OPERATIONAL PLAN FOR ERADICATION OF PACIFIC RATS *RATTUS EXULANS* FROM MOTU MOKOHAE, MOTU TAKAHE, & MOTU OA, AT UA POU (MARQUESAS), FRENCH POLYNESIA

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1	February 2022	Grant Harper	First draft for independent review
	April 2022	Grant Harper	2nd revised draft following review
	July 2023	Grant Harper	3rd revision – final changes

1. SUMMARY

The operational plan for the eradication of Pacific rats *Rattus exulans* from Motu Mokohae, Motu Takahe, & Motu Oa, at Ua Pou (combined area; 50ha, Marquesas), French Polynesia, establishes the methodology, responsibilities and tasks required for the implementation of the proposed eradication operation. This operation is the first of two rodent eradication operations using drones being undertaken in French Polynesia in the spring of 2022.

A series of planning and preparatory tasks needed to be completed prior to an eradication operation proceeding and this plan outlines these tasks and suggests the timing required to allow the field component of the operation to begin on time.

There are three principal components to the field work. The first is transport of the team, bait and drones to Ua Pou in the 3 weeks prior to the second phase. The second is the establishment of the infrastructure and supporting mapping data to undertake the aerial bait. The third is the bait application using drones, across the three islets, which will be split into two periods at least a week apart. This component will be highly dependent on the having dry weather, particularly during and immediately following the bait application.

The operation will be overseen by a Project Manager, with the Operations Manager, and Logistics and Liaison Manager running the field component with the drone company and some local assistance. Access to the Ua Pou will be via scheduled domestic flights and/or ferry from Nuku Hiva (Marquesas). A ~20m boat will be required to operate the drone(s) from and will be sourced from within the Marquesas.

The eradication attempt will use Pestoff 20R, containing brodifacoum. It will be aerially-spread across the islets at a rate of 12kg/ha for the first application and 12kg/ha for the second application for a nominal total of 24kg/ha. A total of 2500kg of bait will be applied which includes a 20% contingency.

Permission to carry out the operation will be secured before proceeding. Subsequently the managers will implement this plan. The field work should begin about the last week of August with the aim of beginning the first bait application about 25 August. It is expected the operation will be completed in early September.

Biosecurity measures for the islets for the islets should be established by the start of the 2nd bait application and then continue after the operation is complete. Monitoring of selected species, particularly, threatened seabird species, will be on-going.

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ACKNOWLEDGEMENTS

My thanks to Steve Cranwell of Birdlife International, Tehani Withers and Tom Ghesthemme of SOP-Manu who have provided much of the support, background material and advice for this plan. Further thanks to Samuel Vye, Cameron Baker and Mike Jensen of Envico Technologies Ltd, and Greg Quinn and Bruce Peterson of Aerospread, for the technical details of drone operation.

2. INTRODUCTION

The purpose of this operational plan is to set out the planning and activities to eradicate from Pacific rats from Motu Mokohae, Motu Takahe, & Motu Oa, at Ua Pou (Marquesas), French Polynesia, Societe d'Ornithologie de Polynesie – Manu (SOP-Manu) are working in partnership with Birdlife International to implement the operation. In addition to this operational plan a feasibility study (Harper 2021) has been drafted for the project. At this stage the operational components of the project are being finalised, of which the logistics planning has been disrupted due to COVID-19 pandemic, so this document is to be used as a planning guide until the final details are confirmed. Once logistical details are determined the final version of this plan will be completed to guide the operation. It should be noted that the author has not conducted a field visit to the site(s) so some information has been gleaned second-hand and accuracy it not assured.

The feasibility study highlighted operational risks for the operation, particularly with regard to the operation being one of the first rodent eradication operations using drones on offshore islands with steep topography at a relatively isolated island. This operation is, to a degree, a 'proof of concept' operation for drones on isolated islands in French Polynesia and this plan should be read with this in mind.

It was concluded that with detailed planning and careful management a successful operation would result in significant national and international conservation gains for threatened seabird species on Ua Pou and provide impetus for other drone-assisted rat eradication operations on many islets elsewhere in French Polynesia.

This operational plan will provide guidance for the Project Manager, Operations Manager, Logistics and Liaison Manager, drone operators, and the local community involved with the operation. It sets out the responsibilities, timing, methodology and sequence of events required to undertake the operation.

3. GOAL, OBJECTIVES AND OUTCOMES

3.1 GOAL

To enable the restoration of endemic and native fauna and flora on the islands of from Motu Mokohae, Motu Takahe, & Motu Oa, at Ua Pou (Marquesas), French Polynesia,

3.2 OBJECTIVES AND OUTCOMES

The objectives that this operation will achieve and the outcomes that can be expected as a result of achieving these objectives are:

Objectives	Outcomes
1. Eradicate Pacific rats from from Motu Oa.	1.1 Protect endemic and native seabird species and allow their populations to increase.
	1.2 Facilitate the re-establishment of seabirds with species currently missing.
	1.3 Allow any native land bird species to establish on the islets and allow their populations to increase.
	1.4 Allow endemic native plant communities to recover through cessation of rat predation of seeds, fruits and seedlings.
	1.5 Allow native reptile and invertebrate populations, including crabs, to recover.
	1.6 Facilitate the recovery of native ecosystem processes and interactions.
2. Eradicate Pacific rats from Motu Mokohae, Motu Takahe, &	2.1 Remove rats to determine possible duration to reinvasion.
	2.2 Facilitate the re-establishment of seabirds on the islets if enduring eradication is successful.

	2.3 Allow any native land bird species to establish on the islets and allow their populations to increase.
	2.4 Allow endemic native plant communities to recover through cessation of rat predation of seeds, fruits and seedlings.
3. Undertake eradication using drones	3.1 Use drones in a difficult field environment to establish the conditions under which drones can be deployed.
	3.2 Increase confidence in use of drones for eradications onsmall islands worldwide
4. Strengthen biosecurity for the islands to ensure they remain rat free and reduce the risk of new invasive species introduction.	4.1 Stricter biosecurity measures and a biosecurity plan are in place to reduce the risk of re-invasion by Pacific rats and introduction of new exotic invaders e.g. plants, invertebrates, other mammals.
5. Increased capacity for invasive vertebrate eradication and support for island restoration in French Polynesia	5.1 Local Ua Pou leaders, community, and officials within the French Polynesian Government understand the benefits of invasive vertebrate eradication and support island restoration including the application of biosecurity 5.2 SOP Manu, and BirdLife have increased capacity to successfully develop and implement drone-supported rodent baiting operations 5.3 A stakeholder plan is in place for further engagement.

4. SITE DESCRIPTION AND BIOTA

The following information is for operational development and more detailed background is outlined in the Feasibility Study (Harper 2021).

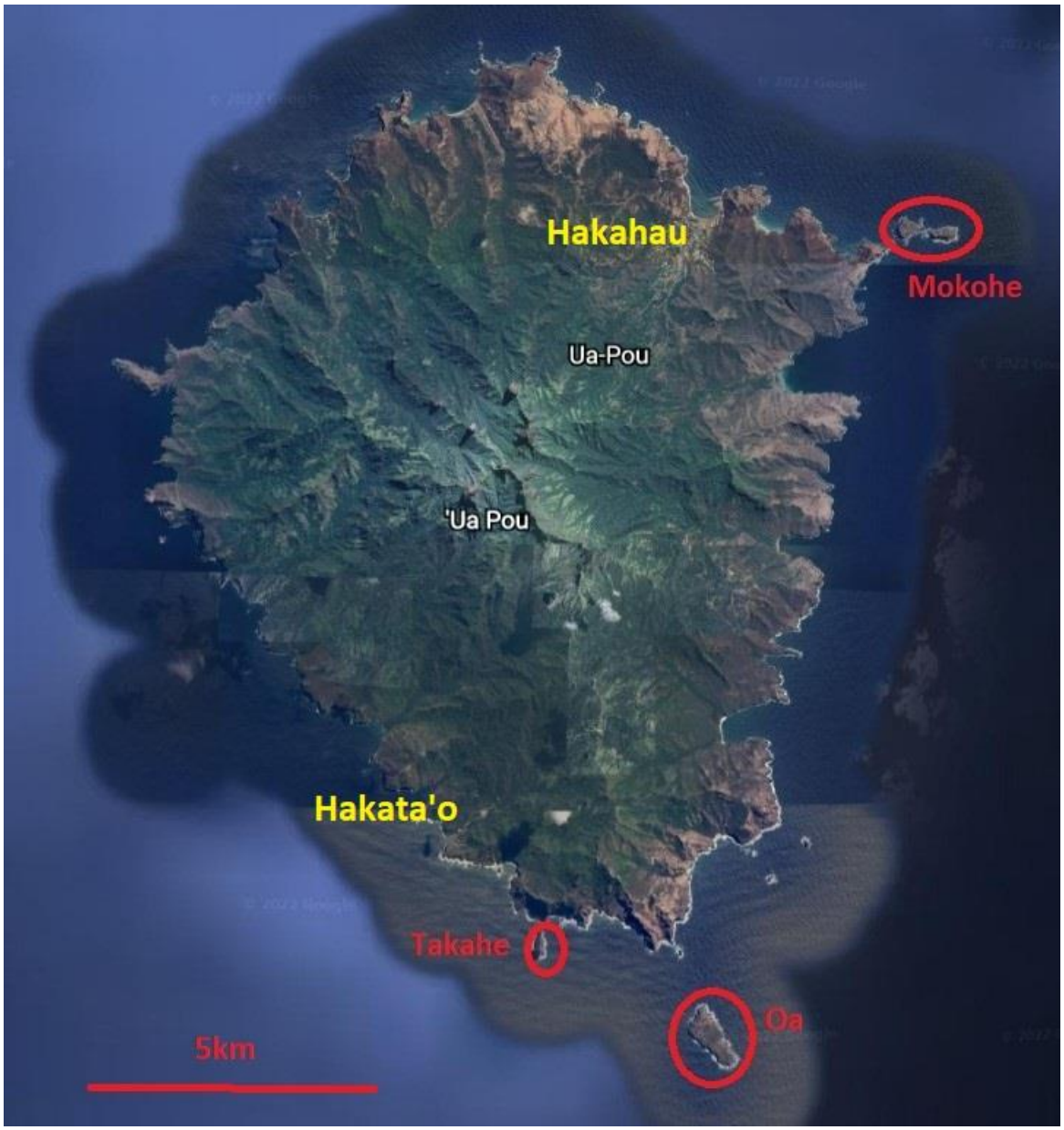
4.1 LOCATION

Motu Mokohae, Motu Takahe, & Motu Oa, at Ua Pou (Marquesas), French Polynesia, are three small islands close to the southern coast of Ua Pou in the Marquesas, northern French Polynesia. Ua Pou ([*French*: Ua Pou, *North Marquesan*: 'uapou], 10,560ha, 9°24'S, 140°04' W), some 1500km NE of Tahiti, is the third largest of the Marquesas Islands, northern French Polynesia. The island is the remnant of previous volcanic activity with several volcanic plugs forming the central highlands, ringed by steep ridges radiating down to the sea (Fig. 1).

