

## Futures in primary science education – connecting students to place and ecojustice

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### Abstract.

After providing a background to futures thinking in science, and exploring the literature around transdisciplinary approaches to curriculum, we present a futures pedagogy. We detail case studies from a year-long professional learning action research project during which primary school teachers developed curriculum for the Anthropocene, focusing on the topic of fresh water. Why fresh water? Living in South Australia—the driest state in the driest continent—water is a scarce and precious resource, and our main water supply, the River Murray, is in trouble. Water is an integral part of Earth’s ecosystem and plays a vital role in our survival (Flannery, 2010; Laszlo, 2014). Water literacy therefore has a genuine and important place in the school curriculum.

Working with teachers and their students, the Water Literacies Project provided an ideal opportunity to explore a range of pedagogical approaches and practices which connect students to their everyday world, both now and in their possible futures, through place-based learning. We describe the use of futures scenario writing in an issues-based transdisciplinary curriculum unit on the theme of Water, driven by Year 5 teachers and their students from three primary schools: two located on the River Murray and one near metropolitan Adelaide. All three schools focused on a local wetland. The research was informed by teacher interviews, student and teacher journals, student work samples, and teacher presentations at workshops and conferences. We report on two aspects of the project: (1) the implementation of futures pedagogy, including the challenges it presented to the teachers and their students and (2) an emerging analysis of students’ views of the future and implications for further work around the futures pedagogical framework. Personal stories in relation to water, prior knowledge on the nature of water, experiential excursions to learn about water ecology and stories that examine the cultural significance of water—locally and not so locally—are featured (Lloyd, 2011; Paige & Lloyd, 2016). The outcome of our project is the development of comprehensive adventurous transdisciplinary units of work around water and connection to local place.

**Key words.** futures thinking; ecojustice; place-based learning; science learning

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*Perspective: Educational visions*

*Fields: Earth Life Support Systems*

*Issues: Water, place, ecojustice*

**Background: Science, ecojustice and futures**

Our introduction to futures in education, and our later use of this work in science education, originated in 1988 through Australia's *Commission for the Future: Bicentennial Futures Education Project* (Slaughter, 1989) and developed through the application of futures studies in schools and, more recently, a middle school teacher education program (Lloyd 2001; Lloyd et al 2010; Lloyd, 2011; Paige & Lloyd 2016). As science educators in schools and later as lecturers in teacher education, we have integrated futures thinking and action into our courses. This paper brings together key passions of our intellectual work in science education over four decades, where ecojustice and connection to place collide with futures thinking. Ecojustice seeks to preserve and, where appropriate, enhance ecological well-being and the integrity of the ecological commons—the 'properties' of the Earth that sustain all life, including human life, properties called 'ecosystem services' (Costanza et al., 1997; Costanza, 2012) or 'the larger systems of life that we depend upon' (Martusewicz et al., 2010, p. 11). To achieve ecojustice, we need alternatives to the further expansion of capitalist consumer culture, including socioeconomic changes that reduce environmental racism, limit the resource exploitation and cultural colonization of non-Western societies, and renew the cultural and environmental commons (Lowe, 2009; Nelson & Cassell, 2016). This ensures that prospects of future generations are not diminished by the current generations' environmental destruction, and that non-human forms of life be understood as having rights within the larger ecosystems of which they are a part (Bowers, 2006b). Given that we are in an era of extreme environmental, social, and cultural change and uncertainty (Goldie & Betts, 2014; Hajkovicz, 2015; Hansen, 2009; Laszlo, 2001; Nelson & Cassell, 2016; Raskin et al., 2002; Raskin, 2016) there is no more important time to explicitly imagine and plan for liveable futures. We argue that science education must include an explicit connection to students' personal and collective futures using a futures methodology which is inclusive of individual and community, material

and cultural needs, and cognizant of planetary boundaries—a safe operating space for humans and all other species (Rockström, 2015; Steffen et al., 2015). This necessitates a transdisciplinary/integral approach to curriculum and pedagogy (Gidley, 2016, 2017; Lloyd, 2007).

