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Trout in hot water: A call for global action

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The road to wild yak protection in China

China is home to about 22,000 wild yaks, which account for 90% of the global wild yak population (*1*). The International Union for Conservation of Nature (IUCN) categorizes the wild yak, a cold-tolerant herbivore, as a vulnerable species (*2*), mainly attributable to excessive hunting for food and trade. China's wild yak is also threatened by land-use change, disease, environmental pollution, genetic contamination, climate change, and resource competition (*1*, *3*, *4*). In recent decades, infrastructure construction in China has grown increasingly disruptive to remaining wild yak populations.

Most wild yaks live in or near the Tibetan Plateau (*1*). These regions are located in or adjacent to areas zoned for the Western Development Strategy (*5*), an ambitious plan proposed in 1999 to increase the economic level and quality of life of China's rural citizens. The plan's implementation has accelerated the construction of railways and roads. Railways in the central western region of China, which account for 76.6% of China's current rail traffic (*6*), expanded from 70,000 km in 2014 (*7*) to 95,000 km in 2016 (*6*). Meanwhile, highway density increased from 7.7 km/100 km^2 in 1999 to 20.6 km/100 km^2 in 2008 (*8*). The increasing density of railways and roads has fragmented the habitats of wild yaks and forced them to migrate to resource-limited areas to escape from predation and conflict with humans.

China's wild yaks are an important genetic resource for breeding new yak species in an effort to sustainably develop animal husbandry in the Tibetan area and enrich the region's biodiversity (*1*, *9*). Wild yaks are also an important component of biodiversity in nature (*9*). To protect China's wild yaks, the Chinese government has built several nature reserves (*10*, *11*), but even there, the yaks are threatened by illegal hunting (*10*). To ensure the safety of China's wild yaks, China must further expand the nature reserves and effectively enforce existing hunting bans. The government should also implement scientific management and protection policies that minimize habitat fragmentation, resource plunder, and predation.

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Trout in hot water: A call for global action

Trout are one of the most culturally, economically, and ecologically important taxonomic groups of freshwater fishes worldwide (*1*). Native to all continents in the Northern Hemisphere, trout belong to seven genera, which are distributed across 52 countries. These cold-water specialists provide recreation and food to millions of people and play important roles in ecosystem functioning and health (*2*). They are also extremely sensitive to human disturbances because they require cold, clean, complex, and connected habitats for survival and persistence (*3*)—all attributes that humans have substantially altered and degraded (*4*, *5*). Despite their importance as societal icons and as indicators of biodiversity, many of the world's trout species and lineages are endangered and some require immediate conservation efforts to reverse their precarious decline.

Of the 124 recognized species of trout (*6*, *7*), only 67 (54%) have been assessed by the International Union for Conservation of Nature (IUCN) (*7*). Alarmingly, 73% of these species are currently threatened with global extinction, and four are now extinct (*7*). Although some of these species are likely subspecies, lineages, or distinct ecotypes, this level of threat is exceptionally high compared with other vertebrate groups assessed by the IUCN (*8*). Widespread imperilment of trout reflects numerous human activities identified in the IUCN assessments, including invasive species, overfishing, pollution, dams, deforestation, agriculture, grazing, and mining (*7*). Climate change is further stressing trout populations by warming water temperatures, shifting streamflow regimes, increasing extreme events (such as floods, drought, and wildfire), and facilitating species invasions (*9*, *10*). Worse, climate change often acts in synergy with other stressors to further endanger trout (*11*, *12*), a pattern that will be intensified in coming decades as global temperatures continue to rise, with important consequences for trout, aquatic ecosystem functioning, and human well-being.

Reversing these declines will require progressive conservation efforts to protect native trout diversity and ameliorate ongoing and future threats at local and global scales. To preserve these unique fishes, we must protect ecological and genetic diversity, which are critical for long-term resiliency, viability, and adaptation in the face of rapid environmental change. Innovative conservation approaches include reconnecting rivers with floodplains, establishing native fish refuges, restoring habitat diversity, and reducing invasive species, including non-native trout stocking programs. Moreover, comprehensive, coordinated, and comparable approaches are needed immediately to assess conservation status and to delineate conservation units across the globe, particularly for data-poor species. Only by

Many trout species, such as these native bull trout, are endangered.

