MARINE *Life*

The EXTREME weather supplement

April 2013

Introduction

Extreme Events and Marine Life

A cliché is one of those phrases you have heard a thousand times over and it sounds all a bit over-dramatic. The trouble with Australia is that no matter how many times you say it, this continent IS a "land of extremes".

Throughout our history we have had to respond to extreme natural events one after the other. No matter how smart, or rich, or hip we get, we are still forced to endure regular doses of fire, flood, cyclone, storm, and drought.

Extreme events are natural forces so powerful they often dwarf our puny accomplishments. They remind us that no matter how much we alter our environment, we are still governed by the same rules as any other animal. Humans are just one adaptive species that must cling to what is left and learn to endure.

Marine animals experience enormous stresses from these events. They will wash up dead in thousands, but life goes on. Populations crash but the kernels of new life find a place of refuge somewhere. Within a short period of time life is adapting and recolonising empty space. Extreme events are destructive, but also one of the driving forces for adaptation and they help to create the varied splendour that is life on our planet.

Extreme weather has again been topical, as we mark two years since floods and cyclones devastated Queensland, with more floods. Recently, great fires have blackened parts of NSW and Tasmania. With scientific modeling suggesting that our planet is warming and extreme events are becoming more common, it is timely to reflect upon these catastrophes and challenges.

We will take a fresh look at how animals generally adapt to these challenges, and also look at any additional stresses that our civilisation may be placing on animal populations trying to rebuild after these catastrophic events.

Queensland Floods

by Mike Jacques

The summer of 2010-11 featured an unusually strong La Niña event that caused exceptional weather across Australia. It led to Cyclone "Yasi", one of the most powerful cyclones experienced since records commenced. In addition to cyclone damage, South East Queensland experienced intense rainfall, up to 400 per cent higher than normal.

Monster Flood

The 2010 floods refer to a series of separate rainfall events that saturated Queensland that year and extended into early 2011. Periodic local flood events had been ongoing for a year or two and cyclone Tasha dumped significant amounts of rain at the previous Christmas. The situation became more intense and widespread when cyclone Yasi hit at the end of January 2011.

For time immemorial floods have happened every year in some part of Australia. In many natural systems, floods link the river with the land surrounding it, recharging groundwater systems, filling wetlands, move useful nutrients into the marine environment. For some species, floods trigger breeding events, migration, and dispersal. Some floods are moderate in size and beneficial, others, like the January 2011 Queensland floods, have massive impacts on the environment.

It is usual for marine life to suffer after a flood. Great pulses of fresh water scour riverbanks and wash sediments out to sea. This blankets marine life with silt and poisons it with water of low salinity. The massive die-backs in some prey species cause population crashes among their predators.

While the January 2011 floods were a natural phenomenon, humans added some extra stresses to these events. They caused a sudden increase in the 'nastiness' we usually release into the water.

Rubbish

According to the State government, Queensland has the highest amount of litter of all mainland states in Australia. Litter dropped on land is washed into stormwater drains and transported into waterways where it affects wildlife and water quality. It was a problem before the floods. South East Queensland recorded a 50% increase in the number of plastic water bottles collected from local waterways between 2007-2010.

The 2011 floods released a massive burst of debris into waterways like Moreton Bay and Hervey Bay. After the waters had subsided in Brisbane streets, the problems were still evident well out to sea.

A good guide to the amount of rubbish in the water is the number of turtle deaths following an event. Turtles are often more susceptible than other marine animals to marine rubbish as they do not have the ability to regurgitate. They swallow plastic and debris and can’t get rid of it. Turtles started washing up emaciated or dead everywhere. About 1800 died along the Great Barrier Reef WHA. Dugong mortality also doubled. Dr Kathy Townsend, of the University of Queensland started studying the phenomenon, "The research so far has found that up to 35% of the sea turtles have died due to marine rubbish, through a combination of ingestion and/or entanglement." In one example, a 14 cm baby flat back turtle was found to have over 100 pieces of plastic in its stomach.

This massive event didn’t wipe out the turtle population. Although breeding was disrupted by the floods, enough turtles had escaped into more remote sections of waterways where they managed to escape the worst effects. Within a year of the flood, scientists found 60 per cent of Moreton Bay's population of 12,000 turtles were preparing to breed.

Chemicals, nutrients and pathogens

Household products such as paint, oil and detergent contain a range of toxins that are hazardous to wildlife and degrade water quality. During heavy rain and floods, a greater amount of chemicals enter waterways. These excess chemicals can cause severe impacts, such as mass fish kills and toxic algal blooms even in normal times.

The 2011 floods inundated industrial and commercial areas too. Most of the State’s coal mines were flooded, including their containment ponds that had collected toxic wastes. Forty four of the mines were given temporary permits to pump out millions of litres of contaminated floodwater into creeks and rivers.

Excessive scouring of riverbeds may also have exposed acid sulphate soils and heavy metals which washed into the marine environment. Nutrients, pesticides, herbicides, and other contaminants also flowed in from farms. Sewerage plants were also flooded sending human waste flowing through the streets and out to sea.

Once the brown flood water started to clear, this allowed more sunlight to penetrate to depths. This caused a bloom of phytoplankton that exploded in numbers to exploit the excess nutrients. The water turned green. Disease pathogens also increased and mortality of many marine species followed. The State government has blamed the disease outbreaks at Gladstone on the floods, while others blame the dredging activity.

Other species, especially various types of algae and crown-of-thorns starfish, can actually benefit from increased input of materials (e.g. nutrients). This can lead to further imbalances in the ecosystem. Changes to water quality affecting small animals living on the bottom, like shellfish, which are a food source for shorebirds and crustaceans. The toxic flood plume covered much of the coast and posed a threat to the Queensland seafood industry. Species like prawns were heavily impacted. In Moreton Bay, voluntary halts on fishing continued for weeks after the flooding event.

