Animal Health Board Project R-10624

Maximising Benefits of Using Existing Possum Control Tools – Developing a Decision Support System

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Summary

Project and Client

The operational and strategic factors that constrain possum control operations were identified and integrated into a web-based decision support system (DSS) to provide end-users with checklists of all meaningful biological and technical constraints, recommendations for preferred control options, and best-practice information relevant to each recommendation. This work was carried out by Landcare Research, Lincoln, with assistance from Massey University, for the Animal Health Board (AHB Contract No. R-10624), between July 2004 and February 2006.

Objectives

To develop two DSSs that will help to ensure both best-practice and strategic options are fully considered during the planning of operational work and vector control programmes, by:

- Identifying all the potential factors that need to be addressed by commercial possum control operators (contractors) when developing operational work programmes
- Identifying all potential factors that need to be addressed by possum control managers when developing vector control programmes
- Integrating all critical factors into two user-friendly DSSs and pilot testing their use by selected control managers.

Methods

The structure and components of the proposed DSS were decided after consultation with a selection of potential end-users. The resulting DSS had three main components, each of which was developed using different methods:

- *Vector manager and control contractor checklists* were developed by reviewing a range of contractor checklists and identifying key constraints from best-practice manuals.
- *Best-practice information* was obtained by reviewing published papers, unpublished reports, and from discussion with research colleagues and industry staff.
- *The decision support system* was developed with assistance from Seradigm (knowledge management consultants). Control scenarios were developed in order to identify a set of rules, which were compiled into a knowledge base and incorporated into an electronic decision support system based on Mandarax.

The three main components (checklists, best-practice information, and DSS) were then integrated into a web-based possum DSS, with special emphasis on developing a user-friendly system. Following discussion with Seradigm it was decided to integrate the vector-manager- and control-contractor-related rules into the one DSS with separate checklists developed for each.

Outputs

- Two checklists were developed, one for vector managers and one for control contractors. Each checklist contains a range of operational constraints that should be considered when planning a possum control operation, and a rationale for each specific constraint.

- Best-practice facts were compiled into information sheets that relate to each of the recommended actions provided by the DSS. Additional supplementary information was also collated, and all this information linked using hyperlinks through keywords to allow the user to easily locate further information as required. In total, 81 pages of information were compiled and can be accessed either directly through a ‘best-practice index’ or through the recommended actions provided by the DSS.
- Mandarax, an open-source software package, was selected as the rules-based inference engine and 29 rules were developed based on 10 control scenarios developed by the authors. A set of 24 queries (prerequisites) that users of the system select as true or false are submitted to the inference engine to obtain a set of recommended actions. If the users of the system believe the recommended action is not appropriate, they can submit comments to the system to provide the developers with feedback that can be considered for future system updates.
- A draft DSS was made publicly accessible on the Web by November 2005, and a range of end-users were requested to test the system and provide feedback.
- The system can be accessed using the URL address: http://possumdss.landcareresearch.co.nz. The system has a front entrance page which leads the user to the links of the three major components of the system: (1) vector managers and control contractors checklists, (2) best-practice index, and (3) the DSS. Feedback can be provided using the email link provided (DSSfeedback@landcareresearch.co.nz).

Conclusions

- The vector manager and control contractor checklists ensure all possible constraints, including operational, behavioural, legal, and public issues, are considered and dealt with appropriately.
- An extensive set of ‘best-practice’ information sheets was developed to provide the end-user with the most up-to-date information on possum control.
- A DSS has been developed that has four components to assist end-users to maximise the benefits they achieve from possum control operations.
- The actual DSS provides end-users with ‘expert’ recommendations of what they should do based on the information provided.

Recommendations

- The AHB should encourage end-users to directly access and use the DSS, and make the necessary links to the system from their own and from the NPCA websites.
- Support should be provided for ongoing maintenance of the system to ensure information is updated as required and to deal with further feedback and recommended changes to make the system increasingly user-friendly.
- Consideration should be given to develop further DSS to support other pest-related activities such as ferret control and population monitoring.

1. Introduction

The operational and strategic factors that constrain possum control operations were identified and integrated into a web-based decision support system to provide end-users with checklists of all meaningful biological and technical constraints, recommendations for preferred control options, and best-practice information relevant to each recommendation. This work was carried out by Landcare Research, Lincoln, with assistance from Massey University, for the Animal Health Board (AHB Contract No. R-10624), between July 2004 and February 2006.

