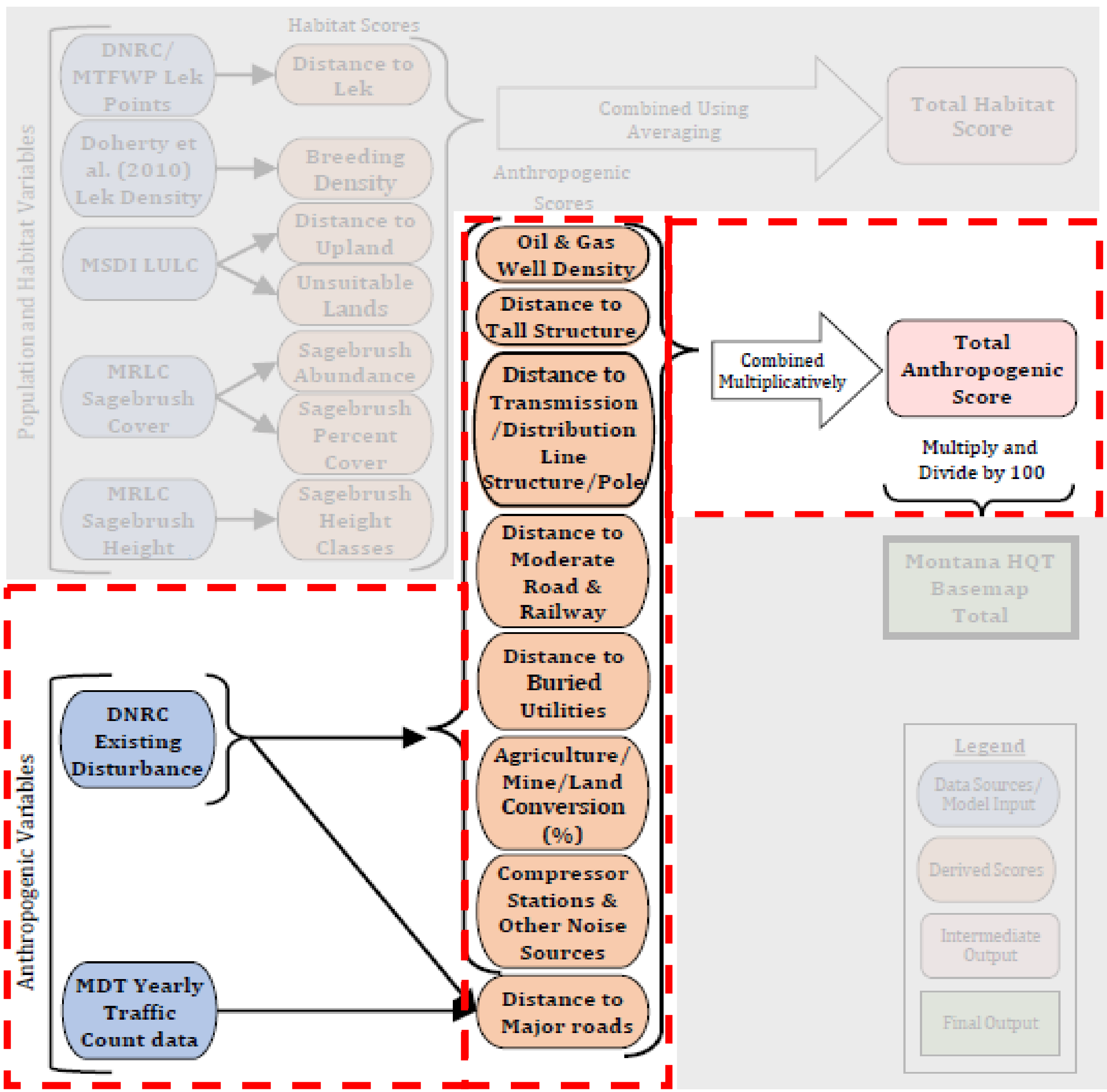
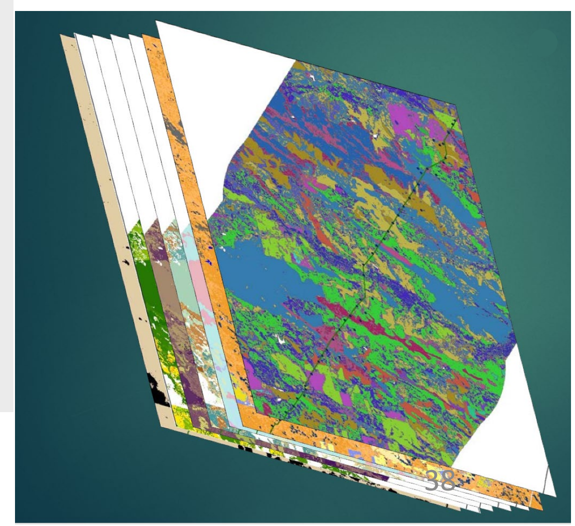
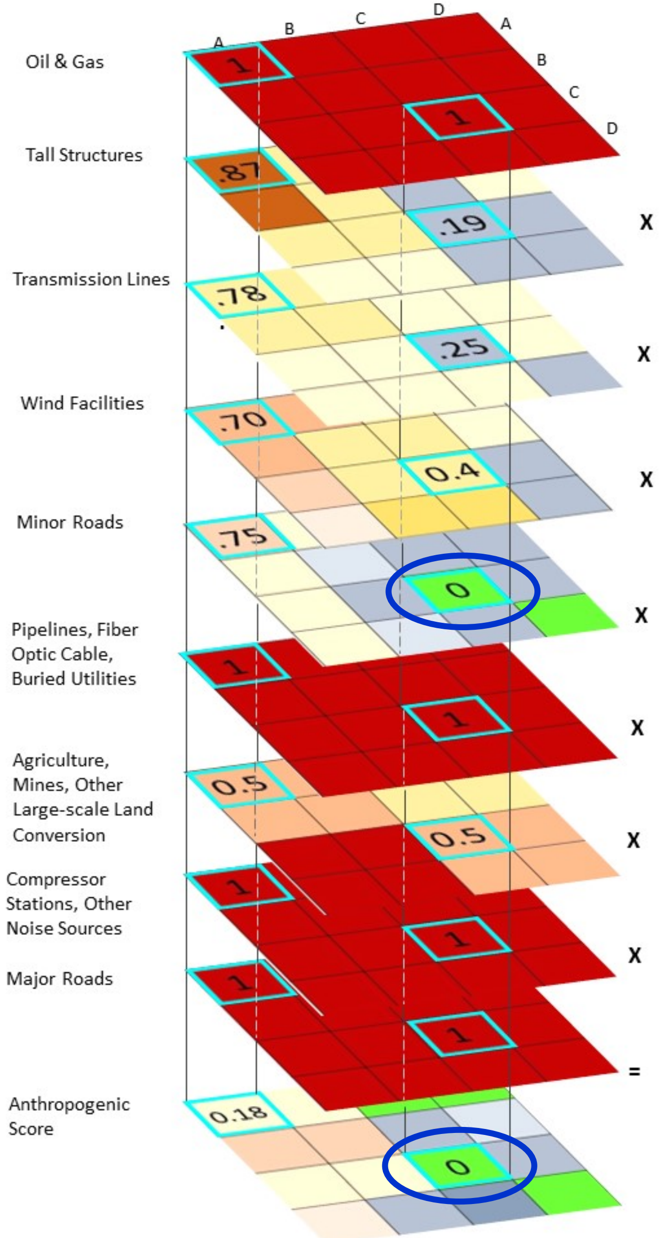


Figure 3. 4. The flowchart for the development of the Montana HQT Basemap.

How the Anthropogenic Score is Calculated



Anthropogenic Score (Existing Development)



Anthropogenic Score (cell 3,0) = 1 x 0.87 x 0.78 x 0.70 x 0.75 x 1 x 0.5 x 1 x 1 = 0.18

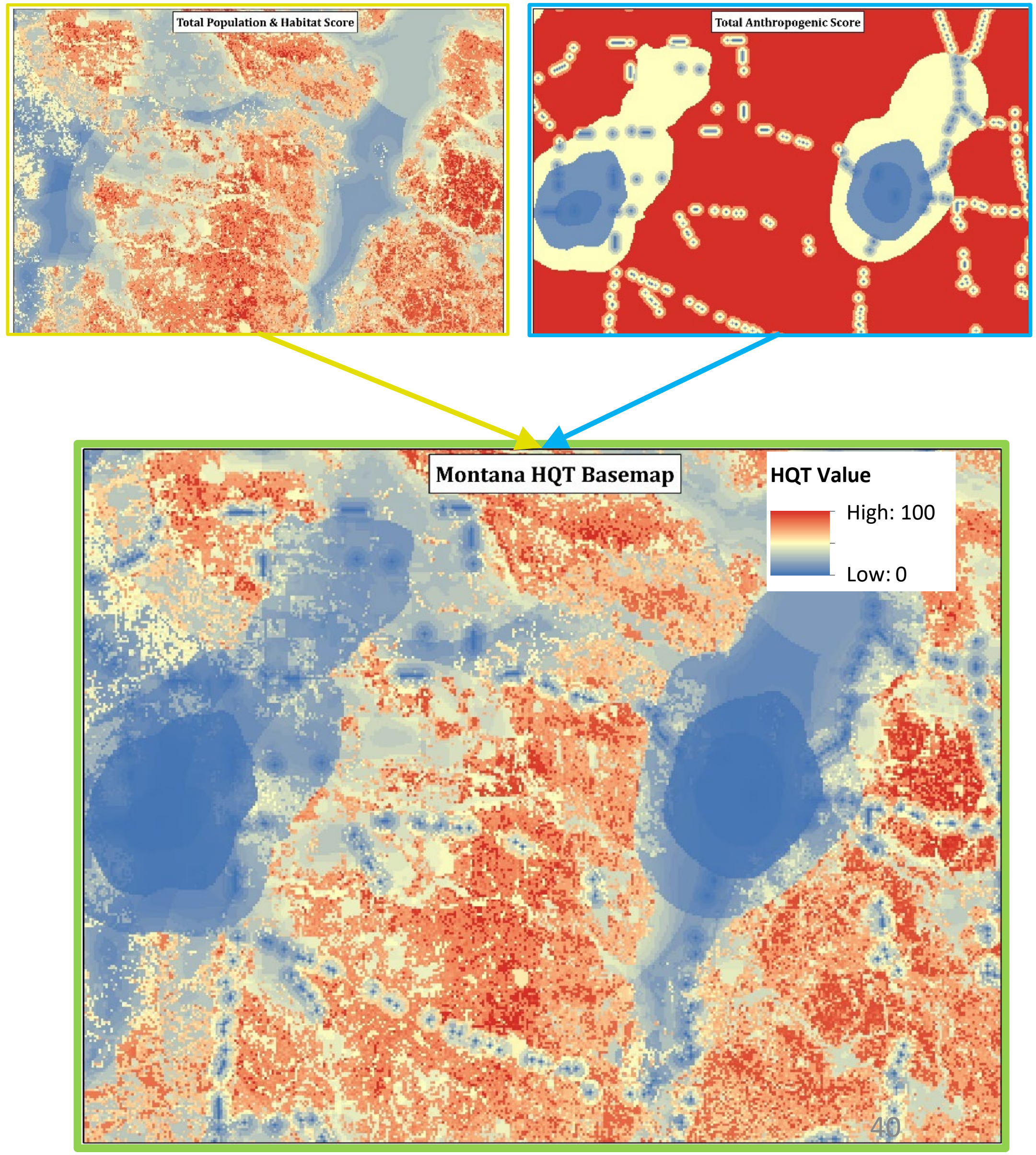
Anthropogenic Score (cell 1,2) = 1 x 0.19 x 0.25 x 0.4 x 0 x 1 x 0.5 x 1 x 1 = 0

