

A Critique of Disease-Screening Requirements for
Community-managed Species Translocations:
A Case Study of Hihi (*Notiomystis cincta*)

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Introduction

In recent times, the landscape of reintroduction biology in New Zealand has gone through significant changes. The first of these shifts has been a significant rise in wildlife management and species translocations by community groups. This community driven approach started in the 1970's with community groups assisting the Department of Conservation in re-vegetation and pest eradication projects on offshore islands. These early models of community conservation have been rapidly adopted and new groups have adapted the model to suit a range of different sites and situations. More recently the community conservation model has been adapted to include pest proof fencing and sustained pest control as a way of restoring large mainland sites. As these projects have progressed their focus has moved to the reintroduction of locally extinct and endangered species. These reintroductions were initially managed by Department of Conservation (DOC) staff and other reintroduction specialists, such as university researchers. But with the expansion of community conservation projects some community groups now have the expertise to undertake the organisation and management of reintroductions themselves.

The other shift has been the increased awareness of the risks of pathogenic disease in reintroduction programmes prompting the increased involvement of wildlife veterinarians. This has resulted in the implementation of disease risk assessment, disease screening and quarantine procedures. In New Zealand these pathogen management practices are guided by the DOC's standard operating procedure (SOP)¹ for the health management of terrestrial vertebrate species protected under the Wildlife Act. This SOP identifies disease as a risk to wildlife and suggests that our management activities can increase the risk posed by disease and that our ability to manage this risk is limited by the lack of information on disease (McInnes *et al.* 2004).

Disease screening is being conducted for two important reasons; (i) to select only healthy individuals for translocation, so as to maximise chances of success, and (ii) to avoid establishment of potentially damaging pathogens into the ecosystem present at the release site. The implementation of disease-screening for translocations has been managed predominantly by veterinary specialists, who often have a very clinical perspective of disease and health. While the involvement of veterinary specialists has been welcomed by conservation managers, the practicalities and integration of a best practice approach to disease and health screening has been more difficult to resolve (Kock 2008). But disease screening needs to include the effect of the procedures on post-release survival and should also consider effects on the source population.

¹ This SOP appears to have been based on a Zoo-to-zoo transfer protocol to control and minimise disease spread in zoos, which are quarantined facilities (Pim de Monchy pers.com).

Here I present the results from:

- (i) Standard disease screening during the five most recent, wild to wild, translocations of an endangered New Zealand passerine, hihi or stitchbird (*Notiomystis cincta*);
- (ii) The monetary cost of the species translocations, disease screening and post-release monitoring; and
- (iii) How the results of the disease-screening was applied to the translocation management.

Methods

Hihi and hihi recovery

Hihi are an endangered passerine species endemic to New Zealand. Following European colonization of New Zealand, predation, severe habitat loss and possibly disease extirpated hihi from the mainland of the North Island and reduced their distribution to a single population on Little Barrier Island (Hauturu, 3083 ha) in the Hauraki Gulf, where they persist to the present day (Taylor *et al.* 2005). Efforts to recover the stitchbird have involved many translocations to other islands including Hen, Cuvier, Mokoia, Kapiti and Tiritiri Matangi and more recently to Karori Wildlife Sanctuary in Wellington (a 250ha predator fenced area) and Ark in the Park Open Sanctuary in the Waitakere Ranges, Auckland (a 2000ha area with continual predator control).

Translocation

For analysis in this report only the five most recent translocations have been used (Karori February and May 2005, Ark in the Park February and June 2007 and Ark in the Park May 2008). All five of these translocations have been sourced from Tiritiri Matangi Island. While none of the original translocations had official disease management protocols in place, these five most recent programmes have incorporated disease-screening.

These recent translocations largely targeted juvenile birds, with a few accompanying adults and adult males were initially taken to both sites as an attempt to reduce dispersal. In contrast, in the second Karori translocation adult females were taken in an attempt to balance the sex ratio between the two translocations. In the final Ark in the Park translocation (May 2008) it was decided not to take any adults, as indications from the initial translocations suggested that the addition of adults was having little effect on reducing dispersal.

Where possible only a single juvenile produced from any given clutch was translocated to maximise genetic diversity of both the translocated birds and the birds remaining at the source site. Adults selected were young individuals who had completed either one or two breeding seasons.

