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ARTICLE

A computerised ark: The International Species Information System (ISIS) and the laborious re-ordering of the zoo world

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Abstract

In 1974, the International Species Information System (ISIS) was launched as a computerised database for zoo animals. Developed by a small group in Minneapolis, ISIS is now used by over 1,300 zoos on five continents and recognised as a crucial tool for ex situ conservation. The founders aimed to transform long-standing global patterns of zoo animal management. Rather than places where wild-caught animals went to die, they envisioned zoos as interconnected hubs supporting the global breeding and survival of endangered species. This article examines how the 'infrastructural globalism' of ISIS took shape. At first sight, the system appears to be a universal instrument for collecting neutral data. Yet, using the lens of 'infrastructural inversion' and examining the legal, socio-political, and scientific contexts in which it was developed, the article highlights how locally rooted ambitions and global competitions shaped its design and operation. Despite its aura of global reach, the effectiveness of ISIS relied on continuous local human effort, which explains its limitations. On a broader level, the history of ISIS reminds us that the influence of infrastructural globalism extends to non-human animals, and the ways they move around the world.

Keywords: history of zoos; ex situ conservation; computerisation; infrastructural globalism

Brochures with customer information usually offer dry reading. This is certainly the case for the various booklets devoted to the International Species Information System (ISIS), a computerised data system set up in 1974 to improve the management of zoo collections. Through circulating booklets, ISIS spokespersons addressed zoo directors around the world to become members and add their animal data to the system. In order to enliven the otherwise monotonous facts and figures, the cover of a 1984 brochure shows a cartoon (Figure 1). It depicts one of the classic themes of the cartoon genre: an animal-filled Noah's ark. The tagline has Noah say: 'Of course, I missed the unicorns. How can I keep track of everybody without a damned computer?'

The cartoon nicely captures the promissory discourse of ISIS's leading figures. It clearly speaks to the ambition of zoo managers to rebrand their institutions as 'Noah's arks'—institutions engaged in saving endangered species through captive breeding. It also speaks to long-standing concerns about maintaining healthy populations of globally scattered and often highly inbred animals. Don Bridgwater, Minnesota Zoo director and ISIS associate, explicitly highlighted both in a letter to a fellow director in 1976. He wrote: 'In order to meet … [the] pressing problems, it is necessary to develop policies to manage gene pools over multiple generations and to collect data and share it among zoos throughout the world. This is basically

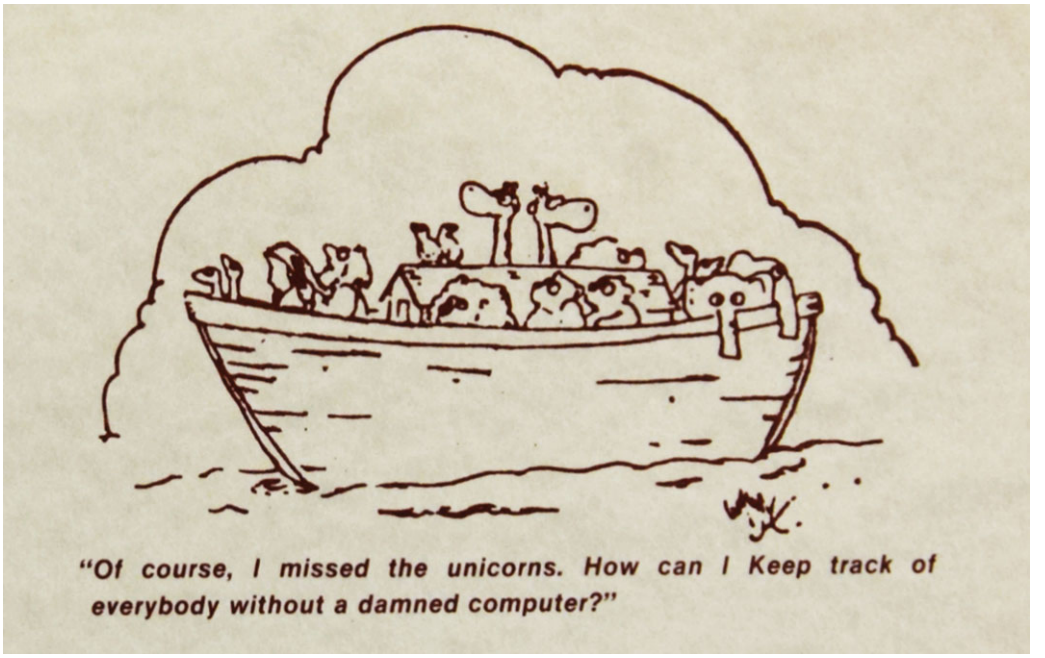

Figure 1. Noah longing for a computer. ('International Species Information System', August 1984, KMDA, B1.5.3.8, ISIS 1054#443, Felixarchief Antwerpen).

what ISIS was designed to do and is accomplishing.'[1] Among the 'pressing problems' Bridgwater referred to were the tightening of laws governing the trade in zoo animals and what he saw as a growing anti-zoo sentiment. He believed that an exchange of computerised information could offer an answer. By allowing an organised, objectified, and global exchange of animal bodies (and the genes these bodies contained), it offered zoos a possibility to rebrand themselves as scientifically run conservation institutions. In the presentation of its developers, ISIS appeared as a ground-breaking instrument for the categorisation, datafication, and globalisation of captive 'exotic' animals, for the standardisation and rationalisation of knowledge about those animals, and for the collaboration between institutions that held them.

The promises raised by men such as Bridgwater managed to capture the imagination for a long time. In 2016, ISIS's name was changed to Species360 (as the original acronym became associated with the terrorist organisation Islamic State of Iraq and Syria), but the original ambitions and promissory discourse surrounding the information system have remained largely unaltered until today. Currently, Species360 serves over 1,300 zoos in 102 countries across five continents. As such, it has become the single most important information system for ex situ conservation—the protection of endangered wildlife outside its natural habitat. Over the past decades, ISIS has indeed shaped the global dimensions of captive breeding. Gradually connecting an expanding network of zoological institutions across the globe, ISIS and later Species360 significantly contributed to the idea of a 'global zoo' in which endangered animals are exchanged to the benefit of their long-term survival in captivity.[2]

This article studies the genesis of ISIS to understand the ideas and practices of 'global' ex situ conservation while still in the making. Generating images of universal science, free-floating

[1]Don Bridgwater to Gary Clarke, 23 September 1976, Minnesota State Zoological Board [MSZB], International Species Inventory System [ISIS] 103.C.16.9B, Correspondence, Gale Library, Minneapolis.

[2]https://species360.org/about-us/about-species360/.

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information, and frictionless flows of animals, the proponents of ISIS envisioned their project as an almost self-evident technological fix for zoological institutions struggling to become Noah's arks. Yet, making ISIS work proved anything but straightforward, and, to this day, it has not fully realised its original ambitions. This can only be comprehended, this article argues, by acknowledging that the functioning of border-crossing infrastructures requires continuous human work that is local, political, and embodied. We will show how this is evident in, firstly, the design of the system and its early adaptations to fit particular legal and scientific contexts; secondly, in the negotiations involved in extending the system's network; and, finally, in the practical routines that kept it together. Only by considering these various instances of work, can we fully grasp the true power of global ex situ conservation, and, importantly, its limitations.

As such, this study of ISIS intersects with several scholarly traditions. The first concerns the historiography of global infrastructures. The rise of ISIS indeed fits into the much wider emergence of so-called 'infrastructural globalism', which, in the words of historian Paul Edwards, was characterised by 'projects for permanent, unified, world-scale institutional-technological complexes that generate globalist information … by design'.[3] The nineteenth and twentieth centuries, and particularly the post-Second World War period, saw a proliferation of such projects, concerning fields as widely divergent as meteorology, engineering and economics, oceanography and state intelligence.[4] Historians have already shown that human-wildlife relations did not escape the grip of this infrastructural globalism. They have notably indicated how cross-border institutions and data technologies have historically shaped the study, monitoring and conservation of free-ranging animals 'in the wild'.[5] This article extends this line of scholarship to the history of ex situ conservation, and explores the ways in which infrastructural globalism has shaped its practices.

