Removing Drift Kelp from Cape Peninsula Beaches: Rationales, Conflicts and Ecological Effects

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ABSTRACT

Rationales and conflicts surrounding kelp removal from beaches along the Cape Peninsula by the Department of Agriculture, Forestry, and Fisheries (DAFF) and the Cape Town Municipality were explored. As a case study of kelp detritus management, an observational study assessing the impacts of the practice of kelp burial at Clifton's 4th beach was conducted. Presented here is a review of the role kelp wrack plays in sandy shore ecosystems, descriptions of conflicts between and rationales of both DAFF and the Municipality, observations about beach sediment layers in areas of kelp burial on Clifton's 4th, and suggestions for management improvement for both specifically Clifton's 4th and the Cape Peninsula in general. Regulation by the Municipality was found to revolve around solely beach aesthetics, while management through DAFF deals with the collection of kelp for only commercial purposes. Though no patterns indicating the biological effects of kelp burial at Clifton's 4th beach were found, management suggestions for this beach include 1) the development of a map detailing location and date of kelp burial, and 2) investigation into the burial of beach-cast trash. Suggestions for management along the Cape Peninsula in general include 1) regular and improved communication between DAFF, the Municipality, and DAFF rights holders, 2) established protocols for dealing with conflict, 3) investigation into alternative use of kelp by the Municipality, and 4) records of quantities of kelp removed from beaches on the Cape Peninsula.

A. INTRODUCTION

Drift kelp (mostly *Ecklonia maxima* with some *Laminaria pallida* and smaller amounts of other seaweeds) that washes up on beaches along the Cape Peninsula is routinely removed for both commercial and aesthetic reasons. This process is managed by two separate regulatory bodies: the Department of Agriculture, Forestry and Fisheries (DAFF) and the Cape Town Municipality. DAFF monitors the collection of beach-cast kelp along the entire South African coast by issuing permits allowing rights holders to collect kelp for commercial reasons such as alginate production within specific concession areas. Within these concession areas, there are regions designated as Marine Protected Areas by South African National Parks, where removal of any material is prohibited and from which no kelp is collected. The Cape Town Municipality, on the other hand, removes seaweed only from beaches on the Cape Peninsula and with the sole purpose of enhancing beach aesthetics. Because the decomposition of kelp on the surface of a beach presents a variety of unsatisfactory conditions for beachgoers such as the smell of rotting seaweed and the presence of kelp flies and other invertebrates, the Municipality

employs workers to remove this beach-cast seaweed in order to make Cape Town's beaches tourist-friendly. None of the drift kelp collected by the Municipality is used commercially, but is rather discarded. Though both agencies operate within their separate boundaries and by their own procedures, these two agencies are often in conflict with regard to how kelp collection should be managed on the Cape Peninsula.

One unique instance of kelp management by the Cape Town Municipality is the case of Clifton's 4th beach, where the collected kelp is buried onsite rather than removed to landfills as it typically is. While detritus from other beaches subject to kelp cleansing by the Municipality is taken to landfills, lack of a road adjacent to Clifton's 4th beach prevents trucks from accessing the area. In order to dispose of the beach-cast kelp, therefore, workers have been burying the seaweed along the top of the beach on a daily basis. The locations and timing of these burials, however, are based purely on practicality and the implications of this practice on both long-term aesthetics and the health and dynamics of the beach ecosystem are unknown.

By conducting an observational study of the effects of kelp burial at Clifton's 4th and investigating the kelp removal rationales of both DAFF and the Cape Town Municipality, this study aims to answer the question, "what are the rationales, conflicts, and ecological effects of removing drift kelp from Cape Peninsula beaches under current management practices?" The specific objectives include 1) to conduct a general inspection into the biological impacts of kelp burial at Clifton's 4th beach, 2) to establish an understanding of the rationales behind the two kelp management agencies on the Cape Peninsula (DAFF and the Cape Town Municipality) and how their management practices may conflict, 3) to review the role of kelp detritus in sandy shore ecosystems, and 4) to advise the Cape Town Municipality and DAFF on management practice.

