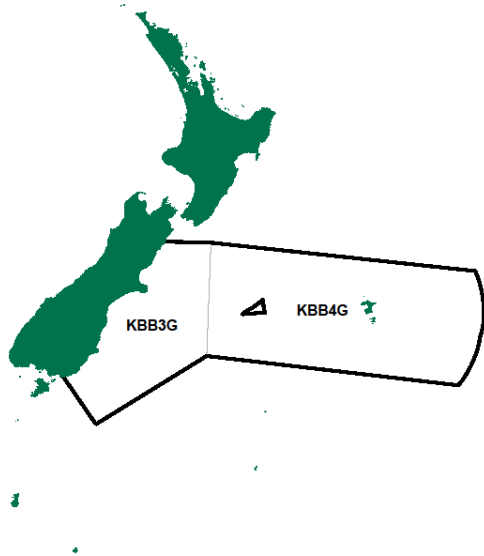# BLADDER KELP ATTACHED (KBB G)

(Macrocystis pyrifera)

1. FISHERY SUMMARY

Attached bladder kelp (KBB G) was introduced into the Quota Management System (QMS) on 1 October 2010, within FMA 3 and FMA 4 only which have the reporting codes KBB 3G and KBB 4G, respectively. The Total Allowable Catch (TAC), commercial, recreational, customary and other mortality allowances issued to KBB G on entering the QMS, and which remain unchanged, are presented in Table 1.

Bladder kelp, like all other large seaweeds, occurs in one of three states: attached (growing on the substrate); free-floating; and beach-cast. The attached growing state of bladder kelp is the only state managed under the QMS. MPI will continue to monitor the use of beach-cast and free-floating seaweeds in FMAs 3 and 4, and will reconsider introducing these states into the QMS if sustainability and utilisation risks are identified in the future. Separate codes refer to beach cast bladder kelp in FMA 3 (KBB 3B) and free-floating bladder kelp in FMA 3 and 4 (KBB 3F and KBB 4F). Unless explicitly stated, this section refers only to attached bladder kelp.

Table 1: Total Allowable Catch (TAC, t), Total Allowable Commercial Catches (TACC, t), customary non-commercial (t), recreational, and other mortality allowances for attached bladder kelp on entering the QMS on 1 October 2010.

Fishstock	TAC	TACC	Customary Non-commercial	Recreational	Other Mortality
KBB 3G	1 238	1 236	0.1	0.1	1
KBB 4G	274	272	0.1	0.1	

1.1 Commercial fisheries

Bladder kelp has been used as a dietary supplement, fertilizer, cultivation for bioremediation purposes, as well as abalone and sea urchin feed (Buschmann et al 2006, Gutierrez et al 2006). There is current research evaluating the utilization of bladder kelp as feed for other aquaculture species such as shrimps (Buschmann et al 2006, Cruz-Suárez et al 2006), as well as an evaluation as a possible feedstock for conversion into ethanol for biofuel use (Wargacki et al 2012). Because of the growing demand for bladder kelp, MPI considered the bladder kelp resource requires active management to ensure its sustainable use, and that management under the QMS was the most appropriate mechanism.

The season for commercial harvest of KBB G has been established between 1 October and 30 September, and catch is measured in greenweight (t).

Restrictions on New Zealand harvests of KBB G have been based on the Californian fishery (where the majority of research into harvesting effects has been conducted) and modified to take into account differences between California and New Zealand. These differences, compared to the Californian fishery, include reduced nutrients in New Zealand waters, the shallower depth at which KBB G is harvested in New Zealand, and the lack of information on New Zealand stocks.

The single restriction on KBB G harvest, implemented on introduction to the QMS on 1 October 2010, is a maximum cutting depth of 1.2 m; details can be found in the Minister's letter on the MPI website.

Harvest of KBB G mainly occurs in QMA3 and has varied since 2001–02 from 3 to 105 t (Table 2). Landings of KBB G in QMA 4 are minimal, with 2.47 t reported in the last 13 years (Table 2).

Table 2: Reported landings for KBB G in greenweight (t) by fishing year. Blank cells indicate nil catches. Values above and below the horizontal line represent historic landings prior to QMS introduction and landings post QMS introduction, respectively. * Pre 2010 landings in KBB 3G include a combination of beach cast, free-floating and attached bladder kelp. Pre 2010 landings in KBB 4G may include a combination of free-floating and attached bladder kelp. Post 2010, the reported landings are for attached bladder kelp only.

