Wildlife of the Mongolian Steppe

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Team Members based in the USA and Mongolia

2018 Field Report

Disclaimer/Authors' Note

Some of the texts, data and figures are being formally published elsewhere; therefore, those items are indicated as "Confidential." If you wish to receive more information regarding these data, or to obtain permission for use, please contact Gana Wingard, gwingard@denverzoo.org.

Dear Earthwatch Volunteers,

We are writing on behalf of our Mongolian and American team members to express our gratitude to you for all of your hard work on behalf of Mongolian wildlife!

Our 2018 fieldwork went exceedingly well in almost every aspect of our work. We captured and radio tagged a large number of animals (4 argali, 4 ibex, and 2 goitered gazelles); we monitored, wing tagged, and leg banded 53 cinereous vulture fledglings; we leg banded and measured 10 saker falcons and monitored nests of 3 raptor species; collected data on over 50 vegetation plots; conducted surveys on 8 small mammal habitats and gathered telemetry data on argali, ibex and gazelles. All of this hard work will provide critical data needed to conserve the important wildlife of the Gobi Steppe ecosystem of Ikh Nart. We know this was a lot of work, but we also had a lot of fun!

Thank you very much! Your hard work is already paying off for the conservation of wildlife. Without you, none of this would be possible.

For those who want to receive updates, please send us an e-mail (gwingard@denverzoo.org) with your e-mail address. I periodically send out updates to volunteers. We were thrilled by all the energy, hard work, and wonderful goodwill you all provided. We hope that our many new friendships will last beyond our time at Ikh Nart! We look forward to continuing our work with Earthwatch and hope to see many of you in the future. Please keep in touch.

With best regards,

Gana Wingard and the team

SUMMARY

With the support of Earthwatch Volunteers, Denver Zoo and partners successfully advanced our understanding of the ecology of many important iconic Mongolian wildlife species and implemented strategies needed to protect the wildlife and ecosystems of the Gobi Steppe. Below is a summary of the highlights from the 2018 field season.

Mongolia's grassland steppe ecosystem provides important habitat for a diversity of species and provides natural resources for the nomadic herding communities who live within the region. Declining grassland productivity because of changing climate and livestock grazing has put this important grassland ecosystem at risk. In 2018, Denver Zoo's Rocky Mountain Great Plains Director and trained rangeland ecologist, Dr. Luis Ramirez, visited Ikh Nart Nature Reserve to assist with training and implementation of rangeland monitoring and participatory mapping. Working closely with Mongolian graduate students and Earthwatch volunteers, he developed methods designed to better understand the drivers and threats to grassland ecosystems and the nomadic herding communities' perspectives on effective rangeland management strategies.

As part of our efforts to better understand the impacts of climate change and livestock grazing on rangeland productivity and species diversity at Ikh Nart, we piloted efforts to research how the population and distribution of Pallas' pika (*Ochotona pallasi*)- a known indicator species of climate change and rangeland function- varies across Ikh Nart. Dr. Chris Ray, one of the leading pika ecologist in North America and Research Associate at the University of Colorado, visited Ikh Nart Nature Reserve to train ecologists on pika trapping and sampling methods designed to monitor the impacts of climate and grazing on Ikh Nart's grassland ecosystems.

With over 20 years of integrated research completed at Ikh Nart, Denver Zoo and partners are using the years of research collected by Earthwatch volunteers to understand the interactions between species and ecosystem function at Ikh Nart. Joseph Zebrowski, a Research Associate for Denver Zoo and a professor at New Mexico Highlands University, visited Ikh Nart to train project personnel and Mongolia National University students on geospatial techniques needed to better understand the interaction between species and the overlapping conservation projects at Ikh Nart Nature Reserve.

As part of our work to implement adaptive management approach at Ikh Nart, we were pleased to host Mr. Amgalanbaatar Sukh, Director of Ikh Nart Nature Reserve, at Denver Zoo. The overall objective of Mr. Amgalanbaatar's visit to the USA was to collect feedback from Denver Zoo's Field Conservation Department and to finalize Ikh Nart's 2018-2023 Management Plan, which utilities the Open Standards for the Practice of Conservation (OS) to develop, implement, evaluate, and adapt conservation goals and strategies to maximize our effectiveness in the conservation of wildlife and ecosystems. For the first time, the Mongolian government has required all protected areas to utilize this adaptive management approach and to engage stakeholders in the development of OS strategies that identify the scope, vision, and targets of the project, develop and implement goals and strategies, and evaluate and adapt strategies based on feedback. To this end, the Ikh Nart Management Plan will be a management plan that utilizes OS processes to develop adaptive management strategy.

Community engagement is at the heart of our conservation work at Ikh Nart Nature Reserve. In 2018, we were able to train and empower Mongolian teachers and conservation biologists to develop a suite of conservation-focused curriculums that will be incorporated into the 4th grade curriculum at three schools surrounding Ikh Nart Nature Reserve. We were pleased to host Mongolian schoolteachers and conservation biologists (Ms. Tsetsegdelger Tserenpil, Ms. Chuluunbayar Dashdondog, Ms. Odontuya Batjargal, Mr. Chimidbat Bat-Erdene, and Mr. Rentsen Oyunbat) at the Denver Zoo as part of a two-week conservation education teaching and curriculum development training. Earthwatch volunteers then had an opportunity to participate in the first annual Ikh Nart field visit where all 4th and 5th grade students from the towns surrounding Ikh Nart had a chance to participate in field research on the important wildlife species in their backyard.

In addition to advancing the conservation of wildlife across the Gobi Steppe of Mongolia, Denver Zoo and partners strive to use Ikh Nart Nature Reserve as a model for protected area management and community engagement in science-based, integrated wildlife conservation strategies across the world. Faced with global climate change, there is substantial concern for how alpine ecosystems and species may be impacted by and may adapt to a changing ecosystem. In 2018, Dr. Chris Ray, a leading pika ecologist in North America, came to Ikh Nart to develop methods needed to compare how Ikh Nart's Pallas' pika have been and are currently being affected by changing climate. Dr. Ray worked closely with one of the leading small mammal ecologists and Ikh Nart research advisor, Dr. Batsaikhan, from the National University of Mongolia. Together, these two ecologists worked to develop field methodologies designed to compare the impacts climate change is having on Pallas' pika in Mongolia and on the American pika in North America. Through this comparison, we will be able to better understand the species' ecology, physiology, persistence and resilience, including how their resilience is impacted by changing habitat characteristics. Extirpations of the American pika have been documented across much of their range, so being able to predict the future impact of climate change on their habitat may help North American protected area managers support their survival.

In addition, Dr. Chris Ray worked closely with Mongolian graduate students and Earthwatch volunteers to implement the Pallas' pika methodology and to build their capacity in field research methods. An expert in ecological modeling, Dr. Ray worked with students and volunteers to help them understand how to map spatial patterns of pika distribution. It was a pleasure to work with Dr. Ray and we appreciate all of her efforts to expand our applied conservation research at Ikh Nart Nature Reserve.

GOALS, OBJECTIVES, AND RESULTS

Objective 1) Each year we will capture, mark, and tag 2-4 adult argali sheep (*Ovis ammon*), 2-8 adult Siberian ibex (*Capra sibirica*), 2-5 Mongolian (*Procapra gutturosa*) and goitered (*Procapra subguttosa*) gazelle to assess movement patterns and habitat use.

Progress towards/against Objective 1 (by hypotheses- H1, H2, and H3): We captured 4 adult argali (4♀); 4 ibex (3♀ and 1♂); and 2 goitered gazelle (1♂ and 1♀) in drive nets in 2018. All 10 animals were fitted with satellite collars, and data from these collars will be integrated into and contribute to our ongoing studies about native ungulate movement and resource use in Ikh Nart.