The island has about 2000 inhabitants, mainly living at the two towns, the principal township of Hakahau on the northeast side of the island, and Hakata'o on the southwest coast, linked by a gravel road. There is a regular air link to Tahiti and a mixed sea freight/cruise ship service provided by the *Aranui 5*, stopping at Hakahau. The local economy is based on fishing, copra, tourism and crafts.

The target islets are owned by the Government of French Polynesia. They are 'managed' by local authorities on Ua Pou. The Ministry of the Environment, the DIREN (Direction de l'environnement) and the Tavana Hau (Polynesia government delegate) have authority on the islands, but the SDR (Service du Development Durable) and mayor can also grant access to the islets. A person who wishes to visit the islands must have a signed authorisation from the organisations and/or persons above before landing. There is a need to determine which entity has overarching authority. However, there is no organisation or capacity to prevent illegal landings and not everyone requests permission, hence locals and tourists have ready access to the islets.

Figure 1. Aerial Photo of Ua Pou showing the location of the three islets (red) and adjacent townships (yellow).



4.2 THE TARGET ISLANDS

The three target islands; Motu Mokohae, Motu Takahe, & Motu Oa, are the largest of the Ua Pou islets and lie off the east coast (Motu Mokohae) and southern extremity of the island (Motu Takahe, & Motu Oa). All are steep, with cliffs of varying extent, and maximum altitudes ranging from 100-229m (Figs. 2 – 4).

The islands are uninhabited but Takahe and Oa have been visited for harvesting of sooty tern eggs, which still occurs on Oa by the inhabitants of the nearby township of Hakata'o. The islands are generally rocky with grassland and patches of low shrubland present.

Landing on the islands can only be done on calm days but access to the uplands is difficult on Oa, and particularly so on Takahe, where most of the island is inaccessible due to the encircling cliffs.

Motu Oa lies further south from Motu Takahe. It is a low plateau with intact native vegetation and a population of sooty terns that may attain several tens of thousands. A visit in October 2009 recorded high population densities of Pacific rats, but few were seen on a visit in 2017.

Motu Mokohe lies close to the eastern extremity of Ua Pou, about three kilometres east of the main township of Hakahau and 60m offshore (Figure 3, Table 1). It comprises two main islands joined by a low isthmus, covered at high tide. Visits in October 2009 and October 2021 recorded high population densities of Pacific rats. Access to the island is by boat from the nearby town, Hakahau.

Motu Takahe is located very close to the southern point of Ua Pou. Geologically it is composed of remnant lava fields protected by a volcanic plug to seaward, forming a very distinctive profile (Fig. 3). They are managed by the Ua Pou council. Access to the island, and Motu Oa, is by a short boat trip (~4.5km) from the nearby village of Hakata'o.

Table 1. Ua Pou and the target islands; their order of priority (1-3), their distance offshore, size, and Pacific rat/ship rat/cat/goat presence.

Island	Distance offshore (m)	Area (ha) [planar]	Pacific rats present (2021)	Ship rats present	Goats present (2019)	Cats present
Ua Pou	-	10,560	✓	✓	✓	✓
Motu Oa [1]	**1,060**	**30.8**	✓			
Motu Mokohe[2]	**60**	**14.6**	✓			
Motu Takahe [3]	**30**	**4.6**	✓			

Figure 2. Motu Mokohe, showing proximity to Ua Pou

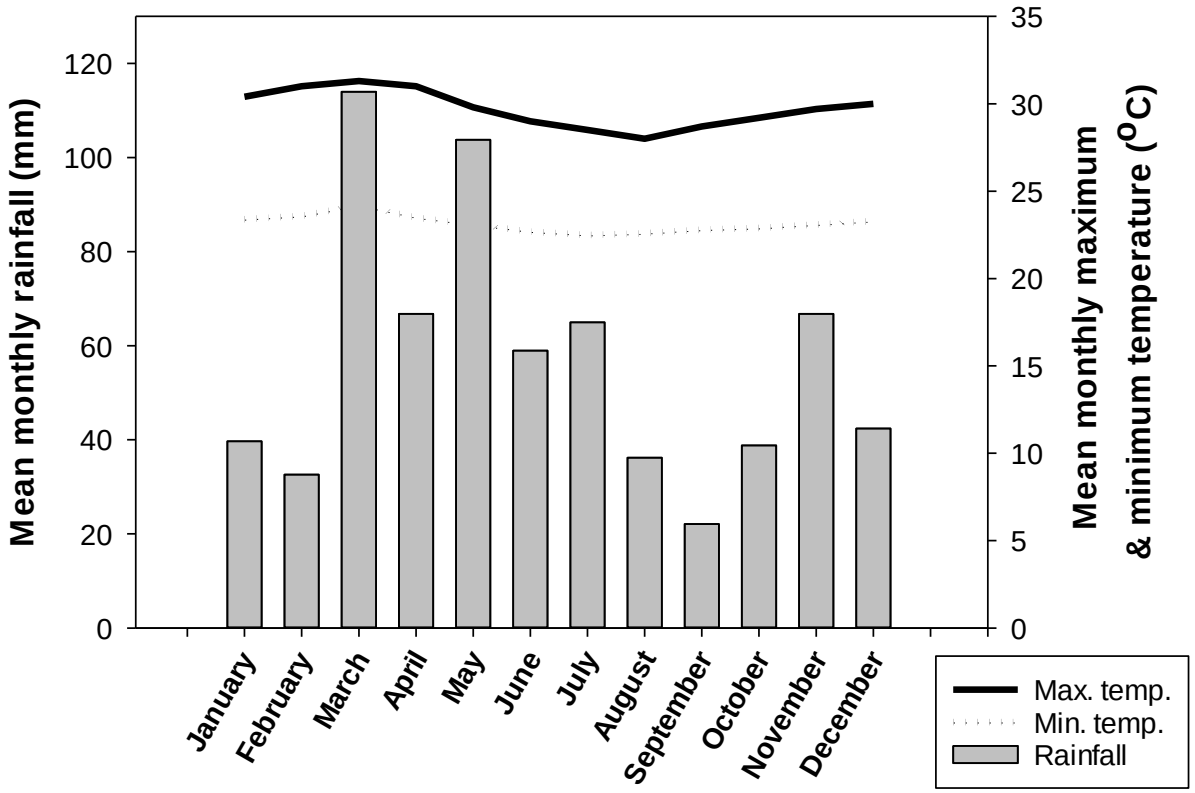
Figure 3. Motu Takahe

Figure 4. Motu Oa

4.3 CLIMATE

The climate is mesic tropical (Huebert & Allen 2016) with an average annual rainfall of about 685 mm recorded at the coast and a distinct wet season from March to July (Fig 5). The mean annual temperature hovers around 26-27°C. Moderate to fresh northeasterly winds persist year round. Whereas the coastal areas of Ua Pou are relatively dry the easterly winds lead to orographic cloud regularly forming on the Ua Pou highlands, which maintains a small montane cloud forest.

Figure 5. Climate of Ua Pou.



5. IMPLEMENTATION PLAN OVERVIEW

The rat eradication would involve the delivery of a grain-based bait containing an anticoagulant poison (brodifacoum) into every potential rat territory on each island as this is the most proven poison and in accordance with best practice worldwide (Broome et al. 2017, Keitt et al. 2015). The operation will be carried out using aerial application from a spreader bucket attached to a drone operating from a purpose-built platform constructed on a ferry, based at the nearby island of Nuku Hiva.. Two bait applications on each islet will be necessary, which will occur at least seven days apart. A drone company (Envico Technologies Ltd, New Zealand) is contracted to undertake the drone operation and bait application.

The islands that are targeted for bait application are listed in Table 1. The highest priority is Motu Oa as it has the most diverse population of seabirds and is the least likely to be re-invaded by rats. However, the initial aim is to trial techniques and procedures prior to applying bait on the highest priority island. Therefore, the smallest and closest islet to Ua Pou, Motu Takahe, will be undertaken first, followed by Motu Oa, as it is nearby. Motu Takahe is in close proximity to Motu Oa with the least number of seabird species present.

Motu Mokohae will be done last as it is further from the other islets.

At the recommended time of year for the eradication (September) the prevailing weather during the operation is likely to be dry, with a mean monthly rainfall of 22mm. The wind strength is fairly constant year-round at ~11-21kt, with a generally low swell.

The first stage of field operations would involve transporting the bait from Tahiti to Ua Pou via the regular (12-day turnaround) shipping link on the *Aranui 5* in late July/early August, prior to the operation. Drones can either be flown with field staff or can be shipped on the Aranui 5 along with the bait. Staff will travel on the regular air link from Tahiti, French Polynesia, to Ua Pou via Nuku Hiva, or alternatively fly to Nuku Hiva and take the interisland ferry to Ua Pou.

Transport on the island to the islands on the eastern and south coasts will be on the contracted ferry.. Two bait applications from the bespoke platform constructed on the stern of the ferry will be undertaken, preferably with a three-night fine weather window following each application. Motu's Oa and Takahe, on the south coast, will be attempted first as they are close to each other and Motu Oa is the highest priority site, followed by Motu Mokohe. The second bait application will occur at least seven days after the first on all the islands. At the end of the operation all the equipment will be packed down. The team, and drones, will return to their home base by flying via Nuku Hiva and Tahiti. The expected departure date from Tahiti is ~21 August, with an expected duration of ~14-21 days at Ua Pou.

