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Idwi, *Xenopus laevis*, and African Clawed Frog: Teaching Counternarratives of Invasive Species in Postcolonial Ecology

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This article presents a Pedagogical Framework for Invasive Species to shift how we understand, teach, and study invasive species, especially when people are responsible for their expansion into new ecosystems. The focus is on a species originating from countries in Sub-Saharan Africa that humans extracted and introduced in certain regions of the Americas, Europe, and Asia: *Xenopus laevis*, African Clawed Frog, or Idwi in the Zulu language. This article re-introduces the frog Idwi through lenses of de/post-colonial theory, Indigenous studies, and Critical Race Theory to create counternarratives. Through a popular press analysis, the article uncovers how humans in colonial contexts extracted species from de/colonizing spaces to export to other regions of the world. When the frogs were profitable, the entrepreneurs who exported them were valorized. However, once seen as invasive, the frogs were targeted with xenophobic projections. This article foregrounds counternarratives that challenge and critique the universal application of the "invasive species" label.

Keywords: Postcolonial theory, Decolonial studies, Indigenous studies, Ecology, Invasive species

Introduction

How might environmental educators and researchers approach the topic of invasive species? Instead of focusing on the ecological harm that "invasive" species cause to "native" ones, this article centers the story of a species that has been labeled as universally invasive. To tell this story and to model possible counternarratives, this

article explores a series of questions. Firstly, what was the geographical site of origin for this species? How is this species named, described, researched, and recognized at the site of origin? How might we, as proponents of environmental education, consider the cultural value and scientific utility of certain "invasive" species? Further, how might we consider the intrinsic value of non-human species, especially those that are labeled as "invasive"? Over the course of history, who has benefitted from the introduction of this species? What social structures enabled this biological extraction? Lastly, how might we conceptualize counternarratives for invasive species more broadly?

Using these guiding questions to study one invasive species, we propose a Pedagogical Framework for Invasive Species Counternarratives (see Table 1). The focal species for this article is a frog that was extracted from multiple countries in Africa and imported into the United States (U.S.), where it is now labeled as invasive. This study aims at "internationalising, indigenising, decolonising, and Africanising" the curriculum – educational concepts that are explored in the South African context (Le Grange, 2018), which is one of the frog's sites of origin. From the voyages of 19th Century European frigates to those of 20th Century U.S. entrepreneurs, this article explores the patterns of imperialism, de/colonization, and corresponding political upheavals that neglected to regulate the extraction and trade of this species. We consider how the history of one frog species can be understood as a microcosm of colonization and exploitation, and we propose how we might start to acknowledge issues like this in environmental education.

With the frog as an example, this article explores how one might address the topic of invasive species in a decolonizing curriculum – decoloniz-ing because the process is on-going and iterative. To dismantle the frog's "invasive" label and apply our proposed framework (Table 1), we weave together multiple counternarratives. In

curriculum studies, the “master narrative" implies that white academics are the foundation of the field itself (Au et al., 2016). One could even trace the genesis of scientific education as we know it to Immanuel Kant and the European Enlightenment (Nejadmehr, 2020). However, one might challenge this "master narrative” in two ways: (1) by foregrounding contributions made by scholars and communities of color and (2) by critiquing the “master narrative" from within.

To foreground contributions made by scholars and communities of color, we challenge the “master narrative” of Idwi, *Xenopus laevis*, and African Clawed Frog (three names for the same animal) by first exploring the history and process of naming the focal species. Next, we describe the species’ site of origin along with their innumerable applications in global research. We ground ourselves in the socio-cultural context of the frog’s site of origin by highlighting scholarship in folk taxonomy, Indigenous Knowledge Systems, and what intrinsic value could be associated with Idwi.

After describing these counternarratives, we further critique the “master narrative” from within by investigating the anthropogenic invasions that displaced tens of thousands of frogs from their site of origin. To do so, we conduct a popular press analysis of newspaper articles over the past century. We identify instances that document the people responsible for the extraction and introduction of the frog. Further, we analyze the language ascribed to the frog – which is ethnicized and xenophobic – once it becomes unprofitable to export them and research reveals them to be an ecological threat.

To foster responsible and responsive changes in environmental education, the present article offers counternarratives of an “invasive” species, Idwi, that can shape how we think, study, and teach about such species. We propose a curricular shift for invasive species which aims to selectively foreground counternarratives and challenge

the “master narrative.” Each species has a site of origin and its own socio-cultural relationship with the community there. Each species may have value in medical and scientific research at a global level and may also have regional ethnobiological significance. Further, one must consider the intrinsic value of organisms, beyond their anthropocentric utility. Lastly, humans are often responsible for dispersal of species beyond their native distribution. Collectively, these counternarratives serve to challenge the universal label of invasive. To inform these counternarratives, this article draws from three theoretical and phenomenological frameworks: de/post-colonial theory, Indigenous studies, and Critical Race Theory.

Theoretical Frameworks

A pedagogical comparative framework developed by Vanessa Andreotti (2011) informs the analysis of our case study in invasive species. In a thorough review of actionable postcolonial theory in education, Andreotti offers a synthesis for the lenses of Postcolonial theory, Decolonial studies, Indigenous studies, and Critical Race Theory. Importantly, Andreotti reminds us of the complexities, nuances, and heterogeneity of scholars in these fields while modelling possible applications of these theories in education. Below, we summarize the comparative pedagogical framework offered by Andreotti and describe how each lens is applied in the present study.