In 2018, we began assessment of home range, resource use, and behavior for the argali sheep, Siberian ibex, and goitered gazelle that have been collared since 2015. Our objective is to understand animal movement, behavior, possible overlap of species range and resource use, difference in winter and summer home ranges, overlap with domestic livestock, and if the species is migratory. We are using a new home range method called 'Continuous Time Movement Model' (CTMM) which accounts for spatial autocorrelation and non-parametric data (Figure 1). Table 1 documents home ranges in square kilometers, and Table 2 documents resource use by cell count.

Table 1: Home range area in square kilometers

ID	Fixes	Species	Km(sq.)
35242	152	argali	86.85
42290	559	argali	66.37
42291	648	argali	99.58
352422	549	argali	140.82
352442	281	argali	76.70
35244	297	argali	400.26
44699	449	argali	79.30
44701	512	argali	128.43
44702	148	argali	127.20
44703	506	argali	1260.83
44704	431	argali	115.22
44705	574	argali	125.72
42287	411	Goitered gazelle	780.90
42288	436	Goitered gazelle	532.38
393032	518	Goitered gazelle	19.48
44706	258	Goitered gazelle	740.11
44707	147	Goitered gazelle	394.75
44708	382	Goitered gazelle	26.98
44700	366	Ibex	21.50
42289	274	Ibex	30.10
393092	373	Mongolian Gazelle	87363.01
35241	4	argali	<100 fixes
35240	18	argali	<100 fixes
35243	68	argali	<100 fixes
393132	76	argali	<100 fixes
42286	42	Goitered gazelle	<100 fixes
352432	17	Ibex	<100 fixes

In 2019, we will be extending our analysis to explore if an animal is selecting for or against a vegetation community, movement behavior, and overlap of species. There is one animal, a Mongolian gazelle, which ranges outside our vegetation layer and will need further exploration of resource use.

Table 2: Percent vegetation community used. Cell count of animal use by species and divided by cell count of vegetation community present. DR=dense rocky outcrops and linear formations; HDS=high-density shrubs (>100/ha); SGF=perennial short grasses and forbs; TV = tall vegetation (>1m); EW=ephemeral water bodies; SS=turfy semi-shrub; and LDS = low-density shrub (<100/ha).

ID	0DR	1HDS	3SGF	4TV	5EW	6SS	7LDS	Species
35242	55	3	58	8	0	4	24	argali
35243	23	5	8	16	0	0	14	argali
35244	23	72	22	11	37	7	81	argali
42290	252	13	160	17	3	4	111	argali
42291	92	72	104	23	28	22	297	argali
44699	159	9	135	15	2	2	120	argali
44701	183	13	162	7	3	7	137	argali
44702	60	12	34	4	3	2	33	argali
44703	106	17	83	20	4	6	108	argali
44704	98	28	36	8	26	10	190	argali
44705	201	15	164	15	2	2	175	argali
352422	142	25	168	26	4	5	176	argali
352442	236	17	259	33	0	4	193	argali
393132	29	1	29	5	0	0	12	argali
Total Cell Count	1659	302	1422	208	112	75	1671	
North Veg	7609	18320	21431	6028	2330	8859	25312	
Percentage	21.80%	1.65%	6.64%	3.45%	4.81%	0.85%	6.60%	
42286	0	7	0	2	0	0	4	Goitered gazelle
42287	0	2	0	3	0	4	0	Goitered gazelle
42288	0	13	6	5	1	10	0	Goitered gazelle
44706	0	66	2	30	2	106	9	Goitered gazelle
44707	0	49	3	12	0	72	1	Goitered gazelle
44708	0	149	3	50	9	170	1	Goitered gazelle
393032	2	288	10	75	0	139	7	Goitered gazelle
Total Cell Count	2	574	24	177	12	501	22	
North Veg	7609	18320	21431	6028	2330	8859	25312	
Percentage	0.03%	3.13%	0.11%	2.94%	0.52%	5.66%	0.09%	
42289	200	0	28	10	0	0	39	ibex
44700	196	4	101	26	0	1	38	ibex
Total Cell Count	396	4	129	36	0	1	77	
North Veg	7609	18320	21431	6028	2330	8859	25312	
Percentage	5.20%	0.02%	0.60%	0.60%	0.00%	0.01%	0.30%	

Figure 1. Home ranges in square kilometers using 'CTMM' for Argali sheep, Siberian ibex, and goitered gazelle in Ikh Nart Nature Reserve in Mongolia
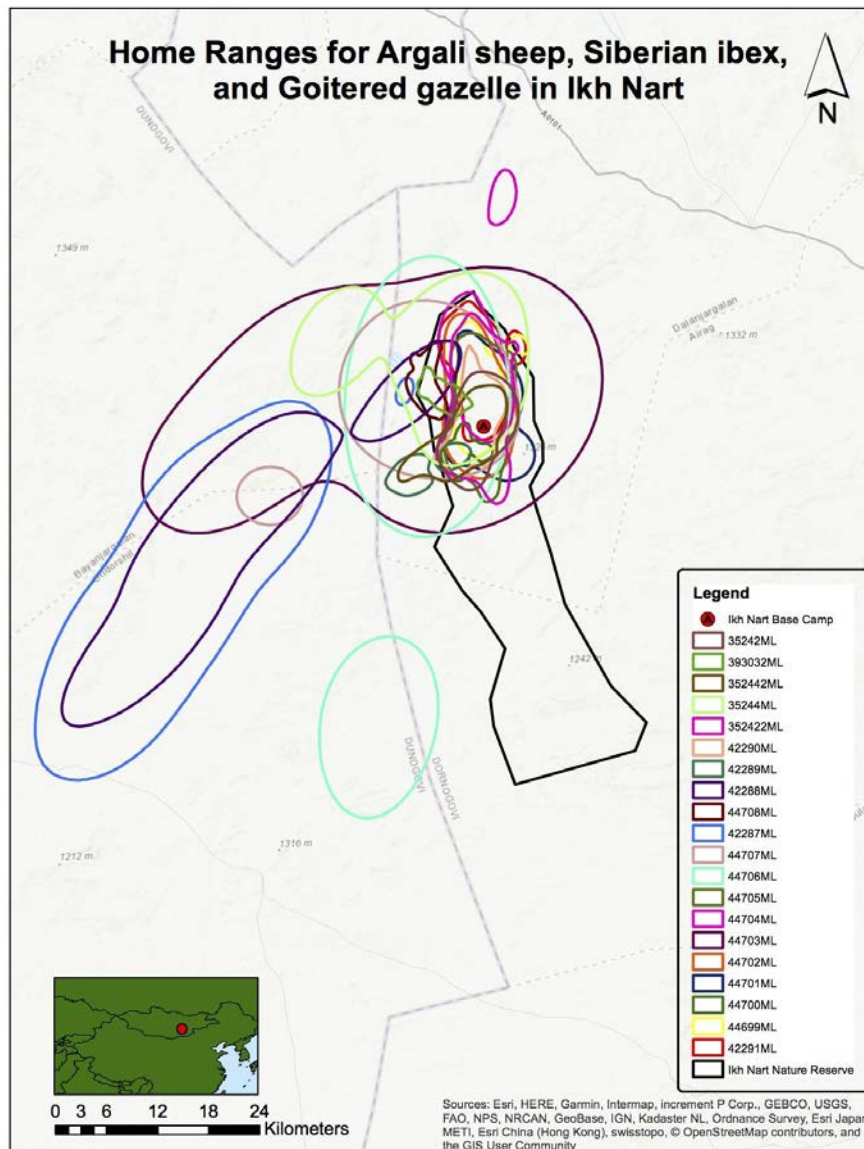

H1 and H2: Analysis for testing this research question has progressed in 2018. We are working on our new paper called "Global cashmere, local livelihoods, and the potential for core zones to conserve biodiversity" by Stefan Ekernas. In this paper, we demonstrated that reducing livestock inside a protected core zone in Mongolia positively affected native herbivores, using a 12-year manipulation. We believe that herders may be part of the problem for rare wildlife, but herders are also key to any solution. Thus, in 2018 we initiated "participatory mapping"- a technique used to evaluate community perceptions and resource use of herding families living within Ikh Nart. We invited an Ikh Nart Nature Reserve researcher and conservation biologist to visit Denver Zoo to learn the latest techniques in rangeland management assessments as well as community participatory mapping. The biologist visited Rio Mora National Wildlife Refuge, a refuge in New Mexico co-managed by the US Fish and Wildlife Service and Denver Zoo, to learn techniques and methods used to evaluate rangeland productivity and to assess the factors that influence patterns of grassland productivity and species diversity. Additionally, Denver Zoo's

