Stressor and Threat Assessment of Nevada Groundwater Dependent Ecosystems

Torrance Ranch (S. Williams/TNC)

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EXECUTIVE SUMMARY

Groundwater dependent ecosystems (GDEs) are those ecosystems that rely on groundwater for all or part of their water needs. GDEs are extremely important to plants and wildlife in Nevada, the driest state in the United States, and they are also important resources for human uses, including drinking water, agriculture, water quality improvements, and recreation. However, the future viability of GDEs can be impacted directly or indirectly from human uses and activities.

In 2019, The Nature Conservancy (TNC) produced a database and maps of indicators of GDEs (iGDEs) to assist with identifying where GDEs occur across the state. The purpose of the assessment presented here was to identify and evaluate stressors and threats to GDEs in Nevada by using the TNC Nevada iGDE database along with additional best available data. For the purposes of this report, we define a **GDE stressor** as *any physical, chemical, or biological alteration of the GDE directly or indirectly caused by humans that reduces the viability of an individual, population, or a species or the viability of its habitat*, and a **GDE threat** as *a potential (or impending) physical, chemical, or biological alteration of the GDE directly or indirectly caused by humans that is reasonably likely to negatively affect an organism, population, species or its habitat.*

The authors focused on five themes of stressor and threat risk factors that are critical for the sustainability of GDEs (Table ES-1): a) groundwater withdrawals; b) climate; c) ungulates; d) non-native species; and e) additional impacts due to human development. Risk factors due to stressors and threats were assessed on a scale of 0.00 (negligible risk) to 1.00 (high risk). To assess overall risk for each iGDE in the Nevada iGDE database, the five themes of risk factors were combined using a weighted approach that assigned the highest weight to groundwater withdrawal stressors and threats, followed by climate stressors and threats, with stressor and threats due to ungulates, non-native species, and additional impacts from human development equally assigned the lowest weight. This resulted in mean risk factor values by GDE types that ranged between 0.00 and 8.00 (Figures ES-1 through ES-5).

Results were focused on highlighting the amount of five GDE types at high risk for stressor and threat risk factors: 1) springs; 2) wetlands; 3) phreatophyte communities; 4) lakes and playas; and 5) rivers and streams. Figures ES-6 and ES-7 show the amount of iGDEs at high risk for each of the stressor and threat risk factors assessed, and Figure ES-8 and Tables ES-2 and ES-3 summarize stressor and threat risks in each risk factor theme by GDE type.

Key takeaways from this assessment include:
- Overall, more than 2,000 springs, over 16,000 hectares (>40,000 acres) of wetlands, over 300,000 hectares (>700,000 acres) of phreatophyte communities, over 16,000 hectares (>40,000 acres) of lakes and playas, and over 1,300 kilometers (>1,000 miles) of rivers and streams are at moderate to high risk for combined stressor risk factors.

- Over 800 springs, over 60,000 hectares (>160,000 acres) of wetlands, almost 175,000 hectares (>425,000 acres) of phreatophyte communities, over 160,000 hectares (>400,000 acres) of lakes and playas, and over 1,000 kilometers (>650 miles) of rivers and streams are at moderate to high risk for overall combined threat risk factors.

- Among stressors overall, phreatophyte communities had the largest percentage at moderate to high risk, followed by springs and GDE rivers and streams.

- For threats overall, lakes and playas had the highest percentage at moderate to high risk, mostly due to threats for the groundwater withdrawals and climate themes.

- The stressor and threat risk factors that pose the highest risk for springs and rivers and streams are the ungulate stressor and threat risk factors, with over 22,000 springs at high risk, and over 13,000 km (over 8,000 miles) at high risk.

- More than 370,000 hectares (> 900,000 acres) of wetlands, 1.3 million hectares (3.3 million acres) of phreatophyte communities, and over 320,000 hectares (>800,000 acres) of lakes and playas are at high risk for the surface water diversions stressor risk factor.

- The proximity of potential groundwater withdrawals in areas with shallow groundwater was the threat risk factor that had the largest areas at high risk for wetlands (>850,000 hectares [>2.1 million acres]), phreatophyte communities (>1.7 million hectares [almost 4.3 million acres]), and lakes and playas (>430,000 hectares [>1 million acres]).

- On average, about one-fifth of all GDEs, regardless of type, are in hydrographic areas that had groundwater withdrawals greater than the perennial yield, which can put them at risk of having groundwater they use captured by excessive groundwater withdrawals.

- At least 40% of all GDE types are at high or moderate risk for the appropriation status threat risk factor.

- Over 70% of wetlands, phreatophyte communities, and lakes and playas are at high risk for the threat of potential groundwater withdrawals within 800 m (0.5 mile) when shallow groundwater is present.

