



A economic justification for government intervention in the control of wild dogs and primary instrument selection

Service Design Research Working Paper 01-12

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1. Project Background

1.1. Project Rationale

Wild dogs have a number of adverse impacts on landowners and the broader community. They attack livestock, impact on dingo populations, and may present human and livestock disease issues and, potentially, threaten human safety (King 2008). Wild dogs in Victoria largely live and breed on public land and impact on enterprises adjoining public land, where populations of wild dogs are concentrated (King 2008). The challenge then is to design management programs that are effective in using limited public resources to foster private management of pest animals while meeting community expectations.

The principle legislation relating to the management of wild dogs is the *Catchment and Land Protection Act 1994*. Wild dogs are defined under this legislation as feral or wild populations of dogs (*Canis lupus familiaris*) and dingo-dog hybrids (*Canis lupus dingo* x *Canis lupus familiaris*) and are declared an Established Pest Animal. The dingo has been listed as a Threatened Species in Victoria under the *Flora and Fauna Guarantee Act 1987* and as a result is protected under the *Wildlife Act 1975*.

All landowners (including State and Local Government and private landowners) have a responsibility under the *Catchment and Land Protection Act 1994* to take all reasonable steps to prevent the spread of, and as far as possible eradicate, established pest animals such as wild dogs (Department of Primary Industries 2010). The *Domestic Animal Act 1994* places responsibility on dog owners for the control and confinement of their dogs (Department of Primary Industries 2012).

The Victorian Government has a responsibility as a public land manager to manage wild dogs on its land. The Department of Primary Industries (DPI) largely undertakes this role on behalf of other public land managers such as the Department of Sustainability and Environment (DSE) and Parks Victoria (PV). The wild dog management program within DPI has a number of components, with the largest proportion of resources and activity devoted to the public provision of control activities. DSE and PV play a supporting role in wild dog control with input into planning and the approval of control activities on public land. This reflects differing legislative responsibilities and priorities, and funding arrangements among the Departments.

The variety of adverse impacts, and the fact that dog attacks arise from wild dogs, feral dogs, and dingoes and their hybrids, creates substantial challenges for the effective management of wild dogs. Statutory provisions in regard to animal welfare and the status of dingoes as a protected species compound these challenges.

1.2. Project objective

Invasive species are recognised to cause a range of serious problems through impacts on parks, forests, waterways, land assets, agricultural production and rural communities. The Victorian Government invests in invasive species management and research, public awareness activities and regulation of certain activities (Department of Primary Industries 2010). The general principle of government involvement in invasive species management is that government invests in the most appropriate intervention to maximise public benefit (Department of Primary Industries 2010). There is a range of actions that can be taken to manage invasive species. However identifying when and how to intervene is a complex problem, therefore government wishes to direct effort to where there is a justified role and can be effective.

It is not feasible or cost-effective for government to enforce or fund the control of all invasive species, nor is it reasonable to apply regulation against them all (Department of Primary Industries 2010a).

In this paper we use economic reasoning to analyse and clarify the nature of the public benefit that arises from government intervention in the management of wild dogs by private

landholders. Knowing the precise nature of the public benefit, which provides the justification for government intervention, is a crucial first step in selecting the kind of policy instrument that will form the foundation of a government program.

The analysis is conducted using three of the component frameworks of the Policy Choice Framework (Johnson et al. 2006; Kaine et al. 2007a; Kaine et al. 2007b; Kaine et al. 2008; Sandall et al. 2009; Sandall et al. 2010; Young and Kaine 2010). The Policy Choice Framework (PCF) is used to choose and design policy instruments to influence the behaviour of landholders. The PCF is composed of a number of economic and social frameworks that are used to select a policy instrument based on the economic justification for government intervention, predict landholders' responses to policy instruments, and predict the organisational implications of policy instruments for government and community agencies. In this paper we describe and apply the frameworks in the PCF that are used to select a policy instrument based on the economic justification for government intervention.

The aim of the research was to contribute to the efforts of the Biosecurity Victoria (BV) Division of DPI to identify effective and efficient policy responses to the problems posed by wild dogs. The findings are intended to assist the managers of the Wild Dog Program by providing guidance for improving program design and resource allocation. Consequently, our objective was to analyse the control of wild dogs as a policy problem to determine what changes to policy instruments might improve the effectiveness of the wild dog control program.

In the next section we describe the economic justifications for government intervention to change the behaviour of private individuals. We also describe, given an economic justification, the logic of selecting a policy instrument to change the behaviour of individuals. We then present three separate analyses for free roaming domestic dogs, dingoes and wild dogs. This separation was important as the groups that were the target for changing behaviour is different in each case. Furthermore, the justification for government intervention, and selection of the primary policy instrument was different for each case.

2. Identifying the product or service of interest

In many circumstances, the free operation of competitive markets is the ideal; however, certain conditions may justify government intervention in the operation of markets to enhance social welfare. A mix of these conditions may be present in any given situations. Establishing which conditions are present is important for determining the form of government intervention and therefore the most appropriate choice of policy instruments (Sandall et al. 2009).

The first step in establishing government intervention in the operation of markets is justifiable is to identify precisely in which market is intervention necessary. There is an extensive literature on the economic conditions such as externalities, market power and information asymmetries that justify government intervention. However, the literature does not describe a systematic process for deciding which market should be analysed when deciding if government intervention is justified

Since there is no logical, replicable method for identifying which market should be the subject of analysis the choice of market can be idiosyncratic. This renders the results of the analysis problematic as the justification for intervention, should there be one, may differ depending on which market is analysed; which may have serious consequences for the choice of policy instrument.

To illustrate, Randall (1983) describes how market failure in the form of externalities occur as a result of certain fundamental properties of products and services; namely non-exclusivity and non-rivalry. Whether or not these properties are present with respect to a particular product or service is an empirical matter. A prerequisite to the application of Randall (1983) is the selection of a product or service for analysis prior to the commencement of the analysis. The selection of the product or service is a matter to be decided using a mechanism external to Randall (1983).

This is the case for the literature on market failure generally.

Consequently, we developed a prototype framework for identifying the product or service that is to be the subject of a market failure analysis, given a policy objective¹. The purpose of the 'policy and products framework' is to:

1. Identify the behaviours that a policy objective is intended to change, and
2. To classify each behaviour as either creating (supplying) a product or service, or using (consuming) a product or service.

The purpose of a policy is to change behaviour of some or all members of a community. Consequently, a policy is constructed on the assumption that, in its absence, individuals or businesses will either:

- Take actions that are not consistent with the policy objective, or
- Not take actions that are consistent with the policy objective.

Hence, the first step in translating a policy objective into a series of behaviours and associated products and services is to identify what actions individuals or businesses could take that are not consistent with the policy objective, in the absence of any public intervention. The second step is to identify actions that would not occur in the absence of any public intervention but would be consistent with the policy objective.

¹ We have used the term 'products and services' rather than 'goods and services', which is more common in economics to avoid the confusion between goods, public goods and 'the public good'.

Any actions an individual or business could voluntarily take that are not consistent with the policy objective can be characterised as one of:

- (i) A business using an input to create a product or service for profit when the purpose of the policy is to reduce use of the input.
In this case the input is the product or service of interest, and the purpose of the policy is to reduce use of the input by the business in transforming the input into a product or service (e.g. capacity of atmosphere to absorb pollutants),
- (ii) An individual uses an input while consuming a product or service for personal satisfaction when the purpose of the policy is to reduce use of the input.
In this case the input is the product or service of interest, and the purpose of the policy is to reduce the use of the input to meet final consumption values (e.g. allowing domestic dogs to roam freely).

The second step is to identify actions that would be consistent with the policy objective but would not voluntarily occur in the absence of any public intervention. If such actions can be identified then they can be characterised as either:

- (iii) A business supplying a product or service.
In this case the action is the product or service of interest, and the purpose of the policy is to encourage the action (e.g. pest eradication service),
- (iv) An individual consumes a product or service.
In this case the action is the product or service of interest, and the purpose of the policy is to encourage consumption (e.g. safety belts, education).