All birds were caught at supplementary feeding stations or in mist-nets away from these feeding stations. Birds were then moved to the holding site for disease screening and quarantine (quarantine periods were governed by the time taken to analyse samples and were between 10 - 14 days). Holding facilities on Tiritiri Matangi included a permanent aviary (8 x 6 x 2.5 m) purpose-built for holding birds during translocation and a portable aviary (2.4 x 1.2 x 1.8 m). About half of the permanent aviary is roofed and walled in timber with the remainder constructed with 13 mm² welded mesh over a wooden frame with the mesh walls lined with shade cloth. The portable aviary consisted of a wooden roof and single end, with the remainder constructed in chicken mesh over an aluminium frame that was similarly lined with shade cloth. In both aviaries birds were provided with *ad libitum* food, extensive fresh vegetation for perching and foraging and ample roosting boxes. The portable aviary was used to hold adult males separately in the February 2005 translocation given their aggression toward other individuals.

Disease and health screening for translocation

DOC's disease-screening requirements were similar in all translocations. The disease-screening protocols and tests required to detect pathogens were determined by a veterinarian recommended by DOC. Each bird was examined visually at the time of capture, weighed and examined for external signs of disease, sub-lingual oral fistula and ectoparasites (*Ornithonyssus bursa* and hippoboscids) or injury by either a veterinarian (February and May 2005) or by an hihi expert (February and June 2007, May 2008).

Karori

Karori Wildlife Sanctuary was required to test for Salmonella, Yersinia, Campylobacter, blood parasites, and Coccidia, as well as completing a white blood cell count. During both translocations all birds brought back to the aviary had faecal and blood samples taken for disease screening. After release into the aviary, they were then given an oral mix of baycox (50mg/ml – 20mg/kg, for coccidia), itraconazole (10mg/ml – 10mg/kg, for aspergillosis) and combantrim (50mg/ml + 3.3mg/ml droncit – 1ml/kg, for intestinal worms) as a precautionary measure to minimise the risk of a disease outbreak during captivity. Birds that were unable to be screened adequately (e.g. no faecal sample) or that were related to birds already captured were transported back to the capture site and released (Empson & Booth 2007).

Ark in the Park

In 2007 the translocation proposal stated that disease screening would be carried out twice: both prior to the translocation, and at the time of translocation. This translocation had initially been planned for 2006, but was put on hold due to the discovery of a new strain of salmonella in the hihi population on Tiritiri Matangi Island shortly before the first translocation was due to occur. This made it especially important to confirm that no salmonella was present in the hihi population before the translocation could take place in February 2007 (Richardson & Jack 2008).

Although the translocation proposal states that disease screening prior to translocation was to be carried out on chicks in nests on Tiritiri Matangi Island, this was not carried out. Instead disease screening at the time of translocation consisted of the following:

1. Faecal samples were obtained by translocation ring the bird from the capture site to the processing room in a plastic ice cream container, as opposed to a bag which would absorb most faecal matter. The faecal samples from the containers were used for coccidia testing. In addition, faecal samples were collected twice daily from the aviary for additional salmonella testing from 16-18 February and 8-10 June.
2. Cloacal swabs were taken from each bird for Salmonella, Yersinia and Campylobacter testing.
3. A blood smear was taken for white cell count and examination for blood parasites and atoxoplasma (a coccidia found in hihi which can have a blood phase).
4. One haematocrit tube of blood was taken for total plasma protein and haematocrit.
5. Half a haematocrit tube of blood was placed in DNA buffer for Landcare research to perform PCR to detect avian malaria.

All samples were sent to Gribbles Veterinarian Laboratory in Auckland for analysis.

Following the advice of Richard Jakob-Hoff, Veterinarian, Auckland Zoo, once all were caught, the birds were given Baycox on Day One and Day Two. The dosage was 0.5ml to 200ml of sugar water daily.

Following the above treatment, Sporonox (itraconazole) was then given to the birds in the aviary, again via their sugar water, from Day Three daily until the day before they were translocated off the island. The dosage was 0.03ml per bird with 1.0ml added to their total sugar water amount daily.

Composition of Transfer Population

Once disease and health screening results were obtained decisions were made to either translocate or release individuals back into the source population. In all cases birds were individually captured and re-weighed to determine changes in mass during quarantine

Karori

The February translocation population consisted of 30 birds, comprising five adult males, 14 juvenile males and 11 juvenile females. Ten birds were caught but not translocated

The May translocation population consisted of 30 birds, comprising five adult males, 14 juvenile males and 11 juvenile females.