2. Background

Vector managers, agency staff, and contractors involved in possum control have a wealth of information available to them on control tools, control strategies, possum behaviour, legal and biological constraints to operational procedures, and the economics of control operations. Unfortunately, much of this information is found only in formally published papers and books, or unpublished reports, and many people involved in the industry do not regularly access such information or know that it exists or where to find it. Consequently, because some possum control operations are planned and carried out without adequate knowledge of 'best-practice', control is sometimes ineffective or overly expensive. Additionally, planning effective control operations requires consideration of a wide range of operational constraints that are currently not readily accessible as general checklists to ensure that planners are aware of all the issues and deal with all necessary requirements. As the control of possum populations moves towards the 2013 goal of Tb freedom, populations of possums still infected will become progressively more difficult to reduce to low levels, and will require increased sophistication in the control tactics and strategies used. The development and testing of a DSS is a logical part of this increased sophistication.

Decision support systems (DSSs) have been developed for managing a range of agricultural invertebrate pests (Stuth & Smith 1993; El-Azhary et al. 2000; Ghosh & Samanta 2003) with the purpose of improving the transfer of information from research to end-users, and to help the end-user interpret and apply the recommendations and information (Knight & Mumford 1994; Turban et al. 2005). The development of such an expert system for vertebrate pest control is novel.

In its simplest form, a DSS can be a set of questions and answers. In a more sophisticated form it may be an electronic rules-based (expert) system that will usually have three to four components including a database management system, an inference engine to interpret rules and compute any required algorithms, a user interface, and sometimes also a knowledge base (Turban et al. 2005). The system developed here is a sophisticated rules-based system and also provides a substantial library of best-practice information.

3. Objectives

To develop two DSSs that will help to ensure both best-practice and strategic options are fully considered during the planning of operational work and vector control programmes, by:

- Identifying all the potential factors that need to be addressed by commercial possum control operators (contractors) when developing operational work programmes
- Identifying all potential factors that need to be addressed by possum control managers

when developing vector control programmes
- Integrating all critical factors into two user-friendly DSSs and pilot testing their use by selected control managers.

4. Methods

The structure and components of the proposed DSS were decided after consultation with a selection of potential end-users including vector managers, control contractors, an AHB regional co-ordinator, and possum control 'experts'. Individuals involved included Judy and Tony Leith (Leith Contractors), Ron Walker (Southern Pest Management), Grant May (Target Pest), Mark Hunter (Environment Southland), John Oliver (AHB), and Dave Morgan, Cheryl O'Connor, and Graham Nugent (Landcare Research). Information was gleaned from these experts during one-to-one meetings and from email requests.

The resulting DSS had three main components, each of which was developed using different methods.

1. Vector manager and control contractor checklists. These are lists that contain all technical and biological constraints likely to affect the operational success that vector managers or control contractors should consider when designing possum control operations. The lists were developed from discussion with industry staff and research colleagues, and from reviewing a range of reports and operational checklists supplied by end-users.

2. Best-practice information. This information was obtained by reviewing published papers and unpublished reports, and from discussion with research colleagues and industry staff. Some of this information is well researched, peer reviewed, and has been well established as best-practice for many years. Other information gleaned from industry 'experts' is less well supported by research, but nevertheless is the best information available and is currently considered best-practice by industry experts. Considerable information, particularly relating to use of poisons and baits, was taken from best-practice manuals and protocols developed previously for the AHB (e.g. Henderson & Frampton 1999; Henderson et al. 1999).

3. The decision support system. Seradigm (knowledge management consultants) were used to review the current and likely future needs of decision/expert systems, to determine if there were relevant standards for system compatibility, data exchange, or data storage, and to identify the types of electronic systems available that supported rules-based decision support. Seradigm also facilitated the development of the DSS structure and content, including examining a range of possum control scenarios developed by Landcare Research that aimed to cover all possible control issues, constraints, and problems. These scenarios were then used to identify the most likely questions vector managers and control contractors ask themselves when designing possum control operations. The questions and the answers provided the basis for developing a set of rules to guide operators when using the DSS.