The second scholarly tradition this article engages with evidently concerns the emerging literature on datafication and conservation. In her work, geographer Irus Braverman has indeed discussed ISIS as one of the instruments that is central to present-day zoos' 'dataveillance', which she describes as 'the global computerized management of animal populations'.[6] Braverman's analysis, which indicates how this management leads to 'collective reproductive control', resonates with a broader interest among geographers and anthropologists in datafication (and its biopolitical dimension) within the context of contemporary conservation practices.[7] To date,

[3]Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (MIT Press, 2010), 25.

[4]Apart from Edwards' work, see, for instance, Azadeh Achbari, 'Building Networks for Science: Conflict and Cooperation in Nineteenth-Century Global Marine Studies', *Isis* 106, no. 2 (2015): 257–82; David Pretel and Lino Camprubí, eds., *Technology and Globalisation: Networks of Experts in World History* (Springer, 2018); Anat Leibler, 'The Emergence of a Global Economic Order: From Scientific Internationalism to Infrastructural Globalism', in *Science, Numbers and Politics*, ed. Markus J. Prutsch (Springer International Publishing, 2019), 121–45.

[5]Examples include: Etienne Benson, *Wired Wilderness: Technologies of Tracking and the Making of Modern Wildlife* (Johns Hopkins University Press, 2010); Etienne Benson, 'One Infrastructure, Many Global Visions: The Commercialization and Diversification of Argos, a Satellite-Based Environmental Surveillance System', *Social Studies of Science* 42, no. 6 (December 2012): 843–68; Raf De Bont, *Nature's Diplomats: Science, Internationalism, and Preservation, 1920–1960* (The University of Pittsburgh Press, 2021); Simone Schleper, 'Victims and Diplomats: European White Stork Conservation Efforts, Animal Representations, and Images of Expertise in Postwar Ornithology', *Science in Context* 35, no. 3 (September 2022): 294–313.

[6]Irus Braverman, 'Zooveillance: Foucault Goes to the Zoo', *Law Journal Articles Faculty Scholarship* 10, no. 118 (2012): 119; Irus Braverman, *Zooland: The Institution of Captivity* (Stanford University Press, 2013), 100; Irus Braverman, *Wild Life : The Institution of Nature* (Stanford University Press, 2015), 68–69.

[7]Jonathan Gray, 'The Datafication of Forests? From the Wood Wide Web to the Internet of Trees', in *Critical Zones The Science and Politics of Landing on Earth*, eds. Bruno Latour and Peter Weibel (MIT Press, 2020), 362–9; Erica von Essen et al., 'Wildlife in the Digital Anthropocene: Examining Human-Animal Relations through Surveillance Technologies', *Environment and Planning E: Nature and Space* (2021), https://doi.org/10.1177/25148486211061704; Monica Vasile and George Iordăchescu, 'Forest Crisis Narratives: Illegal Logging, Datafication and the Conservation Frontier in the Romanian Carpathian Mountains', *Political Geography* 96 (2022): 102600; Christine Biermann and Robert M. Anderson, 'Conservation, Biopolitics, and the Governance of Life and Death', *Geography Compass* 11, no. 10 (2017): e12329, https://doi.org/10.1111/gec3.12329;

however, the *history* of datafication practices in the context of the zoo has been studied to a far lesser degree.[8] As a result, we know little of the context in which ISIS developed, and the historical ways through which it influenced the management of captive animals throughout the world.[9]

This is probably no coincidence. As information scholars Geoffrey C. Bowker and Susan Leigh Star have indicated, historical narratives traditionally background information infrastructures. In their words, such infrastructures consist of 'technologies and arrangements that, by design and by habit, tend to fade into the woodwork'. Only by a methodology of 'infrastructural inversion' that specifically foregrounds these technologies and arrangements, can we come to understand how information infrastructures work. Taking this approach, Bowker and Star state, 'means recognizing the depths of interdependence of technical networks and standards, on the one hand, and the real work of politics and knowledge production on the other'.[10] This means attending to the ways infrastructures are simultaneously political and material. Recently, scholars working in line with Bowker and Star have added specific insights into the development of computerised and digital information systems, stressing how—despite an aura of virtuality and placelessness—such systems can only function through physical realities and localised practices.[11] These dimensions, we argue, are indeed particularly relevant for the functioning of ISIS.

Laying bare the woodwork of ISIS serves a wider argument. Focusing on the development and introduction of ISIS during its first decade, this article seeks to re-examine the global history of captive animal conservation in several steps. First, it investigates how the local socio-technical environment of the Minneapolis computing district influenced ISIS's early history. Second, it highlights how national dynamics in the United States shifted ISIS's direction and fuelled its momentum. In response to 1970s' legislation restricting the trade and transport of exotic animals, American zoo managers envisioned a science-based data system that could ensure the survival of their institutions by refocusing them on global endangered species breeding. They saw ISIS as a tool to facilitate the transition from individual zoos sourcing animals from the wild to a cross-border, scientifically managed 'global zoo' operating as a closed circuit. However, making the data system functional—especially at a global level—was a complex and labour-intensive task. The final part of the article analyses the painstaking process of negotiating ISIS's focus and modalities, of expanding its network beyond its context of origin, and of engaging large user groups in its practical routines. Understanding these inner workings of ISIS's infrastructure is essential to explaining why the envisioned transition to a 'global zoo' was ultimately slow, contested, and incomplete. More broadly, I argue, it is critical for understanding the global history of ex situ conservation—its shape, scope, and reach—in the period after 1970.

Timothy Hodgetts, 'Wildlife Conservation, Multiple Biopolitics and Animal Subjectification: Three Mammals' Tales', *Geoforum* 79 (2017): 17–25.

[8]Historians such as Ian Miller and Marianna Szczygielska have convincingly analysed the ways in which the biopolitical logistics of zoos developed. Yet, overall, the role of computerized data systems for such logistics remain underexplored. Ian Jared Miller, *The Nature of the Beasts: Empire and Exhibition at the Tokyo Imperial Zoo* (University of California Press, 2013), 220–9; Marianna Szczygielska, 'War on Extinction: Wildlife as Statecraft in Interwar Poland', *Historical Studies in the Natural Sciences* 54, no. 2 (2024): 244–67.

[9]Most overviews of the history of zoos leave ISIS unmentioned. One can find some brief asides, however, in: Vernon N Kisling, *Zoo and Aquarium History: Ancient Animal Collections to Zoological Gardens* (CRC Press, 2000), 175–6; Elizabeth Hanson, *Animal Attractions: Nature on Display in American Zoos* (Princeton University Press, 2004), 170.

[10]Geoffrey C. Bowker and Susan Leigh Star, *Sorting Things Out: Classifications and Their Consequences* (MIT Press, 1999), 34.

[11]See, for instance, Paul Dourish, *The Stuff of Bits: An Essay on the Materialities of Information* (MIT Press, 2017); Laura Forlano, 'Digitized Coral Reefs', in *digitalSTS: A Field Guide for Science & Technology Studies*, ed. Janet Vertesi et al. (Princeton University Press, 2019). More generally on theorising the interrelation between the scientific, the political, and the material in human-nature relations: Sara B. Pritchard, 'Joining Environmental History with Science and Technology Studies: Promises, Challenges and Contributions', in *New Natures: Joining Environmental History with Science and Technology Studies*, eds. Dolly Jørgensen, Finn Arne Jørgensen and Sara Pritchard (University of Pittsburgh Press, 2013), 1–17.

Systems across contexts

From its inception, ISIS explicitly carried 'international' in its name. This gestures to the fact that its designers always held an ambition to connect zoological institutions across national borders, if possible globally.[12] Yet, it is also evident that ISIS was developed from a clearly localised centre: Minneapolis, Minnesota. This location might be surprising, as, in the 1970s, Minneapolis was a rather peripheral place in the zoo world. In this period, old and prestigious zoological gardens, such as those of London, Paris, and Zurich in Europe, and New York, Washington, and San Diego in the United States, still served as the most important global models of zoo management. Minneapolis did not have a zoo of such stature. When ISIS launched in 1974, Minnesota Zoological Garden was still under construction—set to open its doors to the public only four years later.[13] Arguably, this brought some advantages as the embryonic zoo could offer the initiators of ISIS a flexible testing ground for their ideas.[14] Yet, the Minnesota Zoo certainly did not provide a ready-made network or reputation in wider zoo circles. Minneapolis's advantages lay elsewhere. In order to understand this, it is important to look at the larger institutional ecosystem on which ISIS drew.