The current scheduled sequence of eradication is as follows, but these details may be adjusted if required due to weather or other circumstances.

Day 1-2. Fly operational team to Hakahau, Ua Pou via Nuku Hiva ex Papeete (daily).

Day 3. Meetings with locals to outline the project.

Day 4. (weather permitting) Ferry to Motu Oa / Motu Takahe. Undertake 1st bait application.

Day 5. (weather permitting) Apply 1st bait-drop on Motu Mokohe from ferry.

Day 6-11. Stand-down period between bait applications.

Day ~12 (weather permitting) Apply 2nd bait-drop on Motu Oa & Takahe from ferry.

. Day 13 (weather permitting). Second bait application on Motu Mokohe from ferry.

Day 14.-Pack down all the gear. Have meetings with locals about completion of the project.

Day 15-16. Fly to Tahiti via Nuku Hiva.

For wet weather, an additional 10% of total days on site should be budgeted for, equating to another 2 days, or ~18 days transit and operational time in total. The current planning suggests the likely return date to Tahiti will be ~5 September.

6. MANAGEMENT APPROACH

Societe d'Ornithologie de Polynesie – Manu (SOP-Manu) are working in partnership with Birdlife International to manage the operation.

Overall project management will be by the Project Manager (PM). Their roles include; management of the project managers, budget oversight, delegation of operational tasks, oversight of the logistics, external communication with media, stakeholder engagement and assessment of operational success 18-24 months post-operation. The operational structure and roles for the field operation are listed in Table 2 and shown in Figure 8.

BRS will facilitate review of the Operational Plan by external reviewers. The PM will facilitate a project readiness check by external reviewers.

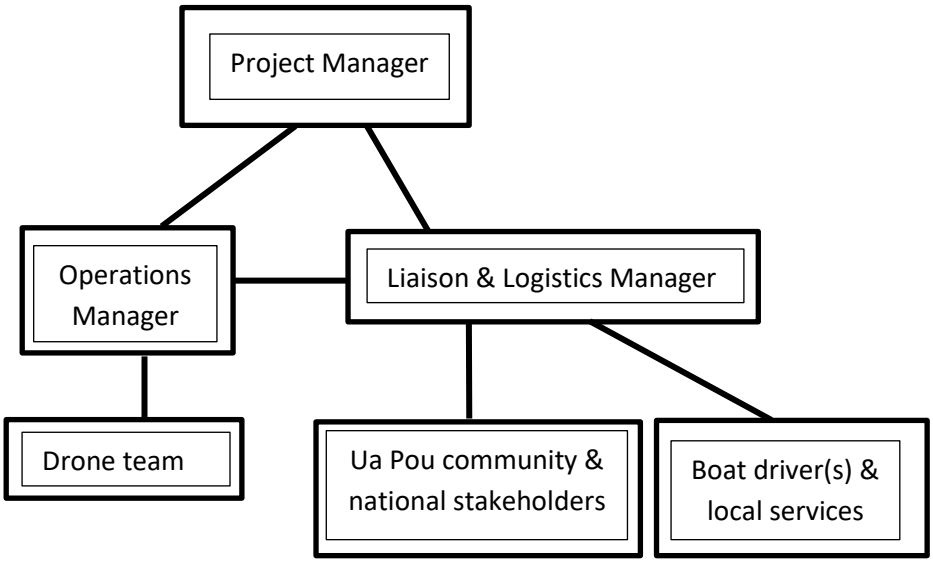
6.1 FIELD TEAM & REPONSIBILITIES

Table 2. Field team roles

Position	Key roles	Person(s) Assigned	Language
Operations Manager (OM)	Execution of Operational Plan Manage bait order Assist with of transit of gear, bait and team to/from Ua Pou. Assist with baiting process Decisions on flying for baiting in consultation with drone team Health and safety management Report to PM on progress during operation Report on operational outcomes	(TBA)	English
Liaison & Logistics Manager (LLM)	Maintain liaison between operational team, the Ua Pou community and boat drivers before and during operation Manage logistics of transit of gear, bait and team to/from Ua Pou Ensure required supplies, accommodation and support (e.g. barge) are ready for the operation well prior to departure for Ua Pou Biosecurity management Provide support for operation in regard to consents/permissions. Organise storage for toxic bait and equipment en route and at Ua Pou	(TBA)	English/French
Drone team	Undertake pre-operation checks – bait calibration and drone field checks	(TBA)	English

	Check all drones and associated equipment and software is secured, ready and fit for purpose before departure to French Polynesia Assist with loading/unloading gear and bait to/from Ua Pou Undertake mapping of target islands prior to aerial baiting Establish repeaters and test to ensure they are working prior to aerial baiting Liaise with OM regarding weather for baiting Undertake aerial baiting of target islands at Ua Pou		
Boat driver(s)	Transport team and equipment (repeaters) to/from island. Provide boat services around target islands during baiting operations	(TBA)	French

Figure 8. Operational management structure



6.2 OFF-SITE SUPPORT

Societe d Ornithologie de Polynesie – Manu (SOP-Manu) are working in partnership with Birdlife International. SOP-Manu are in direct contact with Ua Pou community and are leading the consultation process with the local Council. SOP-Manu are providing the liaison & logistics manager for the eradication team on Ua Pou and will work alongside the Operations Manager. The Ua Pou communities at Hakata'o and Hakahau will provide the permission process for island access and eradication operation.

6.3 EXTERNAL OVERSIGHT

It is recommended this plan has an independent peer review by an external organisation with rodent eradication experience. The Island Eradication Advisory Group (DOC, NZ) or Island Conservation have this experience and should be approached to undertake the review.

6.4 WEATHER FORECASTING

SOP-Manu will source and contract a supplier for weather forecasting services. They will need to provide 72hr forecasts for expected rainfall and 48 hrs for wind and swell conditions.

6.5 MEDIA CONTROLLER

SOP-Manu and Birdlife International will provide press releases and manage media enquiries about the operation.

6.6 GENETIC SAMPLING

SOP Manu staff trapped and confirmed that Pacific rats were present on Motu Oa and Motu Mokohe in late 2021 and retained genetic samples (tail tips), held at Papeete.

6.7 REGULATORY COMPLIANCE

6.7.1 Drone Operation

Drones will require authorisation to be imported and operated within French Polynesia. This has been sought and received for a previous operations and has been secured with the local authorities (Appendix 6). Operating a drone in French Polynesia needs to follow European regulations. The time to secure authorization from application (to the DSAC) takes about 3 months for an operator from a non-UE country.

6.7.2 Bait importation and aerial application

The rodent bait, Pestoff 20R, has been imported into French Polynesia before and the procedures are now well established.

There is national approval for aerial rodent bait application (and associated conditions) and it has been conducted previously on several French Polynesian islands. Local approval for aerial bait application on the islets has been secured from the Ua Pou mayor.

6.8 BAIT ORDERING AND TRANSPORT

Physical or biological damage to the bait before application will seriously compromise the success of the eradication. Precautions will need to be undertaken to ensure the bait arrives in optimum condition for the operation.

Bait

A cereal grain pellet containing the poison brodifacoum will be used for the operation. This poison is the most common 2nd generation anticoagulant used for rat eradications worldwide. Pestoff 20R [Orillion, NZ] has been selected. This bait has been successfully used on several hundred rodent eradications worldwide. Monitoring of baits during trials on Aldabra Atoll (Seychelles) showed that Pestoff 20R baits were largely unaffected after 16mm of rain, so just about any rainfall expected at Ua Pou in September should not adversely affect it. An assessment of the risk to native species on the islets from bait regards it as

minimal at a population level (Harper 2021). Baits will be 2gm pollard (compacted crushed grain) bait with 0.02gm/kg of brodifacoum added.

The baits are dyed green with no other additives. The bait will be packaged in 25 kg multi-layer bags, which will protect it from moisture during transport and storage. All bags will be stamped with a unique identification code referenced by a batch process number. This will be manufactured shortly before the operation and delivered to the departure port (Papeete), plastic wrapped on pallets. The bait will be tested at various stages after the manufacture to ensure it is in optimal conditions for the operation.

Bait order

Pestoff 20R™ was ordered from Orillion (NZ) in March for delivery to Papeete in late July

A. New Zealand to Papeete

Orillion will organise the transport from NZ to Tahiti. Bait will be packaged in 25kg bulk bags, sealed with a plastic liner and packed onto a standard 1.2 x 1m pallet. The pallet load will be plastic wrapped to keep it dry and free of pests. The pallets will need to be stored in containers for travel to Papeete, and then on top of cargo or when it does not have loads stored on them as any loads will crush the bait. The numbers of pallets = 5 (about 15 bags per pallet).

The bait will need to be shipped to Papeete for arrival by 20 July in order for it to be on the ship to Ua Pou with enough time before the arrival of the baiting crew on ~21 August. The bait will be transferred from the container to secure storage at Tahiti (at location to be determined) for eventual transfer to the *Aranui 5* for passage to Ua Pou in late July/early August. This is the responsibility of SOP-Manu via LLM. Transport of the bait will need to be in a cool and dry hold, with minimal temperature fluctuations, and be secure from animal or invertebrate damage until arrival.

At Ua Pou the bait will need to be stored under cover – in a secure shed or warehouse, where it will be dry and secure from weather, rodents and insects. This is the responsibility of SOP-Manu via LLM and will need to be secured by May.

Bait purchase: amount required

The total amount of bait required is 2500kg. Bait calculations given below (Table 3) are estimates based on current practices in New Zealand (Broome et al. 2017).

The bait applications on the islands are calculated with the bait bucket set at 6kg/ha with 50% overlap for 12 kg/ha on the ground for both bait applications. The total nominal bait application for the combined bait drops is 24kg/ha.

The coastal boundary distance and total area of each island has been calculated through digitisation of the islands using images from Google Earth. These distances will be re-confirmed by mapping drone shortly after arrival on the island.

