# Economic Analysis Fiordland Marine Area Pathways Management Plan

## Report prepared for Environment Southland

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# 1 Background

The Fiordland Marine Area is an area that spans from Big Bay in the north to Te Waewae point in the South and 12 nautical miles offshore. Fiordland is well understood for its scenic uniqueness, but there are also significantly unique ecological communities associated with the low light environments caused by the tannin enriched freshwater floating on top of the sea water in the fiords. These marine communities are threatened by the potential introduction of exotic pest species, most immediate of which is invasive marine seaweed *Undaria pinnatifida* (*Undaria*) which is established in Bluff Harbour and Stewart Island, and is the subject of an eradication programme currently underway in Sunday Cove in Breaksea sound.

Environment Southland (ES) has developed a marine pest Pathways Management Plan for the Fiordland Marine Area (FMA) under the Biosecurity Act 1992. This plan was developed in a partnership with DOC, MPI and the Fiordland Marine Guardians, and is intended to reduce the spread of marine pests into the FMA. The plan has a number of components including education, surveillance, and the requirement for vessels entering the FMA to comply with clean vessel, gear and residual seawater standards and to obtain a Clean Vessel Pass.

This report describes an analysis of the benefits and costs of the FMA. It follows the requirements of the recently released National Policy Direction for Pest Management (2015) (NPD) based on the Guidance Document (V 1.0, September 2015).

Under this guidance the requirement for analysis is required to be ranked. The following assessment criteria outcomes are identified:

- There is potential for moderate interest from vessel operators, with both support and opposition from within this group.
- The relationship between costs and benefits is unknown; and
- There is medium uncertainty, with reasonably high certainty about the impacts and spread risk of marine pests in Fiordland, but high uncertainty about the effectiveness of the measures in preventing their spread into the FMA; and
- There is only a low – medium amount of information available as to the costs and impacts of the proposed Pathways Management Plan.

Under the flow chart in Figure 1 of the Guidance, the Pathways Management Plan would be on the boundary between a low and medium level of analysis. For this reason a medium level of analysis has been adopted. Medium analysis requires that:

- Describe the costs (including effects on values) of each option and quantify / value as many as practicable;
- Describe the benefits of each option and quantify / value as many as practicable;
- Apply cost/benefit analysis techniques for each option;
- Take into account the risks to being successful - as required by clause 6(2)(g) of the NPD; and
- Conclude by choosing the most appropriate option.

The analysis incorporates risk by calculating a break even probability of success

# 2 Scenarios

The analysis adopts two scenarios of action associated with managing the incursion of pests into Fiordland.

1. Voluntary action or Do Nothing scenario, in which no action is undertaken to manage the entry of pests into the FMA other than the current voluntary removal of weeds from hulls and gear.
2. Pathways Management Plan, which includes a number of actions:
   a) Public awareness and education
   b) Vessel operators to hold a Clean Vessel Pass when entering the FMA;
   c) Surveillance
   d) Enforcement

Impacts for a range of costs (administration, education, surveillance, enforcement and clean vessel costs) and potential benefits (reduced impacts for commercial fishing, recreation, tourism, and biodiversity) are assessed. The results are incorporated into a discounted cashflow analysis over 50 years. The Guidance document suggests 30 years as an appropriate period for analysis, however the completion of spread under the approach assumed here is not completed until year 43, so a 50 year time horizon is more appropriate.

The discount rate of 8% is adopted, based on Treasury rate in the Guidance document, which is appropriate for a public sector policy intervention.

The Net Present Value (NPV) results for each cost and benefit are provided, and an estimate of the potential impact of different levels of success in preventing pests reaching the FMA is calculated. The results are presented as the value which would need to be attributed to biodiversity in order for the Pathways Management Plan to be more worthwhile than doing nothing.

# 3 Costs of Pathways Management Plan

## 3.1 Administration

There are a number of agencies involved in management of the Pathways Management Plan. Costs were provided by Environment Southland, based on estimate by the different agencies involved. The costs are incurred for public awareness and education, the development and management of the Clean Vessel Pass, and surveillance and enforcement. These costs are shown in Table 1 below. The voluntary action programme is assumed to have no specific costs for administration.

