

ORAL HISTORIES COMPLEMENT AND EXTEND TEMPORAL KNOWLEDGE OF COASTAL EROSION AND ESTUARINE INFILL IN THE SOLITARY ISLANDS MARINE PARK

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Abstract

Natural resource managers rely on quantitative data to identify, monitor and manage environmental change in coastal landscapes along the NSW coast. This knowledge is essential to address issues such as beach erosion. However, long-term data sets are limited, particularly in regional areas such as northern NSW, where coastal process studies did not commence until the 1970s. Coastal residents have observed environmental change over decadal scales, with some recalling changes that pre-date any formal research or monitoring. In the Solitary Islands Marine Park (SIMP), northern NSW Australia, 60 semi-structured oral history interviews undertaken since 2012 recollect environmental condition as far back as the 1930s. When oral history participants were asked if they had observed any changes in the SIMP over time, coastal erosion and/or estuarine infilling were raised by the majority of participants. Beach erosion was most often recounted at Park Beach, Coffs Harbour and estuarine infilling at nearby Coffs Creek. The cause of beach erosion in the SIMP, according to participants, was due to the installation of infrastructure such as breakwalls, sand mining, and/or extreme weather events. The cause of estuarine infill was often perceived to be associated with gradual natural infilling, the modification of creek mouths and/or adjacent land uses. Most participants relayed disappointment in the changing foreshores and estuaries as it affected their cultural practices, livelihoods or recreational pursuits, as well as a loss of visual amenity. Local long-term knowledge and recounted memories, considered in conjunction with data from contemporary studies, can provide (i) an insight into environmental condition prior to formal monitoring, (ii) perceptions of environmental change, and (iii) how these changes impact upon individuals and communities. Reflecting on the past, through oral histories, can assist in formulating future management strategies that better address social, cultural and economic impacts associated with coastal erosion and estuarine infilling.

Introduction

Assessing coastal change is a current focus of researchers and natural resource managers involved in coastal management. Understanding the processes involved can help to better plan for and mitigate impacts on coastal residents, as well as help protect the natural environment. The impact of beach erosion can have serious social and economic implications for residents who live on coastal foreshores, due to potential or actual loss of their land, damage to infrastructure (public and private) or loss of public amenity (Office of Environment and Heritage 2014). Likewise, the accumulation of sediment in a productive

coastal waterway can reduce water depth, increase progradation of shallow areas, change substratum types and smother vegetation (Brooke 2008), and in turn affect commercial and recreational activities.

However, long term coastal process data on which to increase understanding of temporal change, is limited. It wasn't until the 1960s and 1970s that scientists started conducting and publishing systematic studies on coastal systems in NSW, with the majority of early studies in NSW conducted in the Sydney and southern NSW region (Short 2016). In northern NSW, some of the initial studies were conducted by engineers in the mid to late 1970s investigating sediment distribution in major coastal rivers in northern NSW (Roy and Crawford 1997), erosion at Bryon Bay and Hastings Point (Gordon, Lord and Nolan 1978) and coastal processes in Coffs Harbour (Lord and Van Kerkvoort 1981). The latter study commenced in response to "proposed coastal development and recurring erosion problems" and the associated literature review found very limited published information on coastal erosion for the study area at the time of investigation.

Oral history interviews with long term residents can provide a qualitative approach to understanding long term environmental change in the absence of targeted research (Lane 1997). They can also add a personal perspective to quantitative research findings through observations and experience, on the extent of environmental change and the impact of change on people's lifestyles, livelihoods and the broader community (Johannes and Neis 2007; Lane 1997). Robertson et al. (2000) suggest that local knowledge should be accorded equal importance to scientific knowledge with regard to detecting environmental change. Public observations and experiences are also important when developing strategies to address impacts and restore impaired ecosystems as personal accounts can influence decision makers (Alam 2011).