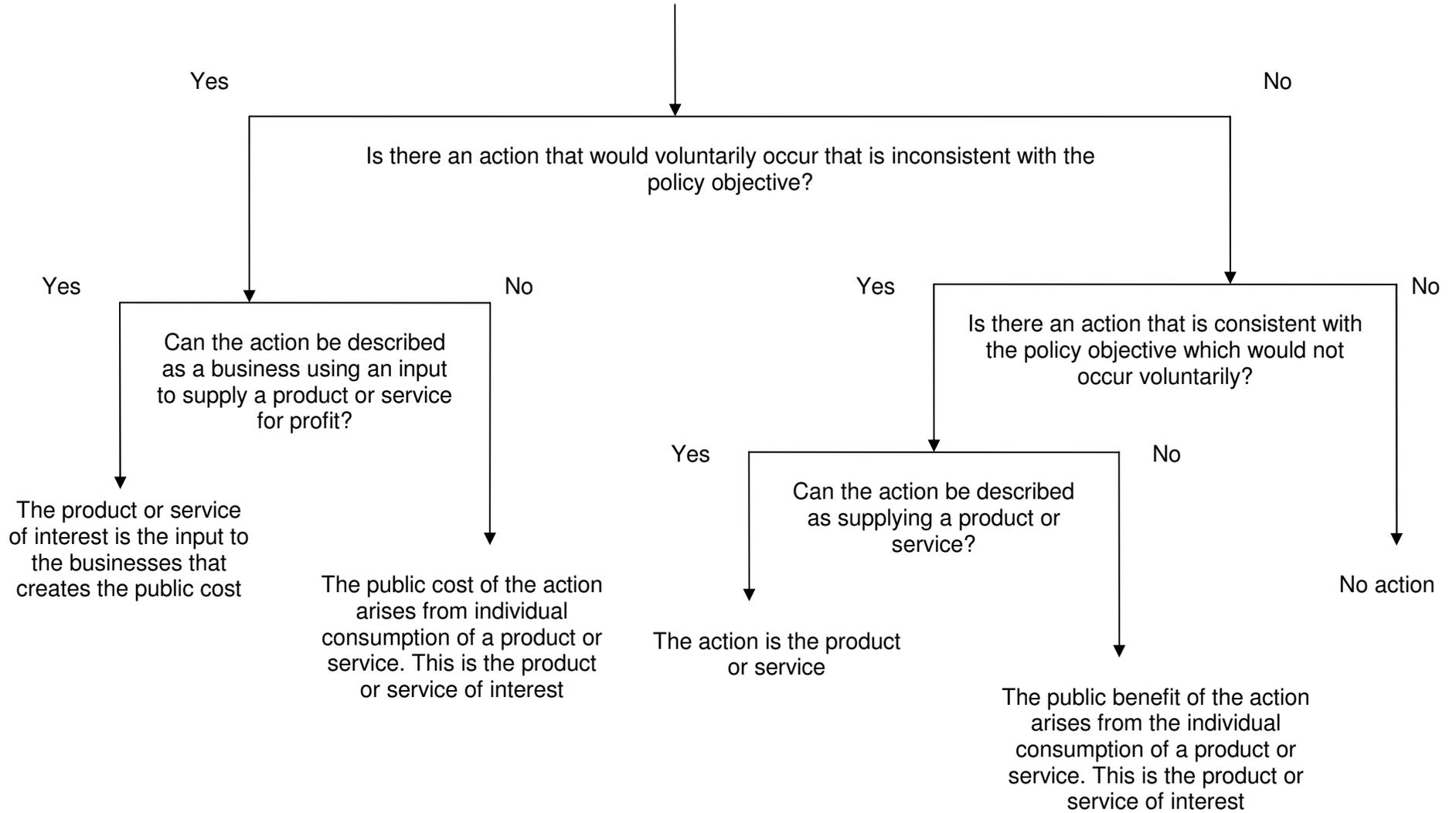
The above provides criteria for translating a series of behaviours associated with achieving a policy objective into a series of products and services for analysis. The criteria are:

- Will the action be taken voluntarily in the absence of intervention?
- Will a business or an individual take the action?
- Is the action consistent with the policy objective?

The criteria are laid out in the form of a decision tree in Figure 1.

The resulting classification provides the information necessary to apply the Economic Justification Framework and, subsequently, the Primary Instrument Framework.

Figure 1: Policy and Products Tree



3. Economic justifications for government intervention

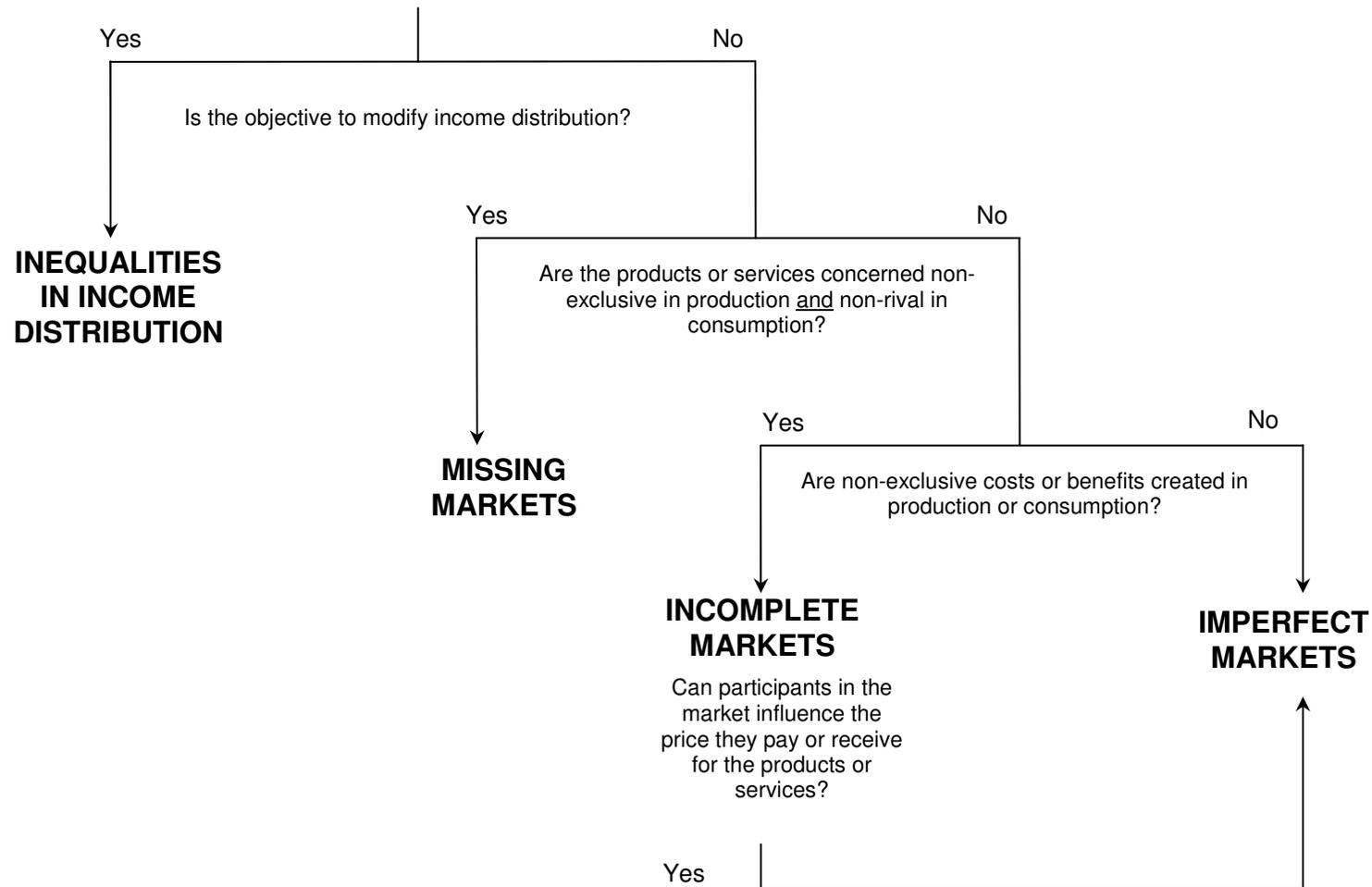
Generally speaking, from an economic perspective, four fundamental economic conditions justify government intervention in the operation of markets. These conditions are inequalities in income distribution, missing markets, incomplete markets or imperfect markets (Sandall et al. 2009) and arise as the result of inequality, externalities, and asymmetries in market power and information. The form of government intervention and, therefore the most appropriate choice of policy instruments, will depend on which conditions are present in a situation. The Economic Justification framework provides a way of distinguishing which of these four fundamental conditions are present.

The presence of these conditions may justify government intervention to overcome social-economic inequalities or market failure. Inequality and market failure can lead to the inefficient allocation of resources; this can result in the production of goods or services at levels that are not socially optimal. Knowing the reason for this inefficiency is crucial if it is to be rectified. It should be noted that other conditions must be met before intervention is fully justified (Sandall et al. 2009).

In principle then, the Economic Justification framework (Sandall et al. 2009) provides a foundation for identifying on economic grounds which policy instrument is likely to be most suitable for dealing with the control of wild dogs as a policy problem. Hence, the framework can support program managers in their efforts to systematically and transparently identify which justifications for government intervention are relevant to policy on wild dog control and to use this understanding to choose suitable types of policy instruments.

A detailed description of the Economic Justification Framework (figure 2) is contained in Sandall et al. (2009).