Ark in the Park

The February translocation population consisted of 30 birds, comprising five adult males, 13 juvenile males and 12 juvenile females. Only one of the juveniles (SM/OG) was from a second clutch, and this bird was thought to be a female at the time of release, but a few weeks after release at the Ark in the Park was noted to be developing male plumage and vocals.

The June translocation population consisted of 29 birds, comprising four adult males (one of which died in the aviary at the Ark in the Park before it was released), 13 juvenile males and 12 juvenile females. One of the juvenile males (BY/M) was thought to be an adult male at the time of release, but was later realised to be one of the first juvenile males of the 2006/07 season.

In May 2008 the translocation population consisted of 51 juvenile birds (25 females and 26 males) along with an additional 5 juvenile females which were translocated to Karori.

Translocation Cost Breakdown

Analysis of the costs of each translocation used the invoices from each organisation for each translocation. Expenditure was summarised into two categories:

1. Transfer logistics, this was the costs associated with the physical costs of the translocation. This included costs such as catching team transport and accommodation, bird food and transport and consumables for the translocation.
2. Disease Screening, this was the costs associated with the required disease screening including processing of the samples by Massey University and/or Gribbles and Landcare Research along with the cost of the consumables required to perform the screening.

Results

Over the five translocations there were a total of 225 birds caught with 175 being translocated and 50 being rejected from the translocation for various reasons (Table 1 & 2).

Table 1: Hihi caught, disease screened and transferred.

Transfer	Caught	Screened					Tx ⁵	Not Tx ⁶
		Bacterial Culture ¹	Faecal Sample ²	Plasma Protein and Haematocrit	Blood Smear ³	PCR ⁴		
K05 Feb	40	35	36	0	34	0	30	10
K05 May	43	36	41	0	37	0	30	13
Karori Total	83	71	79	0	71	0	60	23
Ark07 Feb	35	34	34	0	35	35	30	5
Ark07 Jun	38	38	37	37	38	38	29	9
Ark08 May	69	69	64	69	69	65	56	13
Ark Total	142	141	135	106	142	138	115	27
Overall Total	225	212	212	106	213	138	175	50

1 = Campylobacter, Yersinia and Salmonella tested, 2 = Coccidia tested, 3 = Blood Parasites tested, White Blood Cell Count, Red Blood Cell Inclusions, 4 = Blood Parasites tested, 5 Tx = Translocated, 6 Not Tx = Not Translocated.

In the first Karori translocation (February 2005) 10 birds were rejected from translocation (Table 1). Four birds didn't provide faecal samples and a further 4 were rejected as surplus to the required 30 needed for translocation. Two birds were rejected due to disease screening results, with both these birds returning very high coccidia results (Table 2). None of the 35 birds screened for Campylobacter, Yersinia or Salmonella returned positive results and there were no irregularities found in any of the blood smear results.

Table 2: Reason birds were rejected from transfer.

Transfer	Reason for not-transfer									
	No Faecal	High Coccidia	Bacteria ¹	Blood Parasites	WBC ²	RBC ³	Extra Bloods ⁴	Surplus	Died	Failed Physical Exam
K05 Feb	4	2	0	0	0	0	0	4	0	0
K05 May	2	3	0	0	3	0	0	3	2	0
Karori Total	6	5	0	0	3	0	0	7	2	0
Ark07 Feb	0	0	0	0	1	1	0	0	0	3
Ark07 Jun	0	0	0	0	1	1	0	3	0	4
Ark08 May	0	0	0	7	0	0	0	0	1	5
Ark Total	0	0	0	7	2	2	0	4	1	12
Overall Total	6	5	0	7	5	2	0	11	3	12

¹ = Campylobacter, Yersinia and Salmonella tested, ² WBC = White Blood Cell Count, ³ RBC = Red Blood Cell Inclusions (Including monocytes), ⁴ Plasma Protein & Haematocrit.