B. REVIEW OF LITERATURE RELEVANT TO KELP DEPOSITION AND REMOVAL ON CAPE PENINSULA BEACHES

Though little is known about the implications of burying kelp in sandy shore environments, there is much knowledge of the roles of beach-cast seaweed in sandy shore ecosystems, onshore decomposition of kelp, and the management of kelp collection and use along the Cape Peninsula.

1. Kelp Wrack in Sandy Shore Ecosystems

Along the south-west coast of South Africa, kelp wrack is the primary source of energy for sandy shore ecosystems (Griffiths et al, 1983). The main types of kelps present in this region are *Ecklonia maxima* and *Laminaria pallida* (Anderson et al, 2007), and it has been estimated that over 2 metric tons of these kelps are deposited on each meter of beach per year (Griffiths et al, 1983). Beach-cast kelp has been found to be vital to onshore ecosystems around the globe as it supports intertidal herbivore and decomposer communities (Orr et al, 2005; Revell et al, 2011) and contributes to primary production (Koop et al, 1982). It was also suggested that kelp wrack may assist in beach shaping; through a study of beaches in California, it was shown that seaweed detritus may assist in stabilizing beaches against erosion caused by factors such as wave exposure (Revell et al, 2011). On beaches in Ireland, this kelp wrack that amasses above the high water mark is vital to the development and maintenance of dunes by facilitating the accumulation of sand (McKenna et al, 2000). This kelp also greatly influences various ecosystems, carrying with it the seeds of many seashore plants and providing nutrients and moisture to these environments (McKenna et al, 2000). Kelp accumulations in South Australia have also been shown to play a role in dune formation by trapping sand (Kirkman & Kendrick, 1997).

1.1 Kelp Detritus Onshore Decomposition

Kelp wrack has been shown to provide vital nutrient input for primary productivity in sandy shore ecosystems (Koop et al, 1982; Griffiths et al, 1993; Griffiths & Stenton-Dozey, 1983; Kirkman & Kendrick, 1997). This beach-cast seaweed is typically broken down by detritivores and physical processes, then is remineralised by bacteria on the shore (Kirkman & Kendrick, 1997). At Kommetjie beach on the Cape Peninsula, for example, it was found that complete kelp remineralisation typically takes place within 8 days (Koop et al, 1983) and that 71% of onshore kelp decomposition is completed by herbivores; the remaining 29% is broken down by bacteria and is either washed back into sea or is incorporated into the sand column (Griffiths et al, 1983). While most of the carbon in deposited kelp is ultimately released as CO_2 from faunal

respiration, the majority of nitrogen taken up from kelp wrack is retained by the bacteria (Griffiths et al, 1983). The foul odor associated with rotting kelp on the surface of a beach is due to the release of hydrogen sulphide gas (Kirkman & Kendrick, 1997).

Though it has been shown that exported kelp detritus can significantly enhance secondary production in other systems (Krumhansl & Scheibling, 2012; Harrold et al, 1998) such as the nutrient-poor waters of Western Australia (Kirkman & Kendrick, 1997), it has been found that beach-cast kelp on the Cape Peninsula likely does not play a significant role in the productivity of nearby ecosystems (Koop et al, 1982; Griffiths et al, 1983). While the decomposition of onshore kelp yields high rates of primary production, that productivity contributes minimally to other systems; as much as 95% of nitrogen from beach-cast kelp in Kommetjie, South Africa, for example, has been found to return to sea, yet that amount accounts for only about 0.05% of the total nitrogen used in nearby communities (Koop et al, 1982). Because little inorganic material from this imported kelp is returned to the sea, sandy shore ecosystems reliant on nutrients provided by imported debris are considered to be energy sinks (Griffiths et al, 1983; Griffiths & Stenton-Dozey, 1983).

Though little is known about the effects of burial on kelp decomposition in a sandy shore environment, Blenis et al (1998) found that decomposition of canola straw was significantly increased when buried in terrestrial environments. Additionally, Griffiths & Stenton-Dozey (1983) determined that dissolved or particulate kelp detritus that becomes incorporated into the sand column is promptly taken up by those organisms, namely nematodes, oligochaetes, and bacteria, that typically congregate beneath the driftline.