Rocky Mountain Great Plains Director, Luis Ramirez who is a trained rangeland ecologist, visited Ikh Nart Nature Reserve to assist with additional training and implementation of rangeland monitoring and participatory mapping. He worked closely with Mongolian researchers to develop research questions and methods designed to better understand the impact of livestock grazing on patterns of rangeland productivity. He also worked closely with Ikh Nart Community Engagement Specialists to pilot participatory mapping with local herding families. In 2018-2019, using the techniques learned from these professional exchanges, Ikh Nart community engagement specialists will be using participatory mapping to visit all 150 herding families living in Ikh Nart to better understand their resource use and perceptions of rangeland management. Furthermore, in 2019, graduate students will be expanding research on the impacts of livestock grazing on grassland ecosystems across Ikh Nart. These are essential first steps in our efforts to develop a community-led and science-based rangeland management plan.

H3: In 2018, we continued to track Mongolian gazelles in Toson Hulstai Nature Reserve. Our objective is to understand their movement patterns and assess whether important habitats for gazelles (e.g. breeding areas) are used predominantly by local herder families. In 2018, the home range area for all Mongolian gazelles at Toson Hulstai Nature Reserve is 156,057.37 km^2 (Figure 2) and the historical home range area is 275,317.5 km^2 (Figure 3). Publications on Mongolia gazelles' data from Toson Hulstai Nature Reserve from the last 3 years are in progress.

Figure 2. Home range for all Mongolian gazelle in 2018.   **Figure 3**. Historical home range.
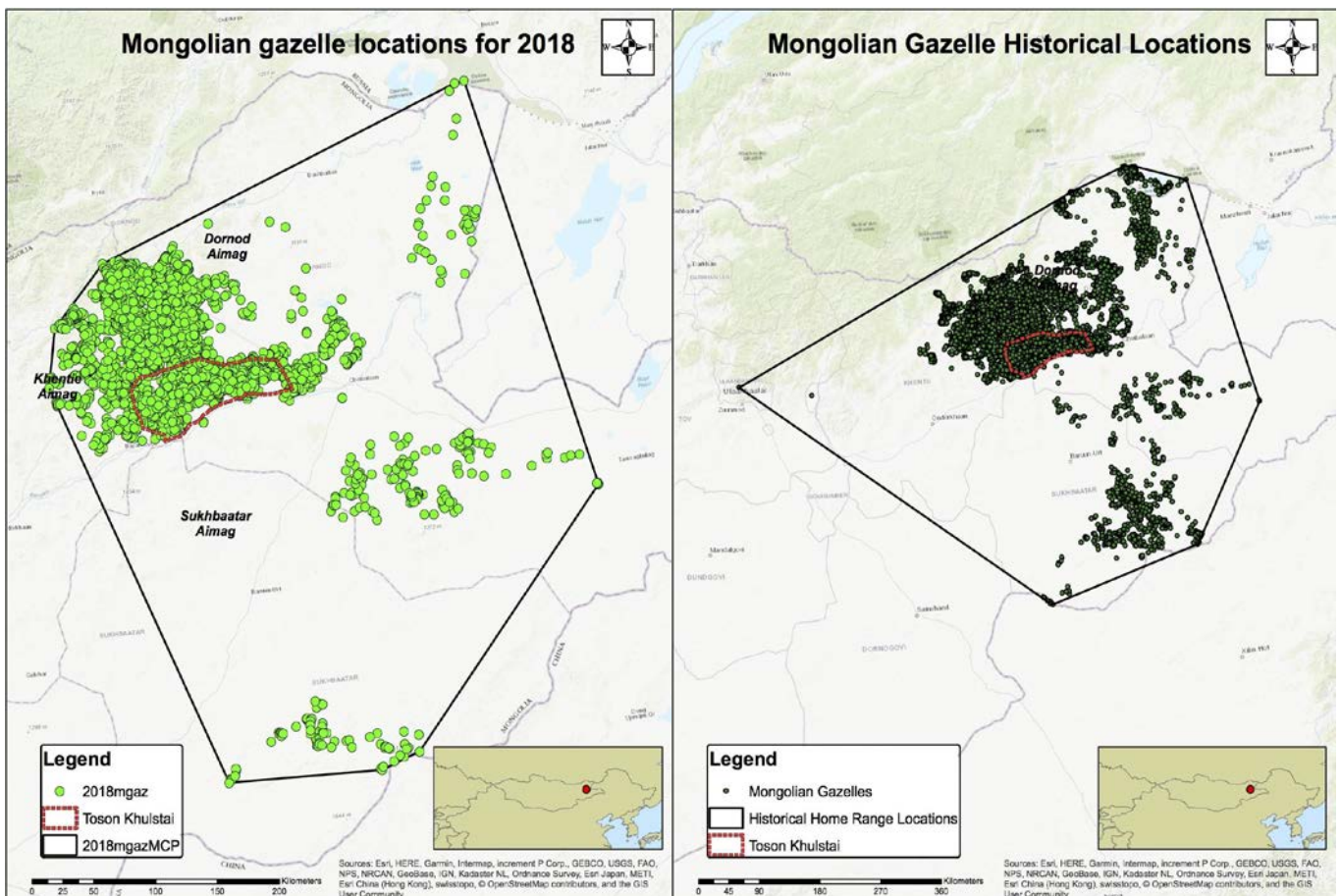
Objective 2) Each year we will capture and tag 0-10 adult lesser kestrel *(Falco naumanni)* and wing tag 20-30 cinereous vulture chicks to track long distance movements.

Progress towards/against Objective 2 (by hypotheses H1 and H2): 53 juvenile cinereous vultures were measured, banded and tagged with patagial tags. 70 juvenile cinereous vultures fledged in Ikh Nart in 2018. 14 historical saker falcon nests were checked. 2 Active saker falcon nests were found each with 5 juveniles prior to fledge. 10 Saker falcon juveniles had various body measurements recorded and leg bands were applied prior to fledge. (By hypothesis H3): In 2018, we checked 5 lesser kestrel nesting colony sites for lesser kestrel activity and we've tried to locate previously tagged lesser kestrels. A graduate student (Serchee) observed a male lesser kestrel with geolocators at a lesser kestrel colony site in early May. This lesser kestrel site had five active nests observed during this trip. We hoped to recapture this bird with a geolocator, but we could not locate him again. We will continue to monitor them next year.

We started collaring juvenile cinereous vultures in 2012, placing GPS backpacks on birds in both Mongolia and South Korea. Since 2012, we have collared 51birds. As of 2018, there were four birds still transmitting. Two of the birds quit transmitting in early 2018, leaving two birds still active. This year we started using the same relatively new home range analysis method described in Objective 1 called 'continuous time movement model' (CTMM). Our figures (4, 5, 6, and 7) below show the results using CTMM analysis. Two birds migrated from South Korea to Mongolia and one of these birds migrated back to South Korea, showing three home ranges. We also calculated area of home range in square kilometers (Table 3).

Figure 4.

