Wildlife Health Australia

Diseases of concern in wild Australian marine turtles

Fact sheet

Introductory statement

Of the seven marine turtle species in the world, six occur in Australian waters:

- flatback turtle (*Natator depressus*)
- green turtle (*Chelonia mydas*)
- hawksbill turtle (Eretmochelys imbricata)
- leatherback turtle (*Dermochelys coriacea*)
- loggerhead turtle (*Caretta caretta*)
- olive ridley turtle (*Lepidochelys olivacea*).

While nesting predominantly on the beaches of northern Australia, marine turtles can be found in waters around the entire continent. Females lay two to six clutches of eggs each year. The young hatch and make their way to the sea after an incubation period of approximately two months. After 20 to 50 years, depending on the species, the females return to the region they were born to continue the cycle (Commonwealth of Australia 2017).

Relatively little is known of the life of a wild marine turtle prior to reaching sexual maturity. This includes any potential disease impacts. Current disease knowledge is based on those individuals that wash up on shore, are inadvertently caught in fishing nets or otherwise enter care because of their debilitated state. The types of diseases affecting turtle populations, the prevalence in different species and populations and the effects these diseases might have on those populations are still largely unknown.

Aetiology and epidemiology

Significant diseases that have been reported in wild Australian marine turtles include:

- **coccidiosis** (see also WHA fact sheet “Disseminated coccidiosis in green turtles”)
- fibropapillomatosis
- spirorchidiasis.

Other diseases have been recognised in marine turtles outside Australia. These include **chlamydiosis** (Homer et al. 1994), **fungal** infections caused by a range of species including *Fusarium* sp. (Cabanes et al. 1997), *Aspergillus* sp. and *Beauveria* sp. (St. Leger 2019), ***Cryptosporidium* sp.** infection (Graczyk et al. 1997), **herpesvirus** infections and **mycoplasmosis** (St. Leger 2019).

Physical factors may also present major threats to sea turtle population viability. Non-infectious disease threats include **traumatic injuries** due to **boat strikes**, **entanglement** (most often plastic and/or fishing line) and **foreign body ingestion**. It is estimated that between 4866 and 14,600 turtles were captured in 8690 ghost nets sampled across northern Australia from 2005 to 2012 (Commonwealth of Australia 2017). Globally, evidence shows at least 52% of all sea turtles have ingested plastic debris. A study found a 22% probability of mortality after ingesting one piece of plastic, which increased to 50% if 14 pieces had been ingested (Wilcox et al. 2018). A range of microplastics were found in every one of over one hundred individuals from a global study of all seven of marine turtles species, including those from in Qld waters (Duncan et al. 2019).

Ingestion can occur at all stages of a sea turtle's lifecycle but appears to be most frequent in juvenile and pelagic stages. Plastic, such as shopping bags, that physically resembles turtles' natural food (jellyfish) is ingested at a higher rate than other types (Wilcox et al. 2018; Innis 2019).

Coccidiosis in wild green turtles, caused by *Caryospora chelonae*, was first described in 1991, from an epidemic affecting large subadult and young adults in south-east Qld and northern NSW (Gordon et al. 1993; Gordon 2005). Subsequent epizootics and sporadic cases have been recorded in Qld and NSW (Gordon 2005; Chapman et al. 2016). The life cycle is unknown. Most cases are seen between September and February. In 2014 over 150 green turtles died of coccidiosis over a three month period, from October to December. The majority of affected turtles were older animals, which is consistent with previous coccidiosis outbreaks (Gordon et al. 1993; Grillo et al. 2015; Chapman et al. 2016). See the WHA fact sheet "Disseminated coccidiosis in green turtles" for more information.

Fibropapillomatosis is strongly associated with chelonid herpesvirus 5 (ChHV5), which is believed to be the aetiological agent. The disease occurs most commonly in the green turtle but has been recognised in all seven species of marine turtles (Jones et al. 2016). Fibropapillomatosis has a worldwide distribution. Most cases occur in juveniles but the disease has also been reported in sub-adults and adults. Spread is believed to be by horizontal transmission either through direct contact, exposure to virus-laden water (Work et al. 2015) or by mechanical vectors such as marine leeches (*Ozobranchus* spp.) (Greenblatt et al. 2004) or cleaner fish (Lu et al. 2000), that have been shown to carry the virus.

Prevalence of fibropapillomatosis in populations can vary from 1% to 92% with a greater prevalence seen in stranded turtles than in nesting populations. A study of green turtles in Qld by Limpus and Miller (1990) found a higher prevalence in inshore seagrass habitats than on coral reefs, possibly because these areas contain a greater proportion of juvenile turtles. In Moreton Bay in 1990 8% of 249 turtles surveyed had fibropapillomas. At Shoalwater Bay prevalence was 2 to 3% from 1988 to 1990. At Repulse Bay prevalence increased from 0% in 1988 to 22% in 1990. At the coral reef sites, no cases were seen in 1697 turtles sampled between 1988 and 1990. In 2011, investigation of a green turtle mortality event near Gladstone in Qld found 8% of 63 turtles with fibropapillomas (Flint et al. 2015).