Bait redundancy is conservative. This is due to estimated height and number of a few internal cliffs which will require an additional bait application for one flight altitude. Moreover, there are some steep slopes of the islands, which increases the 3-D area of the islands above the planar area recorded from an aerial photo. Additional contingency bait will be required to mitigate this risk and any loss due to crushing or water damage. If the total bait amount is applied it will result in an overall bait application rate of 40.6kg per planar hectare.

Table 3. Bait calculations for the three target islands.

Motu	Oa (37.8ha)		
Area covered	Calculation	Weight bait (kg)	Number of flights
1st drop @ 6kg/ha with swaths 50m apart (50% overlap). Effective rate 12kg/ha.	37.8ha x 12kg	454	
1st Coastal swath 50m wide with deflector bucket (0.5 x 50m) 3000m external coast perimeter. 3000 x 25m = 7.5ha.	7.5ha x 12kg	90	
2nd drop @ 6kg/ha with swaths 50m apart (50% overlap). Effective rate 12kg/ha.	37.8ha x 12kg	454	
2nd Coastal swath 50m wide with deflector bucket (0.5 x 50m) 3000m external coast perimeter. 3000 x 25m = 7.5ha.	7.5ha x 12kg	90	
Total for first bait application		544	54
Total for 2nd bait application.		544	54
Total for Motu Oa		1088	108
Motu	Mokohe (17.9ha)		
1st drop @ 6kg/ha with swaths 50m apart (50% overlap). Effective rate 12kg/ha.	17.9 x 12kg	215	
1st Coastal swath 50m wide with deflector bucket (0.5 x 50m) 5450m external coast perimeter. 5450 x 25m = 13.65ha.	13.65ha x 12kg	164	

2nd drop @ 6kg/ha with swaths 50m apart (50% overlap). Effective rate 12kg/ha.	17.9 x 12kg	215	
2nd Coastal swath 50m wide with deflector bucket (0.5 x 50m) 5450m external coast perimeter. 5450 x 25m = 13.65ha.	13.65ha x 12kg	164	
Total for 1st bait application		379	38
Total for 2nd bait application.		379	38
Total for Motu Mokohe		758	76
Motu	Takahe (5.9ha)		
1st drop @ 6kg/ha with swaths 50m apart (50% overlap). Effective rate 12kg/ha.	5.9ha x 12kg	71	
1st Coastal swath 50m wide with deflector bucket (0.5 x 50m) 1150m external coast perimeter. 1150 x 25m = 2.9ha.	2.9ha x 12kg	35	
2nd drop @ 6kg/ha with swaths 50m apart (50% overlap). Effective rate 12kg/ha.	5.9ha x 12kg	71	
2nd Coastal swath 50m wide with deflector bucket (0.5 x 50m) 1150m external coast perimeter. 1150 x 25m = 2.9ha.	2.9ha x 12kg	35	
Additional internal cliff 1st and 2nd bait applications at 12kg/ha Internal distance: 230m. 230 x 12 x 2 = 0.6ha	0.6ha x 12kg	2 x 3.5	
Total for 1st bait application		110	11
Total for 2nd bait application.		110	11
Total for Motu Takahe		220	22
Subtotal: bait for all islets - both drops combined		2066	207
20% contingency		413	41
Total Bait (rounded)		**2500**	**248**

C. Batteries, transport, storage and charging

6S LiPo Batteries (20,000 – 24,000Mah) are used to power the 25kg drones carrying a 10Kg payload. Twenty-eight (28) batteries and three charging stations will be transported by the Aranui 5 in August before the operation. During the bait application batteries can be charged on the ferry and later on land. At least 3x adaptors are needed for the European plugs in French Polynesia..

6.9 HEALTH AND SAFETY

Of critical concern will be staff health and safety. Although Ua Pou is isolated it has an airfield, with facilities for medivacs to Nuku Hiva for onward flights to Tahiti for serious medical emergencies. There is a medical team on the island at all times.

A comprehensive Health and Safety Plan will be developed and reviewed well before departure. It will be approved by the Programme Manager well prior to departure. This will need to be read by all team members. The Operations Manager will double as the Health and Safety Officer. All team members should feel empowered to speak up about possible safety issues at any time, including team meetings. Appropriate corrective action should be seen to be taken where required.

The Safety Plan must detail all significant hazards that could cause serious harm. This will be the responsibility of the OM. The drone crew involved with the bait loading will be very familiar with drone operations. Operating the drones hold potential risks which need to be minimised, which is mainly related to rotor strike and bait handling. The bait loading procedure will be practised before the operation commences to ensure the crew are familiar with the procedure and know what is required of them. It is expected that bait loading will be conducted with the motor turned off. Another good practice for reducing the risk is to allow enough breaks for the crew to be well rested as tiredness can lead to accidents.

The likely risks and required mitigation is outlined in Table 4.

Table 4. Risks and mitigation actions for the Ua Pou rodent eradication operation

Activity	**Risks**	**Mitigation**
Drone battery changes & bait re-loading	Rotor-strike, Fire Bait spillage	All bait loading and re-fuelling carried out by drone staff or staff trained by the drone company Drone shut down for battery changing and re-loading Staff wearing appropriate PPE Extinguisher available during operation Set out tarpaulin at drone landing pad to catch any spilled bait
Drone operation	Rotor strike Bait spillage Drone crash on transit Bait malfunction	Cordon off operational area Retrieval of spilt bait on ferry

Ferry operation	Boat travel	Check forecast and assess sea conditions before attempting boat transit – try for calm conditions. Wear life jackets on boat and during landings and departure Take spare paddles/oars Wear suitable clothing for wet and/or windy transits to island Distress flares taken on boat Inform island authorities of boat trip
Toxic rodent bait	Poisoning	Use appropriate PPE Brief staff on bait loading procedures and precautions Brief staff on brodifacoum and minimising poisoning risk The MSDS for Pestoff 20R is available at the loading site

		Place toxic bait warning signs at the loading sites and on the three islets
Bait damage	Poor handling, rain or insect/rodent damage	Bait needs to be secured in multi-layer bags, shrink wrapped in plastic, on pallets. Bait pallets needs to be handled carefully and have no loads stacked on them. Prior to the operation rodent bait needs to be stored/transported in dry conditions with no pest animal/insects present.

6.10 TRAINING

The drone company contracted to undertake the drone operation will, where required, train any associated staff in the safe use of drones, battery changing and bait filling.

6.11 EQUIPMENT

Aerial baiting equipment will be brought to operational site at Ua Pou by the contracted drone company.

This will consist of;

- 2x battery multi-copter drones for baiting (1x primary and 1x as back-up/spares unit).
- 2x Full swath and directional swath spreader systems, fully calibrated.
- 2x mapping drones, 1x primary and 1x back-up.
-
- Auxiliary equipment
- Tools
- PPE- respirators and glasses.
-3 x battery chargers
-

Additional gear to be provided by Birdlife/SOP-Manu:

- PPE- Coveralls, gloves, and face masks

- Wash-down gear including a tarpaulin, and water supply
- Boat(s) – locally supplied (for establishment bait loading/drone control)

6.11.1 Equipment breakdown

A back-up baiting drone and mapping drone will be brought to Ua Pou, along with additional spares in case of breakdown. A list of critical spares will be provided by the contracted drone company by the end of June.

6.11.2 Spreader bucket calibration

Every bait type operates differently out of spreader buckets and different spreader buckets also spread bait at different rates. Therefore calibration trials run are essential to fine tune the spreader aperture and drone speed to ensure the correct application rate. This needs to be tested on a level open area before departure to Tahiti, using the same equipment and bait for the operation. A suitable site near the contracted drone company's location will be used for this purpose, and this will need to be cleared with the local authorities.

The contracted drone company will calibrate all equipment for appropriate application rates and the effective swath width for both full and deflector bucket swathes. The calibration will be carried out several months prior to departure (April-May; see Task Schedule, Section 11). This can also be the field test of the inter-operability of the drone, repeaters, and spreader bucket. There will be an additional trial run on Ua Pou before the operation, in case of knocks or damage in transit. This will use a single 20kg bag of non-toxic bait on a mown paddock at Hakata'o.

The contracted drone company will receive 5 x 25kg bag of Pestoff 20R bait in early April 2021 to carry out the calibration planned for the April – May 2022.

Fixing position of islands

During a reconnaissance trip prior to the aerial baiting a mapping drone was used to fix the location, outlines and slopes of the islands. This will be used to generate the 3-D map of the islets to overlay with the flight-lines for the operation.

7. IMPLEMENTATION STAGE 2: FIELD OPERATIONS

The field operation comprises three stages,

1. Positioning and trial run
2. Bait delivery
3. Aerial baiting commencement
4. Completion

7.1 OPERATION ESTABLISHMENT AND TRIAL RUN

7.1.1 Positioning

Positioning will involve the establishment of the baiting team, and drones on the ferry offshore from the three islets in order that the drone operator has control during all of the operational flights.

Flights to Tahiti

One member of the drone crew will need to arrive 2-3 days before the rest of the the operational crew to ensure the equipment is present in French Polynesia before the rest of the crew (OM + 2 drone staff). The remainder of the crew will need to fly to Tahiti with at least 24hrs to spare before flying domestically to Ua Pou. Flights from NZ generally arrive in late evening or very early morning (~0100hrs). Flights to Nuku Hiva/Ua Pou depart in the early morning (~0600hrs).

Travel to Ua Pou via Nuku Hiva

The operational crew (OM / LLM /3 x drone staff) will fly to Nuku Hiva. Air Tahiti fly to Nuku Hiva daily, using ATR 72 aircraft. These flights will be used to connect with either a ferry, or local internal flight, to Ua Pou. The Nuku Hiva flight should be planned to connect with the ferry/internal flight with a minimum of down-time (i.e. fly to Nuku Hiva preferably the day of, or day before, the planned transit to Ua Pou).

