Section 4.2 Significant Risks, Costs and Benefits

Significant effects are those assessed as E or F in the effects registers in Section 4.1. These are described in more detail in this section. Note that number of the benefit or adverse effects matches the number in each respective register of effects in Section 4.1.

A. Effects on Market Economy

From Section 4.1A, there are four significant benefits for New Zealand's market economy resulting from the use of 1080 to control vertebrate pests. There are no significant adverse effects on the market economy over the 10 year timeframe of this assessment.

The significant benefits are:

M-B4 Removal or relaxation of restrictions on livestock movements

M-B5 Reduced competition for grazing from pests (wallabies, rabbits, possums and hares)

M-B7 Reduced costs to the agricultural sector and government associated with vector control

M-B10 Decreased likelihood of loss of markets due to market perceptions of New Zealand's Tb status

The benefits from the use of 1080 to pastoral farming (specifically cattle, dairy and deer farming) are realised through vector control programmes, which will reduce or eliminate bovine Tb in cattle and deer from some in areas of New Zealand, and to a lesser extent from the use of 1080 for conservation or other pest control purposes.

A.1 Benefits to the Market Economy

M-B4 Removal or relaxation of restrictions on livestock movements

Identification: Within Movement Control Areas (MCAs) and especially in Tb infected herds, restrictions on the movements of cattle and deer can generate significant costs at an individual level for farmers.

Owners of Tb-infected herds are likely to find that options for movement or trade of stock (other than direct to slaughter) will be further restricted by market demand. The costs to deer farmers associated with movement restrictions can include pre-movement tests and associated costs (time, vet fees, and tests themselves at a cost of $3-10 per animal), and extra feed if enough grazing is not available on-site.

The costs to cattle farmers are the same as for deer farmers with the only exception being that Tb testing for cattle herds is covered by the levy on adult cattle slaughtered (described in benefit M-B2). These costs are difficult to measure, as there are many dependent variables i.e. the availability of grazing within an area, and the Tb status of a herd.

Specific reasons why a loss in farm income may arise for the dairy industry from restrictions on movements are:

- A change from off-farm winter grazing to on-farm winter grazing of cows.
- A change from off-farm heifer grazing to on-farm heifer grazing.
- Heifers out grazing, becoming infected and unable to return home.

- A whole herd that becomes infected is unable to move to a new property.
- Cows infected while grazing are unable to return home.
- Increased cost of grazing stock off farm.
- Litigation costs.

For the beef industry the sources of loss are:

- Change in farm policy to finish stock on an infected property, with consequent increased feed costs.
- Cheaper sale price of young stock.
- Difficulty of moving cattle in a drought.
- Cost and availability of grazing.
- Farm sales – where herd has an infected status.
- Dairy graziers (eg beef farmers) that get an infected status.
- Group of animals unable to move.
- Cost of litigation.

(AHB 1999)

Assessment: With the continued use of 1080 there will be fewer herds infected with Tb overall, therefore it is **EXTREMELY LIKELY** that there will be a reduced cost to farmers associated WITH 1080 compared to the WITHOUT 1080 scenario.

The magnitude of the cost impact of Tb movement restrictions, both directly and through lost income, varies. In one example, the estimated financial burden of not being able to move stock for one farm was close to $200,000. This arose over an eight month period, during which time expenses were incurred finding feed due to the depletion of winter stocks and the premature culling of valuable stud animals (AHB 1999). Depending on variables such as farm size, stock capital and available feed, other farmers may also experience costs similar to these, hence the possible annual cost to a farmer from restrictions on movement has been estimated to be in the range of $30,000-200,000.

Presently there are 190 infected herds, but in a future scenario WITHOUT 1080, it is predicted that this number will increase to 239 infected herds in 2015; while WITH 1080, the number of Tb-infected herds will reduce to 59 infected herds. Even taking into account the small number of herds involved the likely financial savings from the reduction in movement restrictions WITH 1080 compared to savings WITHOUT 1080 would be **MAJOR.**

The magnitude is based on the following calculation:

If we estimate that this benefit is costed at $30,000- $200,000 per herd, then over the next 10 years, savings will be: WITHOUT 1080 (239 herds infected) - WITH 1080 (59 herds infected)

= 180 herds X $200,000 X 10 years = **$360M (upper range of estimate)**

= 180 herds X $30,000 X 10 years = **$54M (lower range of estimate)**

Conclusion: The benefit of reduced costs to farmers through removal or relaxation of restrictions on livestock movements is **EXTREMELY LIKELY** (almost certain) and the magnitude is **MAJOR** (dollar benefit $100M – 500M, regional benefit) resulting in a significant level of benefit **F** (extreme benefits at a national and local level; warrants cost or risk to realise) WITH 1080 compared to WITHOUT 1080.

M-B5 Reduced competition for grazing from pests (wallabies, possums, rabbits & hares)

Identification: Rabbits are the main vertebrate pest threat to pastoral production in New Zealand since they compete with farm livestock for available feed. To a lesser extent possums impact on pastoral values as well - pasture consumption by possums living in the bush/pasture margin has been estimated at 0.1 kg of pasture per possum per day – economic damage has been estimated at $12M worth of pasture annually (Statistics NZ 1994). Wallabies also impact on pastoral production and 1080 is the only pesticide currently registered for their control. As the major impact on pasture is by rabbits, these pests are the focus of this assessment.

The Ministry of Agriculture and Forestry has estimated that 56% of New Zealand is occupied by rabbits but only 9% of this area is moderate to extremely highly rabbit prone (Hackwell and Bertram 1999).

While there is a lack of quantified information about rabbit damage, a study of the cost of rabbits to New Zealand estimated the economic damage at $50M/year, with a possible range of $10-100M (Hackwell and Bertram 1999). This figure assumed that rabbits displace two million sheep, with sheep valued at $25 each. However, the price of a sheep for the 2005/06 season is $55 (Meat and Wool New Zealand 2006). At current prices, the economic damage based on Hackwell and Bertram's calculation is closer to $110M/year.

Assessment: Rabbits are currently controlled through the use of Rabbit Haemorrhagic Disease (RHD), and in some areas it is the main form of rabbit control. Prior to the (illegal) introduction of RHD in 1997, 1080 was extensively used for rabbit control. Several regional councils (including Otago and Canterbury) have submitted that as RHD effectiveness declines control will again rely heavily on 1080 (Refer Appendix D Public Submissions Analysis). The Canterbury Regional Council notes in their economic analysis of regional pest management options that "Individual farmers will potentially lose production in the future from failing to control rabbits when the efficacy of RHD decreases" (ECAN 2002). Norbury and Norbury (1996) note that substantial differences in pasture yield resulting from protection of rabbit prone land in Otago means that benefits for pastoral production land following protection from rabbits will occur.

Alternative control techniques will be limited to smaller and fewer areas than with 1080 control given the availability of aerial application WITH 1080. Given the projected decline in effectiveness of RHD it is **VERY LIKELY** that a greater benefit of reduced competition for grazing from rabbits will occur WITH 1080 than WITHOUT 1080 within the next 10 years. It can be argued that aerial use of 1080 is the only tool that is nationally important for rabbit control (refer Pest Control Scenarios).

From the figures quoted above, the accumulated costs from possums, wallabies and rabbits can be estimated as being in the order of $122M per year, in total. However, no research has currently been undertaken to estimate how much 1080 will be relied upon to reduce rabbit populations over the next 10 years compared to RHD. While the use of 1080 is beginning to increase as the relative effectiveness of RHD continues to decline, 1080 may not become the key tool for rabbit management for some years yet. Therefore, while in a future WITH 1080, the accumulated costs of controlling possums, wallabies and rabbits would reduce by a greater proportion than WITHOUT 1080, the overall level of benefit is assessed as **MAJOR**. The magnitude is based on the following:

If we conservatively estimated that 10% of benefits produced by rabbit control over the next 10 years can be attributed to 1080 then:

($12M (possum cost) + (10% x $110M)) x 10= **$230M.**

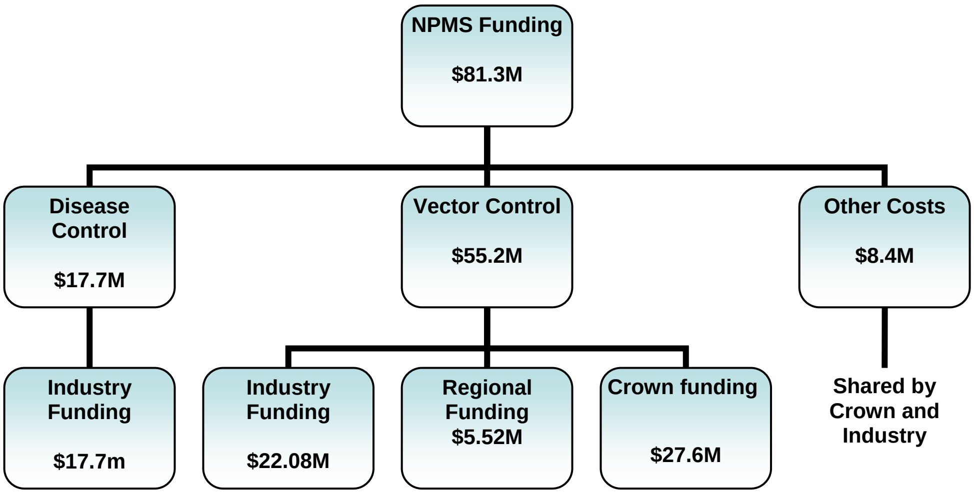
Conclusion: The benefit of improved productivity for farmers due to reduced competition for grazing from pests (wallabies, possums, rabbits and hares) is **VERY LIKELY** (expected to occur if all conditions met) and the magnitude is **MAJOR** (dollar benefit $100M – 500M, regional benefit) resulting in a significant level of benefit **E** (great benefit at a regional and local level, or moderate benefits at a national level; may justify cost or risk to realise) WITH 1080 compared to WITHOUT 1080.

