

Save the Tasmanian Devil program Scientific Research Strategy

Purpose

- To identify how the research agenda fits into the overall strategic plan of the Save the Tasmanian Devil Program.
- To identify strategies to maximise the quality, relevance and rate of progress of scientific research.
- To identify the broad research directions and priorities of the Save the Tasmanian Devil Program
- To foster collaboration by documenting key research questions together with processes for evaluating research proposals.

Background and context

The Tasmanian devil *Sarcophilus harrisii* is the largest surviving marsupial carnivore. It is threatened with extinction as a result of an infectious cancer Tasmanian Devil facial tumour disease (hereafter DFTD) and is now listed as endangered under Tasmanian legislation.

As a result of this disease, which emerged in the mid-1990s, the “save the Tasmanian devil program” was established with the overall goal of “maintaining the Tasmanian devil as an ecologically functional species in the wild”. The aim of this scientific research strategy is to acquire, as rapidly as is possible, the necessary scientific understanding to implement management actions that will achieve this goal.

There are only four basic management levers that can be employed:

1. Establishing insurance populations either in the wild or in captivity, isolated from exposure to disease, or maintaining the isolation of existing disease free populations.
2. Culling or removal of Tasmanian devils to suppress disease spread, reduce prevalence or eliminate the disease from wild populations. Culling may entail attempted removal of all individuals from a given area or may concentrate on infected animals only or on particular age and/or sex classes that are thought to be particularly important for disease transmission.
3. Identification of resistant genotypes, with subsequent artificial selection and reintroduction of resistant animals into the wild.
4. Development of a vaccine capable of being delivered in the wild.

In addition to managing the disease itself and its impact on Tasmanian devils, it may be necessary to manage the impact of disease-induced reduced Tasmanian devil populations on Tasmanian ecosystems.

A complete management strategy is likely to require a combination of two or more of these management levers, in association with strategies to minimize the impact of reduced Tasmanian devil populations on Tasmanian ecosystems. These strategies are

more fully documented in the Strategic Plan of the save the Tasmanian Devil program and in the Save the Tasmanian Devil Business Plan. Research is necessary because insufficient knowledge is available to implement any of these management options or to select between options.

The nexus between research and management

Where there is uncertainty and incomplete knowledge, management actions should be implemented in such a way that whether they were successful can be subsequently determined. This means that all management is experimental and thus contains elements of research. If results of previous management actions are used to modify and improve future actions, this constitutes passive adaptive management. If management actions are taken and designed with the deliberate objective of obtaining further information about the response of the system, this constitutes active adaptive management. All management actions should at least be monitored so that their success or failure can be determined, which constitutes passive adaptive management. If possible, active adaptive management is highly desirable.

Role of the Save the Devil Program in Supporting Types of Research

See Australian Standard Research Classification (ASRC), 1998¹

Pure basic research

Pure basic research is experimental and theoretical work undertaken to acquire new knowledge without looking for long term benefits other than the advancement of knowledge.

DFTD raises many questions of fundamental interest in evolutionary biology, ecology, molecular biology, epidemiology and oncology. Research into these areas may also shed light on the basic biology of cancers and the immune system, with potential applications to human health. The Save the Devil Program should encourage such research where possible through provision of samples and access to data. However, high-quality research in these basic areas should be supportable through major competitive grants programs such as ARC Discovery and NHMRC. The expert peer reviewers of these granting agencies are better placed than are individuals within the Save The Devil Program to assess the value of projects of this type. The limited core research funding should not therefore be used for pure basic research.

Strategic basic research

Strategic basic research is experimental and theoretical work undertaken to acquire new knowledge directed into specified broad areas in the expectation of useful discoveries. It provides the broad base of knowledge necessary for the solution of recognised practical problems.

Some DFTD research will fall into this category. As with pure basic research, high-quality proposals in this area are likely to be fundable by major competitive granting agencies. Research in this area is also likely to be attractive to external collaborators, as it will lead to high impact publications in major scientific journals. Where there are fundamental unknowns requiring strategic basic research, the DFTD program may

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<http://www.abs.gov.au/ausstats/abs@.nsf/0/22E4C184CA111129CA25697E0018FD78?opendocument>

need to directly fund such research, where it is critical and unfunded through other processes. It should also leverage funds from sources such as ARC Linkage, where possible. Strategic basic research may not relate directly to any one of the management levers identified above, but may provide the basic knowledge to underpin more applied research projects.

Applied Research

Applied research is original work undertaken primarily to acquire new knowledge with a specific application in view. It is undertaken either to determine possible uses for the findings of basic research or to determine new ways of achieving some specific and predetermined objectives.

This category encompasses the majority of research projects that directly relate to the management actions outlined above. Applied research is likely to form the majority of research expenditure directly funded from the DFTD program. Whilst external collaborators will be involved in applied research, much will be undertaken by core members of the DFTD program.