In the second Karori transfer (May 2005) 13 birds were rejected from the translocation (Table 1). Two birds didn't provide faecal samples, 1 bird died during blood sampling, one bird was

euthanased due to a leg injury, three were deemed surplus to the required 30 needed for translocation and six birds were rejected due to disease screening results (Table 2). Three of these birds were rejected on the basis of high coccidia counts, two of which were birds that had been rejected in the last translocation and therefore were rejected on that basis. Three birds were rejected on the basis of high white blood cell². Additionally during screening 17 of the 37 blood smears showed the presence of red blood cell inclusions but upon further screening and veterinary advice these birds were translocated.

During the first Ark in the Park translocation (February 2007) five birds were rejected from translocation (Table 1). Three birds failed their physical exam, two due to leg injuries and the other due to low weight, and two birds were rejected based on disease screening results (Table 2). One of these birds presented a low white blood cell count and the other presented a low red blood cell count.

In the second Ark in the Park translocation (June 2007) nine birds were rejected from translocation (Table 1). Four birds failed to provide blood samples for screening, three birds were released as surplus to requirements for the translocation population. Two birds were rejected due to disease screening results (Table 2). One of these birds presented with a low white blood cell count while the other bird had monocytes detected in its blood smear.

In the final Ark in the Park translocation (May 2008) thirteen birds were rejected from translocation (Table 1). Five birds failed their physical exam, one bird had a bill deformity and the other four of these were rejected due to low weight, one bird died in the aviary pre-release and seven were rejected due to the presence of avian malaria in there disease-screening results.

Ectoparasitic mites (*Ornithonyssus bursa*) and/or hippoboscid (Diptera, Hippoboscidae) flies were frequently detected upon physical examination of hihi (average $23 \pm 4.8\%$ of birds in each translocation). No birds were rejected from translocation because of the presence of ectoparasites and in one translocation presence of mites resulted in treatment of the bird with a miticide (Frontline[®]). The effectiveness of these treatments at removing mites in adult hihi is unknown. Three juvenile hihi also presented sub-lingual oral fistula's, two of which were translocated and one which was re-released on providing a positive result to blood parasite screening (see below).

No blood smears showed evidence of haemoparasite infection. Molecular based methods for detection of blood parasites produced slightly incongruent results to blood smear examination. Although the majority of individuals appear not to be infected there was evidence for infections with a *Plasmodium* type haemoparasite in seven individuals during the 2008 translocation (commercial screening by Landcare Research Ltd with faint but consistent bands observed). None of these birds were subsequently translocated, despite

² A general rule of thumb used in this translocation was for further diagnosis and concern if total white blood cell counts were $\geq 20 \times 10^9$ g/L.

being passed as suitable for translocation by the veterinarian. Interestingly, at least five of these individuals remained alive on Tiritiri Matangi and were recorded in the September pre-breeding census and have gone on to breed.

Culturing bacteria from cloacal swab and faecal material has consistently failed to show evidence for *Salmonella* or *Yersinia*. There were, however, a proportion of individuals where *Campylobacter jejuni* was detected. No birds showed clinical signs of pathogenic infection associated with presence of *Campylobacter jejuni* and are likely presenting as asymptomatic carriers of this bacterium. Analysis of faecal samples also showed evidence for infections with *Coccidia sp.* and *Capillaria sp.* Prevalence of coccidian infections ranged from 0 – 50% across the translocations and prior sampling from Tiritiri Matangi Island. Infection intensity was highly variable but reached mean shedding rates of 5583 eggs/gm of fresh faeces in May 2005. Infections with either parasite, however, were not associated with clinical signs of pathogenic infection and its likely these parasites are presenting as sub-clinical chronic infections.

Table 3: Monetary costs associated with different components of each translocation. Disease screening costs vary depending on the number of samples gathered for each test and the different tests incorporated into each translocation (see methods). N is the total number of birds available for testing (there are cases where birds did not provide required samples for some tests).

Translocation/Component	N	Total \$NZD	% of Costs	Cost/Bird
Karori Sanctuary 2005	83			
Transfer logistics		\$5,000	61%	\$60.24
Disease Screening		\$3,162	39%	\$38.10
Total		\$8,162		
Ark in the Park Feb 2007	35			
Transfer logistics		\$1888	27%	\$53.94
Disease Screening		\$5148	73%	\$147.09
Total		\$7036		
Ark in the Park May 2007	38			
Transfer logistics		\$623	11%	\$16.39
Disease Screening		\$5200	89%	\$136.84
Total		\$5823		
Ark in the Park May 2008	69			
Transfer logistics		\$1592	14%	\$23.07
Disease Screening		\$9699	86%	\$140.57
Total		\$11291		
Overall				
Transfer logistics		\$9103	28%	\$40.46
Disease Screening		\$23209	72%	\$103.15
Total		\$32312		

The breakdown of monetary costs associated with these five translocations (Table 3) shows the high cost of disease-screening required to complete a translocation under current translocation protocols, with \$32,312 being spent across all the translocations. Disease screening was the single largest component of the translocations, with \$23,209 being spent over the five translocations, averaging 72% of the costs for each translocation.