Using semi-structured oral history interviews, our study explores the perceptions of long-term residents regarding environmental conditions in the SIMP prior to formal monitoring, observed environmental changes specific to coastal erosion and estuarine infill, and how these changes can affect lifestyles and livelihoods. We review relevant quantitative research and related studies associated with coastal erosion and estuarine infill in the SIMP to understand how oral histories can contribute to current knowledge. We show that oral histories can complement and extend temporal knowledge of coastal erosion and estuarine infill and also provide valuable information on the impacts associated with these changes.

Methods

Study area

The Solitary Islands Marine Park (SIMP) in northern NSW Australia (Figure 1) is one of six marine parks in NSW. The SIMP extends from Muttonbird Island at Coffs Harbour, north approximately 75 kilometres to Plover Island at Sandon. It includes the beaches and headlands to the mean high water mark and estuaries to their tidal limits as well as offshore three nautical miles to the limit of State waters.



Figure 1. Location of the Solitary Islands Marine Park, NSW, Australia. Pink = Sanctuary Zone, Yellow = Habitat Protection Zone, Blue = General Use Zone. Green = Nature Reserve and National Parks estate

Semi-structured, in-depth oral history interviews were undertaken with 60 people who have connections to the SIMP. These interviews commenced in May 2012 and are ongoing; however, preliminary results from the first 60 participants are included in this paper. The use of oral history interviews enabled participants to reflect on their experiences and observations in the Solitaries region over time, including changes in the land and seascape and associated impacts. The key theme relevant to this study explored in interviews was the change that participants had observed over time (environmental, social, economic or cultural). Participants were selected based on: 1) their place of residence or interest in order to represent the full extent of the SIMP; and, 2) their primary activity of interest in order to include a wide range of stakeholder groups (Table 1). Interviews were recorded on video and hand-held voice recorder and then transcribed verbatim. To ensure accuracy in reporting, participants were requested to check their transcript and video.

Table 1. SIMP oral history participant's primary interest group and place of residence

Primary Interest	Number of participants	Location			
Commercial Fishing	11	Coffs Harbour	4	Wooli	1
		Minnie Water	2	Arararra	1
		Sandon	1	Yamba	1
		Woolgoolga	1		
Aboriginal Culture	8	Coffs Harbour	3	Yamba	1
		Arararra	3	Moonee	1
Marine Science	7	Coffs Harbour	3	Regional NSW	1
		Townsville	2	Sydney	1
Recreational Fishing	6	Coffs Harbour	2	Wooli	1
		Woolgoolga	1	Minnie Water	1
		Sandon	1		
Commercial Operators	6	Coffs Harbour	4	Arararra	2
Surfing	5	Coffs Harbour	3	Sandy Beach	1
		Arararra	1		
Diving	5	Red Rock	2	Toowoomba	1
		Coffs Harbour	2		
Residents	4	Minnie Water	2	Moonee	1
		Red Rock	1		
DPI Staff	3	Coffs Harbour	2	Broken Head	1
Surf Lifesaving	2	Coffs Harbour	2		
Sailing / Boating	2	Coffs Harbour	2		
Lighthouse Keeper	1	Central Coast	1		

The epistemological approach guiding the broader qualitative research project was interpretive, to explore participants observations and experiences. The data was coded into nodes and sub-nodes using Nvivo 10, to identify key relationships and themes. 'Changes observed over time' was a key theme coded from the transcripts in an iterative process and given a primary node. Sub-nodes then included: environmental changes, land use change, and socio-economic / technological change. Cultural changes were coded in these sub-nodes where relevant and Aboriginal culture sub-nodes. Two of the environmental change sub-nodes are specific to this study: foreshore erosion and estuarine sedimentation. Recollections were collated within sub-nodes and a narrative formulated. Some participants

recalled more than one change and these were recorded in their respective nodes and sub-nodes, therefore, the total number of responses was not limited to 60 (one per participant).

A literature review was conducted as part of this paper to identify what research and studies have been conducted into coastal processes in NSW generally and the SIMP in particular. It also sourced other historic accounts, including maps and photographs, to complement the recollections of the participants.