- Out of 6,536 wells analyzed for groundwater level trends, 39% had significantly falling trends, 15% had significantly rising trends, and the remainder did not have significant trends.

- Over half of the hydrographic areas in Nevada had at least one well site with significantly falling water level trends, but only 8 had most of the wells in their basins with significant falling trends.

- Over 40% of phreatophyte communities (over 800,000 hectares [~2 million acres]) are within 800 m (0.5 mile) of a well with a significantly falling water level trend, which could affect their sustainability and lead them to transition to a community with less ecological value.

- The small percentage of springs and GDE rivers and streams that were within 800 m (0.5) miles of a well with a significantly falling water level trend could reflect decisions by the Nevada State Engineer in evaluating water right applications for groundwater use near surface waters, indicate that groundwater development has been more prevalent where surface water resources are unavailable, or occur because of capture of surface water from springs, rivers, or other water bodies.

- Because they are often located in recharge areas with local flow paths at higher elevations, more springs and GDE rivers and streams are at high risk for the current climate stressor risk factor than other GDE types, and this high risk will continue into the future.

- Between 2022 and 2060 and across all Localized Constructed Analogs (LOCA) models, all hydrographic areas in Nevada had mean Standardized Precipitation and Evapotranspiration Index (SPEI) values that indicated more droughty conditions than current conditions are expected throughout the state.

- Over 20% of all GDE types were at moderate to high risk for the climate threat risk factor, with almost 50% of lakes at playas at moderate to high risk, which are important locations for endemic fish, migratory bird species, and aquatic invertebrates.

- Almost 90% of springs and over 70% of GDE rivers and streams are at high risk for ungulate stressor and threat risk factors.

- Over 60% of lakes and playas are at high risk from the non-native species presence stressor risk factor.

- Springs had the lowest percentage at high risk from the non-native species presence risk factor, which may reflect a lower rate of reporting of non-native species at springs in the databases used for this report.

- Over 60% of phreatophyte communities and GDE lakes and playas are at high risk for the surface water points of diversion stressor risk factor.

Table ES-1. Risk factors to groundwater-dependent ecosystems assessed in this report.

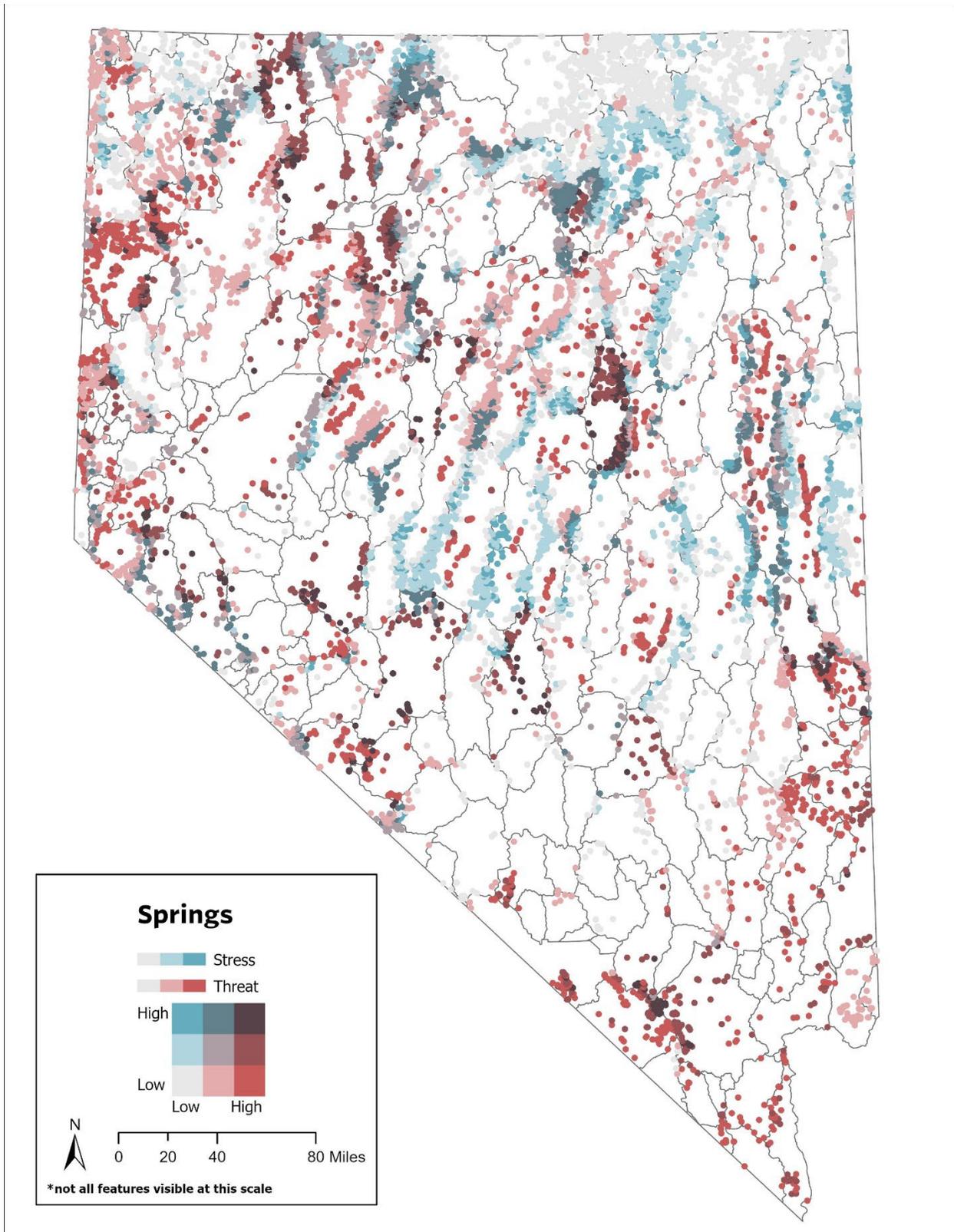| Theme	Risk factor	Stressor	Threat
Groundwater withdrawals			
	Water right appropriation status of hydrographic area		X
	Pumping status of hydrographic area	X	
	Proximity of GDE to potential groundwater withdrawals		X
	Nearby lowering of water tables	X	
Climate			
	Current climate	X	
	Future climate		X
Ungulates			
	Herd management areas, elk distribution areas, grazing allotments	X	X
Non-native species			
	Known presence	X	
	Road density		X
Other human development			
	Housing density	X	
	Nearby surface water diversion	X	
	Future housing density		X