M-B7 Reduced costs to agricultural sector and government associated with vector control

Identification: The benefit to the agricultural sector as a whole is distinct from MB-3 (direct benefits to individual farmers), as it discusses the impact on the New Zealand economy as a whole. The total costs of vector and disease control are met by the agricultural industry, government and local authorities and are split amongst these groups as identified in the following diagram.

Funding for vector control consists of 40% agricultural industry funding (from levies and direct contribution), 50% from Crown funding and 10% from regional funding (regional councils in areas with active Tb vector control operations). Agricultural industry contribution to vector control is funded through a levy on cattle slaughter, and contributions from the dairy industry and the deer industry - this covers most of the cost of disease control and 40% of the costs of vector control. Dairy Insight Inc contributes part of the funding for the dairy industry (cattle slaughter levies comprise the remainder) and the Game Industry Board contributes directly for the deer industry.

2004/05 total costs of vector and disease control



Assessment: Given the reduced number of Tb-infected livestock and reduction in the extent of wildlife Tb infection in the future WITH 1080, it is **EXTREMELY LIKELY** that by 2015 the costs associated with vector control will be reduced. This is reinforced by the yearly budgets for vector control established in the National Pest Management Strategy for Bovine Tuberculosis. Assuming the continuing availability of 1080, the budgets for 2004/05 and 20012/13 (the end of the current Strategy) and the projected budgets by 2025 for each contributor are as follows:

Current and Forecast Contribution Budgets for Vector Control-WITH 1080

Contributor	2005 with 1080 ($M excl GST)	2014/2015 with 1080 ($M excl GST)	2025 with 1080 ($M excl GST)	Difference per year with 1080 2005 - 2025 ($M excl GST)
Industry	22.08	17.36	6	- 16.08
Crown	27.6	21.7	7.5	- 20.1
Regional	5.52	4.34	1.5	- 4.02
Total	55.2	43.4	15	- 40.2

Without the use of 1080, vector control will require a significant increase in budget per year until another cost effective method is identified for containing or eradicating infection from wild animal populations. The cost of vector control without the use of 1080 has been predicted by AHB to be:

Current and Forecast Contribution Budgets for Vector Control-WITHOUT 1080

Contributor	2004/2005 without 1080 ($M excl GST)	2014/2015 without 1080 ($M excl GST)	2024//2025 without 1080 ($M excl GST)	Difference per year without 1080 2004 - 2025 ($M excl GST)
Industry	22.08	22	22	-0.08
Crown	27.6	27.5	27.5	-0.1
Regional	5.52	5.5	5.5	-0.02
Total	55.2	55.0	55.0	-0.2

By 2014/15 it is predicted that the budget will remain virtually the same as currently WITHOUT 1080. The accumulated cost savings for the national economy attributable to the use of 1080 resulting from a reduction in industry and government contributions for vector control are predicted to be around $20M during the timeframe of the baseline (calculated from the National Pest Management Strategy for Bovine Tb 10 year budget and AHB predictions for vector control without the use of 1080). The accumulated reduction in vector control costs WITH 1080 compared to WITHOUT 1080 within the timeframe of the assessment results in a **MODERATE** benefit. This is based on the following:

By the year 2015 there will be a $12M per year decrease in the budget WITH 1080 compared to a $200K decrease WITHOUT the use of 1080. Cost savings over the next 10 years will be between $50-100M WITH 1080.

Conclusion: The benefit of reduced costs to the agricultural sector and government associated with vector control are **EXTREMELY LIKELY** (almost certain) using 1080 compared to the next most efficacious control method used and the magnitude is **MODERATE** (dollar benefit $50M-100M) resulting in a significant level of benefit **E** great benefit at a regional and local level, or moderate benefits at a national level; may justify cost or risk to realise) WITH 1080 compared to WITHOUT 1080.

M-B10 Decreased likelihood of loss of markets due to market perceptions of New Zealand's Tb status

International market restrictions can severely restrict or close down access to overseas markets for New Zealand. Existence of Tb could be a barrier to trade for New Zealand meat and dairy products, and live exports of cattle and deer if our level of bovine Tb infection is perceived to be a risk.

The New Zealand dairy industry provides approximately 20% of all foreign trade (Ministry of Agriculture and Forestry 2005a) and had an export value of $5.9 billion in the year to March 2006 (Ministry of Agriculture and Forestry 2006). Meat products had an export value of $4.7 billion in the year to 30 June 2005 (Ministry of Agriculture and Forestry 2005b) of which $1.9 billion was beef and veal and $198M was venison. The total value of dairy and meat (beef and venison) product exports that will benefit from the use of 1080 is therefore around $8 billion. While the US market dominates export quantities and values, exports go to over 90 other countries. Given the high value of the market any loss would have a major effect.

The risk perception of New Zealand’s Tb status held by the wider international community is likely to be amplified through various communication channels, including media, groups of activists, agencies, politicians, and the public (Kasperson et al., 1988). Slovic et al. (1980) found that two key factors are present in lay people’s ratings of risks: the "dread risk factor" and the "unknown risk factor". Regardless of whether public perception is scientifically accurate or representative of market perceptions, such perceptions are real and play a crucial role in determining the market success (or failure) of the meat, dairy and live export markets. A study by Fitzgerald et al (1995) analysed the awareness of the Bovine Tb problem within New Zealand. Seventy per cent of respondents considered possums a threat to New Zealand’s overseas trade. All focus groups considered Tb to be a threat to trade, whilst the non-primary sector groups linked Tb to past trade and human health risks such as listeriosis in mussels, mad cow disease, and human Tb.

Assessment: As discussed in previous benefits, there will be a difference in the number of Tb infected herds WITH 1080 compared to WITHOUT 1080. (Projected APP WITH 1080 is 0.17%, compared to 0.5% WITHOUT 1080). It is therefore expected that this benefit is **VERY LIKELY** overall.

The magnitude of the benefit is **MAJOR**, when comparing WITH 1080 to WITHOUT 1080 scenarios**.** The magnitude is based on the value of the export market for dairy and meat – should market perceptions prevent access to some or all of New Zealand's markets it is possible some or all export dollars from this source could be lost.

Conclusion: The benefit of reduced market risk to the agricultural sector and government associated with New Zealand's Tb status is **VERY LIKELY** (expected to occur if all conditions met) and the magnitude is **MAJOR** (dollar benefit $100M – 500M, regional benefit) resulting in a significant level of benefit **E** (great benefit at a regional and local level, or moderate benefits at a national level; may justify cost or risk to realise) WITH 1080 compared to WITHOUT 1080.

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B. Effects on Social and Community

From Section 4.1B, there is one significant benefit for New Zealand's social and community values resulting from the use of 1080 to control vertebrate pests and there are no significant adverse effects. However, two adverse effects are further discussed here because they are considered contentious.

The significant benefit is:

S-B5 Enjoyment of recreational activities that rely on maintenance of healthy forest habitat and native biodiversity

The adverse effects warranting further discussions are:

S-A1 Loss of opportunity to hunt due to reduced deer populations

S-A6 Grief caused by pet suffering or mortality resulting from pest control operations

Most social and community effects, risk or benefits are secondary. For example, a benefit may include a reduction in possum numbers that helps reduce conservation estate degradation, therefore increasing enjoyment in recreational activities in public conservation land. The assessment of the likelihood of effects occurring includes the entire 'chain of events' leading to the effect. Assessment of the likelihood of the benefit described above would therefore include both the likelihood of New Zealand's conservation estate being maintained and the likelihood that this would result in enjoyment of the land.

Many social and community effects are based on the public's perception of a risk or benefit occurring. Such assessment is subjective as it is dependent on people's personal opinions, values and emotional responses. AHB and DOC published a Discussion Document "The Use of 1080 to Control Possums and Other Pests" in May 2004 (Green, 2004) and invited submissions from any person or organisation. The analysis of submissions received is contained in Appendix D. For public perception effects, this section draws on the results of that assessment, particularly in relation to perception of risk or benefits.

Note that the assessment of social and community effects based on the submissions to the Discussion Document may skew the assessment in favour of the views of people who are strongly interested in 1080. Only a random survey of the New Zealand population would provide a basis for a truly representative view.

B.1 Benefits to Social and Community

S-B5 Enjoyment of recreational activities that rely on maintenance of healthy forest habitat and native biodiversity

Identification: Many submitters to the 2004 Discussion Document identified themselves as people who enjoy outdoor recreation and who support the use of 1080 for the preservation of the natural values central to their outdoor experience. Submitters described personal experiences of enjoying outdoor recreation activities and of increased sights and sounds of native birds, along with general improved forest health following 1080 operations (URS 2004).

These values are partially dependent on healthy ecosystems and the maintenance of New Zealand's unique diversity of flora and fauna. The enjoyment of most outdoor recreation on public land is likely to improve as conservation outcomes improve (e.g. increased native biodiversity, abundance of wildlife, and protected native habitats).

While there is no research that specifically links the enjoyment of recreational activities with the maintenance of healthy forest habitat and biodiversity commonly accepted concepts underlying recreation planning do acknowledge that environmental setting is important to the recreation experience generally. An example of this is the Recreation Opportunity Spectrum (ROS) planning tool. The term recreation opportunity is used to describe the mix of settings at the places where people visit and the recreation activity they undertake there. The setting comprises the landscape, the facilities and services, the management rules, and the people who are visiting the place. A classification on the basis of setting, activity and the visitor experience is called the Recreation Opportunity Spectrum (ROS), and it ranges from the urban environment to the remote wilderness areas of the backcountry (DOC 2006).