Results and Discussion

Of the 60 participants interviewed so far, the top five environmental changes recollected by participants were in relation to fish stocks (37), humpback whale numbers (31), estuarine sedimentation (30), coastal erosion (22) and climate change / warming water (17). Hence, both estuarine sedimentation and coastal erosion were among those changes that, in particular, generated memories.

Coastal Erosion

The earliest memories of foreshore condition dated back to the 1930s although the majority of observations regarding beach erosion were observed after 1950 and in particular during the 1970s. Cyclone Zoe in 1974 figured strongly in the recollections and caused severe beach erosion in northern NSW (BMT WBM 2011). Participants consistently estimated distances for dune retreat in the order of 10s of metres with some in the 100s of metres since the 1950s. Variability is expected due to natural differences within and between beaches. Of the 12 primary interest groups represented in the study, only three did not comment on coastal erosion. Coastal erosion was reported as occurring on beaches along much of the SIMP's 75 km foreshore.

One of the early observations came from Barbara Knox. Barbara and her husband Keith first arrived in Minnie Water in 1952 and recalled a foreshore with "houses on the beach, a road and space to park two vehicles out the front" before the foreshore was lost to erosion. Overall, Barbara estimates about 20m has eroded between 1952 and 2012. She suggests rocks placed at the bottom of the road to Minnie Water Lagoon (southern end of Minnie Water Beach) did help to hold the remaining foreshore in place at that location but states "now the water is chewing in up here (northern end of Minnie Water Beach)". Ronny Fuller, born in 1941, lived in the Wooli area until 1949 before moving to Minnie Water (initially known as Wire Fence) where he still resides. Ronny is adamant the beach has changed and suggests the "bank has gone back 200 yards (~180m) where we used to live", which was one of the houses along Minnie Water Beach foreshore that Barbara referred to. He provided an old photo that shows a grassy foreshore in front of the houses that is no longer there (Figure 2).



Figure 2. Ron, Lyall (father) and Clarice Fuller in 1947 on the Minnie Water foreshore (Photo courtesy of Ron Fuller).

Lola Fuller (Ronny's mum), born in 1920, moved to Minnie Water in about 1939. Only one man lived there and then moved away leaving the Fullers as the only family in Minnie Waters for years, although during the war she spent time in Wooli with her young family. Lola spoke about sand mining on Minnie Water Beach, which is an activity generally associated with dune destruction and a contributor to coastal erosion (Kemp 2011). However, Lola recollects sand mining very fondly and says "We had a good life there [Minnie Water] and the sand mining was tremendous". She recalls they sand mined the beach in 1940 for about seven or eight months, down past where the houses were and said "it was really great to see it, there were a lot of men working there...The sand mining was one of the loveliest things I've ever seen there...as they all camped there and it was really, really nice to meet people". So, the social aspect of sand mining (i.e. increased number of people) in a small, remote coastal village was viewed positively by Lola.

Formal records of sand mining in the Minnie Water area are limited, and indicate mining was mainly conducted during the 1960s and 1970s (Tuck 2007). However Lola's vivid memory and feelings associated with the activity in the village are likely more reliable, suggesting sourced site specific records are incomplete. Watt (1973) noted that sand mining in northern NSW generally commenced in 1933 but production was small until the second world war where demand for rutile dramatically increased.

Sand mining was raised by Rus Glover, an avid surfer throughout the 1970s, as having a huge impact on many SIMP beaches. He says it not only exacerbated coastal erosion (north of Emerald Beach) but also changed the visual amenity of Sandy Beach from “rolling sand hills, vegetation, beautiful lovely flat beach” to “a flat reserve along the back...and a large sand blow between Back Sandy Beach and Sandy Beach”. Rus believes “sand mining probably had the biggest effect on our actual coastal system along here” and also mentions the impact on Arrawarra Beach, Corindi Beach and Moonee Beach. Rus recalls as a teenager, walking around the edge of a very large sand dune and known Aboriginal midden, 50 or 60 m high, to get to one of his favourite surf spots at Moonee Beach. Rus acknowledges the tremendous value of that midden in terms of Aboriginal culture, and laments its’ loss when it was flattened by sand miners. Kemp (2011) states that sand mining destroyed many archeological sites, including Aboriginal middens and camp sites along the NSW coast.

