



Proposal for the Creation of Recreational Fishing Havens: Cooloola and Fraser Island

This proposal outlines the necessity for greater protective measures of the inshore fish stocks of the Cooloola and Fraser Island region to be implemented. Serious depletion of commercially targeted species' populations have occurred over recent decades, primarily as a result of overfishing by the commercial sector.

Demonstrated in the proposal, are the deficiencies by managers of the fishery in preserving this vital resource over a period of time and the reasons why this has occurred. Also demonstrated, are the impacts upon dependent species such as seabirds, dolphins, turtles and possibly humpback whales, by the commercial sector and the netting practices that have prevailed over a period of time.

The creation of Recreational Fishing Havens (RFHs) as a successful method of conservation for the applicable species is outlined, along with the economic benefits that would be attained through tourism and an improved commercial fishery for all of the South East Queensland's inshore region.

Recent discoveries associated with altered fish behaviour that have ramifications to the inshore fishery of this region, along with dependent species, and which have not been considered before, are integral to the sustainability of the Cooloola and Fraser Island inshore fishery. These same discoveries are integral to the long term social and economic value to our community from the Cooloola and Fraser Island region.

The recent discoveries referred to are included in the proposal in a brief format to enable a concise document that presents all the relevant aspects pertaining to the Cooloola and Fraser Island fishery. The same discoveries have great pertinence to all commercially netted locations.

Methods of fishery management that have been adopted successfully elsewhere in the world and which are yet to be explored by Queensland Fisheries are outlined, as are the success of New South Wales RFHs in preserving inshore fish stocks and commercial catches in that state.

Relevant to the conservation of species and the sustainability of South East Queensland's inshore fishery are the impacts of the recreational sector on fish populations, shellfish populations and also the recent phenomenon of coastal algal blooms.

World Heritage Listing of Fraser Island and the nomination of Cooloola for listing along with fisheries management legislation, provide impetus for these fisheries to be reassessed on environmental and community well-being grounds.

This proposal demonstrates that RFHs are a management tool that best strike the desired balance between conservation of species and the economic value to the community of our inshore fishery.

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By: Lindsay Dines



Netted snub-nosed dart from Teewah Beach.

Executive Summary

Overfishing in many of the world's fisheries is well documented with individual fisheries that are currently overexploited having been identified within Australian waters. This proposal for Recreational Fishing Havens (RFHs) for Cooloola and Fraser Island is the first of its kind to specify that this fishery is overexploited and that the ramifications to fish populations and dependent species are far reaching and may not be recoverable. However, on identification of this current situation, methods that preserve our inshore fish stocks and dependent species, can be applied with a view to also preserving South East Queensland's inshore commercial fishery.

Recently identified alterations of fish behaviour, in relation to the inshore commercial fishery, are vital in enabling fisheries managers of Queensland's inshore commercial fishery to implement currently available technologies that are successfully used elsewhere in the world. Current practices do not take into account either these behavioural alterations of fish to commercial netting, or the application of acoustic technologies such as those being used in cetacean research in Australian waters for successful fishery management practices.

Behavioural alterations of fish to commercial nets includes, but is not limited to the alteration of migrations and spawning habits of commercially harvested species. The resulting poor recruitment attained by these species exacerbates the known pressures applied to fish populations by commercial harvesting of fish aggregations and recreational fishing along with water quality deterioration and habitat loss.

Improved management practices such as acoustic stock surveys and closed areas to commercial netting, allows for fisheries managers to assess stock levels more reliably and less intrusively, and for economic benefits that can be attained through tourism and a sustainable commercial fishery, to be maximised into the future.

Improved management practices that provide a sustainable fishery, also provide an environment whereby dependent species such as various species of seabird, dolphin and turtle can be allowed to prosper, with economic benefits through tourism to be attained. Conservation of these species in World Heritage Listed Fraser Island and World Heritage Nominated Cooloola, are vital in continuing to draw international tourists to this world renowned region.

Australia, as a signatory to various international treaties that commit us to the protection of migratory terns and shorebirds, are falling short of these obligations with the knowledge that now exists into the impact to these species of the inshore commercial netting of Cooloola and Fraser Island.

World Heritage Listing and the criteria associated with listing, obliges the conservation of species and inshore commercial netting practices of the region are now known to seriously compromise the conservation of these species. Fisheries legislation in Queensland also

obliges that the existing inshore commercial fishery of Fraser Island and Cooloola be reassessed, based on the content of this document.

Participation rates of recreational fishers in Queensland is such that the social and economic aspects pertaining to the sustainability of the fishery and the recreational opportunities afforded, must be maintained. The continued deterioration of fish populations in the Cooloola and Fraser Island region, has irreversible ramifications to these social and economic aspects as well as to the South East Queensland inshore commercial fishery.

Recreational Fishing Havens in Cooloola and Fraser Island would be a significant drawcard for interstate and international tourists that enhance the values already recognised around the world. Conflict between recreational fishers and commercial fishers, which was significant in the attempted banning of netting of Fraser Island in the 1980s, is an issue that will continue to fester as fishing pressure increases and fish populations deplete even further.

Current assertions by Queensland Fisheries that the Cooloola and Fraser Island inshore Fishery is sustainable, are exposed by this proposal as being incorrect. Increased efficiencies by the commercial sector that are outlined here and that have not been considered before by fishery managers, requires greater scrutiny of the fishery and the methods of stock assessment currently being used.



Sand mining... then logging... there's just one more box to tick.

Important Information Summary

- Populations of inshore fish stocks in the Cooloola and Fraser Island region that are exploited by the commercial fishery are in serious decline. **Pages 7, 8, 15-19, 20, 22-24, 26-28**
- Species affected have adapted ‘learned predatory responses’ to commercial nets that have led to inefficient feeding and spawning that has compounded the impacts of commercial harvesting and which have devastated the recreational fishery in the region. **Pages 7-21, 23-28**
- Seabirds, dolphins, turtles and potentially humpback whales are negatively impacted upon by predatory fish population depletion and altered fish behaviour. **Pages 23-31**
- Research into audible and chemical communication between fishes has allowed for greater understanding of fish behaviour and to confirm observed fish behaviour in relation to commercial nets. **Pages 7-15**
- Improved commercial netting efficiencies have caused Queensland Fisheries to misjudge the sustainability of the fishery. **Pages 15-17**
- New South Wales RFHs demonstrate that fish populations can rebound both within the RFH and outside, when commercial netting is banned in suitable localities. **Pages 19,20**
- Recreational Fishing Havens are an effective method of preserving commercially and recreationally targeted fish species’ populations whilst achieving great conservation benefits for seabirds, dolphins, sea turtles and possibly humpback whales. **Pages 15, 16, 19, 20, 23-31**
- Recreational Fishing Havens are a significant tourist attraction with substantial economic benefits that outweigh current returns from the commercial sector. **Pages 19, 20-23**
- Cooloola and Fraser Island are ideally located to greatly benefit from increased interstate and international tourism if designated as RFHs. **Pages 20-24, 29-31**
- Passive acoustics must be implemented by Queensland Fisheries as a stock management tool. **Pages 11, 32, 33**
- Coastal algal blooms are an increasingly serious problem for Cooloola and Fraser Island which must be addressed. **Pages 23, 24, 35**

A Treasure Worth Protecting

Australia's inshore coastline is an immensely diverse network of interjoining ecosystems whose future health is critical to the continued and sustainable use by a large sector of our community. Human exploitation of the resources that exist within these ecosystems along with habitat degradation and depleted estuarine and coastal water quality, have in recent decades caused alterations to the dynamics of exploited and non exploited species.

Measures to counteract the increasing pressures being placed on our marine habitat are universally being sought by governments at all levels and with support from the public at large. Opinions vary greatly however as to how best this can be achieved with different recreational user groups, conservationists, commercial operators and government often at loggerheads in finding suitable methods that strike a balance for all.

This proposal for the establishment of Recreational Fishing Havens (RFH) on the Cooloola and Fraser Island coast demonstrates that the objectives of all sectors in both the short and long term can be met. Conservation of species can very successfully occur whilst maintaining recreational and commercial requirements along with an improved affiliated business environment. The locking away of areas to all user groups is not the only method of conservation available.