Fishing Year	KBB 3G	KBB 4G	TACC KBB 3G	TACC KBB 4G
2001–02	104.50*	0.37*		
2002–03	37.00*			
2003–04	7.53*			
2004–05	17.90*			
2005–06	2.82*			
2006–07	8.35*			
2007–08	6.43*	2.10*		
2008–09	63.50*			
2009–10	28.37*			
2010–11	53.34		1 236	272
2011–12	34.25		1 236	272
2012–13	35.00		1 236	273
2013–14	94.00	0.00	1 236	273
2014–15	62.00	<1.00	1 236	273

1.2 Recreational fisheries

There is no quantitative estimate of recreational harvest of bladder kelp at this time, although it is assumed to be restricted to the collection of beach-cast seaweed for composting. Consequently, recreational harvest of attached bladder kelp is assumed to be negligible.

1.3 Customary non-commercial fisheries

The harvest of bladder kelp by customary Maori is currently unrestricted. There is no quantitative information on the extent of customary harvest of attached bladder kelp (or any other state) in FMAs 3 and 4; however, the customary harvest of attached bladder kelp is likely to be negligible.

1.4 Illegal catch

Since introducing KBB G into the QMS, there is no quantitative or qualitative measure of illegal catch for bladder kelp.

1.5 Other sources of mortality

Hydrographic factors (e.g., tidal surge, nutrient limitation, temperature and salinity stress) and biological processes have been demonstrated to result in significant mortality of bladder kelp in the southern hemisphere (Buschmann et al 2004, 2006). Californian and Chilean studies have shown that grazing by sea urchins can result in the detachment of adult plants and their removal from the population (Dayton 1985a, Tegner et al 1995), and/or the removal of recruits and juvenile plants (Dean et al 1984, 1988, Vásquez et al 2006). In Chile, infestations of bladder kelp holdfasts by crustaceans (e.g., amphipods and isopods) may increase mortality by decreasing attachment strength (Ojeda & Santelices 1984).
Due to their large size and high drag, adult bladder kelp are vulnerable to removal by high water motion (Dayton et al 1984, Seymour et al 1989, Schiel et al 1995, Fyfe & Israel 1996, Graham et al 1997, Fyfe

et al 1999), which is considered the primary agent of mortality. In 1994, Fyfe et al (1999) found that winter storms extensively removed floating surface canopies at Pleasant River (north of Dunedin), and that by February 1995, 50% of surface canopies had reformed. High seasonal and year-to-year variability in wave intensity and plant biomass results in high intra- and inter- annual variability in mortality. In California, uprooted plants may become entangled with attached plants, increasing drag and the likelihood of detachment, which may result in a 'snowball effect' capable of clearing large swaths in the local population (Dayton et al 1984). For example, Seymour et al (1989) observed that mortality of bladder kelp in California due to storm-induced plant detachment and entangled was as great as 94%. Graham et al (1997) observed that bladder kelp holdfast growth in California decreased significantly along a gradient of increasing wave exposure, possibly due to greater disturbance to the bladder kelp surface canopy, which reduces holdfast growth (Barilotti et al 1985, McClenenghan & Houk 1985). Thus, increased water motion and decreased holdfast strength can act in combination to decrease plant survival.

Sedimentation can also increase bladder kelp mortality – movement of bottom sediments can scour or bury bladder kelp spores and recruits, and the resuspension of sediments can reduce the amount of light reaching sub-canopy algae, preventing the attachment and development of spores, and inhibiting the growth of bladder kelp recruits (Dean & Jacobson 1984, Pirker 2000).

Over large spatial scales, elevated temperature also appears to be a major influence on bladder kelp mortality, and is likely to limit the northern distribution of bladder kelp within New Zealand (Hay 1990). For example, Hay (1990) described an apparent retraction of the distribution of bladder kelp within Cook Strait since 1942, presumably due to increasing surface water temperatures. Cavanaugh et al (2011) compared changes in canopy biomass with oceanographic and climatic data in California. They revealed that winter losses of regional kelp canopy biomass were positively correlated with significant wave height, while spring recoveries were negatively correlated with sea surface temperature. On interannual timescales, regional kelp-canopy biomass lagged the variations in wave height and sea surface temperatures by 3 years, indicating that these factors affect cycles of kelp recruitment and mortality. The dynamics of kelp biomass in exposed regions were related to wave disturbance, while kelp dynamics in sheltered regions tracked sea surface temperatures more closely.

Although wave disturbance and sea surface temperature appear to be the predominant sources of bladder kelp mortality, there are no quantitative estimates for these sources of mortality available for New Zealand. Further, the relevance of results from studies conducted outside New Zealand may be limited due to differences in hydrographic environment between New Zealand and other locales.