Rus believes that coastal erosion has been gradual over the last 40-50 years and it is therefore hard for people to realise the extent of the erosion. There is a common term for this called ‘shifting baselines’ where each new generation has a new perception of what is the norm. Rus witnessed the loss of a car park at Macauleys Headland in Coffs Harbour due to coastal erosion and a road in front of the Coffs Harbour Surf Lifesaving Club at Park Beach. He estimates at Park Beach “35 metres has gone in my time”. Bob Palmer, born and raised at the Coffs Harbour Jetty was also a keen surfer and he too mentioned the road down to the Surf Club and how the sand dune between the beach and the road eroded away and “eventually they closed off the road because of ongoing erosion”. Both Rus and Bob observed the impacts of extreme weather events in the 1970s on local beaches and the loss of a wooden shark tower at the Coffs Harbour Surf Lifesaving Club. Bob Palmer recalls Cyclone Zoe vividly in 1974 as he recounted surfing “the largest surf ever surfed in Coffs Harbour” off Park Beach with friend Keith at the time of the cyclone, and that Cyclone Zoe was responsible for washing away “a massive sand dune [from Macauleys Headland to Park Beach] that probably extended another two, three hundred metres further out”.

One of the earliest recollections in the Coffs Harbour region was by Bob’s father, Bill Palmer, who arrived in Coffs Harbour in 1945 as a 14 year old and remembers the newly constructed Coffs Harbour outer breakwalls (built between 1914 and 1946) (Figures 3a. and 3b.). Now, reflecting upon the last 70 years living at Coffs Harbour Jetty, he suggests the breakwalls “changed everything” and resulted in the subsequent loss of sand on Park Beach. Quantitative studies indicate that the northerly sand transport rate along the Coffs Coast is approximately 75,000 m³/year but note that the breakwalls intercept nearly all of this sand, preventing it from nourishing the beaches to the north of Coffs Harbour (BMT WBM 2009). Participants estimated beach recession north of the Coffs Harbour breakwall to range between 10-300 m. At interview in 2012, Harvey Lee estimated 10-15 m had eroded at Diggers Beach (a protected beach directly north of Park Beach). Using photogrammetry, Lord and Van Kerkvoort (1981) determined that the extent of erosion at Diggers Beach between 1969 and 1980 was in the order of 3-19 m. Using historic surveys they estimate Campbells Beach (5 km north of the harbour breakwalls) has receded between 50-100 m since 1884, and attribute erosion in this region to the construction of the harbour breakwalls. Variability in reporting is expected due to natural differences within and between beaches, but all sources suggest a similar degree of change. Lane (1997) found through oral histories in the Tumut region, when determining environmental change that included creeks, there is

“a reasonable degree of compliance between what science predicts and what local people have observed”.



Figure 3a. Early construction of the northern breakwall in ~1926, showing Park Beach (south) and Coffs Creek mouth (Photo courtesy of the Coffs Harbour Regional Museum).



Figure 3b. Aerial view of the harbour in 1946, including Park Beach (south) and Coffs Creek mouth (Photo courtesy of the Coffs Harbour Regional Museum).

Other observations of coastal erosion include commercial fisher Darcy Wright who launched his fishing boat off Arrawarra Beach almost daily for over 25 years and estimated that the “bank [on Arrawarra Beach] has eaten back 35 feet (~10 metres) since 1985”. Uncle Milton Duroux, Gumbaynggirr Elder who has lived in the Arrawarra / Corindi Beach area for over 40 years also observed at interview that “the coast, the dunes are all deteriorating” and specifically mentions the loss of an important midden on Arrawarra Beach near the Aboriginal stone fish traps. Similarly, Uncle Tony Perkins, another Gumbaynggirr Elder who was born sometime in the 1940s and called the beaches between Minnie Water and Moonee Beach home, recalled a changing coastline stating “Erosion for starters is to me speeding up compared to when I was a child, looking at certain areas and little bays that we’d fish and so forth, so yeah, there is big changes that I see are happening with coastal erosion for starters”. Aunty Deborah Dootson and her sister Aunty Noleen Dootson grew up in a small Aboriginal settlement on Corindi Beach called ‘No Mans Land’. They spent their early years playing on the beaches between Red Rock and Arrawarra and catching fresh seafood and recall extensive sand dunes with “three car tracks on top of the sand dunes, now there’s none, you can’t even get a track up there”.