A Recreational Fishing Haven is an area that permits recreational fishing but does not permit the use of commercial nets within the boundaries of the RFH. The creation of RFHs in Cooloola and Fraser Island and the banning of commercial fishing gear would establish net free areas that allow for the conservation of species which are presently in decline whilst allowing for recreational fishing and affiliated business to prosper.

It is proposed that the region between the mouth of the Noosa River and Inskip Point and seaward to 500 metres beyond low tide (MLWS) be declared a Recreational Fishing Haven.

At the same time it is proposed that all of Fraser Island's beaches, including the western side, seaward to 500 metres beyond low tide (MLWS) be declared a Recreational Fishing Haven.



This proposal outlines the population dynamics of the many species existing in the Cooloola and Fraser Island region that are affected by beach seine netting of these locations. Australian and international fisheries managers and conservationists aiming to protect marine biodiversity are only now becoming aware of the recent discoveries outlined, which greatly enhances our understanding of marine species' behaviour.

Although specifically focused on the Cooloola and Fraser Island regions, the principles outlined in this proposal can apply to almost any commercially netted location.

Worth saving? You bet.

Sustainability of the Fishery:

Hundreds, if not thousands, of tonnes of various fish species are netted from the beaches of Cooloola and Fraser Island each year. (Qld Fisheries catch statistics) The vast majority of these fish are taken while in spawning aggregations which allows the fisher to achieve best results with minimum effort. Of course, taking fish prior to successful spawning is counterproductive to the survival of these fish species in addition to the harvesting of the fish themselves.

Queensland Fisheries argue that ‘the fishery (Noosa River mouth to Sandy Cape) is sustainable’. Fisheries has drawn this conclusion on the basis of commercial catch statistics which have remained relatively stable since dramatic reductions in overall inshore catches in the 1980s, but have recently begun to fall again. The very small amount of research that has been conducted into surf species of the region indicates that all is not well. Long term recreational fishing observers of fish populations of the region are adamant that fish populations have fallen drastically. Of this there can be little doubt. But the scenario is not as simple as counting sheep in a pen. The population dynamics and behavioral traits of fish species targeted by commercial netting have altered in recent decades as a result of fishing pressure and the individual species’ reduced populations.

Fish have remarkable sensory and communication abilities which allow them to successfully locate prey and assists in avoiding predation. Auditory, chemical and visual communication between conspecifics (same species) and heterospecifics (other species) of the same prey guild (species with common predator) has become very refined in relation to their ultimate predator



Beach Haul Boat at Rainbow Bay, 1930s.

– nets. Learned predatory responses (adaptive behavioral response to predators) of fish in all aquatic environments is very well documented with each of these sensory and communication abilities now being heavily researched.

Fish, when trapped in a net, emit alarm ‘cues’ as a result of their panic (Myrberg 1981; Francis & Williams 1995; Smith 1992). Just as a terrestrial animal would release a cry of alarm when being preyed upon, audible alarm vocalisations by fish, which can travel kilometres through water, warn conspecifics and heterospecifics of the same prey guild which has a history of being exploited by beach seine nets, of the present danger. (Smith 1992) At the same time chemical ‘disturbance cues’ are emitted via a urinary expulsion when the fish become startled or alarmed, (Hazlett 1985; Kiesecker et al. 1995; Ferrari et al. 2008; Wisenden et al.1995;) just as a terrestrial animal would do in similar circumstances. Damage to the skin of the netted fish resulting from contact with the net causes another chemical called schreckstoff to be automatically released into the water which reliably informs receivers (conspecifics and heterospecifics) that conspecific or heterospecifics of the same prey guild have been predated upon (netted). (Von Frisch 1938; Pfeiffer 1977; Smith 1992; Mirza & Chivers 2003; Pollock et al 2003; Brown et al. 2003)

The initial audible alarm causes fish that are of species with a history of being commercially netted by beach seine and are within hearing distance of the netted fish, to flee the area. (Wisenden & Chivers; Brown & Warburton 1999; Smith 1992)) These fish then relay the audible alarm (secondary transmission) on to fish that are further afield who also flee and relay the audible alarm on to fish further afield again. (Smith 1992) Fish as far away as 30 or 40 kms from the netting site to the north, east and south are warned about the danger via audible alarm signals which causes the ‘area evacuation’ of the entire surf zone in the affected region by fish with a history of being netted by beach seine, other than some juveniles that are yet to learn antipredator responses to commercial nets and benthic (bottom dwelling) species



Netted yellowtail kingfish, circa 1930s.

such as flathead, sole and shovel nosed rays that have poor hearing and the ability to escape underneath the net. (Wisenden & Chivers)

Fish receiving the audible alarm and the dire warning communicated, immediately emit disturbance cues. (Wisenden, Chivers, Smith 1995; Ferrari et al. 2010) The two separate chemical alarm cues (disturbance and schreckstoff) which can remain active in water for days, (Smith 1992) warn fish moving into the area of the danger and cause a continued 'area avoidance' (Heczko & Seghers 1981; Magurran 1986; Fricke 1987; Mathis & Smith 1992; Chivers & Smith 1994; Wisenden et al. 1995) of the entirety of that 60 to 80km surf zone to conventionally last for about 1 week (Smith 1992; Personal and anecdotal observation) before some fish begin to return to the area and become vulnerable to nets again.

The size of the area evacuated and the period of area avoidance are influenced by the size of the netted haul, the number and size of recent hauls, food availability, maturity of affected species, hunger levels of the affected species and on ocean conditions at the time.

* A large haul of several tonne of any species causes a larger area to be avoided than a small haul of less than a tonne or two. The level of the avoidance reaction taken by fish is directly proportional to the concentrations of alarm cues. (Helfman 1989; Ferrari et al. 2005; Zhao et al. 2006; Ferrari et al. 2006; Williams & Brown 1991; Hartman & Abrahams 2000; Chivers et al. 2001; Golub & Brown 2003; Marcus & Brown 2003; Dupuch et al. 2004; Zhao & Chivers 2005; Holmes & McCormick 2010) 'Risk assessment' by targeted species, which is conducted to determine the risk of predation against the loss of health that results from a loss of feeding or breeding time when taking avoidance measures, is the determining factor in this regard. (Ferrari et al. 2005; Magnhagen 1992; Chivers et al. 1995; Pollock et al. 2006; Koch et al. 2007; Lastein et al. 2008; Walters 2000; Kusch et al. 2004)

* The first haul of the season causes a small area avoidance that doesn't last more than a few days, (Personal observation) but subsequent large hauls cause a full area avoidance and particularly if at least one net per week is deployed. (Personal observation) Secondary and subsequent hauls to the first of the season, confirm for the target species that a real and present danger exists and avoidance responses required. (Kiefer & Colgan 1992; Kelley & Magurran 2003)

* The presence of large quantities of food for the targeted species can cause area avoidance to be less than would occur when conventional food resources exist. Risk assessment by the fish can determine that it is preferable to stay and feed, rather than instigate an avoidance response which may lead to a loss of food intake.

* Hungry fish have been determined to be more likely to ignore alarm signals than satiated fish and particularly when large food resources are available. (Chivers et al 2000; Hazlett 2003; McCormick & Larson 2008)

* Mature fish of any species are more likely to instigate an avoidance response to commercial nets than are juveniles and to avoid risky areas for longer. (Wisenden, Chivers, Brown, Smith 1995) 'Learned predatory response', as the term indicates, is learned by fish on exposure to predators. It has been demonstrated that a single exposure to a predator is sufficient for fish

to acquire knowledge of that predator and to take avoidance measures on each occasion that exposure occurs following the first. (Suboski 1990; Chivers & Smith 1998; Magurran 1989; Larson & McCormick 2003)

* Heavy ocean and surf conditions cause for alarm vocalisations to be drowned out by the ambient noise of waves breaking and strong currents cause for chemical alarm signals to be dispersed more quickly than in calm conditions, although it is unusual for commercial beach netting to occur in heavy seas. Fast dispersal of chemical cues leads to a shorter avoidance period due to chemical cues no longer being present to warn fish moving into the area of the danger.

There are many variables associated with area avoidance by fishes and the behaviour displayed to each of the various situations that can occur. However, it is known that fish do associate the negative stimulus of a predation event to the location that it has occurred and which leads to a general avoidance of that location when further negative stimuli occur in that location. (Wisenden, Chivers, Brown, Smith, 1995; Pyanov 1993) Therefore, in heavily netted regions such as Cooloola and Fraser Island, the exploited species adopt avoidance responses more readily than they would in locations where nets are less commonly used.