Transporting bait to Ua Pou

The bait will need to travel to Ua Pou before the arrival of the operational crew. The bait will preferably need to depart on the *Aranui 5* from Tahiti on the voyage before the operational crew (i.e. August). The bait will need to be stored at Tahiti and Ua Pou in a secure and dry site, preferably a warehouse or similar, and removed from items that may contaminate it, such as fuel, and away from possible attack by insects or rodents. This location needs to be determined by April. The integrity of the bait and coverings needs to be checked regularly to ensure the bait arrives in optimal condition.

Drone transport to Ua Pou

The drones and associated equipment is expected to travel in six cargo cases with a total weight of ~ 300 kg ($2m^3$). All the equipment will be IATA approved for air travel. The exact weight and dimensions of each piece has been checked with Air Tahiti and been confirmed for travel. The method of transport will has been confirmed with the airline and drone company by May 2022.

The drones and bait will need transportation with adequate protection from weather and sea spray during transit to/from Nuku Hiva to Ua Pou if they need to travel by the local ferry

between the islands. It is expected they will be stored in the hold or in the cabins, along with other valuable cargo, rather than on the deck of the ferry.

Transport on Ua Pou

4WD utility vehicles are available for hire at Ua Pou. At least one vehicle will need to be hired for the duration of the operation for transport to the wharf at Hakahau.

7.1.2 Accommodation

COVID-19 requirements at the time or writing are that persons arriving in Tahiti need to be ***fully vaccinated*** resident and non-resident travellers aged 12 years and over, without needing to justify the reason for travel or complete mandatory quarantine, ***provided*** they have stayed continuously at least 15-days on the French Territory or a designated Green or Orange or Red Zone country (New Zealand as at February 2022) before their departure to French Polynesia. As an additional precaution for Ua Pou, all staff will be vaccinated before departure to expedite the operation timing.

Staff travelling from NZ will require accommodation in Papetee and Ua Pou, Accommodation at both locations will need to be booked by June/July prior to arrival.

Ua Pou locals assisting with the operation will stay at their home residents until required.

7.1.3 Communication

VHF radios will be required for communication for the team while undertaking baiting from the ferry. SOP Manu has radios available on the island. For communication with the outside world internet is available on Ua Pou, and a SOP-Manu will be bringing a Satphone. It is essential that this works and charged batteries or a way of charging them is available. An EPIRB should also be available, which BRS and the drone companies have got.

7.1.4 Establishment of drone and operation infrastructure

The target islands will initially be mapped by a mapping drone to provide maps for accurate bait application and log the coastal boundaries.
The bait application drones will be given a trial run(s) to ensure they are working properly after transport to the island, this will include a trial flight. Control of the drones will be line-of-sight from the ferry and constant contact with the drone is required when undertaking bait application. This will also ensure effective flight management, and quality control of the bait application via video monitoring of the bait flow.

The small Nuku Hiva ferry (*Te Ata O Hiva* - 19.7m, 37 tonnes laden [Figure 9]) has been secured to operate the drones from. An purpose-built drone platform (6.5m x 4m) will be secured to the open stern. Each bait application operation for each island operation will operate from this ferry and will have power for charging the laptops and drone batteries(Figs. 10a & 10b).

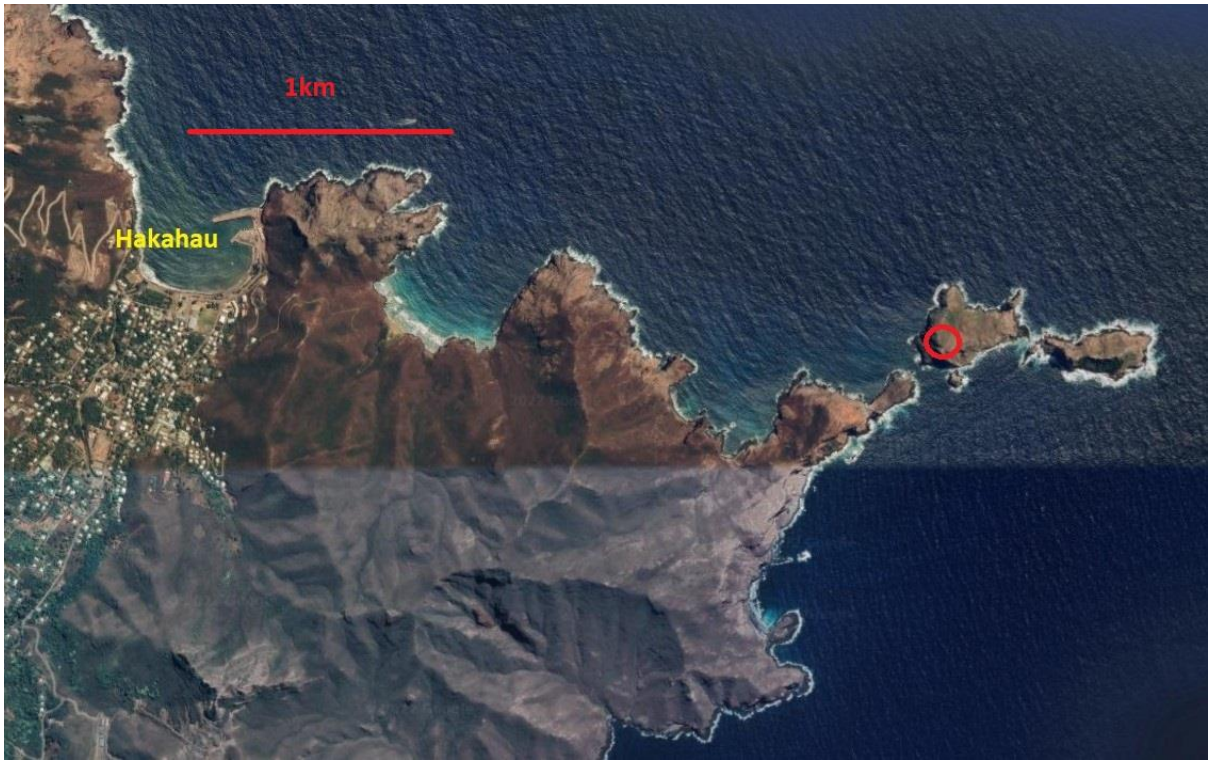
Figure 9 – Nuku Hiva Ferry

The distance between Hakahau and Motu Oa is 21km (12NM). At 18kts (33km/hr) it should take about 45 minutes hrs to travel between to Motu Oa.

The ferry will need to have platform flush with the gunwales of at least 4m X 4m to allow for drone operation.

Figures 10a & 10b. Location of towns and locations of the islets (red circles) Hakata'o & Motu Oa and Motu Takahe (10a), and Hakahe & Motu Mokohe (10b).


Hakata'o
1km


1km
Hakahau

7.1.5 Weather conditions

It is essential for bait to be present on the ground in good quality condition and bait application should not occur at any stage during the operation unless the forecast is suitable.

It appears unlikely that extended adverse weather conditions will affect the operation as fog, low cloud or prolonged periods of heavy rain are highly unlikely. Similarly, wind conditions are unlikely to regularly exceed 20 knots and inhibit flying and payload weight, or the use of a ferry. However, some additional time has been allowed for in case of unseasonal poor weather, particularly heavy showers or high wind.

Bait will be dropped on all suitable days or portions of suitable days. Bait integrity will not be compromised with up to 15mm of rain, so baiting should proceed unless more than this is forecast over the following 72hrs (3 nights). In order to obtain accurate and timely forecasts a suitable supplier/website will be sourced well prior to departure, such as *Windy.com*, and/or *METVUW*. Combined reference to more than one website will provide a better measure of the likely weather conditions as they use different models for their synoptic mapping.

Requirements:

- Operational and logistical details confirmed with the contracted drone company.

- Forecasts secured with Meteo France Polynesie Francaise

(i.e. evening prior to operations)

7.1.6 Trial run

The drones and repeaters should be used for a dry run a day or two before the bait application operation begins with several empty sweeps with the spreader bucket. This would check the operation of the drones and repeaters operating from a ferry in addition to the bait loading arrangements on the barge.

7.2. AERIAL BAITING COMMENCEMENT

7.2.1 Pre-operation

A Go/No Go list for commencement of baiting is listed below.

Required conditions for operation start:

1. Forecast wind is ≤10kts (5m/sec or 18.5km/hr)

2. Forecast rainfall is ≤15mm for following 3 days

3. Actual wind is ≤10 kts at 0630

4. Forecast sea conditions are ≤ 0.5m swell for day

5. Actual sea conditions are ≤ 0.5m swell at 0630

6. Initial morning test flight (0700) shows all systems working
   - Drone operation
   - bait dispenser
   - on-board camera
   - deflector

Sunrise and sunset on Ua Pou in September will be at about 0600hrs-1745hrs, providing ~12 hours of daylight. It is expected that operations will commence by at least 0700hrs to make of the most of available daylight and suitable weather on flying days.

The team will need to take the ferry, operated by local skippers, to a location on the back side of the first target island for the day. The baiting operations cannot occur without suitable weather.

During the operation, the main pilot will have visual checks from the on-board camera system which will provide assurance that bait bridging or blockages have not occurred. It will also provide an additional safety check of the drone's flight path.

The main pilot will have the drone in sight at all times when the drone is applying bait either over the top of the islands or on cliff faces, so the ferry will need to move regularly to allow this to happen. This will ensure a constant signal to the drone.

Bait coverage will be monitored by analysis of aerial tracks from the drone and through a spreadsheet recording the bait used and area covered at the end of each bait application flight. Checks on bait coverage and flight tracks will occur after each flight. This is the responsibility of the OM + GIS technician.

7.2.2 Application priorities

Motu Oa is the highest priority island, followed by Motu Mokohae. However with Motu Takahe and Motu Oa being close to each other it would be opportune to trial the operational procedures on Motu Takahe first to ensure all parts of the bait application operation are working correctly, before proceeding to apply bait on Motu Oa, followed later by Motu Mokohae

7.2.3 Aerial baiting application quality control

After the bait application on each island, the flight data will be checked to ensure there are no gaps in bait coverage. The maximum gap between flight lines will be 1m. If any gaps are highlighted, another flight will be conducted on the same day to fill the gap. If boat access is safe and possible, quality control of the bait application at the islands should be undertaken on the same day.

Any bait applied on coastal tracks should have a deflector attached to reduce the amount of bait falling in the sea.