The visitor needs and the characteristics of all of these defined settings require natural values and natural views to varying extents. A healthy environment is therefore an important part of visitor enjoyment of public land.

An exception to this correlation with environmental setting is hunting, which is dependent on availability of feral vertebrates. The potential adverse effects on hunting are discussed in detail under the adverse effects section.

Assessment: WITH 1080 more benefit to the conservation estate is likely to occur through protection of conservation values compare to a future WITHOUT 1080 (see Pest Control Scenarios and Section 4.1D, Effects on Environment). The likelihood of the benefit of enjoyment of outdoor recreation activities on public land occurring WITH 1080 compared to WITHOUT 1080 is therefore considered to be VERY LIKELY.

Owing to the number of people who participate in outdoor recreation on public land, the importance of conservation outcomes to the level of enjoyment of that recreation, and the benefits of recreation to people participating, the magnitude of the benefit is considered to be MAJOR.

Conclusion: The benefit of enjoyment of recreational activities that rely on maintenance of healthy forest habitat and native biodiversity is **VERY LIKELY** (expected to occur if all conditions met) and the magnitude is **MAJOR** (substantial social benefit to local and regional communities) resulting in a significant level of benefit **E** (great benefit at a regional and local level, or moderate benefits at a national level; may justify cost or risk to realise) WITH 1080 compared to WITHOUT 1080.

B.2 Adverse Effects on Social and Community

S-A1 Loss of opportunity to hunt due to reduced deer populations

Identification: Deer may be exposed to lethal doses of 1080 and cyanide during pest control operation either as by-kill or during operations that target them. This is perceived as a benefit by conservationists due to the significant impact that deer have on native ecosystems (the Benefits Register in Section 4.1D identifies some benefits from reduced deer numbers as a result of 1080 use). However, many recreational hunters view the non-target deaths of deer (and other wild animals) as an unwelcome consequence of aerial 1080 operations. Some submitters to the 2004 Discussion Document did not support the use of 1080 owing to the perceived loss of opportunity to hunt due to reduced deer populations (URS 2004).

The estimated by-kills of deer during aerial operations range from near zero to 93%. There is no consistent pattern in deer by-kill with variation in bait type, sowing rate, or toxic loading, suggesting that other factors determine the outcome (Nugent et al. 2001). Nugent and Yockney (2001) suggest that some of the high kills could be a result of high deer densities and limited food availability.

Assessment: The LD_{50} of cyanide for deer is approximately 3.5-4.5 mg/kg while the LD_{50} of 1080 for deer is 0.5 mg/kg (Eason et al, 2001). While deer are eight times more susceptible to 1080, deer would need to eat significantly less cyanide pellets to receive a lethal dose, due to the high concentration of cyanide in each bait. An 80 kg deer would need to eat approximately 27 g of 1.5 g/kg 1080 baits (over three 6 g baits or over two 12 g baits) or 0.5 g of 600 g/kg cyanide paste (about one cyanide paste bait) to receive a lethal dose. However, as 1080 is able to be applied aerially and cover a greater area than is able to be covered with cyanide (which is applied via ground control only), it is likely that more deer would be exposed to 1080 than cyanide. As a result of this, in a future WITH 1080 compared to WITHOUT it is considered **LIKELY** that there will be a loss of opportunity to hunt deer due to reduced deer populations.

The magnitude of the effect is low for several reasons. The reduction in deer populations as a consequence of 1080 operations has been highly variable. Reduced deer populations have been reported as greatest where deer were in poor condition (low body weights) and where food supplies were limited. Red and fallow deer mortality rates were mostly reported as 40% to 60% of a population following monitoring of aerial pellet operations (Nugent et al 2001; Nugent and Yockney 2001).

Nugent & Fraser (2005) recorded that red deer (*Cervus elaphus scoticus*) pellet group densities (an indicator of deer numbers) recovered to pre-poison levels in just over 2 years and doubled over the next two years following a poisoning operation. Recovery and increases of deer populations have been observed 2 years after an aerial application carrot baits (Coleman et al. 2000). Most deer species populations have relatively high densities in New Zealand and although deer may become locally scarce in some areas following pest control operations, deer populations are not likely to become significantly reduced by toxin use at a national level. Minor losses of individual deer are likely to be replaced within one or two seasons (Green, 2004).

Sub-lethal effects of 1080 on deer are also possible given exposure to baits during an aerial operation. Effects vary depending on the species, however little research has been undertaken on the various deer species. For this reason, it is recommended that no hunting take place for a period of up to four months following a 1080 operation (see further discussion in Section 4.1C, Register of Human Health Effects, in respect of meat from wild animals).

While deer populations are likely to be reduced by 1080 operations this effect will only occur in localised areas and for a short time period. The perception that deer populations are reduced to unsustainable levels is potentially based on the local scarcity of some deer populations in some areas after a poison operation. Recreational hunting can also have an impact on local populations of deer and other wild animal populations, especially in areas that are close to large urban areas (Nugent & Fraser 2005).

The magnitude of the effect is restricted to the deer hunting community hunting in non Recreational Hunting Areas. Given this restriction, the variable rates of by-kill, localised impact of pest control operations and the recovery rates of deer populations within 1-4 years following 1080 applications the magnitude of the adverse effect is assessed as **MINOR.**

Conclusion: The risk of loss of opportunity to hunt deer due to reduced deer populations is **LIKELY** [a good chance that it may occur under normal operating conditions] and the magnitude is **MINOR** [low community and cultural impact for the region and nation, potential social disruption (e.g. community on alert) and some unconnected individuals are affected] resulting in a non-significant risk level of **D** [risks within the ALARP band and broadly classed as tolerable subject to ongoing monitoring and control]. WITH 1080 compared to WITHOUT 1080.

Note that trials are currently underway to test the effectiveness and gain approval for the use of a deer repellent, which it is hoped will reduce the level of by-kill. Therefore this assessment may change in the future. In April 2005, DOC announced that deer repellent could be used on 1080 baits used to control possums in the eight Recreational Hunting Areas within DOC lands. Deer repellent would not be able to be used on other DOC lands. Deer repellent would be able to be used, with the approval of the land owner, on privately owned land.

S-A6 Grief caused by pet suffering or mortality resulting from pest control operations

Identification: Pets that are prone to scavenging are susceptible to toxin poisoning during pest control operations. Some submitters to the 2004 Discussion Document did not support the use of 1080 because of animal welfare concerns over the suffering of poisoned animals, including specific concerns over the suffering of dogs from 1080 poisoning.

The main control in place to reduce pet exposure to 1080 baits is to prevent access to areas where 1080 has been applied by notifying pet owners of 1080 operations (through the use of warning signs). Warning signs remain in place until carcasses are unlikely to be eaten or no longer contain lethal doses of 1080. Monitoring of physical breakdown of bait is undertaken to ensure reduction in risk.

1080 applicators may also issue muzzles or emetics to dog owners (to cause the dog to vomit if poisoned).

Dogs and cats are highly sensitive to 1080 and have an LD_{50} of 0.06 mg/kg and 0.35 mg/kg respectively. The risk of secondary poisoning from 1080 is greater than direct consumption of poison baits, since residues in possum carcasses are potentially lethal to dogs for more than 80 days following 1080 poisoning during cold weather. Residues found in possums killed by 1080 during different pest control operations had between 0.001 and 20 mg/kg 1080 in various parts of their body. For deer, pigs and other feral vertebrates killed by 1080 the reported residues are often higher (Broome et al. 2004). For example, Meenken & Booth (1997) demonstrated that the stomachs and intestines from possum carcasses collected after a winter 1080 drop remained reasonably intact and contained an average of 4.9mg/kg of body weight. A dog weighing 20kg would only need to eat 570g of this possum carcass tissue to have consumed more than twice the LD_{50} of 1080 for dogs.

Cyanide is not a persistent toxin and secondary poisoning is less likely to occur from cyanide compared to 1080 given the rapid breakdown of cyanide within carcasses, but there have been several reports of dogs ingesting lethal amounts of recently laid cyanide baits (Eason et al 2001).

Dogs and cats can be treated for exposure to 1080, and the chances of success are higher if treatment is received early. A lethal dose of 1080 is more likely than a sublethal dose hence there is little research regarding sub-lethal effects of 1080 on cats and dogs.

Assessment: Dogs are susceptible to 1080 and cyanide, however 1080 can be applied over greater areas and uncontained, and secondary poisoning is a greater risk WITH 1080 than WITHOUT 1080, therefore dogs are more likely to be exposed to 1080 poisoning than cyanide. The likelihood of people suffering anguish or grief as a result of losing a highly valued companion animal WITH 1080 compared to WITHOUT 1080 is therefore considered to be **LIKELY.**

While there is a risk of pet exposure to 1080 it is unlikely to have a negative impact on a large number of domestic pets due to the controls placed on 1080 operations, and the location of aerial operations (away from human occupied areas). As a result of controls the actual incidence of dog and cat 1080 poisoning is very low. The main cause of pet 1080 poisoning is when pet owners fail to prevent pets access to poison risk areas or to 1080 poisoned carcasses. A minority of incidents may occur if controls are not strictly adhered to, if communication breaks down between 1080 operators and dog owners, or if a carcass is inadvertently washed down a stream out of the operational area into an uncontrolled area.

The magnitude of the event is restricted to owners of companion animals and those who are concerned with animal welfare in general. Based upon the above information the effect is assessed as **MINOR**.

Conclusion: The risk of anguish and grief at the suffering or loss of highly valued companion animals is **LIKELY** (a good chance that it may occur under normal operating conditions) and the magnitude is **MINOR** low community and cultural impact for the region and nation, potential social disruption (e.g. community on alert) and some unconnected individuals are affected) resulting in a non-significant risk level of **D** [risks within the ALARP band and broadly classed as tolerable subject to ongoing monitoring and control]. WITH 1080 compared to WITHOUT 1080.