Note: Social transmission of predator information can occur between heterospecifics within a prey guild as easily as between conspecifics. (Mathis et al. 1996; Friesen & Chivers 2006; Kraus 1993;). In the case of beach seine netting of Cooloola and Fraser Island, the netting of any of the conventional target species, will cause avoidance responses by all of the other target species. For instance, the netting of mullet, will cause area evacuation and avoidance by bream, tailor, whiting, tarwhine, trevally, jewfish, snub-nosed dart etc. as well as mullet.

Note: All members of a school are alerted to the presence of a predator (net) once a single member of the school has detected it. (Lima 1995; Suboski & Templeton 1989; Brown & Laland 2001; Hall & Suboski 1995) “Predator detection is followed by a fright response which rapidly spreads through the school, providing an early warning to those members that have not independently perceived the approaching threat”. (Godin & Morgan 1985; Godin et al. 1988) Therefore, schooling fish such as tailor, mullet, whiting, bream, tarwhine, trevally, jewfish, snub-nosed dart etc. respond very quickly and universally to the threat of commercial nets with avoidance reactions.

For centuries, commercial net fishers around the world have been aware that fish are seldom found in the region of their netting immediately following the successful deployment of their net. Methods to counteract the area avoidance in recent times have developed as a result.

One such example is the ‘spraywashing’ of the ocean surface beside trawlers or commercial long-line vessels. This involves the use of seawater being sprayed from the vessel on to the ocean surface to replicate the sound and vibration that baitfish make when herded by predatory species to the ocean surface. The sound can be heard by the predatory species such as tuna and the vibration detected by the fish through their ‘lateral line’. Spray washing maintains the presence of the target species and assists in maximising catches.

Similarly, commercial netters of yellowfin tuna in the Solomon Islands have found that to net shoals of baitfish following successful hauls of tuna and to dump those baitfish immediately over the side of the vessel, draws the tuna back to the region of the trawler and allows for further hauls of tuna to occur. (Ian Tibbets – UQ – verbal) The alarm vocalisations of those baitfish that are still alive, combined with schreckstoff emanating from the damaged fish along with disturbance cues, attracts the tuna back to the vicinity of the trawler.

Technologies that are currently being researched to attract target species to a location using sound, utilise the abilities of pelagic (surface feeding predatory fish) species such as the tunas to locate prey. Pelagic ocean going fish species as well as dolphins and sharks, listen for the vocalisations made by baitfish in the baitfish's day to day foraging and spawning activities, or those being made by baitfish being predated upon by predators, to locate their prey. This ability to locate prey using sound is essential for the survival of predatory species of fish and that of dolphins and sharks who would otherwise roam the oceans in the hope of incidentally locating prey which is inefficient to the degree that survival of these species would not be possible.

The predatory fish attraction technology that is currently being developed, involves the use of hydrophone recordings of baitfish vocalisations being played through speakers into the water to attract target species to a desired location. (Wahlberg 1999; Simpson 2005) Just as the Pacific Islanders have for centuries used 'shark rattles' to successfully attract predatory fish species and sharks to a location, this technology has been demonstrated repeatedly to work.

Note: Dolphins are known to use prey fish vocalisations to locate them, with soniferous (vocalising) fish comprising the majority of their diet. (Remage – Healey et al. 2006; Ganon et al. 2005) The vocalising prey species of the dolphin are also known to cease vocalising on detection of the dolphins being present in the region, in the hope that the dolphins won't locate them. (Remage – Healey et al. 1999) Echolocation abilities of the dolphin then become the predominant prey location tool of the dolphin due to the cessation of their prey vocalising.

Audible Alarm Signals:

Over 800 species of fish have had their various vocalisations recorded on hydrophones with the number of species growing in number each year as further testing of species' vocalisations occur. Fish vocalisations can travel extraordinary distances in water and at five times the speed at which sound travels in air. Yellowfin tuna vocalisations for instance, have been detected on hydrophones at distances in excess of 20kms. (Schaefer & Oliver 1999) It is anticipated that fish acoustic abilities are more refined than that of a hydrophone and vocalisations may be heard by the fish over much greater distances. Different fish species have differing vocal abilities which are generally dependent on swim bladder size which acts as an amplifier for the drumming of specialised muscles against the swim bladder. It has also been determined that fish with large otoliths (ears) have better acoustic abilities than those with small otoliths. (Cruz & Lombarte 2004)

Not all fish are soniferous however. As a rule, colourful fish species tend to use visual communication and changes in colour to do so while less colourful fish tend to be soniferous

due to not having colour variation to communicate with.

Of significance in establishing that audible alarm signals by netted fish are causing an initial flight reaction by fish in the surrounding waters, are personal observations of netting activity conducted on Teewah Beach in Cooloola. I have observed on a number of occasions the netting of mullet by beach seine netters while pelagic species such as school and spotted mackerel along with mackerel tuna and longtail tuna are feeding on Australian sardines in the near shore vicinity and visible from shore.

On each occasion that I have witnessed a situation such as this, the mackerel and tuna can be seen to sound (dive) at the very instant that the netted mullet realise that they are trapped and display panic behaviour of leaping and splashing. Mackerel and tuna schools that are kilometres from the netting site disappear at precisely the same time as the other schools close to the netting site. The sardine shoals can still be seen shimmering the ocean surface but the mackerel and tuna do not reappear for at least one week.

Only sound and the secondary transmission of can travel the required distances to alert these mackerel and tuna schools of the danger in such a short space of time (seconds). Other personal observations of fish visibly fleeing through the surf zone within minutes of a net shot at distances as great as 15 kilometres away are also certain indicators that sound and not chemical alarm cues are responsible for the initial flight reaction of the fish.



Snub-nosed dart emit audible and chemical alarm signals.

Note: Sardines and anchovy are not of the same prey guild (taken by beach seine nets) as mullet and the other commercially targeted species of beach seine netting. Therefore, an avoidance response is not required by these species as a result of their not having a history of negative stimulus associated with beach seine netting.

Mackerel and tuna species also are not conventionally harvested by beach seine netting, although hauls of mackerel tuna (*Euthynnus affinis*) which attain poor market value for the commercial fisher, have occurred more frequently in recent years due to species that attain a higher sale price being less readily available. Longtail tuna (*Kishinoella tonggol*) are rarely taken by beach seine nets, but nevertheless demonstrate avoidance responses to beach seine netting, which can only be assumed to be as a result of learned predatory response to the incidental catches that do occur.

Similarly, school mackerel (*Cybium queenslandicus*) and spotted mackerel (*Sawara nipponia*) are not commonly taken by beach seine netting, but sufficiently so to elicit avoidance responses from these species when beach seine netting is occurring.

Many of the species targeted by nets in the Cooloola and Fraser Island region are found elsewhere in the world and have been recorded on hydrophones and their vocalisations placed on the world-wide database of fish vocalisations. Of the species targeted by commercial net fishers in Cooloola and Fraser Island, I have been able to confirm that the following species are indeed soniferous.

Mullet, tailor, swallowtail dart, snub-nosed dart (permit), jewfish, all trevallies, queenfish, longtail and mackerel tuna.

Species targeted commercially in the region but not listed above are: yellowfin bream, tarwhine and whiting. These species have never been tested due to the fact that they are almost exclusively found in Australian waters where testing of fish's acoustic abilities is in its infancy. However, gauging from otolith size, it would be safe to say that each of these species are soniferous also.

Chemical Alarm Signals:

Chemical alarm signal release by fish in all aquatic environments is well documented by many research projects that have been conducted in this field. Experiments in the laboratory and the wild have conclusively established that avoidance reactions by all tested species occurs on exposure to conspecific and same prey guild heterospecific chemical cues. (Wisenden 2003; Kats & Dill 1998; Wisenden & Chivers 1998; Brown & Chivers 2005; Wisenden & Barbour 2005; Friesen & Chivers 2006; Bhatnagar 2008) Establishing scientifically the territory that a chemical cue can penetrate and the size of an area that would be avoided is however a very difficult thing to ascertain.