2. BIOLOGY

Historically, two species of bladder kelp, *Macrocystis pyrifera* (Linnaeus) C.Agardh and *M. integrifolia* Bory, were reported from both Northern and Southern Hemispheres, while *M. angustifolia* Bory and *M. laevis* Hay were reported from the Southern Hemisphere. However, *M. angustifolia, M. integrifolia* and *M. laevis* are currently regarded as taxonomic synonyms of *M. pyrifera* (Graham et al 2007, Demes et al 2009). Therefore, for the sake of this document, the four previously recognized species are simply referred to as bladder kelp, *Macrocystis pyrifera.*

Bladder kelp is globally widespread; it is found in the Atlantic Islands (Baardseth 1941, Chamberlain 1965); North America from Alaska to California, Baja and Mexico (e.g., Carr 1994, Graham et al 2007, Cavanaugh et al 2011); Central America (Taylor 1945); South America from Peru to Chile, Argentina and Uruguay (e.g., Vásquez et al 2006, Thiel et al 2007, Macaya & Zuccarello 2010); the Indian Ocean (Silva et al 1996); Tasmania (Cribb 1954, Womersley 1987); the Antarctic and the sub-Antarctic islands (Ricker 1987, John et al 1994) and New Zealand (Hay 1990, Fyfe & Israel 1996, Brown et al 1997, Hepburn et al 2007).

In New Zealand, bladder kelp has a broad latitudinal distribution, occurring in the southern North Island, the South Island, as well as Stewart, Chatham, Bounty, Antipodes, Auckland and Campbell Islands

(Chapman & Chapman 1980, Adams 1994, Hurd & Pilditch 2011, Harper et al 2012). Bladder kelp does not persist in New Zealand waters where maximum temperatures exceed 18–19° C for several days (Hay 1990). The northern limit of bladder kelp is between Castle Point and Cape Turnagain on the East coast of the North Island, and Kapiti Island on the west coast of the North Island, and appears to correspond to the Southland current, which brings cool nutrient-rich water north from the south (Hay 1990). The distribution of bladder kelp is generally patchy, and there is both seasonal and interannual variation in abundance (Hay 1990, Pirker et al 2000).

Bladder kelp can grow up to 45 m long in New Zealand, and occurs in water 3–20 m deep. Where the bottom is rocky and affords places for it to anchor, bladder kelp grows in extensive kelp beds with large floating canopies, and frequently forms colonies or large populations in calm bays, harbours or in sheltered offshore waters. It can tolerate a wide range of water motion in New Zealand, including areas where tidal currents reach 5–7 knots (Hay 1990). Smaller plants can be found in shallow pools and channels.
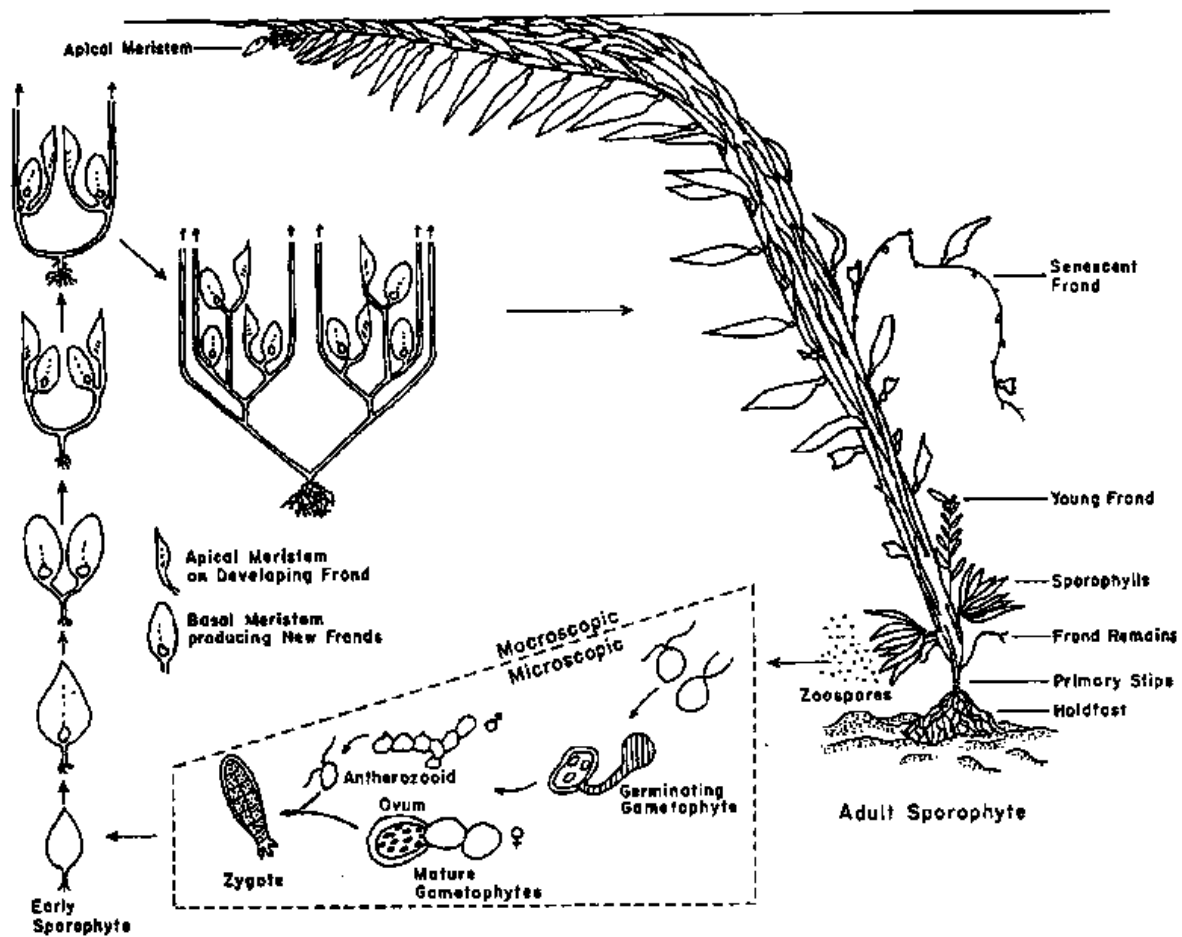