The first theoretical framework that drives this study is de/post-colonial theory. Postcolonialism acknowledges the impacts of colonialism as more than just geo-political dominance but also as an imposition of certain ways of thinking, ranging from the language of instruction in schools to the epistemic superiority of the Western Enlightenment. Imperialism has been described as, “a knowledge project as a way to domesticate a people, control their history and distort their representation through

canons of knowledge" (Leonardo, 2018, p. 7). In general terms, Andreotti (2011, p. 59) describes the problem addressed through a Postcolonial lens to be, "European colonialism based on Enlightenment humanism and its legacies." The problem as seen through a Decolonial studies lens is premised on, "[the] Darker side of Eurocentered modernity: violent appropriation and exploitation of capitalism." The agents of change for Postcolonial theory are "scholars tackling colonialism within academia and society and reaching out to the Other" and for Decolonial studies are "scholars from the global periphery opening spaces for uncontested peripheral knowledges" (Andreotti, 2011, p. 59). The co-authors of this article are positioned accordingly. Even with these important distinctions between the lens of Postcolonial theory and Decolonial studies, there are shared values of anti-colonial and anti-imperial objectives within the scholarship for both 'post-' and 'de-' colonialism (Leonardo, 2018, p. 15). Given the positionality of the co-authors of this article and the shared values for each theory, we opt for a de/post-colonial theory here. The species of our present case study were extracted from various decolonizing African countries, going through a period of transition from colonial rule. They were a part of a series of large-scale biological extractions that occurred during the early stages of decolonization, as several African countries transitioned through civil conflict and liberation. It is well-documented that "many Europeans set off for the colonies because they [could] get rich over there in a very short time…" (Fanon, 2008, p. 88). However, an investigation of how the popular press depicted people who imported species and profited from this biological extraction *during decolonization* is yet to be considered through a de/post-colonial lens in environmental education.

The second framework informing the present study is Indigenous studies. Andreotti (2011, p. 59) lists problems explored through this lens, including but not limited to, "[t]erritorial occupation; genocide; continuous epistemic, geographical, and

economic subjugation; [and] pathologizing practices." Alongside Indigenous teachers and academics are, "critics decolonizing their contexts and seeking to mainstream indigenous knowledges without domesticating them." (Andreotti, 2011, p. 59). Education scholars in the United States are providing materials to teach U.S. history that centers the place, presence, and perspectives of Indigenous Peoples (e.g. Schmitke et al., 2020). In environmental education, there are possibilities emerging from international Indigenous perspectives as well (e.g. Carvalho et al., 2020). Of relevance for the present study, Ngũgĩ wa Thiong'o described not only the struggle of preserving Kenyan and East African languages, but he also went on to advocate for a loyalty to Indigenous values at the center of the syllabus (Thiong'o, 1981, p. 94). However, examples are still needed of how Indigenous languages and values could be centered in environmental education topics related to introduced species. Using the lens of Indigenous studies, this article acknowledges the epistemic subjugation through naming a species taken from its site of origin and also highlights scholarship in folk taxonomy, offering a mechanism of centering Indigenous values at the center of the syllabus.

Lastly, the framework of Critical Race Theory suggests that storytelling and counter stories can serve to challenge racism and colorblindness (Andreotti, 2011). Emerging from legal scholarship (Bell, 1995; Crenshaw, 2010), then explored in the field of education (Ladson Billings and Tate, 1995), and recently subjected to a litany of social criticisms and policy regulations in the context of U.S. education (Copland, 2021), Critical Race Theory invites us to consider what systems reinforce observable social inequities that persist – and can be predicted by – the social construction of race. Here, we investigate how whiteness and objectivity are emphasized in historical popular media to valorize white entrepreneurs and sterilize the same species that, when found outside the laboratory, becomes the object of ethnicized and xenophobic projections.

One may wonder how counternarratives in environmental education might disrupt these socially-constructed projections on invasive species.

These three frameworks aim to foreground subaltern and decolonizing methodologies originating from the communities of interest and to challenge the assumed values of the dominant narrative of Western discourse. These theories in action may be useful for, "those [translators and catalysts] in-between political communities who both benefit from and are critical of ethnocentric global hegemonies and who aspire to use their privilege/lines of social mobility in the work against the grain of ethnocentrism and hegemony" (Andreotti, 2011, p. 8). For educators and researchers in environmental education, we can begin to acknowledge the historical harms of biological extraction that we continue to benefit and profit from today, from museum displays to research specimens. Further, we can foreground the local, community-based methods used to engage people in environmental education around the world, especially in areas subject to the impacts of imperialism.

Before delving into the historical analyses informed by these theoretical and phenomenological frameworks, the next section offers definitions and a critical examination of the term ascribed to the species of our study and to many other translocated species in the world.

Defining Invasive

In·va·sive /inˈvāsiv/ *adjective* (especially of plants or a disease) tending to spread prolifically and undesirably or harmfully. late Middle English: from obsolete French invasif, -ive or medieval Latin invasivus, from Latin invadere (see *invade*).

In·vade /inˈvād/ *verb* (of an armed force or its commander) enter (a country or region) so as to subjugate or occupy it. late Middle English (in the sense ‘attack or assault (a person’)): from Latin invadere, from in- ‘into’ + vadere ‘go’.

The Global Invasive Species Database (GISD, 2020) lists “some of the **worst invasive species** as determined by international experts and analysis of datasets to identify species with serious impacts on biological diversity and/or human activities” [bold added for emphasis]. GISD, funded by a limited number of countries (United States, United Arab Emirates, New Zealand, Taiwan, United Kingdom, France, and Italy), gives a description of the “worst invasive species” that applies a universal label to a species as such, disregarding the potential value of species in their sites of origin. The criteria emphasize negative impacts on biodiversity and human activities, so they may exclude cases where people benefit from introduced species. Importantly, previous work demonstrates there is a geographical bias in invasive species research, with less research on the impact of introduced species in the continents of Africa and Asia (Pyšek et al., 2008). Future plans of GISD are to create a Global Register of Introduced and Invasive Species (GRIIS), offering “country-wise validated, verified and annotated inventories of introduced and invasive species,” which may help to keep track of these geographical discrepancies (GISD, 2020).

There are “widely divergent perceptions of the criteria for ‘invasive’ species” among invasive species researchers (Colautti & MacIsaac, 2004). This observation led to the development of descriptive stages to be applied biogeographically instead of taxonomically; however, the focus for each stage is based on how successfully a species is establishing itself in a certain context. In this proposed research protocol, twelve terms with nuances of how the species arrived (Adventive, Alien, Exotic, Foreign,

Immigrant, Imported, Introduced, Nonindigenous, Transferred, Translocated, Transplanted, and Transported) are collapsed into a single term – "Stage I-V" (Colautti & MacIsaac, 2004). Further, descriptive terms that offer insights into public perceptions of the organism (e.g. Noxious, Nuisance, Pest) are not defined by the model (Colautti & MacIsaac, 2004). While this is useful for creating a common discourse for the study of the *propagation* of invasive species, it does little to advance our understanding of the circumstances around the extraction of those species in the first place. Regardless, inconsistent terminology persists in invasive species research, likely due to the lack of agreement amongst scientists, older publications, and the creeping emergence of new definitions for the same terms over time (Colautti & Richardson, 2009). The inevitability of terminological pluralism leads some scientists to argue that we should embrace the variety of terms as a reminder for the contextualism of invasive species research (Heger et al., 2013).

