Using the Mauri Model to Assess the Impact of the *Rena* Grounding on the Mauri of the Bay of Plenty, New Zealand

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Abstract: On 5 October 2011 cargo ship *Rena* ran aground on Astrolabe Reef. Astrolabe Reef is approximately 22.2 kilometres off the coast of the Bay of Plenty in New Zealand. In the weeks following the grounding, containers and oil washed up on the beaches from Waihi Beach to Maketu. The thick residual oil coated sandy beaches, rocks and marine animals. This disaster impacted the environment and the lives of the indigenous Māori people. The Māori culture places great importance on mauri, the essence that provides life to all living things. When the *Rena* hit Astrolabe Reef the mauri of the area was considerably impacted. This report aims to determine the impact the oil spill had on the environment and the local iwi (Māori tribes) by using the Mauri Model (Morgan 2006), which integrates science and the indigenous culture. Ultimately, the restoration plan must consider both the environment as well as the local culture.

Keywords: *Rena*, Mauri Model, oil spill, indigenous culture/people/values, Bay of Plenty, Māori.

Introduction

The grounding of the *Rena* is considered to be the worst maritime environmental disaster to ever occur in New Zealand. The *Rena* oil spill not only affected the marine life and humans but it also greatly affected the coastlines, ecosystems and mauri of the land. The Māori culture defines mauri as the energy that binds and animates all things in the physical world (Te Ahukaramū Charles Royal 2009). Mauri is the ability for air, water or soil to support life (Marsden, 2003); it is the force that binds all things together (Marsden & Henare 2002). Mauri is the life force that has been passed from the Ranginui (Sky Father) and Papatuanuku (Earth Mother) to their children who are the deities of the forest, ocean and the others (Morgan 2004). When the environment is altered, the mauri of that land changes as well. Therefore, after the oil spill the mauri in the Bay of Plenty coastline was impacted, specifically between Waihi

Beach and Maketu (see Figure 1). This land is important to the inhabitants therefore the health of the environment is of great concern.