Figure 2: Economic Justification framework (source Sandall et al. 2010)



4. Selection of the primary policy instrument

The justification for government intervention is used in the primary instrument framework to identify the type of policy instruments that will efficiently deliver on the policy objective and is workable. The purpose of the primary instrument framework is to identify the policy instrument that, in theory, will most efficiently achieve the policy objective. To reveal the most efficient instrument the framework uses economic and practical criteria to eliminate instruments that are likely to be inefficient or unworkable.

The primary instrument framework consists of four decision trees, which provide a means of using the results from the economic justification tree to determine whether the most efficient instrument is likely to be:

- Public provision of a product or service
- Some type of incentive
- Some kind of regulation
- A variant of a tax or charge
- Some form of market instrument like a cap and trade or credit scheme

The first tree in the primary instrument framework uses the results from the economic justification tree to choose between primary instruments that encourage private behaviour that is desirable because the behaviour will create net public benefits and primary instruments that discourage private behaviour that is undesirable because the behaviour will create net public costs (see figure 3).

The second and third trees in the framework are used to decide whether the primary instrument is (1) public provision of a product or service, (2) the use of some type of incentive to promote voluntary changes in private behaviour, or (3) the use of instruments to create compulsory changes in private behaviour (see figures 4 and 5). The choice between these three options is based on the following criteria:

- Economies of scale or scope in production or consumption
- Rights of those that experience uncompensated costs or benefits (often termed the community) relative to the rights of those who create uncompensated cost or benefits (often individuals)
- Measurement of the creation of the public benefit or cost

The public benefits tree is used where the production or consumption of a product or service creates a net public benefit; the public costs tree is used where the production or consumption of a product or service creates a net public cost. The two trees could in principle be combined into a single tree; however we have created separate trees for clarity and convenience.

In regard to production that creates a net public benefit then public provision (public supply or public funding of supply) deserves consideration as the primary instrument where economies of scale are present. Otherwise, the choice of primary instrument lies between using incentives to encourage voluntary changes in production or consumption when the rights of the individual have priority over the rights of the community, or instruments to create compulsory changes in production or consumption when the rights of the community have priority over the rights of the individual.

In regard to production or consumption that creates a net public cost the choice of primary instrument lies between using incentives to encourage voluntary change when the rights of the individual have priority over the rights of the community, or instruments to create compulsory change when the rights of the community have priority over the rights of the individual.

Where the choice of primary instrument is either public provision of a product or service (e.g. research, extension, and infrastructure), or the use of some type of incentive to encourage voluntary changes in behaviour (e.g. flat, matrix, tender) the next step is to consider landholders' reactions to the instrument.

Where the choice of primary instrument is among instruments that create compulsory changes in private behaviour the next step is to choose between some kinds of regulation, a variant of a tax or charge, or some form of market instrument like a cap and trade or credit scheme. This choice is made using the fourth tree: the compulsory change tree (see figure 6).

The choice among these options is based on three criteria:

- Measurement of individual creation of the public cost or benefit
- Measurement of individual differences in the value of the creation of the public cost or benefit
- Impact of technology and materials on creation of public benefits or costs

Where individual creation of a public cost or benefit cannot be measured then the only options for a primary instrument are (1) regulation of the technology and materials used in production or consumption activities; or (2) the regulation of the management of materials and technologies used in those activities (Bluff and Gunningham 2003).

Selecting between these depends, in the first instance, on how closely the creation of the public benefit or cost is linked to the type of technology and materials used in the activity and the management of the technology (Bluff and Gunningham 2003). The more the creation of the public benefit or cost depends on the type of technology and materials, and less on the management of the technology and materials, the more likely technology standards are feasible. The more the creation of the public benefit or cost depends on the management of the technology and materials, and less on the type of technology and materials, the more likely process standards are necessary. Of course, depending on circumstances, both kinds of standards could be required (Bluff and Gunningham 2003).²

Where individual creation of a public cost or benefit can be measured relatively inexpensively then the options for a primary instrument are (1); the use of a market instrument such as a tax or cap and trade scheme; or (2) regulation of production or consumption activities through performance standards (Bluff and Gunningham 2003). The choice between these depends on whether individual differences in the value of creating the public cost or benefit are present and can be measured relatively inexpensively. If such differences do not exist or cannot be measured, performance standards (including bans) are the preferred option for primary instrument as market instruments are not feasible.

² Technology standards refer to prescriptive regulations in regard to specification standards, technical or design standards.

Figure 3: Primary Instrument Tree

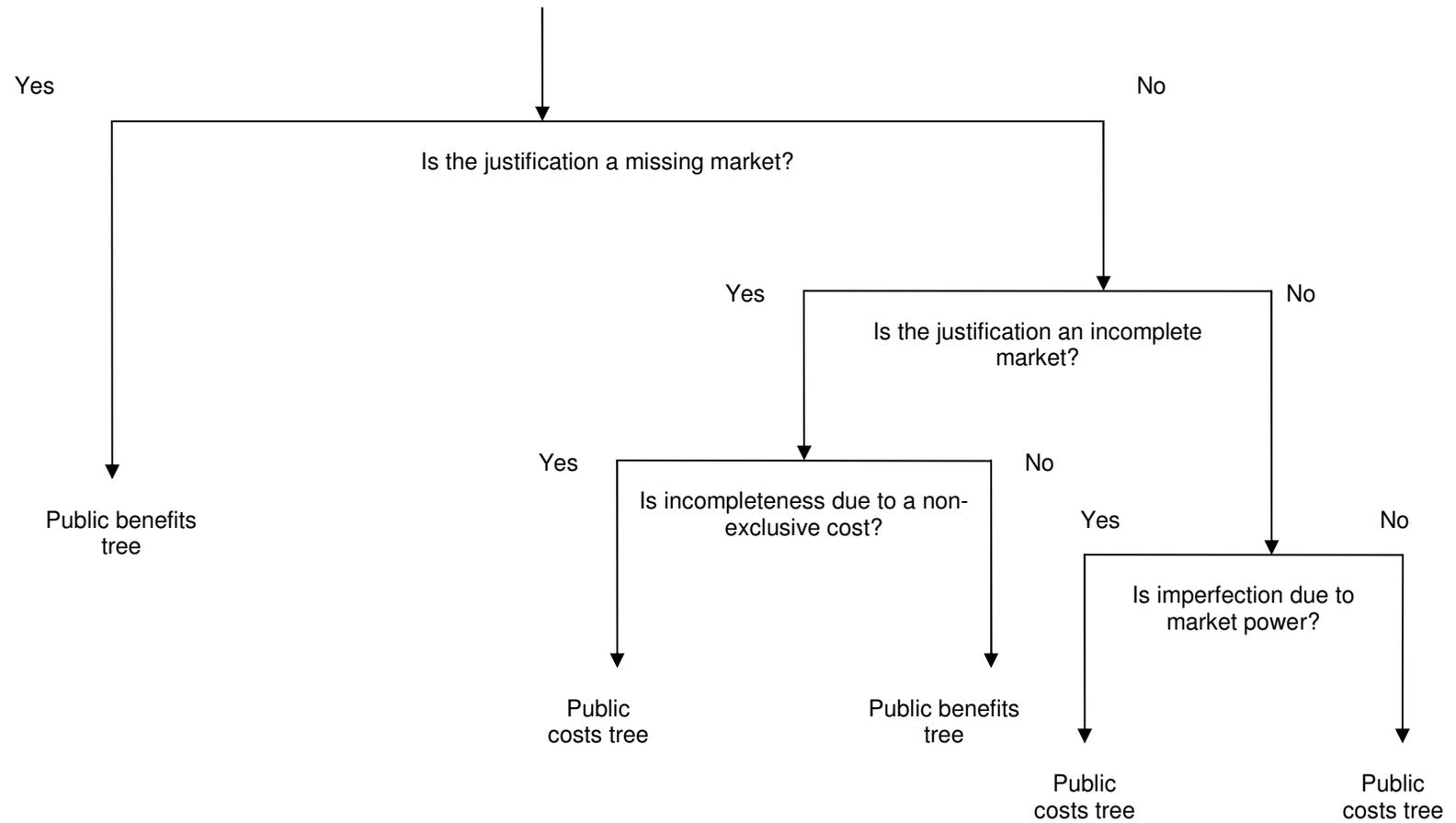


Figure 4: Public Benefits Tree (encouraging behaviour that creates public benefits)