1.2 Kelp Wrack Ecosystem Structure

Assisting in the decomposition of this beach-cast kelp are the many sandy shore organisms dependent on the rich nutrients provided by the kelp wrack. The fauna that is reliant upon this food source is typically diverse and includes organisms such as amphipods, flies, and birds (Kirkman & Kendrick, 1997). While in most beach ecosystems faunal diversity decreases with distance from the water as nutrients become scarce, it was found that ecosystems heavily reliant on kelp wrack display the opposite

trend; on Kommetjie beach in South Africa where kelp wrack typically concentrates high up on the shore, it has been demonstrated that species diversity actually increases up the beach as kelp debris becomes more available (Griffiths et al, 1983; Griffiths & Stenton-Dozey, 1983). The driftline, where the majority of the kelp resource is concentrated, was shown to contain the greatest amount of species diversity and biomass within the Kommetjie beach system (Griffiths et al, 1983).

Communities associated with kelp wrack have also been shown to vary by species of beach-cast seaweed and the decomposition stage of that wrack material. Using talitrid amphipod populations in Southern California and Spain as a case study, for example, it was found that the quantity and type of drift macrophytes can greatly influence the composition of beach consumer populations (Lastra et al, 2008). At Kommetjie, Griffiths & Stenton-Dozey (1981) found that community structure among the 22 species present in the kelp wrack changed dramatically as decomposition took place. Organisms from the order Diptera, for example, were found primarily on fresh kelp material while those from the order Coleoptera increased as decomposition progressed (Griffiths & Stenton-Dozey, 1981).

2. Commercial Uses and Resource Management of Kelp on the Cape Peninsula

2.1 Commercial Uses of Kelp

Of the two types of kelp common on the southern African west coast (*Ecklonia maxima* and *Laminaria pallida*), *Ecklonia maxima* constitutes the bulk of the kelp industry in South Africa (Anderson et al, 2007; Rothman et al, 2006). The South African kelp industry began with the collection of beach-cast kelp in the 1950s to provide the British market with alginate when Japan's kelp resource was cut-off due to World War II (Anderson et al, 1998). In the 1970s, kelp collection expanded from simple collection to the harvesting from kelp beds as seaweeds began to be used locally as fertilizer (Anderson et al, 2003; Anderson et al, 2007) and abalone feed (Anderson et al, 2007). Currently, most beach-cast kelp collected for commercial purposes along the Cape Peninsula is used to supply the international demand for alginate, though some has been used locally as fertilizer (Anderson et al, 1989; Anderson et al, 2003). In Australia, the

majority of harvested beach-cast seaweeds is used as either abalone feed or soil improver, with some used for alginate and agar and as cattle feed (Kirkman & Kendrick, 1997).

2.2 Drift Kelp Resource Management

In order to manage the vast quantities of kelp that wash up on the Cape Peninsula, two regulatory bodies have stepped forward: the Department of Forestry and Fisheries (DAFF) and the Cape Town Municipality. DAFF regulates the collection and harvesting of kelp for commercial uses by dividing up the South African coastline into 23 concession areas; permits are issued for these areas to control who can remove kelp from certain regions along the coast and to ensure responsible collection (Seaweed Rights/Concession List, DAFF; Anderson, pers. comm.). Within these concession areas, there are regions designated by South African National Parks as Table Mountain National Park Marine Protected Areas, from which no material, including kelp, can be removed (SANParks). In locations not included in these concession areas, the Cape Town Municipality facilitates the removal of kelp for beach aesthetics and by public demand (Anderson, pers. comm.). The kelp collected by the Cape Town Municipality, however, is not used for commercial reasons but is rather disposed of in landfills or, in the case of Clifton's fourth beach, through onsite burial (Colenbrander, pers. comm.).

Both of these agencies have developed strict policies for where and how drift kelp can be collected (DAFF, Seaweed Permit Conditions; McKinnon, 2005). In the 2005 "City of Cape Town Beach Cleansing Management Procedure," for example, McKinnon provides aerial photographs of each beach from Mnandi to Kommetjie that undergoes kelp removal by the Cape Town Municipality, clearly marking the specific areas where collection can take place. These measures are taken as attempts to minimize any potential ecological damage caused by beach cleansing while still ensuring that Cape Peninsula beaches are welcoming to the public (McKinnon, 2005).