- Assign values to individual cells for each variable
- Stack up the individual layers
- Multiply across the individual layers to determine final anthropogenic score for each cell
- If existing disturbance exists in any layer it will be reflected in the final existing disturbance layer:

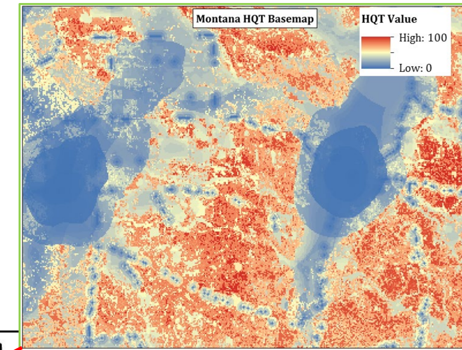
Anthropogenic Score = 0 x 0.19 x 0.25 x 0.5 x 0.05 x 0.70 x 0 = 0

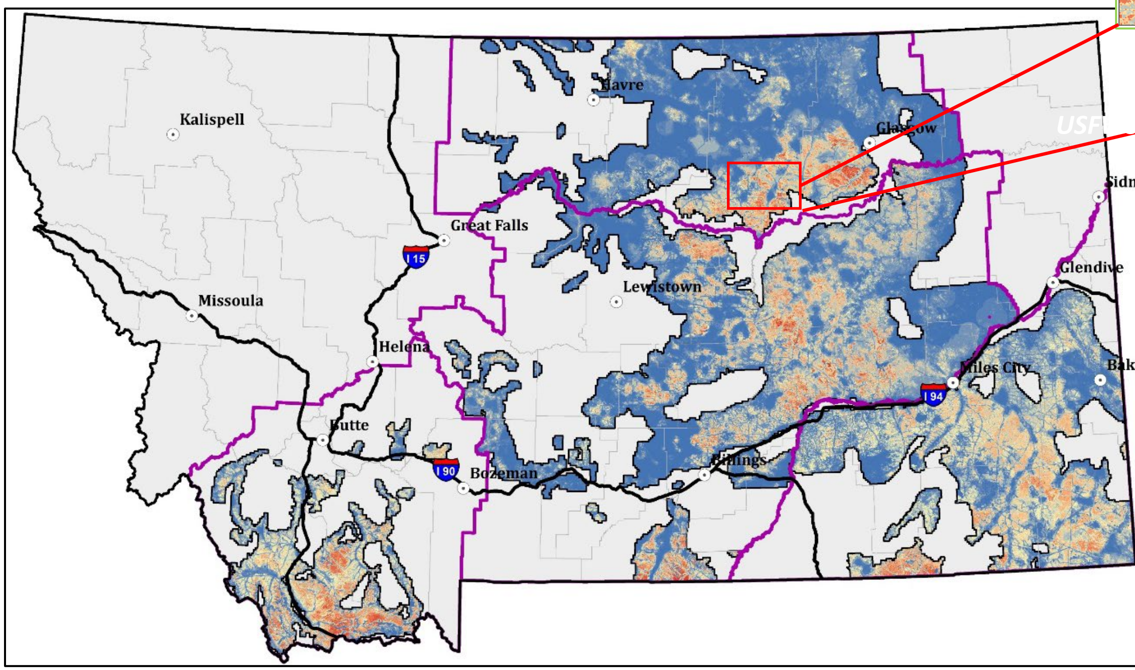
Final Basemap

- Combine the Habitat Score layer with the Anthropogenic Scores layer = Final Basemap

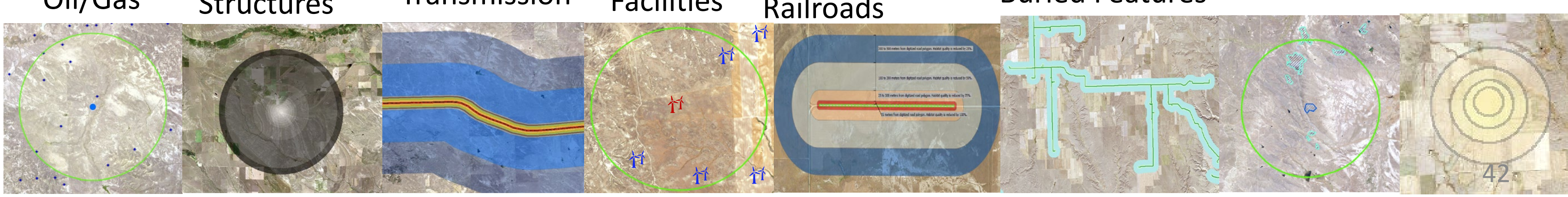


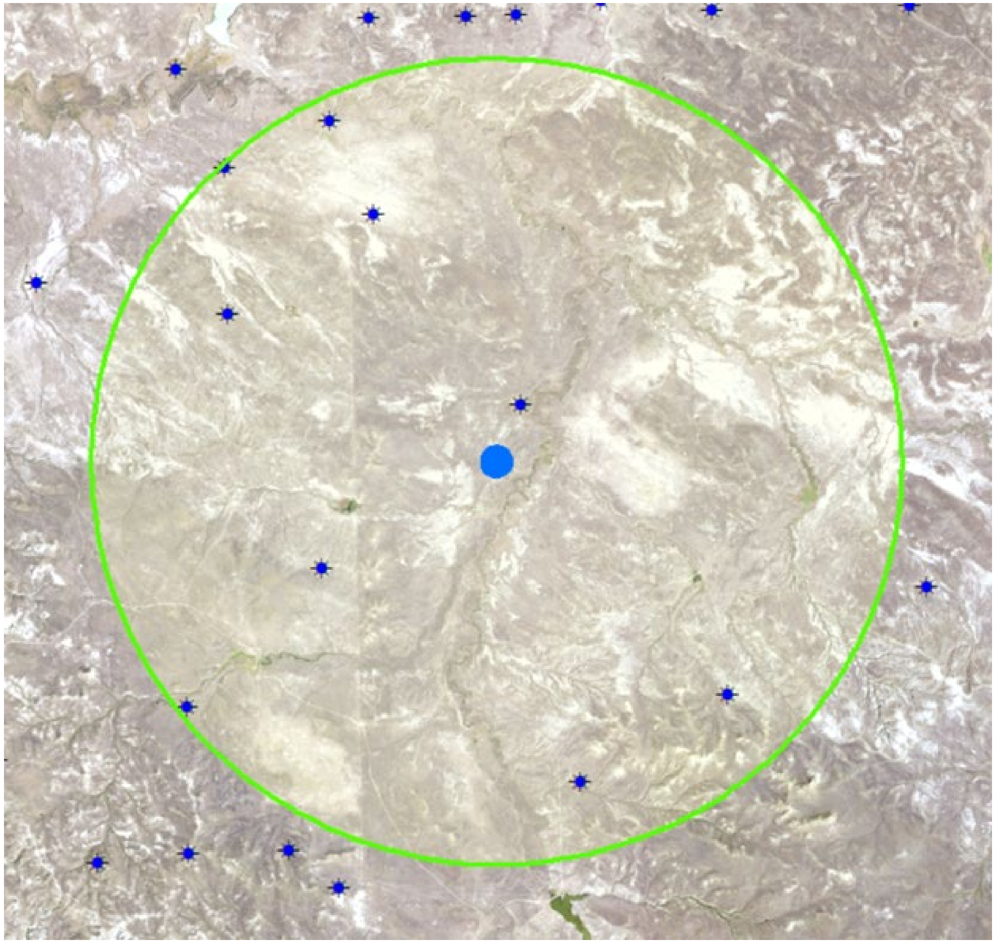
Evaluating Project Impacts for Different Disturbance Types





Oil/Gas | Tall Structures | Transmission | Wind Facilities | Major Roads & Railroads | Pipelines & Buried Features | Ag & Mines | Compressor Stations & Other Noise





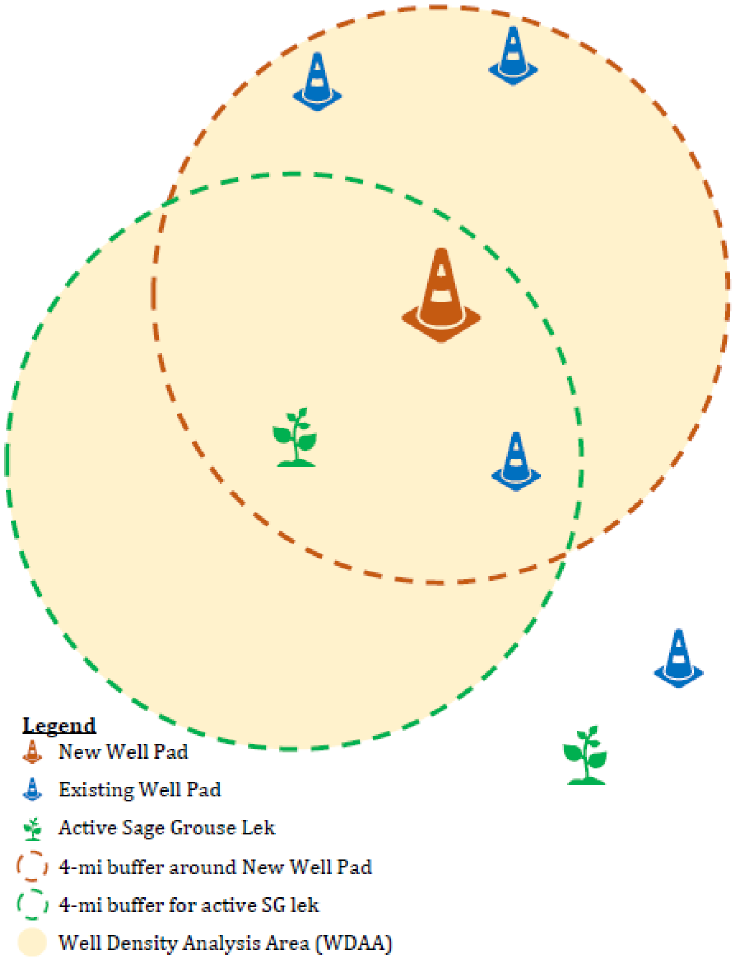
Oil and Gas

The HQT evaluates well pad density across a large landscapes using a count of well pads within 3.2-km (2-mile) radius