Experimental development

Experimental development is systematic work, using existing knowledge gained from research or practical experience, that is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

Research of this type is essential to solve many practical issues associated with managing DFTD. An example would be researching appropriate designs for cost-effective devil proof fences. The results of such research may not be publishable in scientific research journals and therefore may not be attractive to external collaborating scientists. Work of this type is unlikely to attract significant external funds from competitive granting agencies, but may attract support from industry partners, particularly if it employs specific technologies which these industry partners are interested in developing. Experimental development is likely to require direct funding from the DFTD program.

Strategies to maximize research quality, relevance and rate of progress

Strategy 1: Increase collaborations

Rationale:

1. The problem is multidisciplinary and all the relevant expertise will not reside in the current devil team, Tasmania or Australia. The rate of progress in solving problems will be maximized by attracting the input of the leading experts in each field.
2. External organizations have facilities and resources that are unavailable within the current DFTD program

How:

1. Inform national and international scientific community of progress and outstanding problems through the website, refereed publications, conference presentations and visits by members of the devil team to major national and international research centers.
2. Provide access to samples and data, with requests for access to be evaluated by the Senior Scientist in accordance with the *Policy and process for review of research and management* .

3. Evaluate requests for research access to insurance population animals held by ARAZPA and others in accordance with the *Insurance Population Strategy* and *Policy and process for review of research and management*, in consultation with organizations holding the insurance population animals
4. Establish and maintain a website, which will contain publicly available information and restricted access to data, drafts and proposals
5. Require team members and collaborators to post proposals, progress reports and preprints on the website (with access restricted to team members and collaborators if this is necessary)
6. Call for expressions of interest for research in targeted areas.
7. Evaluate research proposals in a timely manner.
8. Develop strategies to minimise concerns about intellectual property.
9. Hold targeted workshops where necessary to maximise collaborations and minimize competition between scientists, research groups and institutions

Strategy 2: Leverage funding

Rationale

1. Despite substantial financial commitments by both Tasmanian and Australian governments, there will not be sufficient resources to do all the research that may be important to save the Tasmanian devil.

How

1. Encourage applications to funding sources such as ARC (Discovery and Linkage), NHMRC and NSF.
2. Approach philanthropic and corporate sponsors for targeted research proposals
3. Prepare a costed portfolio of potential research projects for distribution to potential donors.
4. Develop a strategy to coordinate requests for corporate and philanthropic funding.
5. Ensure that forward commitments for matching funds can be made

Strategy 3: Align research to management outcomes

Rationale:

1. Whilst there are potential benefits for management in any increased knowledge about the Devils, the tumour and their interactions, the program should aim at applied research which seeks directly to acquire knowledge that will address the potential management levers listed above.

How:

1. If research outcomes require substantial changes to management practices and/or amendment of the *Business Plan*, the Senior Scientist to advise the steering committee accordingly.
2. Following the *Policy and process for review of research and management*, all research proposals to be required to identify explicitly how their results will be relevant to management of the disease and or its impacts.
3. The senior scientist to annually review the overall research agenda and portfolio, to identify gaps, re-evaluate priorities and evaluate progress.

Strategy 4: Maximise quality of research

Rationale:

1. High-quality research is most likely to lead to appropriate management actions

How:

1. Ensure all research proposals are independently reviewed before they are accepted (see *Policy and process for review of research and management*). .
2. Require annual progress reports on all research projects for which data, samples or access to animals has been provided (One page report to the senior scientist to be provided on the anniversary of approval of the project, with reports to be posted on the website following comments from the senior scientist and modifications if necessary). “Traffic light” summaries should be provided for each component of the project:
 - a. **Green:** Little or no risk of failure to deliver outputs and on target
 - b. **Yellow:** No significant risk of failure to deliver outputs on time; some aspects of scope, resources, quality or schedule require attention
 - c. **Red:** Significant risk of failure to develop outputs on time, requiring immediate response
3. Provide adequate resources for approved research projects, particularly to ensure adequate replication and controls
4. Encourage publication in high-quality peer-reviewed journals as rapidly as possible.

Attachment: Research Agenda (April 2008)

What is currently known about Tasmanian devil facial tumour disease

The following summary is very brief. An overview of the state of knowledge in early 2007 can be found in a series of papers in a special issue of the *Journal Ecohealth* (Jones et al. 2007, McCallum et al. 2007, Pyecroft et al. 2007, Woods et al. 2007), based on the proceedings of a scientific forum held in Hobart in February 2007. Except where explicitly referenced elsewhere, information below is derived from the *Ecohealth* papers or earlier papers referenced therein.

Tasmanian devil facial tumour disease (DFTD) is an infectious cancer. It is a transmissible cell line: all tumours have characteristic major chromosomal rearrangements that are very different from those of their host. Furthermore, microsatellite and MHC²-based molecular genetic information shows that all tumours are indistinguishable on this basis, but most are genetically distinct from their host (Siddle et al. 2007). Tasmanian devil populations have very low genetic diversity and it is currently thought that the tumours are able to spread between individuals because of this lack of genetic diversity: MHC diversity is so low that tumour cells are not recognized as being "nonself". There is no evidence of any involvement of a virus in the disease.