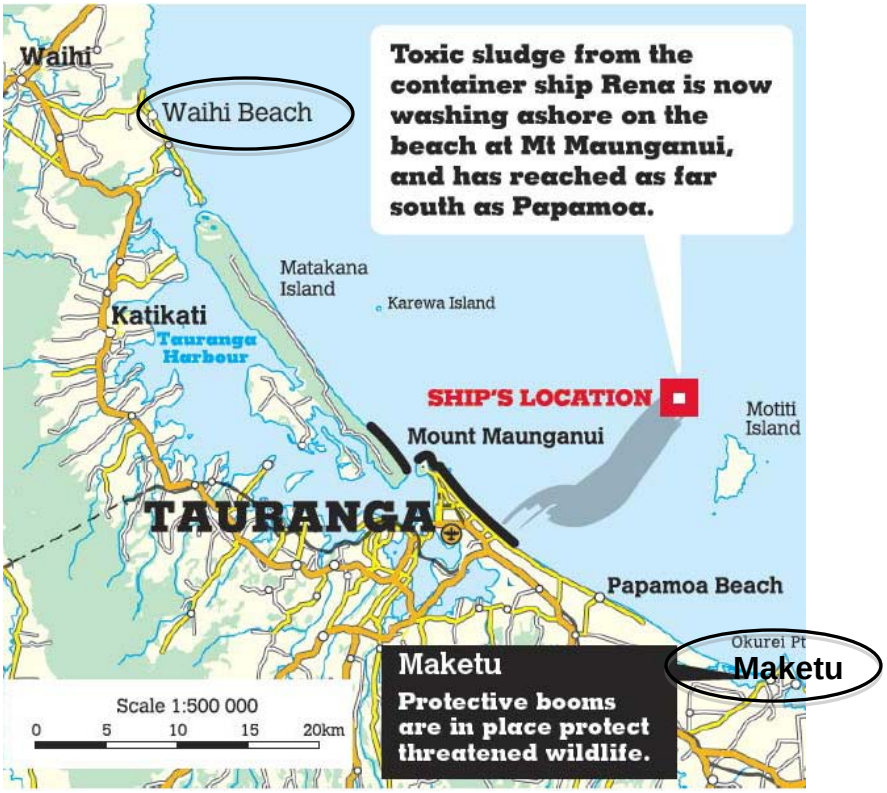

Figure 1. Impacted coastline map

Immediately after the grounding of the *Rena*, a huge clean-up plan was implemented and hundreds of volunteers came out to clean the beaches in the Bay of Plenty. The majority of the beaches were reopened on 16 November 2011. Although most of the clean up removed any visible remnants, the beaches are not the same and the long-term effects are significant. A similar spill occurred on 24 March 1989 in the Prince William Sound of Alaska when the Exxon Valdez hit a reef and spilt between 41,000 and 119,000 m^3 of crude oil (Cutler 2010). This oil spill was of greater scale and affected a larger area, but both the long and short term effects were studied which can provide helpful information into the potential effects in the Bay of Plenty.

Previous research has been done on the ecosystems along the Bay of Plenty coastline and the state of the ecosystems. The Manaaki Taha Moana (MTM) is a research program

primarily funded by the Foundation of Research Science and Technology. Its main focus is on restoring the coastal ecosystems that are important to iwi and hapu (tribe) in the Hawke Bay area. Their main focus is in the Tauranga Harbour and the Horowhenua coast.

Their research aims to study the issues surrounding the recent concern with the degradation of the moana (sea) of most importance to tangata whenua (indigenous people) loss of shellfish, sedimentation and pollution. MTM intends to use their research to inform decision-makers about coastal resources as well as engaging the tangata whenua in the process, management and restoration of the moana. Their research does not focus on the *Rena* oil spill effects; however, their research does look into the recent degradation in a similar coastline ecosystem. In their paper, *State of Ecological/Cultural Landscape Decline of Horowhenua Coastline Between Hokio and Waitohu Streams*, MTM provides data and figures on the health of the coastline, focusing on the wetlands, dunes, shrub lands, bird species, fish and shell fish species. Their research will be beneficial as a similar, comparative study that could potentially add information and insight into the state of similar coastal ecosystems.

There is extensive research focused on similar coastlines and previous oil spills and their recovery plans from around the world, such as the Exxon Valdez oil spill in Alaska; however, there is no accessible research on the effects the oil spill had on the mauri of the land in the Bay of Plenty area.

The grounding of the *Rena* had a major impact on many aspects of the coast, sea and the mauri of the land. Not only did the ship leak 360 tonnes of oil, 86 containers were released from the ship, with 53 still lost at sea (Smith 2011). The oil coated the beaches, birds, penguins and seals. The oil will inevitably affect the ecosystems within the area, which in turn will affect the huge marine kelp forests, fish, filter-feeding whales, crustaceans, shellfish and up the food chain through bioaccumulation.

The environment holds a great meaning to the Māori; therefore any variation in the environment notably impacts their culture. When the *Rena* hit Astrolabe Reef in October 2011 the mauri was considerably affected. In order to restore the damage created by the *Rena*, the impact must first be assessed, thus creating a starting point and goal for restoration. This report uses a model that integrates science and indigenous culture to determine the impact on the environment, community, culture and economy. The Mauri Model (Morgan 2006) assigns numerical values to specifically relevant indicators depending on their current state of mauri. These numbers show the negative or positive impact a specific event, the *Rena* grounding, has on the mauri of the area. A further explanation of this model will be discussed later in this report.

Background

On a clear Wednesday in October, a large container ship, the *MV Rena*, was sailing from Napier to Tauranga with a speed of about 17 knots. On 5 October 2011, at 2:16 AM the *Rena* ran aground on Astrolabe Reef. Astrolabe Reef is approximately 7.4 kilometres north of Motiti Island and 22.2 kilometres off the coast of the Bay of Plenty (Smith 2011). Due to the impact of the grounding two of the cargo holds flooded and the hull was breached in several places. At the time of the grounding, the *Rena* was carrying 1733 tonnes of oil and 1368 containers, which contained about 110 tonnes of hazardous goods. The *Rena* runs on residual oil, which is the leftover material from when the lighter fractions of petroleum are removed during the refining process. On board, the ship heats the heavy fuel oil to reduce its viscosity to syrup-like consistency. Within four days this syrup-like oil spread throughout the Bay of Plenty creating a 5-kilometre oil slick.