The earlier Karori translocations were the most cost-effective in terms of disease screening as Massey University wildlife health facilities processed the disease-screening samples. The Ark in the Park processing was conducted by a commercial veterinary lab (Gribbles) with addition of PCR analysis for blood parasites (performed by Landcare Research Ltd) contributing significantly to the higher costs. The Ark in the Park translocations had a far lower translocation component in the translocation costs, the difference being in the reduced transport component.

Discussion

The screening, for the five translocations, targeted a range of specific parasites and general health measures. Firstly, ectoparasitic mites and flies were found on a proportion of birds during each translocation. Both of these parasites are generalists and widespread parasites of indigenous and exotic New Zealand birds. It has been shown that these parasites cause nestling mortality and reduce the condition of young birds (Ewen et al., submitted) and can limit population viability because of this (Armstrong et al., 2007). No individuals presented major infestations and, apart from some being treated with a miticide, none were rejected from translocation. Blood screens for haemoparasites provided concern with seven hihi testing positive via molecular based PCR to a *plasmodium* parasite. Despite this, veterinary specialists encouraged translocation of these birds. Managers, however, chose to reject these hihi for translocation and subsequent monitoring confirmed five of the seven to be alive and breeding five months later in the source population. Justification to translocate these birds was based on *plasmodium* parasites being detected in another species on Tiritiri Matangi (bellbird *Anthornis melanura*) with no obvious or severe pathogenicity. Interestingly it was the presence of these non-pathogenic *plasmodium* parasites that prompted concern and requested for screening with this method.

Analyses of cloacal bacterial screens found evidence of *Campylobacter jejuni* in a small proportion of birds. This bacterium is a serious concern to human health and also infects poultry and cattle. Wild vertebrate species have long been considered natural reservoirs and vectors of this bacterium. All hihi testing positive to *C. jejuni* have presented as asymptomatic carriers and its presence is no longer considered a risk in hihi translocations, with screening being discontinued in 2007. In contrast, screening continues for another serious bacterium *Salmonella* despite it having never been detected during standard disease screening for translocation. The reason for concern relates to a detected outbreak of *Salmonella enterica* serotype Typhimurium DT195 on Tiritiri Matangi in February 2006 (Ewen et al., 2007). This epizootic disease likely killed 26% of the adult population and was detected from necropsy examination of freshly dead hihi (Ewen et al., 2007). Screening of

living individuals immediately following the outbreak in February and regular screening of faecal matter collected at the supplementary feeding stations in the months following never resulted in positive testing of any *Salmonella* (Ewen et al., 2007). It is likely that this emergent disease spread through susceptible individuals and caused rapid mortality and has subsequently faded out from the population. The source of this bacterium is unknown and there must be an alternative reservoir host that facilitated its transmission. This outbreak was detected was by the intensive monitoring of the population by DOC managers and university researchers. This enabled the collection of freshly deceased birds for necropsy examination. Had this monitoring not been in place, it is likely that the proposed 2006 translocation would have preceded and, as shown by the lack of detection during screening immediately following detection of the outbreak, the disease screening required for the translocation would not have detected the outbreak. Therefore the screening would not have allowed managers to mitigate the risk of transmission. Similarly, screening of *Yersinia* continues despite it having never being recorded in hihi and similar bacterial screening has been applied to multiple recent robin and whitehead translocations with no positive results ever being recorded (Kevin Parker pers. comm.).