In a report discussing rural beach management in Ireland, education concerning the importance of drift seaweed for dune maintenance was proposed as a technique to encourage management authorities to leave beach-cast seaweed on the beach (McKenna et al, 2000). According to the authors, foreign objects such as animal carcasses and trash should be removed from the driftline during beach cleaning, leaving only drift seaweed

on the beach. In situations where rotting seaweed presents a significant problem due to odour, however, the authors acknowledge that removal may ultimately be necessary. In these cases, the authors propose the development of procedures that would work to maintain dune structure while also removing the problematic decomposing seaweed. The authors, for example, propose a potential solution involving the collection, storage, maceration, then redistribution of this drift kelp along the beach (McKenna et al, 2000).

C. METHODS

Observational Study of Clifton's 4th:

Four one-meter deep holes were dug along the top of Clifton's 4th beach by hand and using a spade provided by UCT's Environmental and Geographical Studies Department. The depths of these holes were based on onsite inspection of the burial process; on the day of study, the workers at Clifton were seen burying kelp in a hole approximately one meter deep. Though the hole dug by the workers had a width of approximately 4m, each study hole was created with a width of approximately .5m due to time and labor constraints. The holes were spaced relatively evenly along the back wall of the beach (Figure 1). The characteristics of sediment color, depths at which change in sediment color or texture occurs, smell, and particles found were recorded. Smell and sediment color were measured on scales; for sediment color, sediment color was recorded on a scale of 1-5, with a measurement of 1 indicating the color of the top sand (consistent across all holes) and a measurement of 5 indicating black. Smell was measured from 0-5, with a 0 indicated no discernable difference in smell from the top sand, and a 5 indicating a strong difference in smell between the top layer and the depth at which the smell was noted.

As a control, one .7 meter hole was dug at Camps Bay (Figure 2), a beach relatively close to Clifton that employs removal of beach-cast kelp but not burial. All holes at both Clifton and Camps Bay were dug on the morning of April 26th, 2013. Though the timing of kelp burial in the locations at Clifton is unknown, it is known from a previous site visit that workers buried kelp somewhere within the region of study on February 22, 2013. More holes were not dug due to time limitations.

Figure 1. Clifton's 4th with locations of each hole. The "X" marks the location of burial on the date of study (26 April 2013).

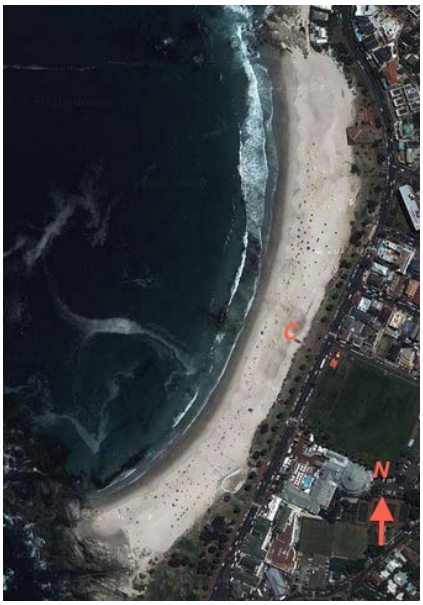

Figure 2. Camps Bay with control location marked.

Cape Peninsula Kelp Management Rationale Study:

Two individuals, Darryl Colenbrander from the Cape Town Municipality and Rob Anderson from DAFF, were interviewed concerning management of beach-cast kelp on Cape Peninsula beaches. Darryl Colenbrander is the Coastal Coordinator for the Cape Town Municipality's Environmental Resource Management Department, and Rob Anderson is the head of DAFF's Seaweed Unit. Both individuals were interviewed in their respective offices, and were asked questions concerning methods of management employed by each regulatory body and conflicts between those two agencies.