Outside Australia, a study of 4407 green turtles and 401 hawksbill turtles in Indonesia identified a prevalence of 21.5% in green turtles and 0% in hawksbill turtles. Prevalence increased up to a curved carapace length of 85 cm and then decreased again, indicating a higher susceptibility in younger turtles (Adnyana et al. 1997b).

Recent reports indicate a prevalence in Florida turtles of 20 to 50% and Hawaiian turtles of 60% (St. Leger 2019).

Spirorchidiasis is caused by a range of digenetic trematodes or flukes from the genera Spirorchis, Henotosoma, Unicaecum, Vasotrema, Hapalorhynchus, Learedius, Hapalotrema, Neospirorchis, Amphiorcus, Carettacola and Haemoxenicon. They are found throughout the world and have been recognised in green turtles, loggerhead turtles and hawksbill turtles (Ladds 2009).

The 1-3 mm adult spirorchids occur in the heart and great vessels. Eggs are laid, which may become trapped in terminal blood vessels producing a granulomatous response. Others may penetrate the gut and are passed via the faeces into the water. Once in the water they hatch to produce miracidia which penetrate the intermediate host, likely a mollusc. The miracidia develop into cercariae, which either leave the intermediate host or are eaten with it, and penetrate the skin or mucous membranes of the definitive chelonian host where they mature in the blood vessels (Reavill et al. 2004).

For spirorchids, one study found a prevalence of 4.8% in 104 green turtles from turtle farms in Torres Strait, 33.3% in 15 turtles from an oceanarium on Magnetic Island, and 72.2% in 22 turtles found on coral reefs ranging from Torres Strait to Townsville (Glazebrook et al. 1989). A later study found a prevalence of 40.9% in 22 wild Qld turtles (Glazebrook and Campbell 1990). A more recent report identified spirorchids as a cause of mortality in 41.8% of 100 green turtles necropsied from southern Qld (Flint et al. 2010). Seven of 12 green turtles necropsied during the Gladstone mortality event mentioned previously were positive for spirorchidiasis (Flint et al. 2015).

Clinical signs, pathology, diagnostic specimens and procedures

Trauma can cause soft tissue, musculoskeletal and shell damage, which can lead to secondary infections and air leakage into the coelom, resulting in buoyancy problems. Entanglement frequently results in drowning. Ingestion of plastic and other debris such as fish hooks can have a range of effects. The items may just pass through the gastrointestinal tract or they may cause gut impaction, buoyancy difficulties or perforation, potentially causing death. New techniques are being developed to help quantify microplastic in sea turtles (Caron et al. 2018a, 2018b).

Trauma and external entanglements are evident on examination. Foreign body ingestion can be difficult to diagnose and relies on a combination of clinical signs and diagnostic imaging to identify fish hooks, impactions or gas in the coelom (Innis 2019).

Coccidial infections can be asymptomatic. Clinical signs, when they occur, include diarrhoea, neurological signs, weakness, buoyancy difficulties and emaciation. Pathology centres mostly on a necrotising enteritis. Schizonts, with associated inflammation, can also be found in extra-intestinal sites, especially the brain. Diagnosis is by histopathology and faecal examination for coccidia.

Fibropapillomatosis-affected turtles are often in poor body condition. Cutaneous masses can be found anywhere on the skin, but most commonly appear on the front flippers, neck and periocular tissues. Depending on size and position the masses may interfere with vision and locomotion (Ladds 2009; St. Leger 2019).

Affected turtles may have a nonregenerative anaemia, lymphopaenia, neutrophilia, monocytosis, hypoproteinaemia, hypoalbuminaemia, elevated aspartate aminotransferase, hypocalcaemia, hyponatraemia and hypochloraemia (Norton et al. 1990; Jones et al. 2016).

Grossly tumours may be up to 20 cm in diameter and appear as rubbery, white or grey, verrucous or smooth, sessile or pedunculated fibrous masses. Tumours may also be found internally, most commonly in the lungs, heart and kidney (Ladds 2009; St. Leger 2019).

Histologically they are classified as fibromas or myxofibromas. Skin tumours are characterised by marked hyperplasia of the epidermis (up to 30 cells thick instead of the normal four to seven cells) with vacuolation of the cytoplasm and ballooning degeneration of epithelial cells with rete ridges extending into the dermis. The dermis often consists of proliferating fibroblasts and mixed perivascular inflammatory cells. Occasional eosinophilic intranuclear inclusion bodies can be seen in epithelial cells. Visceral tumours are characterised by extensive fibroblast proliferation with few mitotic figures (Jacobson et al. 1989; Ladds 2009).

Diagnosis is by observing the characteristic fibropapillomas grossly and by histologic confirmation. Techniques for cell culture and PCR of ChHV5 are being developed (Mashkour et al. 2018).