Importantly however, not all participants who commented on erosion as an environmental change believed that it was an ongoing issue in the SIMP. Commercial fisher Alan Johnson, who moved to the Sandon River in 1969, recalled that in about 1977, following cyclones, he had waves coming over the beach terrace at the Sandon into his backyard causing a “15 foot (approximately 4.5 m) drop straight down to the beach”. Alan now states “...it has all

grown up with trees again and I suppose one day it will wash away again". Jack Blackman, a long term recreational fisher at Sandon since the 1950s also notes at interview that the sand on Sandon Beach, being the main road into the village, "comes and goes" exposing rock from time to time. The cycle of sand loss and replenishment was also observed by Alan Robinson, a trap and line commercial fisherman in the Coffs Harbour region, who recalled being able to drive his boat over the sand spit between Little Muttonbird Island and Park Beach on occasions.

Participants that commented on coastal erosion as a change were generally involved in activities that involved substantial time on beaches such as gathering food for their Elders, surfing, launching fishing boats, or were long term residents in an area who lived very close to the beach. Many of these participants have early recollections of a very different coastal environment than today upon which to compare 'then' and 'now'. Although the extent of erosion in locations varies between participants, there is a repeated theme of observed coastal erosion during a person's living memory with limited accounts of any accretion, which strongly indicates coastal erosion is occurring along the SIMP foreshores. Two participants were reluctant to put a figure on the extent of erosion and suggest that formal monitoring would be a more accurate way to determine the extent of erosion. Terry Maher acknowledged "how time can play tricks on your memory, there's no doubt about that, so it is a bit hard to know exactly how much the dunes have moved over time I guess just by observation". Memory is trained to remember what is relevant to the individual, which makes memory more subjective but more detailed and the accuracy of memory is influenced by many factors: how long ago the event was; the emotional connection to the event; the value of the memory for the individual; and uniqueness (Fernbach and Narin 2007). Subsequent experiences, including changed circumstances and social attitudes, the political environment, absorption of relevant information coming from later sources such as historical books and films, and the individual psyche also affect oral history accounts (Douglas, Roberts and Thompson 1988; Truesdell 2001). While it is acknowledged memory is subjective, early quantitative studies may be inaccurate or incomplete. Photogrammetry for instance can be inaccurate due to errors occurring during image acquisition, rectification and interpretation (Meehan 2005); and historic sand mining records in northern NSW appear to omit early mining activity prior to, and during World War II.

Memories can also reveal quite strong feelings associated with events or activities. Sadness was expressed by Barbara Knox at the loss of sand from Minnie Water Beach as Pandanus trees were washing away, and a once sandy beach was now just stones. The loss of sand on Park Beach observed by participants was not noted as particularly distressing to the individual, but has impacted infrastructure such as roads, a car park and a shark observation tower, which has financial implications for government. Fear was relayed by Lola Fuller, with regard to owning a house on the Wooli Terrace, a known coastal erosion hot spot in recent years, with the belief that "those houses [on the Terrace] will end up over in the river [Wooli Wooli River on the western side of the Terrace]". The issue of coastal erosion in Wooli is ongoing and affecting the social wellbeing in the community.

Aboriginal cultural values have also been impacted significantly by coastal erosion. Most notable is the loss of material from middens in coastal dunes which is a loss of 'unearthed' traditional knowledge, significant artifacts or burial sites, which can never be reclaimed. Dissatisfaction is relayed at the loss of lifestyle, whereby the erosion of extensive sand

dunes impacts the viability and protection of nearby camps, collection of food and conduct of cultural practices.