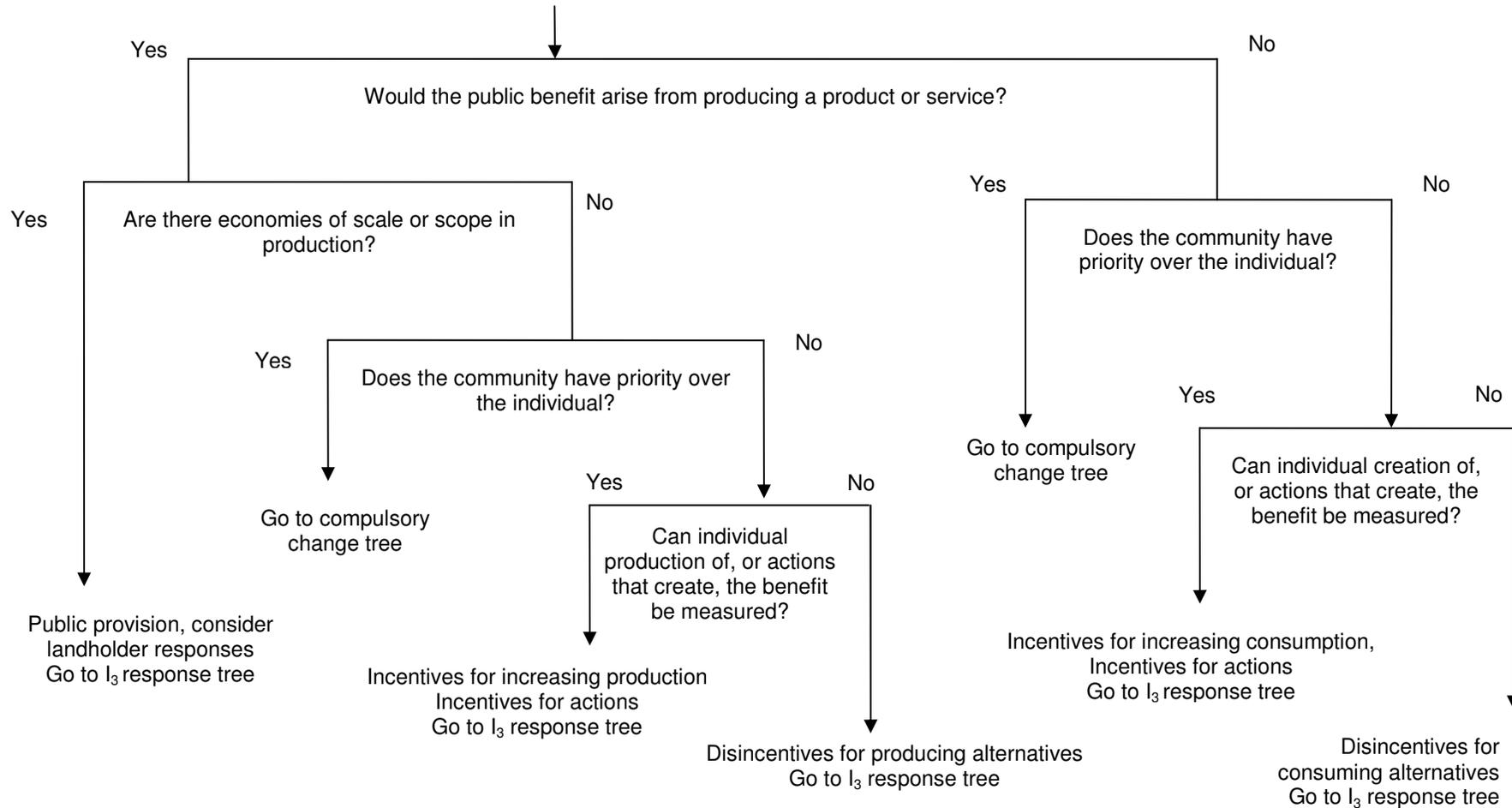


Figure 5: Public Costs Tree (discouraging private behaviour that creates public costs)

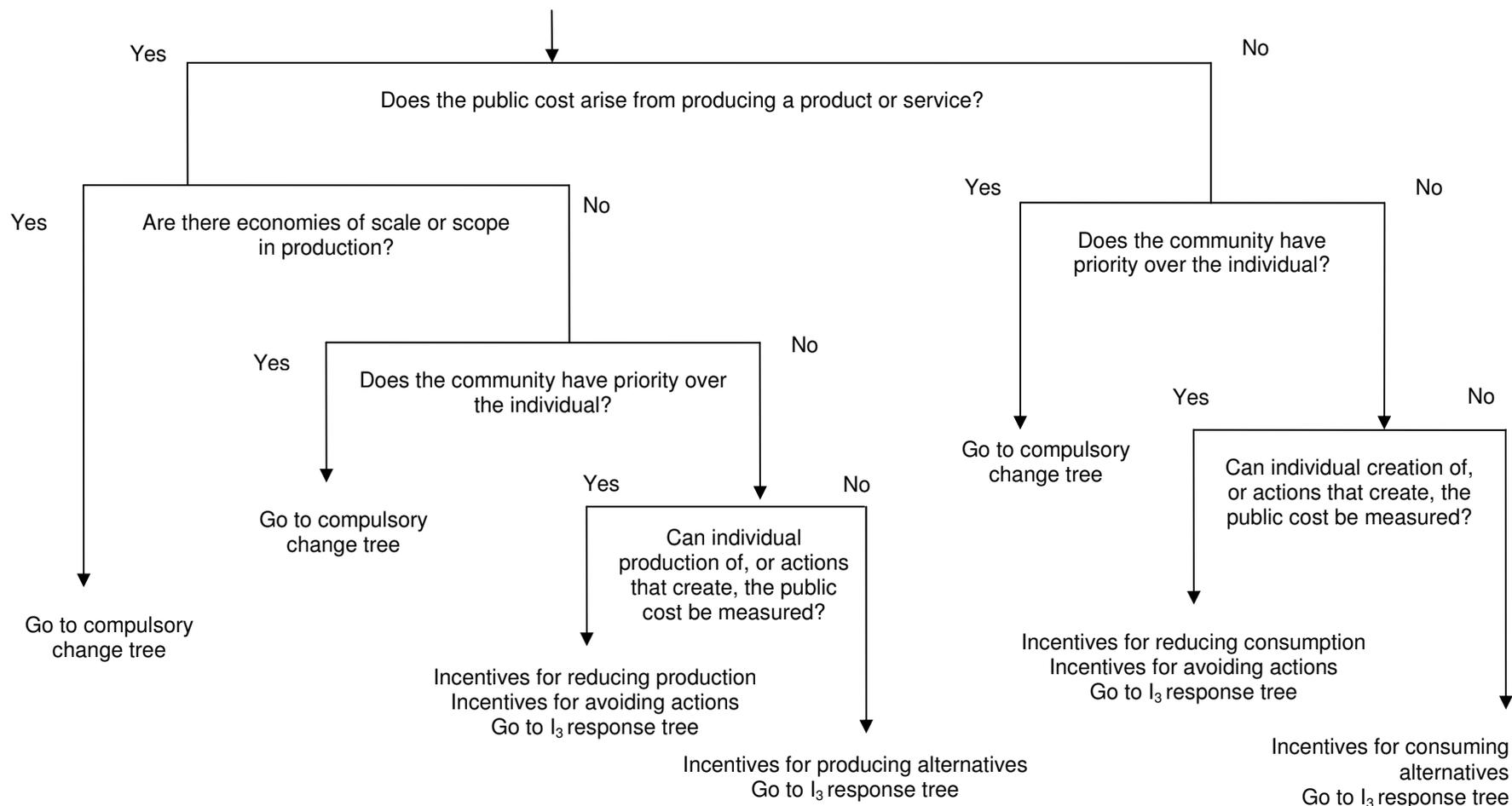
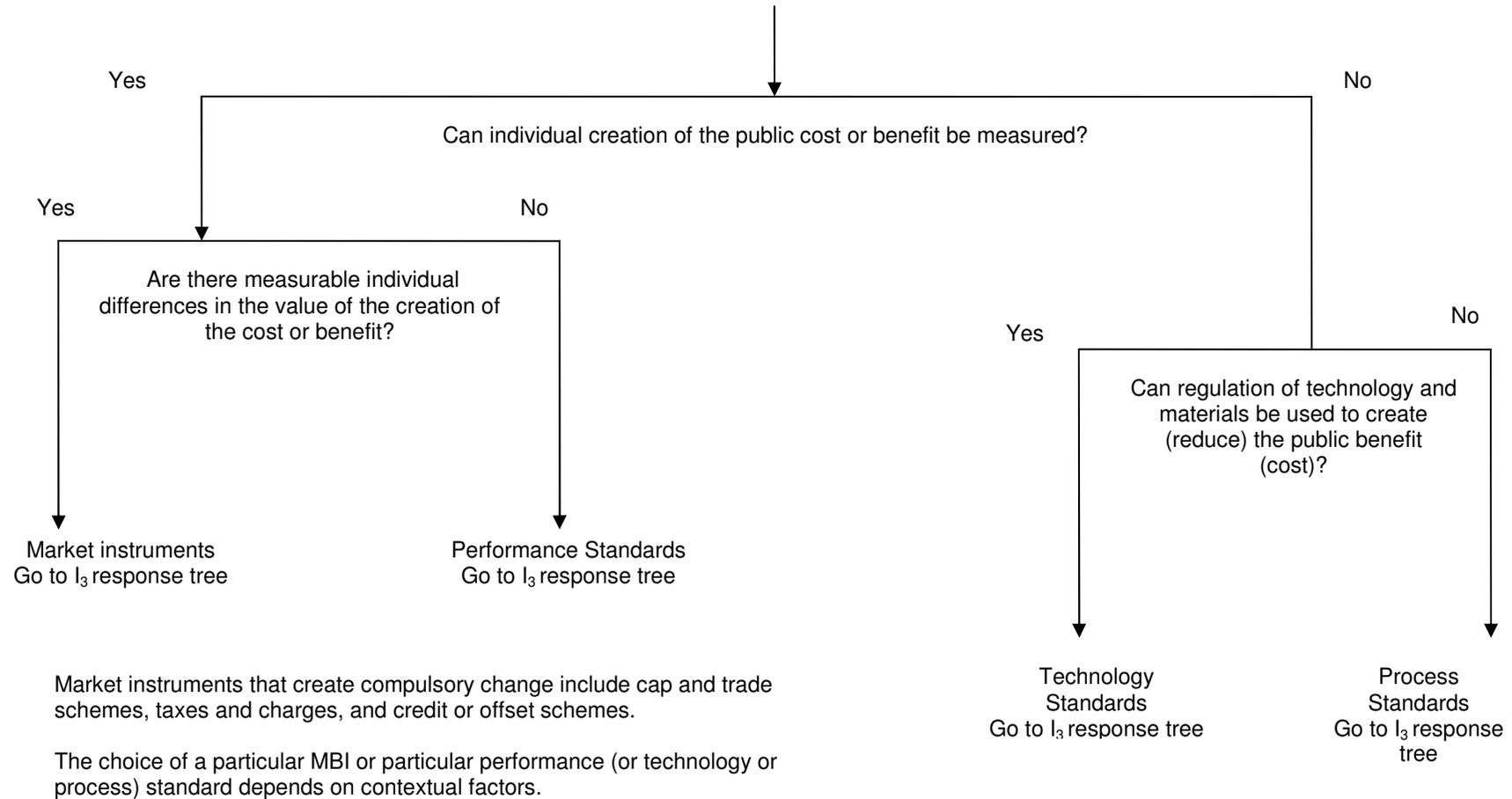