In the first few weeks following the ship's grounding, 86 of the 1368 containers were washed overboard (Smith 2011). The containers contained goods such as timber, frozen fish, ground beef, lamb, and hazardous chemicals. The most destructive aspect of the grounding was the 420,000 litres of oil that leaked from the *Rena*. The thick residual oil coated sandy beaches, rocks and marine animals. Over 2000 dead birds were collected

from the Bay of Plenty after the *Rena* grounding. Maritime New Zealand activated a Tier 3 national oil spill response that included help from thousands of volunteers, community groups, iwi, wildlife response teams, Bay of Plenty District Health Board, University of Waikato and many others (Smith 2011). In the days following the grounding 8000 volunteers registered to help with beach clean up. This included dozens of veterinarians, bird specialists, and experts from the Department of Conservation, regional councils and zoos. On one of the first days of the oil clean-up over 700 birds were found and treated (Warne 2012).

To remove oil, the clean-up crews used chemical dispersants, high-pressured seawater jets, and raking. They were able to collect over 1000 tonnes of oiled sand and over 630 tonnes of waste from the containers (Smith 2011). There has been concern with not only the impacts from the oil spill itself but also the clean-up process. The pressured seawater jets that were used on the rocks may have not only removed the oil but also lichen, seaweed, and may have harmed the molluscs. The raking of the beaches removed the oil and with it, a large volume of sand. The use of chemical dispersants is considered to be a controversial clean-up method. The dispersant decreases the spread of the slick to the coastline and the exposure to birds and the near shore ecosystem; however it increases exposure to the underwater ecosystem and the water column communities of fish, coral, oysters, shrimp and other species (Eco Issues 2010). The trouble with this is the possibility of the toxic chemicals in the dispersant cascading up the food web, which would affect larger marine mammals and humans as well.

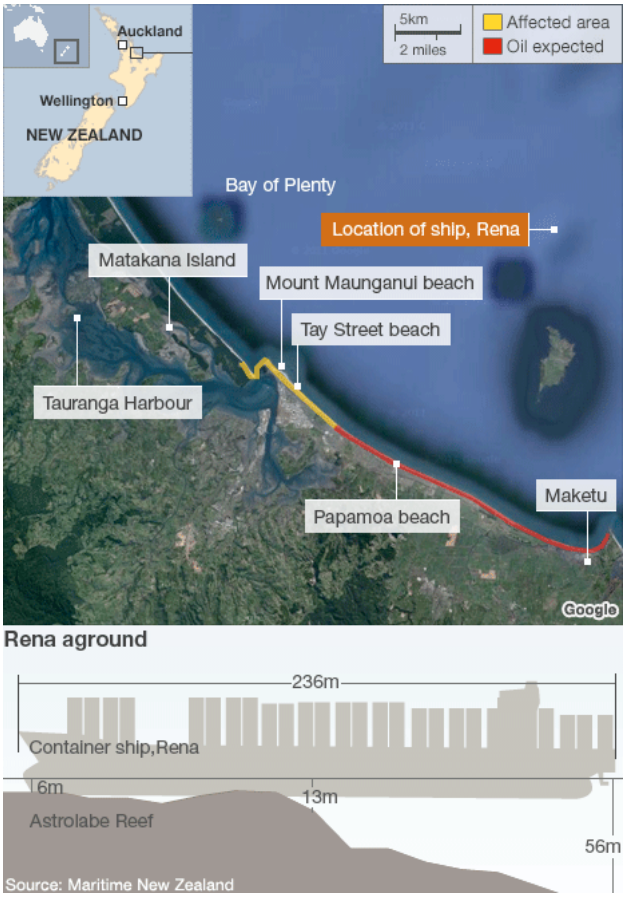

Figure 2. Location of Rena grounding

After most of the coasts were cleaned up, and the *Rena's* bunker oil removed, the salvors turned their attention to the containers that remained in the *Rena*. The possibility of a storm event or large swell knocking more containers off the *Rena* became a major concern. Therefore, five weeks after the grounding the first container was removed with a floating crane (Warne 2012). As of January 2012, 1350 tonnes of oil had been removed from the *Rena* along with 649 containers (Fresh Oil Spill NZ Herald). The *Rena* completely broke in half and the stern end slipped off the reef in January 2012. This shift and variation released a small amount of oil and a few containers. Even months after the initial grounding oil and containers continue to wash up on the coasts, thus proving the immensity of the grounding and impending long term effects.