Figure 1: Diagram of the bladder kelp life cycle showing (left side) development of the young diploid sporophyte, increasing frond numbers through production of basal and apical meristematic blades; (right side) growth habit of an adult diploid sporophyte ca two years old, standing in 10 m of water depth, and liberating haploid zoospores; (below center) development of haploid gametophytes from settled zoospores, proceeding to gametogenesis, and fertilization yielding the zygote and, thence, a diploid embryonic sporophyte. From North (1986).

Bladder kelp is a large perennial kelp (individuals persist for up to 5 years in California; North 1994) with a life history progressing from planktonic zoospores (less than 3 days longevity) to microscopic benthic gametophytes (7–30 days longevity) and finally macroscopic benthic sporophytes (the large plants we see along the coast) (Figure 1). Adult sporophytes typically consist of numerous vegetative fronds that arise from longitudinal splits in meristem tissue (undifferentiated plant tissue which gives rise to new cells) located just above the holdfast. Vegetative fronds consist of a stipe (stem) terminating in an apical

meristem (the primary point of growth at the tip of a frond) which gives rise to new vegetative blades as the frond develops (Figure 1). Blades are attached to the stipe by a single pneumatocyst (gas bladder), which provides buoyancy to the frond. Continued elongation of the stipe, combined with the production of new blades by the apical meristem, results in elongation of the frond and increases in the number of blades. Fronds continue to grow after reaching the surface, forming canopies (Figure 1). Finally, meristem activity ceases in the apical blade and a terminal blade is formed. In California, frond elongation has been observed occurring at a rate of up to 30 cm per day, making bladder kelp one of the fastest growing organisms on earth. Reproductive blades (called sporophylls) are clustered above the holdfast, forming from the lowermost two to six blades on each frond (Figure 1). Sporophylls develop reproductive sporangia (spores) that are densely packed in sori (a cluster of sporangia) on the surface of the sporophylls. Californian studies have shown spores within sporangia take about 14 days to mature, with a mean residence time of about 30 days (Tugwell & Branch 1989). Each sporangium releases numerous mature zoospores that develop into gametophytes (North 1986).

A floating surface canopy consisting of numerous vegetative fronds characterizes adult plants. In California, the floating surface canopy comprises 33–50% of total plant biomass, and produces approximately 95% of organic production (Towle & Pearse 1973). Unlike other perennial kelp genera, giant kelp has limited nutrient and photosynphate storage capabilities, which in New Zealand is about 2 weeks (Brown et al 1997); consequently, growth by young fronds, reproductive material, holdfasts and other tissues near the base of the plant is supported by translocation of photosynphates from the canopy, which follows a source-sink relationship (North 1986). Mature canopy tissue exports both upward to the apical meristem at the frond apex, and downward to sporophylls, meristem tissue, holdfasts, and into apical regions of juvenile fronds (Schmitz & Lobban 1976, Lobban 1978, Manley 1984). The ability of bladder kelp to translocate photosynphates allows it to grow in dense aggregations with overlapping canopies that effectively shade out competitors on the bottom, yet supports rapid growth by young fronds, sporophylls, holdfasts and other tissues near the base of the plant.