D. RESULTS

No observable patterns were found among the holes dug. Each hole exhibited unique layers, with color, smell, and texture of this sediment varying between each hole (Table 1). Hole 1 contained only two distinct layers, with an abrupt change at 63cm below the surface as the sediment color changed from the color of the top layer to an almost black color (rated 4) with no observable transition between the two layers. The smell and texture also changed between the two types of sediment, as pebbles and chunks

of spongy material along with a slight sulfur smell (rated 2) became common in the second layer. The sediment became noticeably damper around 90cm below the surface, but no standing water was reached at any point.

Hole 2, however, contained five separate layers, with a moderate degree of mixing between layers 4 & 5. Significant numbers of decomposing kelp segments were found between approximately 66cm and 79cm, varying in size between 2cm and 5cm. As with hole 1, there was a sulfur smell near the bottom of the hole (rated 2).

In Hole 3, a large amount of trash was found, including plastic bags, Styrofoam, plastic bottle caps, and other small pieces of plastic. This trash was intermixed with wood and some small (2-3cm) pieces of seaweed. Sediment layers here were somewhat mixed, with a small gradient layer between the two layers. The hole could not be dug to one meter due to the presence of rock.

Hole 4 did not exhibit any change in sediment color, texture or smell at any depth down to 1m. There were small pebbles dispersed throughout the sediment, but neither the color nor smell varied from the top sand.

The hole at Camps Bay could not be dug past 72cm, as rocks, bricks, and a large plastic barrier were hit. Bricks and large rocks were hit around 30cm below the surface, and were removed to keep digging. There was a change a sediment color around 57cm below the surface, where the sand became a darker yellow (rated 2). At around 61cm, the sand became significantly damper and a sulfur-like smell was noted.

Table 1: Characteristics of Holes by Layer

Hole Number	Layer Number	Layer Depth Range (cm below surface)	Sediment Color (Scale: 1-5)	Sediment Smell (scale: 1-5)	Observations
1	1	0-63cm	1	0	Sudden change in color between layers 1 & 2. Sediment fine with few larger particles
	2	63-100cm	4	2	Sulfur-like smell. Sediment became courser with some pebbles and some chunks of soft, spongy material.
2	1	0-33cm	1	0	Coarseness remained same throughout all layers.
	2	33-57cm	5	0	No transition between layers 1 & 2
	3	57-66cm	1	0	Exhibited exactly same characteristics as Layer 1
	4	66-79cm	2	0	Seaweed present in small chunks (typically 3-5cm in length). Sand lumpier and damper, filled with seaweed and black spongy material.
	5	79-105cm	3	1	Small, white pebbles and darker yellow sand. Swirls of darker sand mixed in. Barely noticeable sulfur-like smell becomes present.
3	1	0-32cm	1	0	Sediment layers not clearly separated; colors were mixed and were not clearly stratified.
	2	32-63cm	3	0	Found a great quantity of trash, wood, and some seaweed. Hit red/orange rock at 63cm.
4	1	0-100cm	1	0	No changes in sediment color, texture, or smell. Small pebbles were interspersed throughout.

Control (Camps Bay)	1	0-57cm	1	0	Hit bricks and large rocks around 30cm below the surface. Sediment color changed abruptly between layers 1 & 2
	2	57-72cm	2	2	Sediment changed to a dark yellow, significant moisture increase. Hit rock and a large black plastic barrier at 72cm so stopped digging.

E. INTERVIEWS: RESULTS/DISCUSSION

Conflicts Between DAFF and the Cape Town Municipality

Both Daryl Colenbrander (Cape Town Municipality) and Rob Anderson (DAFF) acknowledged significant conflicts between DAFF and the Municipality. The majority of this tension typically arises in regions not designated as DAFF concession territories and in concession areas that fall outside of the Municipality's kelp cleansing zones. Along the Cape Peninsula, these regions constitute much of the beaches with high tourist traffic such as Muizenberg and Camps Bay, (Figure 3) and are generally managed by the Municipality. The conflict that arises in these areas largely stems from differences in beliefs concerning the value of beach-cast kelp and appropriate consequences of kelp removal by the two agencies outside of their designated collection region. The Municipality believes that drift kelp should be removed from only designated kelp cleansing zones (typically high occupancy beaches) where decomposing kelp would significantly diminish the tourism potential