Both qualitative and quantitative studies indicate beach erosion is occurring on SIMP beaches at varying degrees, on particular beaches north of Coffs Harbour. Beach erosion in SIMP was either noted as gradual and attributed to infrastructure such as breakwalls; or planned as a consequence of sand mining; or a rapid loss of sand during extreme weather events such as Cyclone Zoe in 1974, resulting in a range of environmental, social, economic and cultural impacts.

Estuarine sedimentation

Similar to coastal erosion, some of the earliest memories associated with estuarine condition date back to the 1930s. Estuaries were recollected fondly by most participants as a place they spent their childhood and were therefore very familiar with their respective waterway. They were places important for recreation, resource collection and in some cases supported early commercial fishing endeavors. Sedimentation was most often recollected in the southern SIMP estuaries or coastal lakes, in particular Coffs Creek. Participants believed sedimentation was associated with either gradual natural infill, the modification of creek mouths and/or adjacent land uses. All 12 primary interest groups commented on estuarine sedimentation as an environmental change except the lighthouse keeper.

Local Aboriginal people have observed an increase in sediment in SIMP waterways in their lifetime, but also refer to knowledge passed on from the old people about the condition of the local creeks and estuaries many generations ago.

I've seen too many creeks and estuaries just silting up, you know. The old people spoke about how big these estuaries were, the creeks, how deep and narrow they actually were, yeah not so much wide and silted up like they are now. Uncle Mark Flanders, Gumbaynggirr Elder.

Small coastal creeks or lakes, as well as the larger estuaries in the SIMP are culturally important. Changes to these dynamic coastal environments are not unexpected as they are subject to many natural influences such as wind, wave, tide and flooding. However, several Aboriginal Elders suggest adjacent land use has modified these waterways. Uncle Tony Hart recalled fondly the times he spent as a child in the coastal lake at the northern end of Diggers Beach (currently in the grounds of Aanuka Resort) and describes it as “deep, yeah, and there were certain days it was just pure green, it was just so clean”. This is also the location of his most memorable moment where he caught 18 really big prawns with his bare hands. Similarly, sisters Aunty Deborah Dootson and Aunty Noleen Dootson recall Pipe Clay Lake (known as The Lake) at Corindi as more tidal and much bigger and “just green and blue, deep...it's not as clean as it used to be”. They reminisced about staying at the lake for ages catching prawns and crabs “and you could eat them, but now I think with the development it is not the same”. Perceptions of deeper coastal lakes may be associated with that fact that as a child waterways seemed deeper, although, adjacent urban land uses in

these locations is likely to have resulted in increased sedimentation and reduced water depth.

Uncle Mark Flanders recalls growing up on Coffs Creek as “probably some of the greatest moments in my life” and described Coffs Creek as “much deeper back then”. He attributes the change in the creek and increased sedimentation to surrounding development “they discovered concrete in the eighties (1980s) and they haven’t stopped, development went crazy”. Coffs Creek was the subject of most comments regarding the siltation of estuaries. Coffs Creek has, and continues to be, an area of high use by many people for varied activities and therefore changes are more likely to be reported in this location. Local long-term resident and surf lifesaver John Mills recalled as a youngster in the 1930s catching “50 or 60 prawns [in Coffs Creek] in your two hands, they were that thick” but now acknowledges “the creek is a lot different to when I was a young bloke...it was deeper than 10 feet of water, you’d walk across on your knees now”. Interestingly, he also witnessed the placement of barbed wire along Park Beach and Coffs Creek during World War II due to the heightened risk of Japanese attack (Figure 4) and believes this “stopped the flow of the creek for a year or two”.



Figure 4. Barbed wire placed on Park Beach and across Coffs Creek during World War II (Photo courtesy of the Coffs Harbour Regional Museum).