Most of the pollution transported by the flood was deposited on the western side of the bay, north of the Brisbane River. Luckily for the marine life, some zones in Moreton Bay were not significantly impacted by the flood plume, for example, Pumicestone Passage.

Chemicals in Moreton Bay persisted for more than 6 weeks, but after 19 weeks conditions were similar to pre-flood. By May increase in the numbers of the more usual species of small nano- and picoplankton showed things were returning to normal in Moreton Bay at least. These toxic ingredients may need further monitoring to see if they have a significant longer-term impact on local seagrass beds, corals and wetlands.

Silt

Floods tend to most badly degrade already degraded systems. Removal of vegetation in and around rivers, increased channel size, dams, levee banks and catchment clearing all increase erosion. While cycling of sediments and nutrients is essential to a healthy system, too much entering a waterway at once has negative impacts.

During the January 2011 flood, a huge plume of sediment washed out to sea all along the Queensland coast. Erosion of channel banks was severe and resulted in an estimated 1,040,000 tonnes (3 times the average annual load) of sediment being delivered into Moreton Bay. The flood plume extended beyond Moreton Bay and out to sea to a depth of 10m. Excessive silt and sediments smothered corals and seagrasses. Mangrove habitats are also susceptible as they act as a net, catching sediment. A huge event like this can cause damage to their root systems.

The millions of tonnes of sediment that entered Moreton Bay during the flood have now settled on the floor of the bay, causing the existing mud layer to almost double in size to approximately 100 km^2.

Some spots were worse than others. Flood plumes heavily damaged the northern part of Moreton Bay near the Brisbane River. Luckily, the southern part of the bay was not as badly affected, allowing it to be a refuge for displaced dugongs and turtles. The impacts of this mud will continue to be felt for an unknown period. In the summer months winds will continually stir up this sediment, increasing turbidity (cloudiness), and causing fresh algal blooms. This may result in a reduction of food for turtles and dugongs due to the loss of seagrass.

Migratory shorebirds were due to leave for their northern migration when the flood hit. Although it may take a long time to know for sure, reduced food resources may well have led to birds being underweight for migration, possibly reducing their numbers, and for those that do migrate, reducing their ability to breed.

Corals nearer to the Brisbane River mouth have always been a bit less diverse because of regular flooding. Perversely the species that remain tend to be the ones better adapted and have managed to cope with the flood water pulses.

This sediment did more damage to more distant Moreton Bay coral reefs running in an arc from Mud Island, to St Helena, past Peel Island and near Myora Creek on North Stradbroke Island. Within eight weeks of the flood, substantial amounts of the coral had bleached.

Since then the coral has largely recovered. In Moreton Bay they seem to have survived well. This resilience was especially noted in marine protected areas where they recovered faster. No-fishing zones were controversial when declared during the 2009 Moreton Bay Marine Park review. Scientists believe the MPAs have done better because higher numbers of bream and rabbit fish grazed down the damaging algae growing over the reefs. Algae can quickly smother regenerating corals.

Effect on Seagrass

The flood has badly damaged 40 per cent of the seagrass beds on the Moreton Bay side of North Stradbroke Island. These seagrass beds are crucial feeding beds for dugongs, turtles and fish.

The Australian Rivers Institute research has measured energy stores in the seagrass beds, by looking at the amount of carbohydrate in seagrass plants since the flood. Curiously, they found the poorest seagrass beds were located furthest from the mouth of the Brisbane River where they are the least adapted to flood waters'. Forty per cent of Moreton Bay's seagrass beds near Stradbroke Island were in poor condition. ''And if there was a further stress, most likely another flooding event, that would be the one that we would be worried about.'' These particular seabeds we a worry as they are especially important. Dugongs and turtles 'farm' small but nutritious patches and prefer these areas. Even small amounts of damage in the wrong spots can have a big impact on their general health.

Fortunately there was no more immediate flooding and decreases in seagrass biomass and carbohydrates reserves occurred for 4-6 months post flood, before recovering.

Eighteen months later – the old problems are still there

The January 2011 floods posed a major threat to the coral reefs, seagrass meadows and habitats of Moreton Bay. However, there was no catastrophe. Research conducted by the Australian Rivers Institute discovered that these habitats were surprisingly resilient to the flood and have now mostly recovered to their former state. The main lingering issues are to do with the excessive marine mammal mortality and a potential issue with huge quantities of buried contaminants.

Seagrass damage is not just about floods.

Historical trends showed that high level of turtles and dugongs death are normal five to eight months following significant floods. Even then, the serious losses of turtles and dugong may not have all been to do with the flood. The flood only exacerbated the impacts we were already having on the coastal environment. Ongoing dugongs deaths wouldn't be an issue if their habitat was more secure.

In the Moreton Bay region, 574 marine turtle, 22 dugong and 16 dolphin strandings were recorded between 1 January 2011 and 30 June 2012. Causes of the losses can be hard to determine exactly, but 63 deaths were suspected boat strike, 42 were caught in fishing gear, and 6 choked on plastics.

In the Townsville region there were 315 marine turtle mortalities, but due to the smaller human population only 17 were suspected boat strike, 15 were caught in fishing gear, and 4 choked on rubbish.
Any issues existing prior to the flood still exist, but they now impact on a much reduced population base.

Missing fish found after flood!

Floods are bad news for some, but a bonanza for other well-adapted species.