The greatest impacted area was Motiti Island. The people that live on this island rely on the fish and shell fish as a major source of food, so when the *Rena* grounded, the oil destroyed their food source. Another concern was the possible infiltration of the contaminated water into their fresh water supply.

The major environmental impacts of the *Rena* grounding occurred along beaches, shorelines, and on seabeds. Water quality was degraded as well, which impacted kaimoana (seafood) and wildlife. The whanau (family), hapu and iwi were greatly affected since they rely so heavily on the environment; physically, culturally and spiritually. Since mauri includes all land, air, flora, fauna and water, the oil spill had an immense impact on the mauri of the Bay of Plenty.

Method

To best integrate science and indigenous culture, the Mauri Model was implemented to determine the impact the *Rena* oil spill had on the environment and the local iwi/hapu. The Mauri Model allows for the overlap and interaction between economic, environmental, social and cultural impacts, all of which inevitably occur when there is an environmental disaster. Many people rely on the environment for their livelihood, whether it be as a food source, a job source or a cultural source. Therefore, all of these features are affected and changed when the environment is altered. To the Māori, this

means that the mauri in the land has been distorted. Mauri binds and holds together the physical and spiritual components of all things (Morgan 2006). When the mauri is negatively impacted this bond is weakened which could potentially result in the being's inability to support other life (Morgan 2006). Effectively, the mauri of the environment is a direct measure of the integrity of that ecosystem. When the mauri is affected it is a direct indication of the long-term viability and sustainability of that environment or particular object (Morgan 2004). The Mauri Model is based on the four interactive aspects of our ecosystem; economic, social, cultural and environmental (Morgan 2004). The main basis of the Mauri Model is to determine whether the mauri was enhanced, diminished or remained neutral (see figure 3).

Environmental and cultural issues dramatically affect Māori values, for example, water pollution creates concern about traditional food source areas, the sanctity of streams and harbours, human health and the mauri in the ecosystem (Harmsworth 1997). The *Rena* spill threatened all of these values. Research was conducted to identify the impacts the *Rena* had on beaches and shorelines, the seabed, water quality, kaimoana and wildlife. On the shore, the oil on the beaches affected the health of the beach, flora, shellfish and fauna in the rocky shore. The contamination from the oil and antifouling paint, along with the lost containers that either washed up on shore and move along the seabed by the currents, affected many species of the food chain as well as vegetation such as seaweeds and sea grass. Some of the oil leaked from the *Rena* and washed up on the sandy and rocky shoreline while some remained in the water column, which affects the mauri of the marine ecosystem and health of the fish. Aside from the marine animals, humans were affected by the contaminated waters during clean up and from the consumption of contaminated shellfish. When oil comes in contact with fur bearing mammals, they lose their insulating and water-repelling abilities, thus dying from exposure. This issue turned out to be a major problem in the *Rena* grounding causing the deaths of 2000 birds and 13 fur seals (Smith 2011). All of these impacts greatly degraded the mauri in the Bay of Plenty.

In order to restore the mauri back into the land, the current state of the mauri must be determined. The best way to do this is to design a Mauri Model that considers the most significant features to the Māori. First, research was conducted on the *Rena*, the oil spill, the debris and their impact on all aspects of the environment. Specific indicators were assembled in order to best assess the impact. Typically, the local community would determine these indicators; however due to lack of time and resources community-invented indicators were not used in this assessment. Finally, the Mauri Model was formulated based upon the chosen indicators and given the numerical values +2, +1, 0, -1, -2 depending on the improvement or deterioration.

