Isotopic applications assit in forensic tracking of illegally traded wildlife parts

openaccessgovernment.org/article/isotopic-applications-assit-in-forensic-tracking-of-illegally-traded-wildlife-parts/166900

21 September 2023

Keith A. Hobson, a Research Scientist and Professor at Environment and Climate Change Canada, discusses the use of stable isotopes to trace the origins of animal parts in order to mitigate the illegal wildlife trade

As of 2022, the illegal global trade in tissues of (CITES and non-CITES listed) wildlife has been estimated to be on the order of $220 billion,[(1)] placing this practice among the top four of all global criminal enterprises. As ecosystems and the wild animals and plants they harbor come under increasing pressure from human developments, such trade threatens many species with decimation and ultimate extinction.

Governments continue to struggle with the extent of this phenomenon and generally have few tools available to counter this growing trend. However, once seized, wildlife parts can be examined forensically to help ascertain provenance and such tools can contribute in a small way to counter such criminal activity.

This approach relies on the use of intrinsic biomarkers such as trace elements, genetics, and stable isotopes. Our laboratory continues to investigate the use of naturally occurring stable isotope ratios of various elements as a means of assigning approximate origins of biological materials. I have described this approach in several previous contributions, but essentially, the most powerful component of this work uses stable isotope ratios of hydrogen and oxygen in animal parts and attempts to link them with isotopic maps of origin known as isoscapes. [(2)]

Tracing the roots

Tracing the origins of animal parts using stable isotopes is not new, and earlier studies in the late 1980s have used this approach to “fingerprint” the origins of African elephant ivory based on light elements such as nitrogen and heavy elements such as lead and strontium. However, the breakthrough has been linking stable hydrogen and oxygen isotope ratios in animal tissues with precipitation-driven isoscapes based primarily on the amazing dataset provided by the Global Network of Isotopes in Precipitation (GNIP).

While forensic techniques such as stable isotope measurements may never permit consistent 100% accuracy in the assignment of origin, they can contribute immensely to an overall weight of evidence that can be used legally.

Our first venture into this field was sponsored by Environment and Climate Change Canada, which sought both genetic and stable isotope tracing means of determining the origins of polar bears in the Canadian Arctic. [(3)]

As a wide-ranging apex predator, this species is one of the most challenging of all fauna to conserve and manage, but their trophy hides are widely sought. Each polar bear management zone in Canada has strict quotas for harvest, so it is important to have an independent means of assigning a pelt (via analysis of hair) to its claimed region. To date, the efficacy of the genetic approach has not been reported but our use of stable isotope measurements of carbon, nitrogen, hydrogen, and oxygen ($\delta^{13}C$, $\delta^{15}N$, $\delta^{2}H$, $\delta^{18}O$) has shown remarkable promise.

We examined hair from over 1000 individual bears and were able to correctly assign them to their pre-existing management populations with accuracies of ~80%. Importantly, we identified isotopic management areas that better conform to the ecological separation of populations versus those management areas that are largely political.

A second but similar forensic investigation was conducted by our lab on whiskers taken from cheetah cubs seized from the illegal trade between East Africa and the Middle East [(4)]. The cheetah is one of the most endangered felids in the world, and there is an unfortunate trade in cubs for their use as exotic pets among the wealthy. Sadly, the life expectancy of traded cheetahs is extremely low.

Our investigation sought to identify where seized wild cheetah cubs were born as they could be sourced from a broad region of Sub-Saharan Africa or points further south. Using primarily $\delta^{2}H$ and $\delta^{18}O$ measurements in whiskers, we concluded that most animals were from southern Ethiopia and Tanzania. A particularly innovative use of $\delta^{18}O$ measurements allowed us to correct for any effects of nursing by mothers, a factor which would have otherwise diminished our forensic analysis if we had relied only on $\delta^{2}H$.

By land or by sea

There is a rich history of stable isotope analyses being used to probe investigations of food adulteration and authenticity of food products, especially wines. However, there have been a vanishingly small number of attempts to establish this approach to answer questions about the illegal wildlife trade.

Recently, my lab was asked by the Comprehensive and Progressive Agreement for Tans-Pacific Partnerships (CPTPP) to comment on the feasibility of using stable isotope analyses for two classes of CITES-protected species. These concern the illegal trade in sharks and rays and the trade in turtles and tortoises.

The application to terrestrial animals like tortoises is now well established, but readers may be less familiar with the fact that there are reasonably well-defined marine isoscapes that lend themselves to tracking marine organisms.

Recent isotopic work has indeed been applied to investigating regional isotopic “signatures” of the world’s sharks, and so we are poised to exploit this work to combat the illegal wildlife trade in shark fins.

Again, stable isotope measurements hold significant promise as a forensic tool to combat the illegal trade in wildlife parts and provide a comparatively cheap means of ruling in or out populations and regions of origin. This was our recent motivation for refining the δ2H feather isoscape for Brazil as a means of investigating the trade in wild birds, especially parrots from that country. (5)

Moreover, the illegal wildlife trade in wood in Brazil and throughout the tropics is a crime that could well utilize isotopic measurements to infer origins. Simply put, governments are very much encouraged to explore this approach as a viable and inexpensive contribution to the forensic toolbox.

References

1. CITES Secretariat (2022). World Wildlife Trade Report 2022. Geneva, Switzerland.
2. Tracking Animal Migration using Stable Isotopes, Second Edition. 2019. Hobson, K.A. and Wassenaar, LI (Eds). Academic Press, London, 253 pp.
3. Koehler, G., K.J. Kardynal and K.A. Hobson. 2019. Geographical assignment of polar bears using multi-element isoscapes. Scientific Reports, 9:9390 | https://doi.org/10.1038/s41598-019-45874-w.
4. Koehler, G., A. Schmidt-Knutzel, L. Marker and K.A. Hobson. 2023. Delineating origins of cheetah cubs in the illegal wildlife trade: Improvements based on the use of hair $\delta^{18}O$ vs $\delta^{2}H$ measurements. Frontiers in Ecology and Evolution, https://doi.org/10.3389/fevo.2023.1058985.
5. Alquezar, R.D., F. J.V. Costa; J. P. Sena-Souza, G. B. Nardoto and K. A. Hobson. 2022. A feather hydrogen (δ2H) isoscape for Brazil. PLoS ONE, https://doi.org/10.1371/journalpone.0271573.

Please Note: This is a Commercial Profile

More About Stakeholder

The stable isotope approach: Advancing government wildlife management

Here the Department of Biology from the University of Western Ontario explore how “the stable isotope approach” and annual monitoring can help in advancing government wildlife management schemes.