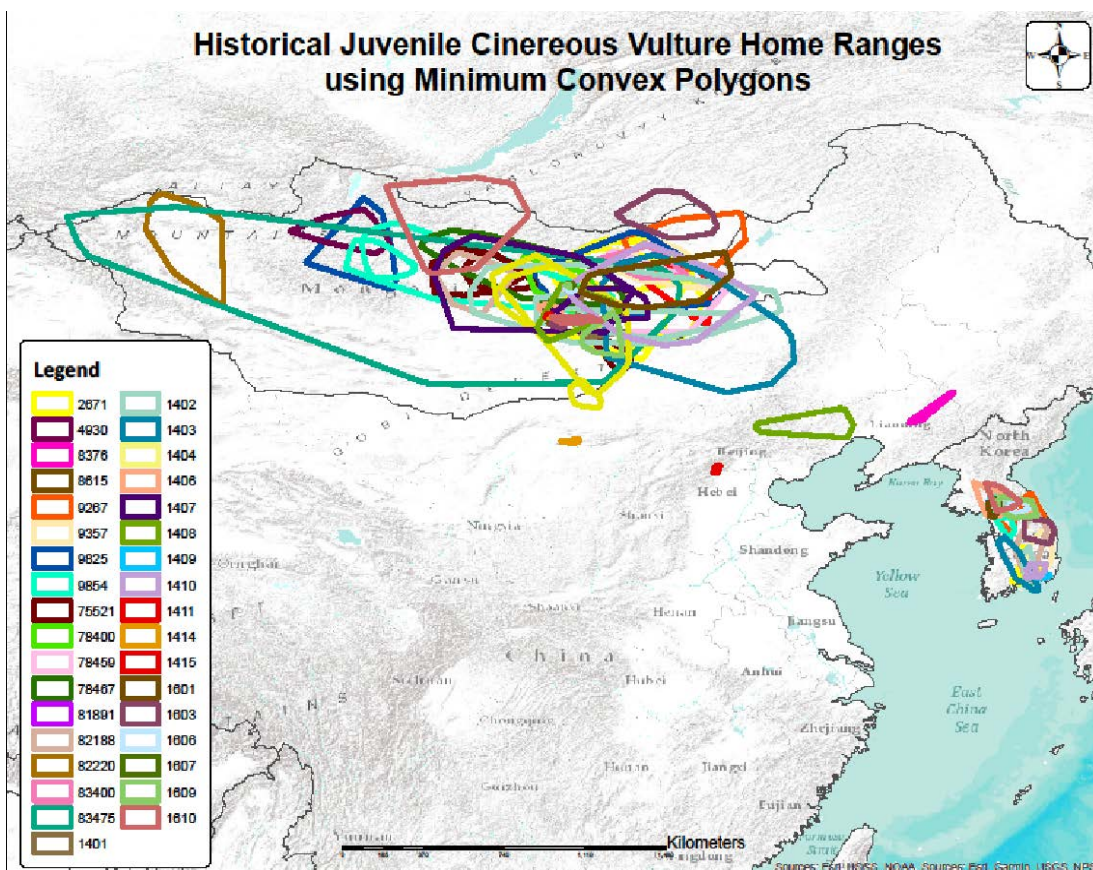Historical Juvenile Cinereous Vulture Home Ranges using Minimum Convex Polygons
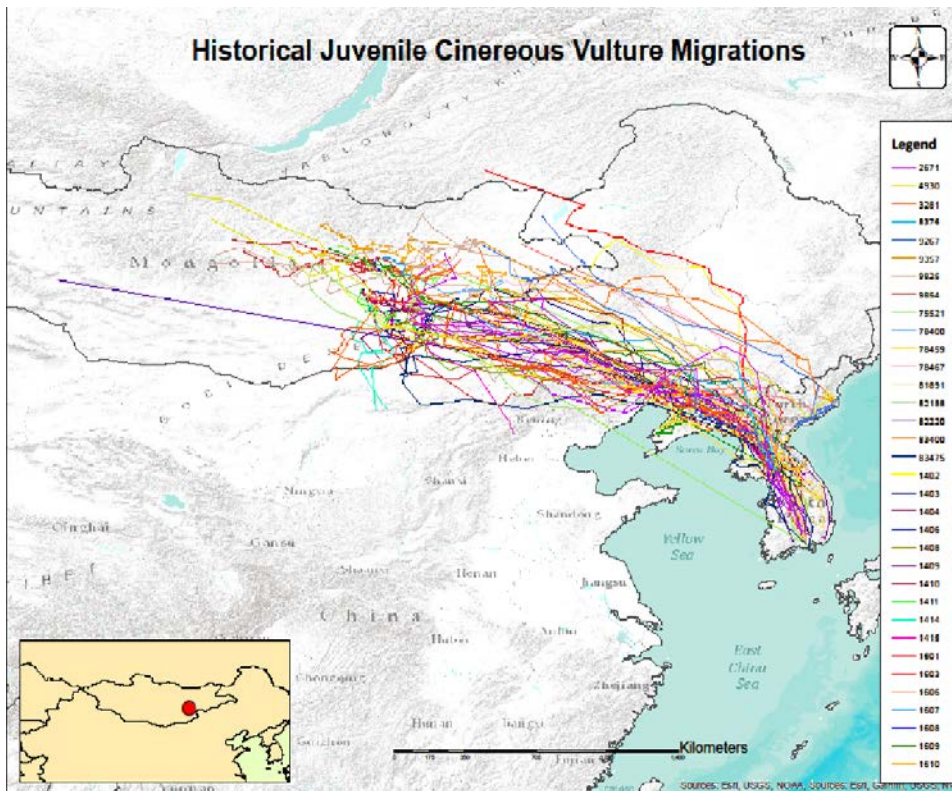
Figure 5.

Figure 6. Home ranges in South Korea for 4 juvenile cinereous vultures using 'continuous time movement modeling' (CTMM). One bird has two home ranges as it migrated from South Korea

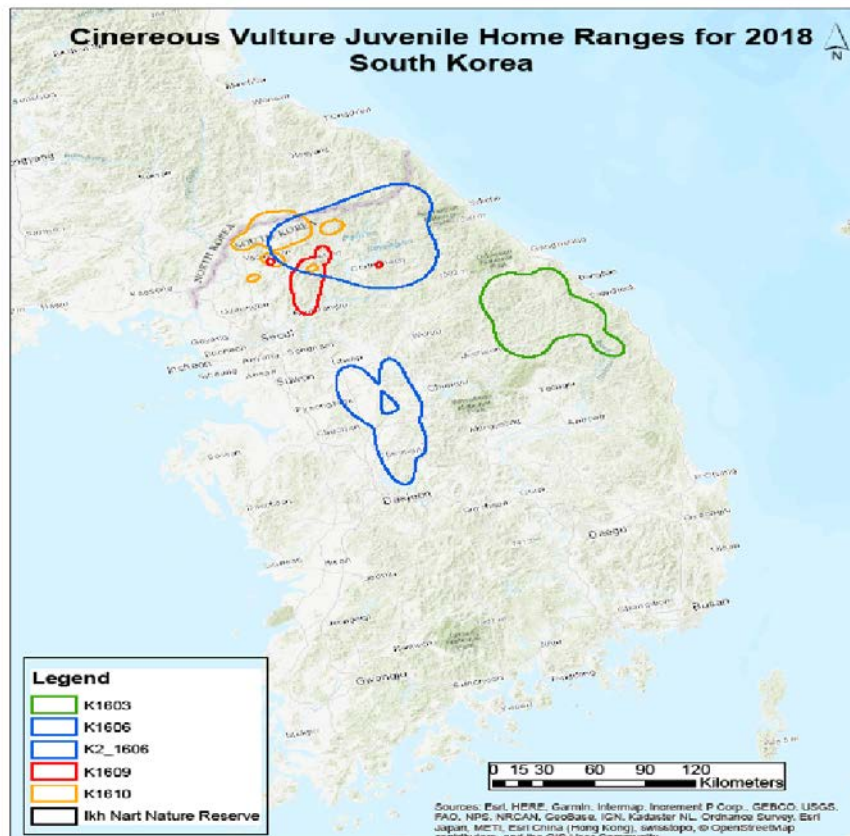to Mongolia, and back to South Korea.

