

Volume 65 | Number 3 | September 2019



teachingscience

THE JOURNAL OF THE AUSTRALIAN SCIENCE TEACHERS ASSOCIATION

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The World Science Festival Brisbane's Loggerhead Turtle Hatchery: A Case Study

Patrick Couper, Maho Go, Andrew Amey & Colin Limpus

ABSTRACT

The Hatchery is a unique wildlife experience hosted by the Queensland Museum for the World Science Festival Brisbane (WSFB). It is a collaborative venture between the Queensland Museum and the Department of Environment and Science, with support from SEA LIFE Sunshine Coast. The event, which runs for four to five days, was initially conceived as science-based, public programming with a strong emphasis on turtle research and conservation measures undertaken to reverse a decline in the number of female loggerhead turtles nesting on the South-East Queensland coast. The event, however, has grown to include school sessions, and in its latest year (2019), focussed heavily on plastic waste in the oceans and the impacts of plastic pollution on marine life. Herein, we discuss this event, its history, and how it aligns with the Australian Curriculum and has produced an educational program reinforcing Queensland Museum's commitment to foster STEM literacy.

Introduction

Loggerhead turtles are listed as an endangered species in Australia, a listing that came after a significant decline was observed in the Eastern Australian nesting population (a 50–80% loss of nesting females between 1970 and the early 1990s; Limpus & Couper, 1993). This loss was, in part, due to turtles drowning in trawler nets and required legislative changes and management strategies to lessen its impact. These included habitat protection and the mandatory use of Trawling Efficiency Devices (also known as Turtle Excluders or TEDs) in trawling operations in Eastern Queensland, the Northern Prawn Fishery and the Torres Strait Prawn Fishery. These measures have been effective in the species recovery and have resulted in an increase in the number of females nesting each year on the South-East Queensland coast.

The Hatchery allows museum visitors the opportunity to witness loggerhead turtle hatchlings emerging from their eggs. In natural circumstances, this occurs out of sight in a nest chamber 60 cm below the beach surface. In the

museum's public galleries, the eggs are viewed in carefully monitored, transparent incubators where all stages of the hatching process can be viewed. The turtles are a focal point for public engagement; they have tremendous appeal and the Hatchery provides a platform for delivering the event's educational content, which is conservation focussed and highlights the importance of scientific research for making informed management decisions.

The plastics theme encourages students to engage meaningfully with a topical issue that empowers them to be agents of change. Through multiple learning experiences (formal talks, object displays, and hands-on work stations), the students interact with the scientific content and learning materials at their own pace, giving teachers the flexibility to connect science concepts to their students' learning abilities. The program addresses key strategies used in successful STEM learning. For example, by showcasing expert speakers and anti-plastic community initiatives, it provides an opportunity to connect STEM educators and their students

with the broader STEM community and workforce (Kennedy & Odell, 2014). STEM education aims to develop a STEM literate society allowing '...an individual's knowledge, attitudes, and skills to identify questions and problems in life situations' (Bybee, 2013). STEM concepts should be presented to cater for the diversity of perspectives, experiences, and values of students (Greene, DeStefano, Burgon, & Hall, 2006), whilst accommodating learner variability in the learning environment (Basham & Marino, 2013). The turtles are a useful vehicle for connecting themes (for example, vulnerability to ingesting plastic waste) and help to increase student motivation, which is of paramount importance in learning situations (Singh, Granville & Dika, 2002).

The Hatchery's popularity has not diminished over its four-year history. It continues to attract large crowds and remains a signature event of the WSFB. It is live streamed to a global audience and receives considerable media attention (Figure 1). By incorporating the school program, it provides a crossover learning opportunity (Kalyani & Rajasekaran, 2018), allowing students to investigate real-world issues in an engaging, out-of-school, environment.

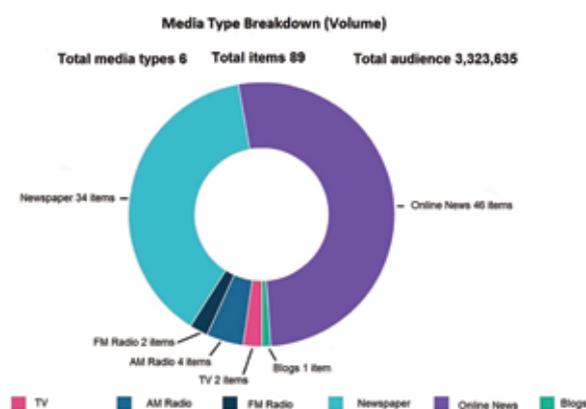


Figure 1: Graph showing Hatchery and turtle-related media coverage for the 2019 WSFB (image: Media coverage as per iSentia media monitors report).