*Table 1: Estimated administration costs (Environment Southland, pers.comm.)*

| Item | Year 1 | Year 2 onward |
|---|---|---|
| **Public Awareness/education** | $7,000 | |
| **Clean Vessel Pass** | $17,000 | $7,500 |
| **Surveillance and enforcement** | $117,750 | $112,500 |
| **Total** | $141,750 | $120,000 |

## 3.2 Clean Vessel management

Under the voluntary action scenario vessels are expected to maintain their vessels in a state that maximises for them the fuel and vessel management benefits associated with a clean hull. Gear is expected to be kept clean to the extent that it reduces maintenance and fouling/tangles, and residual water is maintained to the extent that it fits with standard vessel hygiene and maintenance requirements.

For the Pathways Management Plan scenario the Clean Vessel Pass is likely to include additional costs which are discussed below.

The requirements for clean vessels include gaining a Clean Vessel Pass – this is not onerous and can be filled out online and is only required annually. While the pass itself is self-regulating, in order to meet the standards for clean vessel, gear and residual seawater (bilge and ballast) the following requirements must be met:

- Vessel - only slime and gooseneck barnacles.
- Gear – visibly clean and free of fouling and sediment
- Residual water – treated and/or is clear and free of sediment.

There are a varieties of ways in which the requirement for clean vessels will manifest itself. These include increased antifouling, inspection, spot cleaning, and gear cleaning, and residual water cleaning or treatment. Branson (2012) and Sinner et al (2009) both describe a variety of costs associated with attaining clean vessel standards. Sinner et al largely identify more frequent antifouling and hull treatment as the main options, while Branson draws on NIWA work for MPI to describe costs for a range of vessels and sizes. This analysis relies on the Branson work, but assumes that vessel operators maintain a largely fouling free vessel for fuel reasons, and only inspection and spot cleaning is required above the voluntary action scenario to maintain clean vessel status. It is also worth noting that with the Craft Risk Management Standards for biofouling (CRMS), vessels arriving in New Zealand will have reduced incidence of fouling. Once the CRMS provisions are compulsory (from 2018), this is likely to reduce the amount of fouling on contract deep sea vessels, cruise ships and any other overseas sourced vessels arriving in Fiordland. In general these costs should be conservative, but information from a deep sea vessel operator which is occasionally in the FMA indicates that costs for these operators could be very significant if specific trips were required to undertake antifouling. Costs in this respect would include[1]:

[1] Bill Healey, Sealord, pers.comm.

- Steaming to dry dock – up to $50,000/day
- Pilot hire - $5000
- Pre-treatment - $10,000
- Dry dock hire - $25,000
- Lost fishing time - $50,000 - $100,000 per day.

However visits to the FMA for these vessels are infrequent, with this operator indicating only 1- 2 fishing trips and up to 10 transits depending on the start point, with potential to avoid the area. It seems appropriate therefore that the costings approach adopted below is used for the analysis, noting the potential for significantly greater costs for some operators depending on the circumstances.

The costs for vessels spot cleaning are based on average figures from Branson[2] for all vessel types excepting commercial fishing, for which the 25m vessel figures are used. The commercial fisher vessel is likely to be an overestimate for the typical fishing vessel in Fiordland, but is an adequate and conservative assumption for the purpose of this analysis. Only one spot cleaning per year is assumed, but again this could be exceeded depending on the circumstances. However the assuming an average cost based on a 25m vessel contains some leeway for more frequent cleaning for smaller vessels, which are the more frequent (in terms of number of trips) visitors to the FMA[3].

Costs for cruise vessels are included as per Branson 2012. However it should be noted that these vessels will be covered by the CRMS when they enter the country, and furthermore may be managed by mechanisms outside of the Pathways Management Plan. The costs for these vessels are included but noted as potentially lower.

The clean vessel costs are shown for each category of likely cost (hull cleaning, inspection, gear cleaning, and residual water treatment) in Table 2, Table 3, Table 4, and Table 5. Costs for inspection are based on discussions with a dive operator in Bluff[4] with costs for inspecting a 25m vessel estimated at $390, and $190 for a 14 m vessel. The $500/inspection allows for some leeway in the estimates. Gear cleaning and residual water treatment are nominal assumptions and could be significant underestimates for very large trawlers. Table 6 shows the estimated number of vessels travelling to Fiordland (Sinner, Forrest, O'Brien, Piola, & Roberts, 2009).