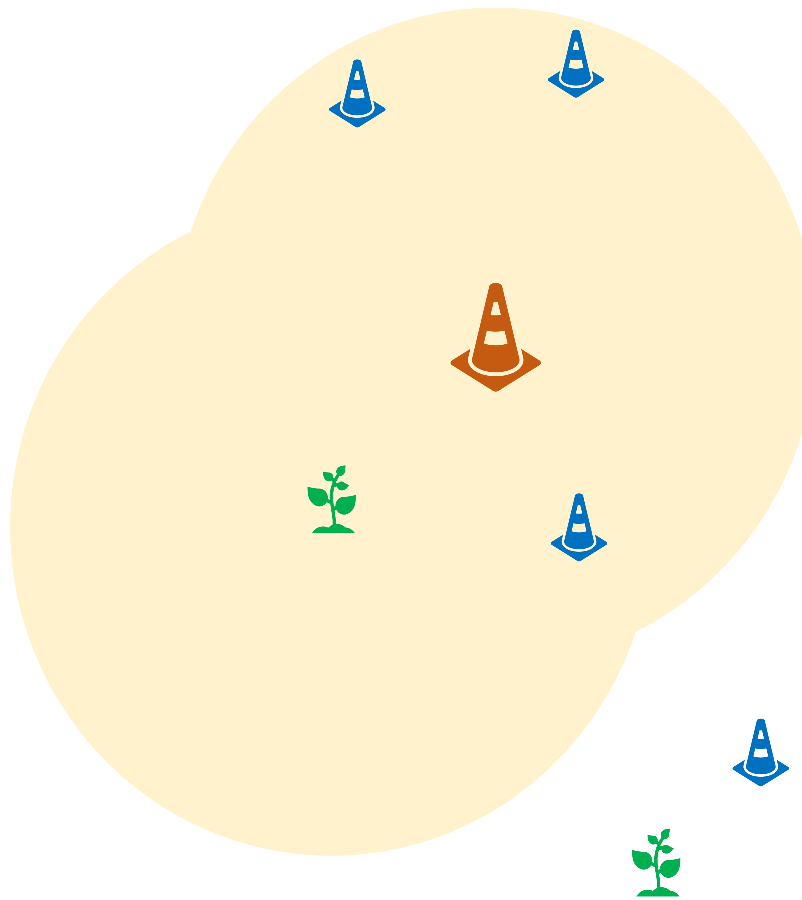
Number of wells	Anthropogenic Score	Doherty's findings
1-12	100	Potential impacts indiscernible at 1-12 wells within 3.2 km2 (< 1 well per 640 acres of land)
13-39	50	In MZ I, the rate of lek inactivity doubled at 13-39 wells.
40-100	20	In MZ 1, the rate of lek inactivity jumped to greater than 5 times that outside of widespread development.
> 101-199	0	Too few leks present in this category

Oil and Gas

$$Well\ Density = \frac{\#\ of\ wells\ in\ WDAA}{(WDAA\ Acres/640\ Acres)}$$



Well pad density is also evaluated in habitat surrounding a proposed well pad in Core Areas evaluating for exceedance of 1 pad/640 acres



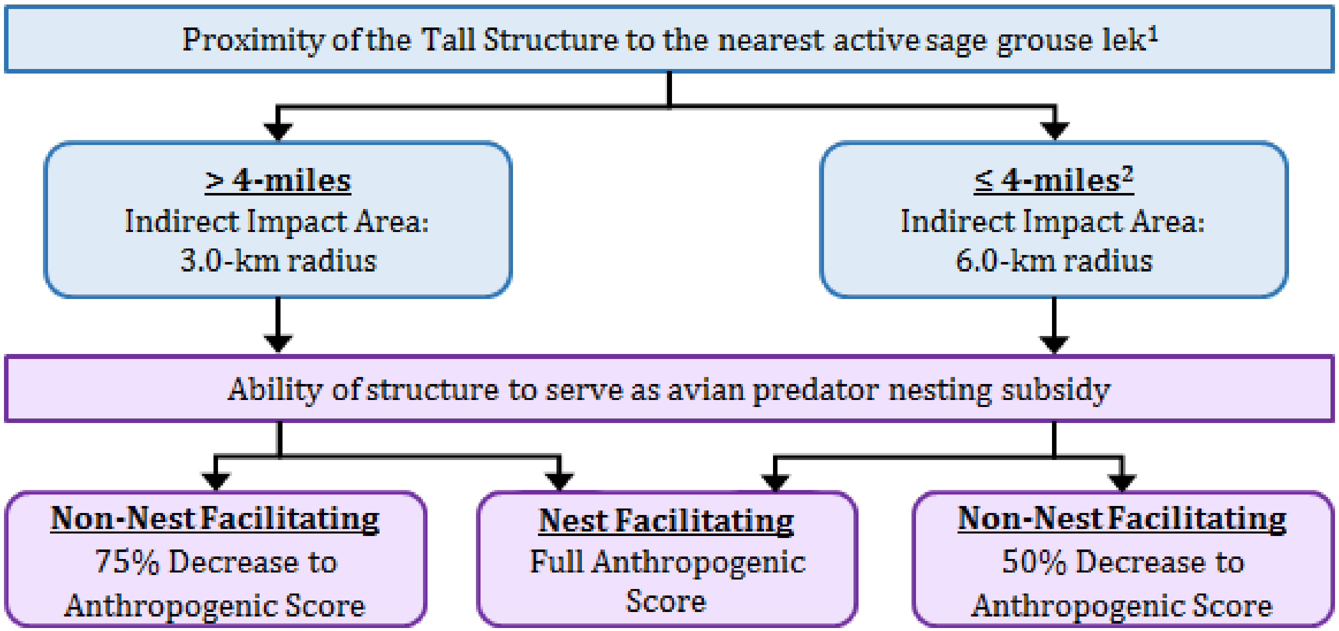
Tall Structures

Distance to Tall Structure (km)	Anthropogenic Score
0 – <0.3	19
0.3 – <0.6	29
0.6 – <0.8	39
0.8 – <1.1	49
1.1 – <1.4	58
1.4 – <1.7	68
1.7 – <2.0	78
2.0 – <2.3	87
2.3 – <3.0	93.5
≥ 3.0	100

- The Basemap uses a 6.0-km (3.7 mile) buffer to reduce the Habitat Score around Tall Structures located **within** 4 miles of an active lek.
- The HQT uses a 3.0-km (1.86 mile) buffer to reduce the Habitat Score around Tall Structures located **beyond** 4 miles of an active lek.

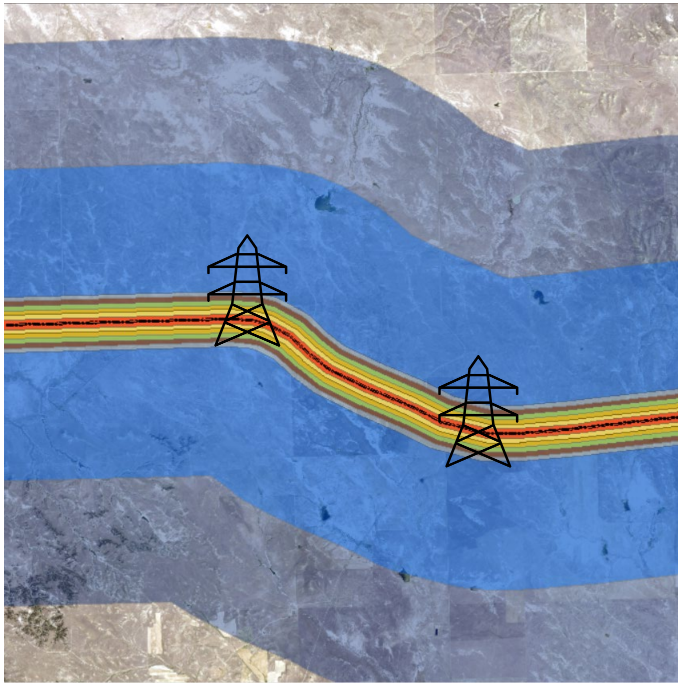
Tall Structures

Non-nest facilitating towers are given a 50% or 75% reduction for the Anthropogenic Score



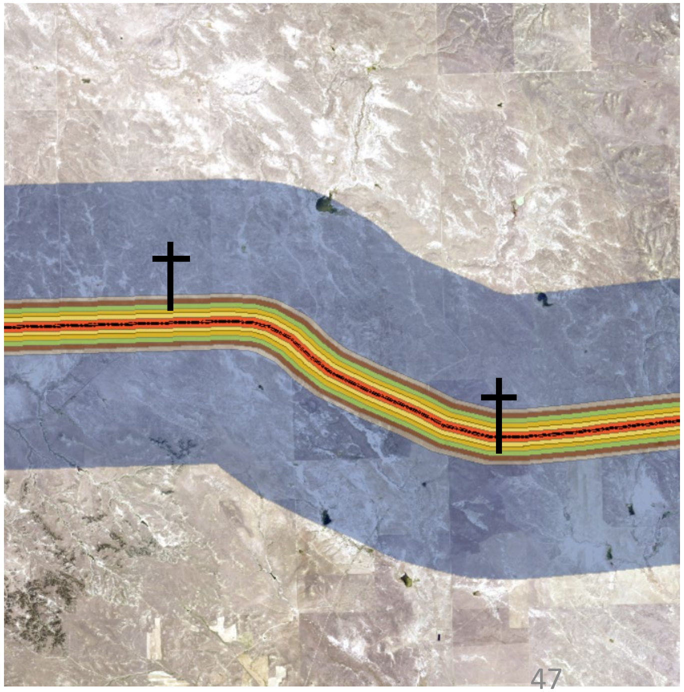
Transmission/Distribution Structures: Lines, Structures/Poles and Substations

The distances for assessment of the indirect impacts from Transmission/Distribution Structures is based on voltage size of the aboveground electrical line