Method

In staging an event of this nature, animal welfare issues are the foremost consideration and appropriate approvals are needed from government conservation agencies. In Queensland, these are obtained from the Department of Environment and Science, which is also a WSFB partner and plays a key role in overseeing the event. In accordance with animal welfare legislation (National Health and

Medical Research Council, 2013), which '... encompasses all aspects of the care and use of animals when the aim is ... teaching associated with an educational outcome in science...', the Hatchery is registered with an Animal Ethics Committee and conducted on best advice from turtle researchers so that the event in no way compromises the turtles' ability to complete a 'normal' life history. An incubation success rate of above 80% is regarded as good for hatchlings emerging from a natural nest and we endeavour to better this target when running this event. The eggs used in the Hatchery are collected from the Mon Repos loggerhead turtle rookery, near Bundaberg, in late January by Department of Environment and Science staff and volunteers. They are taken, freshly laid, over several nights and the collection dates and incubation temperature (29.9 °C) are such that the first hatchlings should emerge a day or two before the festival begins, with eggs continuing to hatch throughout the event. Turtle eggs are delicate during the early stages of development and rotation or rough handling is detrimental, if not fatal, to the developing embryos. For this reason, they are incubated for the first month or so at the turtle research facility at Mon Repos. Incubation takes place in a commercial water jacket incubator which is then transported to Brisbane when the developing embryos are sufficiently robust to survive the 370 km road trip. In Brisbane, the incubator is housed in a low-traffic, temperature-controlled room at the Queensland Museum and monitored twice daily to maintain a constant temperature. The eggs are inspected at regular intervals and those with marked discolouration or associated mould growth are removed to reduce the chances of contaminating other viable eggs.

In the week preceding the festival, the display space in the museum's public galleries is prepared. The display consists of eight, purpose-built, transparent incubators (Perspex boxes measuring 38 cm x 22 cm x 22 cm; Figure 2) with removable lids. Each incubator has a perforated plate sitting 18 cm above its floor, on which the eggs sit. The space below this is partially filled with water heated to approximately 30–32 °C by a submersible 25 W aquarium heater. The water is aerated using an aquarium pump and air stone, creating a humid atmosphere of ~ 28–30 °C that simulates the conditions within a natural nest in the upper section of the incubator. The display space also contains two large aquariums (1800 cm x 600 cm x 600 cm, each containing ~ 450 litres of filtered seawater heated to ~ 26–28 °C) for displaying hatchling turtles.



Figure 2: *The Hatchery, March 2016, showing the layout of the transparent incubators (image: Queensland Museum).*

The first hatchlings emerge from their eggs before the festival begins and are displayed free swimming in the aquaria when the Hatchery opens for public viewing (Figure 3). The incubation of eggs takes place largely behind the scenes. The eggs are only transferred to the display incubators once they show early signs of hatching (the eggshell dimples or is ruptured by a hatchling's egg tooth). Each day, additional eggs are brought into the display space until most, or all, of the incubators contain eggs, showing various stages of the hatching process (Figure 4). At 29.9 °C, incubation takes between 50 to 55 days. The hatchling turtles are left in the incubators for approximately 48 hours, allowing time for their yolk sacs to be fully resorbed; they are then transferred to the aquaria. During hatching, the water within the incubators is fouled by fluid and membranous material falling from the egg shelf above. An outlet valve, level with the base of the incubator, allows this to be drained without disturbing the eggs. The water is replaced as needed. Following the festival, the hatchlings are released, as soon as possible, directly into the Eastern Australian Current (EAC), 20 km off the Sunshine Coast.