Importantly, Minneapolis was one of the three major centres of 1970s' American computing (alongside California's Silicon Valley and Massachusetts' Route 128). Its computing industry had strongly benefitted from military support during the Second World War. After 1945, the presence of a research university combined with backing from local and state governments, as well as the real estate, finance, and banking world led to what Thomas J. Misa has described as the first computing-centred industrial district in the world.[15] The advent of computers in Minnesota's business world in the 1950s and 1960s coincided with an increased focus on information flows within organisations and attempts to create so-called 'totally integrated management information systems'. Such ambitions befitted a corporate world that, in the words of computer historian Thomas Haigh, was 'self-consciously remaking itself around science, high technology, staff experts, and systems'.[16] All these elements clearly echoed in ISIS's design.

More important still than developments in the corporate sphere were those in state-sponsored medicine. It is, after all, in this context that we have to situate ISIS's main architect: Ulysses Seal. Holding an MA in Psychology and a PhD in biochemistry, Seal worked from 1959 onward at the Veteran's Administration Medical Center in Minneapolis, where his research concerned the endocrinological dimensions of prostate cancer.[17] In the margins of this endocrinological work, he developed an interest in comparative biochemistry, studying, for instance, the differences in blood values across species. During this research, which brought him into contact with zoos, Seal found that baseline data for most exotic species remained unknown, and he decided to work towards a computerised database.[18] This was hardly a new idea in a hospital context, as, throughout the 1950s and 1960s, most US hospitals had computerised their patient records.[19] Crossing the species border, Seal just extended the infrastructure to non-human animals in the hope of establishing

[12]Unlike some historians, the designers of ISIS did not use the term 'international' to refer to interstate relations, but to cross-border connections between (mostly private) zoos. The notion only appears in this article as an actors' category in quotes or titles. Throughout, I use 'global' to refer to the emerging trans-border networks of ISIS. This does evidently not imply these networks are covering the full surface of the globe. While there might have been ambitions in that direction, the article will to the contrary rather stress the geographical limitations of the networks involved.

[13]For an impression of the zoo and its ambitions at the opening: 'The New Zoo', *The Minneapolis Star*, 1978.

[14]Interview with Nate Flesness by Monica Vasile, 26 May 2021, 11:00.

[15]Thomas J. Misa, *Digital State: The Story of Minnesota's Computing Industry* (University of Minnesota Press, 2013).

[16]Thomas Haigh, 'Inventing Information Systems: The Systems Men and the Computer, 1950–1968', *The Business History Review* 75, no. 1 (2001): 15.

[17]'Curriculum Vitae: Seal, Ulysses Samuel', 28 September 1993, MSZB, ISIS, 103.C.16.9B, Ulysses S. Seal, CBSG, In Memoriam, Gale Library, Minneapolis.

[18]Interview with Nate Flesness by Monica Vasile, 26 May 2021, 01:44.

[19]Bowker and Star, *Sorting Things Out: Classifications and Their Consequences*, 127.

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what he called 'physiological norms'. To this end, Seal and his graduate student, Dale G. Makey, developed the so-called SEAMAK ZOOGAD system, a database that, in their own words, was to serve 'zoological data storage, retrieval and analysis'. In this same period, they started collaborating with the American Association of Zoo Veterinarians (AAZV) with which they shared the goal to improve individual animal health.[20]

Yet, initial results proved to be disappointing. Seal soon realised that many zoos did not have individual record systems for their animals, which implied he could not tie blood samples to specimens.[21] Hence, he decided to *create* such records, and, once again, he could draw on existing systems of human governance. After all, the United States government had used punch-cards and Hollerith tabulators to inventory its resident population since as early as 1890.[22] In the 1970s, Seal and Makey worked towards a largely similar system for the census and identification of zoo animals that—like Hollerith's old technology—still involved the filling in of data forms and sending them to a central office to keypunch them on 80-column cards.[23] From a technical perspective, a zoo population was not all that different from that of a state.

The context in which ISIS came into existence is thus a multi-layered one. There was, in general, a post-war infatuation with 'systems' in both corporate and government circles. And, more specifically, there were US experiences with punch-card technologies in the record keeping of patients by hospitals and of human populations by government administrations. These traditions translated into Seal's ambitions to set up a 'physiological norm program' and a zoo animal census, respectively. Yet, by the autumn of 1973, when Seal approached the Minnesota Zoo to act as the location for developing a computer program, he had already added a third dimension: an inventory that would specifically serve the breeding of endangered species.[24] This ambition, which would soon overshadow the other two, gained traction because of yet another specific context. It is to this context—which concerns the realm of legal and moral frameworks—that we turn now.

Legislation and science: Constructing self-sustaining populations

Around 1970, the legislative context in which US zoos operated changed rapidly and fundamentally—especially regarding endangered animals. Under pressure from both humane societies and conservation organisations, the United States administration passed several (increasingly stringent) Endangered Species Acts (1966–73) and ratified the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1973).[25] Zoo managers were not amused. According to some, the legislative limitations on the trade and transport of endangered and threatened animals even meant that zoos were 'being legislated out of business'.[26] New regulations largely cut off zoological gardens from trade in wild-caught animals

[20]Ulysses S. Seal and Dale G. Makey, *Seamak Zoogad Systems: Zoological Data Storage, Retrieval and Analysis Systems* (Minneapolis, 1971); Karin Schwartz and Nate Flesness, 'On the Origin of Species Information Systems: An Evolutionary Perspective', in *From Royal Gifts to Biodiversity Conservation: The History and Development of Menageries, Zoos and Aquariums*, eds. Gordon McGreggor Reid and Geofrey Moore (The North of England Zoological Society, 2014), 84–90.

[21]Interview with Nate Flesness by Monica Vasile, 26 May 2021, 04:34.

[22]Keith S. Reid-Green, 'The History of Census Tabulation', *Scientific American* 260, no. 2 (1989): 98–103.

[23]Ulysses S. Seal, Dale G. Makey, and Linda E. Murtfeldt, 'ISIS: An Animal Census System', *International Zoo Yearbook* 16 (1976): 182.

[24]Chairman State Zoological Board to Computer Data Committee, 5 October 1973, MSZB, ISIS, 103.C.16.9B, Grant Requests, Gale Library, Minneapolis.

[25]See extensively in: Mark V. Barrow, *Nature's Ghosts: Confronting Extinction from the Age of Jefferson to the Age of Ecology* (University of Chicago Press, 2009), 301–44.

[26]Frank S. Todd, 'Dilemma of the American Zoo: Can It Be Legislated out of Business?', *AFA Watchbird Magazine* 2, no. 3 (1975): 23.

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and strongly complicated the exchange of animals between zoos. Amid perceived anti-zoo sentiments, zoological gardens tried to take back the initiative.[27]

The American Association of Zoological Parks and Aquariums (AAZPA)—the non-profit organisation speaking on behalf of a large number of American zoos—took a leading role in attempts to both change public perception and amend legislation. In outward communication, AAZPA leaders tried to rebrand zoos from places of public spectacle into institutions that championed conservation through captive breeding. Simultaneously, the association endorsed the newly founded Zoological Action Committee Inc. (also called ZooAct), which lobbied Congress not to give in to 'the latest humaniac boondoggle'.[28] In 1975, several AAZPA-affiliated zoo representatives argued in hearings for the House of Representatives that the Endangered Species Act was actually counterproductive and would render the breeding of endangered species impossible. Among the zoo representatives who took the stand was Ulysses Seal. His appearance at the House of Representatives fit within a wider strategy to simultaneously rethink zoo practice and federal legislation. In this strategy, ISIS would play an important role.[29]

Central to Seal's rethinking exercise was one particular notion: 'captive self-sustaining populations' (CSSPs). Such CSSPs were defined as populations held in captivity, independent from influx from the wild, that can be maintained over extended periods without inbreeding. ISIS, Seal believed, offered a system to render such CSSPs from an abstraction into something concrete. It provided a system to calculate the minimum number of individuals needed for populations to be self-sustaining, *and* to organise exchanges between zoos to avoid inbreeding as much as possible.[30] By offering evidence through ISIS that populations of particular species in American zoos could be self-sustaining, individuals such as Seal and Bridgwater hoped to convince the United States Department of the Interior to loosen legislative restrictions on the movement of breeding stock between zoos. In the words of Bridgwater, ISIS offered a 'tool to demonstrate the value, effectiveness and position of zoos relative to the morass of legislation, emotional outcry, and misinformation currently facing institutions'.[31] And the strategy indeed worked. In 1976, AAZPA and the Interior Department reached an agreement to downgrade species for which a CSSP report was provided, allowing for more liberal transfer requirements.[32]

The explicit association of ISIS with the long-term survival of captive endangered species served three audiences at once. First, as Bridgwater argued, the system was to show to 'the world at large that we [the zoos] are capable of rather intelligent and logical action'.[33] Secondly, stressing ISIS's link with discussions on federal endangered species legislation helped to convince zoo managers to provide information for, and pay membership fees to, ISIS.[34] After all, Seal and Bridgwater highlighted that the survival of the zoo as an institution depended on turning its animal populations into CSSPs. Finally, ISIS also explicitly catered to the Interior Department. In a letter to Earl Baysinger, deputy chief of the Interior Department's Office of Endangered Species and International Activities, Seal wrote that ISIS could provide exactly the information needed for

[27]Anna Fesmire, 'The Role of the HSUS in Zoo Reform', 1980; Todd Bayma, 'Rational Myth Making and Environment Shaping: The Transformation of the Zoo', *The Sociological Quarterly* 53, no. 1 (2012): 116–41.