These rules were then compiled into a knowledge base, which was in turn incorporated into an electronic decision support system based on Mandarax, a Java library for inference rules. Mandarax was selected as the DSS system because (1) it was open-source software (i.e. freely available), (2) the developer of the system (Dr Jens Dietrich, Massey University) was able to assist with integrating the knowledge base into the system, and (3) it was developed to operate as a web-based system. Mandarax uses backward-chaining inference (reasoning). In other words, the factors identified in the operational scenarios that were developed became the prerequisites of the system. For example, if the rule is: 'if rainfall is greater than 2000 mm per year then use carrot bait', 'if rainfall is greater that 2000 mm per year' is a prerequisite, 'greater than' is a predicate, '2000 mm per year' is a constant, and 'use carrot bait' is a conclusion (recommended action).

The three main components of the system (checklists, best-practice information, and DSS) were then integrated into a web-based possum DSS that allowed end-users easy access to and use of the system. Following discussion with Seradigm it was decided to integrate the vector-manager- and control-contractor-related rules into a DSS with one 'front end' with separate checklists developed for each. This decision was made on the basis that many of the rules were relevant to both vector managers and control contractors, and having one system for both end-users enabled both groups to access the same information. The structure of the system allows for easy ongoing management so new information or changes to rules can be readily updated.

5. Output

5.1 Checklists

Two checklists were developed, one for vector managers (Appendix 1) and one for control contractors (Appendix 2). Each checklist contains a range of constraints that should be considered, and a rationale for each specific constraint. At this stage the checklists have no links to supporting information although this could be done in the future if there was sufficient user-demand. The checklists could also provide a basis for audits of the planning process to ensure all constraints are adequately addressed.

5.2 Best-practice information

Best-practice facts were compiled into information sheets that relate to each of the recommended actions provided by the DSS. Additional supplementary information was also collated, and all this information linked using hyperlinks through keywords to allow the user to easily locate further information as required. In total, 81 pages of information was compiled for easy access, either directly through a 'best-practice index' (Appendix 3) or through the links provided with the recommended actions. Best-practice information varied from providing specifications for preparing carrot bait, through to what to do when trapping in areas with ground birds, to suppliers of baits, bait stations and traps.

The best-practice information was formatted as a series of bullet points rather than as large blocks of text in order to make it more user-friendly. Citation of reference material was excluded in order to make the text more readable by end-users. It was assumed at the start of the project that the system was to provide information as an 'expert would' and therefore is not supported by references.

5.3 Decision support system

Mandarax, an open-source software package, was selected as the rules-based inference engine and 29 rules were developed based on 10 control scenarios developed by the authors. A set of 24 queries (prerequisites) was developed that users of the system must go through and select as true or false (Appendix 4). These prerequisites are then submitted to the inference engine, which uses the rules to provide a set of recommended actions. If the users of the system believe the recommended action is not appropriate, they can submit comments to the system to provide the developers with feedback that can be considered for future system updates. Additionally, the system has been developed to be totally transparent so that the user not only receives query results (i.e. recommended actions), but also the explanations (rules) that have been used to compute these results. This allows the users to understand the system better and to develop trust in the system (in contrast to black-box systems). It also enables users to provide constructive feedback. This feature is important as it can turn the system into a collaboration platform (i.e. end-users not only consume knowledge by querying the system, they also produce knowledge by reflecting on the query results, the rules used to support them, and by providing feedback). This should lead to a process of continuous improvement.

A draft DSS was developed and made publicly accessible on the Web by November 2005, and a range of end-users were contacted to test the system and provide feedback. Very little feedback was received, so the system was presented to potential end-users at the National Possum Control Agencies annual conference in Wellington in December 2005. Subsequently, further limited feedback was received and incorporated into the system.

The system can be accessed using the URL address:
http://possumdss.landcareresearch.co.nz. The system has a front entrance page that leads the user to the links of the three major components of the system: (1) vector managers and control contractors checklists, (2) best-practice index, and (3) the DSS. Feedback can be provided using the email link provided (DSSfeedback@landcareresearch.co.nz).