Figure 3: *Museum visitors viewing hatchling loggerhead turtles swimming in a display aquarium during WSFB 2019 (image: Queensland Museum).*



Figure 4: *Eggs and hatchling turtles displayed in a transparent incubator during WSFB (image: Queensland Museum).*

Event history & extension to school program

For the first three years (2016–2018), the Hatchery was largely a public event. Although school groups were amongst the visitors, no sessions specifically targeted this audience. The messages provided were conservation-based and focussed largely on breeding biology, life histories, and research and management strategies. They were delivered by museum staff, assisted by a team of WSFB volunteers. These themes were introduced to the more engaged visitors as they queued to view the Hatchery but much of the conversation involved answering the many questions asked. In its first year, the Hatchery was located in the museum's Coral Coast exhibit, a display largely centred on the life histories of marine turtles. Since then, it has relocated twice and has expanded to include a number of static displays. These include various turtle skulls, showing morphological differences between the species related to dietary preferences, and a display on human–turtle interactions (containing products manufactured from hawksbill turtle shell and information on research and indigenous hunting; Links to Australian Curriculum: Science — ACSSU002, ACSSU043). In 2017, it also incorporated a live jellyfish display, making the link between jellyfish (significant prey items for turtles) and turtles ingesting floating plastic bags (Links to Australian Curriculum: Science — ACSSU002). The following year, the Hatchery introduced a short lecture on turtle biology in an adjacent area. This was presented by a WSFB volunteer with extensive experience in the Marine Turtle Research Program (conducted by the Department of Environment and Science, formerly Queensland Parks & Wildlife Service and Department of Environment & Heritage Protection).

In 2019, the Hatchery became a five-day event (previously four days), targeting school children as its key audience during weekdays. It remained open to all museum visitors during the weekend and periods outside school visiting times. The core messages remained the same but plastic waste in the oceans and its impacts on wildlife became an overriding theme. Plastic is cheap, versatile and durable (Barnes, 2005; Thompson, Swan, Moore & Vom Saal, 2009), qualities that have made it ubiquitous in our daily lives. Between 4.8 and 12.7 million tonnes of plastic enter the ocean annually (Jambeck et al., 2015) and, in so doing, endangers wildlife through entanglement and ingestion (Laist, 1997). Small pieces of hard plastic are particularly hazardous to juvenile marine turtles feeding in surface waters during the pelagic (open ocean) phase of their life histories. A recent study examined the gut contents of 102 dead turtles from three different oceans (the Atlantic, the Pacific and the Mediterranean). Synthetic fibres were present in all samples (Duncan et al., 2019).

Pre-festival school engagement

To promote school engagement with the Hatchery sessions, a Student Inquiry Workbook (<https://www.worldsciencefestival.com.au/wp-content/uploads/2018/03/Turtle-Hatchery-Student-Documents.pdf>) and Curriculum Links (<https://www.worldsciencefestival.com.au/wp-content/uploads/2018/03/Turtle-Hatchery-Links.pdf>) were developed in partnership with the Department of Education. The school sessions were launched in Term 4, 2018 and consisted of 4 x 1-hour rotations. These were mainly promoted through EDMs (Electronic Direct Mail) via the Queensland Museum Network (QMN) Schools Database. Sessions were also promoted through other channels such as QMN social media platforms (Twitter, Facebook and Instagram), Department of Education STEM discussion boards, Independent Schools Queensland Network and Queensland Catholic Education Networks. School engagement also included the Hatchery Crusaders extension program, the aim of which was to increase students' understanding of marine turtle life cycles and the magnitude and consequences of plastic pollution. Using the teacher resource handbook, available on the WSFB's event page, teachers were encouraged to explore key questions with their students. The students, in groups, were asked to produce an installation or piece of artwork using plastics collected from local waterways. The aim was to raise awareness of the environmental costs associated with

waste plastic and other marine pollutants. The target audience for the Hatchery Crusaders program was upper primary students, years three to seven. Final pieces were divided into three categories, three highly commended, one runner-up and one winning school (Figure 5). Each finalist received a certificate; the top five also received trophies presented by Queensland's Minister for Science, and the Queensland Museum's chief executive officer. Two visits were made to participating schools. These students received a talk on turtle life histories, ecology and the impacts of marine pollution from the museum's senior curator of reptiles (Links to Australian Curriculum: Science — ACSSU072, ACSSU073).

Session Format

For school groups, the Hatchery experience included two themed talks. A 20-minute talk



Figure 5: The winning artwork for the Hatchery Crusaders Program 2019 (image: Queensland Museum).