7.2.4 Operation finish

After the final bait application the equipment will be disassembled and packed away for transport. The ferry will be cleaned and returned to its pre-operation state. Team accommodation will be cleared and cleaned.

7.2.5 Return to Tahiti / NZ

The return to Papeete (and NZ for a number of the operational crew) will be via scheduled domestic travel providers (airlines/ferry) from Nuku Hiva, via Papeete.

The OM and drone crew will fly to NZ ex Papeete. Flights to NZ generally leave in late evening or very early morning.

7.3 IMPLEMENTATION STAGE: 3. POST OPERATION

7.3.1 Debrief

Reporting

A written report on the drone operation will be provided by the drone company at the conclusion of the project. This will include flight path data for operational review.

A summary report will be written by the OM, in consultation with the LLM, PM and SOP-Manu.

Aerial imagery and maps will be supplied for future use by SOP-Manu and Birdlife International. These will be more accurate than the currently available maps/aerial photos.

It is expected that a peer-reviewed paper on the operation will be produced, either as a stand-alone paper or in combination with reviews of the other drone operations undertaken in French Polynesia in the same year. As drone eradication operations are in their infancy there will be a number of lessons learnt from these initial undertakings.

7.3.2 Unused bait disposal

It is possible there may be some unused bait at the end of the operation. This should be spread on islands where possible.

7.3.3 Rubbish disposal

Bait bags and linings need to be removed and disposed of as set out in in the MSDS.

7.4 IMPLEMENTATION STAGE: MONITORING

A return visit should be undertaken at least 1-2 years post-operation. A suite of monitoring tools (trail cameras, snap-traps, tracking tunnels, chew cards, chew sticks) should be deployed for at least a week on each of the three islands to detect any possible remaining rodents.

Any positive rodent sign will result in an intensive trapping effort to obtain at least 1-2 rodent carcasses to identify the species present and obtain DNA samples to compare with the pre-operation DNA samples.

Declaration of success

A monitoring check free of rodent sign will be used as the threshold for a declaration of success to stakeholders, funding bodies and the media. As this eradication will be a drone operation, which is a new technique, this factor should be highlighted in any press release.

8. RISKS AND MITIGATION ACTIONS

The Ua Pou islets rodent eradication operation will be a challenging undertaking, incorporating a relatively untested technique at a relatively isolated location.

Operationally, although the total bait amount for the Ua Pou islets operation is quite small, the use of the ferry adds technical risk to drone operation. The other risks to the operation are listed below (Table 4).

Table 4. Operational risks and mitigation for the Ua Pou islets rat eradication operation

Critical risk	Mitigation	Responsible
Suitable platform (ferry) to operate from.	Critical to the success of the operation. Secure a barge as soon as possible	PM/OM/LLM

Delay in arrival due to adverse weather Delay in arrival associated with COVID restrictions on travel resulting in extended down-time for operational staff	Have 10 days on total between bait application with three days being contingency. Attention to reducing unnecessary delays in prior rodent eradication operations –through careful consideration of likely COVID restrictions, and realistic operational timeframes – add additional contingency days if they are likely to be required by August/September.	PM/OM PM/OM
Reinvasion by Pacific or ship rats	Improved biosecurity for any local boat leaving Ua Pou for the islets and a ban on overnight landings Note that the risk of reinvasion as Motu Mokohe and Takahe are within swimming distance from Ua Pou for ship rats and Pacific rats.	LLM
Invasion by other invasive rats (Norway rats)	Effective biosecurity is in place along the entire logistical chain from Tahiti to Ua Pou and for all boat/ship visits	SOP-Manu
Expansion in weed numbers	Intensive weed control in place by the end of the rat eradication operation with a view to eradication of any problem weed species	SOP-Manu
Logistics	Careful planning and management to ensure all the bait, drones and staff arrive at Ua Pou in time for the eradication and in good condition	OM/LLM
Unproven drone techniques	Have a back-up plan (source a ferry to be available for likely days of bait drops) in place if the 'repeater-control' plan for managing drones is not possible or a drone is damaged/lost.	ELT
Cost overruns	Schedule the transport on/off Ua Pou to reduce any additional down time and travel delays for the drone team.	LLM

Local community acceptance of the eradication and ongoing biosecurity	Enhanced consultation and biosecurity outreach in order to secure the islets and Ua Pou itself.	SOP-Manu

8.1 Non-targets

Invertebrates, including crabs, are not susceptible to brodifacoum poisoning (Pain et al. 2000), so the principal risk is through vertebrates consume poison either directly, or secondarily by eating insects or lizards that have ingested bait. As no land birds are present on the islets this risk is nil, although a few waders species (e.g. turnstone) may be susceptible. Some individuals may succumb to the toxic bait as a result of consuming poison, but their populations will quickly recover after the poison application (Harper 2021).

Few land crabs are expected to be active, and mainly on Motu Oa. Land crabs will eat the bait, but due to their blood physiology they will not be affected by it. The small land crabs on the islets are not eaten by locals so the risk to the community is very small, however there is some risk to Pacific golden plovers and sandpipers from ingesting crabs.

9. BIOSECURITY

9.1 Biosecurity Plan

The LLM, in consultation with the OM, will be responsible for biosecurity.

A biosecurity plan will be drafted to ensure the islands are not reinvaded by rodents due to the actions of humans. Once completed the biosecurity plan will be appended to this plan

9.2 Operational biosecurity

The following biosecurity measures will be implemented to minimise any potential biosecurity risks that could be associated with transporting equipment, supplies, people and their personal belongings for the operation:

A. Tahiti

Bait storage while in transit should be secure from insects and rodents.

B. Tahiti to Ua Pou

The following measures will be undertaken for the trip between Tahiti and Ua Pou:

- All equipment and supplies will be checked to ensure that they are free of insects, plant material and soil. Any contamination will be removed or cleaned before packaging *in sealed rodent and insect proof containers*. If necessary, use duct tape around the lids to seal containers against ants.
- All personnel will visually check all their belongings (including backpacks or other bags), footwear and equipment to ensure that they free of any contamination (e.g. soil, plant material) or infestation (e.g. rats, snails, ants and other insects). Any contamination/infestation will removed or cleaned before packing in tightly zipped bags before departing for Ua Pou.
- Bait bags will be visually checked and any contamination removed before loading on the boat to Ua Pou. The same precautions apply regarding minimising the time the bait is sitting at Hakata'o and ensuring it is stored in a secure building.
-

C. On arrival at Ua Pou

If the above measures are properly applied, the equipment should be free from contaminants on arrival at Ua Pou. However, all goods will be checked while being unloaded, in a sealed and secure room to be used for quarantine checks.

10. RECOMMENDATIONS

The following have been actioned:

1. Permissions secured from Tahiti and Ua Pou officials for the operation to proceed:

   - Permission to use drone on and offshore

   - Apply bait on the islets.

2. Bait supplies ordered for the operation.

3. A suitable boat secured from within French Polynesia, and transport of the boat to Ua Pou.

4. Organise secure platform to be attached to stern of ferry to operate drone operations from.

5. Dry, secure storage secured for the bait at Papeete and Ua Pou (5 pallets).

6. Transport to and from Ua Pou secured for the bait, drones and baiting team.

7. Accommodation and transport on Ua Pou secured for the bait, drones and baiting team.

11. TASK SCHEDULE

Tasks	Responsibility	Complete by	Dependency	Complete (Y/N)
Obtain rat DNA on target islands	OM	Late 2021	Access to islands	Y
First version of Operational Plan	Biodiversity Restoration Specialists (BRS)	February 2022		Y
Secure funding for Eradication Operation	PM/SOP Manu/Birdlife Intl.	By March 2022	Acceptable review of final FS and draft Op. plan	Y
Operation Manager selected	PM/SOP Manu/Birdlife Intl.	By March 2022	Funding secured	Y
Liaison Manager selected	PM/SOP-Manu	By March 2022	Funding secured	Y
Confirm bait amounts. Interim notice of supply to bait manufacturer(s)	PM / OM	By March 2022		Y
Order bait	LLM	Mid-March 2022		Y
Send out tender for drone company	PM	Mid-March 2022		Y
Permission to land, apply bait from Ua Pou Mayor	PM/LLM	End March 2023		Y

Secure ferry for use in September	PM/LLM	End March 2023		Y

Tasks	Responsibility	Complete by	Dependency	Complete (Y/N)
Final Op. plan completed	BRS	30th April 2023		Y
Drone authorisations for use in FP.	Drone company	30th April 2022		Y
Service contracts signed (drones / boat charter)	PM	30th April 2023		Y
Final agreement with key stakeholders	PM/LLM	April 2023		Y
Approval to import and use toxin	PM/LLM	April 2022		Y
Decision to proceed with eradication operation	PM/LLM	April 2023		Y
Bait calibration	Drone company/OM	April-May 2023		Y
Review operation preparation	PM	30 April 2023		Y
Confirm landholder permission for use of sites for drones/bait loading/repeaters	LLM			Not required
Organise boats, flight tickets.	LLM/OM	June 2023		Y

Ua Pou accommodation and vehicles booked	LLM	~1 July 2023		Y
Prepare and make warning signs	LLM	June 2023		Y
Bait arrival in Tahiti	LLM	~15 July 2023		Y
Weather forecasting services booked (Meteo)	LLM	31 July 2023		Y
Purchase safety equipment/PPE	LLM	July 2023		Y
Confirm - VHF radios x3 / Satphone / EPIRBs for operation Extension cords x3	LLM	July 2023		Y
Confirm bait is sent to Papeete	PM	31 July 2023		Y
Organise drone platform for ferry to be in constructed.	LLM	31 July 2023		Y
Drone batteries on *Aranui* to Ua Pou	LLM	1 August 2023		Y
Confirm bait arrival at Tahiti – on-ship to Ua Pou	LLM	1 August 2023		Y
Bait shipping to Ua Pou	PM/LLM	Confirmed arrival at Ua Pou, at least 2-4 weeks prior to Op. (by early August 2023)		Y
Ferry transported to Ua Pou	LLM	21 August 2023		

