Impact case study (REF3)

REF2021

Institution: University of Oxford

Unit of Assessment: 5 – Biological Sciences

Title of case study: Feline landscapes: shaping conservation policies and enhancing protection of threatened cat species

Period when the underpinning research was undertaken: January 2000 – July 2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
David W. Macdonald	Director of WildCRU	1986 - present
Andrew Loveridge	Senior Research Associate	1999 - present
Żaneta Kaszta	Postdoctoral Research Fellow	Jul 2017 - Dec 2020
Andrew Hearn	Research Staff	Apr 2017 - present

Period when the claimed impact occurred: August 2013 – August 2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact

The University of Oxford Wildlife Conservation Research Unit (WildCRU) developed and applied a suite of analytical techniques in landscape conservation ecology, based on innovative field methodologies using animal tracking and survey techniques, to understand the distribution, ecology, population biology and vulnerability of the majority of the world's cat species. The research has directly shaped land-use and conservation policies and practice across at least 15 countries in Asia, Africa and Europe. New conservation measures based on this research have helped to protect endangered and vulnerable felids including clouded leopard species, the Indochinese leopard, African lion and Scottish wildcat, and entire ecosystems important for biodiversity and local populations have had improved protection.

2. Underpinning research

Felid species play outsized roles in ecosystems as top-down regulators of community structure, but 27 of the approximately 37 species of wild Felidae are classified as threatened, and all are impacted by human activities, habitat loss and conflict. Since the 1980s, research by the University of Oxford's WildCRU, led by David Macdonald, has addressed the conservation status and threats facing 28 felid species. Since 2000, WildCRU has made major advances through developing field technologies and methods of analysis, and applying these in an integrated, policy-relevant manner.

Camera-trapping & GPS-tracking
Since 2012, WildCRU have developed methods and deployed camera-traps across a broad range of biomes, amassing more than 12,000,000 images of more than 300 terrestrial vertebrate species from 11 countries and covering more than 40,100km^2. This has provided the world's largest and most extensive remote camera database for felids. They have GPS-tracked more than 200 big cats, providing the largest lion movement tracking database, and the only GPS data on clouded leopards. These field technologies are exemplified by a study of 50 GPS-tracked African lions over 10 years in the Kavango Zambezi Transfrontier Conservation Area (KAZA) in Southern Africa [1], and systematic camera trap surveys in Laos between 2013 and 2017, at approximately 300 locations [2].

Animal movement and population connectivity
University of Oxford WildCRU research made several important contributions to developing methods of modelling animal movement and predicting population connectivity. For example, using GPS-tracking data, they used a resistance surfaces approach to model patterns of connectivity of different lion demographic groups [1]. These methods provide empirically-based knowledge of factors that drive animal habitat use and movement, which is essential for accurate assessment of impacts of landscape change. Also using GPS data, they developed two of the

most powerful methods of connectivity analysis: resistant kernel and the factorial least cost path analysis (e.g. [3]), which improve assessment and mapping of population connectivity, corridors and barriers, and enable assessment of connectivity at multiple scales.

Multiple-scale species distribution modelling
With empirical data from camera-traps, the researchers used machine learning methods to optimise multivariate, multiscale habitat relationships, improving the accuracy and utility of species distribution modelling for rare carnivores [2, 4]. The novel analytical approaches used by WildCRU improved prediction of habitat selection and species distributions, and these methods and analyses – exemplified by the research on tigers and leopards in Laos [2] and felids including Sunda clouded leopards in Sabah (Borneo) [4] provide essential information for ecological assessment and conservation planning. In Sabah, the camera-trap survey [4] was a collaboration with the director of the field station (B. Goossens, University of Cardiff).