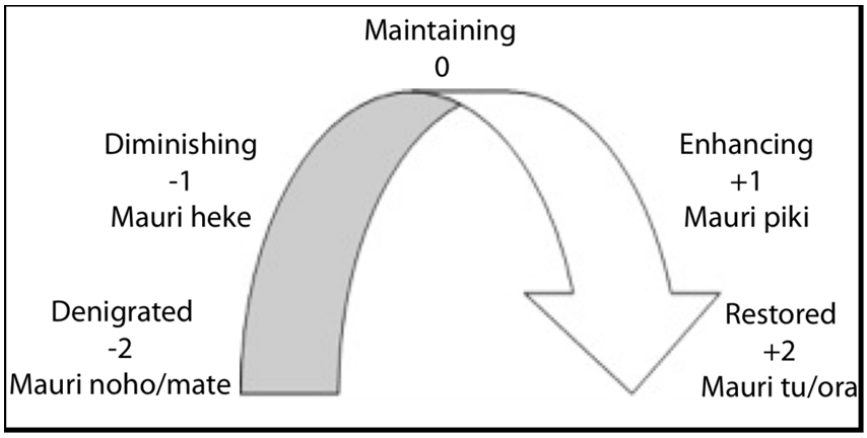

Figure 3. Graphical representation of the Mauri Model assessment (Hikuroa, Slade and Gravley 2011).

Impact on mauri

The Mauri Model was used to assess the impact the *Rena* grounding had on the mauri along the Bay of Plenty coastline. The Mauri Model is based around kaitiakitanga and takes into account four categories: Environmental, Social, Cultural, and Economic. Kaitiakitanga refers to the guardianship and protection of the environment; physical and cultural elements. A brief explanation of each indicator is presented below.

Environmental Indicators

- Anthropogenic contaminants. Any concentration of anthropogenic contaminants has a significant negative impact on mauri. In this case the use of chemical dispersants to clean up the oil has created concentrations of contaminants.
- Fuel contamination. 4,200 litres of oil leaked from the *Rena* into the ocean some of which remained in the water impacting the water quality, marine life and bird life, while the rest washed ashore.
- Timber from containers. Potential damage to marine ecosystem/seabed. Also, prevents swimming and surfing due to the dangers with timber tumbling in the surf.
- Cryolite contamination from containers. There were 21 containers (490 tonnes) containing cryolite onboard the *Rena*. This chemical is toxic to aquatic life with long lasting effects, however it is thought to rapidly dilute due to the rate of release from the packaging. Cryolite is aluminium trisodium hexafluoride that is considered low risk unless ingested or inhaled in its dry powder form ("Tauranga Incident Page").
- Bird life. Over 2000 birds were killed due to the *Rena* grounding.
- Breeding Habitats. As a result of the container and fuel contamination, coastal habitats have been impacted.
- Kaimoana (seafood). Many rely on the fish in the Bay of Plenty as a source of food and recreation. Some of the fish found in the impacted area include; kahawai (a type of schooling fish), kokiri (leatherjacket), snapper, kingfish, hapuku (grouper) striped marlin, and yellow fin tuna.
- Shellfish. Such as mussels, pāua (mullosks), tuatua (mollusk)and toheroa, kina (sea urchin), queen scallops pūpū and pipi (mullosks) were gathered from the shore.
- Coastal Habitat (including, sand, rocks, barnacles, sea grass, dunes). As a clean-up method, workers used high-powered seawater jets to clean the rocky shoreline, resulting in removal of lichens and mollusks. Cleaners also collected and removed oiled sand.
- Sediment/sand on beach. Over a thousand tonnes of sand were removed from beaches along the Bay of Plenty coastline.
- Contaminants from the hull and wreck. Toxic anti-fouling paints peeled off the damaged hull when the *Rena* struck the reef.