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C. Effects on Human Health and Safety

From Section 4.1C, there are no significant benefits nor significant risks to human health and safety posed by the use of 1080 to control vertebrate pests. However, as contamination of surface water in water supply catchments during aerial operations is perceived by the public as a potentially significant exposure route, this section further discusses this issue (H-A14) as it is considered contentious.

Several significant adverse effects of cyanide use have been identified during the risk assessment. These significant effects have been noted but will not be discussed in detail as it is not the intent of this application to assess cyanide and trapping.

C.1 Adverse Effects on Human Health and Safety with 1080

H-A14 Potential for public exposure to 1080-contaminated water

The public may be indirectly exposed to 1080 by coming into contact with water into which 1080 baits fall during aerial pest control operations. Most public concern relates to potential contamination of drinking water supplies. The potential for 1080 to come into contact with water only occurs during aerial operations, as baits are not placed in water during ground operations. Related concerns held by Maori are discussed in Section 4.3 (Risks, Costs, Benefits Significant to Maori).

Controls

The controls on aerial application are described in Section 4.1C: H-A13, and Section 3.4 of the application (Default Controls). The controls on aerial applications require that Ministry of Health approval be given for operations in catchment areas from which potable water is supplied (Clause 6, Additional Controls), and in practice this means that aircraft flight patterns are programmed to avoid major water bodies. In addition, any aircraft carrying out aerial application must not fly over a public drinking water supply or within 100 m upstream of a point of extraction for potable water supply.

Prior to aerial operations, the aerial contractor receives a digital copy of the treatment boundary and exclusion zones, which are uploaded to the aircraft’s GPS system. The operation controller informs the aerial contractor on the treatment area and any sensitive boundaries, and provides copies of relevant resource consents, permissions, and a hard copy of the base map. Maps showing the intended treatment area are also required for the notification process, and confirmed with adjoining landowners. Where appropriate, contingency plans are made with urban and private water supply operators in case of accidents.

Warning signs must be placed at all entrances to areas where baits will be used, and at prominent places around the perimeter of the treated area. Sign information must be in simple language and readable from 10 metres. All warning signs must show the name of the person or body who is applying the substance, skull and crossbones, the name, nature and colour of the bait, the word “POISON”, and the intended date of application and rules to reduce risk. Following consultation with the MoH (Medical Officer of Health), warning signs that display a caution about NOT drinking water may be warranted. The warning signs shall remain until such time that the substance is no longer toxic or when baits have been retrieved from the place; unless legal obligation requires the signs to remain in place for a longer period of time.

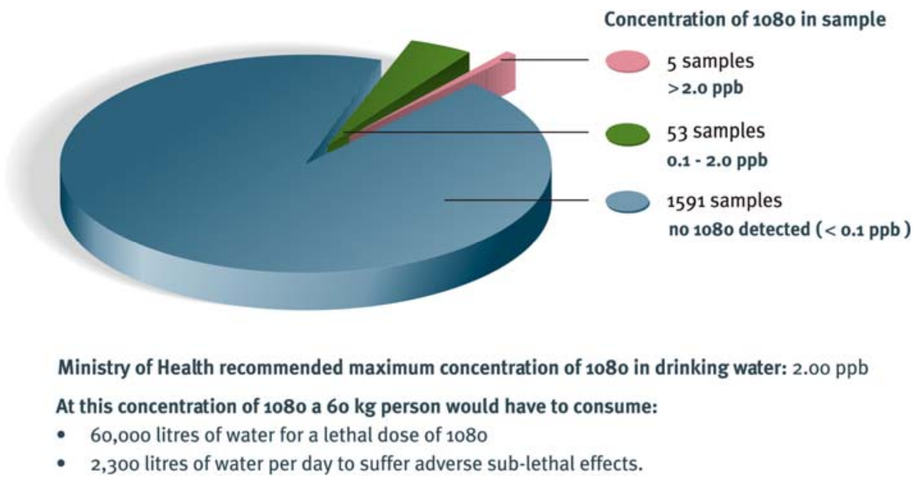
However bait will fall into smaller streams, or ephemeral streams, and the Ministry of Health set rigorous water monitoring requirements during and after aerial applications.

Potential Effects

Research indicates that 1080 degrades rapidly in water (Booth et al. 1999; Ogilvie et al, 1996; Suren & Lambert 2004). Over a 14 year period (1990 – 2003), Landcare Research (Fisher & Wright 2003) has analysed water samples collected from streams on the days following application of 1080, and also after subsequent heavy rain (Fisher and Wright, 2003). 96.5% of the samples revealed no trace of 1080 and when 1080 was detected, it was in very low concentrations and present only for a matter of days. In those samples with detectable levels of 1080, 51 out of those 58 samples showed levels below 1 ppb. On the few occasions it is present in water after aerial operations, it has a transient presence only. Figure 1 illustrates the proportion of samples with no detectable 1080, those where less than 2 ppb were present, and the five samples where 1080 levels exceeded 2 ppb. Samples taken as part of this research were predominantly taken from within or adjacent to operational pest control areas, where there would be the greatest chance of detecting 1080 in water. Of the 1649 samples analysed, 107 were taken from reticulated town water supplies. All of these samples were free of detectable 1080.

The following figure, reproduced from the 2004 Discussion Document (Green, 2004), illustrates this. Water monitoring data continues to be gathered, confirming the overall trend of these results.

Figure 1| **Results of water monitoring after aerial 1080 operations (1991-2003)**



There has been no evidence of 1080 occurring in reticulated water and no evidence of significant or prolonged 1080 contamination in surface or ground waters (Booth et al. 1997; Eason 1997; Eason et al. 2001; Parfit et al. 1994; Eason 1992; Fowles & Williams, 1997; Hamilton & Eason 1994; Meenken & Eason 1995).

If humans ingest a sub-lethal dose, 1080 will be metabolised and excreted in urine in the same manner as in target pests (NZFSA, 2005). Based on the No Observable Effect Level (NOEL) of 0.1 mg/kg-day in rats, a 60 kg person would need to drink 2,300 litres of water containing 2 ppb of 1080 per day, for an extended period of time, for sub-lethal effects to occur. Allowing a safety margin of 1000, a person would need to drink their entire daily intake of two litres per day of water from a contaminated source, for a period of weeks, to be considered potentially at risk of sub-lethal exposure. To receive the LD_{50} dose, 60,000 litres of water containing 2 ppb of 1080 would need to be consumed in one sitting. Given that the daily intake of water of an average person is typically estimated to be around two litres per day, there is no risk of ingesting a lethal dose of 1080 at this concentration. The NOEL has formed the basis of the Ministry of Health's New Zealand Drinking Water Standards published in 2005, with a Provisional Maximum Acceptable Value (PMAV) for 1080 in drinking water of 2 ppb (µg/L). The existing environmental evidence of solubility and biodegradability characteristics of 1080 indicates that this substance does not persist in water, and it is improbable that ingestion of 1080-contaminated water could lead to adverse human health effects.

Risk Profile

Based on the above, the likelihood of adverse health effects from the consumption of 1080-contaminated water in a scenario WITH 1080 is IMPROBABLE [only occurring in very exceptional circumstances]. The level of adverse effect from contaminated water at the concentrations observed is considered to be MINIMAL [no effects], and the risk is therefore assessed as A [either insignificant or minor and not warranting further assessment].

Conclusion: The risk of adverse human health effects resulting from ingestion of 1080-contaminated water is **IMPROBABLE** and the magnitude would be **MINIMAL**, resulting in a level of risk **A** (either insignificant or minor and not warranting further assessment).

C.2 Adverse Effects on Human Health and Safety without 1080

The significant risks identified in a future scenario WITHOUT 1080 are predominantly those associated with occupational exposure during the application of specific cyanide products, and public exposure to all cyanide baits following application in areas of pest control operations. Given the toxicity of cyanide, adverse health effects are likely to result from inadvertent ingestion of even the smallest amount of cyanide or inhalation of cyanide gas. A person weighing 60 kg would need to eat only one of bait (containing around 100 mg CN) to potentially receive the LD_{50} dose. The following activities were identified in Section 4.1C as significant risks to human health :

H-CN- A10	Occupational exposure: inhalation of sodium cyanide paste (Application)
H-CN-A11	Public exposure: ingestion of cyanide baits (all formulations)
H-CN-A12	Occupational exposure: ingestion of sodium cyanide paste and potassium cyanide paste (Application)

It is known that 11 people have died from cyanide poisoning during 1977-1984 alone (PCE 1994). Records of cyanide-related deaths are inadequate and do not differentiate between deaths that have occurred as a result of ingesting cyanide baits and deaths from other causes such as suicide or events unrelated to pest control operations (PCE 1994). No cyanide-related deaths have been reported since the implementation of current HSNO and HSE controls.

Each of the significant effects identified in this section were assigned a risk of **E** [generally warrant further controls to bring them into the tolerable range]. It is not within the scope of this risk assessment to provide a detailed analysis of potentially adverse human health effects resulting from exposure to cyanide. The controls, potential exposure pathways and effects, and risk profiles as they correspond to each of the above activities have been discussed in Section 4.1C (Effects on Human Health and Safety).

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D. Effects on the Environment

The significant effects to the environment are those assessed as E or F in the effects register (Section 4.1D). The effects register identified six significant benefits, and no significant adverse effects, for New Zealand's environment resulting from the use of 1080 to control vertebrate pests. The assessment did identify some significant adverse effects on the environment due to the use of cyanide and traps.