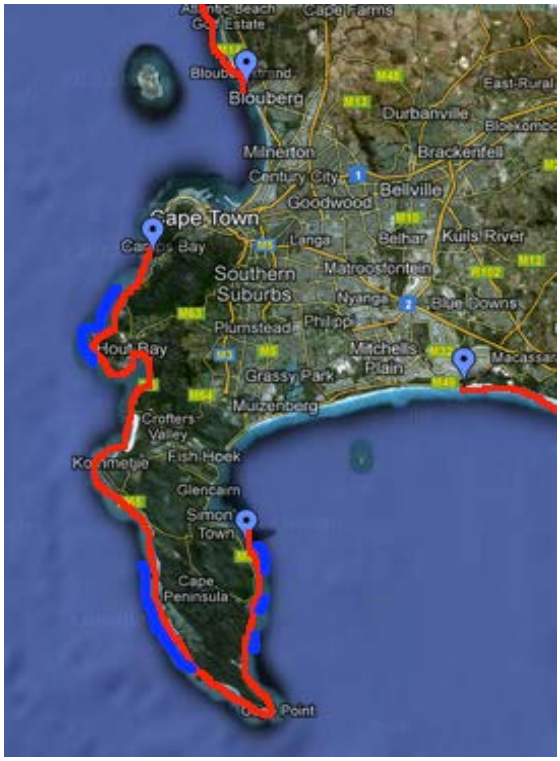

Figure 3. Map of MPAs and DAFF concession areas along the Cape Peninsula. DAFF Concession areas are highlighted in red and Marine Protected Areas are highlighted in blue.

of the beach; in the eyes of the Municipality, kelp on all other beaches within the Municipality's domain should be left untouched to preserve the ecological and structural integrity of the sandy shore ecosystem. DAFF, however, believes that the Municipality is overestimating the benefits of this drift seaweed. For DAFF, beach-cast kelp is not important only for ecological reasons, but is also a valuable commercial product.

This difference in understanding concerning the value of kelp wrack underlies many of the instances of conflict between the two regulatory bodies. One source of conflict, for example, arose when a DAFF permit holder ventured into a non-concession area to collect kelp. Because the Municipality strongly believes that beach-cast kelp should remain on Cape Peninsula beaches, members of the Municipality requested that DAFF make an official note of the incident to formally address this breach of boundaries. According to the Municipality, however, DAFF did not consider this collection out of concession areas to be of the department's concern and refused to take action. Lacking a method of resolving this problem, the individuals from both DAFF and the Municipality discussed law enforcement as a potential next step.

Rationales Behind Kelp Collection

DAFF regulates kelp collection along the South African coast in order to regulate and monitor kelp harvesting in South Africa. In order to conserve South Africa's natural resources as well as support industries using beach-cast kelp for products such as alginate, DAFF designates specific concession areas in which kelp can be collected and strict guidelines indicating how that collection must take place. Rights holders for these areas, however, do not regularly clear the beaches of kelp throughout the entire year; these individuals operate largely under the control of the market and therefore remove kelp when it is economically beneficial to do so.

The Cape Town Municipality, however, removes kelp only for aesthetic reasons and does not use any of this collected wrack for commercial purposes. This management procedure is largely dictated by the Municipal Systems Finance Act, which requires the municipality to be open and transparent concerning any monetary gain; this act, therefore, would make using the collected kelp for commercial reasons an immense administrative

burden. The use of kelp collected by the Municipality for monetary gain would require an extensive and time-consuming process. In light of these barriers presented by the Municipal Systems Finance Act, all collected kelp is taken to landfills or buried on site.