**Context and world view**

The Water Literacies Project used an interdisciplinary or even transdisciplinary approach to learning which aimed to connect primary school students to their environment through the study of a natural waterway in their community. We took a 'Literacies in Place' approach (Comber, Nixon & Reid, 2007) which values 'the interrelationship and cross-fertilisation between the arts and the environment, between feeling and knowing, sensitivity and action, the personal and the lifeworld', achieved 'through the expressive quality of both aesthetic imagination and representation' (p. 156). In effect, this is an integral approach. Wilber (1979, p. 40) observes that 'both modern science and Eastern philosophy view reality not as boundaries and separate things but as a non-dual network of inseparable patterns, a giant atom, a seamless coat of no boundaries' and provides evidence from both science and the spiritual tradition. 'Literacies in Place' education focuses on making connections to the self, to the community and to the natural world through hands-on learning and reflection.

Murphy (2014, p. 78) describes the current 'massive collapse of biodiversity and the ecological destruction' as an 'extraordinary crime against a truly wondrous creation' (see also Kolbert, 2014 for similar comments). Societies are facing an 'inability to relate effectively to the integral functioning of the Earth' (Berry, 2009, p. 35). Consequently, we need a new set of values to inform our actions which can be explored and implemented in our educational institutions and through community conversation. While humans can certainly be destructive and short-sighted, we all also have the capability to be forward-thinking and altruistic (Kolbert 2014).

This flawed worldview, in which earth is fragmented into bits and pieces, can be challenged in a number of ways, and the transdisciplinary Water Literacies Project provides us—teachers, students and communities—with an opportunity to ‘allow the world to work on us so that we may change and mature—we are cultivated by that engagement, and then we see the world anew’ (Zajonc, 2006, p. 75). Through this project we act individually and collectively to value water as a part of who we are. We are using the term *interdisciplinary* to indicate that many disciplines are used in the study of a problem or theme, and *transdisciplinary* to refer to an approach that uses many disciplines to investigate a problem or need in a particular social setting by drawing on grounded, local knowledge (Balsiger, 2004; Després, Brais & Avellan, 2004).

#### **Justification for including futures pedagogy**

There is considerable evidence to suggest that what we think/understand about the future affects all aspects of the self, including our state of well-being (Eckersley, 2002; Frankl, 1964; Goodall, 2003; Hicks, 2002; Hutchinson, 1996; Masini, 2013). Our expectations for the future not only affect how we see reality, but also contribute to reality itself (Alm, 2011; Assadourian, 2017; Lloyd, 2014; Slaughter, 2004). For example, current behaviour and decision-making depends on the image held by an individual or group of individuals where the thinking is more than the cognitive (knowing); it includes other ways of being such as the affective (feeling), the spiritual (connecting) and intentional (doing) (Bowers, 2006a; Wilber, 2006).

According to Bowers (2001), an ecojustice curriculum:

*encompasses an explicit understanding of relationships and processes, an embodied knowledge of community relationships and the ecology of place, and an awareness of the layered nature of the interdependencies of life-sustaining processes (p. 152).*

From our own research (Paige, Lloyd & Smith, 2016) and from the literature (Gidley, 2016; Hutchinson, 1996), we know that students’ views on science and technology are embedded

in a broader social context. Their visions of the future offer an insight into their hopes and fears and are likely to have important implications for them personally and collectively. For humans to thrive in the future, we will need to systematically rethink education, helping students to learn the knowledge that is most useful for their survival on a planet that is undergoing rapid ecological changes (Assadourian, 2017; Murphy, 2014; Wijkman & Rockström, 2012). Despite growing scientific consensus of major environmental threats, societies are largely operating on the basis of ‘business as usual’; at best attempting to tinker at the margins of the problems. This calls for a radically different type of education that tackles the uncomfortable issues created by human-induced rapid ecological changes, unsustainable human population and economic growth, and that directly challenges the current cultural values that promote this unsustainable living (Assadourian, 2017; Kopnina, 2014; Laszlo, 2014; Raskin et al., 2002; Suzuki, & Taylor, 2009). These areas of unsustainable living which, we argue, come under the umbrella of ecojustice and social justice, are key motivators for the development of futures thinking embedded in an integral/transdisciplinary/place-based pedagogy using a critical praxis framework (Hodson, 2003; Lloyd & Wallace, 2004; Moore & Reid, 1992). Futures scenarios and visioning have proved useful for environmental education because they make participants feel responsible and empowered to take action to reach their vision for a better community by raising their awareness of environmental issues (Velarde, Rao, Evans, Vandenbosch & Prieto, 2007). Our own work with futures has also brought us to this view (Lloyd, 2001; Lloyd, 2014; Paige & Lloyd, 2016).