Figure 6: Compulsory Change Tree



The precise design of the market instrument (cap and trade, variable cap and trade, flat rate tax, variable rate charge) or performance standard will depend on the circumstances of the particular case under consideration.

Once the choice of primary instrument has been made, whether it is a market instrument or one of the three kinds of regulatory standards the next step (the I₃ response tree³) is to consider landholders' reactions to the instrument.

The primary instrument framework is based on the application of the following principles which are adapted from Pannell (2008):

- Do not use public resources to encourage behaviour where that behaviour creates a net private benefit and would happen anyway
- Do not use public resources to encourage behaviour where the net private cost of the behaviour will exceed the net public benefit
- No intervention is required if the net private benefits of behaviour outweighs the net public costs
- No intervention is required if a behaviour creates both net private costs and net public costs

The choice of instruments using the framework should be consistent with the following principles from Pannell (2008):

- Do not use instruments to encourage behaviour unless that behaviour generates a net public benefit
- If the net public costs of a behaviour outweigh the net private benefits intervene to discourage the behaviour

In this framework research and extension are treated as products and services, which may be publicly supplied, rather than as policy instruments in themselves. The application of the economic justification framework and the primary instrument framework should produce results consistent with the principle enunciated by Pannell (2008) not to use extension [to promote voluntary change] unless the resulting behaviour would create net private benefits.

³ Kaine, G., Murdoch, H., Lourey, R. and Bewsell, D. 2010. A framework for understanding individual response to regulation. *Food Policy*, 35: 531-537.

5. Justification for government Intervention in wild dogs

In this section we apply the products and services framework (figure 1), the economic justification framework (figure 2) and the primary instrument choice framework (figure 3, 4, 5 and 6) to the policy problem of preventing or reducing wild dog predation of livestock. Wild dog numbers are controlled through activities such as trapping, poisoning and shooting while activities such as the erection of exclusion fencing and use of guard animals reduce the opportunity for wild dogs to attack livestock.

5.1 Product or service

We defined the policy objective as preventing or reducing wild dog predation of livestock. The intention of the policy is to have individuals (landowners) take action that they would otherwise not take to prevent or reduce attacks by wild dogs. In other words, landholders could take actions that would be consistent with the policy, namely to prevent or reduce attacks by wild dogs. However, they would not voluntarily take all of these actions in the absence of the policy. These actions can be described as private provision of a pest control service to prevent or reduce incidences of wild dog attacks (refer Figure 1).

5.2 Economic justification

The first question in the Economic Justification framework (figure 2) asks if the policy objective is to modify income distribution. This question is intended to identify circumstances where the justification for government intervention is to directly address inequalities in incomes that society considers to be unacceptable (Sandall et al. 2009). An example of a policy objective to modify income distribution is ensuring adequate incomes, the policy instruments being social security payments and minimum wage legislation.

The policy objective is defined here as preventing predation on livestock by wild dogs and concerns the supply of pest control services by private landholders; this objective does not immediately and directly concern income inequality though achievement of the objective will have an indirect affect on income distribution in the community. Consequently, the economic justification for this objective must be market failure.

The next step is to determine the type of market failure that is present in the private supply of pest control services for wild dogs (Sandall et al. 2009). A service for preventing attacks by wild dogs involving control measures such as baiting, shooting and trapping is non-exclusive in production. This is because, in the absence of government intervention, it is not possible for an individual to exclude other land managers from the protection created by the control measures the individual takes to prevent attacks by wild dogs, or to compel other land managers to pay for any protection they receive from the control measures the individual implements.

A service involving control measures such as baiting, shooting and trapping is non-rival in consumption because the protection one land manager receives from the service (in the form of reduced attacks by wild dogs) does not exclude other land managers from receiving similar benefits from the same service. Therefore, a pest control service involving these control activities that prevents or reduces attacks by wild dogs is non-exclusive in production and non-rival in consumption. These conditions result in a missing market and, as a result, private investment in providing this service will be less than socially desirable (Sandall et al. 2009).

Control measures for reducing attacks by wild dogs such as exclusion fencing and guard animals are exclusive in production and rival in consumption. This is because, in the absence of government intervention, it is possible for an individual to exclude other land managers from the protection these control measures provide. However, proceeding on the assumption that wild dogs largely dwell on public land, these control measures can be ignored as they simply redistribute among private land managers the uncompensated losses resulting from attacks by wild dogs. The diversion of wild dogs away from the properties of land managers with exclusion fencing or guard animals transfers dog attacks, and consequent losses, to land managers that do not have exclusion fencing or guard animals. Further, in the absence of government intervention land managers bear the full capital and maintenance costs of exclusion fencing and guard animals. Presumably those that invest in exclusion fencing or guard animals expect the costs of doing so to be smaller than the losses they anticipate

from attacks by wild dogs. Hence, the costs of exclusion fencing and guard animals are an uncompensated loss arising from the threat of attack by wild dogs.

In short, the protective benefits offered by wild dog control using baiting, shooting and trapping are available to all land managers, and the benefits of wild dog control enjoyed by one land manager does not reduce the benefits available to other land managers. Individual land managers will under-invest from a social perspective in preventing attacks by wild dogs, as they will not be fully compensated for the protection they create for others. Consequently, private investment in these wild dog control activities will be less than is socially desirable. Hence, government intervention to increase the production of control services that prevent attacks by wild dogs can be justified on economic grounds. Control measures for preventing attacks by wild dogs such as exclusion fencing and guard animals redistribute the uncompensated losses resulting from attacks by wild dogs among private land managers.

5.3 Selection of the primary policy instrument for wild dogs

The first tree (figure 3) in the Primary Instrument framework uses the results from the economic justification tree to choose between primary instruments that encourage private behaviour that is desirable because it will create public benefits and primary instruments that discourage private behaviour that is undesirable because it will create public costs.

The economic justification for intervening to increase the supply of control services for wild dogs was that there was a missing market. Increasing the supply of the service by private land managers is socially desirable and would create a public benefit. Consequently, the next step is to identify a policy instrument that will encourage private behaviour, that is, the increase the supply of control services by private land managers.

The public benefits tree (figure 4) is used where the production or consumption of a product or service creates an uncompensated public benefit (Sandall et al. 2009). The instrument that is used to encourage creation of public benefits depends on whether the public benefit is created by supplying a product or service, or by using a product or service. In this instance the public benefit arises from land managers supplying a pest control service that reduces attacks by wild dogs.