Habitat and Scenario Analysis
WildCRU researchers have integrated several major branches of ecological research – multi-scale modelling, connectivity modelling and individual-based genetic and population simulation approaches – to evaluate spatially explicit scenarios, such as infrastructure developments or conservation interventions (e.g. [5, 6]). This research enables identification of solutions that meet economic objectives while maximizing the efficacy of biodiversity protection. For example, directly with government officials in countries including Borneo [5] and Myanmar [6] they developed and applied data-driven 'tool kits' to evaluate large numbers of realistic alternative future scenarios, to support decision making.

3. References to the research (University of Oxford employees in bold, students in italic)

1. *Elliot N*, Cushman S, **Loveridge A**, & **Macdonald DW** (2014). The devil is in the dispersers: predictions of landscape connectivity change with demography. *Journal of Applied Ecology* 51:1169-1178 DOI:10.1111/1365-2664.12282.
   136 citations (Google Scholar 01-2021)

2. *Rasphone A*, Kéry M, **Kamler JF**, & **Macdonald DW** (2019). Documenting the demise of tiger and leopard, and the status of other carnivores and prey, in Lao PDR's most prized protected area: Nam Et-Phou Louey. *Global Ecology and Conservation*, 20, e00766 DOI: 10.1016/j.gecco.2019.e00766. 19 citations (Google Scholar 01-2021)

3. Cushman SA, **Elliot NB**, **Bauer D,** Kesch K, Bahaa-el-din L, Bothwell H, Flyman M, Mtare G, **Macdonald DW** & **Loveridge AJ**. (2018). Prioritizing core areas, corridors and conflict hotspots for lion conservation in southern Africa. *PLoS One*, 13(7), e0196213. DOI:10.1371/journal.pone.0196213. 31 citations (Google Scholar 01-2021)

4. **Hearn AJ,** Cushman SA, **Ross J**, Goossens B, Hunter LT, & **Macdonald DW**. (2018). Spatio-temporal ecology of sympatric felids on Borneo. Evidence for resource partitioning?. *PLoS One*, *13*(7), e0200828. DOI:10.1371/journal.pone.0200828. 21 citations (Google Scholar 01-2021)

5. **Kaszta Ż,** Cushman SA, **Hearn AJ**, **Burnham D, Macdonald EA**, Goossens B, Nathan SK & **Macdonald DW**. (2019). Integrating Sunda clouded leopard (*Neofelis diardi*) conservation into development and restoration planning in Sabah (Borneo). *Biological Conservation*, 235, 63-76. DOI:10.1016/j.biocon.2019.04.001. 14 citations (Google Scholar 01-2021)

6. **Kaszta Ż,** Cushman SA, Htun S, Naing H, **Burnham D** & **Macdonald DW**. (2020). Simulating the impact of Belt and Road Initiative and other major developments in Myanmar on an ambassador felid, the clouded leopard, *Neofelis nebulosa*. *Landscape Ecology* 35, 727-746. DOI:10.1007/s10980-020-00976-z

4. Details of the impact

The integrated techniques developed by WildCRU for modelling ecological processes and assessing their impacts on wild felids have had widespread impact on decisions and implementation by policy-makers, conservation practitioners, and planners worldwide.

Influencing policy to protect essential habitats

Ulu Muda, Malaysia

In **Malaysia**, WildCRU research had a crucial role in delivering protection of Ulu Muda Forest, which is one of the most critical pristine forests remaining in the region, rich in biodiversity and providing essential habitat for vulnerable clouded leopards and many other species. Ulu Muda covers approximately 160,000ha and is also the source of water for 4,200,000 people and at least 40% of the country's rice production. WildCRU studies of rare leopards in Ulu Muda in 2015 and integration of data into Malaysian national planning for clouded leopards in 2017 (using tools exemplified in [2, 4, 5]) attracted significant interest from the Department of Wildlife and National Parks Peninsular Malaysia (PERHILITAN) [A]. Their camera-traps documented illegal logging and poaching at Ulu Muda, which WildCRU and a local conservation group communicated in 2017 in a video "Saving Ulu Muda" [Bi] that was broadcast on national television as well as online [A], and WildCRU work was extensively highlighted in press coverage [Bii]. These videos were coupled with a petition that gained over 102,000 signatures [A, Biii]; one month after the petition was sent the government, all logging permits at Ulu Muda were revoked in September 2018 [A, Biv].