[28]*ZooAction: A Publication of the Zoological Action Committee Inc.*, Jan. 1976, 1, MSZB, ISIS, 103.C.16.9B, US Department of the Interior, Gale Library, Minneapopolis.

[29]'Endangered Species Overnight Hearings Held', *ZooAction: A Publication of the Zoological Action Committee Inc.*, Oct. 1975, 1 and 8, MSZB, ISIS, 103.C.16.9B, US Department of the Interior, Gale Library, Minneapolis.

[30]Seal to Earl Baysinger, 7 January 1976, MSZB, ISIS, 103.C.16.9B, US Department of the Interior, Gale Library, Minneapolis.

[31]Bridgwater, 'AAZPA-ISIS mid-year report', 20 January 1976, MSZB, ISIS, 103.C.16.9B, Reports: Annual and Participants, Gale Library, Minneapolis.

[32]Ibid.

[33]Bridgwater to Marvin Jones, 19 February 1976, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis.

[34]See, for instance, Seal, Makey, and Murtfeldt, 'ISIS: An Animal Census System', 180.

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enforcing its legislation in a zoo context.[35] In this way, the focus on sustained captive breeding helped to sever important links between federal administrators and the zoo world. This translated directly into funding. From the mid-1970s onward, both the Interior Department and AAZPA provided a yearly subsidy of $10,000 to ISIS.[36] Simultaneously, Seal used ISIS data to immediately prepare petitions to have five species (the tiger, leopard, jaguar, black lemur, and ring-tailed lemur) officially declared as CSSPs.[37]

All this is not to say that Seal's strategy was uncontroversial. In a letter to ISIS systems manager Linda Murtfeldt, the executive director of ZooAct, George Steele, argued that the creation of a special CSSP status sent 'the wrong message to Interior and humane societies', and undermined a general principle of unrestricted 'inter-zoo transfers'.[38] In addition to such strategic concerns, there were also scientific criticisms about CSSPs' taxonomic focus: the species. John Perry, Assistant Director for Conservation at the Washington Zoological Park, argued that, in practice, *subspecies* were the object of most conservation schemes. He admitted there might be reasons to refocus on the species level, but that this should be 'a matter of deliberate choice, not of adapting to well-meant but counterproductive regulations'.[39] Clyde Hill, mammal curator at the equally influential San Diego Zoo, thought along similar lines. Responding to Bridgwater's claim that 'the subspecies concept is too complicated for government', he argued it was 'not ethical' to lump together self-sustaining subspecies with non-self-sustaining ones in a single group.[40] All this offers a reminder of the political nature and real-world impact of taxonomic decisions.[41] Still, Bridgwater managed to rally most zoo managers around a pragmatic position. In correspondence with AAZPA's director Robert O. Wagner, he stressed the importance of differentiating the data needed for successful breeding programmes from those needed (more urgently) to comply with federal regulations.[42] An AAZPA-ISIS Committee meeting in January 1976 indeed recommended using the Interior Department's definition of CSSPs, rather than 'what the functional biologist would consider necessary'.[43] The second might have been more important for the survival of animal populations, but the first was considered crucial for the survival of the zoo as an institution.

Even so, the attention to the long-term viability of captive populations in ISIS circles was more than mere window-dressing. After all, the ISIS team was clearly aware of some worrisome trends. As part of an exploration of how ISIS could contribute to CSSPs, Nathan (Nate) Flesness, a PhD student of Seal's at the University of Minnesota, set up a study of so-called 'inbreeding coefficients' of the Przewalski's horse. At the time, this species (which was extinct in the wild) was considered a zoo conservation success story. Yet, discussing the results of his study at the Second World

[35]Seal to Earl Baysinger, 7 January 1976, MSZB, ISIS, 103.C.16.9B, US Department of the Interior, Gale Library, Minneapolis.

[36]'Memorandum of Agreement between the U.S. Fish and Wildlife Service and State of Minnesota Zoological Garden', May 1974, MSZB, ISIS, 103.C.16.9B, US Department of the Interior, Gale Library, Minneapolis; Linda Murtfeldt, 'Isis Receives Full Support at AAZPA Convention', Draft for AAZPA Newsletter, November 1974, MSZB, ISIS, 103.C.16.9B, Public relations articles, Gale Library, Minneapolis.

[37]'Summary Statement of Petitions', 14 November 1975, MSZB, ISIS, 103.C.16.9B, Reports: Annual and Participants, Gale Library, Minneapolis.

[38]Steele to Murtfeldt, 12 December 1975, MSZB, ISIS, 103.C.16.9B, US Department of the Interior, Gale Library, Minneapolis.

[39]Perry to Wayne King, 30 December 1975, MSZB, ISIS, 103.C.16.9B, US Department of the Interior, Gale Library, Minneapolis.

[40]Hill to Robert O. Wagner, 19 February 1976, MSZB, ISIS, 103.C.16.9B, US Department of the Interior, Gale Library, Minneapolis.

[41]The literature on the turbulent history of taxonomic classification and nomenclature is too extensive to review here. For a good case study indicating the direct impact of taxonomic decision-making on conservation, see: Peter S. Alagona, 'Species Complex: Classification and Conservation in American Environmental History', *Isis* 107, no. 4 (December 2016): 738–61.

[42]Bridgwater to Wagner, 4 February 1976, MSZB, ISIS, 103.C.16.9B, US Department of the Interior, Gale Library, Minneapolis.

[43]'AAZPA-ISIS mid-year report', 20 January 1976, MSZB, ISIS, 103.C.16.9B, Reports: Annual and Participants, Gale Library, Minneapolis.

Conference on the Breeding of Endangered Species in London in 1976, Flesness painted a bleak picture. He argued that uncoordinated breeding practices, in which a limited number of stallions were strongly over-represented, had led to a very high inbreeding coefficient. Flesness claimed that this would not only affect the offspring's health, but might even jeopardise the species' long-term survival.[44] Worse, according to the people within the ISIS team, the Przewalski's horse symbolised a wider problem. As zoo managers usually sought mates that were 'close at hand', Flesness believed inbreeding was a very widespread phenomenon in zoos. ISIS, again, was proposed as a solution. The system could not only help evaluate 'the risks associated with inbreeding', but also develop 'computer-based methods to measure and reduce them'.[45] This promissory discourse shaped much of the further developments.

As a tool to avoid inbreeding (and thus establish CSSPs), ISIS incorporated particular scientific theories into its design. These theories, rooted in demography on the one hand and population genetics on the other, were developed in 1975–6 by two young and part-time ISIS staff members. The first was Tom Foose, a PhD student studying ecology at Chicago University; the second was the aforementioned Nate Flesness. Foose took on the demography work. Starting from P. H. Leslie's 1940s' modelling within the Oxford Bureau of Animal Population, he developed ideas on how to calculate the ideal sex ratio and age divisions for particular species within the 'carrying capacity' provided by zoos.[46] Flesness for his part used 1920s' work by population geneticist Sewall Wright to propose a system of 'maximum avoidance of inbreeding'.[47]

Combining the two approaches, Foose, Flesness, and Seal called for a complete overhaul of existing breeding practices. In their view, zoo managers mostly bred with individuals that were least aggressive, easiest to handle, readily available, and that had a proven record of producing numerous and healthy offspring. They stressed that all of this resulted in inbreeding and 'unintentional domestication'—both of which would undermine the animals' adaptive capabilities and compromise potential reintroductions in the future. To preserve genetic diversity, they believed zoos needed to manage the entire captive population of a species as a whole. Such management included: alternating males in breeding programmes, closely managing the age distribution, and circulating animals between institutions based on maximum genetic difference. Hence, they proposed an ideal that required a constant transfer of individuals, preferably on a global level, and a close monitoring of those transfers. This, in turn, necessitated a system that centralised the necessary demographic and genetic information: ISIS (see Figure 2).[48]

ISIS thus became embroiled in the conceptual and material construction of CSSPs. To this end, the ISIS leadership initiated so-called pedigree, demographic and studbook subsystems in the

[44]Nate Flesness, 'Gene Pool Conservation and Computer Analysis', *International Zoo Yearbook* 17 (1977): 77–81; Monica Vasile, 'Incest at the Zoo: Saving and (in)Breeding the Przewalski's Horse', NICHE, 2016, https://niche-canada.org/2021/08/16/incest-at-the-zoo-saving-and-inbreeding-the-przewalskis-horse/.

