Frogs in the Grass

Community Monitoring of the Growling Grass Frog at City of Whittlesea Quarry – Seasons 1 & 2

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October 2012

The original report, published in September 2011, was prepared by Marion Shadbolt and Ada Nano. This updated version was prepared by Beatrix Spencer and Caitlin Griffith.

Victorian National Parks Association

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The Victorian National Parks Association's NatureWatch program is a community-based biodiversity monitoring program which informs, educates and engages the community in conservation management and practice. The NatureWatch program actively builds links between community members, scientists, and land managers, and develops scientifically based, practical projects that contribute to a better understanding of species and ecosystems, threatening processes, and the management of natural areas.

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Cover photos: NatureWatch volunteers at work in the field, photo Ada Nano; Growling Grass Frog, photo IT'S A WILDLIFE – www.itsawildlife.com.au.

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CONTENTS

SUMMARY

This report presents the results of a NatureWatch Growling Grass Frog (GGF) community monitoring event at the City of Whittlesea (CoW) Quarry, Epping, in January 2011.

It is part of the Victorian National Parks Association's grasslands community monitoring project, run by the association's NatureWatch program and developed to monitor threatened species in grasslands and involve the community in gathering much needed data.

The Growling Grass Frog monitoring component of this project was developed with Daniel Gilmore, senior zoologist at Biosis, and Peter Homan, zoologist and City of Whittlesea.

So far 34 volunteers have helped collect data on Growling Grass Frog populations at the site, led by Daniel Gilmore, Peter Homan and volunteer team leaders Marion Shadbolt and David de Angelis.

The GGF is listed nationally as Vulnerable under the commonwealth Environment Protection and Biodiversity Conservation Act 1999, and in Victoria it is classified as Endangered (DSE 2007a) and listed as threatened under state's Flora and Fauna Guarantee Act 1988. The species is currently threatened by a range of processes. Urbanisation and associated habitat loss and degradation, together with other threats such as chytrid fungus are considered to be the main threats to remnant GGF populations in the greater Melbourne area. On Melbourne's northern fringe where the CoW Quarry is located, extensive urban development threatens many key GGF breeding populations.

The CoW Quarry is an important site for this species within the Epping and Epping North region. The quarry previously formed part of a landfill operation and was filled with water from the Merri Creek on an annual basis between 2000 and 2004. GGFs had colonised the quarry before the land-fill operations ceased. A significant breeding event was last recorded at the site in 2004. The filling regime was reinstated at the CoW Quarry in 2009 as an offset measure for the permitted removal of other GGF habitat nearby and the species has since recolonised the site. Ongoing monitoring of the GGF population is an important recommendation of a management plan prepared for the site.

The CoW has employed a consultant biologist to undertake monitoring of the GGF population at the quarry over the past two years. Growling Grass Frog monitoring, as part of the NatureWatch Grassland community monitoring project, was undertaken to provide further data on the population size and breeding success during the 2010/11 and 2011/12 seasons. For these surveys, we divided the quarry into four sections and assigned each section to a group of 2-4 volunteers. Each group estimated aquatic and terrestrial vegetation cover within their section before undertaking a visual encounter census of GGFs by walking around the edge of the quarry and counting all GGFs seen. Dip-netting for tadpoles and call playback were also conducted.

Our Season 1, 2010/2011 survey recorded a total of 101 GGFs at the quarry, 30 of which were adults. The majority of GGFs recorded were juveniles, indicating a successful 2010-11 breeding season. The number of adult frogs recorded during our survey was comparable to the adult population size estimated by the consultant in December 2010. Adult frog numbers were however considerably lower at the site this year compared with the previous breeding season. It is suggested that this population change is a consequence of varying seasonal conditions between the two seasons and the likely migration of adult GGFs to nearby waterbodies during the wetter 2010/11 season.