High river flows during 2010–11 enabled greater fish migrations. As a result, a freshwater fish species that scientists believed was locally extinct, Cox's Gudgeon *Gobiomorphus coxii*, has been found in the Brisbane River. Cox's Gudgeon is relatively common in coastal freshwater streams of NSW, but rarely found in Queensland and the Brisbane River was once thought to be the northern extent of its range. There has been no record of the species in the Brisbane River since 1941 when a specimen was sent to the Queensland Museum. The most northern record of Cox's Gudgeon, was until recently from Mt Crosby on the Brisbane River.

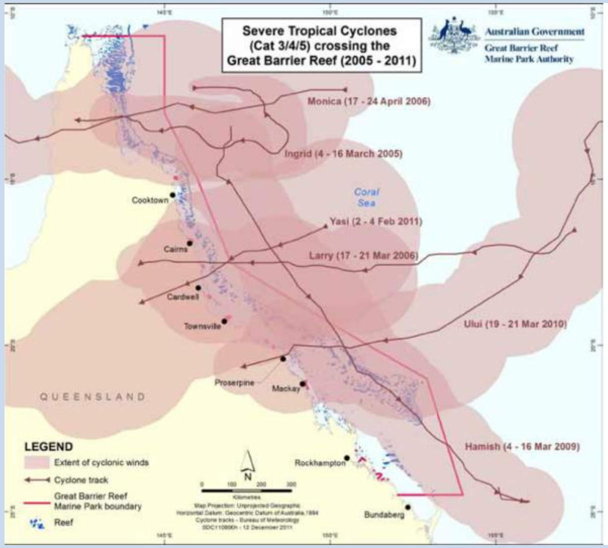
The species is easily confused with the Striped Gudgeon, *Gobiomorphus australis*, which is common in SE Queensland. It appears the recently floods may have resulted in Cox's Gudgeon moving around more than usual and perhaps spawning with more success. The species has recently been found at many sites along the Brisbane River and for the first time on the Sunshine Coast.

Cyclone Yasi

Nothing unusual… apart from its size!

While the Great Barrier Reef is expected to cope with the impacts of climate change better than most coral reefs around the world, the spate of severe floods and intensity of recent cyclones will test its resilience.

Cyclone Yasi was the first category five cyclone to cross the Queensland coast since 1918. Apart from its size it was not exceptional. The Queensland Coastline has been battered by such cyclones throughout its history.



Between 1995 and 2009 approximately 34 per cent of all coral mortality recorded in long-term monitoring of the Great Barrier Reef is attributable to storm damage. Coral reefs have a natural ability to recover from extreme weather impacts, enabling the Reef to bounce back from these events.

Tropical cyclones affect coral reefs in different ways. Cyclones cause exceptionally strong winds which generate powerful waves that smash shallow reef areas. They can also create damaging turbulence in deeper areas that tosses around sand and rubble causing further impact damage.

Flood plumes, caused by the intense rainfall that often accompanies cyclones, can expose large areas to stressful changes in water quality. Particularly intense and large cyclones, such as cyclone Yasi, can also cause destructive currents as huge amounts of water are driven by sustained winds and waves.

Cyclone Yasi caused patchy damage along 400 km of the northern Great Barrier Reef. Approximately 85 per cent of coral reef habitat in the Marine Park escaped largely undamaged by the cyclone. However, approximately six per cent suffered severe damage. Damage was largely confined to an area south of Cairns to around Townsville, sparing major tourism areas.

The worst effects of the flooding from "Yasi" were confined to inshore reefs close to the mouths of major rivers. Surveys of coral reefs in the Keppel Bay region, near the mouth of the Fitzroy River, showed floodwaters had caused severe damage to shallow reef areas. Reefs fringing the mainland sides of islands had the greatest exposure to floodwaters, and it was here that up to 85-100 per cent of corals were killed. Many commercial fishers reported dramatic declines in catch rates of coral trout at shallow reef areas affected by cyclone Yasi. Follow-up research found this was not related to a change in the abundance of coral trout, but appeared to be explained by a decrease in the 'catchability' of these fish, as they retreated to deeper water.

Seagrasses in the intertidal zone can be ripped up by large waves, while deeper seagrass meadows can be scoured by strong currents. Mangroves and wetlands can suffer the effects of fierce winds and unusual or prolonged inundation. Preliminary survey results indicate the extensive and prolonged floods have caused significant damage to important seagrass meadows in the southern Great Barrier Reef. There are indications that many shallow water or intertidal meadows suffered severe scouring within the area affected by gale force winds.

Deepwater surveys using remotely-operated vehicles indicate that cyclone Yasi may even have damaged seagrass meadows down to more than 30m depth. Deepwater sites known to have lush seagrass meadows five years ago were found to be almost completely barren following cyclone Yasi. Recovery rates are also highly variable. Some meadows with intact seed banks or remnant plants can show strong recovery in a year or so, while other slower-growing species and areas with diminished seed banks may not recover for decades. The effects of the extreme weather events follow a series of stressful wet seasons for seagrasses. Prior to the 2010-11 summer, many intertidal seagrass meadows had already been declining.

Cyclone Yasi, possibly in combination with cyclone Anthony, caused the formation of new rubble cays on some reefs and the loss of some sandy cays. The erosion of shorelines by waves has changed beaches and sand spits on many islands. These changes impacted turtles and seabirds that use these sandy areas. Breeding was disrupted on affected islands, with loss of eggs and chicks recorded.

Island surveys confirmed cyclone Yasi caused extensive damage to vegetation on larger islands. Large trees and entire sections of rainforest were destroyed on islands exposed to very destructive winds.

Numbers of breeding pied imperial pigeon on North Brook Island in 2011 are less than ten per cent of previous years, suggesting the island or mainland feeding habitats are too damaged to support normal breeding.