Among scholars in Indigenous Knowledge Systems, there are various perspectives on invasive species as well. For example, one perspective is that, "[t]o most people, an invasive species represents losses in a landscape, the empty spaces to be filled by something else. To those who carry the responsibility of an ancient relationship, the empty niche means empty hands and a hole in the collective heart" (Kimmerer, 2013, p. 150). The responses of Indigenous nations in North America to invasive species, "include all the generalized steps taken by settler governments and NGOs plus some unique, culturally informed strategies" (Reo et al., 2017). As another example, fieldwork with Sault Ste Marie and Bay Mills tribes revealed that some tribal members saw invasive plant species as something to be eradicated in partnership with Western scientists, while other tribal members saw the arrival of these species as an opportunity to explore new uses (e.g. culinary) for the species (Reo & Ogden, 2018).

There is a recent scholarship advocating for invasive species management to consider Indigenous Knowledge Systems, emphasizing the importance of consulting with tribal communities in environmental policy and ecological management more broadly (Mattes & Kitson, 2021; Newman, 2021). The diverse, context-specific perspectives of Indigenous Knowledge Systems can offer insights for responding to invasive species.

Even with divergent perceptions of what counts as an invasive species or how humans might to respond to their propagation, researchers have used the ability to identify invasive species as an objective measure of one's knowledge of nature across ages and contexts (Boshoff et al., 2008; Byrne et al., 2020; Cordeiro et al., 2020; Crall et al., 2013; Preston & Fuggle, 1987; Schreck Reis et al., 2013; Skukan et al., 2020; Zeng et al., 2021). The prevalence of invasive species identification scholarship, as it relates to the public understanding of science and citizen science research, warrants attention. If the focus is on identifying an invasive species and its ecological impact, we miss the opportunity to learn the instrumental and intrinsic value of the species in different contexts or how humans played a role in their introduction. To follow this critique of what is "invasive," the next section explores the name(s) of the focal species.

Naming the Frog

The process of naming a species offers an example of how imperialism and colonialism impacts our perceptions of species to date. The "master narrative" in scientific nomenclature is that European naturalists in the Age of "Discovery" were the first to name and categorize each organism they collected. However, recent investigations highlight the value of understanding Indigenous taxonomy. We propose learning and teaching the Indigenous names of "invasive" species from their site of origin to challenge this "master narrative."

To begin, what is the "master narrative" of the naming of the frog? The French naturalist Daudin (1802, p. 82) is often cited as naming the frog *Xenopus laevis*; however, a review of the original text reveals that Daudin labeled the frog as *Bufo laevis*. According to Frost (2020), the earliest recorded use of *Xenopus laevis* was an Austrian zoologist, Franz Steindachner (1867). *Xenopus laevis* is one of thousands of species collected in global voyages of the sailing vessel *Österreichischen Fregatte Novara*, which was made possible by the Imperial Academy of Sciences in Vienna (Novara Expedition et al., 1867). The Novara voyage was organized less than a decade after Darwin's publication On the Origin of the Species (1859) and less than a decade before the reorganization of Vienna's Imperial Royal Natural History Court Museum, by Emperor Franz Joseph I (Beck & Joger, 2018, p. 515). The natural history museum is one example of many national museums established throughout Europe in the 19th century (Simmons, 2016). However, this practice of collecting organisms for research, private collections, and museums was unregulated biological extraction – a form of epistemic violence and injustice enacted by and for museums of colonizing nations (Vawda, 2019). Not only were specimens collected, but they were also named.

Binomial names derived through Linnaean taxonomy have a notable history. They are valorized as an international system that fosters communication among scientists (Notton et al., 2011) yet also inextricably linked to racist hierarchies and ethnic racism (Kendi, 2017, p. 153; Roberts, 2011, p. 252; Washington, 2006, p. 83). While it is important to not project anthropocentric social issues such as racism on biological methods at-large such as classification, the emergence of the method must not be unilaterally accepted as objective and void of social implications. The myopic emphasis of scientific communities on Linnaean taxonomy also deprioritizes Indigenous names, even though Indigenous names have almost ubiquitous chronological

precedence and can convey in-depth knowledge relating to form, uses, distribution, and ecology of species (Gillman & Wright, 2020).

Given this "master narrative" in naming the frog, how might one challenge it? One of the names for our focal species, used locally in the site of origin in Southern Africa, was only recently documented in a globally accessible format. Phaka et al., (2019) published the folk taxonomy, including Indigenous names of some South African frogs. From semi-structured interviews of habitants of KwaZulu-Natal's Zululand region, Phaka et al., (2019) reported that, "the local name Idwi corresponds perfectly with *Xenopus*."

In addition to Idwi, *X. laevis* in the site of origin is also known as Common Platanna, African Clawed Frog (English), or Gewone Platanna (Afrikaans). "*Xenopus*", a word of Greek origin, means strange foot in reference to the odd appearance of their clawed feet. The Latin word "*laevis*" means smooth in reference to the frog's slimy skin (Du Preez & Carruthers, 2017). Platanna, an Afrikaans name of Dutch origin, refers to this genus' flattened hands and feet (Du Preez & Carruthers, 2017). "Idwi" is an IsiZulu (or Zulu language) word whose etymology is still undetermined (Phaka et al., 2019). Investigations of Indigenous taxonomy in South Africa are lax, thus the etymology of many Indigenous species names is unknown, and other Indigenous names remain unrecorded.

Knowledge of Indigenous taxonomy has been enabled by local community engagement with university partnerships. These partnerships must be built on trust to support the co-creation of local knowledge bases (Mbah, 2019). Community-based efforts to document local frog species in Zululand in IsiZulu has culminated in a bilingual guide on local frogs (Phaka et al., 2017). This initiative required field work, community partnerships, and a multi-disciplinary team to produce South Africa's first

comprehensive life sciences reading material about frogs in one of the country's Indigenous languages (Phaka & Ovid, 2021). Citizen science approaches to environmental education can reveal the challenge(s) of language(s) (Rodrigues et al., 2020). Such local initiatives can be included in environmental education curriculum to deconstruct the global "invasive species" label. The documentation of the frog's name, Idwi, in the language of its local context highlights the importance of community-based research and citizen science. It is worth noting for how many species we may never get to know their names in the Indigenous languages of their local context.