Continuing to screen for *Salmonella* and *Yersinia* and not *Campylobacter* raises interesting questions of the disease-screening process. Certainly the risks of these bacteria are well understood and can be catastrophic in human as well as domestic and wild species. However, problematic bacterium may be difficult or unlikely detected in free flying healthy individuals if infection leads quickly to acute sickness and death. It may be, however, that a small proportion of a population are resistant to the bacteria and act as asymptomatic carriers. This raises risks that; (i) they will become sick once stressed with capture, confinement and translocation, (ii) they will infect other susceptible individuals during this process or (iii) that they will carry these pathogen and risk transmission to other species at the release site. Under each of these scenarios it would highlight *Campylobacter* is the more serious pathogen to screen for and isolate than either *Salmonella* or *Yersinia*. If it is accepted that screening healthy looking individuals is unlikely to be informative then it could be argued screening of any bacterium is not required under current decision protocols.

Whilst the importance of disease management is obvious the implementation is still clearly under development. New Zealand reintroduction programmes have embraced the disease issue yet there are clear problems with the process.

1. Currently there is a lack of clear goal setting, a lack of clarity in risk assessment and then in contingency planning. It must also be recognised that having disease screening in place does not mean disease free individuals are being translocated or that disease risk is mitigated.
2. Veterinary specialists have a restricted armoury of tests available to sample only a small proportion of the many parasites and diseases that may impact on individuals and species. In most cases there is very little background information of parasites and

disease in the target host species to benchmark screening results against and the risks of any detected disease on other species at the release site can be hard to judge.

3. In spite of this disease screening protocols are being enforced upon translocations, with the community groups involved being given the impression that these protocols are mitigating the disease risk when clearly this is not being achieved.
4. In most cases the groups appear to be undertaking disease profiling of threatened species populations as this has not been undertaken by DOC. (I content that if disease management is a significant issue for threatened species, then DOC should be undertaking disease profiling as part of its threatened species management responsibilities.)
5. More effective and reliable screening appears to come from translocation manager's rejecting under-weight and unhealthy looking birds from being held or translocation.

Additionally there is a significant cost being forced on community groups when they are required to carry out current disease-screening protocols. The current disease-screening of healthy individuals for translocation, may be appropriate in some long-lived species with slow reproduction rates, such as kakapo and kiwi, or for translocations involving individuals that have been held in captive and quarantine facilities where the disease risk is far higher. The enforcement of protocols for individual health during translocations of short lived, fast reproducing species from healthy wild populations, such as hibi is a very costly and inefficient use of conservation resources. The extremely low number of birds rejected by the disease-screening is a clear example of this. The overriding aim of all translocations of such species is the establishment of a new population. While the health of individuals is an important component of every translocation, individual losses are expected and are accounted for in the make up of translocation populations. Additionally many of the individuals that have been rejected and released back into the source population, have survived all the stressors of the translocation except for the last few hours of transport, only to be caught in following translocations or picked up in future surveys of the population. These results challenge the effectiveness of the tests being done to indicate the health of an individual and whether an irregular result for these tests provides any information on the potential fitness of the individual.

Similarly, there are high costs for disease-screening to avoid establishment of potentially damaging pathogens into the ecosystem present at the release site. While it is clear that this is an important component that needs to be addressed during the translocation process, veterinary specialists and translocation managers also need to consider scale. Most disease-screening protocols focus on the health of individuals being moved to maximise the chances they will survive the move and the immediate post-release period. A secondary consideration is then given to the impacts of potential disease introduction to other species at the release site. Much less attention is typically paid to the pathogens present at the release site that may

limit the success of translocation programmes and knowing what parasites we actually need to avoid introducing (Swinerton and Greenwood 2008). Knowledge of the varying transmission pathways and range of possible alternative hosts is essential when developing a disease screening protocol. A host specific parasite may be of concern if your scale of risk focuses on the health of individuals moved, but will be of little consequence to other species at the release site. The results of the screening protocols for translocating hihi highlight both the paucity of available information and the limitations in this application. Translocations can provide ideal opportunities for the collection of background data on the prevalence and persistence of disease in wildlife populations. However, expensive disease screening for this purpose should not be enforced as a requirement of translocation permits. If DOC needs this information to better manage wildlife populations, then it should be funded from Vote Conservation.