Island vegetation is already showing early signs of recovery, with abundant reshooting from broken stems and seeds on many islands. However, there is concern that weeds will slow, or prevent, full recovery in some areas. Sections of fringing mangroves killed by cyclone Yasi will take many years to recover, although foliage is quickly sprouting on surviving trees.

Severe cyclones are predicted to occur more frequently as the climate warms. Although the total amount of rainfall and the average number of cyclones is not predicted to increase, intense rainfall events (with increased flooding risk) and severe cyclones are predicted to occur more frequently under a changing climate. Scientific modelling suggests an increase in cyclone intensity of half a category would result in 50 – 60 per cent greater loss in coral cover as a result of cyclones. This affects the natural resilience of important habitats such as coral reefs. Although pressures from climate change are largely beyond the control of marine managers, modelling studies clearly show effective management of local stresses such as pollution and overfishing will play an increasingly crucial role in the fate of coral reefs.

Source:Extreme weather and the Great Barrier Reef GBRMPA

Fast Fact

One of the ongoing pressures that Moreton Bay seagrasses, dugongs and turtles have been subjected to are nutrient inspired blooms of the cyanobacterium (toxic blue-green algae) *Lyngbya majuscula*. Chronic *Lyngbya* blooms on the seagrasses of Deception and Eastern Moreton Bay have occurred since the 1990s. These blooms have affected seagrasses by smothering them and reducing the light reaching seagrass leaves. *Lyngbya* toxins also deter turtle and dugong feeding, with possible health effects if *Lyngbya* is consumed.

The 1918 Cyclones

Yasi may well have been 'the perfect storm', but it isn't the biggest we have seen in Australia. In January 1918, the eye of a huge cyclone passed to the north of Mackay just after sunrise. The winds at her edges tore Mackay apart. The 1918 cyclones remain the most destructive cyclones to strike a populated centre in Australia.

Few buildings in the centre of Mackay escaped without significant structural damage and a thousand were destroyed. The accompanying storm surge resulted in a sea-level-rise of 2.36 metres above the highest spring tide level, with one witness later recalling waves of 2–3 metres breaking in the main street. One observer saw a wall of water 7.6 m high sweep over the beaches towards the town at 5 am. A survivor recalled seeing waves 2.4 to 2.7 m high breaking in the centre of Mackay.

Total Mackay rainfall for January 1918 was 2161mm. The rainfall resulted in the Pioneer River's highest flood level at the time, which took 2 weeks to subside. Communication links into Mackay were destroyed. The outside world did not learn of the Mackay cyclone until five days after impact, leading to some speculation that the city had been completely destroyed. It is now though that a total of thirty people lost their lives in the cyclone and the subsequent floods. The cyclone was very large in size and the destructive winds and flooding extended down to Rockhampton.

To make matters worse, only a few weeks later another cyclone hit the Innisfail area. Around 4:40 pm, a tidal wave was seen surging in from the east into Bingil Bay, taking the bridge over the creek 400 m inland. Mission Beach was covered by 3.6 m of water, extending hundreds of metres inland, with the debris reaching a height of 7 m in the trees. All buildings and structures were destroyed by the storm surge in the Bingil Bay to Mission beach area. 37 people were killed in Innisfail, and an estimated 40 to 60 more in outlying areas.

Around 9 pm the storm centre hit Innisvail, then a town of 3,500 residents. Only around 12 houses remained intact. Babinda also lost many buildings. There was widespread damage at Cairns and on the Atherton Tablelands.

All was not lost. Following this destruction, the area experienced a period of prosperity with booming prices for farm goods. This led to many buildings being rebuilt in a grand art-deco style.

Green Turtles and Flood Deaths

Primary Source:"Status of turtles in queensland after 2010 flood events: a review" by Simon Mustoe, for the Gladstone Ports Corporation.

Sediment loads from the Queensland floods caused seagrass beds to be shaded from sunlight and die off. This caused widespread starvation of turtles.

About Green Turtles

Green Turtles are one of the more numerous turtle species. The "Southern Great Barrier Reef" population, numbering about 750,000 animals is distributed from northern New South Wales to about Townsville.

Green Turtles are still recovering from decimation by hunting in the first half of the 20th Century. Despite similar flooding in the early '70s, the population has been increasing by about 3% per year since 1976.

Importance of small feeding beds

Although turtles move considerable distances to breed, they forage in relatively small areas, returning to the same places year after year. Juvenile turtles have core ranges that are very small, in the order of 5.0 to 54.4 square kilometres'. This means that within their home range, animals like Green Turtles rely on a particular patch, that provides regular and reliable food. The risk involved in shifting to a new location and learning a new way of finding food, usually outweighs the benefits. Green Turtles will still move but they have evolved with a reluctance to do so. Hence, the direct consequence of any seagrass bed decline is loss of body condition for those local Green Turtles. In most cases, animals that turn up dead are likely to be from the most flood-affected areas.

Loss of Seagrass

There is compelling evidence for extensive seagrass loss throughout coastalbregions of the Great Barrier Reef following the 2010 flood events, with northern catchments being particularly seriously affected. The Gladstone and Townsville areas reported substantial loss of seagrass. Recent monitoring commissioned by Gladstone Port Corporation shows a recovery to levels that are not inconsistent with levels reported in previous low-cover years but there is still an absence of seagrass across large areas. "It would be premature to conclude that seagrass is currently recovering. Seagrass abundance at many sites is still at record lows and another wet season is predicted for 2012 / 2013".

Despite depletion in many areas, overall, Great Barrier Reef seagrass coverage over the last 20 years appears to be largely stable, despite significant local losses, mostly as a result of coastal development.