Figure ES-1. Overall stressor and threat risk factor values for GDE springs. Blue gradations indicate strength of stressor risk factors, and red gradations indicate strength of threat risk factors. Darker hues indicate stronger risk.
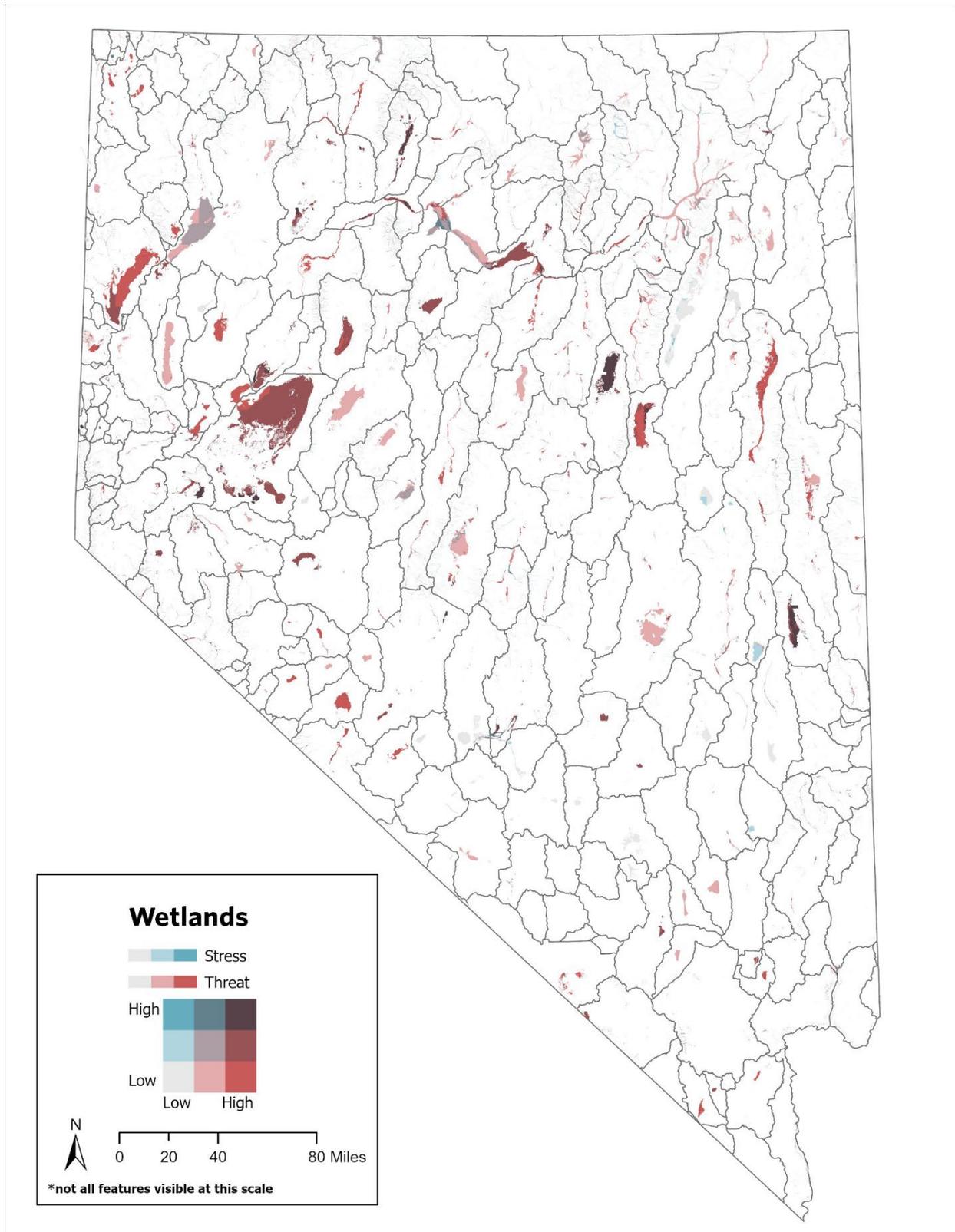
Figure ES-2. Overall stressor and threat risk factor values for GDE wetlands. Blue gradations indicate strength of stressor risk factors, and red gradations indicate