Figure 7. Home ranges in Mongolia for 2 juvenile cinereous vultures using 'continuous time movement modeling' (CTMM).
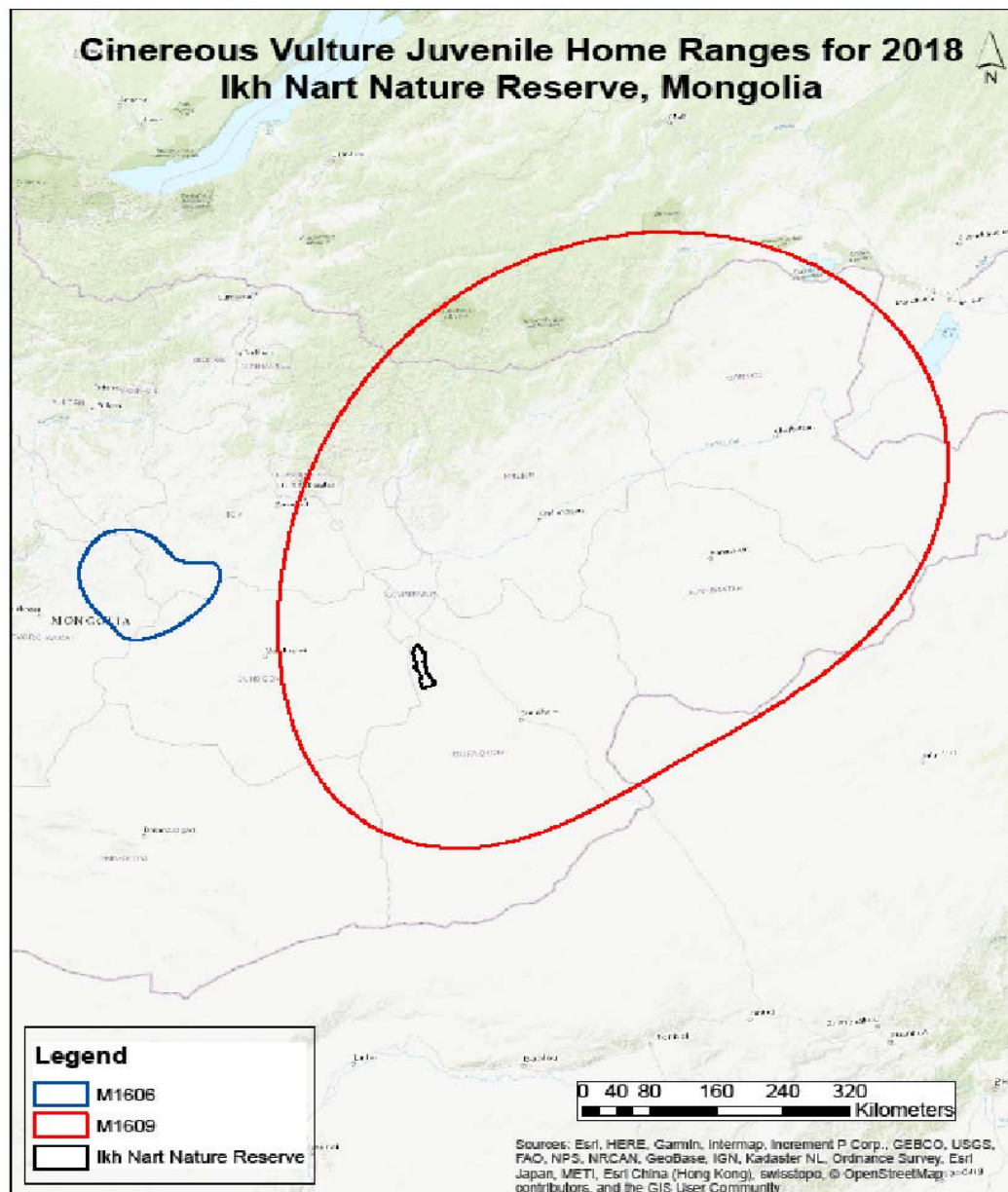

Cinereous Vulture Juvenile Home Ranges for 2018
Ikh Nart Nature Reserve, Mongolia

Legend
M1606
M1609
Ikh Nart Nature Reserve

0 40 80   160   240   320
                              Kilometers

Sources: Esri, HERE, Garmin, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

Table 3: Home range area by square kilometers per bird

ID	South Korea Home Range	Mongolia Home Range	South Korea Home Range2
1603	3368.067		
1606	2644.886	17107.04	5481.421
1609	747.928	490513.1	
1610	1205.581		

NOTE: CONFIDENTIAL PRE-PUBLICATION CONTENT REMOVED

Objective 3) Each year we capture and ear tag small mammals to estimate population sizes, species richness, and composition.

Progress towards/against Objective 3: We sampled small mammals at each of eight habitats, including sandy drainage, shrub, rocky, short grass, and long grass. For small mammals, we logged a total 288 individuals in 2018 - 5 desert hamsters (*Phodopus roborovskii*), 2 Campbell's hamsters (*Ph. campbeli*), 124 mid-day gerbil (*Meriones meridianus*), 87 Mongolian gerbil *(Meriones unguiculatus),* 5 Mongolian hamsters (Allocricetulus curtatus), 26 Siberian jerboas (*Allactaga sibirica*), and 38 northern three-toed jerboas (*Dipus sagitta*). All animals received ear tags. The small mammal study was started in 2005 when a small carnivore project was going on in Ikh Nart Nature Reserve. By now, we have continuously collected 13 years' data and more detailed small mammals analyses (by hypotheses H1, H2, H3 and H4) are in progress.

An indicator species because of their sensitivity to changes in climate and forage, we are exploring patterns of pika distribution and habitat characteristics across Ikh Nart to better understand the potential ecological impacts of climate change and livestock grazing on grassland ecosystems in the reserve. After a pilot year of surveying pika habitat sites in 2017, we developed and implemented methods in 2018 designed to better understand the physiology and health of Pallas' pika and to understand their habitat characteristics and population dynamics across Ikh Nart. During the 2018 field season, we used 10 tomahawk Model 201 Original series collapsible live traps to capture Pallas' pika at 5 previously recorded active pika habitat sites. With 55 trapping attempts, we were able to successfully capture four Pallas' pika. We collected tissue, hair, fecal, caecal, blood, temperature, and body measurements and placed ear tags in each pika (Figure 12). This data will be analyzed by ecologists from the University of Colorado and National University of Mongolia to explore Pallas' pika genetics, stress hormones, and population dynamics in 2019. Furthermore, the piloted data collection procedures have been formalized and will be used for trapping pika in 2019.

Figure 12. Pika trapping data from 2018 in Ikh Nart Nature Reserve

Date	Point	Easting	Northing	Right Ear Color	Left Ear Color	Right Ear#	Left Ear#	Weight	Stage	Sex	Foot Length
6/1/18	Trap 7	320248	5060639	YY	WW	836	896	239	A	F	33
6/4/18	Trap 8	320350	5060746	BB	GG	894	870	211	A	M	33
6/5/18	Trap 14	318944	5060795	RR	RR	715	768	132	J	M	33
6/6/18	Trap 16	319207	5060811	GG	GG	805	869	175	J	M	32
Date	Point	Repro Status	Fleas Obs	Tissue Sample	Hair Sample	Dry Pellet	Wet Pellet	Caecal Sample	Rectal Temp	Body Cond	Hydration
6/1/18	Trap 7	L	0	1	1	0	13	1	NS	good	fair
6/4/18	Trap 8	T	0	1	1	0	14	0	NS	fair	poor
6/5/18	Trap 14	U	0	1	NS	0	13	0	NS	fair	good
6/6/18	Trap 16	U	1	1	1	20	0	0	37.9	good	good

To better understand the habitat characteristics and drivers of pika distributions across Ikh Nart, we developed and implemented methods designed to explore the spatiotemporal patterns of pika distribution and population dynamics. The methods are designed to explore the effort that pikas are putting into building dens, the spatial distribution of den site construction, the activity of sites, the location of hay piles, and the rate of degradation of den sites. This data will help us

reconstruct the history of pika habitat site activity across Ikh Nart. In total, 8 sites were sampled (Figure 13).