The reliance on surface fronds for translocated photosynphate, combined with their vulnerability to disturbance, results in considerable spatial and temporal variability in giant kelp productivity and size. For example, Graham et al (1997), observed that bladder kelp holdfast growth in California decreased significantly along a gradient of increasing wave exposure, possibly due to greater disturbance to the bladder kelp surface canopy. Similarly, Miller & Geibel (1973) and McCleneghan & Houk (1985) observed reduced holdfast growth in bladder kelp following the experimental removal of surface canopies in California. Reed (1987) demonstrated that a 75% thinning of vegetative fronds in California led to an approximate 75% decrease in the generation of reproductive blades. Graham (2002) identified shifts in the reproductive condition of Californian bladder kelp from fertile to completely sterile in response to episodic, sub-lethal frond grazing by amphipods. This change in reproductive condition occurred despite relatively constant sporophyll biomass. Finally, in a New Zealand study, Geange (2014) identified an apparent tradeoff between vegetative growth and the generation of reproductive sporophylls. Relative to controls, the removal of surface canopies did not result in decreased frond generation, despite an 86% reduction in the generation of reproductive blades. Geange (2014) also found that 89% of plants became completely sterile 50 days after canopy removal, with effects persisting for up to 83 days.

Table 3: Growth parameters for KKB G canopy (> 2.25 m) and submerged fronds at Aquarium Point, Otago Harbour during autumn (March/April/May) and winter (June/July/August) 1988. From Brown et al (1997).

Growth parameter	Frond type	
	Canopy	Submerged
Frond-elongation rate		
autumn	1.9 cm d^{-1}	1.2 cm d^{-1}
winter	2.0 cm d^{-1}	1.3 cm d^{-1}
Relative frond-elongation rate		
autumn	0.0065 d^{-1}	0.008 d^{-1}
winter	0.0066 d^{-1}	0.013 d^{-1}
Node-initiation rate		
autumn	0.33 nodes d^{-1}	0.28 nodes d^{-1}
winter	0.30 nodes d^{-1}	0.30 nodes d^{-1}
Relative node-initiation rate		
autumn	0.0047 d^{-1}	0.0064 d^{-1}
winter	0.0044 d^{-1}	0.0089 d^{-1}
Net blade-elongation rate		
autumn	9.4 cm d^{-1}	5.4 cm d^{-1}
winter	12.8 cm d^{-1}	12.1 cm d^{-1}
Elongation rate of immature blades		
autumn	0.22 cm d^{-1}	0.08 cm d^{-1}
winter	0.21 cm d^{-1}	0.10 cm d^{-1}
Relative elongation rate of immature blades		
autumn	0.038 d^{-1}	0.001 d^{-1}
winter	0.036 d^{-1}	0.001 d^{-1}

Growth of bladder kelp in New Zealand appears to be seasonal, with autumn and winter growth rates in 1988 in Otago harbour having been estimated at approximately 1–20 mm per day (Table 3; Brown et al 1997). Brown et al (1997) identified a seasonal pattern of blade relative growth rate (RGR) in Otago Harbour, where blade RGR's during 1986–87 were similar year-round, except for summer when lower rates were recorded. Brown et al (1997) concluded that sufficiently high irradiance levels and seawater nutrient concentrations support relatively constant growth throughout most of the year, but that growth was nutrient-limited during summer months when seawater nitrate levels decline. In a study on Stewart Island, Hepburn et al (2007) found that exposure to waves increased nitrogen uptake, modifying the seasonal pattern of growth by ameliorating the negative effect of low seawater nitrogen concentrations during summer.

3. STOCKS AND AREAS

In New Zealand, patches of bladder kelp are typically small and discrete, usually less than 100 m^2, although large beds (less than 1 km^2) are found along the North Otago coast (Fyfe et al 1999). Although there is currently no data evaluating stock structure for bladder kelp in New Zealand, Alberto et al (2010, 2011) found low but significant genetic differentiation over a 70 km stretch of coast in the Santa Barbara Channel in southern California. In a New Zealand context, where stands of bladder kelp are small and discrete, these results suggest that stocks may display strong spatial structuring; however, these results should be viewed with caution because current regimes in the Santa Barbara Channel are strongly unidirectional.