Aquatic vegetation cover was low throughout the site and below levels suggested for 'ideal' GGF habitat. This is likely to be due to the above average summer rains, which raised the water levels within the quarry, thereby inundating submergent and floating vegetation, together with the nature of the site, which is characterised by large expanses of non-vegetated open water. The abundance of GGFs

in the different survey sections did not appear to be correlated with aquatic vegetation cover. The terrestrial habitat surrounding the water body was found to be dominated by grassland (mainly introduced weed species) and rocky areas. The rocky habitat provides additional habitat for nocturnal foraging for the GGF, as well as shelter from predators. The site is considered high quality GGF habitat and supports a number of key habitat features.

The NatureWatch program is very interested in holding further community monitoring events at the CoW Quarry site.

Season 2 recorded a significant decline in the adult population of Growling Grass Frogs since season 1 (101 Growling Grass Frogs in one survey in season 1 and an average of 4 per survey in season 2). No evidence of breeding was observed. An average of 4 adults were observed over the 3 study dates, with Survey 1 observing a total of 6 adults, Survey 2 a total of 1 adult, and Survey 3 a total of 5 adults. There was no evidence of breeding recorded in season 2, with no tadpoles or metamorphs observed.

Aquatic vegetation cover remained low at 21%, however was at higher levels than Season 1. This increase in aquatic vegetation provides increased foraging and breeding habitat however there has been no correlation observed with frog populations. Terrestrial vegetation declined around the site, with a significant decrease in grass cover. However with the increase in cover of bank side rocks providing shelter habitat this is not expected to have had an affect on GGF's habitat.

These findings are consistent with findings on Growling Grass Frog populations across the region (G Heard 2012, pers comm). Possible explanations for the decline in population at this site include another year for high rainfall resulting in many ponds and wetlands available throughout the Merri Creek Catchment. Adult GGF's may have moved to other locations to breed. However given the low numbers of Growling Grass Frogs recorded at many other sites in the region (G Heard 2012, pers comm) this is not likely. A continuing increase in development of the Epping area and the presence of feral pests (such as foxes & cats) are also possible factors in the unsuccessful breeding of Season 2. There is also the ongoing threat of Chytrid fungus in the Merri Creek Catchment.

1.0 INTRODUCTION

1.1 Project Background

The City of Whittlesea (CoW) Quarry, located at 490 Cooper St Epping (Figure 1) was formerly part of a landfill site operated by Hanson Landfill services. Landfill operations between 2000 and 2005 included the annual filling of the quarry hole with water sourced from the Merri Creek for dust suppression purposes. This practice created an ideal breeding habitat for the Growling Grass Frog (GGF), which is thought to have colonised the area from nearby breeding populations at O'Hern's Swamp and the Merri Creek (Gilmore, 2009)(refer Figure 2). In 2005 the Landfill operation was shut down and the quarry was allowed to dry out. Consequently, the habitat was no longer suitable as a GGF breeding site (Gilmore 2009). While the Epping area has long been recognised as important for the GGF, immense development pressure in recent times has resulted in a number of key breeding sites being degraded or destroyed. Remaining GGF habitat and breeding sites are also under increasing pressure.

In response to the recognised threats posed to the GGF by urban expansion, a sub-regional conservation strategy for Growling Grass Frog, in the Epping/ Somerton area was commissioned by the Department of Primary Industries in 2006 (Renowden et al. 2006). One of the measures identified in the strategy to offset habitat loss for this species was to re-instate the watering regime, and thus the GGF breeding habitat, at the CoW Quarry (Gilmore 2009). In 2009 the then Department of Innovation, Industry and Regional Development commissioned Biosis Research to develop a management plan for the site. This plan identified four key actions to ensure the future success of the quarry as a breeding site (Gilmore 2009). These comprised:

1) protection of the site and its surroundings;

2) re-instatement of annual filling of the quarry with water sourced from the Merri Creek;

3) protection and management of habitat corridors to other GGF populations; and

4) ongoing population and habitat monitoring (Gilmore 2009).