In a lake environment where current flow is minimal, the 'active space' for schreckstoff, which is only released on damage to a fish's skin, has been determined to be at least 8 metres from the sample source. (Wisenden 2008) However, these experiments have been conducted using just

small amounts of skin extract as the schreckstoff source and without the presence of an actual predator or audible alarm vocalisations of alarmed fish and have involved only small numbers of fish subjects.

Actual netting scenarios in a marine environment are vastly different to an experiment of this nature in that audible alarm vocalisations are released by netted fish as well as fish in receipt of these alarm vocalisations in conjunction with schreckstoff and disturbance cues and also 'visual alarm' (Magurran & Higham 1988; Chivers & Smith 1994; Suboski et al. 1990) of fleeing fish. There is also the actual mortality of conventionally thousands of fish. The release of disturbance cues by fish that can be tens of kilometres away from the netting site, causes a far greater area to be permeated by chemical alarm cues than does a piece of skin in a trap in a lake. Therefore, the level of trauma experienced by fish exposed to the actual mortality of thousands of conspecific or heterospecific species, is exponentially more severe than that experienced by fish subjects in the laboratory, which often adopt different avoidance responses to marine fishes.

If we consider that separate experiments have demonstrated that when 1 square centimetre of skin (schreckstoff) extracted from individual fish and placed in a 58000 litre tank of water containing conspecifics and heterospecifics of the same prey guild as that individual, elicits an avoidance response by those fish every time, (Lawrence & Smith 1989; Mirza & Chivers 2003; Dupuch et al. 2004) then the area affected by schreckstoff released by netted fish must on its own be enormous.

To calculate the area in square cm of damaged fish in a single beach seine net that can capture many tonnes of fish, we would find a conservative equation whereby many millions of litres of seawater that is propelled by ocean and wind currents would become laced with schreckstoff (and disturbance cues) and which is certain to elicit avoidance responses from conspecifics and heterospecifics of the same prey guild that are exposed. However, on occasions it is tens of tonnes of fish that are captured by a sequence of nets with very large quantities of schreckstoff along with disturbance and auditory cues released as well as the visual stimuli of fleeing fish.

It has been repeatedly demonstrated scientifically, that when two or more alarm cues (audible + chemical x 2 + visual) are received by conspecifics or heterospecifics of the same prey guild, that the avoidance reaction by fish is most urgent. (Goz 1941; Magurran 1989; Chivers & Smith 1994; Wisenden 2006; Brown et al. 2004; McCormick & Manassa 2008; Wisenden & Harter 2001; Bouwma & Hazlett 2001; Garcia et al. 1992; Brown & Goddn 1999; Wisenden et al. 2004; Salar 2007) The second and third alarm cues confirm for the fish that a real and present danger does exist and an antipredator response required. (Releaser – induced recognition learning)

However, the many decades of netting that have occurred in Cooloola and Fraser Island has instilled in the fish a wariness associated with netting that requires only audible alarm signals to enable the fish to associate this negative stimuli with the threat of mortality and to elicit flight responses. It can be anticipated that thousands of fish all emitting alarm vocalisations with each netting, that the fish have had little difficulty in adapting antipredator responses to beach seine netting.

My personal experience and anecdotal accounts by various individuals, including professional net fishers, has left me in no doubt that flight reactions to commercial beach seine netting in Cooloola and Fraser Island occur on each occasion that a successful haul of fish is conducted and is initiated by audible alarm signals by netted fish. The scientific evidence fully supports this hypothesis.

Area avoidance occurs on each occasion also, which is supported by personal observations of a habitat devoid of fish, dolphins and seabirds, following successful commercial hauls. Recreational catches following commercial hauls are non – existent other than for flathead, sole and shovel – nosed rays. The scientific evidence fully supports the hypothesis of area avoidance following commercial hauls in Cooloola and at Fraser Island.

Area Avoidance and Population Levels:

It may be perceived that the behavioral traits being demonstrated by fishes are a positive mechanism whereby species' populations can be maintained due to their learned avoidance of commercial nets. However, this is not the case. Alterations to migrations, feeding and spawning behaviour resulting from avoidance responses, cause fish to feed and breed in areas that are less conducive to their species' survival than locations that have sustained populations for millions of years.

Insufficient food resources that exist in regions that are not conventional locations for the fish to inhabit, leads to a reduction in individual health. Spawning in locations that are less conducive to fertilisation of eggs than conventional, results in poor recruitment. Spawning in locations that are of a greater distance than conventional to locations such as estuaries where some species of larvae must relocate themselves to, increases predation levels of these larvae and exhaustion mortalities prior to arriving at the desired location. Poor individual health, poor fertilization of eggs and increased predation and exhaustion of larvae leads to reduced recruitment levels and reduced health of the larvae. This in turn leads to reduced fecundity of spawning fish and to fish being smaller at spawning age. Poor individual health and smaller size at age of spawning individuals also causes poor recruitment levels.

All fish in either a marine or fresh water system must assess their risk of predation against their normal requirements of life of feeding and breeding. Avoidance reactions to potential predation occupy time that could otherwise be spent feeding. (Wisenden et al. 2004) A perennial threat such as that posed by commercial nets cause excessive time to be spent by the fish in avoiding this very real threat. Food intake is thought to be reduced as a result and energy levels increased which also leads to less healthy fish and less healthy larvae resulting.

Indicative of this situation is the fact that tailor, which are known to have altered their migration to offshore waters, (Qld Fisheries) are leaving the inshore waters where their historically staple diet of anchovy and sardine are present. Tailor are known to be smaller in size at spawning age today than they were in the 1970s (Qld Fisheries) which is an indication of reduced fecundity or a genetic change in the species.

Hyperstability:

The question at this point is, how is it that the commercial netters still locate fish to net if the above is all true?

The K8 (Noosa River mouth to Inskip Point) netters discovered in the late 1980s that fish schools were becoming increasingly difficult to locate. They identified that by working separately as they had been, they were effectively spooking (scaring) each other's fish away. This led to them teaming up, working together and splitting the catch. By doing so, they were able to circumvent to a large extent the area avoidance by timing net shots to coincide with each other and in locations that allowed for fish to be available in other locations distant from the netted site in the following days.

Assisting the commercial netter to capture fish is the spawning migration of mullet which is the predominant target of the fisher due to the high value of the roe in Asian markets. Mullet are an estuary species that exit their home estuary to spawn in the gutters to the north of that estuary in autumn and winter. While in the estuary, these fish are not privy to alarm cues being released by netted fish and nearby conspecific and heterospecific species on the open beach and the mullet must exit the stream when they are ready to spawn irrespective. Oblivious of what is occurring on the open beach, the mullet can exit the estuary to spawn at any time which assists the commercial netter to land fish during area avoidance phases.

Note: In recent years mullet have demonstrated a reluctance to exit many estuaries when ready to spawn, by congregating inside the estuary mouth for longer than previously. On leaving the estuary to spawn, the mullet have also altered the path taken and are commonly taking a path directly eastward towards the open ocean, rather than the historical northward path to the surf gutters where they spawn. The perpetual presence of commercial netters 400 metres north of the estuary mouth over a period of decades during the mullet netting season, is believed to be significant in altering the path that the mullet are now taking.

Having departed the estuary mouth in an easterly direction and on occasions being sighted tens of kilometres offshore, the mullet must head back to the surf gutters to the north of the estuary where instinct demands that they spawn. It is this offshore path that prompted the commercial fishers of Cooloola to adopt the use of spotter planes to determine the point along Teewah Beach that the mullet would return to the surf.

By teaming up, the fishers are also able to utilise multiple vessels, vehicles and crew to exploit large aggregations of fish that a single licence holder could otherwise only take a portion of before spooking the rest of the fish away. Sequential shots by the different licence holders traps the fleeing fish and allows for hauls in the tens of tonnes rather than merely a few tonne maximum achievable by single licence holders working separately.

Increased efficiencies which came into being at around the same time such as spotter planes and body trucks to cart the catch to the market place allowed the fishers to locate schools more quickly and to be able to handle the despatch of large volumes of fish more effectively than had been achievable before. The sharing of duties by the different licence holders to scour the surf

zone each day from 4wd vehicles on the beach for schools, results in fewer schools being able to escape the attention of the commercial operators and for costs per licence holder to search for fish, to be reduced.