History of Strandings

Because of natural fluctuations in the ecosystem, numbers of nesting Green Turtles in the Great Barrier Reef, fluctuate widely each year. The number of stranded Green Turtles have doubled between 1998-2008, but this is consistent with increases in the population of Green Turtles on the Great Barrier Reef. Mostly juveniles were affected. These have less fat reserves and are more prone to mortality. With small home ranges and significant impacts on seagrass, increases mortality of these young age classes." A high mortality of juveniles is normal and even with the increased number of stranded animals, this is not cause for alarm".

Turtle mortality incidents since 1998 were largely Green Turtles, the most abundant species, accounting for 65% of incidents between 2005-2010. The pre-2004 trend is an increase in recorded mortality of about 3-4.5% per annum, which is not dissimilar to the annual increase in turtle numbers.

In more recent years, the increase may also be due to a problem with entanglement in cray pots, but exclusion devices have since been introduced

Current Strandings

Turtle mortality in 2011 is almost certainly loss of seagrass throughout the Great Barrier Reef. Turtles and seagrass beds co-exist and depend on each other.

Compared to 2009 and 2010 respectively, 2011's verified mortality to September were up by 48% and 70%. About another 100 turtles have been reported dead but not verified. Although the total number of reported deaths could be slightly inflated by recent media attention. There is also the suggestion that a higher percentage of northerly winds could be causing more animals to wash up on beaches. However, it can't be denied that, at the epicentre of the storm events (particularly the cyclones) there has been a notable increase in the number of heavily emaciated turtles being recovered.

There have been a higher than normal percentage of turtles dying in northern latitudes, when normally, the majority of incidents occur between Moreton Bay and Hervey Bay. However, Mustoe states that there is "no direct relationship between the number of animals found stranded in 2011 and the population viability of Green Turtles on the Great Barrier Reef". The overall population is still in good shape.

What are the 'real' risks to Green Turtles?

Today, more than 90% of nesting beaches and many important feeding areas are protected within national parks, but there is concern about broader catchment management practices. Prior to European settlement the waters of the Great Barrier Reef would have been more often clear of sediment. Decades of intensive agricultural practice is blamed for a 10-fold increase in freshwater run-off and a two to four-fold increase in the amount of sediment and nutrients reaching the Great Barrier Reef. This is a common reason for fluctuations in seagrass cover and density.

Seasonally, seagrass (like any plant) needs sunlight for growth. Increased sediment suspended in the water column can reduce the amount of light available for photosynthesis, growth and survival of seagrass. Seasonally, seagrass might also be affected by rising, nutrient levels the result of run-off of farm fertiliser. Seagrass is itself one of most significant sources of vital nutrients for the coastal. Because Green Turtles home ranges appear to be small and they don't tend to disperse very far, they may be particularly sensitive to:

1. Habitat fragmentation when seagrass patches become too far apart; and
2. Loss of important habitat, which could alter carrying capacity.

Nevertheless, Green Turtle populations are increasing on the southern Great Barrier Reef, so at present, the population is going well. The population is currently continuous throughout the reef, enabling movement of turtles between adjacent habitat patches. It's therefore unlikely that the increased incidence of mortality in 2011 is cause for any immediate concern. It would only become significant if either

a) the event was repeated very regularly; or
b) there was continual decline in the long-term health and recovery of seagrass, due to other factors on the GBR.

The Southern Ocean's "Perfect Storm"

Temperate waters also suffer extreme events. The 1972 Tasman Sea storm was one out of the box, a real 'Perfect Storm'.

Over the 22-month "La Nina" weather period from June 1970 until March 1972, rainfall was above average over much of Queensland, NSW, Victoria, Tasmania and the southeast of SA. Tasmania was particularly wet, with most of the state having totals in the highest 10% of the historical record. When this La Nina cycle broke she went off with a monster farewell, a storm surge caused by tropical cyclone "Yolande".

This had started in Fiji some days before and had drifted abnormally far south and was in the middle of the Tasman Sea, level with about Sydney, by the 25th March. By then the wind had died, but the huge swells kept rolling on, like the ripples caused by a giant dropping stones in the water. It produced a strange storm in Tasmania where there were monster waves that lasted for 18 hours, but no wind.

Even very sheltered spots in enclosed waterways were lashed by massive waves up to 30 ft (9 metres) high. As the waves receded they drained away so much water that the moored fishing boats bumped on the rocks on the seabed of the "Gulch" at Bicheno. They also spun around on their chains and collided with other vessels. Three fishing boats sank at their moorings. Another sank in Adventure Bay.
The photo shown below was taken from the jetty but the water was lapping around the legs of the photographer and someone had to hold onto him so they could take the picture.

Most East Coast jetties were damaged by the storm. The Adventure Bay jetty washed 300 metres up into Bligh's Creek. In the 1990s, I interviewed William Wisby, a fisherman from the Tasman Peninsula. He worked at Cuthbertson's fish mill plant in Canoe Bay, Fortescue Bay.

> *"… there was a queer storm that seemed to come up from nowhere. One minute it was calm, the next there were huge waves right across Pirates Bay that almost stopped the fishermen reaching shelter. In Fortescue, the waves leaped around the foundations of the houses and wrecked the timber wharf. The old dredge [hulk of the "William Pitt" sunk as a breakwater for the plant] was picked up off the bottom and pushed around into her present position. The beach at Pirates Bay lost 4 feet of sand and huge piles of kelp were washed up everywhere. The area around the Officers Mess was all flooded with seawater."*

The old timers reckoned there hadn't been a storm this bad since the 1929 floods.

Shattered kelp forests

Many kelp forests on the east and south coasts were ripped apart by this storm. The North-East Coast in particular never recovered from this 'Perfect Storm'.

Black Reef kelp beds in the 1970s, then highly productive commercial abalone grounds.

The Alginates factory at Triabunna, that harvested the kelp to extract food products, noted that after the storm only 700 tons of kelp were available from Tasman Peninsula to Eddystone Point.