[45]'Pedigree Analysis Subsystem', ISIS, 22 July 1975, Typescript, MSZB, ISIS, 103.C.16.9B, Studbook Committee, Gale Library, Minneapolis.

[46]Foose to Seal, 15 February 1976, and Seal to Foose, 26 February 1976, MSZB, ISIS, 103.C.16.9B, Contracts, Foose, Gale Library, Minneapolis; Thomas Foose, 'Demographic Models for Management of Captive Populations', *International Zoo Yearbook* 17 (1977): 70–6; P. H. Leslie, 'On the Use of Matrices in Certain Population Mathematics', *Biometrika* 33, no. 3 (1945): 183–212; On the origins of the notion of 'carrying capacity' and its use in ecology, population biology and eugenics: Thomas Robertson, *The Malthusian Moment: Global Population Growth and the Birth of American Environmentalism* (Rutgers University Press, 2012), 23–9.

[47]Flesness, 'Gene Pool Conservation and Computer Analysis'; Sewall Wright, 'Systems of Mating II: The Effects of Inbreeding on the Genetic Composition of a Population', *Genetics* 6, no. 2 (1921): 124–43.

[48]Foose, 'Demographic Models for Management of Captive Populations'; Flesness, 'Gene Pool Conservation and Computer Analysis'; Nate Flessnes and Ulysses Seal, 'Gene Pool Conservation and Breeding Strategy for Zoos', 1975, Typescript, MSZB, ISIS, 103.C.16.9B, Studbook Committee, Gale Library, Minneapolis.

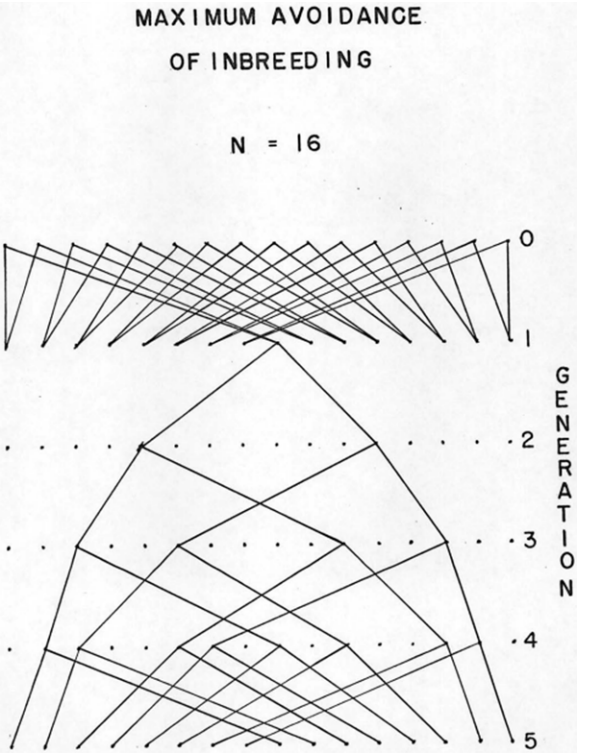

Figure 2. How to organize 'maximum avoidance of inbreeding'? (Flessnes and Seal, 'Gene Pool Conservation and Breeding Strategy for Zoos', 1975, Typescript, MSZB, ISIS, 103.C.16.9B, Studbook Committee, Gale Library, Minneapolis).

spring of 1976.[49] Work on census and physiological norms programmes did continue, but data collection and programming related to the breeding of endangered species took precedence. The latter work was clearly of symbolic importance. It cemented institutional support (from the Interior Department and AAZPA), enabled legal compliance, and it gestured towards the survival of the zoo as an institution. In virtually every publication devoted to ISIS, Seal and his collaborators stressed that 'modern day zoos are faced with the challenge of developing self-sustaining populations of captive exotic species'. Somewhat over-optimistically, they followed this up by proclaiming that 'American and European zoos are confronting this challenge head on through the International Species Inventory System (ISIS)'.[50] The rhetoric resonated widely. When, in 1978, the popular science programme 'Nova' devoted an episode to zoos, it featured a voice-over saying that 'successful breeding means zoos will have to pool genetic information on their animals'. After this statement, images transitioned from zoo enclosures to an interview with Seal. The intermediate frames showed blinking lights and turning computer reels—visualising a computerised future for ex situ conservation.[51]

[49]'Progress Report', April–June 1976, MSZB, ISIS, 103.C.16.9B, Contracts. Office of Endangered Species, US Fish and Wildlife Service 1975–8, Gale Library, Minneapolis.

[50]For the quote: 'ISIS: A Collecting and Sharing of Captive Animal Statistics Source', *The Journal of Zoo Animal Medicine* 7, no. 1 (1976): 4; Seal, Makey, and Murtfeldt, 'ISIS: An Animal Census System'; Ulysses Seal, 'Status of Wild Mammal Species held in American Zoos', undated draft, MSZB, ISIS, 103.C.16.9B, US Department of the Interior, Gale Library, Minneapolis; Ulysses Seal, Linda Murtfeldt, and Dale Makey, 'Isis: An Established Data Bank for Captive Wolves', Draft, MSZB, ISIS, 103.C.16.9B, Public relations articles, 1976, Gale Library, Minneapolis.

[51]'Memories from Eden', Nova, by WBHG, 1978, 6:10. https://archive.org/details/WGBHMemoriesfromEden/NOVA.S05E19.Memories.from.Eden.1978.VHSRip.AAC2.0.x264-astro.mp4.

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Creating networks

ISIS's promoters enveloped their system in an aura of scientific planning and technological innovation. Its databanks, so they argued, could deliver 'long range collaborative strategies in genetic custodianship'.[52] It was an appealing promise. By 1978, IBM, which provided the computer for the ISIS headquarters at the Minnesota Zoo, even used this example in advertisements to showcase the potential of its data management systems (Figure 3). Yet, in order to deliver on his promise, Seal and his collaborators needed more than a scientific blueprint and novel technology. They also needed data and, crucially, the involvement of people and institutions that could provide them.

For ISIS to function, enough (and preferably all) global institutions that engaged in captive breeding programmes had to take part. Its developers explicitly expressed the ambitions to 'universalise' such breeding and to 'store data on every animal in every zoo in most countries of the world'.[53] Getting those zoos involved was not a given. In the United States, AAZPA's active propaganda did enable a relatively high participation among the association's paying members. Yet, there was resistance, too. Some saw the development of ISIS as a sign that 'bureaucratic agencies' were taking over American zoos as 'private initiatives'.[54] Others felt the system was not geared to smaller zoos with more common species, and they questioned the necessity of 'databanking woodchucks and raccoons'.[55] Additionally, some zoos enrolled for a few years, but then dropped out again. To address all this, the ISIS staff ultimately set up a 'phone polling exercise', of which the goal was 'not so much polling', but 'massaging and re-recruitment'.[56] Clearly, building a functioning information system proved as much a social exercise as a technological one.

Expanding beyond North America proved to be even more difficult. Initially, ISIS was clearly a United States initiative, funded through national institutions (the Interior Department, AAZPA and AAZV) and responding to national legislation. With an all-American board, the 'international' in the title was certainly premature. Still, the cross-border ambitions were clearly there. In 1976, Bridgwater explicitly stated in an internal memo that 'our primary service and products, namely conservation, education and animals, have become international commodities that do not respect national boundaries and involve both international communication and coordination'.[57] At an international zoo conference in Calgary, Alberta, in 1976, European zoo agents seemed to show interest, but, when ISIS representative Marvin Jones travelled through Europe, he only found the zoos of Rotterdam and Copenhagen willing to join. At a London conference, the local organiser Richard Brambell did not even allow him to present the data system, which Jones ascribed to Brambell's anti-American attitudes. More generally, Jones reported that many of the 'old line leaders' of European zoos proved 'opposed to ISIS'.[58] The universal blueprint for data exchange clearly faced local sensitivities.