Spirorchid infections are often asymptomatic. Clinical signs, when they occur, are non-specific and include anorexia, debilitation, emaciation, weakness, anaemia, inability to dive and neurological signs (Glazebrook et al. 1989; Ladds 2009).

Grossly, the presence of adult trematodes is associated with thrombosis and thickening and hardening of blood vessel walls (Glazebrook et al. 1989; Ladds 2009).

Histologically affected turtles demonstrate widespread granulomatous vasculitis, thrombosis and micro abscesses associated with extensive aggregations of spirorchid eggs within vessels of the myocardium, aorta, lungs, liver, kidney, spleen, brain and gastrointestinal tract, with the spleen, lungs and gastrointestinal tract predominating. Granulomas consist of lymphocytes, macrophages, multinucleate giant cells, fibroblasts and occasional eosinophils (Glazebrook et al. 1989; Gordon et al. 1998; Ladds 2009; Chapman et al. 2017).

Diagnosis is by finding eggs via faecal examination or in tissues. Flotation techniques are not reliable and either a sedimentation technique or a direct smear is recommended for faecal examination. Adults can be difficult to find (Reavill et al. 2004). In one study, although eggs were detected microscopically in tissues, adults could not be found in 59.2% of 27 turtles examined (Glazebrook et al. 1989). An ELISA test was developed in the USA that can detect serum antibodies to the spirorchids *Learedius learedi, Hapalotrema dorsopora* and *Carettacola hawaiiensis* in green turtles (Graczyk et al. 1995). A PCR test is available that can be used to identify spirorchids in tissue samples (Chapman et al. 2017).

Differential diagnoses

The presence of diarrhoea is strongly suggestive of **coccidiosis** but could be seen with other causes of enteritis. The main differential diagnoses for neurological signs are **spirorchid** or **coccidial** infections. The gross appearance of **fibropapillomatosis** is characteristic. Clinical signs of **spirorchidiasis** are non-specific and could occur with a range of conditions including hypothermia, malnutrition or opportunistic bacterial, fungal and viral infections.

Prevention, control and treatment

There is no effective treatment for **coccidiosis**.

The only treatment for **fibropapillomatosis** is surgical removal of the masses. One study found no recurrence two months following removal (Jacobson et al. 1989). Turtles with mild disease may recover spontaneously.

Praziquantel is reported to be effective at treating **spirorchid** infections (Adnyana et al. 1997a; Jacobson et al. 2003).

Surveillance and management

Wildlife disease surveillance in Australia is coordinated by the Wildlife Health Australia. The National Wildlife Health Information System (eWHIS) captures information from a variety of sources including Australian government agencies, zoo and wildlife parks, wildlife carers, universities and members of the public. Coordinators in each of Australia's States and Territories report monthly on significant wildlife cases identified in their jurisdictions.

There are over 150 marine turtle events recorded in eWHIS (25 March 2019), from all states and territories in Australia where marine turtles occur in the wild. Green turtles are the most common species represented, followed by hawksbills and loggerheads. The range of diagnoses is wide. Diagnoses recorded in at least five separate events include (in alphabetical order) cachexia (anorexia, emaciation, starvation), coccidiosis, obstruction, parasitism, pneumonia, septicaemia, trauma and trematodiasis. At least ten cases (primarily green turtles) also had significant evidence of foreign body ingestion and entanglement. NOTE: access to information contained within the National Wildlife Health Information System dataset is by application. Please contact admin@wildlifehealthaustralia.com.au.

Research

Despite considerable research being carried out on sea turtle biology and ecology relatively little is known about the impact of disease. The epidemiology of both coccidiosis and fibropapillomatosis is yet to be fully elucidated and will possibly involve multiple factors such water quality, water temperature and the presence of biotoxins (Jones et al. 2016; Cardenas et al. 2019). The life cycles of both *C. cheloniae* and spirorchids also remain to be determined. The effects that these diseases may have on turtle populations are not known.

As well as infectious disease research, long term studies need to be carried out to determine the effects that physical factors such as climate change, boat strike, fishing line entanglement and plastic ingestion could have on sea turtle populations.

Human health implications

None currently recognised.

Conclusions

Relatively little is known about the impact of both infectious and non-infectious disease on marine turtles. With their global distribution it seems likely that, as disease surveillance increases, additional infectious diseases will be recognised. These will likely add to the challenges directly caused by human activities such as harvesting, fishing and plastic pollution, which already threaten turtle populations.

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To provide feedback on this fact sheet

We are interested in hearing from anyone with information on this condition in Australia, including laboratory reports, historical datasets or survey results that could be added to the National Wildlife Health Information System. If you can help, please contact us at admin@wildlifehealthaustralia.com.au.

Wildlife Health Australia would be very grateful for any feedback on this fact sheet. Please provide detailed comments or suggestions to admin@wildlifehealthaustralia.com.au. We would also like to hear from you if you have a particular area of expertise and would like to produce a fact sheet (or sheets) for the network (or update current sheets). A small amount of funding is available to facilitate this.

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