[2] Updated to 2015 using Reserve Bank CPI index
[3] The smaller vessels are used for the fresh market, with less need to accommodate the large catches because they return frequently to base to unload for the fresh market.
[4] Mike Haines, pers.comm.

*Table 2: Estimated costs for spot cleaning of vessels travelling to Fiordland, additional to voluntary action ($/annum, from Branson 2012)*

| Vessels | Cost for spot clean/out of water | Opportunity cost | Frequency/ year | Proportion requiring treatment | Total (including CPI update) |
|---|---|---|---|---|---|
| Commercial fishing | $3,500 | $2,944 | 1 | 35% | $112,770 |
| Recreational (yachts and launches) | $420 | 0 | 1 | 80% | $33,600 |
| Commercial charters and tourism | $3,500 | 0 | 1 | 35% | $17,150 |
| Research and agency | $3,500 | 0 | 1 | 35% | $4,900 |
| Cruise | $13,750 | 7000 | 1 | 63% | $235,305 |
| **Total/annum** | **$24,670** | | | | **$403,725** |

*Table 3: Estimated costs for inspection of vessels travelling to Fiordland, additional to voluntary action (from Branson 2012)*

| Vessels | Inspection cost | Proportion requiring inspection/annum | Frequency (per annum) | Total/annum |
|---|---|---|---|---|
| Commercial fishing | $500 | 50% | 2 | 25,000 |
| Recreational (yachts and launches) | 0 | 0 | 0 | - |
| Commercial charters and tourism | $500 | 50% | 2 | 7,000 |
| Research and agency | $500 | 50% | 1 | 1,000 |
| Cruise | 0 | 0% | - | - |
| **Total** | | | | **$33,000** |

*Table 4: Estimated costs for gear cleaning on vessels travelling to Fiordland, additional to voluntary action (from Branson 2012)*

| Vessels | Costs for inspection and cleaning | Proportion requiring gear cleaning/annum | Total/annum |
|---|---|---|---|
| Commercial fishing | $500 | 10% | $30,000 |
| Recreational (yachts and launches) | 0 | | |
| Commercial charters and tourism | 0 | | |
| Research and agency | 0 | | |
| Cruise | 0 | | |
| **Total** | | | **$30,000** |

*Table 5: Estimated costs for treatment of residual water for vessels travelling to Fiordland, additional to voluntary action (from Branson 2012)*

| Vessels | Costs for inspection and cleaning | Proportion requiring gear cleaning/annum | Total/annum |
|---|---|---|---|
| Commercial fishing | $100 | 50% | $30,000 |
| Recreational (yachts and launches) | $100 | 80% | $12,000 |
| Commercial charters and tourism | $100 | 80% | $3,360 |
| Research and agency | $100 | 80% | $1,280 |
| Cruise | 0 | | |
| **Total** | | | **$30,000** |

*Table 6: Vessel movement assumptions, additional to voluntary action (from Sinner, Forrest, O'Brien, Piola, & Roberts, (2009)*

| Vessels | Number of vessels visiting FMA | No vessels Bluff resident | Trips into FMA /year (average) | Average days/trip |
|---|---|---|---|---|
| Commercial fishing | 50 | 25 | 12 | 10 |
| Recreational (yachts and launches) | 100 | 10 | 1.5 | 5 |
| Commercial charters and tourism | 14 | 4 | 3 | 60 |
| Research and agency | 4 | 0 | 4 | 14 |
| Cruise | 18 | 0 | 4 | 1 |
| Total | 186 | 39 | | |

# 4 Benefits of Pathways Management Plan

Under the voluntary action/Do Nothing scenario no measurable difference is expected from historic experience with marine pests, which has seen reasonably rapid spread of marine pests within New Zealand. The impacts described here are therefore the costs saved as a result of preventing spread into the FMA.

The estimates for a number of benefits were calculated either from specific information (marine tourism), or where specific information was not available by apportioning national level benefits from Branson (2012) to the FMA on an area basis.

Recreational fishing was excluded because no good figures are available on recreational fishing in the FMA – some good data (Davey & Hartill, 2011) is available on the breakdown of recreational fishing activity, but not in a format that allows extrapolation to total population of recreational fishers in the FMA, and recreational shellfish gathering and recreational use of beaches were excluded because they are not considered to be significant activities in the FMA. Aquaculture, which currently does not take place in the FMA, is also excluded.