[52]Edward Kohn (ISIS) to Edward Mareska (president of AAZPA), 3 March 1979, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis.

[53]For the quotes: Bridgwater, 'AAZPA-ISIS mid-year report', 20 January 1976, MSZB, ISIS, 103.C.16.9B, Reports: Annual and Participants, Gale Library, Minneapolis.

[54]Roy Shea (Indianapolis Zoo) to Bridgwater, 24 February 1976, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis.

[55]William B. Stark (Oxbow Zoo) to Bridgwater, n.d. [1976], MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis.

[56]Judith Block to members of the AAZPA-ISIS liaison committee, 16 April 1980, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis.

[57]Bridgwater, 'Report of the IUCN/SSC meeting in Morges', n.d. MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis.

[58]Marvin Jones (San Diego Zoo) to Bridgwater, 29 February and 22 April 1976, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis.

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Advertisement

Who's Zoo: A Social Register for Animals

One American zoo needed a Celebes ape not long ago. Another needed an echidna (or spiny anteater). A computer helped each identify a zoo with a surplus of the desired animal.

The American Association of Zoological Parks and Aquariums, in conjunction with Federal agencies and private foundations, sponsors a project that some day will store data on every animal in every zoo in most countries of the world. The association's International Species Inventory System (ISIS), headquartered at the Minnesota Zoological Garden, Apple Valley, has already placed in an IBM computer detailed information on 25,000 mammals and 10,000 birds located in zoos in the United States, Canada, and Europe. ISIS will someday also include data on reptiles, amphibians, and fish.

A Vital Task

Says Janice M. Olsen, systems manager of ISIS: "A vital task of modern zoos is to develop and maintain self-sustaining populations of captive wild species and—in certain cases—to provide the only reservoir of species on the verge of extinction. To do this, we must collect data and share it.

"ISIS tells us the captive numbers and reproductive rates of animals on the endangered species list, such as the Indian rhinoceros, Siberian tiger and orangutan. This information aids the development of breeding management programs for captive wild animals."

Finding Rare Mates

Another valuable service of ISIS—the acronym spells the name of the Egyptian goddess of motherhood and protection—is the finding of a mate for a rare species in a zoo that does not have one of each sex. The computer, which is an IBM System/370 Model 158 in the state data processing center in St. Paul, Minnesota, helps to match animals needing mates with available candidates, to the benefit of the rare species themselves and of zoos all around the world.

The International Species Inventory System (ISIS), a computer data base of animals in zoos, is helping endangered species like this Siberian tiger.

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Figure 3. Selling computers through tigers (IBM advertisement in: Scientific American, 238, no.5 (1978): 95.

It is important to understand that ISIS was launched in (and partially exemplified) a period in which the geographical centre of zoo science shifted. For a long time dominated by European zoos, American zoo biologists increasingly dominated the global zoo circuit in the 1970s. The

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application of population genetics to zoo breeding was largely an Anglo-American phenomenon, with many European zoo curators having little experience in this area. Ernst Lang, for instance, the Basel zoo director known as an expert on captive breeding, explicitly addressed Seal to get advice on 'the management of the genes'.[59] Others, like the influential Cologne curator Waltraut Zimmermann, continued to emphasise that morphological characters were more crucial for breeding decisions than genetic ones.[60] In any case, by spreading North American understandings and priorities, ISIS carried a hint of cultural imperialism. Initially, ISIS committee and subcommittee members were without an exception North Americans, and in early ISIS versions, English was the only language available for entering common species names.[61] Further practical problems contributed to European reluctance. Some zoos that initially expressed interest shied away from the costs—especially as taxes on sending information sheets by post proved higher in Europe than in the United States.[62] Fears that CITES would render cross-border exchange virtually impossible also cooled the enthusiasm for taking part in a system managed from across the Atlantic.[63]

It was only through direct and time-consuming informal contacts that the ISIS network slowly expanded beyond its North American core. Jones's stay in Rotterdam, for instance, where he consulted on the entry of data, lasted almost a month. To Bridgwater he reported that it had taken ages 'just to determine what the zoo had, when it came to ages, etc.'.[64] Such efforts were important. The established contacts and continuous networking activities meant that the number of participating west European zoos could gradually increase in the 1980s.[65] Expansion on other continents was even more laborious and slow, and establishing a global reach proved to be a matter of decades. A report from 1999 would still mention that 'zoos in the developing world' were 'poorly represented'. The abstract language of science and technology had made universalism seem easy. The report, however, highlighted obstacles that were of a very mundane kind: 'economics, staff training and language'.[66]

The fact that ISIS was not the only organisation with universal ambitions to coordinate the breeding of endangered animals further complicated matters. In the mid-1970s, it entered a field in which several established institutions were already active. There was, for instance, the *International Zoo Yearbook*, the London-based periodical that served as a clearinghouse of information between zoos across the world. There were the 'international studbooks' that assembled pedigree information on specific endangered species. Additionally, there were the International Union of Directors of Zoological Gardens (IUDZG) and the International Union for the Conservation of Nature (IUCN), which functioned as meeting places for the (partially overlapping) elites of the zoo and conservation world.[67] The strategy of the ISIS leadership was to align themselves with these various bodies, enter their boards and committees, and incorporate their data. Again, this required intensive networking.

[59]Lang to Seal, 24 March 1976, MSZB, ISIS, 103.C.16.9B, Studbook Committee, Gale Library, Minneapolis.

[60]Monica Vasile, 'Reproduction against Extinction: The Value and Labour of Two Przewalski's Mares', *Yearbook of Women's History* 42 (2023): 271.

[61]Lee Simmons, 'International Species Inventory System', in *International Union of Directors of Zoological Gardens, Calgary: 1975* (Calgary, 1975), 97–100.

[62]Jones to Bridgwater, 22 April 1976, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis.

[63]Roger J. Wheater (Scottish National Zoological Park) to Bridgwater, 10 May 1976, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis.

[64]Jones to Bridgwater, 22 April 1976, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis.

[65]Booklet 'International Species Information System', August 1984, Koninklijke Maatschappij voor Dierkunde van Antwerpen [KMDA], B1.5.3.8, ISIS 1054#443, Felixarchief Antwerpen.

[66]'Isis Futures Search 2000', Unpublished report, 1999, KMDA, B1.5.3.8, ISIS 1054#443, Felixarchief Antwerpen.

[67]The history of these various international initiatives still partially remains to be written, but see: Laura Penn, Markus Gusset, and Gerald Dick, *77 Years: The History and Evolution of the World Association of Zoos and Aquariums 1935–2012* (Gland: WAZA, 2012); Simone Schleper, *Planning for the Planet: Environmental Expertise and the International Union for Conservation of Nature and Natural Resources, 1960–1980* (Berghahn Books, 2019); Bont, *Nature's Diplomats*.

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Early on, ISIS staff established friendly relations with Peter Olney of the *International Zoo Yearbook* to exchange information, and they contacted studbook keepers to standardise their data entries and incorporate them into ISIS.[68] Relations with IUDZG proved more cumbersome, however. From an American perspective, the union appeared to be an archaic old boys' network, which ISIS officials felt was unrepresentative and ill informed.[69] Still, ISIS representatives decided to attend IUDZG meetings to push their agenda.[70] At IUCN, finally, they managed to secure a seat at the table, too. In 1976, Seal was appointed as a special consultant to IUCN's Species Survival Commission, and, in 1979, he became the chair of its Captive Breeding Specialist Group—leaving the directorship of ISIS to Flesness from then onward. These ties to IUCN not only allowed Seal and Flesness to argue for the special significance of zoos for conservation, but also to promote ISIS as their tool.[71]

The realignment of the zoo world in the 1970s (with ISIS at its centre) aimed at the global consolidation of captive breeding as an accepted conservation strategy. This was not uncontested. Scepticism towards zoos still lingered within the IUCN, and at the 1976 General Assembly a small delegation of zoo representatives only narrowly succeeded in averting what they saw as 'a potentially disastrous anti-zoo resolution'.[72] In this context, the assertiveness of Seal and his collaborators stands out. Not only did Seal claim that ISIS would bolster ex situ conservation, but he even argued that zoo expertise would ultimately benefit traditional conservation in the wild. With wild populations becoming increasingly small, scattered, and isolated, protected areas were turning into 'megazoos'. Seal believed that, in order to avoid inbreeding, such megazoos would require management tools similar to those of actual zoos—tools such as ISIS.[73] For the time being, claiming a role for ISIS in the conservation of non-captive populations was certainly over-ambitious. Yet, through multi-level networking activities, the system did slowly gather transnational visibility.