- Plastic beads (nurdles) and polystyrene pollution. Small plastic beads were strewn along Matakana Island beaches. These beads are known to block the digestive tract of seabirds, fish and turtles when ingested.
- Marine Mammals. Over 50 dead seals and whales found along the impacted coastline

Social Indicators

- Swimming. Many of the impacted beaches were used for local swimming as well as major tourist sites.
- Fishing. The Bay of Plenty is a common fishing area. Catches include; snapper, kingfish (haku or kahu), hapuku, striped marlin, yellowfin tuna.
- Family interaction. Almost all the impacted beaches were closed for over a month, which prevents family activities such as swimming, fishing.
- Helplessness. Locals were unable to control what pollutes/happens to their land.

Cultural Indicators

- Hosting of visitors. This refers to the Māori's inability to provide traditional foods from the sea to their guests, which can be embarrassing for the hosts.
- Psychological impacts. Close knit Māori communities in Maketu and Papamoa (predominantly Māori).
- Perishable food contamination on tapu. The washing up of shipping containers with rotting food on beaches at places regarded as tapu (sacred) such as ancient burial grounds, negatively impacts mauri considering food and tapu represent total opposites in the Māori world.
- Mana. This refers to the prestige and ability to provide food. This was negatively impacted due to decreased food supply.
- Mahinga kai. The ability to collect seafood in the traditional way.
- Flora collection. Karengo seaweed is a traditional Māori delicacy.
- Kaimoana. The oil contamination impacted the Māori customary diet.

Economic Indicators

- Cost of clean-up/restoration. The clean-up operation is estimated to cost $130 million dollars, $35 million of which is paid by New Zealand taxpayers.
- Food costs and supply. There was an increase seafood cost due to lower supply. This also includes the additional costs to families who originally collected their own seafood in the bay and now have to buy food. The rāhui (temporary restriction) prevented the public from collecting their own seafood after the spill.
- Tourism. Mount Maunganui, Tauranga and Papamoa are large tourism hubs. Most of the beaches along the coast were closed due to oil and container contamination which in turn affected tourism.
- Legal Costs. The court costs for the trial of the *Rena's* captain and navigator, who were sentenced to seven months in jail for several charges including operating a vessel in a manner likely to cause danger.
- Loss of Potential Earnings. The locals who lost business due to the lack of seafood supply and the decrease in tourism.

Assessing impact on mauri

The Mauri Model was formulated around the chosen indicators, which were given the numerical values +2, +1, 0, -1, -2 depending on the improvement or deterioration. +2 represents mauri fully restored or at its full potential; +1 indicates mauri partially restored; 0 means no change; -1 signifies diminishing mauri; and -2 means full denigration.

To determine the impact of the *Rena* alone, an assessment of mauri for the indicators chosen was conducted as a before and after – one at the time the *Rena* hit the reef, meaning prior to *Rena* induced impacts, and one for the present day. The results of that assessment are shown in Table 1.

Results

Table 1. List of indicators of impacts of *Rena* Grounding

Indicator	When Rena Grounded	Post Rena Grounding

Environmental	Anthropogenic Contaminants	1	-2
	Fuel Contamination	1	-2
	Timber Damage	1	-1
	Cryolite Contamination	0	-1
	Contaminants from the hull and wreck	0	-1
	Marine Mammals	2	-1
	Bird Life	2	-1
	Breeding Habitat	1	-1
	Fish	1	-1
	Shellfish	1	-1
	Coastal Habitat	2	-1
	Plastic Beads and Polystyrene	0	-1
	Sediment/Sand (beach)	2	-1
Social	Swimming	2	-2
	Fishing	2	-2
	Family interaction	2	-1
	Helplessness	1	-2
Cultural	Mana	2	-1
	Mahinga Kai	2	-1
	Flora Collection	1	-2
	Psychological Impacts	2	-2
	Perishable Food Contamination on Tapu	2	-1
	Hosting of Visitors (tradition)	2	-1
	Kaimoana	2	-1
Economic	Cost of Clean-up/Restoration	2	-2
	Food Costs and Supply	0	-1
	Tourism	2	-1
	Loss of Potential Earnings	0	-1
	Legal Costs	2	-1
	Mauri Assessment	+1.4	-1.3

Discussion

According to the mauri assessment, these results show that the *Rena* grounding negatively impacted the mauri of the Bay of Plenty coast, as expected. Prior to the grounding the coast had some human impact that prevented the mauri from being mauri ora (restored). There was a negative shift of 67.5% from +1.4 to -1.3.