Many other residents recollected Coffs Creek being much deeper, with Bill and Ruth Palmer stating “the water was so deep, and the sand bank wasn’t there near the Pet Porpoise Pool (now Dolphin Marine Magic), it was all water and no mangroves”. They, and other participants, recalled a swimming pool and diving board located near the site of the current Promenade (old butter factory) where swimming carnivals and exhibition swims were held that attracted visiting swimming champions such as John Konrads, Ilsa Konrads, Lorraine Crapp and John Henricks. In 1946 commercial fisherman Keith Anderson also recalled a much deeper creek where he hauled mullet and could “often get eighty, a hundred box of mullet”, and stated the nearby railway bridge at the mouth of the creek “used to be on piers

and that was easy, 200 metres long...half a mile across". Keith attributes the siltation of Coffs Creek to the modifications of the creek mouth when building the new bridge "they made the bridge about a quarter of what it was...and the water loses its speed, its momentum, and it drops its silt". Bill and Ruth Palmer also suggested that the "siltation of the creek mainly happened when the rail bridge and the road bridge over the creek (replacing the old wooden bridge) were built [1966 and 1950 respectively]...they built the approaches up, both for the rail bridge and the road bridge and they choked the creek at that point, it narrowed the water flow". This was also summed up well by long-term resident Lionel Innes (and depicted in Figures 5a and 5b):

The reason it silted up was because they shortened the span, they put the new bridge in and they shortened the span up one or two spans, and with that, silted the bloody creek up. Before that it was quite good...used to be 20 foot of water there...little 20 footers [vessels] used to go up under there and that is why the [old] bridge had a hump in it, cause they used to drop their masts and they'd go under it. Lionel Innes, Recreational Fisher.



**Figure 5a. Unidentified people standing on the railway bridge ~1925
(Photo courtesy of the Coffs Harbour Regional Museum).**



Figure 5b. The same perspective of the rail bridge with the road bridge in the foreground, Coffs Creek, 12 October 2016.

Lionel also noted a significant loss of seagrass from the creek and an increase in mangroves. The effects of a shallower creek have impacted boating and fishing in the creek. John Wait, a local resident, sailor and commercial fisher recalls a time commercial fishers moored their boats outside the front door their houses. At that time five fishermen lived on the bank of Coffs Creek where Dolphin Marine Magic is now and would take their boats out of the creek and go fishing offshore. Ron Rigdon, a local long-term commercial fisher, has a very similar recollection of a deep creek, no sand banks and five fishing families living on the creek, but suggests “you couldn’t make a living out of it now cause it is all silted up”. With sedimentation, commercial fishing in the creek became less viable, and the capacity to moor offshore fishing vessels was lost. A commercial lobster trapper Ron Stewart, who still fishes today, has noticed the impact of sediment coming out of the creek “We do get a lot of siltation from Coffs Creek [on the adjacent inshore reefs] and that definitely turns the lobsters off, it might even move them actually...and sometimes the lobster pots will be covered in mud for weeks and weeks then gradually it will settle down”. He noted that sediment may be worse at Coffs Creek as opposed to Moonee Creek due to higher levels of land development in the Coffs Creek catchment.

Reports of estuarine sedimentation were not confined to Coffs Creek. There were several references to increased sedimentation in Moonee Creek, which is joined on its eastern side by Moonee Beach Nature Reserve. Rus Glover noted that “Moonee Creek has completely changed” as, when he was a teenager in the 1960s it was deep enough to freeboard [water ski on a surfboard] behind the Anderson’s Hartley half cabin (vessel). He believes the first

change to the Pacific Highway in the 1970s is when he noticed the sediment load coming into Moonee Creek. He also observed a loss of seagrass and increase in mangrove distribution. Similarly, Rus and a Woolgoolga local recalled Woolgoolga Lake being much deeper in the 1960s. They recounted water skiing occurring in the lake saying “it was deep enough to have a ski jump in, you can’t do that now” and attribute the subsequent infilling to either gradual natural infilling over thousands of years, the housing development on the south side of the lake, and/or the change in the Pacific Highway.