The CoW (who now own and manage the quarry site) and Melbourne Water have since collaborated to reinstate annual filling of the quarry (see Figures 3 and 4) and to undertake ongoing protection and management of the site. Since re-filling the quarry in 2009, GGFs have returned to breed at the site.

Monitoring over the 2009/10 season recorded a limited breeding event but initial monitoring in December 2010 indicated a very successful 2010/11 breeding season (Homan, 2010).

To contribute to the requirement for ongoing monitoring of the GGF population at the quarry site, this community monitoring project was developed and run by the VNPA NatureWatch program in collaboration with Biosis Research and the CoW. The season 1 monitoring was undertaken in late January 2011, and season 2 over three activities in November and December 2011, as well as January 2012. This report summarises the findings of that work. The surveys augment the findings of Homan (2010) and were aimed at determining if the tadpoles observed in December successfully metamorphosed. Evidence of recruitment is an important measure of the success of the CoW Quarry management plan.

1.2 Biology of the Growling Grass Frog

The Growling Grass Frog (*Litoria raniformis*) is a native Australian frog that formerly occurred throughout southern New South Wales, northern and eastern Tasmania, south-eastern South Australia, and much of Victoria (DEWHA 2009). Once common across its range, the species has suffered recent widespread decline, with many significant populations having declined or disappeared (DEWHA 2009). In Victoria, populations persist in the greater Melbourne area and in the south-west, central and eastern parts of the state.

The GGF is an attractive frog with bright emerald to olive green colouration and a warty back with gold to brown spots and blotches. It has bright blue colouration in its groin and a creamy-white underside. Males can be distinguished by their muddy-coloured throat, compared with the cream-white throat of females. Males also have prominent nuptial pads on the inside of the thumbs. The females (60-104 mm) are generally larger than their male counterparts (55-65 mm).

The GGF inhabits a range of different water bodies including slow-flowing streams, lagoons, lakes, swamps, farm dams and disused quarry holes (DSE 2007b). Important features of GGF habitat include the presence of floating, submergent and emergent vegetation, rocky habitat, grasslands and bare ground (DEWHA 2009). The species is thought to be an opportunistic feeder with prey items including

tadpoles and frogs (including those of its own species), lizards, snakes, small fish and invertebrates (DEWHA 2009).

The distinctive growling call of the male GGF can be heard from spring to late summer with most eggs laid during spring to allow their large tadpoles (up to 110mm total length) ample time to develop over summer (DSE 2007b).

The recognised threats to this species include: loss and alteration of waterbodies; barriers to movement between waterbodies; reduction in water quality due to pollution; salinity and pesticide/herbicide use; disturbance and loss of terrestrial habitat; predation on eggs and tadpoles by introduced fish; and chytridiomycosis (DEWHA 2009).

Spread of chytridiomycosis is considered to be a key factor in the decline of the GGF. This disease is caused by an introduced fungus, *Batrachochytrium dendrobatidis*, or 'chytrid fungus', which infects the skin of adult frogs and inhibits their ability to breathe (NPWS 2001). Since its introduction, the fungus has spread throughout Australia and has been implicated in the decline and extinction of numerous frog species. Chytrid fungus is also affecting frog populations elsewhere in the world (NPWS 2001). The rapid decline in GGF populations since the 1980s has been largely attributed to this disease. The disease has been confirmed in GGF populations in the Merri Creek corridor and is likely to be present in the population at the CoW quarry, which is functionally connected to other populations along the Merri Creek (D. Gilmore, Biosis Research, pers. comm.).

Habitat loss, fragmentation and degradation also pose a significant threat to GGF populations. This is particularly the case in areas of Melbourne where urban development pressures overlap with critical GGF habitat, such as on Melbourne's northern urban periphery. Surveys for the GGF in this region in 2009 found that nearly 60% of previously known populations had disappeared, the majority of these from areas that had been urbanised (Heard and Scroggie 2009). Many key remnant populations of the GGF around Melbourne occur in areas designated for future urban growth, such as in the Epping/Epping North region.