> *"It is apparent from this survey that all the northern beds have suffered heavily as a result of the heavy seas caused by the cyclonic depression of the 25th March. In all areas surveyed many hundreds of tons of cast weed are lying on the beaches, in places up to four feet deep. The one consoling feature of this situation is that much of the cast weed appears to be old growth and hopefully much of the young regrowth has not been damaged."*

Recovery of the kelp beds following the major storm event of 25th March 1972 was very slow. In May 1972, Bruny Island kelp beds did not show any sign of recovery at all, with minimal regrowth in Port Arthur and Fortescue Bay. At the June 1972 survey of the northern kelp beds, no recovery of beds was observed:

> *"The fact that concerns me most is that in all areas surveyed, the remaining weed is all old growth and there does not appear to be any young regrowth at all."*

By 15th June 1972, "regrowth" in Port Arthur had improved, with a fourfold increase in available kelp since the previous survey. By July 19th 1972, there were signs of recovery of the Bruny Island kelp beds. However, the "northern" kelp beds did not show good recovery:

> *"Of the 285 tons present, only 160 tons would be worthwhile harvesting. The remainder is of such low density that it is not practical to harvest it. The only regrowth noted is in the Ansons Bay - Bay of Fires - Gardens Lagoon area. The remainder is mainly very old weed in advanced stages of decay. There is practically no regrowth apparent at all south from Paddy's Head (Island) to Wineglass Bay."*

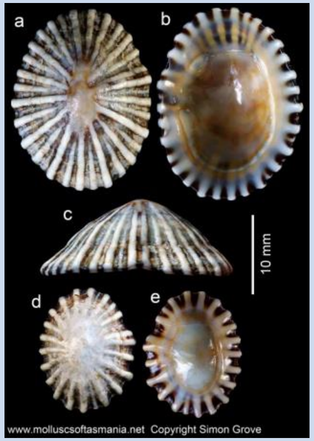
By July 1973, there appears to have been partial recovery of all the kelp beds along the southern and eastern coasts. In particular, the "northern" kelps beds (ie. Eddystone – Friendly Beaches) and "southern" beds (Dover – Recherche Bay). Both of these regions, had already been in decline prior to the storms and had already suffered significant prior kelp loss in 1972, and to a lesser extent in 1971. In 1973, the "northern" beds (and to a lesser extent, the southern beds), partially recovered (but only to <25% and <50% of their 1970 biomass).

Fishermen still reckon the kelp was never quite the same after the storm, especially in the north, and commercial abalone 'hot spots' like the NE offshore rocks aren't as productive as they use to be. These same rocks are now also heavily impacted by spot damage from NSW black urchins.

Damage to reefs

Three days before the storm, the University of Tasmania Zoology III class of 1972 had been down at Fossil Island near Pirates Bay conducting inter-tidal surveys. Dr Eric Guiler, a zoologist from the University of Tasmania, saw the devastation of the 1972 storm as a golden opportunity to collect 'before and after' data on the effects of the shoreline storm damage.

He recorded that the severe swell caused intense damage to intertidal communities in Tasmania. Measurements of transects before and after



the event showed that the numbers of most organisms were greatly reduced. In effect, the rocks were basically bare. Even the tough Bull Kelp fronds had been smashed by the waves and many animals had been poisoned or smothered by the remnants of other destroyed animals and plants. In some areas even the barnacles were dead. Limpets, chitons and sea squirts had all been completely removed. Even the encrusting pink coralline algae had been ripped off.

About the only animal to have survived in great numbers was the tiny blue Australwink *Melarphe unifasciata*. It was small enough to get down into tiny indentations in the rock, and built like a small armoured car, it had managed to ride out the storm. The only other survivors were the few animals who had found the shelter of a boulder or crack.

The students kept up their surveys for another 7 months, but by then the animals had largely recovered. As whole sections of coastline had been destroyed, the area wasn't recolonised by adults from other areas as usually occurs. Instead, the bare rock was covered in juveniles that had spawned recently. There was no particular wave of succession (one quick-growing animal covering it first, then giving way to others), basically the whole range of animals had quickly recolonised the area. The only losers were the limpets, who only slowly recovered and were still rare 7 months later. The Tasmanian False Limpet *Siphonaria Tasmanica* hadn't reclaimed the rocks by the time the study ended [they are there now].

SUMMARY

A normal marine community is very adaptable and survives even the most massive events if the overall environment is healthy. Scientists call this "resilience". We can't always rely on the recovery powers of our reefs. When storms come on top of other problems like climate change and alien species infestation, eventually the reef's "resilience" gives way.

Recent studies from Maria Island have suggested that if we had the same storm again, that the bare reef areas might be first colonised by new alien species, like the Japanese kelp *Undaria,* possibly crowding out native species and ensuring that they do not recover fully. Vulnerable species like Giant kelp stop growing back when storm damage comes on top of other stresses. It is interesting to note that Giant kelp had already declined significantly even before the storm, perhaps a response to climate change? This process has continued with intermittent ups and downs. Tassie's East Coast has now lost more than 90% of its kelp forests. As a result, species that rely on the kelp, like Bastard Trumpeter, have also plummeted in numbers. It has also possibly affected the abalone and crayfish stocks. While we don't need to frighten ourselves into insomnia, we do need to learn more and care more.

Weather Cycles and Big Storms

It was only during my lifetime that scientists noticed that the wet and dry periods across the Pacific were inter-related and occurred in cycles. Having discovered this they were able to more clearly predict extreme weather events.

La Nina July 1974, Lauderdale goes under after rain plus a high tide event.