Over the next 5 years, we will continue to monitor these pika habitat sites to better understand the potential impacts of climate change on pika distributions and persistence. We will use this data to analyze the biophysical drivers of pika persistence and distribution across Ikh Nart. In addition, this survey data will be used to look at the relationship between historical patterns of vegetation and climate and the historical patterns of pika distribution and activity. This analysis will provide critical information for Ikh Nart Managers on the potential impacts of climate change on pika populations and Ikh Nart grassland ecosystems, and may also be useful to protected area managers in American pika range in the U.S.

Figure 13. Pika Habitat Sites sampled in 2018, Ikh Nart Nature Reserve
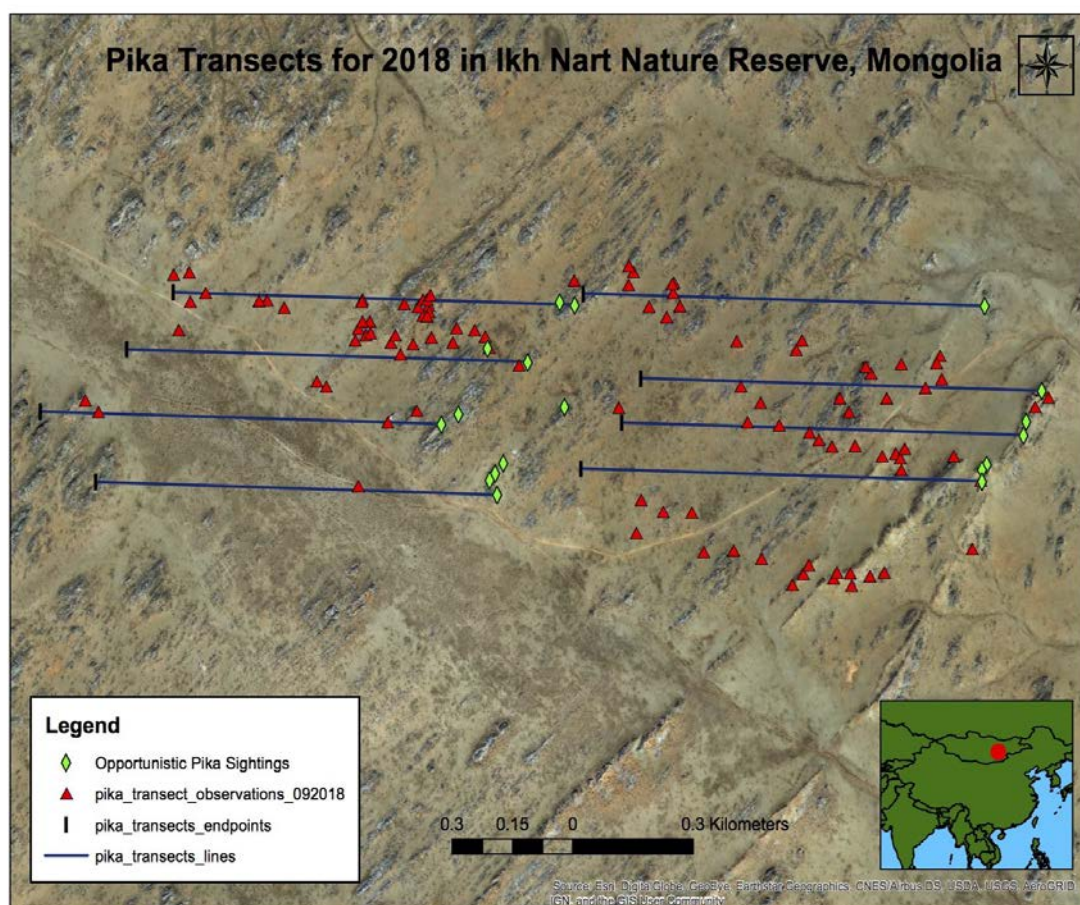
Objective 4) Each year we will capture and wing-tag 20-100 bats to determine species abundance; composition and diversity.

Progress towards/against Objective 4 (by hypotheses H1 and H2): All data from previous surveys are being compiled now and we are starting to work on its analysis and further publications. Up to date, four species have been identified at Ikh Nart including steppe whiskered bat (*Myotis aurascens*), particolored bat (*Vespertilio murinus*), Asian particolored bat (*Vespertilio sinensis*), and Gobi big brown bat (*Eptesicus gobiensis*).
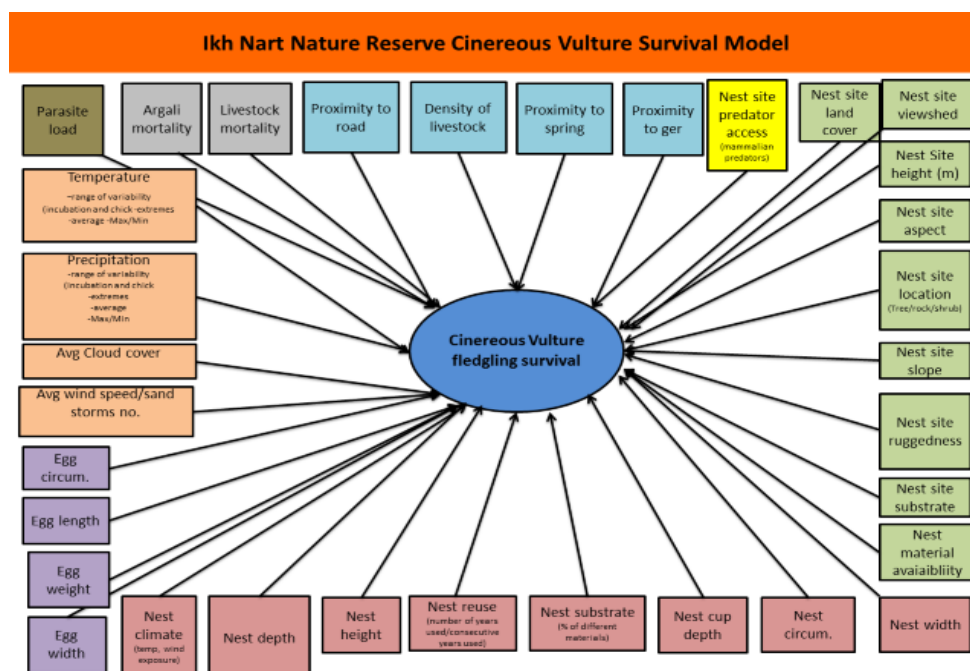
Progress towards/against Objective 5 (by hypotheses H1 and H2): We used Distance program to analyze annual abundance. For northern Ikh Nart, the density estimate is 0.1504 argali/ha or 120 argali, but the 95% Confidence Limits are 0.7602- 0.2974 argali/ha or 61 – 237 argali. For Hetsuu Teeg area: Using Hazard Rate Key Curve with 2 order of cosine adjustments, we got a density of 0.3297 argali/ha or 205 argali, but again wide 95% Confidence Limits of 0.1299-0.8368 argali ha or 81 - 521 argali (huge range, because of the small sample size for both sites).

Objective 6) Each year we will gather data on cinereous vulture and lesser kestrel nestlings to monitor nesting success. We will track the nesting success and survivorship of tagged adults of both species.

Progress towards/against Objective 6: We performed cinereous vulture observations in March (476 checked); April (120 active); and June (78 active). A total of 70 fledglings fledged and 53 juvenile vultures were measured, banded and tagged in 2018 in Ikh Nart. In 2018, 5 lesser kestrel nesting colony sites were checked for lesser kestrel nesting success and we've observed 5 active lesser kestrels at one of those colonies.