The circumventing of area avoidance and the increased efficiencies combined, caused catch statistics to level out during this period which provided Fisheries with a level of confidence that the fishery was and is sustainable. At a time when commercial and recreational fishing pressure had reached a peak, this conclusion would appear to lack supporting logic and demonstrates a lack of intimate knowledge by Fisheries of the fishery.

The term that is used to describe a situation where catch statistics data being used for stock assessment is artificially inflated by commercial fisher efficiencies compared to the actual population level is 'hyperstability'.

When there is insufficient scientific research to refer to and use as a control in stock assessment methods, the reliance on catch statistics alone as a single method of assessment, is fraught with danger. In the case of Cooloola and Fraser Island, the only available research indicates and states that the fishery is overfished. To not reconcile the available scientific and anecdotal evidence with that of the catch statistics, is indicative of a department that at the time was mismanaging this vital natural resource with repercussions to be felt in the current era.



Mullet schools being netted from Teewah Beach.

The Precautionary Principle:

The precautionary principle is written into Fisheries legislation in Queensland. The principle states that “where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.”

I am presenting a scenario which is suitably supported by scientific and anecdotal evidence that commercial nets in Cooloola and at Fraser Island are causing fish population depletion and behavioural alterations that impact the sustainability of the fish resource and that of other dependent native wildlife. Anecdotal accounts by recreational fishers of the Cooloola and Fraser Island region of reduced fish populations combined with recent downward trends of commercial catch statistics of key target species, should have alarm bells ringing for us all.

Based on the precautionary principle alone, a cessation of netting in Cooloola and at Fraser Island would seem an appropriate measure. But there are many factors other than just the precautionary principle that demand that this should occur sooner rather than later.

Further to the precautionary principle are the ‘Legislative Requirements’ of the Queensland *Fisheries Act* of 1994. The requirements of this Act are:

* Ensuring fisheries resources are used in an ecologically sustainable way.



Commercially netted tailor from the beach are rarely suitable for human consumption.

- * Achieving the optimum community, economic and other benefits obtainable from fisheries.
- * Ensuring access to fisheries resources are fair.

A strong argument exists that the commercial harvesting of inshore fish species in the Cooloola and Fraser Island region are not sustainable and are contrary to the legislative requirements of the 'Act'. The available evidence brings into serious question the sustainability of the fishery itself and also that pertaining to dependent species such as the endangered Little Tern as well as that of the other seabirds, dolphins and possibly humpback whales.

Economic returns to the state of Queensland and Australia from recreational fishing exceed that of commercial fishing. Employment derived from recreational fishing exceeds that which is derived from commercial fishing and the community benefits from recreational fishing far exceed that derived from commercial fishing. Therefore, the 'Act' demands that recreational fishing opportunities be provided and if commercial activity is restrictive of this, then measures to rectify this situation must be emplaced.

Whilst commercial beach seine netting is occurring in Cooloola and Fraser Island, there is a distinct lack of resource allocation fairness. The 'Act' again demands that recreational fishers be provided with a fair allocation of the resource which cannot occur in Cooloola and Fraser Island whilst commercial beach seine netting is permitted.

New South Wales Recreational Fishing Havens:

In 2001, 29 inshore RFHs were created in NSW using funding derived from the sale of recreational fishing licenses to buy back 209 inshore commercial net licenses. Recreational fishers reported improved catches in some of these RFHs within months of establishment and which improved year by year. In 2005/06, NSW Dept of Primary Industries commissioned research into two of these RFHs to establish the success or otherwise of RFHs. Researchers found that fish populations had indeed recovered and substantially despite an increased recreational participation rate. (Steffe et al. 2005)

Sydney Harbour, being the most remarkable and well known location where fish have returned in numbers following the cessation of netting there in 2006 due to water toxins being present in fish, indicates along with this research that commercial nets are the single greatest factor causing fish stock depletion. Habitat loss, recreational impacts and water quality issues being cited by the commercial net fisher as being the cause of fish population depletion has been exposed as incorrect by this and the success of NSW RFHs as well as applicable research. (Ward & Myers 2005; Johnson et al. 1999)

Catch statistics for the NSW inshore fishery have also stabilised or increased for most target species since 2001 (NSW commercial catch statistics 1948 - 2009) despite there being 209 less licences active and 29 less locations in which to operate. This indicates strongly that there is a 'spillover' of fish populations to outside of the RFHs and that RFHs alone

can be an effective conservation tool in managing fish stocks universally. This fact is not unexpected given that many species are migratory or conventionally move from location to location in their foraging and spawning habits. (Johnson et al. 1999; Gell & Roberts 2003) Commercial viability for the remaining fishers has been maintained in the process and this can be expected to occur in Queensland also with the creation of suitable RFHs. It should be noted however that not all of the NSW RFHs have been as successful as others. This is due to insufficient knowledge about fish behaviour and the subsequent poor application of some of the RFHs and the 'zone' they occupy.

Recreational fishing tourism to these areas has increased as have 'local' participation rates. Affiliated businesses are benefiting at the expense of other areas such as Queensland which has yet to identify that net free areas increase species abundance and business opportunities. Each of the other states of Australia have net free regions with the Northern Territory having benefited from high recreational fishing tourist numbers for decades.

Recreational Fishing Tourism:

As opposed to the NSW RFHs, recreational angling participation rates at Cooloola and Fraser Island (and state wide) have fallen in recent years as success rates have plummeted. The consensus is that it is not worth the time and increasing costs associated with fishing this region when other localities are net free and provide opportunities that are no longer available here. Western Cape York, where some areas are net free and fishing pressure less, has seen a boom



Golden trevally are commonly caught from the beaches of Fraser Island.
This fish came from the Sandy Cape area.

in recreational fishing tourism in recent years. Distance from the major population centres and the costs associated with travel to this region however are a limiting factor for tourism benefits to be exploited fully.

The waters of Cooloola and Fraser Island have a number of fish species that are extremely desirable to recreational fishers around the world. Golden trevally, giant trevally, bonefish, snub nosed dart, longtail tuna, yellowfin tuna, queenfish and tarpon, which all inhabit the waters of Cooloola and Fraser Island are species that are recognised around the world as sportsfish of the highest order that attract anglers who are prepared to pay substantial sums of money to catch and release. This is also the case for black, blue and striped marlin as well as sailfish that bring big spending international tourists to the likes of Cairns and Broome each year. Fraser Island and Cooloola are famous locations for tailor which are recognised around the world as a highly regarded light tackle sportsfish. Spanish, grey, school and spotted mackerel also inhabit this region and are highly sought after by many anglers along with wahoo, cobia, mahi mahi and yellowtail kingfish.

Hervey Bay and the waters offshore from Cooloola and Fraser Island present deep sea reef fishing options and a wide variety of reef fish such as the spectacular red emperor, coral trout, red throat emperor, sweetlip, jobfish, snapper and scarlet sea perch.

The estuaries of the region are home to threadfin salmon, burnett salmon, mangrove jack, jewfish and barramundi along with the bread and butter species such as whiting, bream, and flathead which can also be caught from the beaches where swallowtail dart are a favorite with the kids.

It could be argued that few locations anywhere in the world possess the diversity of recreationally desirable species as this region. Combined with other attributes such as coloured sand dunes, whale watching, fresh water lakes, rainforests, bird watching, endless white sandy beaches and proximity to the major human population bases of Brisbane, the Sunshine Coast and Hervey Bay and the associated access abilities, Fraser Island and Cooloola can be a major drawcard for large recreational fishing tourist numbers from interstate and overseas.

Value To the State Economy of Recreational Fishing:

Studies have shown that recreational fishers spend close to \$1 billion per year in Queensland with a reasonable percentage being derived from interstate or international visitors. In the Hervey Bay region, it is estimated that \$38 million is spent by recreational fishers to go fishing with \$103 million being spent by visiting anglers on accommodation alone. (Sunfish commissioned study 2001) The commercial sector is said to have a statewide annual turnover of less than \$1billion and which includes many species not targeted by recreational fishers such as the Queensland scallop.

Unfortunately, recreational fishing tourism to the Cooloola and Fraser Island region is in decline as results for anglers deteriorate. Charter operators are leaving the industry due to a lack of clientele and potential International angling visitors are expressing a desire to visit the

region, but at the same time stating that they will not until net free areas are set aside.