Fuel benefits were calculated by Branson (2012), and it is likely that there will be some incidental benefits from more frequent antifouling. The limited discussion with the fishing industry has indicated that the preference of vessel operators is to maintain the hull antifouling at limited levels because of the high fuel penalties associated with fouling. The spot cleaning assumed in this analysis as a result of these comments means there are not likely to be major impacts on the fuel costs, and so an associated benefit has not been included in this analysis.

## 4.1 Incursion response

Incursion response is estimated variously at $51,120 by Dustow (2010) based on the cost for the *undaria* incursion response, or $380,000/year by Branson (2012) based on the average of 6 national incursion responses over the period from 2005/06 to 2010/11. The Branson costs were incurred at a national level for between 2 and 4 years, and the figure of 3 years was adopted. The Branson (2012) figures are considered more appropriate here because they are an average of a number of previous incursion responses while the Dustow (2010) figures are a projection of the costs. The Branson figures may overestimate costs because of the greater potential scale of national incursion responses, but conversely the difficulty of operating in a remote Fiordland environment is likely to increase the costs associated with a Fiordland response. In the absence of a reasonable means of adjusting the national estimates up or down, they are adopted directly.

The Branson (2012) analysis assumes that both incursion response and spread occurs. This appears appropriate because to date incursion responses do not appear to have been successful in halting spread. This has been adopted for the Fiordland situation, but it may be that the incursion responses either do not happen, or alternately are more successful at preventing spread. If either of these were to occur, the benefits of the Plan would be overestimated.

## 4.2 Commercial fishery

The commercial fishery impacts are calculated from the Branson 2012 estimates, with pro rating for the proportion of New Zealand marine area that occurs within the FMA. This proportion is 5.1%, and is derived from the total area of New Zealand territorial waters (182,000km$^2$) and the size of the FMA (9,280km$^2$).

Branson (2012) calculated the total loss for New Zealand commercial fishery at $1.1 million per year per species introduced at full spread, which when applied to the FMA on an area apportionment, which gives an estimate of $0.56 million per species per annum at full spread.

The Sinner et al (2009) paper cites the value of quota in the FMA at $200 million. On an annualised basis at 9% as per Branson (2012), this gives an annual return of $18 million per annum. The impact suggested by the pro rating of the national estimates is approxiamtely 3% of the annual returns, which seems a reasonably conservative estimate of impact.

## 4.3 Marine tourism

Butcher (2006) estimated the number of visitors to Milford Sound and Doubtful Sound at 560,000 annually. Branson (2012) used GDP loss as a proxy for benefit from marine tourism, which is likely to overestimate the loss but is sufficient for the purposes here. She used an assumption of 1.4% reduction in marine tourism expenditure resulting from reduced visitor numbers associated with loss of amenity from pest incursion. Using these assumptions, and the Butcher (2006) estimate of the daily expenditure ($120) and ratio of GDP to expenditure (0.5775), updated using Reserve Bank inflation statistics between 2005 and 2015, gives an annual GDP reduction of $680,000 from pest incursions at full spread.

## 4.4 Indigenous Biodiversity

The estimated loss for New Zealand indigenous biodiversity in Branson (2012) is $0.6 million per annum per species introduced, which converts to $0.03 million per annum per marine pest species for the FMA at full spread based on an area pro rate as for the commercial fishery. This seems a very low estimate for biodiversity impact in the FMA, given its unique flora and fauna, and relatively pristine nature. Sinner, Roberts, & Piola, (2009) assessed the impact introduced marine pests in Fiordland, and estimated the benefits of Fiordland's marine environment at $750 million ($1000/ha) based on an indicative multiplication of the $400/ha derived from Patterson & Cole (1999). This figure is also used in Dustow (2010) in her assessment of the impacts of undaria in Fiordland. This Patterson and Cole (1999) based figure involves some double counting however as it includes fisheries and marine tourism benefits.

The uncertainty around valuing biodiversity, and the disparity between the Branson (2012) and the Sinner, Roberts and Piola (2009) figures means a definite esitmate was not able to be made for the impact on biodiversity. Instead biodiversity is used as a balancing item – i.e. it is left to the decision maker to determine whether they will assign sufficient value to reduced impact on biodiversity to make the strategy worthwhile.