Myanmar

In 2018 in **Myanmar**, the results of WildCRU analyses (including [6]) of the impact of many major past, ongoing and potential future developments on clouded leopard populations were presented to senior government officials including the Director General of the Myanmar Forest Department, and international non-governmental organisations [C]. After meeting D. Macdonald, Aung San Suu Kyi (State Counsellor of Myanmar and Minister of Foreign Affairs) assigned people from her personal charity to facilitate application of the WildCRU methods in Myanmar [C]. Based on this research and using the WildCRU 'toolkit', the Forest Department modelled important wildlife corridors for felids at the country-scale and applied this information to assess the environmental feasibility for all development projects in the country [C]. These development assessments included proposed mining exploration in northern Myanmar and proposed highway development project in central Myanmar.

Wider South-East Asia

Similarly, in **Borneo** from 2017, WildCRU used their multispecies modelling tools (e.g. [5, 6]) to assess the likely impact of 59 components of the infrastructure and land-use plans in Sabah state (the Sabah Structure Plan 2033) on the vulnerable Sunda clouded leopard; notably, Sabah has one of the highest deforestation rates in the world. This analysis influenced senior government officials, exemplified by a meeting with the Sabah Deputy Chief Minister in 2018 [A, Di]. WildCRU multi-species and multi-scale analyses (exemplified by [5, 6]) have also helped several other governments in South-East Asia to identify important areas for conservation, such as core habitats and corridors. For example, in **Thailand**, a key breeding area for tigers was identified as threatened by a proposed major roadway and dam project, contributing to UNESCO strongly advising against the development in 2017 [Dii]. In **Bhutan**, WildCRU has worked closely with the government to develop a toolkit identifying key areas for conservation [Diii]. In **Sumatra, Indonesia**, in 2020 the government planned designation of high conservation value areas based on WildCRU methods, and adopted the framework for identifying core areas and corridor networks between protected areas [Div].

Shaping landscape-level land use strategies

KAZA Transfrontier Conservation Area

The WildCRU landscape conservation planning toolkits and analyses (based on research including [1, 3]), including approximately 6,000,000 camera-trap images, have directly guided development and conservation decisions in the Kavango Zambezi Transfrontier Conservation Area (KAZA TFCA, spanning **Botswana, Zimbabwe, Zambia, Namibia, Angola**), an area of approximately 520,000km^2 with exceptionally high global biodiversity value. WildCRU has worked closely with KAZA officials [E] and led workshops in Botswana and Zimbabwe in October 2018, attended by senior government and conservation officials [E, F]. Through these close interactions, WildCRU research has directly influenced incorporation of wildlife corridors and landscape connectivity into large-scale development and conservation strategies including: Master Integrated Development Plan for KAZA TFCA (2015-2020); Wildlife Dispersal Areas for KAZA TFCA (2013-2015); and KAZA Carnivore Conservation Coalition Strategy (2018-2022) [E, F]. The Executive Director of the KAZA Secretariat stated that the impact of the WildCRU research has

been "*hugely significant and at a landscape-level scale*" [E]. Within KAZA, the research has also shaped national policies, including in **Zimbabwe**. The Zimbabwe National Parks and Wildlife Management Authority National Coordinator for Transfrontier Conservation Areas stated that WildCRU research was important for landscape-level scale integrated land-use planning that evaluated the compatibility of activities such as mining, tourism, conservation around Hwange National Park, directly influencing the Authority's thinking on lion conservation, and providing "*pivotal*" information for policies including the Hwange National Park General Management Plan (2016-2026) and Lion Conservation Strategy for Zimbabwe (2020-2025) [F].