The significant benefits identified are:

E-B1	Increased protection of vulnerable plant species from browsing by pest species and resulting biodiversity benefits
E-B2	Increased protection of native ecosystem health and habitat values
E-B4	Reduced predation of mohua (yellowhead), kakariki (orange fronted parakeet) and Southern New Zealand dotterel
E-B5	Reduced predation of native birds, particularly threatened species (excluding mohua, kakariki and Southern New Zealand dotterel)
E-B6	Reduced competition for food supply and some habitat resources for native birds particularly threatened species
E-B10	Protection of *Powelliphanta* land snails from predation

The environmental benefits that occur are a result of:

- Reduced populations of browsers of native plants- possums, wallabies, deer, goats, rats, mice, rabbits, and hares
- Reduced populations of predators of native birds - possums, mustelids (e.g. stoats and ferrets), rats, mice and cats
- Reduced predation of native bird species that have important relationships with native plants e.g. aid in seed dispersion, fertilisation, and other symbiotic, or mutualistic relationships
- Reduced competition for food – possums, rats, mice, and ungulates compete for food with native fauna.

All these benefits contribute to improved native ecosystem functionality as a whole.

The primary focus of this discussion will be on the benefits resulting from the use of 1080 to control possums. This is because possums impact on many of New Zealand's native ecosystems. They are generalist feeders, eating foliage, flowers, fruits and fungi, and also prey on birds and insects. While other pests also have major impacts on New Zealand's native ecosystems, effective control of possums for conservation outcomes is highly dependent on the availability of 1080. The benefits of controlling other predators i.e. rats, is discussed, but to a lesser extent.

Efficacy of 1080

To appreciate the benefits of 1080 as a control tool, the success of 1080 in reducing target pest numbers needs to be recognised. In 2004, DOC reviewed the kill rates achieved during its 1080 pest control operations. The results were as follows (where n = the number of operations):

Possums (operations since 1990, following standard operational procedures)

The mean kill following pre-fed aerial operations using:

- 1.5 g/kg 1080 cereal pellets was 92.9% (n=23);
- 1.5 g/kg 1080 carrots was 93.7% (n=4); and
- 0.8 g/kg 1080 carrots was 90.5% (n=5).

The mean kill for non-pre-fed aerial operations using cereal pellets was 77.6% (n=16).

The mean kill for uncontained ground operations using:

- Handlaid 1.5 g/kg 1080 cereal pellets was 85.3% (n=4); and
- Handlaid 1.5 g/kg 1080 paste is 77.1% (n=5).

The mean kill for contained ground operations using:

- 1.5 g/kg 1080 cereal pellets in bait stations was 94.4% (n=4);
- 1.5 g/kg 1080 gel (No Possums® 1080 gel block) was 78.4% (n=2); and
- 1.5g/kg cereal pellets in bait bags was highly variable.

Rats (operations since 1990, following standard operational procedures)

The mean percentage kill following pre-fed aerial operations using 1.5 g/kg 1080 cereal pellets was 92.7% (n=3).

The kill rates for bait bag operations using 1.5 g/kg 1080 cereal pellets was 87.7% - 100%.

Wallabies

A wallaby kill of greater than 90% was reported following a pre-fed aerial operation using 1.5 g/kg 1080 carrot bait. Two field trials of hand-laid 5% and 10% 1080 gel also achieved kills of greater than 90%.

Deer and goats

During three field trials of hand-laid 10% 1080 gel to control deer, kills ranged from 79% - 100%. Two field trials using hand laid 10% 1080 gel to control goats achieved kills of greater than 87%.

It is neither possible nor useful to compare efficacy of cyanide to 1080 operations, as cyanide is only registered for the control of possums and it cannot be applied aerially in New Zealand.

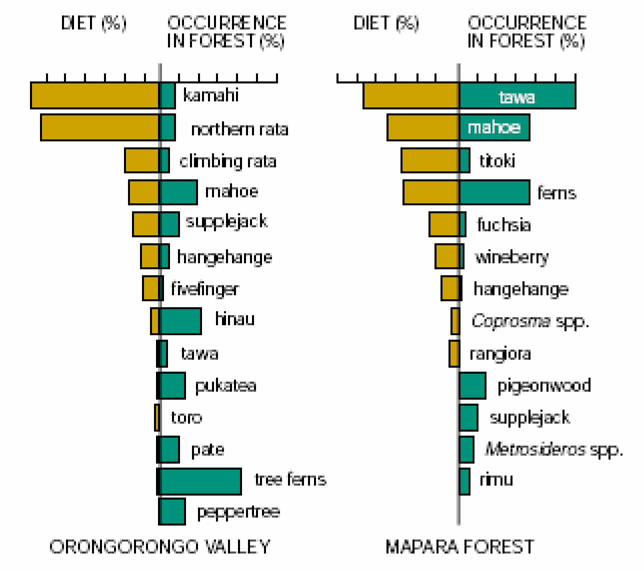
D.1 Benefits to the Environment

E-B1 Increased protection of vulnerable plant species from browsing by pest species and resulting biodiversity benefits

Identification: Many native plant species are highly palatable and lack natural defences against browsing by introduced mammals, having evolved in isolation from browsers. Plants that are particularly susceptible to the impact of browsing by possums include:

- Canopy species such as rata, pohutukawa, kohekohe, kamahi, Halls totara and pahautea; and
- Understorey species such as mahoe, pate and tree fuchsia.

The figure below demonstrates how possum dietary preferences can place significant pressure on certain plant species within forest ecosystems.



Possum dietary preferences in relation to plant availability in two North Island forests.

DOC National Possum Control Plan 1993-2002.

Possums selectively feed on favoured species and will kill them by defoliation over a period of several years. Where they concentrate on canopy species, this can result in the collapse of the canopy across large areas of forest. For example, in the Ruahine Ranges, a catastrophic rata-kamahi canopy collapse occurred about 25 years after possums colonised the area. Canopy collapse leads to a highly modified forest ecosystem, with the loss of palatable species and an increase in unpalatable species.

Some highly palatable species e.g. native mistletoes (*Alepis flavida, Peraxilla* spp., *Tupeia antarctica*), *Dactylanthus taylori*, kaka beak and *Pittosporum patulum* have been affected to such an extent that their ranges and population sizes have been extensively reduced to the point where they are classified as chronically or acutely threatened. Continued browsing pressure could lead to extinction of these species.

Due to funding limitations control of pests is undertaken on less than half of the land administered by DOC. Remaining land administered by DOC receives no or limited pest management. As a result, priority setting for at risk biodiversity, species, habitats and ecosystems continues to drive management decisions. Ecosystems with vulnerable plant species gain priority over other habitats for this reason. Control undertaken by AHB, regional councils and private groups in rural or forested areas also contribute to general conservation outcomes.

Assessment: The changes in forest condition, composition and structure resulting from possum browse have been well documented (e.g.Rose *et al.* 1992, Owen and Norton 1995, Allen *et al.* 1997, Pekelharing *et al.* 1998, Sweetapple *et al.* 2004), and a number of studies have demonstrated general forest recovery following the removal of possums (e.g. Atkinson 1992, Miller and Anderson 1992). Other studies have shown that individual species will recover after possum control e.g. Mistletoes (Sessions *et al.* 2001, Sweetapple *et al.* 2002) and kohekohe (Nugent *et al.* 2002). However there have been fewer studies that directly link long-term vegetation survival and condition in response to sustained 1080 possum control (Norton 2000).

Green (2003) reviewed 70 Department of Conservation reports and scientific papers on monitoring vegetation recovery following 1080 operations. At most sites, the vegetation showed a significant improvement in condition within a year of possum control. However, at some sites the response was short term, e.g. while a positive response was noted for West Coast rata/kamahi forest understorey species it only lasted a year, while at other sites no response was observed. Often this was due to a poor kill of possums or the species being monitored e.g. pahautea (cedar) was too slow growing for a response to be observed at the time of monitoring. Despite the mixed results, Green concluded that 1080 operations did reduce possum browse pressure and the use of 1080 clearly benefited vulnerable species and biodiversity.

Payton *et al.* (1997) monitored eight indicator species (northern rata, totara, Hall’s totara, kohekohe, mahoe, five-finger, pate and raukawa) following an aerial 1080 operation in Waipoua forest in 1990. The operation killed 87% of possums. Possum impacts (browsed foliage, stem damage) were significantly reduced within a year of the poison operation. While kohekohe was the only indicator species to show a significant short-term increase in foliage cover, the poison operation did halt the continuing downward trend in vegetation condition of the other species when compared to a nearby non-treatment area. The authors concluded that while a large initial population reduction is required to halt vegetation decline, an ability to maintain residual possum populations at very low levels appears necessary for significant vegetation recovery.

Tree fuchsia is an important component of temperate New Zealand forests. It is a preferred possum food and possums can defoliate and kill fuchsia within two years once possum trap catch rates exceed 25% (Pekelharing *et al.* 1998). Tree fuchsia populations in the Tararua Range were monitored between 1994 and 2004 to assess the effectiveness of aerial 1080 possum control. At the end of the study, Urlich & Brady (2005) reported possums continued to have a significant impact on fuchsia at untreated sites compared to sites where 1080 operations had occurred. At the treated sites, tree fuchsia was more likely to survive and maintain a healthier foliage condition.

Possums have been widely attributed as a major cause in the decline of mistletoes, and mistletoe condition been shown to improve significantly following possum control (Sessions *et al.* 2001, Sweetapple *et al.* 2002). Following an aerial 1080 operation in Waihaha in 1994, possum trap catch rates dropped from 24.2% pre-control to 0% immediately after the operation. As a result of reduced possum browse, the condition of the 79 monitored mistletoes recovered substantially. However, three years later possum densities had increased to 3% trap catch and mistletoe condition began to decline and possum browse on mistletoe plants increased (Sweetapple *et al.* 2002).