It can be demonstrated experimentally that tumour cells are infectious (Pyecroft, unpublished). The mode of transmission in the field is thought to be by biting, which is common in both sexual and aggressive interactions in devils (Hamede et al. in press). However, there is little direct evidence to confirm how disease is transmitted in the field, and in particular, the stage of tumour development at which transmission occurs is unknown. The possibility of tumour transfer via devils scavenging on the carcasses of diseased devils or via co-feeding on prey carcasses cannot be discarded. There is no evidence of vertical transmission. As yet, there is no clear evidence that any animals are resistant to the disease.

DFTD appears to be invariably lethal, with the death occurring in less than six months following first appearance of lesions. It has dramatic effects on devil populations (Lachish et al. 2007): a virtual total disappearance of all animals older than three years (devils can usually live to five or six in the wild), overall population declines in affected populations of up to 90%, and an estimated decline in the total population in Tasmania in excess of 50%. The disease was first reported in the north-east of the State and has now spread over the majority of the Devil's former range, with only the north-west of the State still supporting high-density uninfected populations. There is no indication that disease prevalence decreases once devil populations have become very low. Models therefore suggest that the disease is likely to lead to local extinction within 15 years of diseased arrival and current rates of spread suggest that the disease will cover the geographic range of the devil within five years. Extinction over a timeframe of 20 to 30 years is therefore a real possibility.

² MHC refers to the Major Histocompatibility Complex, a gene family that is associated with the ability of the immune system to distinguish between "self" and "non-self"

Research Portfolio

The current portfolio of research projects associated with the save the devil program can be found on the program website at <http://www.tassiedevil.com.au/>.

Top ten critical questions for research

These are roughly listed in priority order (as of June 2008) although there are at least four dimensions on which they can be prioritised:

- urgency (how rapidly the answer is needed)
- importance (how critical the answer is to saving the devil)
- feasibility (the extent to which the question could be answered if sufficient resources were dedicated to it)
- cost (how much it is likely to cost to answer the question)

1. **Is there evidence that animals with MHC profiles differing from the tumour and from east coast animals are resistant to disease?** There is now some evidence that populations from the west coast of Tasmania have MHC profiles that are somewhat different both from the tumour and from the currently infected East Coast populations. Whether the extent of difference is sufficient for some west coast individuals to be partially or completely resistant is unknown. It is clear that if some animals are resistant to disease, this will totally change the overall management strategy for the disease and the prognosis for the species as a whole.
2. **What are the latent and incubation periods?** Determining the time between acquiring infection and first showing clinical signs (the incubation period) and the time between acquiring infection and first becoming infectious (the latent period) is critical for establishing appropriate biosecurity protocols for establishment of insurance populations and for appropriate regulation of movements of animals between population. Further, knowledge of the latent period is critical for determining the basic reproductive number R_0 of the disease, which in turn is which in turn is essential for evaluating the feasibility of various control strategies.
3. **What are appropriate strategies for managing extensive captive population?** There are numerous proposals for establishing fenced populations in areas of a few to several hundred hectares. Given that natural devil densities are of the order of one to two per square kilometre, how such captive populations need to be managed to minimise excessive aggression and maximise reproductive success is unclear.
4. **Is the tumour evolving and do any such changes have functional significance?** There is some evidence based on karyotypes that there are several strains of the tumour. Whether these changes are degenerative or adaptive is unknown, but understanding whether or not the tumour is a fixed or moving target is critical
5. **Can modern molecular techniques be used to identify genes in the tumour and the host responsible for establishment of the disease or for resistance to the disease?** Identification of such genes would support developing vaccines, selection for resistance, understanding tumour evolution and managing insurance populations.
6. **Can diseased animals be identified before clinical signs develop or from hair or scat samples?** The ability to identify animals with disease before tumours are visible would be very helpful for range of management actions, particularly collecting animals for the insurance population. Similarly, the

ability to identify the presence of disease in a population from noninvasive sampling such as hair collection or scat samples would be very useful.

7. **What is the basic reproductive number of the disease and how does it depend on devil density?** The basic reproductive number³ R_0 is central to disease dynamics and all potential control strategies need to be evaluated in the context of their ability to reduce R_0 , with disease eradication possible if $R_0 < 1$. Whether R_0 is dependent on density is critical to understanding whether or not the disease can drive the host population entirely to extinction.
8. **What are appropriate strategies for maximising breeding success in closely managed populations?** Although females are capable of producing 4 young per year and most wild females two years and older do have four pouch each year, reproductive success in captivity is variable and often much lower.
9. **Can offshore islands or fenced peninsulas be used for establishing or maintaining disease free devil populations?** Critical questions here include identifying which islands or peninsulas might be suitable, identifying strategies to minimise impacts on other species that might be present on islands, evaluating fence designs and developing approaches for ongoing management of such populations.
10. **Can removal of infected individuals from semi-isolated populations eliminate disease or at least maintain a viable devil population?** There is a trial currently in progress on the Forestier Peninsula, but whether it will be successful ultimately is unclear. Whether it is possible to replicate it elsewhere is even more unclear.

³ The basic reproductive number R_0 of an infectious disease is the number of secondary cases per primary case when disease is rare. As well as the varying between diseases, it may depend on host density and the environment for a given disease and host.

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