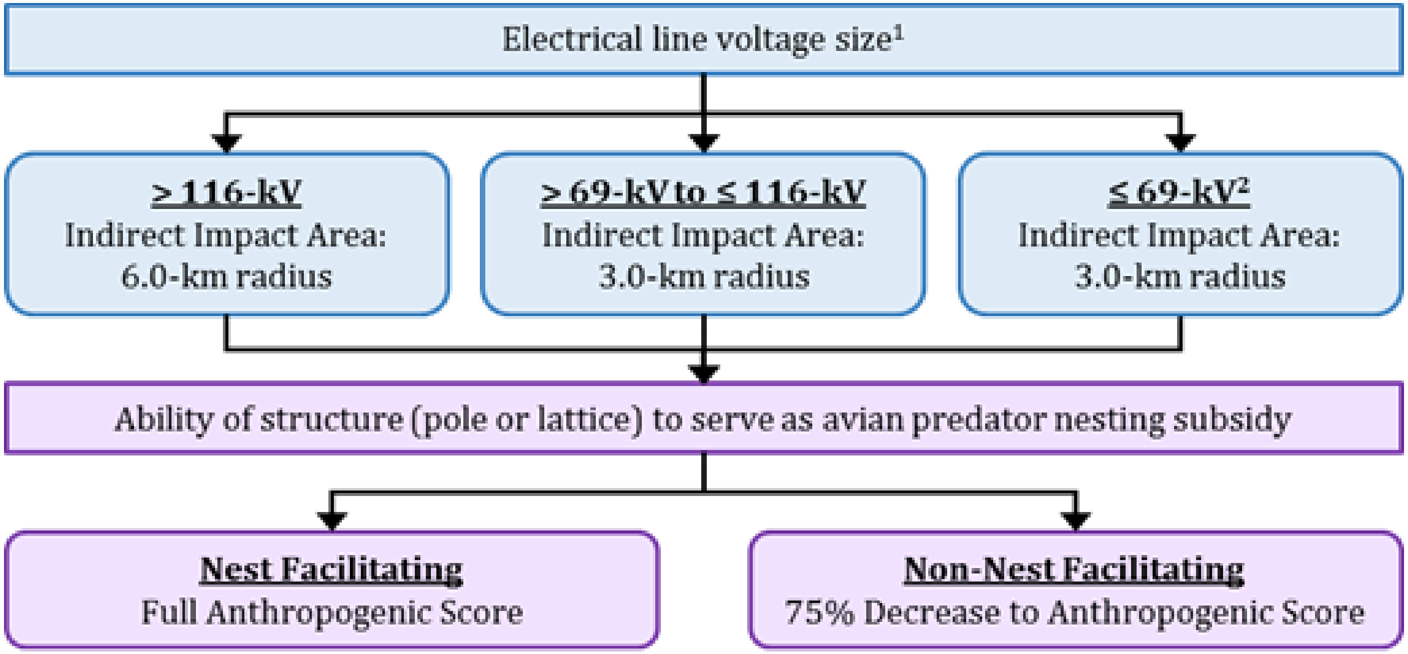
The HQT uses a 6.0-km (3.7 mile) buffer for lines >116kV lines to calculate Indirect impacts from Transmission or Distribution Structures

The HQT uses a 3.0-km (1.86 mile) buffer for lines < 116 kV to calculate Indirect impacts from Transmission or Distribution Structure

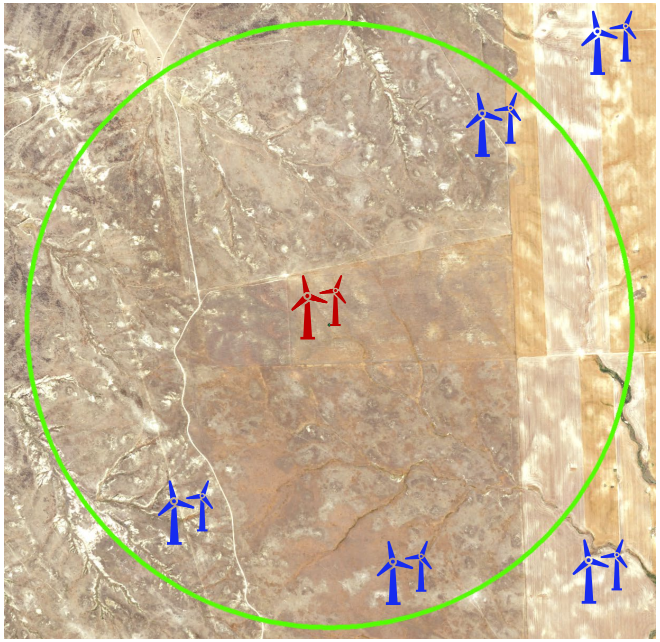


Transmission/Distribution Structures: Lines, Structures/Poles and Substations

- Non-nest facilitating structures are given a 75% reduction for the Anthropogenic Score

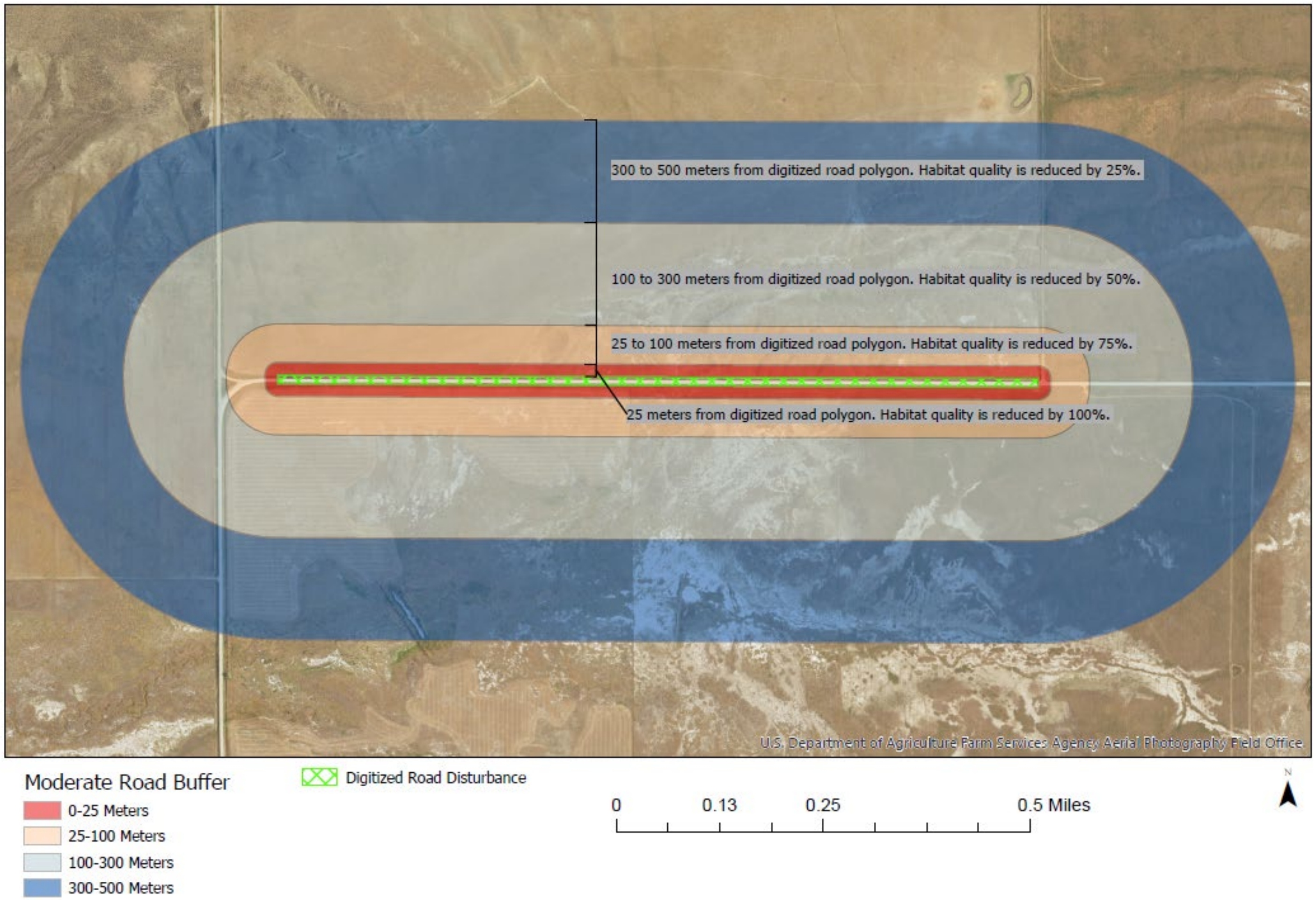


Wind Facilities

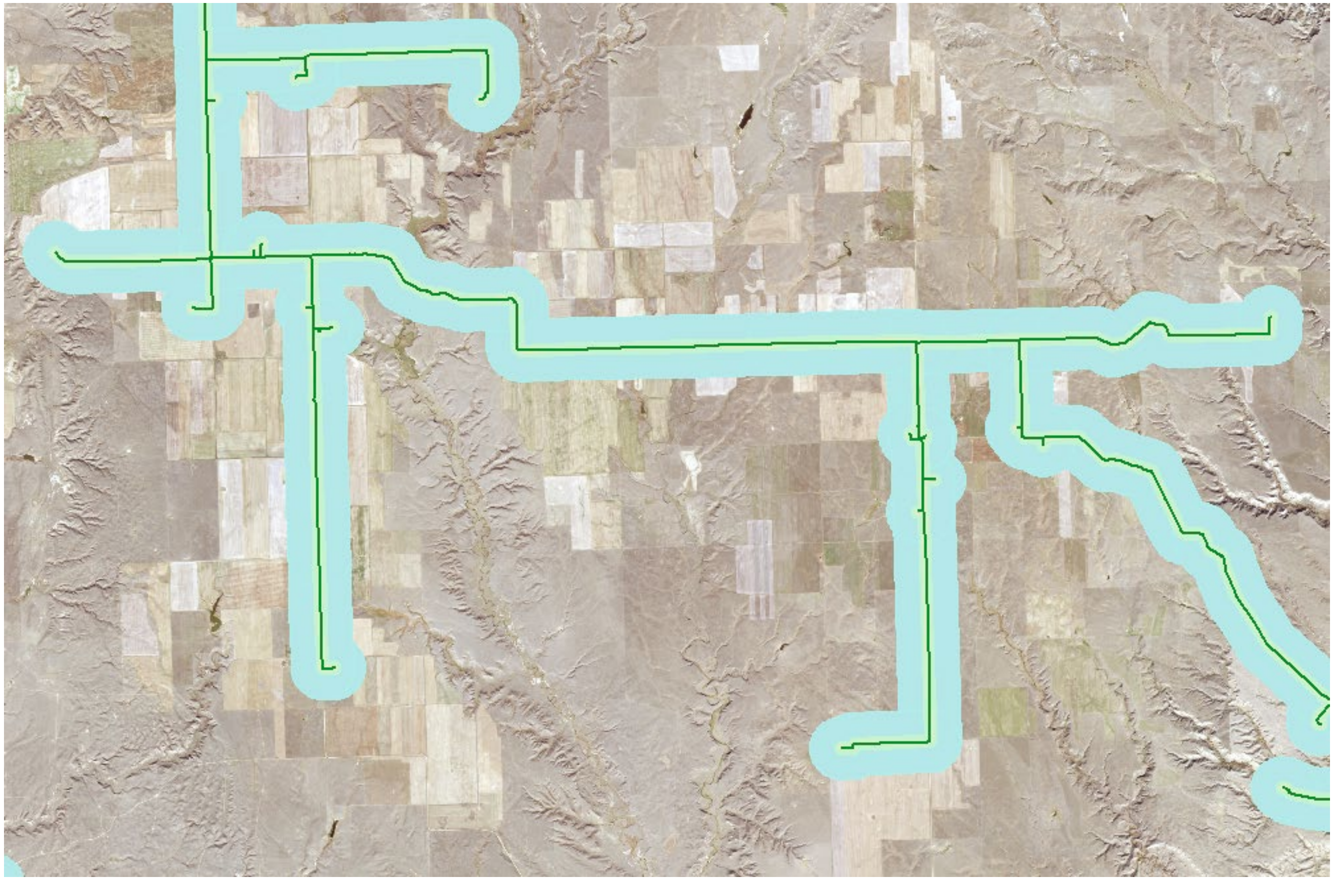


Percent Disturbance from Wind Energy Infrastructure within 1.5-km moving window (%)	Anthropogenic Score
0 – <0.5	100
0.5– <2	70
2 – <3	40
3 – <4	20
≥4	10