F. DISCUSSION

Cape Peninsula Kelp Management Recommendations

Although Koop et al (1982) showed that beach-cast kelp can be reminiseralised in as little as 8 days at Kommetjie beach in South Africa, it is clear that kelp must be removed from certain beaches along the Cape Peninsula to support tourism. For similar economic purposes, it is additionally important to uphold the industry of kelp collection for commercial reasons. While kelp detritus is important in sandy shore ecosystem ecology, the importance of removal must be acknowledged in light of the economic benefits of tourism and alginate export, and in the absence of strong evidence demonstrating the importance of drift kelp for the health of specific beaches. At the same time, however, it is clear that kelp detritus plays important roles in beach ecosystem dynamics by serving as a primary source of carbon and nutrients, and, in some cases, stabilizing beach structure. Even in light of these central roles, it must also be acknowledged that a change in an ecosystem does not always mean that damage has occurred; many sandy shore ecosystems operate without nutrient input from kelp wrack, and removal of kelp may change a system without necessarily harming it. In order to sustainably balance the economic uses and ecological benefits of kelp, however, there must be some changes to how the collection of drift kelp is managed on the Cape Peninsula.

The first step in improving kelp management on the Cape Peninsula is to greatly increase communication between DAFF, the Municipality, and commercial rights holders. Currently, these three groups seldom meet and do so only in response to conflict. These meetings are often made largely unproductive due to mounting hostilities and poor communication. Though theoretically the two regulatory bodies do not overlap in management areas, there are clearly situations in which collaboration between both DAFF and the Municipality is required to adequately manage beaches on the Cape

Peninsula. Rather than viewing each agency as discrete entities with separate motivations, it should be acknowledged that both are working within the broad goal of managing kelp for both ecological and socio-economic purposes. In order to address this overlap, there should be meetings scheduled on a regular basis to identify and address any potential issues before they become sources of conflict. In addition to ameliorating conflict between the regulatory bodies, collaboration between DAFF, the Municipality, and rights holders could lead to more innovative and improved management along the Cape Peninsula.

Through these discussions, clearly defined protocols must be developed detailing how breaches in collection or other violations of management procedure should be handled. Explicit understanding of which agency has authority over specific areas and how conflicts are to be approached will be invaluable to both resolving future conflict and improving relations between DAFF and the Municipality. Much of the conflict stems from lack of acknowledgement that successful management on the Cape Peninsula, even though each agency has defined areas in which collection occurs, depends immensely on collaboration between both agencies. When situations do arise, there must be standard ways of dealing with them, whether it be through law enforcement or internal procedures.

In order to make these discussions fruitful, however, in depth studies of the role of kelp detritus on specific Cape Peninsula beaches should be conducted. Because much of the conflict between DAFF and the Municipality stems from different notions of the importance of drift kelp in sandy shore ecosystems, discussions between the two agencies concerning kelp management would be more productive given an informed base of knowledge. Rather than focusing on debates about the ecological importance of kelp in general, members from DAFF and the Municipality would be able to discuss issues of kelp management on a local, case-by-case basis. Since the main concerns about removing kelp from beaches revolve around structural and ecological integrity, these studies should investigate how removal and management at the specific location may affect the beach. While this research will not solve management issues, it will be valuable in facilitating informed discussions between the two agencies. Having an understanding of the implications of certain management procedures that is supported by literature based in the Cape Peninsula is vital to crafting management practice.

Though this research will be beneficial in informing management practices, it is also necessary to acknowledge that change to an ecosystem does not necessarily equate to damage; removal of kelp from a system, though it will alter the dynamics of that system, may not ultimately harm it. There are numerous functioning beaches along the South African Coast that do not receive an input of kelp wrack, and they operate as healthy ecosystems. Though there is often a perception of environmental change as a negative and destructive force, it must be acknowledged that this change may not be detrimental to the ecosystem.

Aside from improving the collection management process, kelp collected by the Municipality could be used in productive ways rather than discarded. While the Municipal Finance Management Act serves to ensure responsible and effective use of public resources by municipalities, in the case of kelp management it is inhibiting a more productive use for the collected kelp detritus. Instead of discarding all of the removed seaweed in landfills, alternative uses that would benefit members of the community should be considered. The use of kelp locally for fertilizer, for example, would benefit community members and could perhaps even be used in projects such as urban parks or gardens. Though the amount of kelp detritus currently being removed to landfills likely greatly exceeds the amounts that could be utilised for other purposes, the use of some of this kelp for local development should be considered.