1080 has a significant role in DOC's management of introduced browsers and protecting vulnerable plant species. WITHOUT 1080, the area of forest that could be treated annually by DOC would drop by about a third. This would lead to the total area treated by DOC on a sustained basis decreasing to about half of the one million hectares treated WITH 1080. Ground control over the remaining area WITHOUT 1080 would be less effective and patchier. WITHOUT 1080, there would be further loss, and local extinctions, of vulnerable plants from forest ecosystems. It would only be possible to protect some vulnerable plants by focusing on localised pest control programmes at a few, small, representative sites i.e. the most threatened plants could be protected through targeted use of cyanide/trapping although at a few local sites rather than improving their status nationwide.

Based on the above it is VERY LIKELY that this benefit will occur WITH 1080 compared to WITHOUT 1080. WITHOUT 1080 it is not possible to achieve the large reductions of pest populations that benefits vulnerable plant species at a population level or on a large scale. The ability to achieve a significant reduction of possum populations has prevented further canopy collapse of native forests in places such as Egmont National Park, Westland and the Coromandel Peninsula (see Context: Pest Control Scenarios). It would not be possible to control pests in inaccessible tracts of land WITHOUT 1080 – this means there will be no treatment at all in some inaccessible areas and vulnerable species in those areas may not survive. The magnitude of the effect WITH 1080 is therefore EXTREME compared to WITHOUT 1080.

Conclusion: The benefit of reduced browsing of vulnerable flora species and resulting biodiversity benefits is VERY LIKELY (expected to occur if all conditions met) and the magnitude is EXTREME (long term, widespread benefits to species and/or ecosystems, protects native biodiversity and significant benefits to native species of national significance) resulting in a significant level of benefit F (extreme benefits at a national and local level) WITH 1080 compared to WITHOUT 1080.

E-B2 Increased protection of native ecosystem health and habitat values

Identification: An ecosystem can be defined as an ecological community (or communities) together with its environment, functioning as a unit. Pest impacts affect the sustainability of New Zealand's native ecosystems, particularly forest ecosystems. The HSNO Act requires that the sustainability of all native and valued introduced flora and fauna be taken into account when applying for and using a hazardous substance. Indicators of sustainability include biodiversity measures (such as loss of species) complemented by considerations related to the long term viability of the ecosystem or its constituent parts.

While change is inherent within any ecosystem, the changes caused by introduced pests can threaten the overall health of ecosystems, and the physical and biological resources that define the life-supporting capacity of habitats (i.e. habitat values).

Assessment: Three key indicators of healthy forest ecosystems and their vulnerability to the impacts of pests are discussed here: Understorey and canopy species, Regeneration capacity and Keystone species. A benefit to any one of these indicators will have benefits at an ecosystem level.

Benefits to understorey, canopy and other vulnerable species

A key impact of introduced mammals selectively browsing preferred species and individual trees in New Zealand forests (as in E-B1) is the change in the overall composition and structure of forests as some plant species are eliminated and other, less palatable plants become dominant. The loss of structure makes forests more vulnerable to climatic events such as storms and drought and there is the potential for increased erosion. At the same time, browsing on plants establishing on sites disturbed by events such as fire and windthrow interferes with vegetation succession. These impacts have wider biodiversity implications than just a highly modifying forest composition and structure. There are flow on effects to native fauna through the loss of habitat and food sources.

Benefits to regeneration capacity

Removal of successive generations of seeds, seedlings and adult trees by introduced mammals progressively depletes seed banks, which reduces the capacity of forests to regenerate. Several studies have demonstrated vegetation recovery and improved regeneration capacity resulting from the removal of browsing pressure by possums (e.g. Atkinson 1992, Miller and Anderson 1992). However, there have been few studies that directly address the benefits 1080 operations have for the regeneration capacity of ecosystems. Miller and Anderson (1992) reported there was extensive flowering of rewarewa (*Knightia excelsa*) the spring following a 1080 operation on Rangitoto Island, and pohutukawa were observed to have more buds than in previous years. Regenerating pohutukawa and poroporo (*Solamun avicualre)* were also noticeably more abundant after the 1080 operation.

The regeneration capacity of native forest ecosystems is also dependent on the presence of pollinators and seed dispersers. Native honeyeaters (tui, bellbirds) play an important pollination (Castro and Robertson 1997, Anderson 2003) and kereru are an important seed disperser. These species have declined in numbers since the introduction of mammalian predators. The regenerative capacity of a wide range of native plants is likely to have been affected as a result of fewer birds pollinating flowers and dispersing seeds. Timing 1080 operations to occur in later winter or early spring can release browsing pressure on native plants during flowering and seed set, and improve the breeding success of the pollinators and seed dispersers. See E-B4, 5 and 6 for further discussion on reduced predation on native bird species.

Benefits to keystone species

Keystone species are species that have a major influence on an ecosystem such that their loss would be detrimental to ecosystem functions.

Kereru are an example of a keystone species, dispersing the seeds of large tree species that characterise some forest communities (e.g. miro *Prumnopitys ferrugineus*, tawa *Beilschmiedia tawa*, taraire *B. taraire*, karaka *Corynocarpus laevigatus* and puriri (*Vitex lucens*). Mammalian predators are the main cause of mortality of kereru eggs, chicks, fledglings and adults (Powlesland *et al.* 2003), with kereru adult mortality rates exceeding recruitment from reproduction at some sites (Clout *et al.* 1995). Reduced seed dispersal by kereru may have significant implications for seed dispersal and forest dynamics. Benefits to kereru and seed dispersal functions requires control of predators over large areas – something which only aerial application of 1080 makes possible. See E-B5 and 6 for further information on why 1080 creates benefits for kereru.

Overall Assessment

WITHOUT 1080 it is likely that all of the above elements of a functioning ecosystem will be threatened to a greater extent and over a larger area of land than in a future WITH 1080. WITHOUT 1080 rugged and inaccessible areas of conservation land and their associated populations of endangered, threatened or vulnerable species will be without protection – this area has been estimated at 500,000 ha of DOC administrated land (refer Pest Control Scenarios). Progressive attrition or forest collapse may occur over thousands of hectares of forest without 1080.

WITH 1080 it is predicted that there will be improvement in the condition of native ecosystems by protecting threatened and vulnerable species as well as from improvement in understorey and canopy conditions of several forest types across a wide range of protected areas (e.g. forest health and habitats within Egmont National Park would be under significant threat as it has significant vegetation diversity in inaccessible difficult terrain)

Based on the above it is VERY LIKELY that a future WITH 1080 there would have increased protection of native ecosystems and habitat values than WITHOUT 1080.

1080 is the only poison that can be distributed aerially, enabling inaccessible and large tracts of land to be targeted with greater efficacy than other poisons can achieve as a result. It is the only poison which can achieve three critical objectives *simultaneously* for threatened species protection:

(1) reduction of possum densities to below 5% residual trap catch level;

(2) reduction of pest populations of rats and other predators: and

(3) rapid achievement of low possum densities over large areas.

As a result WITH 1080 the magnitude of this benefit has been estimated as MAJOR compared to WITHOUT 1080.

Conclusion: The benefit of protection of forest health and habitats is VERY LIKELY (a good chance that it may occur under normal operating conditions) and the magnitude is MAJOR (long term benefit to localised species and/or ecosystems, improves native biodiversity and major benefits to native species of national significance), resulting in a significant level of benefit E (great benefit at a regional and local level, or moderate benefits at a national level; may justify cost or risk to realise) WITH 1080 compared to WITHOUT 1080.

E-B4 Reduced predation of mohua (yellowhead), kakariki (orange-fronted parakeet) and Southern New Zealand dotterel

Identification: Rats, mustelids (particularly stoats) and feral cats eat adult birds, chicks and eggs of mohua, orange-fronted parakeets and the Southern New Zealand dotterel. Ship rats and stoats are the most significant predators of mohua and orange-fronted parakeets in southern beech forests. Feral cats are the biggest threat to Southern New Zealand Dotterel survival. These predators threaten populations, and the long term survival of these species. Aerial 1080 operations can effectively control ship rats (Innes *et al.* 1995) and will kill stoats via secondary poisoning (Murphy *et al.* 1999). 1080 is the only poison registered to target feral cats.

Assessment:

Mohua

The mohua is a small, insectivorous, forest passerine bird, endemic to the South Island. In the 19th century, mohua were one of the most abundant and conspicuous forest birds in the South Island, present over some 6.5 million hectares. However by the 1980s mohua had disappeared from 75% of its former range and populations were continuing to decline. Today, the mohua is acutely threatened and the core mohua populations are fragmented. Most mohua now occur in scattered areas of Fiordland and Southland/Otago hill-country. Small outlying populations also exist in North Canterbury (O'Donnell *et al.* 2002).

Mohua have been found in stomach contents of stoats and mohua feathers were found lining stoat dens (E. Murphy, pers. comm.). Several cases of ship rats (*Rattus rattus*) preying on incubating female mohua have now been recorded using infrared video (P. Dilks, pers. comm.). A monitoring programme and detailed research recognised that sudden mohua population crashes coincided with years in which stoat and rat numbers irrupt. Population monitoring indicated that in mohua populations with low productivity, the period between the crashes is probably insufficient for mohua to recover fully, and consequently such populations are declining (Elliott 1996). Experimental predator control during a predator plague increased mohua breeding success to *c.* 80%, whereas breeding success was only 36% in untreated areas (O'Donnell *et al.* 2002).

Ship rat irruptions occur in conjunction with beech mast events and with warmer than average winter temperatures. These events increase rat survival, resulting in a rapid increase to very high rat numbers and an expansion of their range in altitude into mohua habitat. When this occurs DOC requires a control tool that can effectively and rapidly reduce rat numbers to very low levels over large areas of mohua habitat. This can only be achieved by the aerial application of 1080 baits. It has the additional benefit of causing a secondary kill of the other main predator of mohua, stoats.