The values in the above table were specifically chosen based upon the indicator's abundance, availability, and the severity of impact. Here are a few examples to demonstrate the reasoning behind the numerical values. Before the *Rena* grounded the beaches along the coast were open all year for swimming thus receiving a +2 because there was nothing hindering the people's ability to swim. However, after the oil spill, the

beaches were closed for at least a month restricting any swimming, therefore receiving a score of -2.

Fuel contamination received a “before” score of +1 because there are boats and large ships that travel through the Bay of Plenty that produce a small fuel concentration in the water, however the 420,000 litres of fuel oil leaked from the *Rena* brought the score to a -2.

For the hapu in the Bay of Plenty area it is tradition to serve their guests food from the sea. Before the oil spill this tradition was not significantly affected hence receiving a score of +2. After the significant fuel and debris contamination the iwi’s instated the rāhui (temporary restriction) which prevented the collection of seafood, meaning the Māori were unable to serve their traditional foods to guests which is embarrassing to the hosts. This cultural indicator received a -2 due to the significance of this tradition and the longevity of the rāhui in the area.

A clean-up cost was unnecessary until the *Rena* hit the reef; therefore this indicator was given a score of 0 because of its neutrality. Due to the $130 million clean-up cost, the “after” grounding score was -2 since this is a very large amount of money. For the indicators that received a negative 1, it was clear that the mauri was negatively impacted but not completely destroyed. A positive 2 denotes almost pristine conditions with very little to no human impact, while a negative 2 indicates complete damage, incapable of use.

Conclusion

The *Rena* grounding is considered the worst environmental disaster to occur in New Zealand history. There are no previous studies assessing the impact the oil spill had on mauri in the Bay of Plenty, therefore, it was important to look into the short and long term impacts of this tragedy. This report assigned numerical values to the state of mauri using the Mauri Model (Morgan 2006). This model determined the extent of the *Rena* oil spill impact while simultaneously considering both science and indigenous culture. The

Mauri Model in this report shows a significant degradation in the mauri in the Bay of Plenty. To further this assessment, it would be valuable to look into the limitations of this study. Firstly, water sampling would be beneficial in order to determine the measure of oil and chemical contamination in the water column. To construct a more comprehensive Mauri Model, the local iwi and residents in the Bay of Plenty should develop indicators and assign the numbers they believe to be accurate. This would not only improve the accuracy of the model but would also help determine which aspects of the four well-beings are of most importance to the locals.

This report and the Mauri Model are imperative in determining the current degradation of the mauri, which in turn leads into restoration. From here, iwi, trustees and the New Zealand Government can make informed decisions on repairing the ecosystems without dismissing indigenous knowledge. The findings in this report form a foundation for the restoration of the Bay of Plenty. The ultimate goal would be to convert all the negative numbers to positive 2, meaning the mauri would be completely restored. The restorative works will likely take years to carry out and fully restoring the mauri will prove to be a demanding and difficult process. However, prepared with the Mauri Model analysis, the trustees can begin restoring the mauri and maintain their roles as kaitiaki.

Glossary

(Māori to English)

Hapu……..clan, tribe, kinship group
Hapuku……..grouper (fish)
Iwi…….tribe, people
Kahawai……an edible coastal schooling fish
Kaimoana……..seafood, shellfish
Kaitiaki……..gaurdian, keeper
Kaitiakitanga…….guardianship
Kina……...sea urchin
Kokiri……leatherjacket (fish)
Mahinga kai……..ability to collect seafood in traditional way, garden, fishery
Mana……..inherited status, prestige, ability to provide food
Mauri…….the energy that binds and animates all things in the physical world
Moana……sea, ocean
Papatuanuku……..Earth Mother
Pāua/Pūpū ……....edible univalve mollusks
Pipi/Tuatua……edible bivalve found at low tide just below the surface of the sand
Rāhui……..temporary restriction
Ranginui……Sky Father
Takutai……..coast, shore
Tangata Whenua …...indigenous people of the land
Tapu……...sacred
Tarakihi…….silver marine fish
Whanua…….family

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