Animal bodies and human labour

The establishment of the ISIS network coincided with concrete transfers of animal bodies. A good example, again with Seal in a central role, concerns the management of captive Siberian tigers. From the mid-1970s onward, the subspecies already constituted one of the theoretical test cases of ISIS.[74] Working towards practical applications over the following years, Seal simultaneously acted

[68]Olney to Seal, 24 July 1976 and Seal to Olney, 4 August 1976, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis; Alan Shoemaker (South Carolina Zoo), Studbook report, Mid-year report, 9 January 1975; Shoemaker to Bridgwater, 18 February 1976 and Bridgwater to Shoemaker, 10 March 1976, MSZB, ISIS, 103.C.16.9B, Studbook Committee, Gale Library, Minneapolis.

[69]Jones to Bridgwater, 22 April 1976, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis; Bridgwater, 'AAZPA-ISIS mid-year report', 20 January 1976, MSZB, ISIS, 103.C.16.9B, Reports: Annual and Participants, Gale Library, Minneapolis.

[70]Bridgwater to John Werler, 8 October 1976, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis; Bridgwater, 'AAZPA-ISIS mid-year report', 20 January 1976, MSZB, ISIS, 103.C.16.9B, Reports: Annual and Participants, Gale Library, Minneapolis.

[71]'Progress Report', April–June 1976, MSZB, ISIS, 103.C.16.9B, Contracts. Office of Endangered Species, US Fish and Wildlife Service 1975–8, Gale Library, Minneapolis; Bridgwater 'Report of the IUCN/SSC Meeting in Morges', 1976, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis; Flesness and Kohn, Annual Report, 1980 MSZB, ISIS, 103.C.16.9B, Reports: Annual and Participants, Gale Library, Minneapolis; 'Obituary', *Star Tribune*, 21 March 2003, MSZB, ISIS, 103.C.16.9B, Ulysses S. Seal, CBSG, In Memoriam, Gale Library, Minneapolis.

[72]King to Werler, 10 October 1976, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis.

[73]Ulysses S. Seal et al., 'ISIS: A Computerised Record System for the Management of Wild Animals in Captivity', *International Zoo Yearbook* 16 (1977): 68–70.

[74]Tom Foose, 'Demographic Models for the Management of Zoo Populations', draft [1976], MSZB, ISIS, 103.C.16.9B, Contracts, Foose, Gale Library, Minneapolis.

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on a national and global stage. At the national level, he managed to launch a Species Survival Plan for the Siberian tiger in North America under the auspices of AAZPA—the first of its kind. At the same time, he promoted such plans globally as a model for the management of endangered species within the Captive Breeding Specialist Group.[75] All this mattered for individual Siberian tigers. By analysing ISIS data, Seal had come to realise that the North American captive population was highly inbred and in urgent need of 'new bloodlines'. Using personal contacts with the Moscow zoo director, Vladimir Spitsin, he managed to trade three young tigers from wild-caught stock for a California sea lion. The tigers, named Tulip, Alisa, and Astra (or, more prosaically, 2430, 2431, and 2432) were flown to Omaha, New York and Indianapolis in 1983, accompanied by Seal himself. The media hyped the transfer as 'a fresh genetic endowment' from the Soviet Union.[76] To contribute to the maximum avoidance of inbreeding, Seal planned to move the young tigers from zoo to zoo and have them sire at least fifteen offspring each. In practice, both the moving and procreating proved less straightforward than anticipated, but the three tigers did bring ten, nine, and eleven cubs to the North American gene pool.[77]

Interestingly, the physical movement of the tigers from Moscow preceded the extension of ISIS itself into the communist bloc. Only in the mid-1980s, Seal managed to mobilise a grant from the Pew Trust to waive costs for Eastern European zoos to take part in ISIS.[78] Apart from Moscow, ISIS also welcomed Leipzig zoo—the East-German institution that held the international studbook of the Siberian tiger, and that, like Moscow, had recently sent three Siberian tigers to the United States.[79] Like in other examples of infrastructural globalism, ISIS thus gradually managed to function across the Cold War divide—albeit at the expense of a lot of personal effort.[80] Through individual contacts and tough negotiations with tiger studbook keeper Siegfried Seifert, Seal succeeded in having the latter's data actually entered into the system. A witness to the negotiations remembered that 'surrendering the decades of studbook information to ISIS … across the big pond was understandably a tall order for Seifert', particularly given an existing fear among central European zoo directors that this would enable 'the Americans to control assignment of breeding stock, perhaps to their advantage'.[81] The movement of data and animals indeed constituted closely entangled political acts, and, as such, both relied on diplomatic skill and hard work.

As important as creating border-crossing networks to enable an exchange of data and tigers, was engaging individual ISIS users to perform the daily routines to make infrastructural globalism function. It is on this level that ultimately most complications arose. Despite the imagery that accompanied computing in the 1970s, ISIS still required a lot of human intellectual and manual labour. Zoo representatives filled in long numeric codes on elaborate data sheets, using a series of heavy directories that had to (but did not always) assure taxonomic and procedural homogeneity. They then had to send the sheets by mail to Minneapolis in order to keypunch them. Subsequently, a magnetic tape was transported to the Bureau of Information Services, a division of the State of Minnesota, and the University Computer Centre, for use in a mainframe computer—at that point an IBM System/370 Model 158. It was at this Bureau that ISIS's actual centre of calculation—to use

[75]Ulysses S. Seal and Tom F. Foose, 'Siberian Tiger Species Survival Plan: A Strategy for Survival', *Journal of the Minnesota Academy of Science* 49, no. 3 (1983): 3–9; Peter Muller, 'Tiger', in *Encyclopedia of the World's Zoos*, vol. 3 (Fitzroy Dearborn Publications, 2001), 1234–9.

[76]'Crossing the Distance', Smithsonian World Special, 15 February 1984, https://revelation.unomaha.edu/_video/MSS0046_00X_m_vi_000001.html.

[77]Kathy Traylor-Holzer, *North American Regional Amur Tiger Studbook (Panthera Tigris Altaica)* (IUCN SSC Conservation Breeding Specialist Group, 2013).

[78]Interview with Nate Flesness by Monica Vasile, 26 May 2021, 41:50.

[79]Kathy Traylor-Holzer, *North American Regional Amur Tiger Studbook (Panthera Tigris Altaica)*, 67–9.

[80]See also: Edwards, *A Vast Machine*, 193–202.

[81]Peter Karsten, 'Past Presidents, Pt 1: Memories and Reflections', *WAZA News* 15, no. 1 (2015): 9–10.

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Bruno Latour's terminology—was situated.[82] There, the ISIS staff generated inventories of individual zoos as well as reports of general trends across other zoos (so-called species distribution reports). They sent those reports back on paper and microfiche with relative time intervals. Zoo managers, who often did not have microfilm readers, could sometimes only read the latter using microscopes.[83] Looking back at the procedures over forty years later, Flesness described it as 'all very awkward'.[84]

In the 1970s, several paying participants proved unhappy, too. Joel Wallach of Overton Zoo Park wrote Bridgwater in 1976 to complain that 'our curators feel that the filling in of information requires a lot of time, and that there is nothing in return'.[85] Along similar lines, George Speidel of Milwaukee County Zoo wrote: 'It is one thing for someone at a university to sit down and carefully fill out all these forms. But carrying this all out in the field will require an entirely new department. ... If ISIS is to survive, practicality is to be considered'.[86] Bridgwater for his part complained about members' misguided expectations about what ISIS could offer. In 1977, he wrote to AAZPA's then president, Don Wagner: 'They think it consists of magic buttons, which just need to be pressed for answers to all kinds of questions.' In fact, he added, retrieval was still largely 'a matter of reviewing existing records by hand'.[87] Even AAZPA board members themselves seemed to have excessive expectations. In a letter describing an official AAZPA visit to the ISIS premises in 1980, Flesness wrote about 'widespread myths about large computers and 40 story buildings'.[88] Grand visions about the automated data system clashed with everyday reality. Of course, the problems were surmountable. Most participants in the ISIS network could be convinced to put in the necessary work, and piecemeal adaptations to the system gradually eased its use. Still, returning complaints in correspondence show the system did not rely on magic, but on sometimes frustrating labour.