## 4.5 Assumption regarding frequency of arrival and spread

Branson (2012) modelled the arrival and spread of pests as a near certainty under a Do Nothing scenario, with one arriving each year from overseas. This is based on the historic rage of introduction of 34 new species over a nine year period from 2000 – 2008. Based on the 1226 unique vessel arrivals per annum into the FMA, it is expected that Fiordland's rates of introduction on a pro-rata basis would be 15% as great as national arrivals. There are various offsetting factors, with larger ships more prevalent as national arrivals than Fiordland arrivals potentially indicating a lower rate (less hull area for marine pests to hitchhike on), but conversely the shorter distance between ports for local arrivals may mean greater opportunity to spread. A straight pro rata basis is adopted as a main estimate giving an estimated 0.6 arrivals of marine pests annually in the absence of regulatory control.

Branson (2012) also estimated a variety of rates of spread around New Zealand, from which we have adopted the simple average of aquaculture spread rates (18 years). This assumes that a species will spread to occupy its potential habitat in a local area at approximately the same rate as it would spread at a national level. As for arrival rates this has offsetting factors – Fiordland is smaller than the national are over which the Branson spread was modelled, but conversely there are relatively few vessel movements within and between the fiords.

These two factors are used to give a proportion of maximum impact for each year in the absence of any control measures. The number of potential species identified as a risk in Branson (2012) is divided by the annual arrival rate (0.6) to give a period over which maximum arrival rate is achieved (23 years)[5]. The spread rate (17 years) is then added onto that, to give a time period (40 years) by which maximum impact is assumed to have been achieved. The impact between year 1 and maximum impact (year 40) is interpolated linearly.

[5] This is not strictly correct on a probabilistic basis, but is appropriate for a simplified analytical approach adopted here.

The voluntary action scenario in the Branson (2012) analysis does allow for some reduction of risk, however this is associated with programmes of action in overseas jurisdictions, which are not relevant here. Therefore no difference in rates of arrival or spread between the voluntary action and Do Nothing scenarios are assumed in this analysis.

# 5 Risk

## 5.1 Assessment of Risks

This section assesses the extent to which the proposed option for the Pathways Management Plan is likely to be affected by risks. This assessment is taken in accordance with Section 6(3) of the NPD.

a) The technical and operational risks of the programme.

   The technical and operational risks are relatively minor. Hull cleaning is a well established operation, both in a hauled out or in water situation. If no species are present on the hulls or gear, there is little risk of spread into the FMA. There are no particularly technical or operational issues in this regard.

b) The extent to which the Pathways Management Plan will be implemented and complied with.

   - The implementation and compliance risks are the major source of risk associated with the plan.
   - The Plan requires self-policing by vessel owners and operators, with the Clean Vessel Pass a self-assessed process.
   - There appears to be general recognition in the community of the value of protecting the FMA, although the extent to which the objectives of the Plan are supported by vessel owners is unknown.
   - The costs of compliance are relatively significant, particularly for vessels that are not currently cleaned regularly. However it should also be noted that there are potentially some fuel benefits likely to be gained by cleaning heavily fouled vessels that are not currently cleaned regularly.
   - In order to exclude spread of marine pests into the FMA 100% compliance with the Pathways Management Plan would be needed. However lower compliance rates that reduce the rate of spread into the FMA are still likely to produce some benefit.
   - Monitoring of vessels will occur, but only a small sample of vessels visiting the FMA are able to be monitored with the level of resources proposed.

   These range of factors mean that a significant risk of non-compliance does exist, but the extent to which the Clean Vessel Pass requirements will be adhered to is unknown. For that reason the risks are represented in the Results section as a range in risk of arrival into the FMA.

c) Risks that compliance with other legislation will adversely affect implementation of the plan

There are some risks from RMA and HASNO legislation associated with hull cleaning and antifouling, which will limit where and how these activities can take place and the extent to which cleaning can take place in the water. However these restrictions have been present for a number of years and are well understood. They have been taken into account in the development of the plan and its requirements. No other risks from legislation impacting on achievement of the Pathways Management Plan are known.

d) Risks that public or political concerns will adversely affect implementation of the plan

While risks of a public or political change always exist, there appears to be general public and political support for the Plan. Enforcing cleaning requirements on vessel operators is potentially politically unpopular, which does represent a risk from a political perspective.

e) Other material risks

No other material risks are known at this stage.