#### **Action research methodology**

For this project, we engaged teachers in long-term professional learning through action research (Grundy, 1994; Kemmis, 2008; Kemmis & McTaggart, 1988). The teachers researched aspects of their own pedagogy as they developed and delivered a unit of work to engage their students with the theme of water.

They then evaluated the success of their units of work by observing student behaviours and actions in coming to understand the environmental and scientific issues around water and acting to defend the integrity of their local wetland.

This was a collaborative process between researchers, teachers and students in which professional learning experiences were delivered to the teachers by the researchers through workshops and on-going conversations. In this pilot study, teachers participated in five one-day workshops throughout the academic year. The workshops included discussion around a critical praxis teaching framework, integral futures scenarios, the meaning of place-based learning, the value of citizen science, and transdisciplinary approaches to learning. During follow-up visits to the three schools, teachers and researchers discussed the teachers' progress as they implemented integral futures thinking with their students as they learnt about and acted to maintain and value their local wetland.

Over four terms, five teachers with their Year 5 classes worked as co-researchers alongside the research team. Each teacher identified aspects of their pedagogical practice on which to focus their action research. They developed comprehensive adventurous transdisciplinary units of work around water which involved the *Science* of water quality (measuring salinity, turbidity, pH), the *Mathematics* of data collection (locating middle of data, mean, mode and median), the *English* of constructing future scenarios and the *Art* of accurately depicting and recording local animal and plant species. The program engaged the teachers to explore pedagogies that connected students to their place.

The futures pedagogy presented to participating teachers lies within an Anticipatory Critical Praxis Pedagogy—an action orientated approach to futures thinking. Moore and Reid (1992) advise that:

especially in moments of significant decision-making, we do call on past experiences both in our own lives and the lives of others to inform them. We try to learn from the past in order not to repeat its failures, and to select courses of

action which seem to carry a potential for success. (p. 181)

This innovation focuses on developing a primary curriculum for the Anthropocene (the current era in Earth's history). The curriculum aims to place people within nature rather than distinct from it (Comber, Nixon & Reid, 2007; Corcoran, Weakland & Wals, 2017; Sobel, 2008; Somerville, 2013). It addresses problems of 'separation'; both the separation of people from nature (Louv, 2008; Suzuki, 2010), and the separation of knowledge across disciplines (e.g. arts and science) that is typical of the Australian school curriculum.

The sequence of professional learning workshops conducted over the school year was structured around the following phases:

- Term 1 - Provocation
- Term 2 - Redesigning curriculum and pedagogy
- Term 3 - Enacting the redesigns and collecting student data
- Term 4 - Evaluation and documentation of the data. (Paige, Hattam & Daniels, 2015)

#### **Data collection and findings**

We have been informed through teacher interviews, student and teacher journals, student work samples and teacher presentations and reflections at workshops and conferences. After teachers were introduced to the futures approach we asked them a series of questions: *How did you go about introducing futures to your students? How do you think they coped with/managed the focus on futures? What messages from the students stand out?*

The findings are organised around two key themes:

Part A: Engaging students in futures scenarios (illustrated narratives and persuasive text)

Part B: Student examples and emerging themes.

#### **Part A: Engaging students in futures scenarios**

The teachers used two strategies to engage their students in imagining possible futures for their wetland: illustrated narrative and persuasive text in response to a stimulus.

#### ***Illustrated narrative***

One of the teachers, a resident of the area for twenty years, indicated that she could not

herself imagine that a wetland was possible, yet one was now established. She encouraged the students to imagine how the wetland could look in 30 years and to write and draw what they envisaged as an illustrated narrative. She says, *We brainstormed what the wetlands could look like in 30 years. This included things like flying cars, robot rubbish collectors, Pokémon hideouts and automated 'just about everything'. This is more of a reflection of the cartoons they watch on Netflix.*

However, on further discussion, students started to ask questions about possibilities for the wetland. They started to reflect on what they loved about the area in its present form (the playground, the bridges and waterfalls, birdlife, the lizards, and plants as well as fishing) and then proceeded to think about the future of the wetland. Through guided instruction from the teacher the children generated a creative list of 'I wonder' questions.