Take a moment to reflect on the history of naming this frog; *Xenopus laevis*, African Clawed Frog, Gewone Platanna, and Idwi. Next, we consider the frog's site of origin.

Idwi's Site of Origin

The distribution of the *Xenopus* genus is often framed as "throughout Sub-Saharan Africa" (Blackburn et al., 2019). Various African Clawed Frog species occur in most, if not all, of the countries south of the Sahara Desert (Channing & Rödel, 2019). *Xenopus laevis* is among the most widespread species of the *Xenopus* frogs with a wide distribution within South Africa along with occurrences in other Southern African states including Botswana, Lesotho, Malawi, Mozambique, Namibia, Swaziland and Zimbabwe (Channing & Rödel, 2019; Du Preez & Carruthers, 2017; Minter, 2004). Southern Africa has a rich amphibian diversity due to its diverse topography, habitats, and climatic conditions where rainfall increases from west to east (Du Preez & Carruthers, 2017). Within this Southern African distribution, Idwi is reported to have wide habitat tolerance (Du Preez & Carruthers, 2017) including disturbed habitats (Measey et al., 2012), human-made waterbodies, and eutrophic waters (Minter et al.,

2004). *Xenopus laevis* is an ecologically important species for South African wetlands due to its abundance and voracious predation. It also gets preyed upon by larger vertebrate species including mammals and birds (Minter et al., 2004). The species scavenges (Minter et al., 2004) and preys on terrestrial organisms (Measey, 1998). Idwi's wide habitat tolerance poses a threat to native restricted species. In South Africa, the endemic *X. gilli* is being displaced from its range by Idwi (G. Measey & Davies, 2011; Picker, 1985).

Exports of *X. laevis* from South Africa, prompted by its usage in laboratories, first went to the United Kingdom and then to the rest of the world (Measey et al., 2012). Laboratories across the world keep living populations of *X. laevis* to such extents that it is the most widely distributed amphibian (Measey et al., 2012). This frog's history as a laboratory subject is linked to its usage as a human pregnancy test around the 1930s (Gurdon & Hopwood, 2000) and as a model research animal (Van Sittert & Measey, 2016). The global pet trade is also a contributor to Idwi's dispersal out of Africa (Weldon et al., 2007). Colonization of other continents by *X. laevis* is human-assisted, but at the site of origin, this species is expanding its native distribution through local invasions resulting from a combination of natural dispersal and human-assisted translocation for research and training purposes (G. Measey et al., 2012; G. Measey & Davies, 2011; Van Sittert & Measey, 2016). Later in this article, we investigate the people responsible for dispersing Idwi beyond its native distribution range. In the subsequent section, we consider the frog's global scientific significance.

The Value of Idwi to Scientific Research at a Global Level

One of the earliest research articles into global invasions of Idwi was published in 1996 (Tinsley & McCoid, 1996). *Xenopus laevis* research in its native country of

South Africa encompasses various subject areas in addition to invasion biology. A search on the Scopus database for *X. laevis'* original research articles focused on South Africa returns results spanning at least 15 subject areas including Engineering, Planetary sciences, Neuroscience and Pharmacology. Globally, Idwi is considered a model amphibian and one of the most studied organisms alongside fruit flies, mice, nematodes, and zebrafish (Measey et al., 2012). Idwi is a preferred model for research in developmental, molecular, and cellular biology (J. B. Gurdon, 1996; Lee-Liu et al., 2017; Tseng & Levin, 2008). For developmental biology in particular, research on *X. laevis* has received high honors from the scientific community. John B. Gurdon and Shinya Yamanaka shared the 2012 Nobel Prize in Physiology or Medicine for their cell development research on this frog, showing that mature cells can become stem cells (Johnson & Cohen, 2012). Idwi's importance in developmental biology extends to it being a model for studying disorders such as Wolf–Hirschhorn syndrome (Lasser et al., 2019) and retinal degenerative diseases (Vergara & Del Rio-Tsonis, 2009). This frog has also served as a model for research into genome editing (Park et al., 2017) and ethology (Karplus et al., 1981; Rothman et al., 2016). *X. laevis* has been a subject of parasitology since the 1900s and at least 25 genera of parasites have been associated with this frog (Tinsley & Kobel, 1996). More recently, *X. laevis* has been dubbed "The UberXL of nematodes" in reference to seven previously unrecorded nematode species for which the frog acts as a reservoir within its native range (Schoeman et al., 2020). Additionally, findings from studies of *X. laevis* have been used to explore possible treatments in humans, such as electrical stimulation of the immune system to manage COVID-19 (Allawadhi et al., 2020).

Other scientific counternarratives exist for *X. laevis*, but there are too many to outline in one article. What is notable is that a species universally labeled as "invasive"

in certain contexts of environmental education, yet it has broad scientific applications, beyond its ability to survive in a wide range of habitats that it has been introduced to. The frog also has ecological relevance in its site of origin, South Africa, contributes to our understanding of Indigenous Knowledge Systems, and has an intrinsic value outside of anthropocentric utility, as described in the next section.

Folk Taxonomy and Indigenous Knowledge Systems as Counternarratives

Beyond the modern sciences, there are several counternarratives that may serve to dismantle the universal "invasive" label of the frog. Here, we consider counternarratives that center the significance of the frog in ethnobiology, folk taxonomy, culture more broadly, and intrinsically – in and of itself.