Detailed analysis of data of cinereous vultures from last the 13 years is in progress (by hypotheses H1, H2, H3 and H5) by Denver Zoo raptor team members. Using a robust multi-season, multi-state occupancy model, we are using the 13 years of cinereous vulture activity data and nest site characteristics to explore the biophysical drivers of the various stages of fledging success (e.g. nest selection, incubation, nestling, and fledgling stages) (Figure 14). Specifically, these models will be used to assess the role of climate, nest characteristics, nest site characteristics, predator density, proximity to human disturbance, and food availability in cinereous vulture fledging success. We use AICc model selection criteria to identify the top model of cinereous vulture survival and used the top model to assess the relative importance of those variables in driving the different stages of cinereous vulture fledgling success. Understanding the relative importance of each biophysical variable in cinereous vulture survival will guide Ikh Nart management and conservation action.

Figure 14. Survival Model for Cinereous Vultures, Ikh Nart including all biophysical variables included in the model.

Objective 7) Each year we monitor and assess the habitat of key species.

Progress towards/against Objective 7: We gathered vegetation data on fifty 10m^2 plots from June through September, including data on vegetation cover and composition; plant species diversity; plant rarity, use, abundance, distribution, and ecology; and community characteristics. We have now gathered vegetation data for last 11 years at Ikh Nart, and vegetation project team members continue to work on analysis of data and publications (by hypotheses H1, H2 and H3) in 2018. Last year, the vegetation team collected GPS locations of vegetation communities in the southern half of Ikh Nart and we have worked on its analyses in 2018. Our new paper Reece et al, 2018 "**Using Random Forest to Classify Vegetation Communities in the Southern area of Ikh Nart Nature Reserve in Mongolia**" is in progress.

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PROJECT IMPACTS

Report contributions in the categories below for the past fielding year.

1. Increasing Scientific Knowledge

Total citizen science research hours

Provide an estimate for the number of hours per day that volunteers spent collecting data, being trained to collect data in the field, and performing data entry. Include in this estimate transportation from housing site to the field site, and all sorts of activity for which you would typically pay a technician.

In 2018, EW volunteers spent 2,784 citizen science hours for collecting data, being trained, performing data entry, and for travel to the field site in Mongolia.

For the following items, provide full references for publications and material resulting from or supported by your Earthwatch project, indicate the status of the publication (in press, published, etc.) and whether Earthwatch was acknowledged. Include papers/material from all staff, whether or not the lead scientist is a co-author.

Peer-reviewed publications:

1. **Munkhzul, T., J.D. Murdock, and R.P. Reading. 2018.** "Ectoparasites on Meso-carnivores in the Desert-steppe of Mongolia." Mongolia Journal of Biological Sciences http://dx.doi.org/10.22353/mjbs.2018.16.06. (Published and Earthwatch acknowledged)
2. **Munkhzul, T., R.P. Reading, B. Bayarbaatar, J. Murdoch. 2018**. "Comparative Craniometric Measurements of Two Sympartric Species of *Vulpes* in Ikh Nart Nature Reserve, Mongolia." Mongolia Journal of Biological Sciences http://dx.doi.org/10.22353/mjbs.2018.16.03. (Published and Earthwatch acknowledged)
3. **Munkhzul, T., J.D. Murdock, and R.P. Reading. 2018**. Current Population Status and Conservation Properties for Genus of Vulpes in Mongolia. **(In Process).** (Earthwatch acknowledged)
4. **Ganbold, O., et. al. 2018**. The Breeding of Lesser Kestrels (*Falco Naumanni*) in Mongolia. Journal of Ornithology (**In review**). (Earthwatch acknowledged)
5. **Reading, R.P., J. Azua, J., N. Bragin, T. Garrett, D. Kenny, H. Lee, W. Paek, P. Tsolomjav, M.J. Willis, and G. Wingard. 2018**. Human-Induced Migration of Juvenile Cinereous Vultures (Aegypius monachus). (**In Process**). (Earthwatch acknowledged)
6. **Reece, N., G. Wingard, R. P. Reading, and B. Mandakh. 2018** Using Random Forest to Classify Vegetation Communities in the southern area of Ikh Nart Nature Reserve in Mongolia. (**In Process**). (Earthwatch acknowledged)

Non-peer reviewed publications (technical reports, white papers, articles, sponsored or personal blogs):

Books and book chapters:

Presentations - indicate if this was an invited paper, panel presentation, keynote speech, plenary address, or other:

1. **Wingard, G et.al.** 2018 Building and Running a Conservation Program, Ikh Nart Nature Reserve, Mongolia. Presentation to AIP Master's Program, Denver Zoological Foundation, Denver, CO.

2. Mentoring

a) **Graduate students -** *list graduate students doing thesis work on the project and include student CVs and their research proposal on file with the university as an attachment (if possible) when you submit your annual report*

Student Name	Graduate Degree	Project Title	Anticipated Year of Completion
BATZAYA	MASTER'S	ASSESSMENT OF LIVESTOCK GRAZING EFFECTS ON NESTING SUCCESS AND NESTING FAILURE AT IKH NART	2019
ENKHTUVSHIN	MASTER'S	PLANT SEPCIES DIVERSITY AT IKH NART NATURE RESERVE	2019
KHUDERCHULUUN	MASTER'S	AGE AND SEX MORTALITY RATE OF ARGALI SHEEP AT IKH NART NATURE RESERVE	2019
SUMIYA	MASTER'S	DIETARY OVERLAP OF GOITERED GAZELLE AND DOMESTIC CAMEL AT IKH NART NATURE RESERVE	2019
SERCHINMIYADAG	MASTER'S	NEST SUCCESS OF VULTURES AT IKH NART NATURE RESERVE	2019

b) **Community outreach -** *provide details on how you have supported the development of environmental leaders in the community in which you work.*

In 2018, Denver Zoo worked with partners to implement a new community engagement strategy based on the results of the 2017 Open Standards Planning meeting in which community stakeholders identified conservation targets, direct and indirect threats, and strategies for mitigating threats to these targets. The strategy focuses on (1) increasing student and teacher understanding and engagement in the conservation of wildlife, (2) engaging herding community members in the development and implementation of conservation management strategies at Ikh Nart, and (3) reducing the impact of threats to conservation targets through community awareness and participation in conservation management and ecosystem stewardship.

As part of our efforts to increase teacher and student awareness and engagement in the conservation of wildlife at Ikh Nart, Denver Zoo worked closely with three lead teachers from local schools to develop and implement a suite of conservation-focused lessons designed to supplement the 4th grade science curriculum. In collaboration with Ikh Nart conservation biologists, the three lead teachers developed 10, 4th grade lessons focused on Ikh Nart conservation messaging and piloted the lessons in the classroom with students. In addition, the teachers and Ikh Nart community engagement specialists implemented the first annual Ikh Nart field visit for all 4th and 5th grade students from three primary schools

surrounding Ikh Nart. With the help of Earthwatch volunteers, students had a chance to learn about and participate in field conservation research and management. As a result of this visit, students and teachers showed an increased understanding and appreciation for the wildlife of Ikh Nart and committed to continued involvement in conservation at Ikh Nart.

In addition to our efforts to engage 4th and 5th grade students in the conservation of wildlife, Denver Zoo and partners engaged secondary students from the Airag school eco-club in a field visit designed to increase student's awareness and engagement in conservation. During this eco-club visit, students had a chance to follow and assist Mongolian graduate students in research on wildlife at Ikh Nart. As a result of this visit, eco-club students showed increased understanding of the importance of the conservation of wildlife at Ikh Nart and an increased interest and commitment to pursuing a career in conservation.

Engaging community members in the development and implementation of conservation strategies is essential for effective and sustainable wildlife conservation. In 2018, Denver Zoo and partners began piloting "ger to ger" outreach with the goal of better understanding the perspectives and values of the 150 families living within Ikh Nart Nature Reserve. During these outreach visits, community engagement specialists will be collecting data on the demographics of each family, their perspectives on the value of Ikh Nart, and their knowledge about how the rangelands and wildlife of Ikh Nart has varied through the duration they have lived in Ikh Nart. In addition, they will participate in a participatory mapping activity that will assess their spatial and temporal pasture use and perspectives on the drivers of grassland productivity. This data will provide baseline information on the perspectives of local community members needed to ensure that management strategies align with the needs and resource use of community members.