strength of threat risk factors. Darker hues indicate stronger risk.
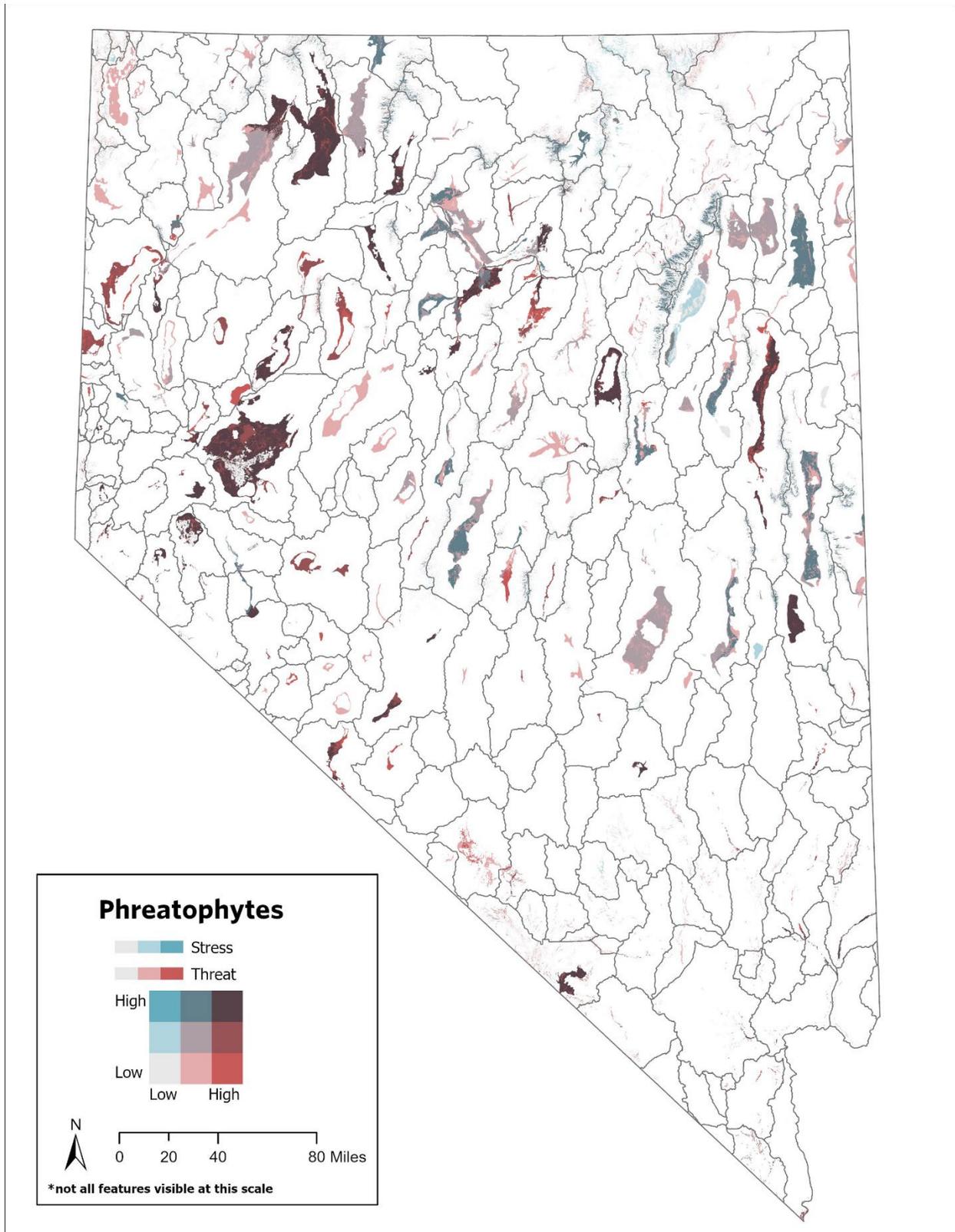
Figure ES-3. Overall stressor and threat risk factor values for GDE phreatophyte communities. Blue gradations indicate strength of stressor risk factors, and red gradations indicate strength of threat risk factors. Darker hues indicate stronger risk.
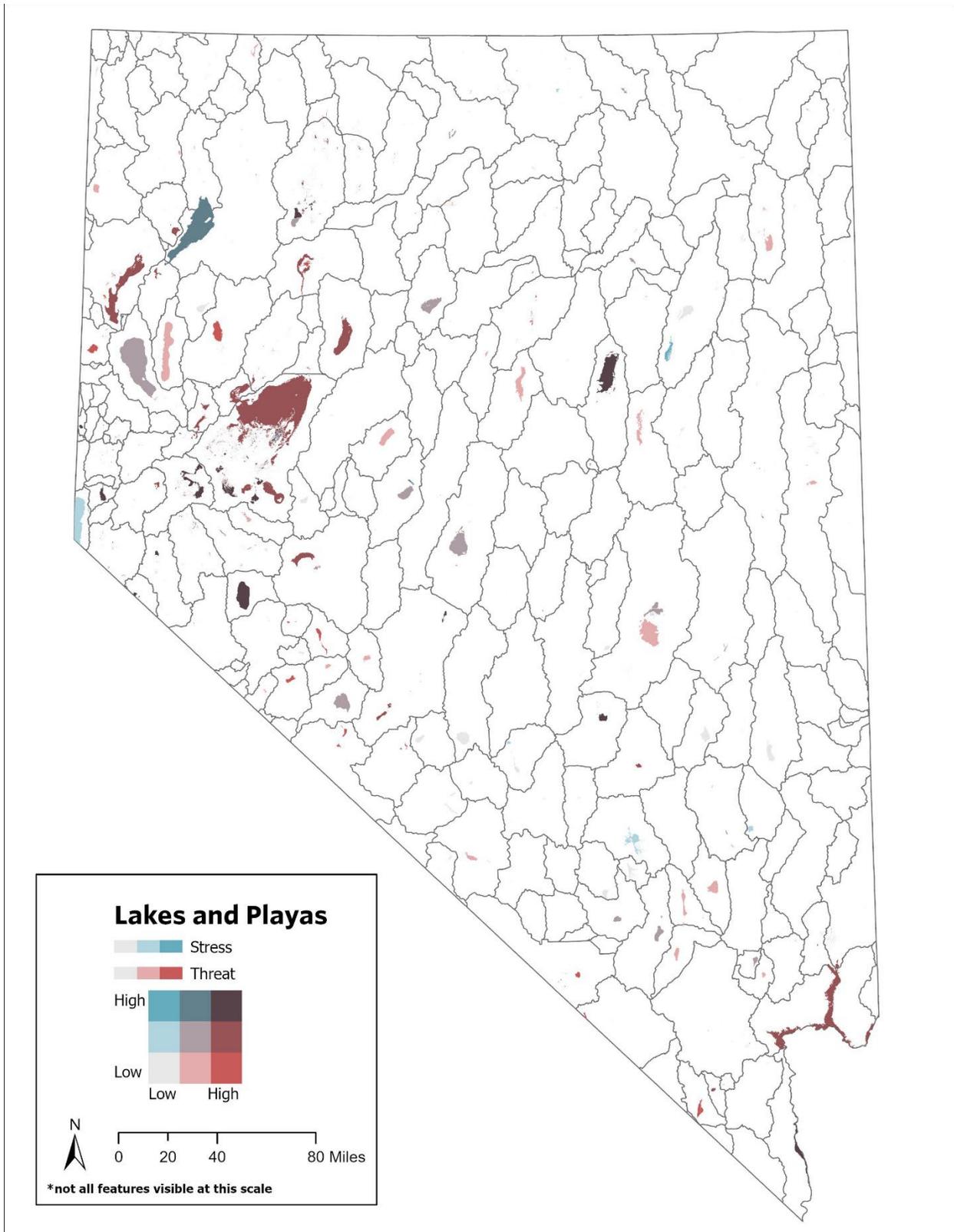