For scholarship in ethnobiology and folk taxonomy, *X. laevis* is proving to be a valuable species. Ethnobiology focuses on the environmental and cultural relationships of humans and non-humans. Idwi has been used to increase understanding of behavioral observations, rooted in Indigenous Knowledge Systems (Phaka et al., 2019). For examples, some "cultural misconceptions" may be attempts to explain observed animal behavior without knowledge of the organism's biology. A common myth about Idwi was that the frog would, "fall from the sky during torrential rain" (Phaka et al., 2019). This observation that Idwi are found outside their usual aquatic boundaries during heavy rainfall corresponds to their behavioral response to venture overland to other ponds as a part of seasonal dispersal (Measey, 2016; Villiers & Measey, 2017). Ethnobiological investigations of Idwi also provide evidence that the more visible a species is to a cultural group the more likely it is to have a species level ethnic name – when ethnic names are usually generic. Studies in folk taxonomy explore how organisms are named and classified across cultures. For the most part, folk taxonomy is

not documented or recognized outside the culture in which it is understood (Phaka et al., 2019). In this case, Idwi is the Indigenous uninomial equivalent to the scientific taxonomy of the genus *Xenopus* and the family Pipidae (Phaka et al., 2019). Additional studies in folk taxonomy can challenge the universal label of "invasive" by selectively foregrounding the name of the species in the vernacular of the species' geographical site of origin. This serves as a reminder that there is a place where this species is not "invasive." Further, in this place, Idwi and other frogs were the subject of a partnership between scientists and Indigenous communities to develop a bilingual field guide, resulting in a book in IsiZulu and English on South African frogs (Phaka et al., 2017; Phaka & Ovid, 2021). Such partnerships in ethnobiological investigations increase understanding of cultural perspectives of South African amphibians and add to the country's small knowledge pool of ethnoherpetology. Further, this community-based collaboration could serve as a model for future studies in ethnobiology and folk taxonomy.

Counternarratives might also include how Idwi's cultural significance extends to one of South Africa's earliest inhabitants, the Khoi and San communities. Khio-San drawings resembling *Xenopus* have been found among the rock art in the Drakensberg, South Africa (Thorp, 2013). The interpretation of these *Xenopus* drawings is that they are linked to human reproduction (Thorp, 2013, 2015). It is, however, not possible to determine the precise *Xenopus* species depicted in the art as the various Clawed Frog species have similar morphology. This interpretation of a traditional culture is interesting, for a *Xenopus* species (*X. laevis*) also has significance to human reproductive health in modern culture (J. Gurdon & Hopwood, 2000).

Beyond the ethnobiological and cultural utility of the frog, counternarratives might also consider the intrinsic value of this non-human species. To explore this

concept, one may consider previous studies on how humans have engaged with the perspectives of non-human species. For example, emerging scholarship in animal cultures may offer a more animal-centered perspective (Montford & Taylor, 2020). Performative acts of "minor players," such as young people pretending to be an animal labeled as invasive, are yet another approach to exploring human-animal relationality (Taylor, 2020). Even African literature – written as a first-person narrative with animals as the protagonists – may offer creative insights into the lived experiences of non-human species (Mwangi, 2019). Although this might be perceived as anthropomorphism, Mwangi's interpretation reframes narrative agency as setting the conditions of possibility for recognizing the intrinsic value of animals, beyond their instrumental value for humans. In the context of Indigenous studies, the tension of maintaining a "bi-epistemic negotiation within settler societies is often marked by the paradox of the need to resist the dominant epistemology while fighting to revive and protect indigenous epistemologies *through the dominant epistemology itself*" (Andreotti, 2011, p. 68). One might imagine a parallel with the tension between seeking to understand and communicate the intrinsic value of non-human animals and yet being confined to an anthropocentric discourse in environmental education. This tension highlights a need for Indigenous epistemologies to inform such counternarratives.

So far, this article has aimed to challenge the "master narrative" (Au et al., 2016) of invasive species by introducing counternarratives stemming from the species' site of origin. After foregrounding Indigenous Knowledge Systems, the remainder of this article aims to dis-orient the western knowledge regime with a self-critical approach (Nejadmehr, 2020). In the context of invasive species, we describe the narrative of biological extraction to divulge the underlying cause of the frog's global dispersion. By using historical evidence in mainstream U.S. media as a symptom of western ideology,

we critique western thought in efforts to decolonize the curriculum on this and other invasive species.

Analyzing Press Coverage of *Xenopus laevis*

Newspapers have been described as a continuous reflection of public attitudes and concerns with content shaped by consumers (Montford & Taylor, 2020). In previous studies, the popular press has been a resource for studying human-animal relationships (Lloro & Hunold, 2020; Lloro-Bidart, 2017). From advice columns to op-eds, popular media analysis can offer insights into how a given species is represented in public discourse over time. Additionally, one might infer what socio-political structures enabled (or even encouraged) the extraction and redistribution of species that become invasive.

To investigate how public perceptions of *X. laevis* were shaped over the course of the century, we examined newspapers in one of the largest online repositories, archiving over 21,600 historical newspapers based mostly in the United States (newspapers.com). Using the search term "Xenopus" yielded 799 results, with the year of publication ranging from 1890 to 2021. If a search result met the inclusion criteria, it was archived through an extension for open-source citation management, Zotero. Excluded search results were reprints of the same article in different newspapers (n = 292); duplicate scans of the same newspaper (n = 230); ads/announcements for job postings, research talks, and grants or degrees awarded (n = 154); search results about a different *Xenopus* species (n = 18); or articles that only mentioned *Xenopus* once on a list of other animals and/or research topics for featured scientists (n = 27). The

remaining 78 articles described *X. laevis* in greater detail for thematic analysis. The next section summarizes major themes emerging from this qualitative approach, based on the press coverage descriptions of *X. laevis*. Major themes included: (1) biological extraction of the frog from decolonizing African countries, (2) scientific and educational utility of the frog, and (3) problematization of the frog as an invasive species.

Biological Extraction of Idwi by Entrepreneurs in Decolonizing African Countries

Critiquing the "master narrative" (Au et al., 2016) in a site of the frog's introduction (in this case, the U.S.) could inform societal counternarratives by describing the human activities resulting in Idwi's worldwide dispersal. Idwi has been used for pregnancy tests in hospitals, pets in aquaria, and tools for dissection and experimentation in classrooms. It eventually became labeled as an invasive species. Public perceptions of *X. laevis* and their site of origin can be deduced from the language choice in U.S. newspapers.

During times of biological extraction for their instrumental value, the frog was described with anthropomorphic and positive language. For example, reporting on the London Zoo describes the frog as an "African ally" to other frogs at the zoo, and as an "expert swimmer" with "an excessive fondness of water" (Beddard, 1895). As they were extracted and imported, the frogs are said to be "an exotic variety, rare even in their native Africa" as one article describes how "2000 very lively frogs" arrived by ship and were "greeted" by the "dapper" entrepreneur Jay E. Cook (Banner, 1947). Another reporter writes, "Nine big and very important frogs are getting the best of care at McKennan Hospital. They have their own special multiple compartment tanks…and are given specially prepared raw meat twice a week–all this because they are to help to

answer some mighty important questions. They are to be used in tests for pregnancy…" (Bechtold, 1948). Several articles directly associate the usefulness of the frog to anthropomorphic language, such as naming the frog Gertrude and referring to her as "a martyr for science" (Bothwell, 1949), reassuring readers that the pregnancy tests "do not harm them in any way" (Browne, 1947), calling the frog "a very, very smart little feller" (Comfort, 1945), and even using first-person language in photo captions, such as "I'm *Xenopus laevis*…and I'm the best thing going for pregnancy tests" (R. Clark, 1961).