### 5.2 Mitigation of risks

The main risks are associated with non-compliance with the Clean Vessel requirements, for which the primary methods of mitigation are likely to be education of vessel operators, and surveillance and enforcement.

Education about the requirements of the Pathways Management Plan is allowed for in the operational costings already. Since there are a limited number of vessel operators regularly visiting the area, and because there are a limited number of departure/entry points, the likelihood is that the education plan will be reasonably effective. It is expected therefore that no further reduction in risk will be achieved by increasing the education effort and increased mitigation from this source is not included.

Surveillance and enforcement is also allowed for in the programme costings at ~$100,000 per annum. Additional surveillance and enforcement will reduce the risks, but in order to ensure 100% compliance every vessel would need to be inspected on every trip into the FMA. This would substantially increase costs and more importantly would increase the public and political risks associated with the Plan. We assume therefore that the current level of monitoring offers about the optimum level of risk reduction, and no further mitigation is allowed for from this source. This assumption could be tested during consultation on the proposed Plan.

The mitigation of public and political risk is best achieved by wide socialisation of the proposal prior to implementation, and by minimising the costs associated with the Plan. It appears that these have both been attempted by the proponents of the Plan, and it is likely therefore that risks from this source have been adequately mitigated. No further mitigation of this risk source is allowed for.

## 6 Results

There is little information on which to base an assessment of the risk of arrival with the Pathways Management Plan in place. This analysis therefore adopts the approach whereby a range of risks are assumed, with the breakeven assumption regarding the value of biodiversity and level of risk being the decision making criteria.

The results are presented in two forms which follow the format laid out in the NPD Guidance. Using Option 1 approach, a 50% risk of non-achievement of the plan objectives is assumed.

This 50% risk is incorporated into the analysis, and an expected value of the costs and benefits estimated.

The second approach uses the Option 2 method in the NPD Guidance. This uses a range of failure risks, and estimates the breakeven value that would need to be assigned to biodiversity values in order for the Plan to be worthwhile.

## 6.1 NPD Option 1 Results

The results for the analysis are shown in Table 7 for the 50% risk of arrival, and these are shown in greater detail in Appendix A. The results show that there are potentially significant impacts associated with the Do Nothing Scenario, with impacts associated with incursion response forming a significant part (57%) of the $12.43 million NPV cost of that option. However the Pathways Management Plan potentially also has significant costs associated with administration and clean vessel requirements, at a total cost of $15.6 million.

The net benefit of the Pathways Management Plan is the difference between the outcomes under the Do nothing/voluntary scenario and those under the Pathways Management Plan. This difference in outcomes therefore at a 50% risk of arrival is NPV -$3.17 million – i.e. the Pathways Management Plan has costs NPV $3.17 million more than the Do Nothing scenario at a 50% risk of arrival. This represents the value that would have to be exceed from the prevention of damage to biodiversity and ecological health in the FMA in order for the Pathways Management Plan to be worthwhile.

It should be noted that a significant proportion (44%) of the costs are associated with the assumed cleaning of cruise vessels. As noted above, whether these costs would be incurred is not clear, and so the results should be seen as conservative in that respect.

*Table 7: Results for key impact items with a 50% reduction in risk of arrival for Pathways Management Plan ($ million NPV (8%))*

| | ***Do nothing/ voluntary*** | ***Pathways Management Plan*** | ***Net Do Nothing – Pathways*** |
|---|---:|---:|---:|
| Administration | | $1.73 | -$1.73 |
| Clean Vessel Pass | | $6.28 | -$6.28 |
| Incursion response | $7.09 | $4.15 | $2.94 |
| Commercial fishing | $2.86 | $1.84 | $1.02 |
| Marine tourism | $2.48 | $1.59 | $0.88 |
| **Total** | **$12.43** | **$15.60** | **-$3.17** |

## 6.2 NPD Option 2 method

Because the actual risk of non-compliance is unknown, this Option 2 approach estimates the breakeven value that would be required to be assigned to the biodiversity values for a range of risk. The results of this analysis are shown in Table 8. This shows that with an 80% risk of arrival associated with the Pathways Management Plan, biodiversity values protected would need to exceed $6.4 million NPV in order for the plan to be worthwhile. The plan would need to have a threshold risk of arrival of no more than 25% in order for there to be no value attributed to biodiversity protected and the plan still be worthwhile.