5.3.1 Are there economies of scale or scope in production?

The first step (figure 4) in choosing a policy instrument to create public benefits by increasing the supply of services to control wild dogs is whether economies of scale or scope would exist in the production of service. When economies of scale are present the cost per unit of supplying a product or service decreases as the volume of production increases because the fixed costs of production are distributed across a greater volume. Economies of scale mostly occur in manufacturing of products. When economies of scope are present the cost per unit of supplying a product or service decreases over a limited range because, for example, specialist skills are required to supply the product or service. Hence, economies of scope can occur in the provision of specialist services.

If economies of scale or scope exist then public provision of the product or service becomes an efficient option as a primary instrument (e.g. research, extension, and infrastructure).

We suspect that economies of scale are not present in supplying a wild dog control service because the service requires limited capital equipment and wild dogs are distributed across the State. This means, for example, services need to be regionally replicated and customised. However, economies of scope may be present in the specialist skills required to conduct control activities such as baiting, trapping and shooting wild dogs.

To the extent that specialist skills and knowledge are required to engage in the following activities for preventing or reducing attacks by wild dogs then public provision may be the primary instrument for increasing the supply of these activities:

- Killing the wild dogs by trapping, poisoning and shooting
- Research into new wild dog control technologies

While public provision of wild dog control might be one instrument for reducing attacks from wild dogs the extensive geographic dispersal of wild dogs means that public provision of control services cannot

be effective in isolation. At the very least such a service will require cooperation from land managers in supplying intelligence on wild dog activity. Hence, the next matter to consider is identifying an appropriate instrument for obtaining cooperation in the supply of control services from private land managers.

Note that if the costs of public provision exceed the benefits created, then public provision is not an option and the next step to consider is securing the supply of control services by private land managers.

5.3.2 Securing supply of control services from private land managers

The next step (figure 4) in the public benefits tree considers the rights of the impacted community who experience uncompensated losses relative to the rights of those individuals who create those losses. If the rights of the impacted community have priority over the rights of the individuals that create the losses then a policy instrument that enforces compulsory change is appropriate. When the rights of the individuals that create the uncompensated costs have priority over the rights of the impacted community then a policy instrument that encourages voluntary change is appropriate.

In this instance the impacted community is defined as those that experience uncompensated costs or benefits (e.g. losses of livestock from predation by wild-dogs, impacts on dingoes such as hybridisation, potential health impacts, and environmental stakeholders). The individual is defined as those who create the uncompensated costs or uncompensated benefits. In this instance, the individual is all land managers on whose land wild dogs reside.

In this instance, we assumed that the rights of the impacted community had priority over the rights of the individuals that create the losses and therefore a policy instrument that enforced compulsory change was appropriate. This assumption is consistent with the current legislation creating a legal obligation for all landowners to take reasonable steps to control wild dogs.

5.3.3 Compulsory supply of services

Having identified, in the first instance, that a policy instrument that enforces compulsory change is the appropriate kind of policy instrument to secure the cooperation of private land managers in wild dog control, the next step (figure 6) is to choose between some form of regulation, a variant of a tax or charge, or some form of market instrument like a cap and trade or credit scheme.

The choice between the use of a market instrument or regulation through performance standards depends on whether the creation of public costs or benefits can be measured. For market instruments to be feasible the ability to measure the individual creation of public costs or public benefits is necessary. Hence, the first question in the compulsory change tree is whether the public benefits created by individual supply of a service can be measured relatively inexpensively?

The individual creation of public benefits from supplying control services for wild dogs could be inferred for some control activities based on the number of wild dogs killed. For these activities the next matter to consider is whether there are measurable individual differences in the cost of supplying a wild dog control service. Given that individuals would know the costs they incur in undertaking activities such as shooting then a market instrument may be feasible.

Market instruments that create compulsory change include cap and trade schemes, taxes and charges, and credit or offset schemes. An example of a market instrument that might be feasible would be a cap and trade schemes where a limited number of licences to kill wild dogs are issued, kills attract a bounty, and licences are sold by tender.

However, measuring the public benefit created by some activities, such as reporting wild dogs or baiting of wild dogs, may be problematic. In this case a market mechanism is unlikely to be feasible. Consequently, the only feasible options are:

- (1) Regulation of technology and materials; or
- (2) Regulation of the management of materials and technologies.

If the type of technology or material used in control activities strongly influences the public benefits created by those activities then control activities can be regulated through specification of technology

standards. Technology Standards are specification standards, technical or design standards. For example technology standards for wild dog exclusion fence construction.

Where the creation of the public benefits depends in part on the management of the technology and materials used in an activity as well as the type of technology and materials used then both technology and process standards may be necessary. Process standards are prescribed procedures and parameters. For example standards for trapping (placement and timing, checking regimes), baiting standards (baiting product standards, baiting densities), standards for wild dog exclusion fencing maintenance and standards about the management of guard animals.

The strict enforcement of technology and process standards for wild dog control by private land managers may be impractical or prohibitively expensive. If this were the case then compliance by land managers with standards becomes, largely, voluntary. In other words, notwithstanding the creation of compulsory standards, the supply of control services by private land managers becomes a matter of co-production (Wright et al. 2011a; b). This raises the possibility that incentives might be useful in maximising compliance with standards for some control activities (e.g. payment of incentives subject to meeting standards for exclusion fencing).

5.3.4 Voluntary supply of services

If the rights of individuals that create the uncompensated costs are given priority over the rights of the impacted community then a policy instrument that encourages voluntary change is appropriate. This means offering some form of voluntary incentive that encourages the supply of wild dog control services, or a disincentive for producing alternatives. This decision depends on the measurement of actions that create benefits (figure 4).

Individual creation of public benefits might be inferred for some activities by recording or estimating the number of wild dogs killed (e.g. trapped or shot). Therefore, incentives could be offered to private land managers to increase the supply of activities that kill wild dogs such as poisoning, shooting, trapping, or actions that reduce wild dog habitat.

The public benefit created by activities that reduce the opportunity for attacks on livestock may be more difficult to measure. Hence, setting incentives for actions of activities that reduce the opportunity for livestock attack such as fence wild dogs in or out, using guard animals, and stock management activities may be problematic.

5.4 Summary

Our analysis reveals some key decisions that influence the choice of policy instruments for controlling wild dogs. The first is to what extent economies of scale or scope exist in the supply of control services for wild dogs and therefore there is merit in the public provision of control services.

The second is whether cooperation from private land managers would improve the effectiveness of public provision of control services and, if so, whether such cooperation should be supplied voluntarily or made compulsory. The answer depends on the priority accorded the rights of those that experience the uncompensated costs or benefits relative to the rights of those that create the costs or benefits. Whose rights have primacy determines whether the instrument should create compulsory change, (regulation through technology or process standards or market instruments) or rely on voluntary change (incentives).

The third key decision is whether the creation of the public benefits or costs by land managers can be measured. Measurement is important to instrument choice because, for example, the ability to measure creation of cost or benefits by land managers is required for market instruments to be feasible. Where individual creation of a public cost or benefit cannot be easily measured then the only options for forcing a change in behaviour is regulation through technology or process standards.

Where individual creation of a public cost or benefit cannot be easily measured then incentives are the only options for encouraging a voluntary change in behaviour.

Therefore the analysis revealed, given the limits to the feasibility of public provision of wild dog control, the voluntary contribution of landholders, and enforcement of technical and process standards for wild dog control, the following mix of policy instruments should be considered for control of wild dogs:

- Public provision of wild dog control activities and research
- Market Instrument cap and trade scheme
- Technology Standards e.g. standards for wild dog exclusion fencing construction; standards for production of baits
- Process Standards e.g. baiting methods and procedures, baiting densities and use of guard animals
- Incentives for increasing production of control activities (bounties) and incentives for actions preventing attacks (exclusion fencing and guard animals)

6. Justification for government intervention for domestic dogs

In this section we apply the products and services framework (figure 1), the economic justification framework (figure 2) and the primary instrument choice framework (figure 3, 4, 5 and 6) to the policy problem of preventing or reducing predation of livestock and wildlife by free roaming domestic dogs. Public costs arise, including attacks on livestock and native animals, if individuals do not restrain domestic dogs that are their personal property.

6.1 Product or service

We defined the policy objective as restraining domestic dogs to prevent them preying on livestock and wildlife. The intention of the policy is to have individuals, owners of domestic dogs, take action that they would otherwise not take to prevent or reduce attacks by their dogs. In other words, owners of domestic dogs could take actions that would be consistent with the policy, namely to restrain their dogs in a way that would prevent or reduce attacks by their dogs. However, they would not voluntarily take all of these actions in the absence of the policy.

Actions to restrain dogs may be described as reducing a public cost arising from using domestic dogs as an input to meet final consumption values (refer Figure 1). Hence, the focus for determining a justification for government intervention is centred around imperfections in the market for domestic dogs.

6.2 Economic justification

The policy objective is preventing predation on livestock and wildlife by domestic dogs and concerns the control of domestic dogs by their owners; this objective does not immediately and directly concern income inequality though achievement of the objective will have an indirect effect on income distribution in the community by reducing the losses land managers and other members of the community bear as a result of domestic dogs attacking livestock and wildlife (figure 2). Consequently, the economic justification for this objective must be market failure.