Ultimately, ISIS was a connective technology. The connections it fostered were designed to enable the flow of abstracted data and concrete animal bodies. Embracing the ideal of CSSPs, the ISIS staff conceived globally scattered populations as wholes. Hence, through the digital, they aimed for an elimination of physical distance. Yet, ISIS's connection work was clearly not just digital, but always social as well. It did not just rely on machine calculations, but also on networking activities in boardrooms and at conferences, and on extensive form filling by zoo staff across the world. Despite IBM's calculating power, physical space always continued to matter. This showed, for instance, in the geographically highly uneven reception of ISIS, and in the slow and expensive practice of sending paper sheets and heavy instruction manuals across oceans by mail. If anything, rolling out ISIS was a laborious enterprise.

Conclusion

The creators of ISIS had aimed to restructure long-established global flows of zoo animals. From the 1800s until well into the twentieth century, public zoos had a reputation as places where wild-caught animals came to die.[89] ISIS promised to offer an alternative. Its global data infrastructure sought to turn zoological gardens into networked places that served the global breeding and

[82]Bruno Latour, *Science in Action : How to Follow Scientists and Engineers through Society* (Harvard University Press, 1987), 215–57.

[83]'ISIS – A Collecting and Sharing of Captive Animal Statistics', 2 January 1976, MSZB, ISIS, 103.C.16.9B, Reports: Annual and Participants, Gale Library, Minneapolis; Schwartz and Flesness, 'On the Origin of Species Information Systems', 85.

[84]Interview with Nate Flesness by Monica Vasile, 26 May 2021, 08:30.

[85]Wallach to Bridgwater, 16 January 1976, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis.

[86]Speidel to Bridgwater, 14 February 1976, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis.

[87]Bridgwater to Wagner, 26 August 1977, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis.

[88]Flesness to Kohn, 7 November 1980, MSZB, ISIS, 103.C.16.9B, Correspondence, Gale Library, Minneapolis.

[89]See extensively in Violette Pouillard, *Histoire des Zoos par les Animaux. Contrôle, Impérialisme, Conservation* (Champvallon, 2019).

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survival of endangered species. Yet, while the system changed the way zoos functioned, it did not do so to the extent, or in the ways, its originators envisioned.

From the mid-1970s until today, the main legitimising ground of ISIS remained the same: enabling the long-term survival of endangered animals in captivity.[90] While the promise of a 'global zoo' through datafication failed to materialise in the 1970s, technological innovations throughout the 1980s, 1990s, and early 2000s kept the original idea alive. Floppy disks and CD-ROMs replaced heavy paper reports and unreadable microfilms; PCs became more widely available; ISIS developed its own software systems (first called ARKS and then ZIMS); the number of potential reports and the information it contained increased; the internet emerged.[91] Artificial insemination eased the circulation of hereditary material as the movement of semen partially replaced the movement of animal bodies.[92] It all reinvigorated initial visions of endangered genes freely flowing across the globe according to a digitised management scheme.

Yet, while ISIS did increasingly streamline ex situ conservation across the world, the ultimate goal of a closed global zoo circuit that optimally manages genetic material proved hard to realise. In 1999, a report indicated that 30% of the acquisitions or removals recorded in ISIS came from or went to unknown entities: 'small pet shops, ranches, natural resource departments, private individuals'. Of the specimens transferred between ISIS members, 15 to 30% remained unrecorded.[93] In an interview in 2021, Flesness still estimated that only half of the endangered and threatened species in North American, European, and Asian zoos had management plans based on demographic and genetic data. On top of that, he believed that zoos implemented recommendations resulting from such plans only in about half of the cases. As the major reason for this state of affairs, he highlighted the amount of work involved—notably filling data gaps, correcting mistakes, analysing the resulting information and practically organising the transport of animals (or their genes).[94] Despite technological advancement, non-automated labour indeed continues to be crucial in managing self-sustaining populations, hampering the realisation of ISIS's original ideals.

Often, historians have assumed that the advent of computers brought a radical and sudden transformation of existing knowledge practices. Jon Agar has already indicated how such a representation glosses over long-term continuities and gradual change.[95] This is clearly the case for ISIS. The system built on pre-existing practices and technologies, ranging from patient records to punch-card censuses and studbooks. Its power as a management instrument depended on the extension of a social network of data providers, and, consequently, it grew only incrementally. Furthermore, the laborious growth of ISIS's network was always highly context-dependent. The system germinated in a time and place of systems euphoria: 1970s Minnesota. Its focus on ex situ conservation through genetics and demography was not a pre-given, but resulted from its mid-1970s entanglement with particular US American institutions (such as AAZPA and the Interior Department) and legal instruments (the Endangered Species Act). From then onward, ISIS's categorisation, datafication and globalisation of captive animals came with a form of genetic reductionism. This drove a wider development in ex situ conservation, in which, with the words of Matthew Chrulew, 'embodied and emplaced beings are decontextualised and conceived as

[90]See, for instance, the 'Why?' section in: Booklet 'International Species Information System', August 1984, KMDA, B1.5.3.8, ISIS 1054#443, Felixarchief Antwerpen.

[91]Nate R. Flesness, 'International Species Information System (ISIS): Over 25 Years of Compiling Global Animal Data to Facilitate Collection and Population Management', *International Zoo Yearbook* 38 (2003): 53–61; Schwartz and Flesness, 'On the Origin of Species Information Systems'.

[92]Betsy L. Dressler, 'Cryobiology, Embryo Transfer, and Artificial Insemination in Ex Situ Animal Conservation Programs', in *Biodiversity*, ed. Edward O. Wilson (Washington Academy Press, 1988).

[93]'Isis Futures Search 2000', Unpublished report, 1999, KMDA, B1.5.3.8, ISIS 1054#443, Felixarchief Antwerpen.

[94]Interview with Nate Flesness by Monica Vasile, 26 May 2021, 25:00.

[95]Jon Agar, 'What Difference Did Computers Make?', *Social Studies of Science* 36, no. 6 (2006): 869–907.

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calculable and controllable genetic information'.[96] Spreading and applying this vision globally was never just a matter of technology. It also involved a hard-won geographical and numerical expansion of memberships, the linking up of the system to new global and regional legislative regulations, the development of new manuals and training workshops, the labour-intensive correction of double entries and mistakes, and a continued massaging and re-recruitment of members and funders. For all these reasons, computerised data systems did not lead to the overnight creation of a 'global zoo'. Rather, they were part of a decade-long development that remained slow, laborious, and (until this day) incomplete.

When ISIS turned into Species360 in 2016, the organisation came with a new branding: The '0' of the '360' in the logo was a simplified globe looked at from outer space; the accompanying catchphrase was 'global information serving conservation'.[97] The imagery literally and figuratively offers a view from afar, suggesting once again abstraction, detachment and neutrality.[98] Yet, looking at the development of ex situ conservation through the lens of infrastructural inversion has offered an altogether different image. The project of ISIS was always (and Species360 remains) situated and political, material and embodied. It is these aspects, I have argued, that explain both its labour-intensive character and its relative power. Infrastructural globalism ultimately is hard work.

On a broader level, the history of ISIS serves as a reminder that infrastructural globalism extends its influence to non-human lives. For all its limitations, the 'globalist information' it provided served the conceptualisation of a globally organised form of ex situ conservation, directly influencing the transcontinental flows of captive Siberian tigers, Przewalski's horses, and animals of many other species. The (partial and hard-won) globalisation it enabled was a more-than-human one.[99]

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[96]Matthew Chrulew, 'Managing Love and Death at the Zoo: The Biopolitics of Endangered Species Preservation', *Australian Humanities Review* 50 (2011): 148.

[97]https://species360.org/.

[98]See, for instance, Sebastian Vincent Grevsmühl, 'Visualising the Global Environmental: New Research Directions', *Geo: Geography and Environment* 4, no. 1 (2017): https://doi.org/10.1002/geo2.35.

[99]For a more programmatic development of this general point: Raf De Bont, 'Globalising Animals: Histories for the Anthropocene', *Journal for the History of Environment and Society* 7 (2021): 11–34.

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