4. ENVIRONMENTAL AND ECOSYSTEM CONSIDERATIONS

This section was reviewed by the Aquatic Environment Working Group for the May 2013 Fishery Assessment Plenary.

4.1 Role in the ecosystem

Forests of bladder kelp are amongst the most productive marine communities in temperate waters, they act as keystone species, altering the abiotic environment and providing vast amounts of energy and highly structured three-dimensional habitat (Foster & Schiel 1985, Graham 2004, Graham et al 2008). In

California, bladder kelp has been identified as altering abiotic and biotic conditions by dampening water motion (Jackson & Winant 1983, Jackson 1998), altering sedimentation (North 1971), shading the sea floor (Reed & Foster 1984, Edwards 1998, Dayton et al 1999, Clark et al 2004), scrubbing nutrients from the water column (Jackson 1977, 1998), stabilising substrata (North 1971), and providing physical habitat for organisms both above and below the benthic boundary layer (Foster & Schiel 1985).

There are three primary components to the provisioning of habitat by attached bladder kelp: the holdfast, the mid-water fronds, and the surface canopy (Foster & Schiel 1985). Studies from California, Canada, Chile, the Sub-Antarctic, and Tasmania have shown that a highly diverse assemblage of organisms colonizes each of these three components. Holdfasts are primarily colonised by algae and invertebrates and encrusted with bryozoans and sponges. The mid-water fronds and surface canopies are host to a variety of sessile and mobile invertebrates (e.g., amphipods, top and turban snails), encrusting bryozoans, and hydroids. Juvenile and adult fishes may also associate with mid-water and canopy fronds, although kelp-fish associations in New Zealand appear to be weaker than those reported in California.

Although the following associations are not exclusive, the major species associated with bladder kelp forests in New Zealand include: (i) understory brown algae, *Ecklonia radiata, Carpophyllum flexuosum, Marginariella boryana* and *Cystophora platylobium*; (ii) a rich fauna of sessile invertebrates, including *Callana spp., Calliostoma granti, Cookia sulcata, Evechinus chloroticus, Haliotis iris, Trochus spp.*; and (iii) fishes, including *Notolabrus celidotus, N. cinctus. Odax pullus* and *Parika scaber* (Pirker et al 2000, Shears & Babcock 2007). Of these species, *Ecklonia radiata, Evechinus chloroticus* (kina) and *Haliotis iris* (paua) have significant recreational value.

A significant proportion of annual kelp production becomes free-floating and beach-cast in response to storm events, seasonal mortality, or ageing. Bladder kelp continues to provide habitat resources after detachment from the substratum. Studies in California, Chile, Macquarie Island, South Georgia and Tasmania, have shown that holdfasts, mid-water fronds and canopies can retain epifaunal fishes and mobile and sessile invertebrates when drifting long distances, and play an important role in the dispersal of invertebrates and fishes (Edgar 1987, Vásquez 1993, Helmuth et al 1994, Hobday 2000a,b,c, Smith 2002, Macaya et al 2005, Thiel & Gutow 2005a,b). Mature free-floating individuals may also be important in the connectivity of bladder kelp populations, and may explain low genetic diversity of bladder kelp over large geographic extents in the south eastern Pacific (Thiel et al 2007, Macaya & Zuccarello 2010).

The beach-cast state is either washed back into the sea over subsequent tidal cycles or remains in the beach environment, with New Zealand and Californian studies demonstrating that it is incorporated into physical beach processes, or into the terrestrial or marine food webs through consumption and decomposition (Inglis 1989, Lastra et al 2008). In New Zealand, beach-cast material supports a diverse ecology of organisms through nutrient cycling and decomposition, including various micro- and macro-fauna (Inglis 1989, Marsden 1991), and if washed up high enough on the beach, can aid sand dune formation.

4.2 Incidental catch (fish and invertebrates)
Small scale harvesting experiments carried out in Akaroa Harbour showed that harvesting canopy biomass had no measurable effect on bladder kelp and the dominant understorey species (Pirker et al 2000).

4.3 Incidental catch (marine mammals, seabirds and protected fish)
None known.

4.4. Benthic interactions
None known.

4.5 Other considerations
None known.

5.   STOCK ASSESSMENT

Currently there is insufficient information on canopy area and density to allow for a stock assessment for KBB G. Furthermore, due to large temporal and spatial variation in bladder kelp growth, estimates of biomass should be looked at conservatively when applying regional scale management.