The next step is to determine the type of market failure that is present in the market for domestic dogs (Sandall et al. 2009). Domestic dog ownership is exclusive in production because, in the absence of government intervention, it is possible for the owner of a domestic dog to exclude others from receiving the consumption benefits (e.g. companionship, security) of dog ownership. The ownership of domestic dogs is rival in consumption because the benefit of owning a domestic dog accrues to the owner, and the owner can exclude other individuals from receiving those benefits by preventing access to their dog.

Therefore, the ownership of domestic dogs is exclusive in production and rival in consumption. Therefore a missing market is not an economic justification for government intervention.

However, the ownership of domestic dogs does impose uncompensated costs on others (losses associated with predation on livestock) through owners not restraining their dogs. Examples of uncompensated costs created by domestic dogs include dog waste in public spaces, barking and attacks, and threats to dingoes through hybridisation. This means ownership of domestic dogs creates non-exclusive costs and that ownership of dogs may be greater than is socially optimal because owners are not bearing the full costs of ownership. The presence of these non-exclusive costs indicates that the market for domestic dogs is incomplete and therefore government intervention to prevent the creation of these uncompensated costs may be justified.

In summary, ownership of domestic dogs may impose uncompensated costs on others; by failing to restrain their dogs, owners create the potential for losses associated with the predation on livestock and native wildlife. As a result, ownership of domestic dogs may be greater than is socially optimal because the owners of the pets do not bear the full costs of ownership. The presence of these costs indicates that the market for domestic dogs is incomplete and government intervention may be justified to prevent the creation of these uncompensated costs.

6.3 Selection of the primary policy instrument for domestic dogs

The justification for government intervention in preventing predation on livestock and wildlife by domestic dogs is a case of an incomplete market. The next step (figure 3) depends on whether the incompleteness results in a public cost or a public benefit. The answer to this question determines if the primary instrument should discourage private behaviour that is undesirable because it creates a public cost, or should it encourage private behaviour that is desirable because the behaviour will create public benefits.

As already argued, ownership of domestic dogs creates uncompensated costs (non-exclusive costs) for others therefore the primary instrument should discourage the undesirable private behaviour associated with dog ownership.

6.3.1 Securing restraint of domestic dogs by dog owners

The public costs tree (figure 5) is used where the production or consumption of a product or service creates a public cost. Which instrument is used to reduce the creation of the public cost depends on whether the public cost is created by supplying a product or service, or using a product or service. In this instance, the public costs arise from the consumption of a product namely, the ownership of domestic dogs.

The next matter to consider is whether the rights of the impacted community have priority over the rights of those that create the uncompensated costs. In this instance the impacted community is defined as those that experience the uncompensated costs. The individuals who create the public costs are defined as those who create the uncompensated costs, which, in this case, are domestic dog owners. For the sake of argument, we took the view that the rights of the impacted community have priority over the rights of those that create the uncompensated costs. Consequently, a primary instrument that enforced compulsory restraint of dogs is appropriate.

6.3.2 Compulsory restraint of domestic dogs

The next step (figure 6) is to choose between some form of regulation, a tax or charge, or some form of market instrument like a cap and trade or credit scheme. The choice between compulsory instruments, either the use of a market instrument or regulation through performance standards depends on whether the creation of public costs can be measured.

In our view the creation of public costs by individual dog owners is difficult and expensive to measure.

Where individual creation of a public cost or benefit cannot be easily measured then the only options for a primary instrument are:

- (1) Regulation of technology and materials; or
- (2) Regulation of the management of materials and technologies.

If the type of technology or material used in restraining domestic dogs strongly influences the reduction in public costs created by those activities then restraint can be regulated through specification of technology standards. Technology standards are specification standards, technical or design standards and have merit where the reduction in cost can be achieved by regulating the technology used, rather than the way the technology is used. For example, compulsory technology standards could be formulated for installation of pet parks for domestic dogs and fencing of domestic dog play areas, designated domestic dog beaches, prohibition of particular dog breeds.

Where the creation of the public benefits, or reduction in public costs, depends in part on the management of the technology and materials as well as the type of technology and materials used the primary instrument would require both technology and process standards. Process standards are prescribed procedures and parameters. For example, standards compelling use of pet parks for domestic dogs and fencing of domestic dog play areas, times for use of designated dog beaches, leashing and muzzling of dogs in public places.

In principle, incentives for installing pet parks and fencing, public investment in designated play areas and the provision of free leashes may increase compliance with standards. Such incentives encourage dog owners to avoid actions that are contrary to the policy objective. In other words the incentives encourage dog owners to stop allowing their dogs to roam freely.

6.4 Summary

The analysis revealed the justification for government intervention in preventing predation on livestock and wildlife by domestic dogs is that private ownership of domestic dogs creates uncompensated, non-exclusive costs. Hence, the market for domestic dogs is an incomplete market. The key decision in choosing a primary instrument is deciding whether the rights of those that experience the uncompensated costs have priority over the rights of those that create the costs, that is, owners of domestic dogs. We assumed the rights of those that bear the uncompensated costs did have priority over the rights of dog owners. Consequently, the primary instrument should create compulsory change.

Since the creation of the public costs by individual dog owners cannot be easily and inexpensively measured then the only options for the primary instrument were regulation through technology or process standards.

Therefore the analysis revealed the choice of a primary instrument for restraining domestic dogs to prevent attacks on livestock and native wildlife was:

- Technology Standards e.g. prohibit particular breeds, design of pet parks, fencing of dog play areas, designated dog beaches
- Process standards e.g. use of leashes and muzzles, curfews and dog registration, use of pet parks and play areas, use of dog beaches

Incentives to promote compliance with standards and encourage dog owners to stop allowing their dogs to roam freely may also have merit.

7. Justification for government intervention for dingoes

The policy objective is defined as preventing or reducing predation by dingoes on livestock. The public cost of predation by dingoes on livestock arises from the protection of dingoes as a public asset. Therefore the objective concerns the protection of dingoes.

In this section we apply the products and services framework (figure 1), the economic justification framework (figure 2) and the primary instrument choice framework (figure 3, 4, 5 and 6) to the policy problem of preventing or reducing predation of livestock and wildlife by dingoes. Public costs arise when dingoes, which are the protected species in the State of Victoria, attack livestock.

7.1 Product or service

We defined the policy objective as restraining dingoes to prevent them predating on livestock. The intention of the policy is to have entities, protectors of dingoes, take action that they would otherwise not take to prevent or reduce attacks by dingoes. In other words, protectors of dingoes could take actions that would be consistent with the policy, namely to restrain dingoes in a way that would prevent or reduce attacks. However, they would not voluntarily take all of these actions in the absence of the policy.

The restraint of dingoes by their protectors, the State of Victoria on behalf of its citizens, does not seem describable as a product or service per se. Actions to restrain dingoes may be described as reducing a public cost arising from the consumption of dingoes by the Victorian community as a protected species, that is, a retail product (refer Figure 1). Hence, the focus for determining a justification for government intervention is centres around imperfections in the market for protecting dingoes.

7.2 Economic justification

The policy objective is preventing predation on livestock and wildlife by dingoes and concerns the control of dingoes by their owners (the State of Victoria); this objective does not immediately and directly concern income inequality though achievement of the objective will have an indirect affect on income distribution in the community by reducing the losses land managers and other members of the community bear as a result of dingoes attacking livestock (figure 2). Consequently, the economic justification for this objective must be market failure.

The next step is to determine the type of market failure that is present in the market for protection of dingoes (Sandall et al. 2009). The State of Victoria on behalf of the community protects dingoes. Protection of dingoes is exclusive in production because in principle the State has the power to extract payment from all members of the community for protecting dingoes. Protection of dingoes is rival because the State can exclude individuals, other than those who are members of the community, from enjoying the benefits of having dingoes by preventing their access to the dingoes. Since the protection of dingoes is exclusive in production and rival in consumption then government intervention to prevent dingoes attacking livestock is not justified by a missing market.

However, the protection of dingoes does impose uncompensated costs on others through losses associated with predation on livestock through protectors (the State of Victoria) not restraining them. This means protection of dingoes may be greater than is socially optimal because those responsible for the protectors of dingoes are not bearing the full costs of protection. The presence of these non-exclusive costs indicates that the market for protecting dingoes is incomplete and therefore government intervention to prevent the creation of these uncompensated costs may be justified.

7.3 Selection of the primary policy instrument for dingoes

The justification for government intervention in preventing predation on livestock by dingoes is a case of an incomplete market. Since the incompleteness results in a public cost the primary instrument should discourage the behaviour that is undesirable because it creates a public cost.