Figure ES-4. Overall stressor and threat risk factor values for GDE lakes and playas. Blue gradations indicate strength of stressor risk factors, and red gradations indicate strength of threat risk factors. Darker hues indicate stronger risk.
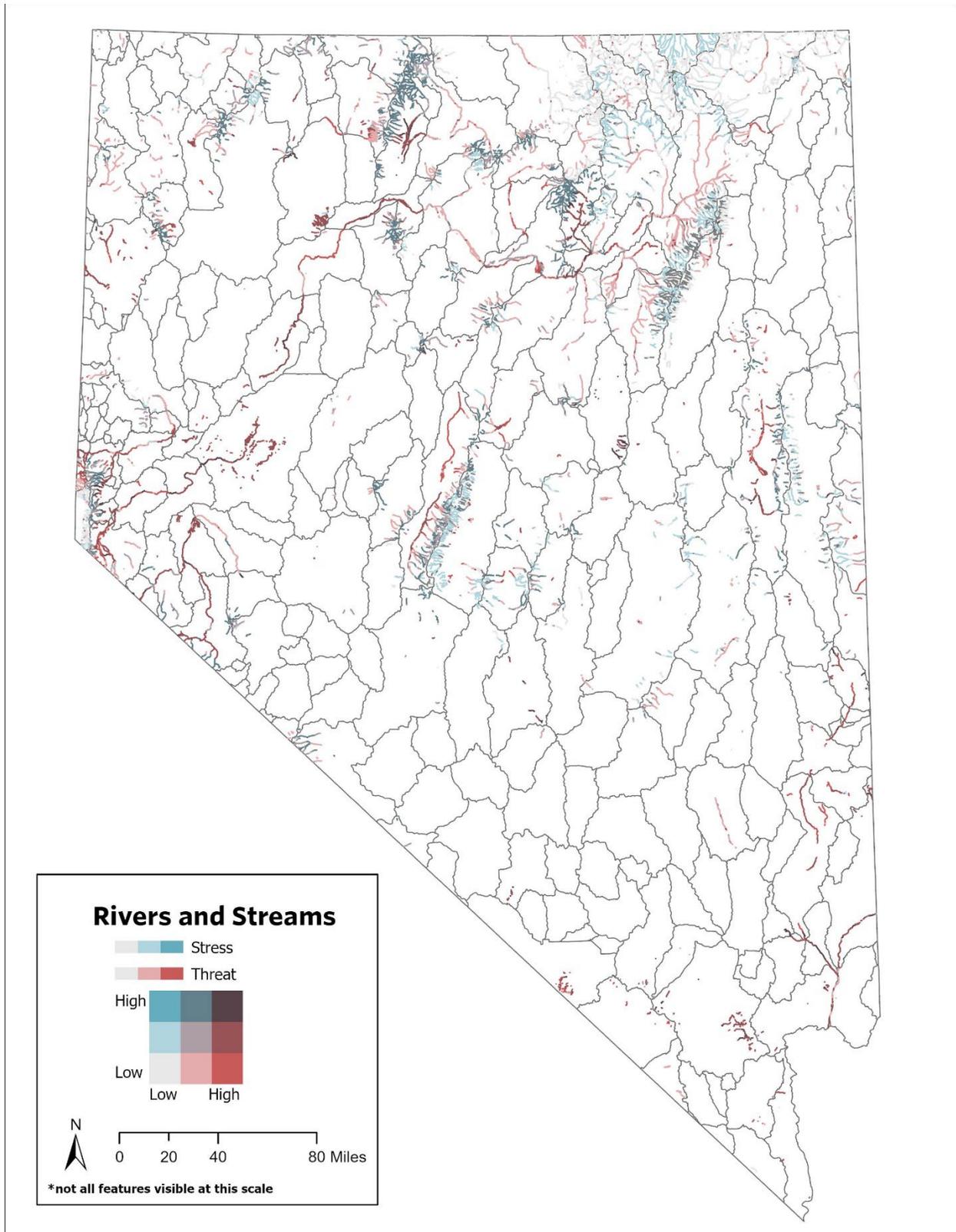
Figure ES-5. Overall stressor and threat risk factor values for GDE rivers and streams. Blue gradations indicate strength of stressor risk factors, and red gradations indicate strength of threat risk factors. Darker hues indicate stronger risk.