*I wonder if we could camp there? Could we build a cubby house? Could scientists establish a breeding program? Could we protect the fish by introducing a fishery program? Would camping affect the animals? How could we camp there without destroying the wildlife? Could we have an underground viewing chamber, so we could see the fish and macro-invertebrates? Could we expand the wetlands so that small boats or hovercraft could be used for fishing? Imagine if we could build a restaurant with glass panels so we could see across the wetlands. Is it possible to create an enviro-dome for the birds to protect them from predators?*

This imagery allowed students to understand that they can contribute to creating a future for the wetlands.

#### ***Persuasive text in response to a stimulus***

A second strategy involved a teacher-generated stimulus designed to evoke the futures scenario writing. The teacher wrote a stimulus letter, purportedly from the Local Council, to encourage students to think about why the wetlands were important to them. This letter indicated that the Council planned to fill in the wetland and use the site for housing. The students responded with their own *Save the Wetlands* letters to persuade the Council to

reconsider this plan. These persuasive texts demonstrated the students' invested commitment and connections with the wetland as a place of significance and belonging and a part of their community—their future vision for the wetland. The teacher reported that the students became advocates and showed a real understanding of the importance of citizens defending their rights to protect the wetland.

Through their previous involvement in a locally-developed Biodiversity Corridors project students had already been introduced to the history and geography of the wetland. Subsequent lessons focused on water sustainability and water surveys which gave students the chance to build on their knowledge of how water is used, the concept of water harvesting, and sustainable practices. These lessons were complemented with weekly visits to their wetlands during which students developed a keen interest and enthusiasm for investigating the importance of waterways to wildlife and people with the help of 'citizen scientists' and 'citizen science projects'. Students became passionate about the possibility of losing the wetland to housing developers as we illustrate in Part B using examples from their *Save the Wetlands* letters.

#### **Part B: Student examples and emerging themes**

An analysis of a selected sample of students' scenarios provides a strong indication of the value of futures work for students' cognitive and socio-emotional development. A more comprehensive analysis of student work samples is planned when further data is collected. We analysed student work using a framework of four dimensions: cognitive learning, ecojustice, social justice, and physical health. Together, these dimensions provide us with insights into the value of the wetland study for students' overall healthy development (see, for example, Louv, 2011). Cognitive learning involves 'knowing about' and is valued in student assessment by the school and education system. However, ecojustice and social justice connect with students' affective and socio-emotional development. Baldwin (2017, p. 143) argues that 'Water and its

management ... evoke deeply held values and emotions' and are thus related to the affective. Although ecojustice and social justice tend to be less valued than cognitive learning—they relate to students' mental and emotional health. In addition, through their visits to the wetland, students engaged in physical activity which has significant implications for healthy child development. As Louv (2008) observes, 'the quality of exposure to nature affects our health at an almost cellular level' (p. 43).

The development of an ecojustice disposition comes through strongly in the future scenarios. Both the cognitive (knowing) and the affective (feelings/connection) are clearly evidenced. Students are developing a social conscience and are prepared to be active participants in the current and future management of the wetland. They also see the value of the wetland as a place of learning, relaxing, exercising, meditating—a place of peace and reflection.