Orange-fronted parakeet (Kakariki)

During the 19th century the endemic orange-fronted parakeets occurred from Stewart Island, up the West Coast to Paringa and then from Lake Brunner and Mount Oxford north to Tasman Bay. There were also occasional records from the North Island. Historical records indicate that orange-fronted parakeets steadily declined from around 1900, although they appeared to have persisted longer in the region from Arthurs Pass north to Nelson. Fulton (1907 in Grant and Kearvell 1999) was one of the first to record the decline of the parakeets and considered 'weasels and rats' to be the main agents of decline. By 1975 the species was officially considered extinct, but was rediscovered in 1980 in the Hope Valley, North Canterbury. Today, the orange-fronted parakeet is listed as acutely threatened and is only known to occur in three alpine beech (*Nothofagus* spp.) forested North Canterbury valleys, the Hawdon, the South Branch of the Hurunui and the Poulter.

While little is known about the biology of orange-fronted parakeets, it is known they use similar nest sites to sympatric yellow-crowned parakeets (Kearvell *et al.* 2002). Elliott *et al*. (1996) suggest that stoats and rats pose a considerable threat to the hole nesting yellow-crowned parakeet, both when they are breeding and roosting. Current evidence indicates that this also applies to orange-fronted parakeets. In particular, ship rat irruptions following beech masting, pose a major threat to the survival of orange-fronted parakeets.

During an irruption, there is a rapid increase to very high rat numbers and the rats expand their altitudinal range into orange-fronted parakeet habitat. When this occurs DOC requires a control tool that can effectively and rapidly reduce rat numbers to very low levels in the valleys where orange-fronted parakeets occur. This can only be achieved by the aerial application of 1080 baits. The other main predator, stoats, will also be killed via secondary poisoning.

Southern New Zealand Dotterel

The Southern New Zealand dotterel now breeds solely on the alpine tops of Stewart Island. A population of about 350 birds survived on Stewart Island until the early 1950s, but subsequently declined and reached a low of 62 in 1992. Predation of adults, particularly males, by feral cats (and possibly rats) is thought to be the main reason for this decline (Dowding and Murphy 2001).

The Dotterel Recovery Plan (Dowding 1993) set a target of restoring the population to 250 birds by 2011 through predator control at the main breeding sites between mid-August and the end of the following February. Feral cat control was initiated in 1993. Unfortunately, the isolated nature of the breeding sites means that they are not easily accessible. Trapping cats at the dotterel breeding sites is not considered feasible because to date there is no proven kill trap for cats. Leg-hold and cage traps must be checked daily which would require a person to be permanently present at each of the five main breeding sites for six months of the year. It was therefore decided to use the only poison registered for cats - 0.10% 1080 feral cat bait. The bait is placed in bait stations at the start of the breeding season and refilled at regular intervals. Since the use of 1080, the dotterel numbers have already increased to 253.

Overall assessment

WITHOUT 1080 it is likely that the risk of extinction for mohua, orange-fronted parakeets and Southern New Zealand dotterel will increase and there will be a substantial further restriction in their ranges.

1080 is the only toxin effective for pest mammal control that can be distributed from the air. This means that for mohua and orange-fronted parakeets, aerial application of 1080 is the only effective way to:

(1) Rapidly reduce irrupting rat populations to very low numbers over large, isolated areas; and

(2) At the same time get an effective secondary kill of mustelids.

For Southern New Zealand dotterel, 1080 cat baits are the only cost effective method for controlling feral cats at the dotterel's breeding sites.

As no other pest control method can achieve the objectives required to protect these three species it is considered EXREMELY LIKELY that a future WITH 1080 will reduce predation of these three bird species when compared to a future WITHOUT 1080. Given the significance of 1080 as a tool for mohua, kakariki and dotterel the magnitude of this effect is EXTREME.

Conclusion: Based on the above the likelihood of this exposure occurring is EXTREMELY LIKELY (almost certain). The effect is EXTREME (long term, widespread benefits to species and/or ecosystems, protects native biodiversity and significant benefits to native species of national significance), therefore the benefit is F (extreme benefits at a national and local level).

E-B5 Reduced predation of native birds, particularly threatened species (excluding mohua, kakariki and Southern New Zealand dotterel)

Identification: Possums, rats, mustelids and feral cats all prey on the adults, chicks and eggs of birds and have caused the decline in numbers of many of New Zealand's native birds. As a result of these predators being controlled during aerial 1080 operations, their impacts will be reduced. A number of acutely threatened (kokako, kaka and Rowi (Okarito brown kiwi)) and chronically threatened (North Island brown kiwi, South Island brown kiwi, Great spotted kiwi and kereru/kukupa) species benefit from a reduction in predators during aerial 1080 operations. Even birds that are not threatened (e.g. tui, bellbird, fantail, whitehead, robin and tomtit) will benefit from aerial 1080 operations timed to assist the breeding season.

Assessment: Following pest control with 1080, populations of birds in controlled areas are expected to increase due to reduced predation and improved breeding success. Additional benefits include a decreased risk of extinction in treated areas and migration of native birds to unpopulated areas (Veltman 2000). There are a number of case studies which demonstrate these benefits from 1080 control for native birds. Several are presented below (also see Section I, Case Studies).

North Island brown kiwi

Prior to the 2001 aerial 1080 operation in Tongariro forest, kiwi chick survival averaged less than 5% per annum due to predation, primarily by stoats. In the year following the operation, the chick survival rate increased to 40%. Additionally all 32 adult kiwi that were radio tagged prior to the operation survived (Green 2004).

North Island Kokako

The population recovery of kokako depends primarily on the control of key predators, especially ship rats and possums (Basse *et al.* 2003). A reduction in these predators to low levels significantly increases kokako chick output and adult survival (Innes *et al.* 1999). Pest control operations undertaken to protect kokako aim to reduce possums to < 1% residual trap catch and rats to < 1% tracking rates at the start of the kokako breeding season, the time when kokako are most vulnerable to predation. This approach has been successfully applied to most of the remaining (approx. 14) mainland kokako populations (Basse *et al.* 2003), leading to a 50% increase in kokako numbers nationally.

1080 is a key tool for protecting kokako from possums and ship rats. It offers a number different bait types and application techniques (see Context: Pest Control Scenarios for further information). By alternating it with other control techniques, any surviving pests can be prevented from becoming bait or trap shy. It can achieve a very rapid knock down in pest numbers and has the additional benefit of controlling stoat (another predator of kokako) through secondary kill.

Kaka and *Kereru*

Kaka were formerly widespread and abundant in native forests throughout New Zealand, but are now common in only a fraction of their former range. Stoat predation of breeding females appears to be the main reason for the kaka's decline, although other predators such as possums and rats may also contribute (Moorhouse *et al.* 2003).

As discussed in E-B2, mammalian predators are the main cause of mortality of kereru eggs, chicks, fledgings and adults (Powlesland *et al.* 2003), with kereru adult mortality rates exceed recruitment from reproduction at some sites (Clout *et al.* 1995).

Both kaka and kereru have 'good' and 'bad' breeding years in response to food availability (mast fruiting and flowering). The use of 1080 to control possums and rats, and any resulting secondary kill of stoats, can significantly improve kaka and kereru survival if the control occurs during a 'good' breeding year.

Green (2004) reported that the kaka populations in part of Pureora Forest Park increased by 33% within six months of aerial 1080 control in 2001. All of the 20 females with radio transmitters in the treated area survived, whereas in a nearby untreated forest, stoats killed at least five of nine kaka females during the 2001 nesting season.

Following a study of the effects of an aerial 1080 operation on kaka and kereru survival and nesting success, Powlesland *et al.* (2003) concluded 'Aerial 1080 operations carried out just before kaka and kereru start breeding (normally in November for North Island podocarp forests) that result in low density populations of possums (< 5% residual trap catch), rats (< 5% of tracking tunnels tracked), and stoats (< 0.5 per 100 trap-nights or < 5% of tracking tunnels tracked) in years of podocarp mast fruiting would greatly benefit both kaka and kereru populations through improved nesting success and fledgling survival.'

Insectivorous birds e.g. robin, tomtits

Individual robins and tomtits have been killed by 1080 operations. However, the impact of 1080 operations on populations of robin and tomtit is low or nil. This is because the breeding success of these two species increases dramatically when predators are removed.

Following an aerial 1080 possum control operation in Pureora Forest, robin nesting success during the 1996/97 breeding season was much higher in the block where possums were controlled than in a nearby non-control area. The increased recruitment, attributed to the impact of the control operation on predators such as ship rats, led to the population being above pre-treatment levels within a year (Powlesland *et al.* 1999). Powlesland *et al.* (2000) reported tomtit nesting success was enhanced in the 1997/ 98 breeding season following 1080 possum control operations.

Other birds

One year after an aerial 1080 operation on Rangitoto Island in 1990, tui, silvereyes and Australasian harrier hawks were reported to have increased in numbers (Miller and Anderson 1992). Notably, by 1999, two years after possums and wallabies were finally eradicated from Rangitoto Island, only tui and silvereye counts were significantly higher than the 1990 bird counts. The counts of all other bird species had not changed. This lack of change in abundance was attributed to the continued presence of predators, particularly ship rats, cats and stoats (Spurr and Anderson 2004).

Overall Assessment:

While 1080 has caused some native bird mortalities in the past (discussed in Section 4.1D, Effects on the Environment), Innes and Barker (1999) concluded, based on present evidence, "the ecological costs of using toxins is much less than the damage if they are not used".

It is likely that there will be decreased security and local extinctions of threatened (and common) bird species, leading to reduced species diversity, over more than 500,000 ha that DOC will not be able to manage for pests WITHOUT 1080, although not all of this would be attributable to direct predation by pest species. The major benefit of 1080 is that it can achieve a rapid reduction of predators (possums, mustelids, and rodents) to low numbers over very large areas. This is particularly important when control operations are timed occur just prior to the breeding season when many bird species are most at risk.