Once so abundant they were collected and used for university scientific dissections, the GGF is now listed as Vulnerable nationally under the Environment Protection and Biodiversity Conservation Act 1999. It is classified as Endangered in Victoria (DSE 2007a) and is listed as threatened under the Flora and Fauna Guarantee Act 1988 (DSE 2007b).

An adult Growling Grass Frog. Photo: Daniel Gilmore

1.3 Objectives

The objective of the NatureWatch event was to undertake monitoring of the GGF at the CoW Quarry, as recommended by the GGF management plan (Gilmore 2009). The main aims were to:

- Estimate the adult population present at the site.
- Estimate the level of reproductive success over the 2010/11 and 2011/2012 breeding seasons.
- Assess habitat suitability for the GGF by estimating the percentage cover of water body and terrestrial vegetation at the study site.

The VNPA also sought to:

- Inform NatureWatch volunteers about the Growling Grass Frog and factors threatening its survival.
- Engage and train volunteers in monitoring techniques.

Data collected as part of this activity has been provided to the CoW to supplement monitoring results from December 2010 (Homan 2010).

2.0 METHODS

2.1 Study Area

The study is at a quarry in Epping. Due to the historical filling of the site in September each year between 2000 and 2004, the quarry hole essentially provided an ephemeral wetland which contained water throughout the summer months. This created ideal conditions for GGF reproduction as the species' breeding season usually starts in early spring with the majority of tadpoles undergoing metamorphosis by late summer to early autumn. The quarry site has naturally developed a range of emergent vegetation (reeds and sedges including *Phragmites australis*, *Typha* spp and *Juncus* spp.), submergent vegetation such as pond weed (*Potamogeton* spp.), and floating aquatic vegetation (Gilmore 2009). The waterbody is surrounded by moderately steep, rocky cliffs covered by grasslands composed mainly of introduced weeds (Gilmore 2009).

2.2 Survey Methods

NatureWatch season 1 monitoring took place on the evening of 27 January 2011. A total of 11 volunteers participated in the event. Season 2 monitoring took place on the evenings of 17 November 2011, 14 December 2011 and the 21 January 2012. Monitoring was conducted by skilled ecologists and others, including skilled ecologists and others with no formal ecological training. For the survey the quarry site was divided into four sections comprising both terrestrial and aquatic habitat (Figure 5). An area of the quarry between sections 1 and 4 was deemed too dangerous to survey due to the presence of steep cliffs and loose, rocky habitat.

Volunteers were initially briefed on the history and characteristics of the site, safety issues and the objectives of the survey. Participants were then requested to sterilise their footwear (following guidelines outlined in NPWS, 2001) to ensure that chytrid fungus was not carried into the site unwittingly.

Prior to dusk, four groups of 2-3 volunteers were assigned a particular section of the quarry in which they conducted a vegetation assessment to determine the percentage cover of terrestrial and aquatic vegetation. Terrestrial vegetation was divided into three classes: grass cover, shrub cover and rock/log. The aquatic vegetation was also divided into three categories: emergent, floating and submergent vegetation. The mean aquatic vegetation cover was calculated from cover estimates for these three categories (refer to the data sheet in Appendix 1 for definitions of each aquatic vegetation class). Any plant species identified by participants were also recorded.

NatureWatch volunteers search for Growling Grass Frogs by torchlight. Photo: Ada Nano

Call-playback was conducted on dusk in an attempt to stimulate calling by adult GGFs. This involved using a loud haler to amplify a recording of a male GGF call and listening for a response. This was undertaken as a group activity. Dip-netting was also conducted in shallow areas of the water body to determine the presence of GGF tadpoles.

After dark, the four groups surveyed their designated section of the quarry site for GGFs. This involved walking around the edge of the water body and using

Zoologist Daniel Gilmore drills NatureWatch volunteers in Growling Grass Frog survey methods. Photo: Ada Nano

headlamps and torches to actively search for GGFs in the fringing terrestrial habitat. Torches were also shone over the surface of the water body within each section to look for the bright eye shine of the GGF.