In addition to the anthropomorphic language ascribed to the frog, several newspapers feature white U.S. entrepreneurs extracting frogs from decolonizing African countries and shipping them around the globe. One article titled "Clawed-Toad Capital of America" (Walker, 1952) begins, "It's a long haul from the upper reaches of the Limpopo, the Congo, and the Zambesi rivers in Africa to Baltimore county, yet in a specially designed cellar...10,000 female clawed toads from the Dark Continent are quite at home." The article claims that just "[b]y communicating with the Government of the Union of South Africa," the entrepreneur Jay E. Cook was able to import 3,000 frogs. Cook, featured again in an article at 92 years old, reported selling frogs to "8,000 customers from Alaska to Argentina, and as far west as Guam" (Kobren, 1978), without mention of its subsequent ecological impacts.

Xenopus laevis could be used as a pregnancy test by injecting urine into the frogs (Associated Press, 1946; Bechtold, 1948; Golden, 1949; Wolfe, 1955), thus driving demand from research labs and hospital. Imports came from multiple de/colonized countries in Africa such as "Abyssinia" (No author, 1948), an exonym for Ethiopia. Eventually, the demand for frogs declined with the development of chemical pregnancy tests. At this point, John B. Aderhold was praised for offering "free frogs for

science" (No author, 1972). However, the decline in demand did not stop persistent U.S. entrepreneurs from taking advantage of political upheaval in recently decolonized African states. Entrepreneur Roger Ruvell, "a handsome, curly haired six-footer" from Chicago, is reported to catch animals with "a Dahomeyan assistant" (Zeitlin, 1967). Dahomey was the name of the West African French colony, which became the decolonizing country of Benin. His original plan was to catch frogs, "but Dahomeyans are reluctant to catch them." The assistants were paid 25 cents to $1 depending on the species. "Local python priests" were described as presenting pythons to Ruvell as "gifts, the idea being they could not sell the sacred critters." An unnamed villager is quoted at the end of the article: "I know that you take the frogs and send them to France to put them in tins...then you will sell them to us to eat. Well, we don't eat frogs." France began the process of decolonization from Dahomey in the late 1950s, and political strife followed from the subsequent decade. Roger Ruvell and others like him took advantage of this political strife to extract biological resources, shipping reptiles and amphibia from their site of origin to other countries by the thousands. Ruvell is described in the headline: "Rhodesia man exporting frogs" (Canadian Press, 1975) in the middle of the Zimbabwe War of Liberation—a civil conflict from 1964 to 1979. Another white U.S. scientist and entrepreneur, Louis C. Herring was described as being one of the first to test the use of *Xenopus* for pregnancy tests. Herring "led an expedition to South Africa and collected 5,000 of the frogs and returned them to Orlando" (Martin, 1973). The celebratory depiction of white entrepreneurs may have reinforced a practice that culminated in the excess of *X. laevis* found in U.S. waterbodies today.

As we acknowledge the harm and socio-historical context of biological extraction when talking about any invasive species in environmental education, we learn from it. This historical analysis of U.S. press coverage reveals changing attitudes

towards Idwi that correlate with their profitability. When entrepreneurs were profiting from the frogs, popular press used positive language to describe Idwi. The possible implications of introducing Idwi to novel environments were ignored. Furthermore, entrepreneurs who continually introduced a non-native species were valorized in the U.S. newspapers featuring them, and the decolonizing contexts in which these men conducted their business were ignored in the reporting. When money could no longer be made from Idwi, negative and xenophobic language started to be used to describe this frog. The harmful implications of its introduction to novel ecosystems started gaining attention. Even with the change of sentiment towards Idwi, the human element is still ignored. The rapid redistribution of Idwi could have been avoided. The success of this frog in new ecosystems was predicated on continual import of the non-native species. Neither the biosafety measures nor the potential impacts of this imported species to establish itself in new ecosystems and outcompete native species for resources were addressed. Next, we will consider other applications for the frog that drove marketable demand and provided chances for it to establish itself in even more ecosystems, thus further exacerbating their ecological impacts in the U.S.

Historical Use of the Frog for Pets and Education

The demand for frogs that drove their biological extraction led to new markets and applications in the U.S. For example, the continued decline of frog usage in pregnancy tests coincided with journalistic promotions of their use as pets and as educational tools. On the sociozoologic scale, pets and tools are considered to be "good animals" (Arluke & Sanders, 1996, p. 171), and *X. laevis* for these purposes were described accordingly. Chace (1974) writes that the frog was replaced by chemical pregnancy tests "and would normally now be left in its African environment…

[however] importation was revived to supply the pet shops." *X. laevis* is described as an easy pet to feed that can live for 15 years, or more. An advice column circulated widely, urging readers to breed and sell *X. laevis* as a profitable hobby (Heartline, 1979).

In in the context of education, U.S. newspapers feature several educators talking about the frog. For example, *Xenopus* is one of few animals called upon to represent the letter X when teaching the English alphabet (Hinds, 2001; Knapp, 2014). One teacher describes students' interest in animals as an opportunity to teach other skills like reading (Ross, 2000). An alphabet book written by a schoolteacher highlighted "uncommon" and "exotic" animals, with *Xenopus* among them (Greene, 2014; Knapp, 2014). Along with this use of the frog's name was the use of the frog itself. Perhaps one of the earliest interactions with *X. laevis* in educational contexts is through classrooms introducing science students to dissections. One newspaper articles begins, "Frogs, longtime candidates for high school lab dissections, don't get much respect" (Stanley, 1997). Additionally, several newspapers showcase student finalists of local science fairs who conducted studies on *X. laevis* (Dukes, 1990; No author, 1977, 1989a, 1989b, 1993, 1998, 2011).