Kenya

Similarly, in **Kenya**, WildCRU modelling (based on research including [1, 3]) supported the government and the Kenya Wildlife Service (KWS) to develop the national Recovery and Action Plan for Lion and Spotted Hyena 2020-2030 [G, Hi], for these two species with important ecological roles in savannah ecosystems and major population declines. Launched in August 2020, the action plan takes landscape-level approaches towards conservation and includes utilisation of the WildCRU decision support toolkit methods [Hi]. The Minister for Tourism and Wildlife acknowledged the key role of WildCRU in the action plan [G, Hi]. The Chief Executive of a landowner membership organisation (The Kenya Wildlife Conservancies Association), also representing Maasai communities, commented that "*the National Strategy, and the consultations and research that underpinned it…have already changed things here, both on the ground and at a policy level*" and that the work is "*a beacon of how conservation should interact with local people and with local decision makers to deliver impact on the ground*" [Hii].

Enhancing species protection

International species status

WildCRU research has informed international decision-making on the status of several felid species. The International Union for Conservation of Nature (IUCN) Red List of Threatened Species is used globally as a basis for conservation and policy changes, and WildCRU data has been essential for assessments that have determined the status of felids in South-East Asia (confirmed by [A]): Sunda clouded leopard (vulnerable, 2015) [Ii]; Borneo bay cat (endangered, 2016) [Iii]; marbled cat (near threatened, 2015) [Iiii]; leopard cat (least concern, 2015) [Iiv]; and, crucially, the up-listing of the Indochinese leopard to critically endangered in 2019 [Iv], based almost entirely on WildCRU work [J]. In 2017, lions were added to the UN Convention on Migratory Species (CMS), and the Head of the Terrestrial Species Team for CMS confirmed that evidence from WildCRU research on lions ([1, 3], as examples of a large body of work) was pivotal in this decision [Ki]. Furthermore, the Chief of the UN CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) Science Unit stated that WildCRU work on lions has been "*extremely influential*" on decision making, including on measures for conserving lions and other big cats that the 183 Parties to CITES agreed to in 2016 and 2019 [Kii].

National action to protect rare leopards

The work by WildCRU and their collaborators on Sunda clouded leopards in Sabah, **Borneo** (Malaysia) (e.g. [4, 5]), underpinned an international workshop on conservation of this species in June 2017 and the drafting of the first state-level action plan for the species [A]. This 'Sunda Clouded Leopard Action Plan for Sabah' was endorsed by the state government in June 2019 [A], and was instrumental in securing a donation of approximately GBP700,000 (MYR4,000,000, 06-2019) from the Sime Darby Foundation to support anti-poaching work, in June 2019 [A].

In **Cambodia**, camera-trap work by WildCRU (exemplified by [2]) since 2012 showed an alarming population decline in one of last remaining populations of Indochinese leopards. From 2014, this resulted in WWF-Cambodia and local authorities changing their patrolling regime to focus on hotspots of remaining leopards and hiring 6 new WWF staff in 2016 to improve efficacy of patrols [J]. The WildCRU data also led to implementation of snare-removal teams (which have removed 5,000 snares between 2016 and 2020), and identification of poacher movements, leading to arrests [J]. As an emergency measure to protect the last leopards, WWF implemented fencing of areas where the leopards occur, identified from the camera-trap data. WWF-Cambodia stated that the WildCRU research "*has led to vast improvements and increased efficiency of our law enforcement activities, approved by the Cambodian government*" [J].

In **Iran**, WildCRU used species distribution models (e.g. based on [2, 4]) to map potentially suitable habitats for the Persian leopard and Asiatic cheetah. In 2019, these data influenced the inclusion

of the Persian leopard in the Central Asian Mammals Initiative (CAMI) and the Iranian Department of Environment's submission for future inclusion in the UN CMS [Li]. The WildCRU work directly resulted in the development of a tool kit for managing conflict between human and large carnivores, including Persian leopards, which was distributed to more than 3,000 Iranian rangers, and formally adopted and published in 2019 by the Iranian Department of Environment [Lii].