<b>Futures scenarios Analysis</b>	
<b>Ecojustice (positive student statements)</b>	<p><i>I strongly believe the wetland shouldn't turn into houses because we can feed the ducks and the fish, count the ducks, do the testing, play at playground. If it turns into houses and then there will be nothing.</i></p> <p><i>You will kill all the macro invertebrates and where would the ducks live? If you cut the plants/trees down there will be no more oxygen because they clean the air from germs.</i></p> <p><i>The little grass bird wrote down a message 'you have been destroying our homes and eating all our food. You are going to kill us. Our babies will be disturbed and die from fright. We will have to leave and go to a different home. But we like it here! You don't want to leave. It's not fair that you can destroy our homes and we can do nothing much about it". Little grass bird flew through the window and placed the note in front of the fishermen. When the fishermen read it they could understand what the birds were saying and why they attacked them. From that day on the fishermen were careful about the nests and gave equal fish to the birds.</i></p> <p><i>The waterfall gets cleaned out every week and a half and if it doesn't get cleaned out it will not clean any more water because it will be too full.</i></p> <p><i>Okay I think that the next thing that we should do is to go to the things that keep out litter.</i></p>
<b>Ecojustice (negative student statements)</b>	<p><i>The wet land has gone and that's where the animals lived.</i></p> <p><i>The whole wetland was on fire and burning orange and yellow everywhere.</i></p> <p><i>We walked around the whole wetland, but the water was pretty polluted.</i></p> <p><i>Over the last 20 years there have been campers, bridges and domes built in my home which is wrecking it! I have had enough.</i></p> <p><i>We started complaining about the campers. The geese have lost their home to fishermen and there is barely any fish left. The Pelican complained that the fishermen are disturbing them when they come in their boats and steal their fish.</i></p>
<b>Learning: Social justice (Access to the commons)</b>	<p><i>Some people do their exercise there and they take the dog for a walk. If you put/build houses there, where would they go?</i></p> <p><i>I went for a walk around my old school... And memories came flooding back to me - my friends, teachers and just people I know but are not really my friends.</i></p>
<b>Learning: Cognitive</b>	<p><i>Then we arrived at the wetlands. All the students were so excited to see the wetland and meet the wetland's scientist. The scientist worked at the colourful tree house. The scientist told us her name, which was Miss Emily, and she told us lots of facts about the wetland. We enjoyed it.</i></p> <p><i>We went to the wetlands nearby and did testing on Tuesdays and Thursdays.</i></p>
<b>Learning: Physical &amp; mental well-being</b>	<p><i>I love the wetlands - it's so clean and shimmering in the bright hot sun.</i></p>

Supporting observations from a teacher:

*Each morning I would be bombarded with ideas, research and questions from students. I introduced a Learning Journal so students could write down their ideas and I would look at them when time permitted. I implemented many of*

*their ideas, so they realised I valued them. I would allow time for students to present their ideas and receive feedback from their peers.*

**Persuasive text in response to a stimulus**

An analysis of a sample of the persuasive texts also provided strong evidence of valuable and deep learning.

<b>Persuasive text in response to a stimulus</b>	
<b>Ecojustice</b>	<p><i>Firstly, you will kill all the living things in the wetlands that help the environment in all different ways. You are destroying habitats of the birds and any other animals and there would be endangered species of birds or animals in the wetlands. There could also be a rare species of birds and animals and a new species of birds and animals.</i></p> <p><i>The macro invertebrates are dying because the water is polluted.</i></p> <p><i>I am against your decision to take down the wetland and build a house block because there are living creatures and plants that help the environment and will die because of construction.</i></p> <p><i>Where would ducks and fishes lay their eggs?</i></p> <p><i>If there were no more wetland, you mightn't find any new birds and we won't be able to explore the wetland any more.</i></p>
<b>Social justice</b>	<p><i>Now think of all those families that go to the wetlands they have picnics, a walk around the wetlands, kids play on the playground and people enjoy relaxing and watching ducks and other birds. Just think how disappointed they will be when the next time they go to the wetlands, the wetlands is filled in and houses are being constructed.</i></p> <p><i>If you take down the wetlands our families and ourselves will have nowhere to hangout.</i></p> <p><i>It is a beautiful place where people go and look at the cute little birds and the beautiful stuff, especially old people.</i></p> <p><i>What I am trying to tell you is that room 17 is connected to the wetland.</i></p> <p><i>Where would the kids play?</i></p> <p><i>Where would room 17 have a picnic?</i></p>
<b>A learning place</b>	<p><i>Room 17 has been going to the wetlands to test the water and learn about birds and macro-invertebrates.</i></p> <p><i>It takes way too long to go to a different wetland for our learning. If we don't go to the wetland that would take away nearly 50% of the learning that we do. Also, we help the NRM and the University as well as our own learning. We help them by collecting water.</i></p> <p><i>How could we do our testing?</i></p> <p><i>We go to the wetlands and collect the rubbish, practice mapping the wetland and drawing birds.</i></p>
<b>Recreational</b>	<p><i>Now think of all those families that go to the wetlands they have picnics, they walk around the wetlands, kids play on the playground and people enjoy relaxing and watching ducks and other birds.</i></p> <p><i>How could we go for a walk with our class?</i></p> <p><i>There will be no more family walks.</i></p>
<b>Physical and mental well-being</b>	<p><i>Lots of people go there just to look at the scenery and relax, watch the ducks, walk around the wetland and much more.</i></p> <p><i>We will be sad and mad at the same time.</i></p> <p><i>I go there sometimes for a walk for peace and quiet.</i></p> <p><i>You will take away all the memories we had as kids and we see all the community doing things there as well.</i></p> <p><i>Please don't take our wetlands away.</i></p>