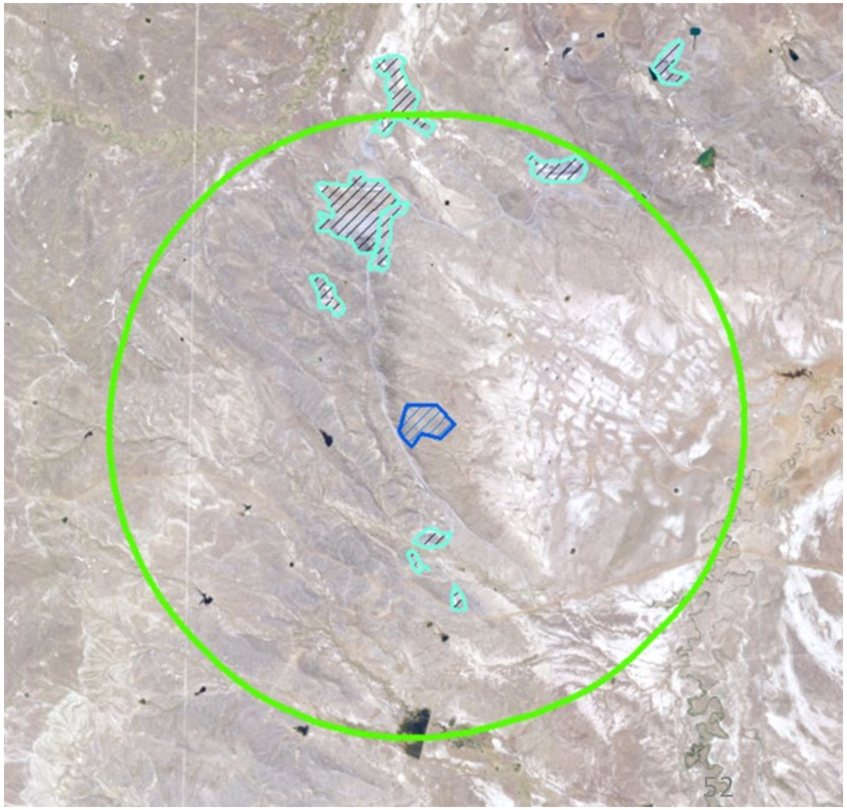
Roads, Railways, and Active Construction Sites



Pipelines, Fiber Optic Cable and Other Buried Features



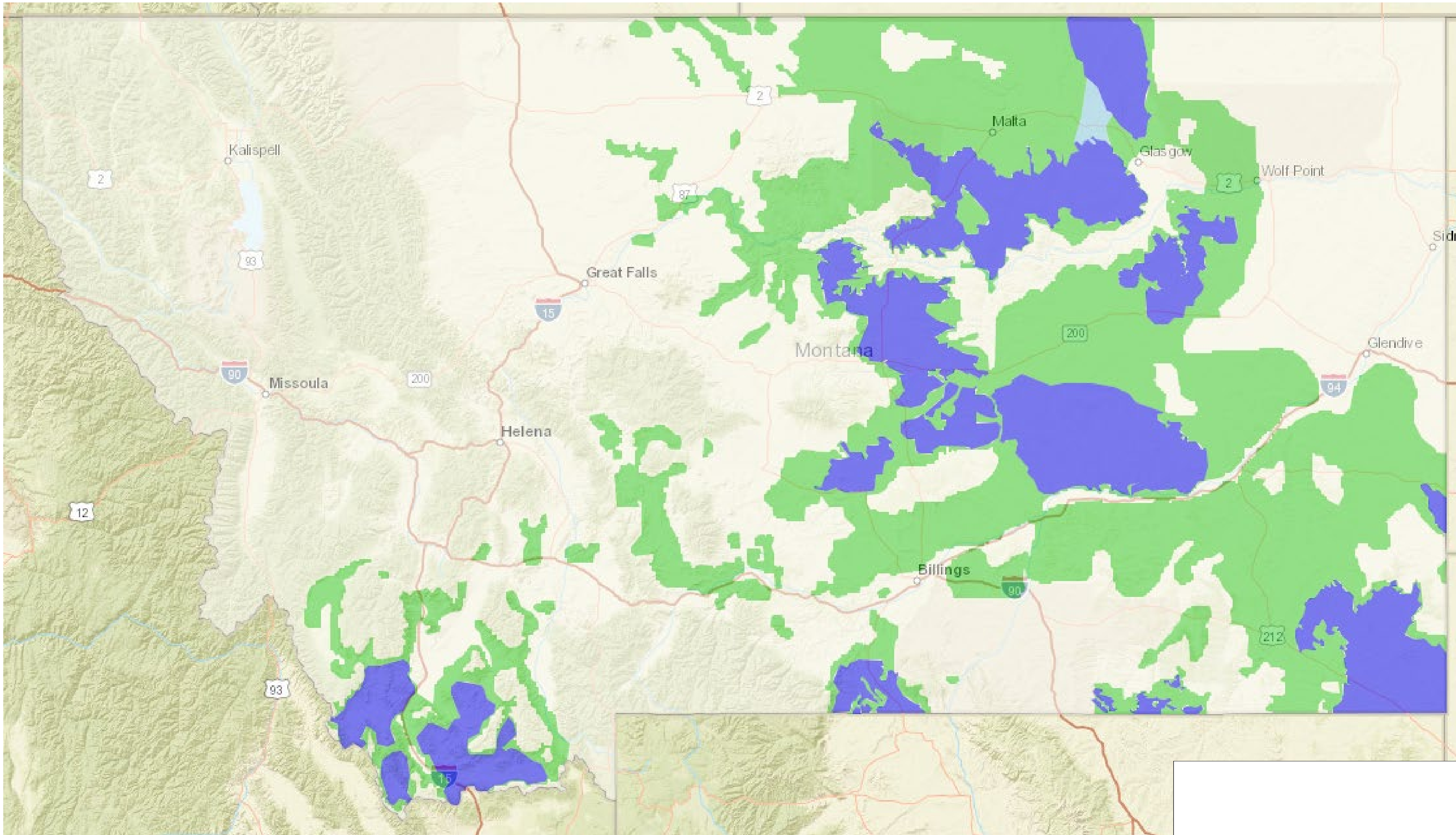
Agriculture, Mines and Other Large-scale Land Conversion Processes



Compressor Stations and Other Noise Producing Sources

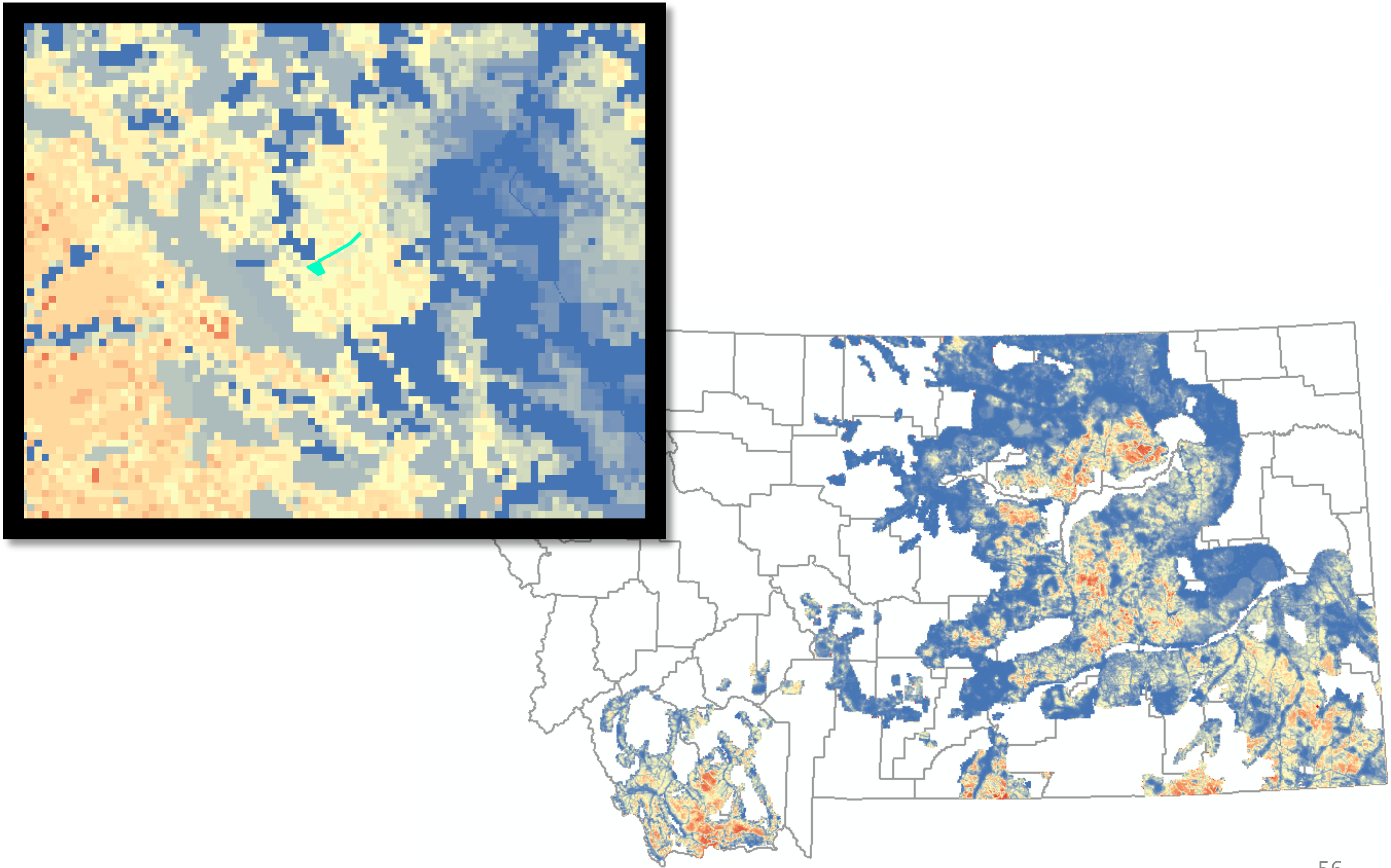
Distance (km)	Anthropogenic Score
0 – 0.05	0
>0.05 – 0.10	50
>0.10 – 0.40	70
>0.40	100

First Level – Is the Project located inside of Designated Habitat?