(presented in the museum's theatre) was provided by scientists studying marine turtles and included information on life cycles, anatomy and interactions with the environment (Links to Australian Curriculum: Science — ACSSU002, ACSSU072, ACSSU043, ACSSU094). The presenters were asked to provide information showing why marine turtles are particularly vulnerable to ingesting plastic waste, but they were given sufficient freedom to discuss aspects of their own research. The students

then received a 10-minute talk and hands-on experience looking at various plastic pollutants and their impacts in the environment. A group of postgraduate students from the Queensland Alliance of Environmental Health Science, at the University of Queensland, discussed environmental plastics (samples included: sand from Brisbane beaches containing micro-plastics; virgin and beach-washed 'nurdles' — the raw plastic pellets used in the manufacture of plastic goods; plastic microfibrils associated with washing machines and synthetic fabrics; micro-plastics in a biosolids sample from a waste water treatment facility; micro-plastics embedded in the tissues of oysters and synthetic rubber 'dust' eroded from car tyres). They also discussed their research methodologies and the wider implications of their research in society (Links to Australian Curriculum: Science — ACSHE013, ACSHE022, ACSHE217, ACSHE220). Plastic presentations were also provided by the founder and CEO of the Tangaroa Blue Foundation and the Australian Marine Debris Initiative. The space included a video presentation illustrating the extent of plastic pollution and its impacts on wildlife. These presentations focussed on many collaborative and interdisciplinary efforts between community initiatives and scientific research (Links to Australian Curriculum: Science — ACSHE013, ACSHE022, ACSHE217, ACSHE220). There were static displays featuring beach-washed plastics, micro-plastics collected from the Great Pacific Garbage Patch and plastic objects removed from the digestive tracts of both marine turtles and seabirds.

Following the formal presentations, the students moved to the Hatchery where they viewed the turtle eggs hatching within the display incubators and hatchling turtles swimming in the aquaria (Figures 3 & 4). Here, information on their biology including: diet, anatomy, breeding (including temperature-dependent sex determination), ecology and life histories was provided by museum staff and WSFB volunteers (many with experience working on turtle nesting beaches; Links to Australian Curriculum: Science — ACSSU002, ACSSU017, ACSSU072, ACSSU043). Students were also encouraged to ask any questions they might have (Links to Australian Curriculum: Science — ACSIS024).

Issues and Challenges

Organising live animal exhibits can be challenging and this is particularly true of the Hatchery, where batches of loggerhead turtle eggs are timed to hatch in sequence over a series of fixed dates. The Hatchery requires considerable planning to ensure things run

smoothly but, despite this, problems always occur that require adaptive measures. For instance, in 2018 the first lot of eggs began hatching five days prior to the event. The 2nd, 3rd and 4th lots, timed to hatch a day apart, all began hatching on the same day, three days early. This required reducing the incubation temperature (reduced to 26.2 °C) to ensure the remaining unhatched eggs were slowed sufficiently to continue hatching throughout the festival. The early hatching was probably attributable to a heatwave causing unusually high temperatures during the month that the eggs were incubating at Mon Repos, which resulted in difficulties maintaining a constant temperature in the incubator room at the turtle research facility. Climatic events have, likewise, impacted the hatchling releases in 2017 and 2018. In both years, the release was delayed significantly due to rough seas resulting from cyclonic events further north. To ensure that the hatchling turtles were well cared for until their release could be arranged, they were placed in the care of SEA LIFE, a specialised marine facility on the Sunshine Coast (<https://www.facebook.com/UnderWaterWorld.Mooloolaba/>). Despite the Hatchery being well received, it has attracted a few negative comments associated with the museum's Hatchery-related Facebook posts. These comments are generally associated with the belief that turtles must return to nest at their natal beaches (where they were hatched) as adults and that the Hatchery turtles may be compromised in their ability to do so. These comments are counteracted by a pre-prepared statement explaining the current, science-backed, view that it is the region that is important, not a specific beach. All the WSFB Hatchery activities occur within a region where loggerhead turtles nest annually on the South-East Queensland coast, so we believe there is nothing preventing these turtles, as adults, from returning to suitable nesting beaches.

Results

The Hatchery continues to satisfy permit and animal ethics requirements by delivering a high incubation success rate, averaging 84% over four years, with 88% in 2016 and 2019. It continues to be a popular event, and consistently attracts around 8,000 visitors to the Queensland Museum's display floors during the WSFB. This figure does not include online visitors viewing the live stream.