When scale is considered, a more epidemiological approach to disease screening becomes of far greater importance, with risk assessment being identified as a highest priority (Cleaveland *et al.* 2002). Yet the current permit process, being carried out to assess the suitability of translocations in New Zealand is not adequately addressing this issue. Risk assessment needs to consider not only the pathogens themselves but also the specifics of the source and receiving sites and also the other potential vectors for disease to be transmitted between those sites. All five translocations examined here have been from a site where there is a healthy free living population of not only hihi but many other endangered native bird species (Tiritiri Matangi Island). All five translocations have also been to mainland locations with ample pathways for the free transmission of disease between locations, especially in the case of Ark in the Park (being only 45km from the source population), through the movement of many other bird species between Tiritiri Matangi Island and the mainland. Considering this, all of the disease management for these translocations has been implemented using a method based on a zoo-to-zoo transfer protocol designed to control and minimise disease spread in zoos. Translocations from such captive quarantine facilities pose a far greater disease risk than the wild-to-wild translocations currently being carried out.

The current landscape in reintroduction biology has seen the rapid emergence of pathogen management in translocation protocols at a time when the community has become far more involved in conservation management. With translocation managers being employed by community groups and DOC policy makers have become separated from the realities of funding and the implementation of sound and efficient conservation management. In the case of disease screening this has created a very inefficient and expensive process which is not achieving the objectives of the disease-screening SOP and policy. The screening protocols required by the permitting process for these translocations have been directed by the DOC Wildlife Health SOP which aims to minimise the risk of transferring pathogens and requires that veterinary consultation be included in the risk management process. This is the key area where the rapid implementation of disease management protocols has led to a breakdown in the implementation of conservation policy. During the five translocations analysed, all the protocols for disease management were set out by a veterinarian during discussions with the

project manager and DOC staff during the permitting process. As part of this permit process there has also been separate discussions at the Hihi Recovery Group considering the ecological implications, translocation design and methods and monitoring. Both the DOC Wildlife Health and Translocation SOPs indicate that disease management needs to be done as part of the permit process and that it needs to be done in consultation with a wildlife veterinarian. The flaw in the process is that ecological management and disease management discussions are being held separately. For the process to be efficient, there clearly need to be an integrated approach to all components of the translocation process. When independent community groups are involved this process also needs to consider any expenditure allocated to the translocation should be borne by DOC, the translocation applicant or a research agency seeking additional data. Profiling diseases in a DOC-managed population should be funded by DOC, whereas disease profiling at the recipient site is the responsibility of the translocation applicant. While an equitable allocation of costs and effort may have been achieved in the past through the internal workings of the DOC, there has been a clear breakdown in the process when community groups are involved.

Recommendations

1. It would be far more efficient to remove the clinical individual health screening required as part of current disease-screening protocols and for translocation managers to use physical examination and observation of birds to screen out unhealthy individuals that are unsuitable for translocation. Individual health screening has resulted in very few individuals being rejected from translocation while physical examination and observation of birds is clearly screening out far more unhealthy individuals that are unsuitable for translocation. Preventative treatment of external and internal parasites should be continued.
2. Any future disease screening needs to be based on a sound risk analysis of the specific translocation situation. This risk analysis needs to integrate both the ecological and disease management issues during the translocation permit process.
3. If disease management is an important part of threatened species management, then DOC need to be regularly sampling diseases in threatened species populations. The responsibility for disease screening for translocations relates to the disease profile at the recipient site, and this needs to be carried out by the translocation agency/group. Currently community groups appear to be funding most of DOC's threatened species disease profiling through translocation requirements.
4. Clear standardised decision making protocols, for the emergence of positive results from any future disease screening, need to be implemented prior to the request for any disease screening. The detection of avian malaria in 2008 and then subsequent advice to translocate anyway, after having requested expensive clinical tests specifically to mitigate the threat of spreading this disease, indicates defects in the decision-making process.
5. If the methods to detect and therefore mitigate the risk of spreading disease cannot be successfully achieved, then the research required to rectify the methodology needs to be proposed and funding sources for this research need to be sought through concurrent proposals to translocation permits. The results of the screening protocols for translocating hihi highlight both the paucity of available information and the limitations in the current application of disease screening.
6. Further collection of background disease data is required for many native species, so that disease management issues can be better understood and more efficient protocols for the mitigation of disease risk can be formulated, and this is DOC's role and funding responsibility. Further collection of such data should be conducted using rigorous experimental design to ensure the cause and effect of disease risk can be established.

7. The current breakdown in the implementation of conservation policy highlights the need for a review of how both community conservation management and disease management are being dealt with through the translocation permit process. This process needs to ensure the implementation of integrated risk assessment and that any expenditure allocated to the individual components of the translocation design are a sound investment with clear benefits to the programme.

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