To make a comparison between recreational and commercial fishing and the value to the economy per fish, a recreational fishing tourist can spend thousands of dollars on accommodation, charter boats, hire vehicles, food, alcohol, tackle, clothing etc., and in the majority of cases, release any fish caught. A netted fish such as a snub nosed dart which is very highly sought by fly and lure fishers around the world, achieves a sale price of no more than \$5 per kg for the commercial fisher, but tonnes of them are generally killed in the process.

The various studies around the world into the value to economies of recreational fishing vs commercial fishing have differing results, but always show recreational fishing exceeding that of commercial to a value of no less than 3 to 1 and as high as 30 to 1 for targeted species. The value to the Queensland economy of recreational fishing is such that healthy fisheries must be sustained in order for future benefits to be maximised.

The social and health benefits to the greater community of recreational fishing are well documented. However, as participation rates fall due to declining catches, so too does the general health of our human population. Cooloola and Fraser Island along with countless other netted regions have become victim to a scenario whereby many of the tourists who would conventionally fish for several hours in a day, no longer do so due to poor returns for their time.



Tailor such as this specimen are becoming increasingly rare in Cooloola.

The reduced average health of Queenslanders brings about additional costs to the community in health care.

Recreational Fishing in Cooloola and Fraser Island:

The fact of the matter is that it is virtually impossible for anglers to catch fish in Cooloola in particular due to commercial nets spooking the fish during the mullet and tailor netting season. The now annual coastal algal blooms that affect Cooloola and Fraser Island such as *anulus australis*, *hincksia sordida* and *lingbya majuscula* are also a significant problem in preventing successful prospects during the period from October to April since the year 2001 when these blooms first began appearing with any intensity. Small windows of opportunity for successful angling occur as fish return to the Cooloola surf after each haul in a net during the months not affected by algal blooms, but these windows can be very short lived as the professional fishers are aware when the fish are due back and are ready with their nets for them.

Fraser Island fares a little better in this regard in that the region between Tooloora Ck and North Ngkala Rocks, a distance of 70kms is net free. However, netting to the south and north of these localities causes area avoidance penetration well into the net free zone from both directions.

There are three avoidable factors influencing fish populations in Cooloola and Fraser Island, all of which are caused by commercial netting. Population depletion of fish species due to excessive harvesting of fish numbers and poor recruitment to replace those fish populations due to area avoidance and the resulting alteration of spawning and feeding locations along with the harvesting of fish during spawning aggregations.

It is my belief and that of the world's leading marine scientist in this field, that poor recruitment and feeding as a result of area avoidance of commercial netting, has caused fish population crashes around the world when managers believed they were on top of the situation. However, they cannot have taken into account area avoidance and behavioral responses by fish to netting and hyperstability is likely to have been significant in exacerbating flawed management practices.

Seabirds:

There are several species of seabird which inhabit the Cooloola and Fraser Island region. They are the Little, White-winged and Common terns which are migratory terns protected by international treaties of which Australia is a signatory. Crested terns are sedentary (non – migratory) terns found all year round and Gull-billed and Caspian terns are nomadic and are periodically present each year. Australasian gannets arrive in the region to coincide with the tailor spawning migration in autumn which coincides with the arrival of spawning shoals of Australian sardine being inshore. At the northern end of Fraser Island, other terns are occasional visitors.

Each of these seabirds are entirely dependent on predatory fish species such as tailor, swallowtail dart, giant trevally and the mackerels and tunas along with dolphins which herd baitfish to the

ocean surface where the seabirds can access the prey. Without the predatory fish species to do this herding, baitfish would stay deeper in the water column in order to avoid predation from seabirds. The level of dependency is such that should predator fish species' populations collapse, then so too would each of the seabird populations.

As it stands, there are still predatory fish swimming in our oceans albeit in reduced numbers. However, due to area avoidance by these species which are largely pelagics, concentrations of these species are to be found more offshore than would historically be the case. This means that for the shore based terns to feed, they must travel far greater distances than would otherwise occur. This also means that these shore based terns cannot feed multiple times per day as they would normally do, due to the flight distances required each time.



Terns roosting at the mouth of the Noosa estuary.

Greater flight distances cause greater energy consumption and combined with less food resources as a result of overfishing of the predatory species and area avoidance, seriously compromises the individual health of each of the tern species. The health of chicks is also compromised due to less food being delivered by the parents.

Migratory terns undertake enormous migrations to northern Asia and must store body fat prior to commencement of their annual migration. The loss of feeding ability and increased energy loads causes the migratories to undertake these enormous flight distances in an underprepared state which leads to fatalities during migration.

It should be noted that the Little tern which is listed as endangered on the Queensland Conservation Act of 1992, was, up until the 1980's, nesting in several locations in Cooloola and on Fraser Island. This is no longer the case with the reasons for this unknown – until now. Disturbance of little terns at their roosting and nesting sites would also be a factor in this regard.

There are several hugely important roosting sites in Cooloola and Fraser Island for all of the tern species. The mouth of the Noosa River being probably the most significant on the eastern seaboard of Australia with a closed beach to 4wd vehicles established to reduce disturbance levels. Unfortunately, the mouth of the Noosa River is probably the most intensely netted river mouth on the eastern seaboard which results in this protective measure achieving less benefit than is desirable for the terns. Other very significant roosting sites are Double Island Point and Inskip Point in Cooloola and Hook Point, Sandy Cape, Moon and Rooney Point on Fraser Island.

Of particular concern for the seabirds is the reducing population of tailor to be found inshore. Tailor are virtually the only predatory species able to herd baitfish during the winter months (spawning migration) and due to population depletion and area avoidance, they are not providing the food availability for terns that can sustain populations. Crested terns are most affected by this due to these terns being the vastly predominant tern species present during winter and a subsequent near total reliance on tailor alone. Similarly, tailor are not found inshore during the warmer months to anywhere near the numbers of the past. This impacts on each of the tern species due to tailor historically being the predominant inshore predatory species in spring, summer, autumn and winter.

Note: The commercial harvesting of tailor has been banned in New South Wales in response to the recognised overfishing of the species. However, the benefits of this ban are nullified by the fact that tailor migrate from New South Wales waters into Queensland waters during their annual spawning migration where fishing mortality remains very high. Effective conservation measures for this species cannot occur without a coordinated approach by both states.

It has become apparent that tern counts conducted monthly by Jill Denning at the mouth of the Noosa estuary have a direct correlation with predatory fish presence in Laguna Bay and towards Double Island Point. As would be expected, very little surface feeding activity by pelagic species such as tailor, mackerels and tunas in this region has consistently seen low tern counts at the same time at the estuary mouth. It is also notable that the migratories seem always to arrive soon after commercial netting has ceased for the year in November and leave our shores on commencement of the mullet netting season at the mouth of the Noosa estuary in May.

When terns that traditionally roost at the mouth of the Noosa estuary are deprived of food in their traditional feeding grounds, then it is certain that these terns must feed in other areas. If, for arguments sake, fish were available to the south of Noosa Heads where netting is less intense but still of a commercial scale, then these terns would be competing for food with terns that traditionally roost at locations in this region.

The mouth of the Maroochy estuary is a very important roosting site for the same species of



Common terns resting in the Noosa estuary.

terns as at Noosa. Should terns from multiple locations be competing for food from a single resource region, then it stands to reason that the average food intake per tern would be reduced. However, due to the extensive nature of area avoidance by fish to netting activity along all of our beaches, terns at all roosting locations in South east Queensland are more often than not forced to seek prey in offshore waters.

It should be noted that research into tailor populations in 2004 by Qld Fisheries, found that populations were at 40% of virgin levels and that poor recruitment was of real concern to researchers at that time and that a single year of “low recruitment could necessitate drastic management measures”. It was recommended that a recreational size limit increase to 40cm should occur immediately and that if recruitment didn’t show dramatic improvements during the following 2 years that a total ban should occur on the taking of tailor, but with still “no certainty that the species would recover at all.” (Qld Fisheries 2004)



Terns feeding on abundant baitfish that have been herded to the ocean surface.

Fisheries increased the size limit to 35cm, but there is no indication that populations or recruitment have improved, and it is likely that they have fallen, but nothing otherwise has been done to remedy this situation. The closure of the region between Indian Head and Waddy Point on Fraser Island in the 1990s for the months of August and September to all fishing which is designed to improve tailor spawning rates is ineffective due to this not being the main area of spawning and Sandy Cape netting which causes area avoidance of this locality anyway. The fact that the above research was conducted nearly a decade later, conclusively indicates that this closure to fishing on its own, is insufficient.