However, some teachers were criticizing the frog. Science teachers like Clinton Owen bred mice and frogs for high school classes. He reportedly said, "the African clawed frog...[is] competing unfairly with the existing frogs," specifically naming bullfrogs as threatened by *X. laevis* (Golum, 1978). American Bullfrogs, while endemic to the eastern U.S., are regarded as invasive in the western U.S. (Snow & Witmer, 2010), illustrating just how contextual the "invasive" tag is. Regardless, Owen states in his interview:

"I'm systematically wiping out the population...I'm never gonna get them all. It's too late...The African frog has killed everything. But if you knock down the

> African, the balance will come back. They're just vicious little beasts, ugly compared to our native frogs." (Golum, 1978)

While this science teacher was acknowledged for doing a self-asserted public service, one may wonder how he talked about the frogs in the science classroom. Did he refer to the frogs as "African," as quoted in the article? Did Owen justify his commitment of "systematically wiping out the population" based on anecdotal observations of a single pond? Was he modelling an individual-level approach to environmental rehabilitation based on assumptions about how the environment ought to be? In this science teacher's interview, the role of U.S. entrepreneurs in the redistribution of the frog was not acknowledged. One may wonder if the sentiment expressed by this science teacher is an exception or an exemplar. It seems to be the latter, based on the ethnicized projections on the frog once it became labeled as invasive. We discuss this further in the next section.

Over time, the frog goes from being valued for its medical applications to being marketed for its potential as a pet and educational tool. Eventually, people who purchased the frogs began to find ways to dispose of the frogs, leading to the subsequent ecological impacts that rendered the frog a globally invasive species.

Becoming Known as an Invasive Species

When Idwi were no longer used as pets or educational tools, they became labeled with language associated with pests on the sociozoologic scale, or "bad animals" (Arluke & Sanders, 1996, p. 175). Metaphorical language may be ascribed to animals, such as the rhetoric of immigration debates (in sparrows, Fine & Christoforides, 1991) and other social problems (Best, 2018; Kim, 2015). One example of this language applied to Idwi is observable in a fable by columnist Doug Clark

(1987), who anthropomorphizes a character called, “Billy Bob the Frog,” who, “takes the fall for fugitive frogs,” according to the title. Clark writes, “while friends and loved ones looked on, the [armed game officers] got the jump on Billy Bob and nailed him with a 232-12-017. Suspicion of being an illegal amphibian, that is…He didn’t have a green card.” The mention of a green card, an identity document that allows people from other countries to legally reside and work in the U.S., directly ties the frog with xenophobic rhetoric. Comparable to African-American image making in the U.S. curriculum, historians described how images of African-Americans were created to “support the thesis that they were inherently incapable of being full-fledged citizens in the United States” (Au et al., 2016, p. 120). The fable of Clark (1987) invisibilizes the origins of frogs (white U.S. entrepreneurs’ biological extraction) and the historical context of their site of origin (decolonizing African countries). Instead, Clark writes, “he is a yucky xenopus laevis. (That’s African clawed frog, to the rest of us.)” From the title to the fable therein, Clark depicts the frog as an illegal criminal with stereotypical archetypes analogous to racist literature (Au et al., 2016, p. 122). A comparable observation was made in Mel Chen’s analysis of an ethnicized yet non-living chemical, the lead found in U.S. children’s toys sourced from China referred to as “Chinese lead” in the media (2012, p. 160). The fable of Clark (1987), along with other news stories that warn of the “African clawed frog” (Jefferson City, 2005), ethnicizes a non-human animal found in U.S. aquaria by using “African” in every mention of the name. The ethnicized name is juxtaposed with xenophobic rhetoric, going so far as to challenge the immigration status of frogs that did not enter the country on their own volition. Many species have the country-of-origin in their common English name; however, this critical assessment of the use of xenophobic rhetoric in media and educational materials

warrants increased attention, even reconsideration, to how ethnicized names are used with non-human species labelled as invasive.

Public consideration for how to dispose of an increasingly less desirable pet turned pest became mainstream. *Xenopus laevis* were found in California riverbeds (Applegate, 1974). Local fishermen reported sighting the frogs in Tia Juana River, and the head of California Department of Fish and Game warned, "They can live anywhere, eat anything" (Sahagun, 1977). The headline "Voracious African frog turned into state agents: The illegal amphibian was left in a jar on the steps of Kaiser High" further depicts the frog with xenophobic terminology (Bernardo, 2002). They are described as "a threat" to local ecology (Org, 2004), an "enemy" to the endangered Three-spined Stickleback (Campuzano, 2004), and "one of many destructive exotic plants and animals" (Jefferson City, 2005). The empathy afforded to "good animals" like pets was publicly discouraged for the "bad animal" with which *Xenopus* was now associated.

Despite increased awareness of environmental impacts, U.S. entrepreneurs continued to conduct business as usual. In 2008, the press sympathized with Paul Rudnick for encountering "not so friendly" western states who banned his product. *Xenopus* was described as the "frog from hell" that could "wreak havoc in a native ecosystem," yet Rudnick still applied for a waiver to ship frogs to states that banned them (Anderson, 2008).

Eventually, *X. laevis* was not only labeled as invasive but also linked to a deadly fungal disease called chytrid. The media compared chytrid to the Ebola virus and AIDS, and yet chytrid is described as a "fungus, which probably originated from Africa, [that] kills by thickening the frogs' skin...suffocating the animal" (Rust, 2006). The spread of chytrid was tied to individual actions of pet owners, releasing their frogs or dumping water from aquaria, again not mentioning the U.S. entrepreneurs. Another headline,

"Invasive frog linked to disease," contradicts the main text claiming, "which species affected the others remains unresolved" (Mohan, 2013). The science teacher suggesting bullfrogs were threatened by *X. laevis* (Golum, 1978) could not have predicted that the spread of American Bullfrogs from the eastern U.S. to western states facilitated the spread of chytrid (Yap et al., 2018). The tag of "invasive" may mislead media consumers, teachers, and learners that *X. laevis* is at fault for the spread of chytrid. A species endemic to the continental U.S., American Bullfrog, has been associated with the spread of this fungal disease that is lethal to countless other amphibia. As a species endemic to the U.S. is found to be the carrier of chytrid, we learn yet another lesson in how environmental history and new scientific discoveries call into question our assumptions around invasive species. If the frog had not been the target of xenophobic projections, would the media and scientific community have blamed *X. laevis* for chytrid so readily? Counternarratives in environmental education can reshape potential biases like these.