A second teacher explained that by the end of the topic students had identified key issues such as pollution, storm water, illegal dumping and water leaks and this was accompanied by a readiness to take action. She explains:

*This was due to the lessons on civic responsibility and government to respond to situations identified during wetland visits. By this time in the project the students had had experience in taking action and were familiar with the local and state government bodies that they could approach in protest to this happening. They also knew so much about their wetlands that they could use their knowledge and experience to discuss and argue against the stimulus proposal confidently.*

### **Discussion**

When referring to how students managed the focus on futures, one teacher commented that the futures narrative writing allowed students to consider the possibilities of a futures wetland. They were excited and inventive about the possibilities and considerate of the wildlife. For example, a camping narrative from one student was written from the perspective of the ducks and the disturbance to their habitat. The teacher also commented that the persuasive text responses to the stimulus letter was extraordinary. Her words below tell a powerful story of what happens when students are connected to their place:

*The stimulus I created incorporated our discoveries; a fly fisherman talked about European Carp in the wetlands, Genius Hour, we learnt not to feed the ducks bread because it makes them ill, we learnt about the cost of maintaining the stormwater drains. I included all of this in the stimulus as evidence to why the wetlands would be redeveloped. I finished reading the letter to the students at 5 minutes to home time. They just sat there and stared. Not a word was spoken. The bell rang. The students kept silently staring. Then one student called out, 'Let's protest!' The break in silence created a storm of questions and ideas. At 5 minutes after home time, I stopped the students and told them the letter was a stimulus to help them write a persuasive text. Relief washed over them, this was the indicator that the*

*students were totally committed to the preservation of the wetlands. The realisation that they play a part in its future.*

The students also wanted to inform their community about the importance of looking after the wetlands and worked hard to create brochures to present at the local shopping centre. This was a challenging experience for most of the students, who overcame their shyness in talking to strangers as they shared their knowledge and passion for looking after the wetlands.

The teacher believed that student interest in the project and their futures thinking was tied very strongly to the fact that there were weekly visits to the wetlands and the creation of a sense of belonging to place.

*I had many conversations whilst walking with students, many of whom expressed their joy in watching the wetland changes and bird life change through the seasons, asking questions or posing ideas about their questions. Often students' comments dwelt on imagining what the wetlands would look like in a future season or when they were grown up. Some said they hoped that it was going to be a place they could bring their own children to one day. They talked about building glass bridges to walk over the water so you could look into the water and see what was there, building a waterfall that would clean the water like a giant filter, creating tree houses where you could go to watch the birds without disturbing them or that could be like a restaurant where people could eat and enjoy looking at the birds.*

### **In conclusion**

Students have identified in their futures writing many of the problems with maintaining and improving their local wetland; their place. They have come to a working understanding of wetland ecosystems and the need to value all of the species that live there including humans, an ecojustice mindset. Our analysis suggests that the issues students feel strongest about are keeping the wetlands healthy and vibrant with abundant flora and fauna for the future generations. What they don't want is the wetlands turning into a drain or housing estate. Their understanding and connection to place

resulted in them being able to internalise what the loss would mean to themselves and community. Active citizenship, both local and planetary, was a critical aspect of this transdisciplinary unit of work. There was evidence that teachers valued the development of children's futures thinking and enactment. They listened to the children's visions and supported them to take action to get there.

We conclude using two teacher comments that we think encapsulate the value of the futures work in the Water Literacies Project:

*Whilst some of the students struggled to create narratives that captured future scenarios of possibilities for the wetlands most students were able to draw future possibilities with vision and creativity. All of the students were able to discuss its importance to themselves and many could articulate what its loss could mean to themselves and the community in the "save the wetlands" writing.*

*I think that it is due to the students' connection with their place that made it possible for them to try to imagine the future of the wetlands.*

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