The Wooli Wooli River was also mentioned by several participants as a river that has silted up. Commercial fisher and long term resident Bob Howard said “the fact that the breakwall is there, the river doesn’t flow like it used to and all the big deep holes have gradually silted up, the sand boils up with the waves on the bar and pushes in with the run-out tide, but only about ninety-eight percent of that comes out, so over a period of time those holes do silt up”. He also mentions the influence of droughts and flooding rains on sedimentation over the years. Bob mostly refers to the Wooli breakwall as a contributing factor to sedimentation in the downstream region of the river but acknowledges the role the breakwall, which was completed in 1972, to cater for an expanding fishing fleet in the port of Wooli (Figures 6a and 6b). The Wooli Wooli River catchment falls almost entirely in Yuraygir National Park and is therefore not impacted by large scale development, industry or other adjacent land uses.



**Figure 6a. Wooli Wooli River mouth before the breakwall was built
(Photo courtesy of Bob Howard).**



Figure 6b. Woolli Woolli River with the current breakwall, 2012.

There were no reports from any participant that the rivers were getting deeper over time, but two participants mentioned shifting sands, as opposed to increasing sediment in rivers, causing channels to move. One recreational fisher in Woolli, Richard Taffs, noted a benefit with increased sedimentation, stating “In terms of change, one of the positive things, as a lover of mangroves is we’re seeing an increase in the mangrove population because the sedimentation actually favours them”.

The repeated accounts of increased siltation in SIMP estuaries suggest that this environmental change is valid. There has been limited targeted research in the SIMP which specifically looks at the extent and cause of siltation in local waterways. Sawtell (2002) investigated historical changes in estuarine vegetation and land use in a number of estuaries around Coffs Harbour, observed from aerial photographs. Estuary Management Plans and Coastal Zone Management Plans commissioned by Local Government assess stream conditions but generally derive their findings from photogrammetry and past surveys.

Observations of change were often gradual but generally attributed to an activity or action such as building public infrastructure. Development was also implicated in increased sediment loads by participants. Sawtell (2002) noted significant changes to vegetation in and around Coffs Creek between the years 1954 and 1994 which were likely linked to development of the catchment. He found that the extent and location of seagrass fluctuated during this period, mangroves increased by 78% and saltmarsh reduced by 79%. During this period, housing in the Coffs Creek catchment increased by 249% and banana cultivation peaked in 1974 with 490ha in cultivation. Development and horticulture in the broader Coffs Creek catchment, including steep lands, is likely to have significantly increased sedimentation loads into Coffs Creek. Increased fluvial sand and silt loads entering from upstream catchments will cause sedimentation although infilling of coastal estuaries also occurs from marine sands making their way into the lower estuary. Sedimentation is a natural process but human activities can increase the speed at which it takes place (Sawtell 2002). The majority of observations relating to increased estuarine infill were in the southern

half of the SIMP, which coincides with the majority of urban settlement. The northern half of the SIMP is adjacent to Yuraygir National Park, with only a few small coastal villages located sporadically along the northern SIMP coastline.

Through oral accounts, sedimentation was identified as an environmental change that is impacting upon environmental, social, economic and cultural values and caused by either gradual natural infill, the modification of creek mouths and/or adjacent land uses. Further research on the nature and extent of estuarine infill in SIMP waterways is required to improve understanding and enhance estuarine ecosystem health and social well-being.

Conclusion

When developing future coastal management strategies, the consideration of oral histories is beneficial. They provide a historical perspective from people who know their coastline intimately and can provide a narrative associated with their experiences and feelings about environmental change, including coastal erosion and estuarine sedimentation. Oral histories can also reveal broader social, economic and cultural impacts (or benefits) that result from such changes. Recollections from long term residents in the SIMP have added a 'human element' into the story of a changing coastline and complement quantitative research, monitoring and modelling. In combination, oral histories and coastal process research can provide a more complete picture of environmental changes upon which to base future management decisions.

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