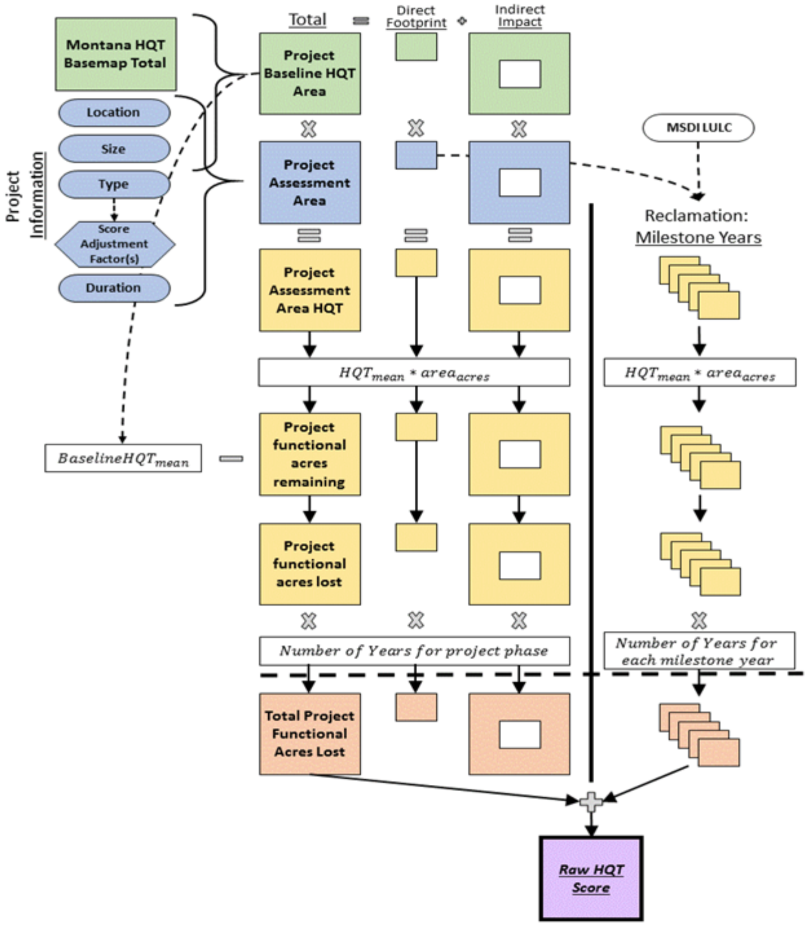


Project Footprint is placed on the Basemap.

- The underlaying habitat values determine the functional acres lost once the project is implemented



HQT Analysis Overview



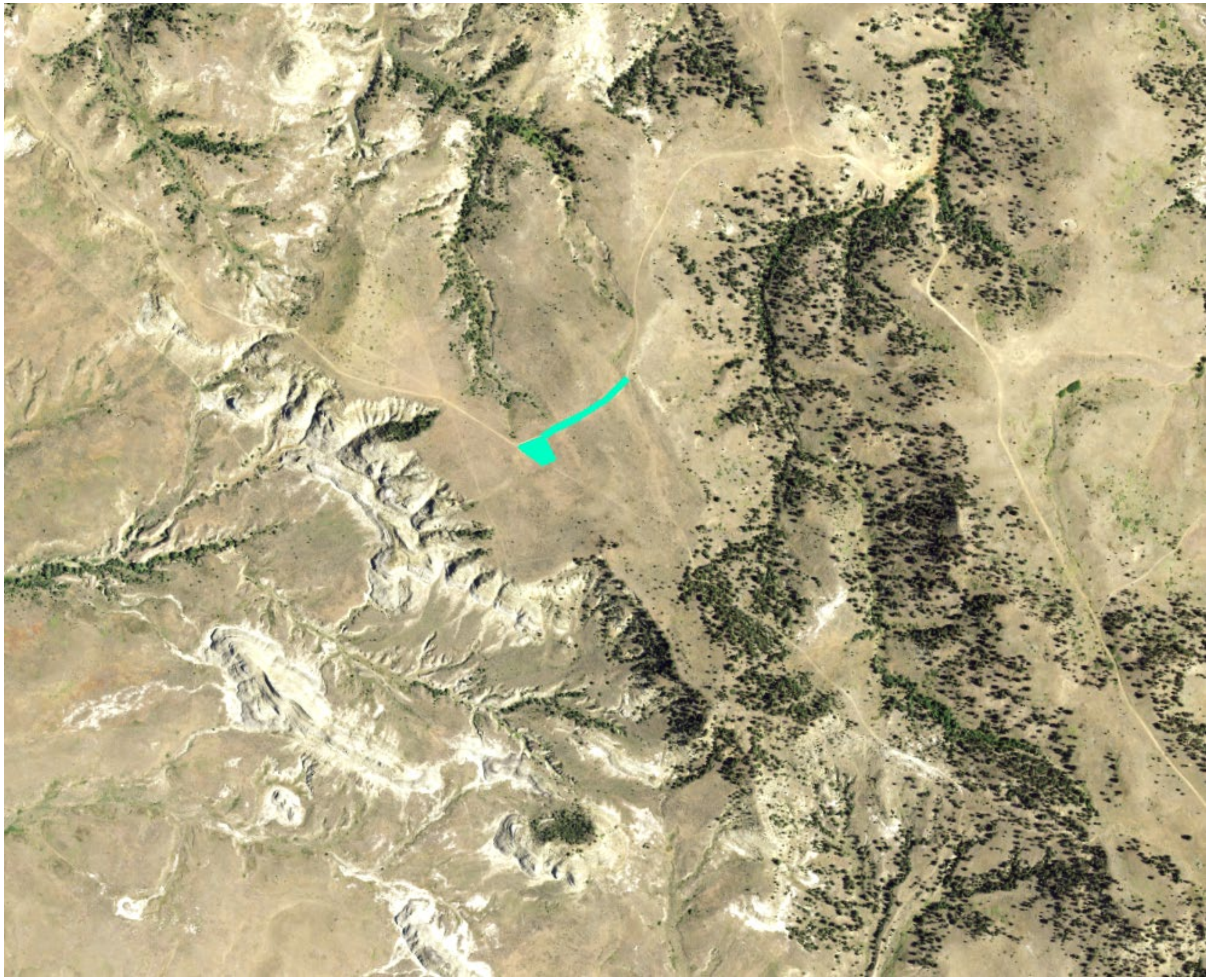
Project direct footprint placed on the Basemap to determine **Functional Acres** lost

Project **Disturbance Type** determines the buffer or density calculation for **indirect impacts**