7.3.1 Securing restraint of dingoes

The public costs tree (figure 5) is used where the production or consumption of a product or service creates a public cost. As the public costs arise from the consumption of a product namely, the protection of dingoes, then the next matter to consider is whether the rights of the impacted community have priority over the rights of those that create the uncompensated costs. In this instance the impacted community is defined as those landholders that experience the uncompensated costs. The entity that creates the public cost is the State of Victoria, which is acting on behalf of its citizens.

For the sake of argument, we took the view that the rights of the impacted community have priority over the rights of those that create the uncompensated costs. Consequently, a primary instrument that enforced compulsory restraint of dingoes would be appropriate.

7.3.2 Compulsory restraint of dingoes

The next step (figure 6) is to choose between some form of regulation, tax or charge, or some form of market instrument like a cap and trade or credit scheme. The choice between compulsory instruments, either the use of a market instrument or regulation through performance standards depends on whether the creation of public costs can be measured.

In our view the creation of public costs by protectors of dingoes, especially in regard to individual dingoes, is problematic. Furthermore, the creation of public costs by dingoes cannot be easily separated from creation of public costs by wild dogs and free roaming domestic dogs.

Where individual creation of a public cost or benefit cannot be easily measured then the options for a primary instrument are:

- (1) Regulation of technology and materials; or
- (2) Regulation of the management of materials and technologies.

If the type of technology or material used in restraining dingoes strongly influences the reduction in public costs they create then restraint can be regulated through specification of technology standards. Where the reduction in public costs depends on the management of the technology and materials as well as the type of technology and materials used, the primary instrument would require both technology and process standards.

The focus for dingo control may first be on activities that reduce the opportunity for dingoes to access and attack livestock. This would mean technology standards for the construction of exclusion fencing, or any technologies that confine dingoes to public land, may be appropriate. Process standards describing procedures for maintaining exclusion fencing may also be required.

Activities that reduce attacks by capturing or destroying dingoes on private land may be a secondary focus. This would involve compulsory process standards describing suitable procedures for the capture and destruction of dingoes discovered on private land.

7.4 Summary

The analysis revealed the justification for government intervention in preventing predation on livestock and wildlife by dingoes is that protection of dingoes creates uncompensated, non-exclusive costs. As a result, protection of dingoes may be greater than is socially optimal because the protectors of dingoes do not bear the full costs of protection. The presence of these uncompensated costs indicates that the market for dingoes is incomplete and therefore government intervention may be justified on economic efficiency grounds.

The key decision in choosing a primary instrument is deciding whether the rights of those that experience the uncompensated costs have priority over the rights of those that create the costs, that is, the State of Victoria which protects dingoes on behalf of its' citizens. We assumed the rights of

those that bear the uncompensated costs did have priority. Consequently, the primary instrument should create compulsory change.

Since the creation of the public costs by dingoes cannot be easily and inexpensively measured, the only option for the primary instrument was regulation using technology or process standards.

Therefore the analysis revealed the choice of a primary instrument for restraining dingoes to prevent attacks on livestock was:

- Technology Standards e.g. construction standards for exclusion fencing
- Process standards e.g. maintenance standards for fencing, procedures for the capture and destruction of dingoes on private land

8. Conclusion

Invasive species including wild dogs are known to cause a range of serious problems through their impacts on parks, forests, waterways, land assets, agricultural production and rural communities. The Victorian Government invests in invasive species management and research, public awareness activities and regulation of certain activities. The general principle of government involvement in invasive species management is that government invests in the most appropriate intervention to maximise public benefit. However, there are a range of actions that can be taken to manage invasive species. Furthermore, it is not feasible or cost-effective for government to enforce or fund the control of all invasive species, nor is it practicable to apply regulation against them all. Consequently, identifying when and how best to intervene is a complex problem. The challenge for government then, is to design programs that are effective in using limited public resources to foster private management of pest animals while meeting community expectations.

In this paper we use economic reasoning to analyse and clarify the nature of the public benefit that arises from government intervention in the management of wild dogs by private landholders. Knowing the precise nature of the public benefit, which provides the justification for government intervention, is a crucial first step in selecting the kind of policy instrument that will form the foundation of a government program.

We found that government intervention to prevent wild dogs, free roaming domestic dogs and dingoes from attacking livestock could be justified on the grounds that intervention would increase economic efficiency.

Specifically, we argued that the justification for intervening to reduce attacks by free roaming domestic dogs and dingoes was that the markets for domestic dogs, and the market for dingo protection, were incomplete as uncompensated costs were created in both instances. On the assumption that the rights of those who experienced uncompensated costs had priority over those who created the uncompensated costs, we concluded that the primary instrument for reducing the creation of these costs were compulsory technology and process standards. This is consistent with the approach taken by local government to controlling domestic dogs.

We argued that the justification for intervening to reduce attacks by wild dogs was that the market for supplying pest control services in relation to wild dogs was missing, resulting in sub-optimal private investment in supplying control services. The market was missing because the benefits arising from the supply of the services were non-exclusive and non-rival. We concluded that, on the grounds there are economies of scope in the supply of control services for wild dogs, the primary instrument was the public provision of wild dog control.

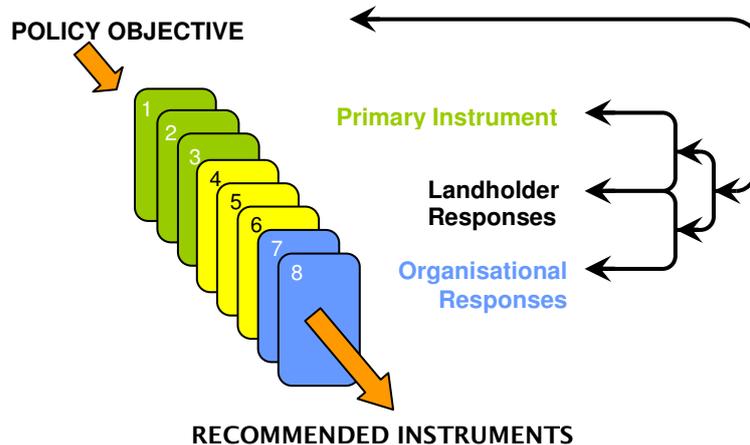
The effectiveness of public provision could be improved by the compulsory supply of control services by private landowners. This could be achieved by prescribing technical and process standards for dog control (e.g. exclusion fencing). However, given the limits to the feasibility of public provision of wild dog control and enforcement of technical and process standards for wild dog control on private land, incentives for increasing the supply of these services (e.g. bounties) and incentives for actions preventing attacks (e.g. exclusion fencing and guard animals) would also have merit.

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Appendix 1: The Policy Choice Framework⁴

The Service Design research team has been developing a Policy Choice Framework (Kaine et al. 2007, Sandall et al. 2009) to help policy makers to choose a package of policy instruments. In developing the Framework, the team have drawn together recent developments in adoption, compliance, institutional, and economic research. The Policy Choice Framework is a systematic way of predicting the critical issues that will need to be dealt with to achieve a policy objective. It provides a basis for putting together an appropriate package of policy instruments.



The 8 Policy Choice Framework components

Primary instrument

The Framework has eight components. The first component is used to identify precisely in which market intervention is necessary. The next two components are grounded in economics and provide a foundation for choosing the policy instrument to deliver on the policy objective. The second component is used to clarify the economic justification for government intervention that underpins a given policy objective, such as nutrient reduction in agriculture or assisting primary producers to adapt to climate change. The form that the government intervention takes and, therefore, the most efficient types of policy instrument, will depend on this justification. The third component is used to identify the specific policy instrument that will efficiently deliver on the policy objective. In this component, efficiency is evaluated on the basis of the relative private and public net benefits associated with changes required to deliver the policy objective.

Landholder responses

The fourth, fifth and sixth components are used to predict the responses of landholders to the policy instrument that has been identified as technically feasible and efficient. In the fourth component, the responses of primary producers to the policy instrument are predicted on the basis of their involvement with the policy issue and the policy instrument. In the fifth component, the potential for landholders to comply with the policy instrument in ways that are counter-productive to the policy objective are assessed. In the sixth component, the potential for the policy instrument to change the behaviour of landholders on the scale, and rate that is required is evaluated. These components provide an opportunity to refine or supplement the policy instrument under consideration to account for the likely responses of landholders.

Organisational responses

The seventh and eighth components are used to predict how the organisations responsible for implementing government policies are likely to respond to the policy instrument under consideration.

⁴ adapted from DPI VCCAP project sheet: Department of Primary Industries (2008) *Policy Research*. Victorian Climate Change Adaptation Program, Research Theme.

In the seventh component, the policy instrument under consideration is compared with those already in place. If there are large differences in the features of these instruments then successful implementation may require significant changes in the way that responsible organisations operate. In the eighth component, factors that influence relationships among responsible organisations are examined. These organisational components provide an opportunity to refine or supplement the instrument under consideration to account for the likely responses of responsible organisations.