WITHOUT 1080, pest control to protect species would be focused around a small number of priority sites. Only a small number of populations of threatened or endangered species would be protected WITHOUT 1080. Elsewhere species ranges would retract and local extinctions would be more likely to occur.

As no other pest control method can achieve a rapid reduction of predators to low numbers over very large areas above it is considered **VERY LIKELY** that a future WITH 1080 will achieve benefits for native birds when compared to a future WITHOUT 1080. WITHOUT 1080, range contractions will occur for several threatened species including kiwi, kokako and kaka and there will be a gradual decline of chronically threatened species over very large areas. Over a longer timeframe than that considered in this assessment (10 years) more species may become extinct as ecosystem level effects that are not noticeable within 10 years occur.

Potential gains for other species such as tomtit and kereru will not be realised by ground control only. Given the case studies above and the significance of 1080 as a tool for improving the success of native birds the magnitude of this effect is **MAJOR.**

Conclusion: The benefit of reduced predation of native birds, particularly threatened species, is VERY LIKELY (a good chance that it may occur under normal operating conditions) and the magnitude is MAJOR (long term benefit to localised species and/or ecosystems, improves native biodiversity and major benefits to native species of national significance), resulting in a significant level of benefit E (great benefit at a regional and local level, or moderate benefits at a national level; may justify cost or risk to realise) WITH 1080 compared to WITHOUT 1080.

E-B6 Reduced competition for food supply and habitat resources for native birds, particularly threatened species

Identification: There is considerable overlap in the diets of possums and many native birds. Hence, by feeding on flowers, fruit, leaves and invertebrates possums reduce the food resources available to many native birds. For example, possums compete with frugivorous birds for seasonal fruit supplies (Cowan 2005) and with honeyeaters e.g. tui and bellbirds for nectar sources. Deer, rats and mice are also significant competitors with birds for food.

Possums also compete for nest sites with hole nesting birds such as kaka, kakariki and saddlebacks (Cowan 2005).

The effects of this competition are probably highest during the breeding season of native birds. If breeding females are unable to obtain enough food, breeding condition, nesting success and chick condition will be adversely affected (Green 2004).

Assessment: There is limited research that has specifically looked at the benefits of 1080 pest control operations for native birds due to reduced competition.

Following the 1990 aerial 1080 operation on Rangitoto Island, tui and silvereyes increased in numbers (Miller and Anderson 1992). Following the control operation rapid recovery of the pohutukawa forest occurred on the island. At the same time honey production on the island increased from 7-8 kg per hive pre-control to 25 kg per hive (Mowbray 2002). Spurr & Anderson (2004) suggested that the increase in tui and silvereye numbers was the result of increased flowering of rewarewa and pohutukawa.

Kohekohe is a dominant canopy species in northern forests and a food source for kereru (Nugent *et al.* 2002). It is also a preferred food of possums - on Kapiti Island sustained possum browsing had prevented any flowering or fruiting for several years before possum eradication began in 1980 (Cowan 2005). After possums were reduced to a 2% RTC via 1080 in bait stations, the mean foliage cover for kohekohe rose dramatically from 17% (indicating heavy browse) to 53% within two years (Green 2003). Similar improvements in kohekohe foliage cover have been recorded after aerial 1080 operations (Green 2003). The recovery of kohekohe following possum control will have made additional food available for kereru.

Native mistletoes are very slow-growing, long lived, plants that provide a nectar source for honeyeaters such as tui and bellbirds. They are also a highly preferred food by possums and have suffered a dramatic decline in many forests. Following 1080 operations good mistletoes recovery has been reported (Sessions *et al.* 2001, Sweetapple *et al.* 2002). In South Westland, kaka and kereru both rely heavily on foods preferred by possums (Sweetapple *et al.* 2004). The diets of possums and North Island kokako extensively overlap, contributing to the kokako's decline (Innes *et al.* 1999). In all these cases, control of possums and the resulting improvement in vegetation will have increased food supplies for these birds.

While 1080 has caused some native bird mortalities in the past, Innes and Barker (1999) have concluded that based on present evidence "the ecological costs of using toxins is much less than the damage if they are not used.

It is likely that there will be reduced diversity of species, decreasing security and an increase in local extinctions of threatened species over an additional 500,000 ha that DOC will not be able to manage for pests WITHOUT 1080 (refer Context: Pest Control Scenarios) – although not all of this would be attributable to competition from pest species.

1080 is considered a key tool for the protection of native birds from competition from pest species as it provides the ability to *simultaneously* cover large areas of ground (some of it inaccessible for pest control by other means apart from aerial application), kill rodents and knock down possum populations quickly. As no other pest control method can achieve this it is considered **VERY LIKELY** that a future WITH 1080 will achieve benefits for native birds when compared to a future WITHOUT 1080. Given the case studies above and the significance of 1080 as a tool for threatened animals of national importance the magnitude of this effect is **MAJOR**.

Conclusion: The benefit reduced predation of native birds, particularly threatened species is VERY LIKELY (a good chance that it may occur under normal operating conditions) and the magnitude is MAJOR (long term benefit to localised species and/or ecosystems, improves native biodiversity and major benefits to native species of national significance), resulting in a significant level of benefit E (great benefit at a regional and local level, or moderate benefits at a national level; may justify cost or risk to realise) WITH 1080.

E-B10 Protection of *Powelliphanta* land snails from predation

Identification: There are 61 recognised species of *Powelliphanta*. They are long-lived with an average life span of about 12–14 years. The snails also have a low fecundity. *Powelliphanta* are found in both the North and South Islands, often in remote mountainous regions with dense ground cover of scrub and tussock.

Many populations of extant species of *Powelliphanta* have been lost in the last 150 years as a result of vegetation clearance. However, the primary cause of the snails' decline is now introduced possums, ship rats, pigs, and less frequently thrushes and hedgehogs preying on eggs, juveniles and adults year round (Walker 2003).

Possum predation first appeared in the 1970s and at first was only found in snail colonies in high altitude beech forests. However, snail predation by possums gradually spread to more snail colonies throughout the 1990s. It appears that snail-eating behaviour is learnt. Possums are now the main predator of many *Powelliphanta* populations, occupying all habitats of *Powelliphanta* and often reaching high population densities. In one *Powelliphanta* population studied in North Westland the density of live snails in the study site averaged approximately 100 snails/500 m^2 until possums started eating snails there in 1987. Predation by possums then caused the snail population to decline by 50% in one year and the population continued to decline until only four animals remained in 1993 (Walker 2003). Similar impacts have been recorded in other populations.

To enable the populations of *Powelliphanta* to recover, possum and rat control needs to be undertaken to reduce the numbers of these pests to very low levels.

Assessment: Possum and rat control can dramatically improve survival of snail populations. At Kahurangi Point, north-west Nelson, 54 live and 64 shells of possum-killed *Powelliphanta gilliesi kahurangica* snails were found in a 500 m^2 monitoring plot in 1996. An aerial 1080 operation in 1997 reduced possum numbers to 0.03% residual trap catch. When the monitoring plot was re-measured in 1999, snail numbers had increased dramatically to

147 live snails and there was no sign of recent possum predation. At Gouland Downs *Powelliphanta superba mouatae* increased from zero live snails/100m^2 to 4.5 /100m^2 over the 4 years following an aerial 1080 operation that had reduced possum numbers to less than 1% RTC. Similarly, on Mount Burnett, *Powelliphanta* numbers increased from 3.3/100m^2 to 13.2/100 m^2 following two successful aerial 1080 operations (Walker 2003).

The *Powelliphanta* Recovery Group (Walker 2003) sees 1080 as an important tool in the survival of the snails. *Powelliphanta* often occur as small and widely scattered populations over very large (> 10 000 ha) remote forest blocks. Aerial 1080 is the only way to control both possums and rats on the scale required to protect these populations. Even at sites where *Powelliphanta* are protected by intensive, annual, pest control, 1080 is important. A toxin that kills possums and rats equally well is required. Due to the frequent use of pesticides, the recovery group aims to generally avoid the overuse of accumulative anticoagulant pesticides, and by alternating a range of pesticides; the potential for anticoagulant pesticide resistance and bait shyness to acute toxins developing in pest species is prevented.

WITH 1080, DOC will be able to protect most populations of *Powelliphanta* snails. WITHOUT 1080, DOC would be unable to protect the small, widely scatter populations in large remote forest block. Annual ground control at intensively managed sites would be less effective WITHOUT 1080. This would lead to increased predation, local extinctions of snail populations, and possibly the extinction of some *Powelliphanta* species.

Conclusion: The benefit of reduced predation of *Powelliphanta* land snails is **VERY LIKELY** (a good chance that it may occur under normal operating conditions) and the magnitude is **MAJOR** (long term benefit to localised species and/or ecosystems, improves native biodiversity and major benefits to native species of national significance), resulting in a significant level of benefit **E** (great benefit at a regional and local level, or moderate benefits at a national level; may justify cost or risk to realise) WITH 1080.

D.2 Adverse Effects on Environment without 1080

There were no significant adverse effects on the environment from the use of 1080. However the following activities were identified in Section 4.1D as significant risks to environmental receptors due to the use of cyanide or traps:

E-CN- A15 Direct exposure of weka to Feratox pellets (Level of risk = F)

E-TR-A1 Effects of leg hold traps on weka (Level of risk = E)

It is not within the scope of this risk assessment to provide a detailed analysis of potentially adverse environmental effects resulting from exposure to cyanide. The controls, potential exposure pathways and effects, and risk profiles as they correspond to each of the above activities have been discussed in the registers in Section 4.1D.

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