Additionally, the Municipality must keep records of how much, when, and from where kelp is removed from sites along the Cape Peninsula. Even if merely in units of truckloads, knowledge of the quantities of seaweed removed is beneficial for both monitoring management practice along the Cape Peninsula and in identifying trends or changes in the timing and quantities of kelp wash-up.

Though these recommendations require significant inputs in time and money, steps to reform the current system must be taken. In order to ameliorate conflict between DAFF and the Municipality and improve the process of Cape Peninsula beach management, both parties must be willing to dedicate increased time and effort.

Case Study: Management at Clifton's 4th and the Biological Impacts of Kelp Burial

Through the first glance that this study offers, there does not seem to be any major impact on the beach ecosystem caused by kelp burial. No significant patterns were found to indicate negative biological effects at Clifton's 4th. While decomposition under the sand without a doubt alters ecosystem dynamics from a system where the kelp decomposes on the surface, the buried kelp at Clifton's 4th is still being remineralised onshore and entering the sandy beach ecosystem. More investigation into this management procedure is, however, necessary. Though this study offers a brief observational insight into how kelp is decomposing beneath the surface, it does not make use of quantitative measurements and the shortcomings must be acknowledged. Firstly, the lack of a map indicating the location and time of each burial makes it impossible to know if the study sites were even in regions of past burial and at what time kelp was buried there. Due to lack of manpower and time limitations, no repetition of sites could be conducted and few holes could be dug. In order to further explore the impacts of burial at Clifton, there must be many more areas investigated along the top of the beach and further down the shore. Rather than simply noting qualities observed by the naked eye, however, there must be in depth study into the meiofauna and nutrient levels present. Areas where kelp is washed up but collected, where drift kelp is left on the shore to decompose, and where kelp is being buried should be assessed. Though Camps Bay is close to Clifton, it is not an ideal control site, as there were clearly many man-made manipulations to the top of the beach such as bricks and plastic supports, potentially used as structural elements. While an area along Clifton where burial does not occur would be the ideal control site, the lack of a map dictating sites of past burial makes the determination of this area difficult.

Additionally, the methods of viewing sediment layers used in this study are not ideal for accurate observation. Because sand from the surface rushed down into the holes as they were being dug, it is possible that this top sand obscured or altered some of the layers of colors and smells. In future studies examining the sediment composition, therefore, equipment such as prawn pumps or corers should be used to retrieve accurate samples unobscured by other sand.

Even in light of this lack of understanding of how kelp burial differs ecologically from leaving or removing the kelp, however, there are ways in which the Municipality should improve the process of management at Clifton's 4th. Many of these recommendations are informed by the difficulties that arose in designing this study of Clifton's 4th beach. To begin with, there must be records of how much, where, and when kelp is buried along the beach. Not only is this record important for monitoring kelp management procedure and potentially shedding light on problems that may occur on the beach, it can also be used to indicate how much kelp is being washed up at and at what times of the year. As mentioned previously, similar records, even if simply in the units of truckloads, should also be kept for other sites along the Cape Peninsula where kelp is removed.

In light of the significant amounts of trash alongside decomposing kelp found in Hole 3, there should be further investigation to ensure that only kelp is being buried at these sites. Though it is possible that the trash is being deposited onto the beach by a nearby storm drain or by beachgoers, it is also possible that washed up non-kelp debris is being buried alongside the drift kelp. Management should therefore more carefully monitor what material is actually being buried.

G. CONCLUSION

This project is a first step to identifying potential problems and future areas of study. Though there is no conclusive evidence concerning the impacts of kelp burial at Clifton's 4th beach, there is clearly room for improvement in the management of beach-cast kelp both specifically at Clifton and in general along the Cape Peninsula. At Clifton, improvements should begin by establishing records of where, when, and how much kelp is being buried. These records for both specifically Clifton and beaches all along the Cape Peninsula will not only be immensely helpful for future studies, but can also be informative concerning kelp bed communities.

Improvement in management along the Cape Peninsula must begin with greatly increased communication between DAFF and the Municipality. By defining more concrete protocols for dealing with breaches in management procedures and establishing a better understanding of the role kelp detritus plays on beaches along the Cape

Peninsula, a more harmonious balance between the two regulatory bodies can be established.

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