Platform securely constructed on ferry stern	LLM	21 August 2023		
Press release preparation	PM	August 2023		
Bait arrival at Ua Pou	LLM/OM	At least 2-4 weeks prior to baiting operation (1 August 2023)		Y
Overseas operation team arrives at Tahiti	PM/OM	~4 days prior to operation start		
Operation team fly to Ua Pou/Nuku Hiva (with drones / equipment)	LLM	~ 2-3 days prior to operation start	Bait has arrived and stored at Ua Pou	
Arrival at Ua Pou Pick up vehicles	LLM	1-2 days prior to operation		
Public briefing at Ua Pou	LLM /Drone company / PM	1 day prior to operation		
Ferry motors to Motu Oa	LLM / Drone company / PM	Day 1 of operation		
Determine breeding status of rats	OM	Day 3-4 of operation		
Set out toxin bait signs at landing sites on target islands	Drone team / OM / LLM/ barge team	Day 3-4 of operation		
Begin aerial baiting	PM / drone team	Day 3 of operation	All above needs to be complete & good weather forecast	

Review baiting and repeat sites where necessary	Drone team / PM	After first application on each island	At conclusion of first baiting on each island	
Check repeaters and drones for maintenance. Re-trial if required	Drone team	At conclusion of first baiting on three target islands		
Undertake 2nd bait application on three target islands	Drone team / OM/barge team	At least 7 days post first bait application.	Good weather forecast	
Pack up rubbish	Drone team / OM / LM	At conclusion of 2nd baiting on three target islands		
Return ferry to home port	LLM/OM	At conclusion of 2nd baiting on three target islands		
Fly to Tahiti ex-Ua Pou	LLM / OM	early September 2023		
NZ team returns to NZ	LLM / OM	~04 Early September 2023		
Operational Review	OM / LLM	October 2023 post-operation		
Post-eradication rat monitoring	PM / LLM	September - December 2024		
Press release	SOP Manu and Birdlife Intl.	On successful eradication of rats from island		
Project report	PM / OM / LLM	15 months post-operation		

Biological monitoring reports	SOP Manu & Birdlife Intl.	After each island visit, post-operation		

12. REFERENCES

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Harper GA (2021). The feasibility of eradicating Pacific rats *Rattus exulans* from motu Mokohae, motu Takahe, & motu Oa, near Ua Pou, French Polynesia. Report for Birdlife International & Société d'Ornithologie de Polynésie – Manu. pp 34.

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Holmes ND, Campbell KJ, Keitt BS, Griffiths R, Beek J, Donlan CJ, Broome KG. (2015). Reporting costs for invasive vertebrate eradications. *Biological Invasions* 17: 2913-2925.

Pain DJ, Brooke M de L, Finnie JK, Jackson A. (2000) Effects of brodifacoum on the land crab of Ascension Island. *The Journal of Wildlife Management* 64: 380-387.

13. EQUIPMENT

Equipment	Where used	Responsible for provision	Done (Y/N)
Bait application drones (2)	Ua Pou & target islets	Drone company	
Mapping drone (1)	Ua Pou & target islets	Drone company	
Additional support equipment for drones	Ua Pou & target islets	Drone company	
Rat toxic bait Pestoff 20R	Target islands	OM / LLM	
Warning signs (3) + stakes, hammers (2), nails	Target islets	LLM	
PPE – nitrile gloves (15 pr), dustmasks (20), goggles (10), overalls (5+).	Loading site		
Tarpaulins (for under drones when loading and to cover bait during operation) (6)	Loading site		
GPS (3) Garmin 62S	On islets		
VHF radios (4 minimum)	Loading site, on islets & boats	LLM	

EPIRBs (2 minimum)	On islands/boat transport	OM / LLM / Drone company	
Satphone	Boats & islets	LLM	
Permanent markers (15)	On islets	LLM	
Laptop & GIS Software	Loading site	Drone company	
Ferry	Ua Pou & target islets	LLM/PM	
1st Aid kits (2)	Loading site, boats & islets	LLM	
Lifejackets (minimum of 6)	On boats	LLM	

14. APPENDIX 1. SDS - PESTOFF 20R

Data Sheet **PESTOFF Rodent Bait 20R** **Brodifacoum 20ppm**

orillion

sses: 6.9B, 9.1D

IDENTIFICATION OF THE SUBSTANCE AND MANUFACTURER

PRODUCT IDENTIFIER

Trade Name PESTOFF Rodent Bait 20R

RELEVANT IDENTIFIED USES OF THE SUBSTANCE OR MIXTURE AND USES ADVISED AGAINST

Cereal based baits for rodent or possum control.

DETAILS OF THE SUPPLIER OF THE SAFETY DATA SHEET

Company Orillion, 408 Heads Road, Wanganui 4501, New Zealand. (Orillion is the trading name of Animal Control Products Ltd.)

Telephone +64 (6) 3445302 or +64 (21) 919 624

Email address enquiries@orillion.com

1.4 Emergency telephone number

National Emergency Contact number **111**

NZ National Poisons information Service **0800 764 766**

HAZARDS IDENTIFICATION

Classification of the substance or mixture

Acute oral toxicity	**Class 6.9B**
Ecotoxic – Toxic to terrestrial animals	**Class 9.1D**
CAS Registry number or active ingredient:	**56073-10-0**

Warning

Precautionary Statement

Hazard Statements:	**H373**	May cause damage to organs through prolonged or repeated exposure.
	H413	May cause long lasting harmful effects to aquatic life.
Prevention Statements:	**P103b**	Read Label before use.
	P260	Do not breath dust
	P273	Avoid release to the environment.
	P314	Get medical advice/attention if you feel unwell.
Storage Statements:	**P405**	Store locked up.
Disposal Statements:	**P501**	Dispose of contents/container in accordance with label directions.
2.3 Other Hazards	No data.	

COMPOSITION / INFORMATION ON INGREDIENTS

SUBSTANCES

Contains no substances of concern other than the active ingredient.

MIXTURES

Chemical Nature: Brodifacoum

Component	**CAS Number**	**Concentration (% w/w)**	**Classification EU**
$C_{31}H_{23}O_3Br$	56073-10-0	0.002%	2588
Other non-Hazardous ingredients *		**Cereals, sugars, waxes and binders**	

* do not affect the hazardous classifications of the substance.

FIRST AID MEASURES

INGESTION:

In the event of ingestion, do not induce vomiting. Consult a physician and provide an estimation of the amount of product ingested. In the case of very small amounts of product (< 10 grams) being taken, no symptoms may develop but larger amountsmay affect blood clotting times. A physician can assess this and provide Vitamin K1 therapy as necessary.

EYE CONTACT:

Wash eyes with water.

SKIN CONTACT:

Wash exposed area thoroughly with soap and water, then rinse.

CONTAMINATED CLOTHING:

Remove contaminated clothing and wash before re-use. Wear gloves and overalls when handling baits. Do not eat, drink orsmoke. Clothing and gloves should be decontaminated by washing in hot soapy water.

SYMPTOMS OF POISONING:

Early Symptoms:

No symptoms may be apparent for several days if poisoning has occurred. Can kill if swallowed in large quantities. Nausea andvomiting may occur soon after ingestion.

LATER SYMPTOMS:

The active constituent (Brodifacoum) is an anticoagulant chemical, which if taken by humans, domestic animals, or pets, willreduce the clotting power of the blood. In some cases, effects from exposure may be delayed for several days or may not beevident unless checked by a physician. Typical overt symptoms of poisoning include bleeding gums, increased tendency to bruising, blood in urine and faeces and excessive bleeding from minor cuts.

SEVERE SYMPTOMS:

Haemorrhagic shock, coma and death may follow in cases or severe poisoning.

AS THE SYMPTOMS OF POISONING WILL BE DELAYED FOR SEVERAL DAYS, ALWAYS SEEK MEDICAL ADVICE IF POISONING ISSUSPECTED.

FIRE FIGHTING MEASURES

The product contains no toxic emissions as vapours, gases or odours. The principle hazard route is via ingestion.

SUITABLE EXTINGUISHING MEDIA:

Water fog, fine water spray, foam or as appropriate to surrounding materials.

UNSUITABLE EXTINGUISHING MEDIA:

None identified.

ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS, PROTECTIVE EQUIPMENT AND EMERGENCY PROCEDURES:

Wear personal protective equipment.

See protective measures under points 7 and 8.

METHODS AND MATERIALS FOR CONTAINMENT AND CLEAN UP:

In the event of major spills, isolate the spill area and take all practicable steps to manage any harmful effects of a spillage including preventing baits from entering streams or waterways. Scoop spilled baits into secure containers. Recover any undamaged bait for later use by placing in appropriately labelled containers and dispose of spoiled bait as directed in the disposal section below. Use a broom to collect fine material and wash down the spill area with copious water only after allspilled bait has been removed.

ENVIRONMENTAL CONSIDERATIONS:

Consider possible hazards arising from irrigating spill sites. Brodifacoum is not water soluble but fine bait material may pose arisk to people, pets, livestock, wildlife and fish.

HANDLING AND STORAGE

PRECAUTIONS FOR SAFE HANDLING:

When handling open containers or baits, wear latex or rubber gloves. When loading aircraft or working in windy conditions, wear overalls, goggles and a dust mask as protection against dust entering the eyes or mouth. Do not eat, drink or smoke whenusing the product or handling open containers. Wash protective

clothing and equipment after use. Remove the outer layer of clothing and wash hands and exposed skin thoroughly before meals and after any contact.

CONDITIONS FOR SAFE STORAGE, INCLUDING ANY INCOMPATIBILITIES:

Store in original container, tightly closed, under lock and key and away from feed or foodstuffs. Keep out of reach of children,pets and livestock.

INCOMPATIBLE MATERIALS:

None identified.

EXPOSURE CONTROLS / PERSONAL PROTECTION

OCCUPATIONAL EXPOSURE LIMITS:

Not Applicable (not assigned).

ENGINEERING MEASURES:

Decontamination is through microbial decomposition in a biologically active medium.

PERSONAL PROTECTION EQUIPMENT:

Operators using or handling the product in open containers must wear gloves. Do not smoke, drink, or eat while handling theproduct. When working around aircraft, wear a suitable dust mask to prevent inhalation of airborne particles.