Initially identified as an event forming off Chile, the El Niño/La Niña effect has now been found to be part of a much more complex weather phenomenon, across a large part of the globe. The phenomenon has kept its Spanish names, El Niño (the boy child, pronounced 'el Ninyo') and La Niña (the girl child, pronounced 'la Ninya'), to identify each changing phase of the cycle**.** The technical term is the Southern Oscillation.

Scientists are still not exactly sure what triggers the phenomenon, but every three to seven years or so, the difference in atmospheric pressure between the eastern and western sides of the Pacific triggers a change in the cycle. When this happens a huge system known as the *Walker Circulation* intensifies, pushing the westerly flowing trade-winds with greater force towards Australia. This also causes sea levels to rise locally. In some vulnerable places like

ABC News, 2009 - Bellerive beach is usually sheltered with flat seas, but even the quietest places experience extreme events.

Papua New Guinea, by nearly as much as half a metre. The Carteret islands now almost disappear beneath the waves during severe events of this type. The swollen warm pool of air picks up moisture, resulting in a massive increase in rainfall in the western Pacific and cyclones in Australia. Climate change may be speeding up the frequency of these shifts making our weather change more rapidly and become more extreme and violent. This doesn't mean that every day the weather goes ape, we are talking about changes in AVERAGE weather conditions.

La Niña/El Nino is nothing new, the Bureau of Meterology has gone back through its records and can tell that the La Nina cycle operated in 1942/3, making it an especially sodden and malarial year for the diggers fighting it out in the tropics. They also had La Niña events in 1949-51, 1954-57, 1964-65, 1970-72, 1973-76, 1988-89, 1998-2001, and 2007-2009.

October 1984, El Nino breaks and a storm breaks the dunes at Roches Beach

The El Niño/La Niña cycle has an impact on animals as well as people. Instability can generate some big storms and El Niño conditions in Tasmania will often cause an increase in the zonal westerly winds. This phenomenon may have contributed significantly to big storms and big kelp loss during El Niño episodes off the east and south coasts of Tasmania.

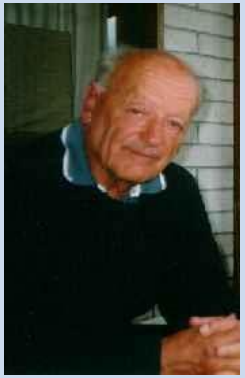
Many areas in Tasmania are already vulnerable to extreme erosion from extreme events. Climate change just makes it worse. While most of us might not see a 1M change in sea level until 2100, places like Lauderdale are going to experience the effects well before then in increasing levels of damage following major storm events.

Marine People

Dr Eric Guiler

Dr Guiler is mostly remembered as a leading researcher into Tasmanian Devils and Thylacines, but he was also a marine biologist who studied the marine impacts of large storms.

Eric Guiler was born in Belfast, Ireland and served with the British Army in World War II. After the war he trained as a marine biologist and, eventually majored in zoology at Queen's University, Belfast. Eric Guiler had worked under Professor TT Flynn (father of Errol Flynn) while he was teaching at Queen's University. Guiler, was inspired by Flynn's theatrical tales of Tasmanian marsupials, and took up a post at the University of Tasmania in 1947. Guiler completed one of UTas' first PhDs in Zoology.

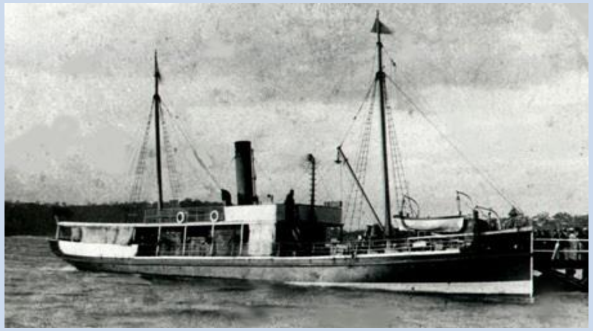


He had a particular passion for marsupials and cetaceans and got involved in local research. He was a President of Tasmanian Field Naturalists Association in 1952 and 1953. In the words of an old student, "Eric was an inspiring lecturer and passionate researcher. His lectures were enhanced by his wit and humour. It is 35 years since I was a zoology student at UTas, but my memories of him do not fade". He was a prolific writer with eclectic interests and published over 100 scientific papers. He also published books on thylacines and even a history of old Tasmania jetties. In 1980, Dr. Eric Guiler was appointed a Member of the Order of Australia. He retired from teaching in 1983.

After suffering a disabling stroke while investigating thylacine reports in the Arthur River area, Eric's health steadily declined. He died in 2008. To honour him, two Guiler scholarships are awarded at the University of Tasmania every year.

Ship Killers – the 1909 Southern Storms

Storms seem to occur regularly along all coasts, but in June 1909 a month of storms seemed to catch several ship's masters unawares.



A cyclonic depression centred over Tasmania caused rains all over south-eastern Australia and an 84 mile per hour gale in Sydney damaged houses. Several small boats in the harbour were swamped, but miraculously no-one drowned. The Gippsland was damaged by flash flooding. The cutter "Orme" went missing off the Victorian coast.

Shipwrecks at Bruny Island

The weather was even worse in Tasmania. At the Adventure Bay sawmills on Bruny Island it was very rough, with mountainous seas rolling in from Storm Bay. One hundred thousand feet of timber stacked on the jetties was washed away, and it was feared that the jetty itself would also disappear. The 34 ton ketch "Priscilla" was tied alongside the Gray Bros jetty in Quiet Corner, loaded with timber for Hobart. The 33 year old sailing vessel "Priscilla" had been recently purchased by the newly-formed Hobart Timber Company. A hole was knocked in her hull as she banged against the jetty and she lost her rudder. The crew managed to remove her cargo, but the pumps couldn't keep up with her leaks. The S.S. "Seabird" was sent from Hobart to assist the "Priscilla". She arrived when it was too dark to do anything, so the vessel anchored near Penguin Island in the southern part of the bay. Meanwhile the "Priscilla" anchors let go and she ended up on the beach full of sand.