PHOTO: JOEL SARTORE

addressing threats at their root causes can we accomplish these conservation goals.

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6. We searched the FishBase database (www.fishbase.org) for all described freshwater species of trout belonging to the genera *Oncorhynchus*, *Salvelinus*, *Salmo*, *Hucho*, *Parahucho*, *Brachymystax*, and *Salvethymus*.
7. We searched for each species on The IUCN Red List (www.iucnredlist.org). Of the 124 species, IUCN has assessed 67, and of those, 49 are listed as Vulnerable, Endangered, or Critically Endangered, and 4 are extinct.
8. IUCN Red List, "Table 1: Numbers of threatened species by major groups of organisms (1996–2017)" (http://cmsdocs.s3.amazonaws.com/summarystats/2017-3_Summary_Stats_Page_Documents/2017_3_RL_Stats_Table_1.pdf).
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TECHNICAL COMMENT ABSTRACTS

Comment on "Plant diversity increases with the strength of negative density dependence at the global scale"

Lisa Hülsmann and Florian Hartig

LaManna *et al.* (Reports, 30 June 2017, p. 1389) claim that subadult trees are proportionally less common at high conspecific adult density (CNDD), and that this effect increases toward the tropics and for rare species. We show that the CNDD-abundance correlation may have arisen from a methodological artifact and that a range of processes can explain the reported latitudinal patterns.

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Response to Comment on "Plant diversity increases with the strength of negative density dependence at the global scale"

Joseph A. LaManna, Scott A. Mangan, Alfonso Alonso, Norman A. Bourg, Warren Y. Brockelman, Sarayudh Bunyavejchewin, Li-Wan Chang, Jyh-Min Chiang, George B. Chuyong, Keith Clay, Susan Cordell, Stuart J. Davies, Tucker J. Furniss, Christian P. Giardina, I. A. U. Nimal Gunatilleke, C. V. Savitri Gunatilleke, Fangliang He, Robert W. Howe, Stephen P. Hubbell, Chang-Fu Hsieh, Faith M. Inman-Narahari, David Janík, Daniel J. Johnson, David Kenfack, Lisa Korte, Kamil Král, Andrew J. Larson, James A. Lutz, Sean M. McMahon, William J. McShea, Hervé R. Memiaghe, Anuttara Nathalang, Vojtech Novotny, Perry S. Ong, David A. Orwig, Rebecca Ostertag, Geoffrey G. Parker, Richard P. Phillips, Lawren Sack, I-Fang Sun, J. Sebastián Tello, Duncan W. Thomas, Benjamin L. Turner, Dilys M. Vela Díaz, Tomáš Vrška, George D. Weiblen, Amy Wolf, Sandra Yap, Jonathan A. Myers

Hülsmann and Hartig suggest that ecological mechanisms other than specialized natural enemies or intraspecific competition contribute to our estimates of conspecific negative density dependence (CNDD). To address their concern, we show that our results are not the result of a methodological artifact and present a null-model analysis that demonstrates our original findings—(i) stronger CNDD at tropical relative to temperate latitudes, and (ii) a latitudinal shift in the relationship between CNDD and species abundance—persist even after controlling for other processes that might influence spatial relationships between adults and recruits.

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Comment on "Plant diversity increases with the strength of negative density dependence at the global scale"

Ryan A. Chisholm and Tak Fung

LaManna *et al.* (Reports, 30 June 2017, p. 1389) found higher conspecific negative density dependence in tree communities at lower latitudes, yielding a possible mechanistic explanation for the latitudinal diversity gradient. We show that their results are artifacts of a selective data transformation and a forced zero intercept in their fitted model. A corrected analysis shows no latitudinal trend.

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Response to Comment on "Plant diversity increases with the strength of negative density dependence at the global scale"

Joseph A. LaManna *et al.*

Chisholm and Fung claim that our method of estimating conspecific negative density dependence (CNDD) in recruitment is systematically biased, and present an alternative method that shows no latitudinal pattern in CNDD. We demonstrate that their approach produces strongly biased estimates of CNDD, explaining why they do not detect a latitudinal pattern. We also address their methodological concerns using an alternative distance-weighted approach, which supports our original findings of a latitudinal gradient in CNDD and a latitudinal shift in the relationship between CNDD and species abundance.

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