Large spatial and temporal fluctuations in biomass within and between individual kelp forests necessitates the need for initial annual stock assessments of targeted beds to determine credible biomass and sustainable yield information to ensure long-term sustainability (Pirker et al 2000). A combination of aerial photography and *in situ* measurements provide an easy method for assessing canopy biomass (Fyfe & Israel 1996, Fyfe et al 1999, Pirker et al 2000).

5.1   Estimates of fishery parameters and abundance
No estimates of fishery parameters or abundance are available at present.

5.2   Biomass Estimates
Maximum biomass occurs in winter (Cummack 1980, Pirker et al 2000). Growth rates and peaks in biomass can vary significantly over very short distances (i.e., kilometres) and temporal scales (i.e., seasonally) in response to changes in currents, light, nutrient levels, and other environmental factors. Fyfe et al (1999) found that the wet biomass of closed canopy at Pleasant River in KBB 3 fluctuated from an estimated 10 639 g m^{-2} (SE = 1566) in November 1995 to 3761 g m^{-2} (SE = 1237) in November 1996. Pirker et al (2000) noted that marked differences exist in the demography of bladder kelp at a spatial scale of only a few kilometres – and that beds decline and regenerate at different times. Because of the apparent rapid spatio-temporal fluctuations in biomass, the status of KBB 3G and KBB 4G biomass is unknown and unable to be reliably estimated using best available information. Therefore, MPI is unable to ascertain whether the current biomass of both attached bladder kelp stocks is stable, increasing or decreasing.

There is some limited information on past harvestable bladder kelp biomass and potential yield at three sites in Akaroa Harbour (Wainui, Ohinepaka, and Mat White Bays: located in KBB 3G) (Pirker et al 2000). Pirker et al (2000) estimated a combined annual harvestable canopy biomass of 377 tonnes for 1999. Further, Pirker et al (2000) concluded that at Akaroa Harbour sites no one forest was capable of supporting the removal of consistent amounts of canopy, although two harvests could be sustained per year – one in late spring/early summer just prior to frond senescence, and then another cut in late autumn/early winter. However, this estimate should be treated with caution – the survey provides only seasonal point estimates of harvestable biomass during the time the survey was conducted, with the 1999 estimate being the highest. Further, the 1999 estimate does not provide an indication of biomass at a QMA level.

There is also some limited information on the location of bladder kelp beds throughout KBB 3, although the biomass of floating surface canopies is unknown. In November 1995, Fyfe et al (1999) used aerial photography to quantify whole plant biomass (surface canopies and subsurface fronds) of bladder kelp forests at Pleasant River. They estimated 42 ha of closed bladder kelp canopy and 43 ha of broken canopy, with a combined biomass of 7900 tonnes (+/- 1300). Shears & Babcock (2007) also provide per square metre biomass estimates for entire bladder kelp plants from 247 sites within 43 locations across the North and South Islands (Figure 2) between 1999 and 2005. 12.1% of sites surveyed had bladder kelp, with a mean ash free dry weight (AFDW) biomass of 5.43 g m^{-2}. In KBB 3, biomass of attached bladder kelp ranged between 0.8 g AFDW m^{-2} (+/- 0.5, Fiordland) and 374 g AFDW m^{-2} (Banks Peninsula, Figure 25 Shears & Babcock 2007). Again, estimates from these studies should be treated with caution as they only provide point estimates of biomass, estimates are not of harvestable biomass, and they do not provide estimates of biomass at the QMA level.
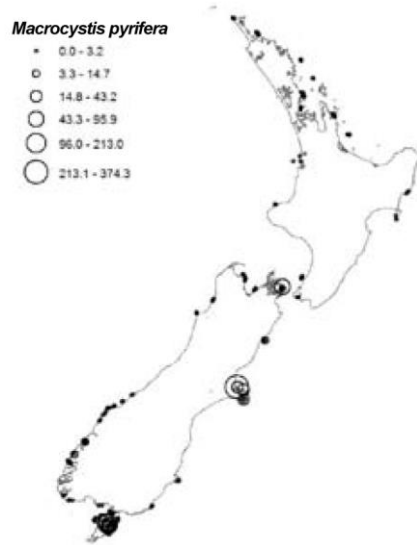
Figure 2: Mean biomass (g ash free dry weight m⁻²) of attached bladder kelp at all sites, averaged across 4 depth categories from < 2 m to > 10 m depth. From Shears & Babcock (2007).

5.3   Yield estimates and projections

As absolute biomass has not been estimated, MCY cannot be estimated.

CAY cannot be estimated.

5.4   Other yield estimates and stock assessment results

No information is available.