Duration - length of time project footprint remains on the landscape

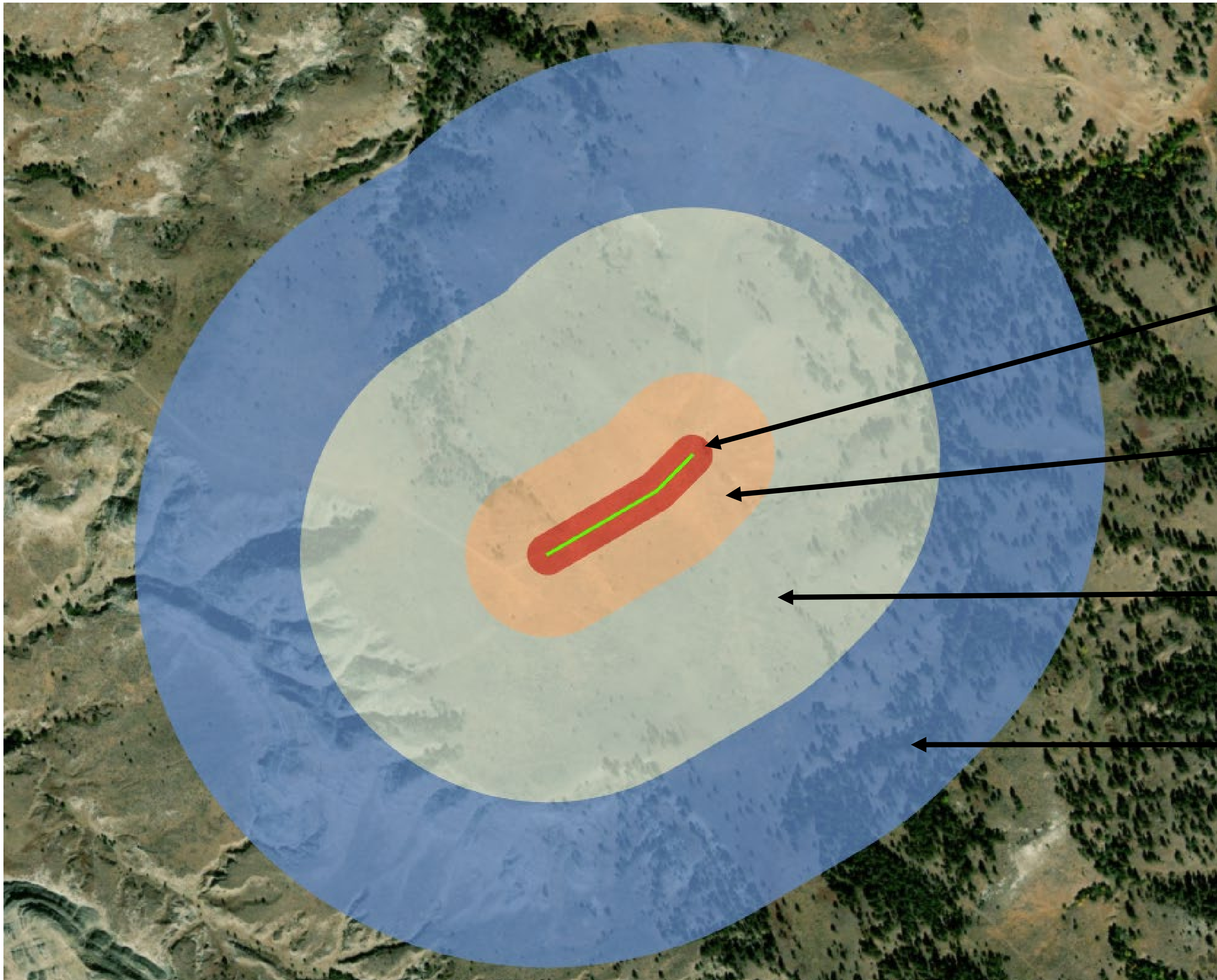
Result = **Raw Score**

Example Project



- New Oil Well Pad
- New Access Road

Access Road



500 Meter Buffer

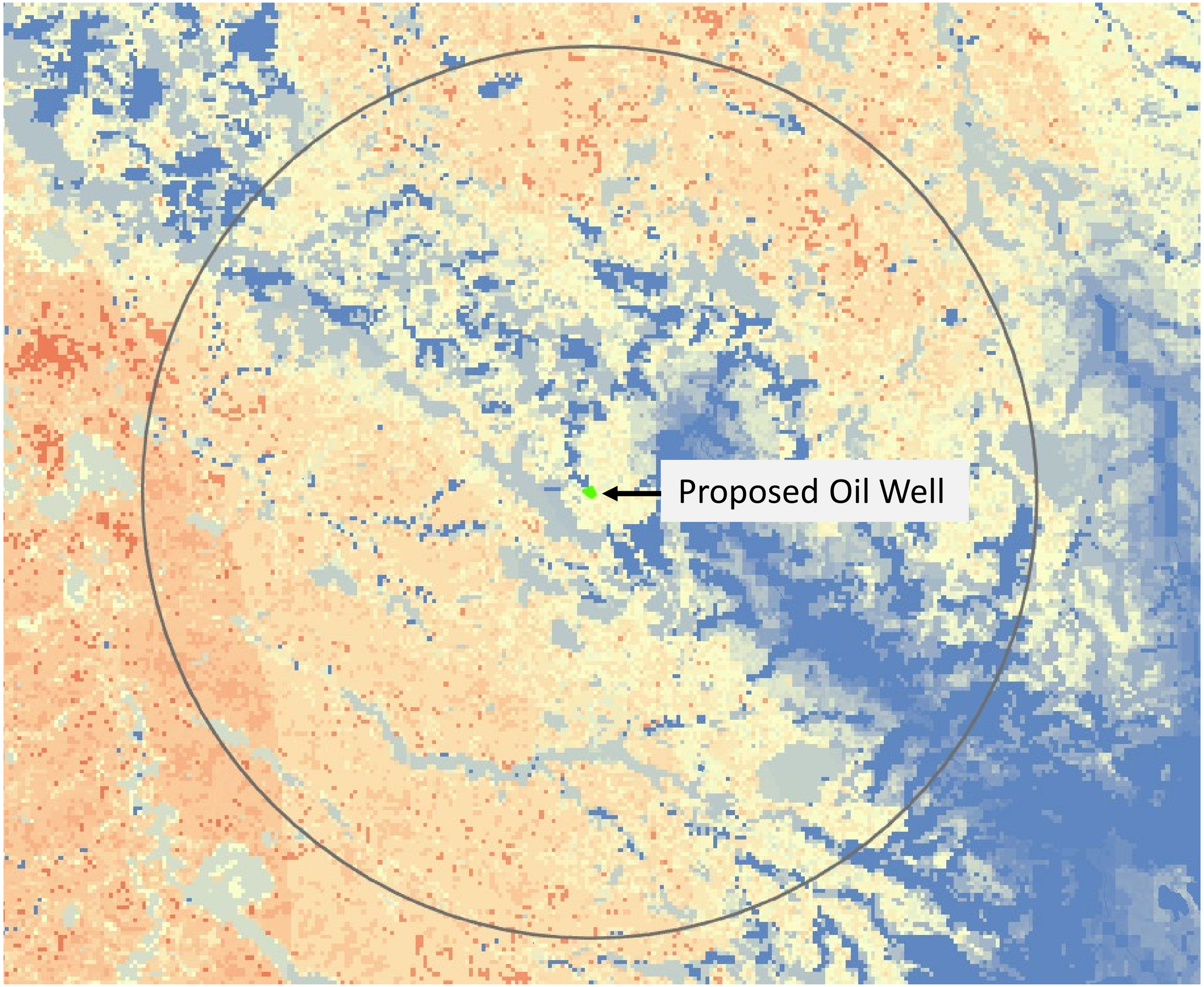
0-25 Meters, 100% Reduction in Habitat

25-100 Meters, 75% Reduction in Habitat

100-300 Meters, 50% Reduction in Habitat

300-500 Meters, 25% Reduction in Habitat

Oil Well



3.2 Kilometer Density

Counts the number of existing oil/gas wells within 3.2 km of each cell.