Lastly, based on the threats to wildlife and the potential mitigation strategies identified by community stakeholders in 2017, Denver Zoo and partners have assisted Ikh Nart Park Administration with the development of a new 5-year management plan. This management plan focuses on the implementation of strategies that have been identified and are supported by community members and are designed to balance human resource needs with wildlife conservation. This management plan includes continued conservation education with local schools, increased herding community engagement in the development of a rangeland management plan, and the implementation of a community ambassador program. These community engagement strategies will increase community support for and engagement in the conservation of wildlife at Ikh Nart.

Name of school, organization, or group	Education level	Participants local or non-local	Details on contributions/ activities
Dalanjargalan School students	Primary School	Local Mongolian students and teachers	150 Mongolian 4th and 5th grade students and 10 teachers were engaged in conservation-focused lessons integrated into the curriculum and participated in an Ikh Nart field visit in June 2018
Airag School students	Primary School	Local Mongolian students	200 Mongolian 4th and 5th grade students and 10 teachers were engaged in conservation-focused lessons integrated into the curriculum and participated in an Ikh Nart field visit in June 2018

Airag school eco-club students	Secondary School Students	Local Mongolian students	15 secondary school students from Airag school participated in conservation-focused activities and attended a field visit to Ikh Nart Nature Reserve to participate in field research.
Airag and Dalanjargalan School teachers	Teachers	Local Mongolian teachers	15 teachers from Dalanjargalan and Airag primary schools participated in a series of workshops to develop a suite of conservation-focused lessons that complement the 4th grade curriculum, piloted the implementation of these lessons in the classroom, and helped organize and lead a field visit to Ikh Nart in June 2018.
Ikh Nart Nature Reserve herding community	All	Local (Mongolian herders, students, teachers, researchers, government officials)	150 families are participating in ger to ger outreach designed to better understand their perspectives and values related to the conservation of wildlife at Ikh Nart.
Local government	Soum government	Soum government officials	Two governors from the local Soums participated in a workshop designed to evaluate and implement strategies to engage community members in the conservation of wildlife at Ikh Nart.

3. Partnerships

List your current active professional partnerships that contribute to your project and indicate the type of support these partners provide

Partner	Support Type(s)[1]	Years of Association (e.g. 2006-present)
DENVER ZOOLOGICAL FOUNDATION	FUNDING, COLLABORATION, AND TECHNICAL SUPPORT	1996 – PRESENT
MONGOLIAN CONSERVATION COALITION (NGO)	LOGISTICS, COLLABORATION AND CULTURAL SUPPORT	2004 – PRESENT
ARGALI RESEARCH CENTER (NGO)	PERMITS, TECHNICAL SUPPORT AND LOCAL COLLABORATION	2004 – PRESENT
NATURE CONSERVANCY MONGOLIA OFFICE	PERMITS, TECHNICAL SUPPORT AND LOCAL COLLABORATION	2015- PRESENT
MONGOLIAN NATIONAL CENTRAL VETERINARY LABORATORY	DIAGNOSTIC TESTING, SURVEILLANCE AND RESEARCH OF DISEASE, TECHNICAL SUPPORT AND LOCAL COLLABORATION	2010 –PRESENT
NATIONAL UNIVERSITY OF MONGOLIA	UNDERGRADUATE AND GRADUATE STUDENTS' PARTICIPATION	2004 – PRESENT
MONGOLIAN STATE UNIVERSITY OF EDUCATION	ACADEMIC SUPPORT AND UNDERGRADUATE AND GRADUATE STUDENTS' COLLABORATION	2004 – PRESENT

[1.] Support type options: funding, data, logistics, permits, technical support, collaboration, academic support, cultural support, other (define)

4. Contributions to management plans or policies

List the management plans/policies to which your project contributed this year

Plan/Policy Name	Type[2]	Level of Impact[3]	New or Existing?	Primary goal of plan/policy[4]	Stage of plan/policy[5]	Description of Contribution
Asian Raptor Research and Conservation Network	Management Plan	International	Existing	Species conservation	In progress	Reviews
Ikh Nart Nature Reserve Management Plan	Management Plan	Local	New	Species conservation	In progress	Recommendations

[2] Type options: agenda, convention, development plan, management plan, policy, or other (define)
[3] Level of impact options: local, regional, national, international
[4] Primary goal options: cultural conservation, land conservation, species conservation, natural resource conservation, other
[5] Stage of plan/policy options: proposed, in progress, adopted, other (define)

5. Conserving natural and sociocultural capital

a) Conservation of taxa

List any focal study species that you did not list in your most recent proposal

Species	Common name	IUCN Red List category	Local/regional conservation status	Local/regional conservation status source

   ii. *In the past year, has your project helped conserve or restore populations of species of conservation significance? If so, please describe below.*

Species	IUCN Red List category	Local/regional conservation status	Local/regional conservation status source	Description of contribution	Resulting effect[6]
Siberian ibex (*Capra sibirica*)	Least concerned	Threatened in the Mongolian Red Book of Threatened and Endangered Species	"Mongolian Red List of Mammals" Edited by S. Dulamtseren, J. E. M. Baillie, N. Batsaikhan, R. Samiya and M. Stubbe	Since 2003, we have captured and radio collared 74 ibex. Based on locations from tracked collared animals, the project analyzes argali home ranges	Population increase; Range increased Improved habitat for species
Eurasian black vulture (*Aegypius monachus*)	Near Threatened	Appendix II of CITES and Bonn Conventions	Websites of CITES and BONN Conventions	We collected valuable data on juvenile vulture migration routes as we have begun research into seasonal movement patterns.	Improved habitat for species
Siberian Marmots (*Marmota sibirica*)	Endangered	Threatened in the Mongolian Red Book of Threatened and Endangered Species	"Mongolian Red List of Mammals" Edited by S. Dulamtseren, J. E. M. Baillie, N. Batsaikhan, R. Samiya and M. Stubbe	We continue to collect data on marmot habitat sites using camera traps.	Range increased; Improved habitat for species

[6] Resulting effect options: decreased competition, improved habitat for species, range increased, population increase, improved population structure, increased breeding success, maintained/enhanced genetic diversity, other

b) **Conservation of ecosystems** - in the past year, has your project helped conserve or restore habitats? If so, please describe below.

Habitat type	Habitat significance[7]	Description of contribution	Resulting effect[8]
Canyons leading into valley floors at Ikh Nart	Other: Corridors towards known springs and washes	We have built over 25 rock dams, Zuni bowls and half-moon structures designed to restore and recover natural hydrologic processes.	Improved resilience by encouraging the recovery of strained hydrologic processes due to climate change, drought and overgrazing. Additionally, the project is designed to expand the availability of water resources spatially and temporally, between storm events, and beyond seasonal summer monsoons.

[7.] Habitat significance options: nursery, breeding ground, feeding site, corridor, migration path, refuge, winter range, summer range, spring range, fall range or other (define)

[8.] Resulting effect options: extent maintained, condition achieved, restored, expanded, improved connectivity or resilience

c) **Ecosystem services** - indicate which ecosystem service categories you are directly studying in your Earthwatch research and provide further details in the box below.

☒Food and water

☐Flood and disease control

☐Spiritual, recreational, and cultural benefits

☐Nutrient cycling

☐Carbon sequestration

Details:

In 2018, we continued to protect water sources in the area. We fixed fences near the sources at Burgas and Red Rock Valleys, the only permanent water sources in the reserve. Otherwise, these natural water sources would be destroyed and damaged by the increasing numbers of livestock in the reserve.

d) **Conservation of cultural heritage** - provide details on intangible or tangible cultural heritage components that your project has conserved or restored in the past year.

Cultural heritage component[9]	Description of contribution	Resulting effect

[9.] Cultural heritage component options: traditional agriculture, artifacts, building(s), hunting ground or kill site, traditional ecological knowledge and practices, monument(s), oral traditions and history, spiritual site, traditional subsistence living