*Table 8: Breakeven/exceedance value for biodiversity values in order for the Pathways Management Plan to be worthwhile under a range of different risk assumptions ($million NPV(8%))*

| **Risk of non-compliance with Pathways Management Plan** | 100% | 80% | 60% | 40% | 20% | 10% |
|---|---|---|---|---|---|---|
| **Breakeven value of saved biodiversity** | $8.01 | $6.40 | $4.34 | $1.84 | -<br>$1.10 | -$2.70 |

## 6.3 Discussion

The analysis shows that there are significant potential costs associated with the Pathways Management Plan. Most of these costs are from the Clean Vessel programme, and the majority of this is from inspection and cleaning of vessels. Some caution is warranted with these figures. They are abstracted from the Branson (2012) report, and the figures for fishing vessels are for 25m vessels, where the majority of the fleet visiting Fiordland is likely to be smaller than this. The larger deep sea vessels are reported (Talleys and Sealord) to only infrequently visit the area and could potentially transit further offshore to avoid the zone. These vessels have been included in the total costs, but may not actually incur significant costs. Similarly the two small vessel operators spoken to did not expect to incur any costs because:

- One operated a trailerable craft which was pulled from the water between trips.
- The other cleaned the hull annually and maintained it in a clean state for fuel reasons, and rarely experienced hull fouling due to speeds travelled.

Similarly as discussed above the costs for cruise vessels, which make up a large part of the overall costs, my not be incurred as part of the plan.

However on the other hand survey information indicates that hull fouling occurs more frequently than vessel operators expect, so costs have been included for a proportion of vessels (35% - 80%). Inspection, gear and residual seawater costs have also been included, but these should be regarded as indicative only, and are not based on any reliable data source.

The major items of benefit have been adapted from a national study, and the degree to which these apply to the Fiordland situation are unproven. However they provide an indicative point of comparison for the vessel and administrative costs of the programme, and suggest that overall the known benefits and costs are of a similar order of magnitude if not of value.

The analysis also assumes that incursion response will be undertaken for all pest incursions in the absence of the Pathways Management Plan, and that these responses are not effective in preventing the establishment and spread of the pests. It may be that incursion responses either do not occur, or when they do occur they reduce or prevent the spread of marine pests. To date incursion responses to marine pests do not appear to have been successful in halting spread, but it may be that they have reduced spread. The extent to which this may occur, and the associated reduction in benefit associated with the Plan, is unknown.

However the major unknown and unquantifiable variables are the value from protection of biodiversity in the FMA, and the reduction in risk that results from the introduction of the Pathways Management Plan. Therefore the results are most appropriately viewed as what combination of risk and biodiversity value is required to be accepted in order for the plan to still be worthwhile. The results of this analysis in Table 8 suggest that at high risk of arrival

(>=80%) even with the plan, values of $6 - $8 million NPV would need to be attributed to biodiversity protected. At smaller risks of arrival (<25%) with the Pathways Management Plan, the strategy would be worthwhile even without any protection of biodiversity.

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# Appendix A Cashflow results year 1 – 10, 49 and 50. 50% reduction in risk of arrival