Note: Queensland Fisheries established that the principle locality for tailor spawning at Fraser Island is between Indian Head and Waddy Point which led to recreational fishing closures between these two headlands. Water sampling for eggs and milt found greater concentrations in this northern facing bay than in any other region.

I am of the opinion that Fisheries have incorrectly drawn this conclusion and that Breaksea Spit is the principle spawning location. Southerly currents at this time of year along with northerly winds cause the eggs and milt to move south from Breaksea Spit and be trapped in this bay which acts as a ‘bottleneck’ where fertilisation of eggs can occur when northerly winds cause stronger than ideal current flow and which has caused Fisheries to err. My opinion is supported by the available evidence of tailor (*pomatomus saltatrix*) spawning methods in Queensland, Western Australia, Africa and the United States. (Pham 1998; Lananton et al. 1998; Hare & Cowan 1996)

Each of the seabird species’ reliance on tailor as the predominant inshore predatory fish species has serious ramifications for these seabird species under the current circumstances. With the total allowable commercial take of tailor still at 120 tonne in Queensland and recreational bag and size limits still too generous, there is little likelihood of anything changing. However, RFHs in Cooloola and at Fraser Island which are major spawning locations for the species, would quickly improve this situation with more and larger tailor likely to become present in the region and in all regions encompassed by the tailor migration. (Gell & Roberts 2003) Essential is the cessation of netting at the northern end of Fraser Island (Sandy Cape/Breaksea spit) which is the spawning ‘mecca’ of this species.



Laguna Bay and Noosa Heads.

Note: Research into the relationship that exists between bluefish (tailor) and common tern feeding at Long Island New York, found a strong reliance by the common tern on the bluefish for their food resources. (Safina & Burger 1995) Experienced anglers are well aware of this relationship with tern feeding known to be a sure sign of the presence of predatory pelagic species including tailor. It is well known that Common terns, Little terns and Crested terns feed in the same manner on baitfish and are reliant on predatory fish to assist their feeding.

Like any ecosystem, the inshore marine ecosystems of Fraser Island and Cooloola comprise a myriad of species that have evolved and adapted to the elements that present seasonally. Of extreme importance to all of the seabirds, predatory fish species and dolphins are the annual spawning habits of Australian anchovy (*Engraulis australis*) and Australian sardine (*Sardinops sagax*).

Australian sardines spawn in bays and at the mouths of estuaries of South East Queensland from winter to spring in large shoals which provide sustenance for tailor undertaking their northern spawning migration at this time. Subsequently, Crested terns and Australasian gannets are conspicuous by their presence during this period and prosper from the tailor herding the shoals of baitfish to the ocean surface. Unfortunately, in recent years the sardines have arrived in Laguna Bay in large spawning shoals that are unattended by tailor or other predatory species which prohibits the terns and gannets from feeding effectively on this bonanza that has historically been assured. This can be directly attributed to netting and the area avoidance by predatory species.

Australian anchovy spawn in the bays and estuary mouths of South East Queensland during spring to late summer. Just as the sardine is the basis of the migratory habits of the tailor and focus of gannets and Crested terns, anchovy are the basis for the migration of many pelagic fish species that rely on this food source. The mackerels and tunas migrate south from Central Queensland waters and coincide their arrival in South East Queensland waters with that of the anchovy. The southern migration of tailor in summer and autumn following their northern spawning migration also benefits greatly from the anchovy presence.

The migratory terns invariably arrive in South East Queensland at the same time as the anchovy and predatory species and tend to join the southern migration of mackerels and tunas to South East Queensland at Hervey Bay and Fraser Island. By the beginning of January the migratory tern and fish species are established in Laguna Bay where no beach netting occurs at this time of year. Effective feeding by all species is allowed to occur until May when the first nets are again deployed and all species begin their migration away from Cooloola.

A cessation of netting in Cooloola and Fraser Island would have substantial conservation benefits to each seabird species that cannot be achieved otherwise.

Dolphins, Sharks and Turtles:

Any animal that feeds on fish in the wild is certain to have their species' health affected by overfishing. A smaller food resource obviously leads to smaller dependent species populations.



Green turtles at Browns Rocks – Fraser Island

Area avoidance also causes fish to not be where the dolphins, sharks and turtles have historically found them. As per fish feeding and breeding occurring in areas less conducive to maximum health and recruitment, each of these species are forced to feed and breed away from areas which have served their species for millions of years.

Dolphins at Sandy Cape, which at times can number between 50 and 100 animals are deprived of a consistent food supply. As per terns competing with terns from other roosting sites for food, dolphins forced away from Sandy Cape to feed would also be competing with other dolphins from surrounding regions for their food intake. When it is recognised that much of our coastal fish resource is overfished and netting occurring in nearly all of our waters, then this scenario cannot be dismissed lightly as impacting on dolphin populations and that of their prey in these localities.

A cessation of netting at Sandy Cape would lead to healthier fish populations and provide dolphins, sharks and turtles with a food resource in a critical location for the survival of each of these species that inhabit the region. An increase in the tailor population that can be expected to result from the establishment of the RFHs and a return of increased spawning numbers at Breaksea Spit, would have substantial benefits in itself for dolphin populations at Sandy Cape. Tailor being one of the dolphins' main prey due to their soniferous and schooling nature which allows the dolphins to hear the tailor when hunting and to herd the school for easy feeding.

Dolphins in a sizeable pod of 6 or more animals can successfully herd prey schools of anchovy, pilchard, slimey mackerel, tailor, queenfish and other species. But less dolphins in a pod prohibits successful herding behaviour by the dolphins. These dolphins which are not attached to a large pod are more opportunistic feeders and tend to prey on fish that have been herded by predatory fish species such as tailor, tunas and mackerels. They also follow recreational and commercial vessels for the chum (berley) deployed by the fishers to attract target species and also by stealing hooked fish from the lines of fishers.

Inshore dolphin populations of the Cooloola region consists largely of pods of two or three



Dolphins herding prey against the ocean surface.

dolphins with just the one larger pod of a dozen or more dolphins that range north and south of Double Island Point. This pod remains inshore during the netting season and feeds on sardine and anchovy they are able to herd themselves, but the remaining dolphins are forced offshore where the predatory fish have fled to in order to benefit from the herding by these fish and to scavenge around fishing vessels on reef structures. Competition for the food resource potentially becomes an issue again and opportunities for the human tourist to view these animals in the wild are dramatically reduced. It is the case that dolphins are rarely sighted from the shore in Cooloola whilst netting is occurring, but become quite visible once the season has completed.

Humpback Whales:

It has long been believed that humpbacks do not feed during their migration. However, this is not the case with many observations of humpbacks of all migrations in all the world's oceans opportunistically feeding on baitfish during migration. (Baraff et al. 1991; Gendron & Urban 1993; Swingle et al. 1993; Stockin & Burgess 2005) Although documentation of humpbacks

feeding on baitfish on the eastern seaboard of Australia is not extensive, there is most certainly quite a number of observations of this occurring. (Stockin & Burgess 2004) Most notably is that of humpbacks feeding at the northern tip of Fraser Island. (Observations of whale watching tours – Hervey Bay)

Like the seabirds, humpbacks benefit from the herding of baitfish by predatory fish such as tailor, tunas, mackerels and by dolphins. (Stockin & Burgess 2004) When the predatory species have the baitfish herded against the ocean surface in a ball, the humpbacks' 'lunge' feeding technique allows them to consume vast quantities of fish in a single mouthful which has been filmed several times. Apart from humpbacks in Antarctic waters that have learnt to herd fish by 'bubble netting', humpbacks do not have the ability to herd fish on their own and are reliant on predatory fish and dolphins to do the herding for them.

Humpbacks migrating north along the east Australian coast during July and August take a path that is more offshore than that taken during their southern migration. It is feasible that area avoidance by predatory fish species to netting activity inshore during the mullet netting season between May and August is causing the offshore path to be taken. It is also feasible that audible alarm vocalisations by netted and alarmed fish which are at a frequency which can be heard by humpbacks, is also a factor in this regard. It may not be a coincidence that the humpbacks come close to shore on their southern migration during the months of September and October when the beach netting season has completed.

