ARTIFICIAL LIGHT HAS DELETERIOUS EFFECTS ON MARINE TURTLES

Numerous studies conducted in Australia and other countries have demonstrated that artificial lights negatively impact on turtles, both female adults as they come to and go from their home beach to lay eggs, and to turtle hatchlings as they seek out the way to the open ocean. Nesting numbers have been shown to decline on beaches which are more brightly lit, and bright lights at nesting sites can disrupt the ocean-finding behaviour of both adult females and hatchlings.

Most of the earlier research about turtle nesting and hatching behaviour has been done in Florida, where two turtle species, the Green (*Chelonia mydas*) and the Leatherback (*Dermochelys coriacea*) turtles were found to be negatively impacted by artificial light at night. Further studies have established that different genetic stocks of Loggerhead (*Caretta caretta*) turtles behave differently towards the same wavelength of light – Atlantic Loggerheads are not affected by bright lights,whereas Indo-Pacific strains are adversely affected (Fritsches 2012).

Australian sea turtle guru Dr Col Limpus has been studying turtle biology and ecology since the 1970s, including ocean-finding behaviour of adult females and hatchlings. Early studies in Florida were carried out in the 1980s and 1990s. This early research led to the development of lights with a wavelength thought to be "turtle-friendly", using yellow and amber sodium vapour lights and, with technological advances, amber LED lights, which have been installed globally near turtle nesting beaches.

However, more recent studies in Australia and a re-examination, by Dr Limpus and colleagues, of previous data have reached different conclusions (Kamrowski et al 2012). **All** turtle species nesting in Australia are negatively impacted by artificial light, because the impact on the turtles is not the lights *per se*, but the perceived light horizon – they are unable to locate the true ocean horizon because of bright lights. Turtles are not attracted to bright lights, but are disrupted from locating the horizon in the presence of bright lights, because the glow of the horizon is less intense than that of the closer and brighter lights. Hatchlings head to horizons of lowest angle of elevation, and away from elevated dark horizons, but are blinded by bright lights. Illumination from up to three kilometres away can disrupt ocean-finding behaviour. Heavy cloud cover and salt spray exacerbate the light glow.

Light intensity is a vital issue for turtles and this is also a function of wavelength. Research has shown that turtles are sensitive particularly to the blue end of the spectrum and to the intensity of the light source. That intensity is proportional to the square of the distance, and the number of light sources has a cumulative impact. This is extremely significant for hatchlings, which locate their oceanic destination by the glow of the distant horizon, but which can be blinded by closer lights. This "altered light horizon" encourages female adults returning to the ocean and hatchlings to head towards the stronger glow from lights on streets and buildings. Collective lighting, from multiple dwellings, street lights and other lighting, have a cumulative effect.

South-East Queensland has the brightest coastal illumination in the state and it is rapidly increasing.

Historically, turtles bred all along the Queensland coast, and they still feed in southern areas, but development has led to major reduction of the breeding range. This is true in most parts of the world. Monitoring of turtle breeding on the Sunshine Coast since 2005 has records of Loggerhead and Green turtles nesting from Caloundra to Noosa, mostly on dark stretches of beach. Recently, volunteers have observed lower nesting numbers on the southern Sunshine Coast at Shelly Beach near Caloundra, coinciding with more lighting from dwellings there.

The Sunshine Coast is currently threatened by high-rise development just behind the foredunes at Yaroomba and Kawana. Beaches there are relatively dark, as the nearest residences are low-rise and away from the beaches. Further north, Mon Repos beach near Bundaberg has the highest intensity of turtle breeding in SEQ. In 2014 trials were carried out using 40W (the lowest possible wattage) amber LED streetlights on a trailer, without a moon. In every case, hatchlings headed towards the light. Other tests, using plates to reduce sideways spillage from lights, still had some effect. Even more worrying was the discovery that hatchlings, having struggled through the shallow water to get beyond the waves, could still be influenced to turn around and head back to the shore if they see a glow in the distance that resembles the oceanic horizon. This means that they would struggle three times with the zone most dangerous for them, the beach surge, where predators lie in wait for an easy meal. If only one in a thousand turtles historically survive to adulthood and breeding age, this figure will drop drastically if the last remaining dark beaches are opened up to highrise development and the associated light regime.

At a recent workshop for Turtle Care volunteers and SCC staff on the Sunshine Coast, Dr Limpus stressed that darkness is the best option for the survival of turtle breeding in SEQ. All lights are disruptive. At Mon Repos, government departments and residents are working with the researchers and are making changes to lighting regimes in an effort to reduce lighting near turtle breeding beaches. Street lights have been replaced by reflective markers on roads and signs, LED lights are embedded in the roads, advertising lights and light from businesses are turned off after a certain time, to ensure that maximum darkness greets emerging hatchlings. Lighting in residences, especially in highrise structures, would need to be controlled after sunset. Such restrictions would be difficult to enforce, but are essential if these magnificent reptiles, already endangered or threatened species, can continue to breed and exist.

References

Fritsches KA 2012. Australian Loggerhead sea turtle hatchlings do not avoid yellow. *Marine and Freshwater Turtle Behaviour and Physiology* **45:** 79-89.

Kamrowski, RL, Limpus, C, Moloney, J and Hamann, M 2012. Coastal light pollution and marine turtles: assessing the magnitude of the problem. *Endangered Species Research* **19**: 85-98.