| Year | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 49 | 50 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Costs - additional costs under Pathways Management Plan | | | | | | | | | | | | | | |
| | | NPV | | | | | | | | | | | | |
| *Administration* | | *$1,734,096* | $141,750 | $141,750 | $141,750 | $141,750 | $141,750 | $141,750 | $141,750 | $141,750 | $141,750 | $141,750 | $141,750 | $141,750 |
| *Clean Vessel Pass - cleaning, inspection etc* | *Commercial fishing vessels* | *$2,419,418* | $197,770 | $197,770 | $197,770 | $197,770 | $197,770 | $197,770 | $197,770 | $197,770 | $197,770 | $197,770 | $197,770 | $197,770 |
| | *Recreational (yachts and launches)* | *$557,847* | $45,600 | $45,600 | $45,600 | $45,600 | $45,600 | $45,600 | $45,600 | $45,600 | $45,600 | $45,600 | $45,600 | $45,600 |
| | *Commercial charters and tourism* | *$336,543* | $27,510 | $27,510 | $27,510 | $27,510 | $27,510 | $27,510 | $27,510 | $27,510 | $27,510 | $27,510 | $27,510 | $27,510 |
| | *Research and agency vessels* | *$87,836* | $7,180 | $7,180 | $7,180 | $7,180 | $7,180 | $7,180 | $7,180 | $7,180 | $7,180 | $7,180 | $7,180 | $7,180 |
| | *Cruise ships* | *$2,878,600* | $235,305 | $235,305 | $235,305 | $235,305 | $235,305 | $235,305 | $235,305 | $235,305 | $235,305 | $235,305 | $235,305 | $235,305 |
| *Total* | | **$8,014,342** | **$655,115** | **$655,115** | **$655,115** | **$655,115** | **$655,115** | **$655,115** | **$655,115** | **$655,115** | **$655,115** | **$655,115** | **$655,115** | **$655,115** |
| Impacts - Do Nothing/Voluntary Action scenario | | | | | | | | | | | | | | |
| | | NPV | | | | | | | | | | | | |
| Probabilistic spread (% maximum species number and site occupancy) | | | 2% | 5% | 7% | 10% | 12% | 15% | 17% | 19% | 22% | 24% | 100% | 100% |
| *Incursion response* | | *$7,093,804* | $684,000 | $684,000 | $684,000 | $684,000 | $684,000 | $684,000 | $684,000 | $684,000 | $684,000 | $684,000 | $0 | $0 |
| *Commercial fishing* | | *$2,864,158* | $19,006 | $38,012 | $57,018 | $76,024 | $95,030 | $114,036 | $133,042 | $152,048 | $171,055 | $190,061 | $784,000 | $784,000 |
| *Marine tourism* | | *$2,475,919* | $16,430 | $32,860 | $49,289 | $65,719 | $82,149 | $98,579 | $115,008 | $131,438 | $147,868 | $164,298 | $677,728 | $677,728 |
| Total | | **$12,433,881** | **$719,436** | **$754,872** | **$790,307** | **$825,743** | **$861,179** | **$896,615** | **$932,051** | **$967,487** | **$1,002,922** | **$1,038,358** | **$1,461,728** | **$1,461,728** |
| Impacts - Pathways Management Plan scenario | | | | | | | | | | | | | | |
| | | NPV | | | | | | | | | | | | |
| Probabilistic spread (% maximum species number and site occupancy) | | | 2% | 3% | 5% | 6% | 8% | 9% | 11% | 12% | 14% | 15% | 76% | 77% |
| *Incursion response* | | *$4,150,994* | $342,000 | $342,000 | $342,000 | $342,000 | $342,000 | $342,000 | $342,000 | $342,000 | $342,000 | $342,000 | $0 | $0 |
| *Commercial fishing* | | *$1,843,073* | $12,139 | $24,279 | $36,418 | $48,557 | $60,697 | $72,836 | $84,975 | $97,115 | $109,254 | $121,394 | $594,828 | $606,968 |
| *Marine tourism* | | *$1,593,243* | $10,494 | $20,988 | $31,482 | $41,975 | $52,469 | $62,963 | $73,457 | $83,951 | $94,445 | $104,939 | $514,199 | $524,693 |
| Total | | **$7,587,310** | **$364,633** | **$387,266** | **$409,900** | **$432,533** | **$455,166** | **$477,799** | **$500,432** | **$523,066** | **$545,699** | **$568,332** | **$1,109,027** | **$1,131,660** |
| Benefits (Do Nothing - Pathways Management Plan scenario) | | | | | | | | | | | | | | |
| | | NPV | | | | | | | | | | | | |
| *Incursion response* | | *$2,942,811* | $342,000 | $342,000 | $342,000 | $342,000 | $342,000 | $342,000 | $342,000 | $342,000 | $342,000 | $342,000 | $0 | $0 |
| *Commercial fishing* | | *$1,021,085* | $6,867 | $13,733 | $20,600 | $27,467 | $34,334 | $41,200 | $48,067 | $54,934 | $61,800 | $68,667 | $189,172 | $177,032 |
| *Marine tourism* | | *$882,676* | $5,936 | $11,872 | $17,808 | $23,744 | $29,680 | $35,616 | $41,551 | $47,487 | $53,423 | $59,359 | $163,529 | $153,035 |
| Total | | **$4,846,572** | **$354,803** | **$367,605** | **$380,408** | **$393,210** | **$406,013** | **$418,816** | **$431,618** | **$444,421** | **$457,224** | **$470,026** | **$352,701** | **$330,068** |