PHYSICAL AND CHEMICAL PROPERTIES

Form / Colour / Odour:

Property:	**Specification:**
Physical State:	Solid
Appearance:	Cylindrical blocks
Odour:	Cinnamon, fruit, or chocolate
Odour Threshold:	Not relevant
pH:	Not determined
Melting point/range:	Not relevant

Boiling point/range:	Not relevant
Flash Point:	No Data Available

Evaporation rate:	No Data Available
Flammability:	No Data Available
Upper/lower flammability or explosive limits:	No Data Available
Vapour Pressure:	Not relevant
Vapour density:	Not relevant
Relative Density:	No Data Available
Water Solubility:	Brodifacoum is not water soluble.
Lipid Solubility:	No Data Available
Partition coefficient (N-octanol/water):	No Data Available
Auto-ignition Temperature:	No Data Available
Decomposition Temperature:	No Data Available
Viscosity:	No Data Available

STABILITY AND REACTIVITY

Brodifacoum cereal based pellets are stable and non-reactive under normal storage and use conditions.

TOXICOLOGICAL INFORMATION

The baits present a very low hazard to operators unless taken orally.Toxicity Data for the Active Ingredient - Various Species *

Species (Oral) LD50	**LD50- active**
White Laboratory Rat	0.26 mg/kg B/W
Brush-tailed possum	0.8 mg/kg B/W
Dog	3.56mg/kg B/W

Cat	25.0 mg/kg B/W
Mouse	0.4mg/kg B/W

ECOLOGICAL INFORMATION

Use the products only for the purpose indicated and, in the manner, prescribed by the product label.

Brodifacoum may persist for many months in the fatty tissue, liver and kidneys of sub-lethally poisoned animals. Mortally poisoned animals may present a secondary poisoning risk to carnivorous birds and mammals. Tertiary poisoning risks for example when feral pigs eat poisoned possums and are subsequently taken and eaten by pig hunters. Take steps to mitigate anypotential non-target exposure by wildlife, domestic animals or humans. Studies have shown that brodifacoum concentrations will decline within decaying carcasses.

Improper disposal of unwanted pesticide is unlawful. If wastes can not be disposed of according to label instructions contactyour local Regional Council hazardous waste advisor for guidance.

DISPOSAL CONSIDERATIONS

Product which is surplus or spoiled should be disposed of by burying with other organic material on the active tip face of an appropriately managed landfill or buried within the biologically active layer of soil elsewhere within a secure area. Ensure that agood covering of earth is applied over the bait immediately to prevent access by scavenging birds. Avoid deep disposal.

Alternatively, burn unwanted bait material in a suitably constructed and appropriately located incinerator and bury any residuesas above. As the smoke and fumes produced by burning is irritating and potentially harmful, ensure wind does not carry smoke plume towards populated areas.

TRANSPORT INFORMATION

NOT CLASSIFIED DANGEROUS GOODS:

Toxicity falls below Packing Group III threshold.

MAXIMUM TRANSPORT QUANTITY WHEN FOR USE AS TOOLS OF TRADE:

No Limits.

REGULATORY INFORMATION

REGISTERED PESTICIDES:

PESTOFF Rodent bait 20R – V009014.

HSNO APPROVAL:

HSR001612

OTHER INFORMATION

SPECIAL PRECAUTIONS & OTHER COMMENTS

Do not use poisoned or contaminated animals for food or feed.

This product is toxic to most wildlife. Birds and mammals feeding on carcasses of contaminated animals may be killed. Take measures to minimise the chance of baits entering any body of water. Apply the product only as specified by its label directs.

Where practicable, exposed bodies of all poisoned animals should be collected and destroyed by complete burning or deep burial at a landfill approved for hazardous wastes.

CONSULT NEAREST POISON CONTROL CENTER FOR CURRENT INFORMATION

All information contained in this data sheet is as accurate and up to date as possible. Since Orillion cannot anticipate or control the conditions under which this information may be used, each user should review the information in the specific context of theintended application.

Revised by: ADC - January 2021

15. APPENDIX 2. HEALTH & SAFETY PLAN

To be added during latter stages of operational planning

16 APPENDIX 3. COMMUNICATIONS PLAN

To be added during latter stages of operational planning

17. APPENDIX 4. COMPLIANCE REGISTER

To be added during latter stages of operational planning

18. APPENDIX 5. BIOSECURITY PLAN

To be added once completed

19. APPENDIX 6. DRONE AUTHORISATION

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté Égalité Fraternité

ACCUSÉ DE RÉCEPTION DE LA DÉCLARATION D'ACTIVITÉ D'UN EXPLOITANT D'AÉRONEFS SANS ÉQUIPAGE À BORD

ACKNOWLEDGEMENT OF RECEIPT OF THE DECLARATION OF ACTIVITY OF A UAS OPERATOR

Arrêté du 3 décembre 2020 relatif à la définition des scénarios standard nationaux et fixant les conditions applicables aux missions d'aéronefs civils sans équipage à bord exclues du champ d'application du règlement (UE) 2018/1139

dgac direction générale de l'Aviation civile DSAC

Le présent accusé de réception est délivré conformément au § 3.3.1 de l'annexe de l'arrêté du 3 décembre 2020 précité, à la suite de la déclaration d'activité suivante :

This acknowledgment of receipt is issued in accordance with § 3.3.1 of Annex of the aforementioned Order of 3 December 2020, following the following declaration of activity:

N° D'EXPLOITANT DÉCLARÉ : ED17292

DECLARED OPERATOR NO.

EXPLOITANT: / ***OPERATOR***

Nom: **Envico Technologies Ltd**
Name
Nom commercial: **Envico**
Trading name

ADRESSE: / ***ADDRESS***

5 De Havilland Way
3116 Tauranga
NOUVELLE-ZÉLANDE

DÉCLARATION: / ***DECLARATION***

Date de la déclaration d'activité : **21/06/2022**
Date of the declaration of activity
Scénarios opérationnels : **S1**
Operational scenarios
Manuel d'exploitation : **Unmanned Aircraft Operating Manual du 05/10/2021**
Operations manual
Activités de formation de télépilotes autres que ceux de l'exploitant : **Non**
Training activities of remote pilot other than those of the operator
Liste des aéronefs : voir page(s) suivante(s)
List of aircraft: see following page(s)

ACCUSÉ DE RÉCEPTION DÉLIVRÉ LE: 21/06/2022 / ***ACKNOWLEDGEMENT OF RECEIPT ISSUED ON***

DATE DE FIN DE VALIDITÉ : 20/06/2024 / ***END OF VALIDITY***

ACCUSÉ DE RÉCEPTION DÉLIVRÉ LE: 21/06/2022 / ***ACKNOWLEDGEMENT OF RECEIPT ISSUED ON***

DATE DE FIN DE VALIDITÉ : 20/06/2024 / ***END OF VALIDITY***

Rappel des dispositions réglementaires applicables (annexe de l'arrêté du 3 décembre 2020 précité) :
Reminder of the applicable regulatory provisions (Annex of the aforementioned Order of 3 December 2020)

§ 3.3.1. Un exploitant ne peut utiliser un aéronef dans le cadre d'un scénario standard national que s'il détient un accusé de réception émis depuis moins de 24 mois par le ministre chargé de l'aviation civile à la suite d'une déclaration d'activité. La déclaration d'activité peut être réalisée par voie électronique sur le portail internet mis en place à cet effet par le ministre chargé de l'aviation civile.

§ 3.3.1. An operator may only use an aircraft in the context of a national standard scenario if he/she has an acknowledgment of receipt issued less than 24 months ago by the Minister in charge of civil aviation following a declaration of activity. The declaration of activity can be carried out electronically on the Internet portal set up for thispurpose by the Minister in charge of civil aviation.

§ 3.3.2. Tout changement de l'activité modifiant un des éléments de la déclaration d'activité ayant permis la délivrance de l'accusé de réception nécessite la réalisation d'une nouvelle déclaration d'activité selon les modalités définies au § 3.3.1.

§ 3.3.2. Any change in the activity modifying one of the elements of the declaration of activity that led to the issue of the acknowledgment of receipt requires the completion of a new declaration of activity according to the procedures defined in § 3.3.1.

§ 3.3.4 Chaque année en janvier, l'exploitant déclare au ministre chargé de l'aviation civile le nombre d'heures de vol réalisées et fait une synthèse des problèmes rencontrés dans le cadre du suivi de la sécurité durant l'année civile précédente. Cette déclaration est réalisée par voie électronique sur le portail internet mis en place à cet effet par le ministre chargé de l'aviation civile.

§ 3.3.4 Each year in January, the operator declares to the Minister in charge of civil aviation the number of flight hours completed and summarizes the problems encountered in the context of safety monitoring during the previous calendar year. This declaration is made electronically on the Internet portal set up for this purpose by the Minister in charge of civil aviation.

Pour plus d'informations sur les obligations réglementaires attachées à l'usage des aéronefs télépilotés, consultez le site internet de la Direction générale de l'Aviation civile et pour vos démarches en ligne, utilisez le portail AlphaTango (https://alphatango.aviation-civile.gouv.fr/).

For more information on the regulatory requirements for the use of remotely piloted aircraft, visit the Direction générale de l'Aviation civile website and for your administrative procedures, use the AlphaTango portal (https://alphatango.aviation-civile.gouv.fr/).

ACCUSÉ DE RÉCEPTION DE LA DÉCLARATION D'ACTIVITÉ D'UN EXPLOITANT D'AÉRONEFS SANS ÉQUIPAGE À BORD
EXPLOITANT n° ED17292, DÉCLARATION DU 21/06/2022, AR DU 21/06/2022

N° enregistrement (registration No.)	Type d'aéronef (aircraft type)	Constructeur (manufacturer)	Modèle (model)	N° de série (serial No.)	Scénarios / masses (scenarios / masses)
UAS-FR-285164	Multicopter	Joyance	JT20L-606	ECT011	S1 non captif (25kg)
UAS-FR-285163	Multicopter	Joyance	JT20L-606	ECT010	S1 non captif (25kg)