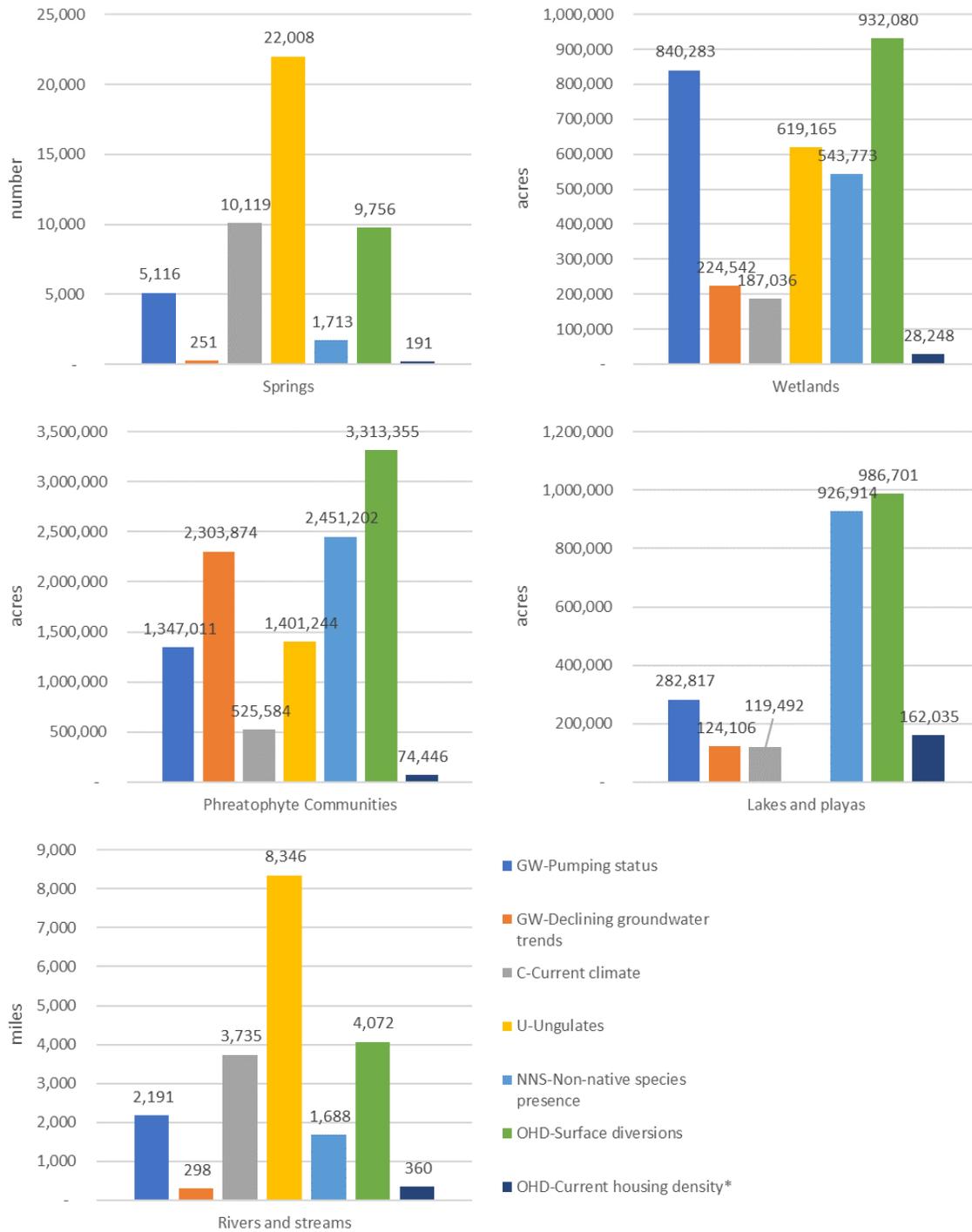
Figure ES-6. Amount of iGDEs in Nevada at high risk for stressor risk factors (asterisk [*] indicates amount of iGDEs at moderate to high risk for current housing density). Legend abbreviations for stressor risk factor themes: GW = groundwater withdrawal; C = climate; U = ungulates; NNS = non-native species; OHD = other human development