5.5   Other factors

It is not known whether the biomass of bladder kelp is stable or variable, but the latter is considered more likely.

6.   STATUS OF THE STOCKS

KBB 3G

Stock Structure Assumptions

No information is currently available to determine biological stocks for bladder kelp. Therefore, where quota has been allocated this has been to existing fishery management areas (3 and 4).

Stock Status	
Year of Most Recent Assessment	1995 and 1999
Assessment Runs Presented	Survey biomass from different parts of KBB 3
Reference Points	Interim Target: 40% B_0 Interim Soft Limit: 20% B_0 Interim Hard Limit: 10% B_0 Interim Overfishing threshold: F_{MSY}
Status in relation to Target	Due to the relatively low levels of exploitation it is likely that all stocks are still effectively in a virgin state, therefore they are Very Likely (> 90%) to be at or above the target.
Status in relation to Limits	Very Unlikely (< 10%) to be below the soft and hard limits
Status in relation to Overfishing	Overfishing is Very Unlikely (< 10%) to be occurring
Historical Stock Status Trajectory and Current Status	-

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Unknown
Recent Trend in Fishing Intensity or Proxy	Fishing is light in KBB 3G averaging 33 t since 2001–02.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Unknown
Probability of Current Catch or TACC causing Biomass to remain below, or to decline below, Limits	Current catches are Very Unlikely (< 10%) to cause declines below soft or hard limits
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Current catches are Very Unlikely (< 10%) to cause overfishing to continue or commence

Assessment Methodology and Evaluation		
Assessment Type	Level 2 Partial quantitative stock assessment	
Assessment Method	Ground-truthed remote sensing biomass surveys	
Assessment Dates	Latest assessment: 1999 and 1995 (in different areas of KBB 3)	Next assessment: Unknown
Overall assessment quality rank	1-High quality: it is very likely that fishing is light and having little impact	
Main data inputs (rank)	Biomass surveys	2 - Medium or mixed quality as surveys only cover part of the range and are dated
Data not used (rank)	-	-
Changes to Model Structure and Assumptions	-	-
Major Sources of Uncertainty	-	-

Qualifying Comments
There are large temporal and spatial fluctuations in biomass within and between beds; therefore, biomass estimates should be utilised conservatively.

Fishery Interactions
Bladder kelp plays an important role in structuring habitats and providing beach-cast material, but harvesting the canopy biomass has no known measurable effect on associated or dependent species.

KBB 4G

Stock Structure Assumptions

No information is currently available to determine biological stocks for bladder kelp. Therefore where quota has been allocated this has been to existing fishery management areas (3 and 4).

Stock Status	
Year of Most Recent Assessment	None
Assessment Runs Presented	None
Reference Points	Interim Target: 40% B_0 Interim Soft Limit: 20% B_0 Interim Hard Limit: 10% B_0 Interim Overfishing threshold: F_{MSY}

Status in relation to Target	Due to the relatively low levels of exploitation it is likely that all stocks are still effectively in a virgin state, therefore they are Very Likely (> 90%) to be at or above the target
Status in relation to Limits	Very Unlikely (< 10%) to be below the soft and hard limits
Status in relation to Overfishing	Overfishing is Very Unlikely (< 10%) to be occurring
Historical Stock Status Trajectory and Current Status	-

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Unknown
Recent Trend in Fishing Intensity or Proxy	Fishing is very light in KBB 4G with less than 3 t reported since 2001–02.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Unknown
Probability of Current Catch or TACC causing Biomass to remain below, or to decline below, Limits	Current catches are Very Unlikely (< 10%) to cause declines below soft or hard limits
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Current catches are Very Unlikely (< 10%) to cause overfishing to continue or commence

Assessment Methodology and Evaluation		
Assessment Type	-	
Assessment Method	-	
Assessment Dates	-	Next assessment: Unknown
Overall assessment quality rank	-	
Main data inputs (rank)	-	-
Data not used (rank)	-	-
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	

Qualifying Comments
There are large temporal and spatial fluctuations in biomass within and between beds; therefore, any biomass estimates in the future should be utilised conservatively.

Fishery Interactions
Bladder kelp plays an important role in structuring habitats and providing beach-cast material, but harvesting the canopy biomass has no known measurable effect on associated or dependent species.

7.   RESEARCH NEEDS

Future high priority research areas include: (i) updated (or new in the case of KBB 4G) biomass surveys; (ii) an evaluation of stock structure and inter-stock genetic differentiation; and (iii) quantitative estimates for different sources of mortality.

8. FOR FURTHER INFORMATION

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