Shaping conservation actions for the Scottish wildcat

WildCRU applied their camera-trap and GPS collar approaches (exemplified by [1, 2]) to survey wildcats in **Scotland** from 2010 and 2015, respectively [M]. The camera-trap data and WildCRU researchers made important contributions to the 2015 Scottish Wildcat Conservation Action Plan, including identifying 6 priority areas for conservation efforts [M]. These data, and WildCRU work on wildcat genetics, led to the IUCN concluding in 2018 that the wildcat was at risk of immediate extinction in Scotland without population reinforcement [M]. In response, the European Union funded the Saving Wildcats project (2019-2015) to re-introduce and reinforce wildcat populations, with WildCRU GPS data contributing to choices of re-introduction sites [M].

5. Sources to corroborate the impact

A. Letter from Wildlife Officer, PERHILITAN, Malaysia (Jan 2021), describing influence of WildCRU research.

B. Communications and campaigning about saving Ulu Muda Forest: i) video on YouTube, Sep 2017 https://www.youtube.com/watch?v=yYEEa5t_Ugo; ii) articles in The Star (Malaysia) May 2017 describing threats to Ulu Muda, and WildCRU work; iii) online petition, "Protect the threatened Greater Ulu Muda forest" and update; iv) The Star TV (Malaysia) report, 4 Sep 2018 (video available online https://www.thestartv.com/v/no-more-logging-in-ulu-muda).

C. Letter from Wildlife Conservation Society, Country Director for Myanmar (Jan 2021), describing influence of WildCRU research.

D. Descriptions of application of WildCRU tool kits in south-east Asia: i) Borneo Post news report on tool kit for planners in Sabah, Borneo (Dec 2018); ii) UNESCO World Heritage Committee decisions on Dong Phayayen Khao Yai Forest Complex, p25 (July 2017); iii) letter from Director, Department of Forests and Park Services, Bhutan (Jan 2021); iv) letter from Director General of Natural Resources and Ecosystem Conservation, Indonesia (Jan 2021).

E. Letter from Executive Director of the KAZA Secretariat (Jan 2021), describing influence of WildCRU research on policy.

F. Letter from Zimbabwe National Parks and Wildlife Management Authority National Coordinator for Transfrontier Conservation Areas (Jan 2021), describing influence of WildCRU research on policy.

G. Kenya Recovery and Action Plan for Lion and Spotted Hyena 2020-2030, acknowledging contribution of WildCRU to the strategy. https://wwfke.awsassets.panda.org/downloads/national_recovery_and_action_plan_for_lion__digital_copy_.pdf

H. Letters from Kenyan wildlife professionals: i) from Director General, Kenya Wildlife Service (Jan 2021); ii) from Chief Executive, Kenya Wildlife Conservancies Association (Jan 2021).

I. IUCN Red List of Threatened Species assessments, each citing WildCRU research: i) Sunda clouded leopards; ii) Borneo bay cat; iii) marbled cat; iv) leopard cat; v) Indochinese leopard.

J. Letter from Head of Law enforcement, WWF-Cambodia (Jan 2021), describing influence of WildCRU research on leopard conservation.

K. Letters from UN bodies, confirming influence of WildCRU research on decisions: i) Chief of Science Unit, CITES Secretariat (Jan 2021); ii) Head of Terrestrial Species Team, CMS Secretariat.

L. Documents on conservation of the Persian leopard: i) Convention on Migratory Species news report (Oct 2019), describing protection of Persian leopard by CAMI;
ii) A Manual on Human-Large Carnivore Conflict Management in Iran (in Persian, references in English, August 2019), citing WildCRU studies (e.g. ref 28-32), and co-authored by WildCRU researcher. ISBN 9786008364559.

M. Letter from Species Project Manager, NatureScot (formerly Scottish Natural Heritage) (Jan 2021), describing WildCRU contributions to wildcat conservation.