Figure ES-7. Amount of iGDEs in Nevada at high risk for threat risk factors (asterisk [*] indicates amount of iGDEs at moderate to high risk for future climate, road density and housing density increase threat risk factors). Legend abbreviations for threat risk factor themes: GW = groundwater withdrawal; C = climate; U = ungulates; NNS = non-native species; OHD = other human development
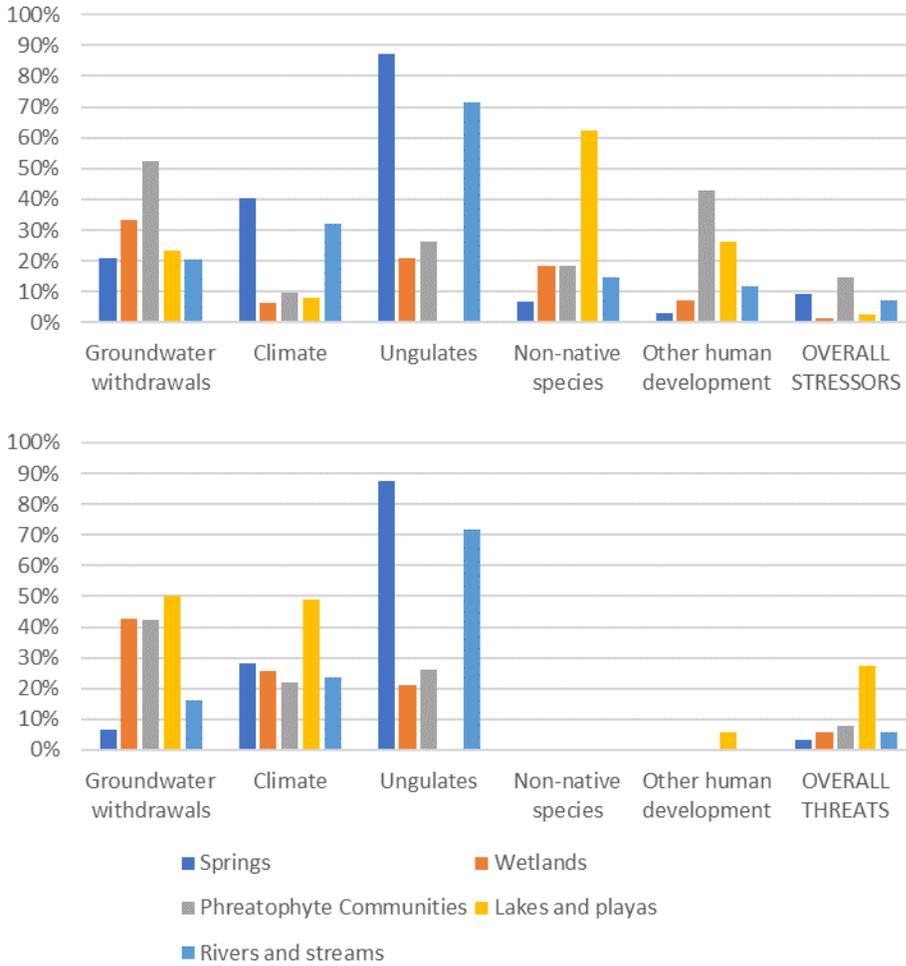
Figure ES-7. Percentages of GDE types at moderate to high risk by stressor theme (top) and threat theme (bottom). Percentages are percent of points for springs, percent of length for rivers and streams, and percent of area for other GDE types. PY = perennial yield.