Now, the “Seabird” was also in trouble. At about daybreak heavy seas rolled in, and caused the anchor chain to part. A second anchor was got out, but failed to hold, and the steamer drifted onto a rocky shore near Penguin Island. Her bows were on the rocks, and stern very low in the water. The wooden 58 ton steamer “Seabird” was owned by the Calvert family of South Arm, and was purchased from Victorian owners about eight years before for the trade between Hobart and South Arm. The “Seabird” was built at Berry Bay in Sydney 1897 by Dunn Brothers.

Storm number 2

Things quietened down for a while, but 2 weeks later a storm of equal violence appeared. High seas sprang up quickly and cast up huge masses of debris and seaweed in a 50 metre wide belt along the East Coast foreshore. On the Denison beaches north of Bicheno, “thousands of crayfish and many unknown kinds of fish are lying”. A whale sought shelter in the Tamar, one of the first to be seen there for decades.
The storm at Adventure Bay was phenomenal, while rain fell so heavily that the watercourse rose 2 ft. higher than the previous record. The floods carried away bridges, cutting off communication, and the Huon Timber Company's tramway was washed away for a quarter of a mile. The barque Natal Queen, 241 tons, was finishing loading timber at the long wooden Gray Bros sawmill jetty that once ran out to sea near Quiet Corner. She was almost ready to sail for Adelaide and for now it was calm. The mill owner could sense a rising swell and suggested she get to sea right away, but the crew wanted to finish their dinner. By then it was blowing a “hurricane”. The captain attempted to get the barque out to sea. She couldn’t get enough headway and the anchors couldn’t hold her on the sandy bottom. She got on the nearby rocks and fell apart. The crew of nine men, landed safely.

Southern Ocean Drama

During the same storm a lifeboat appeared at Macquarie Heads. It was Captain Lindstol with six men from the Norwegian barque “Orleans”, of 686 tons, bound from Seychelles to Dunedin with a cargo of guano. The ship had sprung a leak and the crew worked the pumps until they were exhausted. She foundered 200 miles from the west coast of Tasmania and the crew took to the sea in two lifeboats.

The second lifeboat containing seven men became separated after several days at sea. They were never seen again. In August a smashed boat washed up on Ocean Beach. It appears the crewmen made it to the coast but were then drowned in the massive surf.

The wash up

Capt Shimmins had earlier lost the ship “Mary Wadley” and he was criticised in the papers for his tardiness in moving the “Natal Queen”. He did not suffer any punishment as the main cause of the wreck had been the unusual weather.

The “Seabird” and “Priscilla” were heavily salvaged and little remains of them today. The remains of the “Natal Queen”, now mostly a few iron knees, can still be seen on the rocks at low tide. The huge sawmill and jetty at Adventure Bay has now disappeared, finally claimed by the incessant swells. The only remaining relic of this venture is the nearby sawmill manager’s house “Lumeah”.

The sheltered area makes for an interesting snorkel dive with no hint that Quiet Corner isn’t always so quiet.

The Technical Stuff – Defining Resilience

by Mike Jacques

An understanding of the ability of nature to recover from big disturbances, especially human disturbances, has led biologists to think about the marine environment in a different way under a general heading called "resilience theory".

Ecologists describe four critical aspects of resilience: *latitude*, *resistance*, *precariousness*, and *panarchy*.

1. Latitude: the maximum amount a system can be changed before losing its ability to recover (before crossing a threshold which, if breached, makes recovery difficult or impossible).
2. Resistance: the ease or difficulty of changing the system; how "resistant" it is to being changed.
3. Precariousness: how close the current state of the system is to a limit or "threshold."
4. Panarchy: the degree to which a level of an ecosystem is influenced by other levels. For example, organisms living in communities that are in isolation from one another may be organized differently than the same type of organism living in a large continuous population.

Resilience refers to ecosystem's stability and capability of tolerating disturbance and restoring itself. If the disturbance is of sufficient magnitude or duration, a threshold may be reached where the ecosystem undergoes a change or *regime shift*, possibly permanently. We can apply a similar term to the way humans adapt to events like bushfires and floods called *adaptive capacity*, which refers to the ability of humans to deal with change in their environment by observation, learning and altering the interactions. Coincidentally, the problems we are causing that reduce ecosystem resilience can be resolved when we engage our adaptive capacity.

In my neighbourhood, resilience theory has provided a very coherent way of explaining why urchin barrens are suddenly popping up everywhere along Tasmania's East Coast as the oceans warm. Since then the idea has got even more adaptive than the ecosystems that inspired it, and is currently tangled up in our ongoing argument about growth, development, and human social systems. Economists talk about it now.

The theory gets especially controversial when we talk about the "sustainable" use of environmental resources. In something like a fishery, we often look at a single species and not always its environment, which varies a lot in its sustainable capacity. The marine ecosystem is about complexity and natural fluctuations that can mask the extent of damage from things like fishing. It is argued that we need to know a lot more about the oceans before we can claim to be truly "sustainable" in the way we exploit it. The critics argue that this is all very impractical. We can't wait until everything is known, the world is hungry and there are other more practical ways of managing the risks.

These arguments aside, the moral of this story is that we have a big, wonderful ocean out there. It's been built tough and adaptable even to infrequent but extreme floods and storms. However, that resilience has its limits and an ecosystem can collapse suddenly. We can't continually load it up with increasing human pressures and expect to get away with it forever.