In August 2018, a school component was added — which included school engagements during National Science Week — accompanied by the

launch of a teacher resource handbook and the Hatchery Crusaders program. Bookings for the 2019 school events commenced in October 2018 and were booked out almost immediately, catering for 1,500 students (final attendance ~ 1,350 students). The program aligned closely with the primary school curriculum, with students learning about marine turtle life histories and the ever-growing problem of plastic waste in the environment.

Following the WSFB, a questionnaire was sent out to the participating schools. This was of a general nature, aimed at assessing the overall festival experience, not specific events. Out of the 22 schools responding, 11 indicated the Hatchery as being the highlight of their festival experience. Of the remaining 11, three gave no response to the 'highlights' question, five chose other events as their highlight and three gave positive, yet ambiguous, answers that may or may not have included the Hatchery experience ('The delivery of information. Three specific areas really worked. The students engaged and absorbed with so much quality information and personnel'; 'interactive stalls'; 'The exhibits'). The responses to a question rating the 'school/group's overall experience' were particularly telling, with eight of the 22 schools giving a 'met my expectations' answer and 13 stating it 'exceeded my expectations'. One school stated: 'We brought 250 Year 5 & 6 students (Year 5 Q&A with Dr Karl, Year 6 Cool Jobs, and 60 Hatchery tickets) and overall they rated the day 10/10'. The only negative response related to one of the festival's regional events, which did not include the Hatchery.

Conclusions

In 2019, the Queensland Museum actively promoted school engagement with the WSFB's Hatchery event by developing, in partnership with the Department of Education, a program with strong curriculum links. A pre-festival component, involving a Student Inquiry Workbook and Hatchery Crusaders program, prepared teachers and students for an enhanced learning experience. Hatchling turtles have tremendous appeal and incorporating them as a focal point for this event provided a platform for delivering its educational content and supporting the Queensland Museum's commitment to foster STEM literacy.

The topics of waste management and sustainability have been widely incorporated into school programs, both in the classroom and as extracurricular, schoolyard activities. Increased interest in this area stems, in part,

from the airing of mainstream documentaries such as *Blue Planet 2* (BBC) and *War on Waste* (ABC). Additionally, many government and non-government agencies now offer education resource kits for schools, targeting waste management and sustainability (e.g., Keep Queensland Beautiful, Brisbane City Council; Sustainability Victoria; Sustainable Schools NSW; EPA Tasmania; Tangaroa Blue Foundation; and Plastic Pollution Solutions). In view of this, our focus on plastic waste and its impacts on marine life, particularly turtles and seabirds, provided a link to existing science learning areas in the Australian Curriculum.

The Hatchery continues to evolve to meet the needs of its audience. Follow-up surveys suggest that schools were satisfied with the Hatchery's content and learning experience. Some problems were identified, but these were of a logistical nature, relating to large crowds and the flow of people through confined spaces; these came through feedback from visitors attending the public sessions. Different approaches have been taken to address these issues (e.g., ticketing with allocated time slots; visitor engagement, etc.) but crowd control, although closely managed, is likely to be an ongoing problem because of the short duration of the event and its continuing popularity with museum visitors.

Acknowledgements

The authors wish to acknowledge support from their respective organisations: the Queensland Museum and the Department of Environment and Science. Additionally, we thank the following organisations for their in-kind or financial contributions to the WSFB: Department of Education, Tourism Events Queensland, University of Queensland, Griffith University, Queensland University of Technology (QUT), Tangaroa Blue Foundation, Inspiring Australia and SEA LIFE Sunshine Coast. This event would not have been possible without help from the many volunteers who gave generously of their time.

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Patrick is a reptile taxonomist with an active interest in the conservation of marine turtles. He has overseen the Loggerhead Turtle Hatchery at the World Science Festival Brisbane for the last four years.

Maho Go, Producer, Queensland Museum.

Maho has a strong background in the cultural sector developing and implementing children's

public programs, and in particular, education programs. Originally graduating with a science degree, Maho has been creating engaging science content for the World Science Festival Brisbane for three years.

Andrew Amey, Collection Manager, Herpetology, Queensland Museum.

Andrew manages the museum's herpetology collections (amphibians and reptiles) and has assisted with the production of the Loggerhead Turtle Hatchery for the last four years.

Colin Limpus, Chief Scientist, Department of Environment and Science Queensland.

Col is a biologist whose research focuses on the biology and conservation of marine turtles. He has been monitoring loggerhead turtles nesting on the Bundaberg Coast for 52 years and oversees the collection of turtle eggs for the World Science Festival Brisbane.

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