Discussion

From these examples, environmental educators could consider how to use language to describe invasive species with care. Instead of anthropomorphizing the species with ethnicized and xenophobic rhetoric, educators might focus on counternarratives that challenge and critique the "master narrative" throughout this article.

Teaching about invasive species without their origin story invisibilizes the root causes of their global distribution. In the case of *X. laevis*, the root causes are humans. Idwi were collected by European naturalists and displayed as a museum oddity then harnessed as reusable pregnancy tests. The biological extraction of Idwi from

decolonizing African countries by U.S. entrepreneurs is inextricably connected to colonialism, exacerbating the socio-economic inequity of the Global South. From ethnicized names used in the fables of U.S. popular press, *X. laevis* becomes a figurehead of xenophobia. These anthropomorphic associations arguably underlie the subsequent speculation of the frog as implicated in the spread of disease. In response to these attitudes towards *X. laevis* as conveyed in popular press, stakeholders in environmental education must be proactive in countering false stereotypes perpetuated by this "master narrative."

Previous investigations in invasive species offer models for responsible and responsive interventions. For example, one study models how "scaling down" and studying "minor players" can offer key insights into how we might study and educate ourselves about invasive species in the Anthropocene. By focusing on the embodied and performative connections of young people with rabbits in Australia, Taylor noted how during informal outdoor learning opportunities, such as recess, young people looked for, observed, and even pretended to be rabbits (Taylor, 2020), leaving us to wonder – what lessons might adults learn from minor players?

In the realm of policy, regulation, and even morality, Claire Jen Kim provides a case study on the regulation of animals, such as turtles and frogs, in the live markets of Chinatown in San Francisco, California, U.S. Kim (2015) reveals how self-proclaimed environmentalists and animal rights activists are caught up in xenophobic rhetoric when making arguments in public forums. The subsequent pattern that follows from people and cultures getting blamed for the importation of species – especially species perceived as causing ecological harm – is that the cultural communities regard such accusations as racist. Kim explores how both arguments are zero-sum games and that, "[i]n the meantime, the forces of neoliberal capitalism face few obstacles as they transform

racialized others, nonhuman animals, and the earth into 'resources' in the game of perpetual capital accumulation." (p. 287). Biological extraction, as previously described with Idwi, is just one part of ongoing patterns of resource exploitation that perpetuates ecological and societal harm, disproportionately benefiting the U.S. and Europe and harming the Global South (Funk, 2015; Klein, 2007, 2015). From the investigation of popular press provided this article, we urge environmental education scholars, practitioners, and activists to consider how we might hold businesses accountable for on-going biological extraction, as well as how we use language to describe species extracted and transported across geo-political borders.

Limitations and Future Directions

The way we teach about invasive species in environmental education can be enriched by the frameworks offered by de/postcolonial theory, Indigenous studies, and Critical Race Theory without detracting from lessons about the ecological impacts of species expanding into novel habitats. However, we note there are limitations to the present study that offer fruitful areas for future research. First, we acknowledge that there is skepticism about the value of Indigenous languages research in conservation contexts. Some may argue that such research does not contribute to advancing "real" scientific research or conservation efforts. We predict that using the language of people who are native to a particular region to describe endemic species can support conservation efforts by engaging the local community in monitoring species of relevance while also incorporating diverse worldviews and including people that were previously marginalized from conservation. Biomonitoring is a prerequisite to conservation because it detects subtle shifts in population numbers or even just the presence/absence of an organism. Future research might compare regions with

Indigenous language research to regions that have not engaged in such research to determine the extent to which biomonitoring occurs. Second, skeptics might misinterpret this work as an effort to undermine scientific taxonomy and then argue that Indigenous languages are not "robust" enough to replace the existing nomenclature. We are not attempting to replace scientific nomenclature but rather acknowledging that the binomial names used to describe species of the world (e.g. *Xenopus laevis*) are essential for communication among specialists. These scientific names are likely unrecognizable in the Indigenous communities where specialists carry out their conservation initiatives, and in such cases, local species names would help ensure conservation action in collaboration with communities is directed at the correct species. In future studies, one might consider the language of instruction and scientific content of environmental education curriculum and then assess the extent to which community members perceive value in documenting and using Indigenous languages in these contexts. Lastly, in the present study, there were several newspaper articles that addressed larger topic areas and merit a deeper dive. Frogs, as amphibians with aquatic and terrestrial life stages, offer unique insights into water quality, environmental impacts of pollutants, and climate change. Future work could explore the implications of scientific research on *X. laevis* in areas such as sex differentiation and morphological mutants that are impacted by environmental pollutants. Popular press coverage of such phenomena could be analyzed through theoretical frameworks of gender and sexuality studies and disability studies. Further, one might consider how the xenophobic rhetoric expressed by popular press towards the frog – particularly in the U.S. – connects to how people consider the impacts of climate change on the frog's habitat and life cycles.

Conclusion

By focusing on one species through a wide range of fields and perspectives, we aim to recontextualize previously extracted organisms in their socio-cultural, linguistic, and ecological contexts – locally – and recognize historical harms that have exacerbated conservations problems – globally. From an investigation into the language surrounding this one species, we uncover ties of Idwi to its colonial past and present. This narrative is inextricably connected to a colonial matrix of power, and it is the ethical imperative of environmental educators to disentangle these power relations when discussing global issues in the classroom (Sund & Pashby, 2020). We believe this includes curriculum reform on the global issues of invasive species, for the "radical cut within the denominator of the human made by colonialism within an imperialist ontology makes curriculum reform a matter of life and death as colonial subjects fight off forms of social death in everyday life." (Leonardo, 2018, p. 13). Species like Idwi also connect to broader issues of climate justice: "The way that they zone us, where they locate their coal factories, where they plunder lands in Africa—that's how slavery started, stealing resources from black and brown communities," said Jazzlyn Lindsey (Lim, 2017). To teach about "invasive species," we must also teach about the role and responsibility of humans – both in biological extraction and in community-based education, advocacy, and reform.

It is imperative that environmental educators consider the counternarratives of so-called "invasive" species to include an understanding of the many names given to each species, the cultural and scientific value of each species, the socio-cultural value of each species to the communities of their endemic geographies, the intrinsic value, and the narrative of biological extractions responsible for their global dispersions.

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