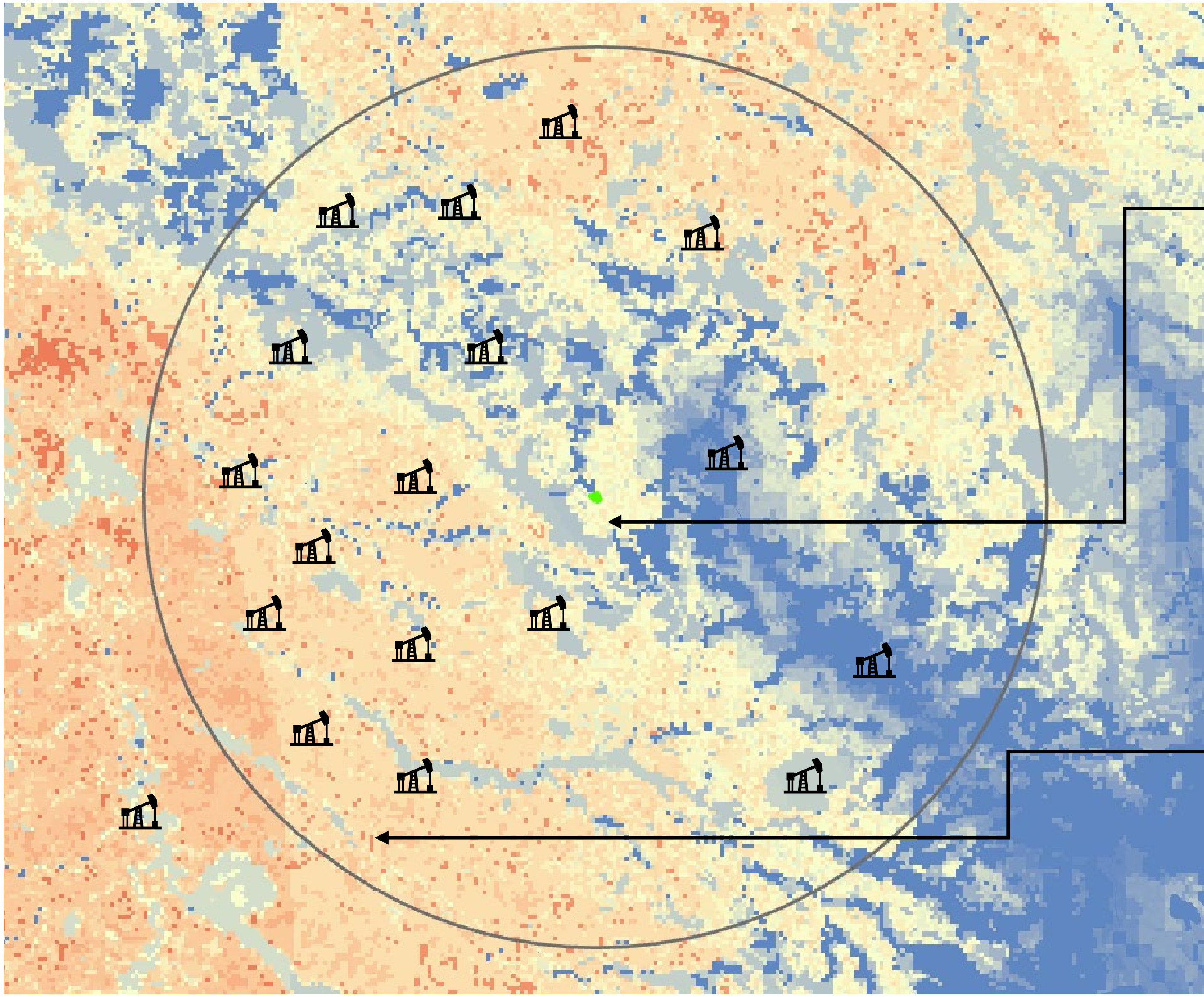
0-12 wells, No Reduction in Habitat

13-40 wells, 50% Reduction in Habitat

41-100 wells, 90% Reduction in Habitat

101 or more wells, 100% Reduction in Habitat

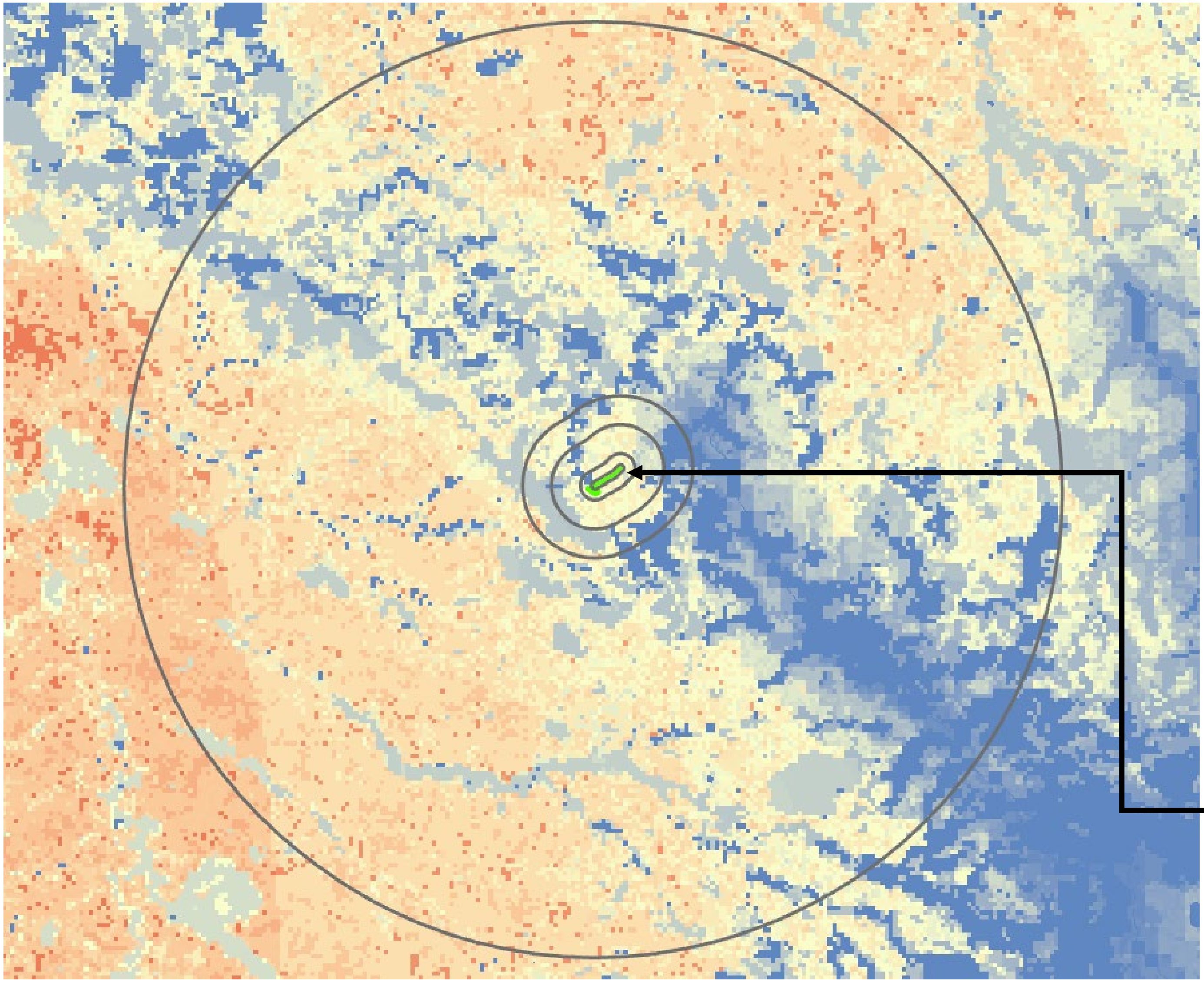
Oil Well



Example Cell 1
18 Wells within 3.2km
Habitat reduced by 50%

Example Cell 2
10 Wells within 3.2km
No habitat reduction

Combine Impact Rasters

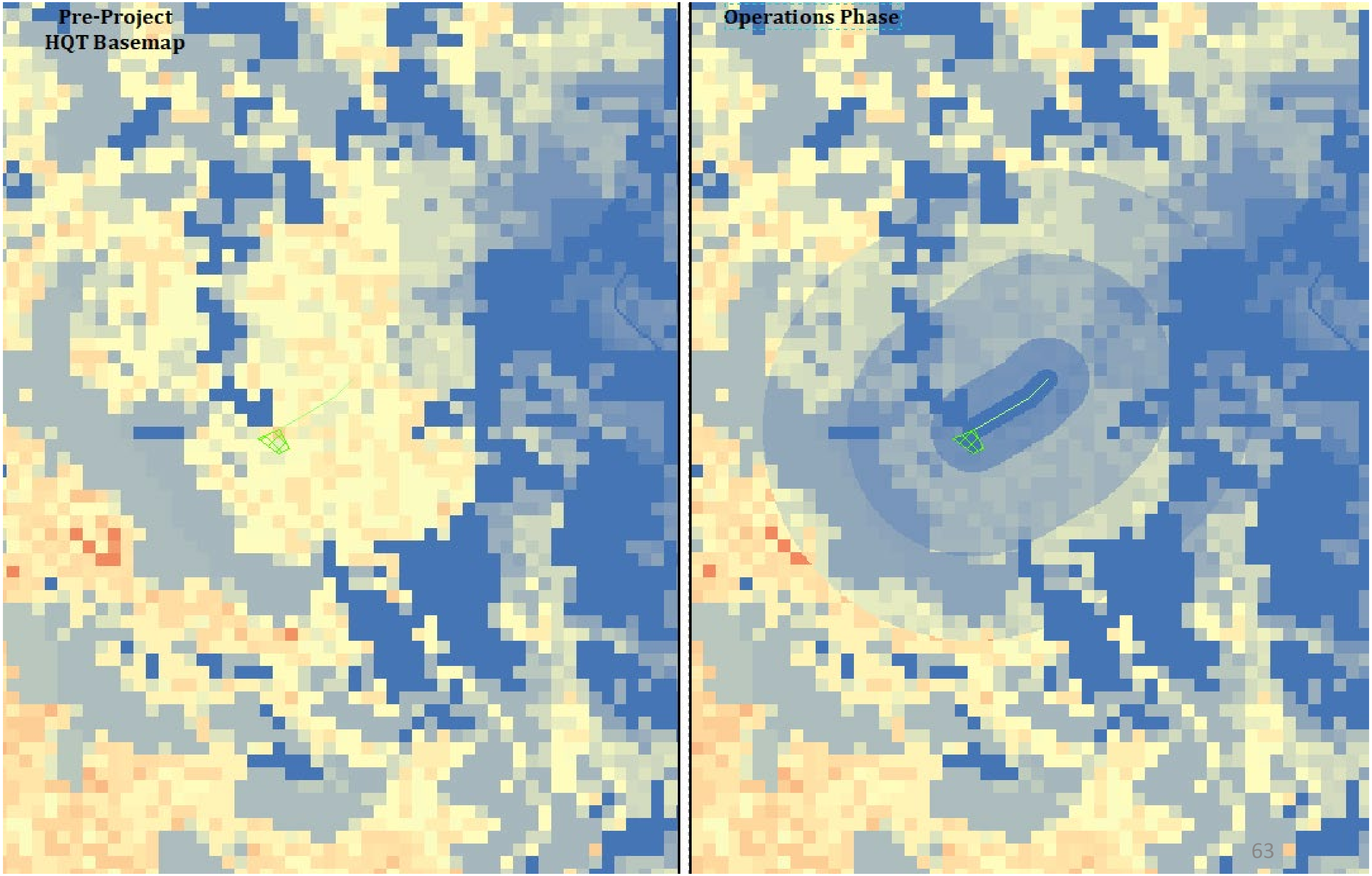


For projects with more than one disturbance type like this project the impact rasters are combined before multiplying them with the basemap.

For this project:
Access Road Impact Value = 0.25
Oil Well Impact Value = 1.0

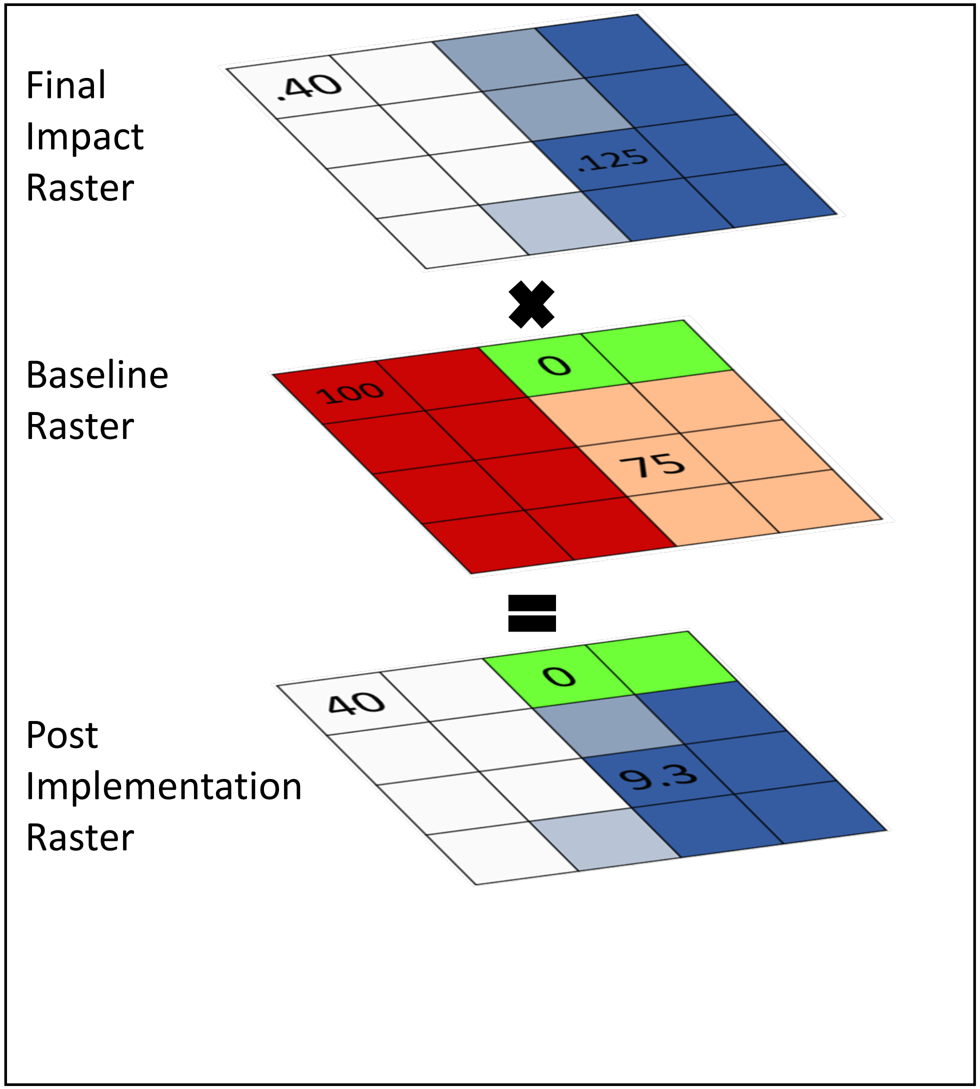
Final Impact Raster Value = 1.0 x 0.25 = 0.25

HQT MAP- Pre and Post Implementation



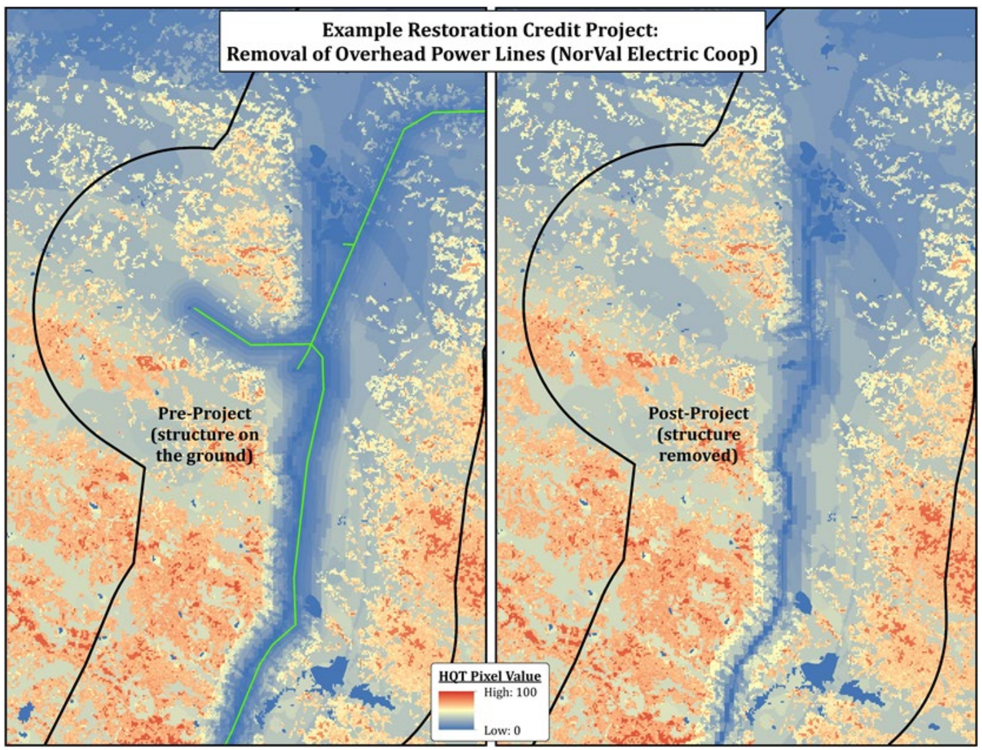
Final Calculations

- Total Impact score multiplied by the baseline score equals habitat quality remaining on the landscape after the project is implemented.
- Baseline scores and post implementation scores are then calculated by dividing the value of the cell by 100 and then multiplying it by the area in acres.
- The difference of these two scores is the raw HQT score.
- For one cell at 3.75 meters this would be
  - Baseline = 100/100 * 0.0009266 = 0.0009266 FxA
  - FxA remaining = 40/100 * 0.0009266 = 0.00037064 FxA
  - 0.0009266 - 0.00037064 = 0.00055596 FxA Lost



How the HQT calculates Credit for Conservation Projects

The HQT is used in a similar manner to determine credits for restoration projects.



- HQT used to determine pre-project conditions
- Re-run HQT to determine post-project conditions

Lift = Credit

HQT and Policy Work Together

- **HQT results are commensurate, proportional to project: Functional acres gained or lost [Technical Manual Oct. 2018 v1]**
  - policy neutral
  - objective, data-driven using developer's own; repeatable
  - results driven by project location, size, type, duration, habitat quality at the site

Habitat and Anthropogenetic Scores (Basemap) + Project HQT = Raw Score

Stay Tuned

Policy Multipliers will be discussed in a future Webinar

- **Use policy to encourage / discourage actions [Policy Guidance Oct. 2018 v1]**
  - multipliers: incentivize consistency with EO / BLM LUPs for debit projects
  - consistency important: addresses vulnerable life history stages missed by HQT (functional acres lost)
  - multipliers: incentivize creation of new Fx-acres for credit projects (restoration, enhancement)
  - address unique situations

- **HQT Results + Policy multipliers = debits**


Joel Maes