Table ES-2. Amount of GDE types at moderate to high risk for stressor risk factors by theme and overall.

Theme	Springs (number)	Wetlands (ha / ac)	Phreatophyte communities (ha/ac)	Lakes and playas (ha/ac)	Rivers and streams (km / mi)
Groundwater withdrawals	5,299	397,464 / 982,155	1,135,113 / 2,804,922	140,523 / 347,241	3,806 / 2,365
Climate	10,119	75,691 / 187,036	212,697 / 525,584	48,357 / 119,492	6,011 / 3735
Ungulates	22,008	250,567 / 619,165	567,064 / 1,401,244	-- / --	13,431 / 8,346
Non-native species	1,713	220,057 / 543.773	991,967 / 2,541,202	375,109 / 926,914	2,716 / 1,688
Other human development	735	86,828 / 214,557	931,567 / 2,301,951	157,794 / 389,916	2,241 / 1,393
Overall stressors	2,284	16,284 / 40,238	314,650 / 777,517	16,678 / 41,212	1,322 / 821

Table ES-3. Amount of GDE types at moderate to high risk for threat risk factors by theme and overall.

Theme	Springs (number)	Wetlands (ha / ac)	Phreatophyte communities (ha/ac)	Lakes and playas (ha/ac)	Rivers and streams (km / mi)
Groundwater withdrawals	1,621	507,914 / 1,255,081	921,375 / 2,276,765	302,348 / 747,118	3,036 / 1,886
Climate	7,127	308,032 / 761,163	476,661 / 1,177,854	293,433 / 725,088	4,470 / 2,777
Ungulates	22,008	250,567 / 619,165	567,064 / 1,401,244	-- / --	13,431 / 8,346
Non-native species	1	13 / 33	0 / 0	0 / 0	4 / 2
Other human development	22	1,713 / 4,234	9,085 / 22,449	34,579 / 85,447	56 / 35
Overall stressors	807	66,746 / 164,933	173,488 / 428, 698	163,705 / 404,523	1,053 / 654