6. Conclusions

A decision support system has been developed that has three components to assist end-users to maximise the benefits they achieve from possum control operations, and includes checklists, the actual DSS expert system, and best-practice information. The vector manager and control contractor checklists ensure all possible constraints including operational, behavioural, legal, and public issues are considered and dealt with appropriately. The actual DSS provides end-users with 'expert' recommendations on what they should do based on the information they provide. These recommendations are supported by the most extensive set of readily accessible 'best-practice' information sheets available, and provide the end-user with the most up-to-date information on possum control. Additionally, this 'best-practice' information can be used directly as a comprehensive electronic source of information on possum control without having to go through the DSS.

Because new information will be continually produced from ongoing research and from knowledge gained by control operators, there is a need for some limited ongoing management of the system to ensure the recommendations and 'best-practice' information is kept up-to-date and relevant.

7. Recommendations

- The AHB should encourage end-users to directly access and use the DSS and make the necessary links to the system from their own and from the NPCA websites.
- Support should be provided for ongoing maintenance of the system to ensure information is updated as required and to deal with further feedback and recommended changes to make the system increasingly user-friendly.
- Consideration should be given to develop further DSS to support other pest-related activities such as ferret control and population monitoring.

8. Acknowledgements

We thank Julian Carver (Seradigm) for his review of rules-based decision support systems and for his facilitation and guidance in developing this project. We also thank Judy and Tony Leith (Leith Contractors), Ron Walker (Southern Pest Management), Grant May (Target Pest), Dave Morgan (Landcare Research), Mark Hunter (Environment Southland) and John Oliver (AHB) for providing initial input at the early stages. Andrea Byrom provided comments on this report, Christine Bezar editing, and Wendy Weller final formatting.

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Appendix 1 Vector managers' checklist

This checklist is to ensure control effectiveness is maximised through making all personnel involved in planning possum control strategies aware of, and ensuring they address, all possible constraints that might impact on the success of a control operation.

1. Vector control boundaries:

Vector control boundaries must be selected to ensure:

- Potential immigration of any vectors, especially Tb-infected animals, is minimised
- Rate of population recovery is minimised
- Control puts all targeted vectors at risk
- Control is optimised with respect to adjacent operations

Have you considered:

Adjacent DOC operations? ☐Yes ☐No

Previous/concurrent Tb control operations? ☐Yes ☐No

Local herd histories? ☐Yes ☐No

Geographic features inhibiting vector immigration? ☐Yes ☐No

Land tenure and recalcitrant landowners? ☐Yes ☐No

Possum movement and control frequency (buffers etc.)? ☐Yes ☐No

2. Stratification:

Vector control areas should be stratified to ensure:

- Contractors manage blocks that can be controlled as single operations
- Control effort is focused on high priority areas if required
- Control effort does not miss areas
- Monitoring assesses control effectiveness in areas that could potentially have different outcomes (e.g. aerial vs ground, easily accessible vs difficult access areas, treated areas vs excluded areas)

Have you considered:

Contract blocks/progress payment? ☐Yes ☐No

Vector risk rating? ☐Yes ☐No

Access (topography/vegetation/roads/tracks)? ☐Yes ☐No

AHB requirements (e.g. forest, forest/pasture edge)? ☐Yes ☐No

Control methods (e.g. aerial vs ground)? ☐Yes ☐No

3. Residual trap-catch target:

The RTC target selected should ensure:

- Tb is eradicated most cost-effectively
- Contractors can achieve the target with the tools available
- Unnecessarily low RTCs do not have opportunity costs
- High risk areas are most intensively controlled

Have you considered:

Initial vs maintenance control? ☐Yes ☐No

Relationship between RTC targets and time to eradication? ☐Yes ☐No

Previous control success in same area? ☐Yes ☐No

4. Control options (strategic):

The chosen control option(s) should ensure:

- The most cost-effective control is achieved
- Competent control contractors are selected
- Possible aversions developed from past control are ameliorated
- Legal constraints are adhered to
- All non-target and environmental impacts limited
- All land users (public, farmer and sports groups) are not unnecessarily disadvantaged

Have you considered:

Aerial vs ground? ☐Yes ☐No

Margins vs buffers (frequency vs area of control)? ☐Yes ☐No

Timing/urgency? ☐Yes ☐No

Seasonal useage by other users of control area? ☐Yes ☐No

Appropriate stratification? ☐Yes ☐No

Contractor's capacity to undertake control? ☐Yes ☐No

Control of minor vector species? ☐Yes ☐No

Development and circulation of publicity material? ☐Yes ☐No

5. Legislation:

Vector control must be managed to ensure:

- Public is not put at risk
- Risk to stock and pets is minimised
- Risk to indigenous non-target species is minimised
- Soil and water are not unduly contaminated

Have you considered:

Aerial vs ground? ☐Yes ☐No

Public safety? ☐Yes ☐No

Operator safety/experience/training/licensing? ☐Yes ☐No

Animal welfare? ☐Yes ☐No

Non-target impacts? ☐Yes ☐No

Consent procedures/public hearings? ☐Yes ☐No

Environmental testing? ☐Yes ☐No

6. Monitoring and audit:

Vector control must be monitored to ensure:

- Contractors achieve the target RTCs
- Contractors are not paid for inadequate control or monitoring jobs
- If required, that trigger RTCs are reached before initiating maintenance control
- That no control gaps remain
- That complete or partial failures are remedied
- That control strategies can be incrementally improved
- That good and poor-performing contractors are identified

Have you considered:

Aerial vs ground? ☐Yes ☐No

Contractor performance? ☐Yes ☐No

Pre-control RTC assessment? ☐Yes ☐No

Strategy assessment? ☐Yes ☐No

Auditing of monitoring contractors? ☐Yes ☐No

Follow-up control? ☐Yes ☐No

Re-monitors and reworks? ☐Yes ☐No

Auditing of monitors undertaken in high risk areas? ☐Yes ☐No

Appendix 2 Control contractor checklist

This checklist is to ensure control effectiveness is maximised through making all personnel involved in planning possum control aware of, and ensuring they address, all possible constraints that might impact on the success of a control operation.

Constraints

1. Capability to do the required job

Can you do the job to ensure:

- That the job is completed cost-effectively
- That the job is completed on time
- That all legislation is adhered to?

Have you:

The capacity (sufficient skilled staff and equipment) to complete the job? ☐Yes ☐No

Identified all hazards? ☐Yes ☐No

OHS policies in place? ☐Yes ☐No

The necessary skills to complete the job? ☐Yes ☐No

Public liability insurance? ☐Yes ☐No

2. Cost-effectiveness

Cost-effectiveness issues must be addressed to ensure:

- Control coverage and percentage kill is maximised
- Job is profitable but competitive
- Control target (i.e. required RTCI) is achieved

Have you considered:

Choice of control tools? ☐Yes ☐No

Strategic choices? ☐Yes ☐No

Coverage? ☐Yes ☐No

Avoidance of public tracks, riparian strips? ☐Yes ☐No

Habitat? ☐Yes ☐No

Bait quality? ☐Yes ☐No

Trap performance? ☐Yes ☐No

Best practice? ☐Yes ☐No

Timing and cost of avoiding wet weather? ☐Yes ☐No

3. Legislation

Legislation requirements must be adhered to, to ensure:

- Public safety
- Staff safety
- Livestock are not put at risk
- Pest control industry is not put at risk
- Animals killed in an approved manner

Have you considered:

Pesticide use? ☐Yes ☐No

Animal welfare? ☐Yes ☐No

Toxin residues? ☐Yes ☐No

Access? ☐Yes ☐No

Non-targets? ☐Yes ☐No

Staff health and safety? ☐Yes ☐No

4. Environmental risks

Environmental risks must be evaluated to ensure:

- Persistence of toxins in the environment is minimised
- Persistence of toxins in wildlife and livestock is minimised
- Risk to humans is minimised

Have you considered:

Risk of persistent toxins? ☐Yes ☐No

Rates of decay (soil, water, carcasses)? ☐Yes ☐No

At-risk non-target species? ☐Yes ☐No

Risks of human consumption of game meat? ☐Yes ☐No

5. Non-target risks

Non-target risks must be evaluated to ensure:

- That indigenous species and livestock are not put at risk

Have you considered:

Primary poisoning? ☐Yes ☐No

Secondary poisoning? ☐Yes ☐No

Poison selection and use? ☐Yes ☐No

Traps selection and use? ☐Yes ☐No

Threatened species risk? ☐Yes ☐No

Livestock risk? ☐Yes ☐No

6. Public opposition

Public opposition must be evaluated to ensure:

- That operational planning and implementation is not jeopardised

Have you considered:

Public perceptions? ☐Yes ☐No

Consultation? ☐Yes ☐No

Land access? ☐Yes ☐No

Vandalism? ☐Yes ☐No

Education? ☐Yes ☐No

Additional liaison? ☐Yes ☐No

Public use of land? ☐Yes ☐No

7. Target animal behavioural risks

Target animal behaviour must be evaluated to ensure:

- That all animals are put at risk from the control tools being used
- Shyness is not developed in the surviving population

Have you considered:

Shyness? ☐Yes ☐No

Avoidance of shyness? ☐Yes ☐No

Mitigation of shyness? ☐Yes ☐No

Control history (type and frequency)? ☐Yes ☐No

Appendix 3 Best-practice index

    - Aerial control within 3 years
    - Ground control within 12 months
- Deer repellent
    - Supplier
- Deer present with Tb
- Deer present and free of Tb
- Ground birds present
- Ground control
    - Coverage
    - Traps
    - Bait stations
    - Poisons
    - Prefeeding
- Handling Tb-infected wildlife
    - Risks and safety procedures
- Human health
    - General issues in pest control
- Lures
- Non-target risks
    - Aerial control
    - Ground control
- Poison use
    - Best practice – environmental
- Prefeeding
    - Aerial control
    - Ground control
- Protocol for assessing bait size
- Protocol for assessing sowing rates

- Protocol – confirming bait coverage and bait density
- Public issues
    - General concerns and their alleviation
    - Special-interest groups
    - Consultation
    - Land access
- Raised trap sets
- Residue risks to hunters
- Shyness
    - Avoiding
    - Overcoming
- Sowing rates
- Special considerations
    - Access denied by private landowners to areas greater than 50 ha
    - Access denied by private landowners to areas less than 50 ha
    - Areas physically inaccessible to ground hunters
    - Control area dominated by dense vegetation/gorse
    - Area receives high rainfall
    - Ground control used in previous 12 months
    - Area aerially controlled in last 3 years
    - Stock present in area planned for control
    - Pigs and deer harvesting in area containing anticoagulant baits
    - Deer present and infected with Tb
    - Weka and kiwi present in proposed control area
    - Deer present and free of Tb
    - Area free of infected vectors
- Specifications for 1080 carrot baits
    - Characteristics

    - Storage/durability
    - Toxin loading/leaching
- Specifications for 1080 cereal baits
    - Characteristics
    - Storage/durability
    - Toxin loading/leaching
- Stock present in control area
- Suppliers
    - Baits for aerial control
    - Baits for ground control
    - Bait stations
    - Traps
    - Lures
    - Prefeed
    - Repellents
- Traps
    - Leghold and kill trap types
    - Best practice
- Weka and kiwi constraints on trapping

Appendix 4 End-user queries (prerequisites)

Control area is predominantly grazing land, horticultural land, or life-style blocks:	☐true☐false
Parts or all of operational area is inaccessible to ground hunters and any inaccessible part is greater than 50 ha:	☐true☐false
Control area is forested or largely forested and greater than 2000 ha:	☐true☐false
Aerial control is strongly opposed but the only suitable option:	☐true☐false
Aerial control is prohibited by the landowner:	☐true☐false
Stock are present in control area:	☐true☐false
Control area can be destocked:	☐true☐false
Area has been toxic baited in the last 12 months:	☐true☐false
Area has been aerial baited in the last 3 years:	☐true☐false
Rapid bait degradation is important:	☐true☐false
Carrot-cutting equipment and experience in preparing carrot bait is available:	☐true☐false
Control area gets more than 2000 mm of rain per year:	☐true☐false
Area contains or is likely to contain deer infected with Tb:	☐true☐false
Landowner does not want deer targeted:	☐true☐false
Area contains regularly harvested Tb-free deer:	☐true☐false
Area contains regularly harvested pig or deer:	☐true☐false
Area contains weka or kiwi:	☐true☐false
Access denied to parts of control area greater than 50 ha:	☐true☐false
Access denied to parts of control area less than 50 ha:	☐true☐false
Area contains dense stands of gorse or other very dense vegetation:	☐true☐false
Control area is free of Tb-infected vectors (including possums, ferrets, pigs or deer):	☐true☐false
Control area is surrounded by untreated habitat:	☐true☐false
Ground control is unlikely to complete the job on time:	☐true☐false
Control operation lacks urgency:	☐true☐false