Although there may not be issues associated with reduced feeding by the humpbacks on migration in that they are still able to feed offshore and populations are steadily growing year by year, there is the potential that visitor experience levels to Cooloola and Fraser Island are compromised by not seeing whales from the shore. Potentially, this tourist



Humpback whales just off Teewah Beach in Cooloola.

drawcard can also be enhanced by a cessation of netting along this 200km stretch of coastline.

World Heritage Listing:

World Heritage Listing of Fraser Island includes the area seaward of the low tide mark all around the island to 500 metres. Commercial netting of the island is therefore occurring within the confines of the World Heritage area. There is no doubt that to allow for this to occur is entirely contrary to the principles associated with the criteria that led to Fraser Island being listed in the first place.

Nomination of Cooloola for World Heritage Listing places this region in the same circumstance as Fraser Island should listing occur. However, based on the criteria required for listing, it is doubtful that Cooloola would be listed while commercial netting is occurring on its beaches and with ramifications to various species other than just the fish.

Commercial License Buy back:

It is proposed that funding, or part funding of the buy back by government of existing commercial licenses in Cooloola be derived from revenue attained via the sale of vehicle access permits to Cooloola which were introduced in October 2010 as part of the Recreation Area Management (RAM) declaration of Cooloola. Anticipated revenue of \$2 million per year from permit sales is expected and which must be allocated to the Cooloola Recreation Area for maintenance and improved visitor experience.

It is difficult to know where this money can be spent otherwise when very little infrastructure is required or wanted. Increased Ranger numbers would be wasteful when visitor numbers were anticipated to fall with the introduction of vehicle permits and have actually fallen by 40% since RAM declaration of Cooloola. It is appropriate that revenue from permit sales be used to buy back the K8 licenses given that the area that they are required for is the precise area which the K8 licences are permitted to net.

Improved visitor experiences of catching fish, observing dolphins, seabirds, whales and fish and not seeing the slaughter of tonnes of fish, warrant the use of this revenue. Reduced (halted) conflict between commercial and recreational fishers which is an ongoing issue can be seen as an improved visitor experience also. Increased revenue from the sale of permits can be anticipated as a result of the creation of a RFH for Cooloola which can fund extra Rangers if required.

Recommendations:

1/ My research and 40 years of constant observations has exposed me to scenarios and technologies that Qld Fisheries are yet to investigate. In particular is the use of 'passive acoustics' to assess stock levels. Passive acoustics are used in various locations around the world and with great success. This technology involves the use of static and mobile hydrophones that

detect vocalisations of spawning or feeding fish without the need to sample or tag fish which is unreliable and invasive. (Baltz & Campos 1995; Struik & Bray 1979; Parsons et al. 2009)

Like birds, fish can be positively identified by their species - specific call/vocalisation. Uncertainties associated with major spawning sites need not occur with the introduction of this technology. This allows for fishing closures to protect spawning stocks at appropriate times and in appropriate locations without impacting unnecessarily on the commercial or recreational fishery.

Western Australian Fisheries have begun the usage of passive acoustics to assess spawning locations and behaviour of the mulloway (jewfish) in the Swan River (Parsons et al. 2009) and also spawning locations of yellowtail kingfish in offshore waters. It is early days for researchers in W.A., but already great strides have been taken in the effective use of this stock management tool.

Essential to the overall success of this technology in managing an entire fishery is the recording of each of the commercially targeted species in our waters and their vocalisation placed on the world wide database of fish vocalisations. As mentioned earlier, much of this work has already been done for us overseas and there are merely some gaps to fill. Suitably experienced and skilled scientists currently exist within Queensland and Australia who can potentially carry out this work.

2/ Recreational bag and size limits for key recreational and commercial species should be readdressed. An increase in the size limit for tailor to 40cm and a bag limit of 10 fish would seem appropriate given the significance of this species to the well being of many other species. Particularly as recreational catches are thought to be greater in volume than the commercial take of this species. Bag limits must be introduced for dart and less than 30 for yellowfin bream.

3/ In recent times there has been a push from the recreational fishing sector for some desirable recreational target species such as snub-nosed dart and golden trevally to be allocated a 'recreational only take species'. Unfortunately, there are few benefits to be attained by this measure in the context of the Cooloola and Fraser Island inshore recreational fishery. Commercial beach seiners may well avoid taking these species, however will move further along the beach and take another species which will elicit avoidance responses by the desired recreational only species anyway. Only the complete removal of nets from the region will allow for these desirable species to become more readily available to recreational fishers.

4/ Of real concern to many of the regular visitors and locals of Cooloola and Fraser Island as well as other districts along the eastern seaboard of Australia is the rapidly dwindling availability of the pippi (eugarie/wong) along all beaches. The eastern Australian population of these shellfish are of the same genetic stock and are universally under threat as a result. The diminishing numbers of pippis impacts on inshore fish species such as whiting, swallowtail dart, yellowfin bream and tarwhine that rely heavily on them for their food resource. Dart and whiting coincide their spawning with that of the pippi so as to ensure that juvenile fish have a ready food supply of juvenile pippis to feed on. The implications of a stock collapse of these

vital shellfish are obvious.

I strongly recommend a reduction in bag limits to no more than 20 shellfish per person and the non – removal of the pippi from the beach as is now the case in NSW.

5/ The incidence and severity of coastal algal blooms in Cooloola and Fraser Island waters has dramatically increased since 2001. Blooms of *Anaulus australis* are now permanently present in the surf zone of Cooloola and Fraser Island’s eastern beach between the months of October and April. This algae which causes the surf zone to become brown in colour, restricts oxygen availability for fish and can prevent habitation of the surf zone. *Hincksia sordida* has similar ramifications to water quality and has been responsible for dramatic tourism losses at Noosa in particular. *Lingbya majuscula* is commonly present on the western side of Fraser Island where it is responsible for mass mortalities of ‘white half cockles’ and mangrove trees in Wathumba Creek and is thought to be integral to the incidence of ciguatera fish poisoning and the die – back of sea grass beds in Hervey Bay.



Accumulations of beach traffic at peak periods are counterproductive to species recovery and visitor experience levels.



Anaulus australis bloom in the surf zone of Teewah Beach



Dead white half cockles at Awinya Creek, Fraser Island

These algal blooms are unsightly and severely detrimental to the health of the inshore habitats of the region.

The cause of coastal algal blooms is known to be the increased nutrient produced by our modern society that flows off the land, into our waterways and inevitably into the ocean. Natural predators of these naturally occurring algae such as shellfish and some fish species are overfished which exacerbates nutrient outfall in allowing the algae to flourish.

Addressing both the level and types of nutrients such as phosphate and the overfishing of key natural predators is essential in preventing further deterioration of our waterways and particularly as ocean temperatures rise.

6/ The promised success of RFHs in drawing increased visitor numbers causes for a re-evaluation of how vehicle and camping permits should be issued for Cooloola and Fraser Island. Large numbers of visitors in these locations at any one time such as during the tailor spawning migration is counterproductive to species recovery and diminishes visitor experience levels and degrades the natural attributes of these locations. I strongly recommend the issuing of permits on a maximum quota per month basis in order to spread visitor numbers over the year more evenly. This allows for one of the intended benefits associated with vehicle permits for Cooloola to occur in reducing traffic flow along the beach and to manage an increase in visitor numbers resulting from RFHs.

Conclusion:

The beach netting of Cooloola and Fraser Island has been a controversial issue for many years. Conflict between recreational and commercial fishers dates back to the 1960s and shows no indications of lessening while fish stocks continue to plummet and competition for the remaining resource increases.

The time has arrived where the interests of Queenslanders and Australians, the inshore fish stocks and that of the seabirds, dolphins, turtles and humpback whales must come first.

As it stands, viability of the commercial fishery is nearing a point where the beach hauler will soon be forced to hang up his nets and look for alternative employment. At that point, it is too late for the recovery of the fishery and the dependent species which we all want to see protected now. I speak for all of us who desperately do not want to see such a situation occur.

I encourage our State Government to buy back the existing commercial licences and allow for Cooloola and Fraser Island to prosper in providing both the fantastic natural amenities that has caused the region to be world renowned and the economic benefits that only a net free region can now deliver.

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