GGFs were allocated to one of the following five classes:

1) late-stage tadpole (full tail± legs);
2) metamorph (<30mm Snout Groin Length (SGL) ± tail stub);
3) sub-adult (30-50mm SGL);
4) adult (>50mm SGL); or
5) unknown (see datasheet in Appendix 1 for further details).

Any GGFs heard calling during the survey period were also recorded. In addition, participants noted the presence of other frog species seen or heard, along with any other notable fauna species. General weather conditions on the night were also recorded.

Growling Grass Frog caught in torchlight during the monitoring.
Photo: Marion Shadbolt

Aquatic vegetation at the quarry. Photo: Marion Shadbolt

3.0 SURVEY RESULTS

Season 1, survey 1: A total of 101 Growling Grass Frogs at various stages of development were recorded on the night (table 1). Metamorph GGFs were the most common age class recorded (41) followed by sub-adult frogs (33) and adults (27). No GGF tadpoles (late or early-stage) were recorded. Detailed data collected during the survey is provided in Appendix 2.

The abundance and age class of frogs varied across the four sections surveyed (see fig. 6). The largest number of frogs was observed in section 4 and this comprised a high proportion of metamorph and sub-adult frogs but only five adults. Over half of all adult frogs recorded during the survey were found in section 3. This section also had the second lowest number of metamorph and sub-adult frogs combined.

The terrestrial habitat was found to be dominated by grassland habitat. This largely comprised weed species with a small number of native plants. Grass/herb species recorded included wild mustard, canary grass (*Phalaris aquatica*), deadly night shade (*Solanum* sp.) and artichoke thistles (*Cynara cardunculus*). The shrub layer comprised the native shrub and tree species recently planted as part of the site restoration works, along with African boxthorn (*Lycium ferocissimum*).

The type and cover of aquatic vegetation varied across the waterbody. Section one was dominated by submergent vegetation while sections 2-4 contained mainly emergent vegetation. Each section contained at least five per cent cover of each aquatic vegetation type. Emergent vegetation species included *Eleocaris* sp. and *Typha* sp. Floating vegetation species included various types of algae and water couch (*Paspalum distichum*). Average total aquatic vegetation cover was found to be low at 15%.

Other notable species detected on the night included several sightings of the Banjo Frog (*Limnodynastes dumerili*), which were also heard calling throughout the survey. A small number of tadpoles of this species were also observed. Other observed species included a small number of Spotted Grass Frogs (*Limnodynastes tasmaniensis*) and two Common Long-necked Turtles (*Chelodina longicolis*). One of the turtles was found upturned and trapped under a rock but was subsequently rescued by a participant.

3.1 Season 2, Survey 1: 17 November 2011

A total of 6 Growling Grass Frogs were recorded during Season 2, Survey 1. Only adult GGF's were observed with no tadpoles, metamorphs or sub-adults recorded. The 6 adults observed were not able to be identified as male or female. There were 2 calling adults recorded at the site.

Adult frogs recorded were only observed in section 2 (5 frogs) and 3 (1 frog) of the quarry (see fig. 6 map). Calling frogs were only observed in section 1 (2 calling) and there were no frogs observed or heard in section 4.

There were numerous other species recorded on the night both sighted and calling. There were 4 Banjo Frogs (Limnodynastes dumerili) and 2 Spotted Grass Frogs (Limnodynastes tasmaniensis) observed with 1 calling Banjo Frog and 11 to 12 calling Spotted Grass Frogs. There was a large number of Common Froglets (Crinia Signifera) heard calling (> 50) and 10 observed. Striped Marsh Frogs (Limodynastes peronii) were also recorded calling (1-10).

There was no vegetation survey conducted at this monitoring activity (only one vegetation survey is required per season).

The weather conditions on this evening were:

- Air temp 23°C.
- Wind (None).
- Cloud cover 5%.
- Sprinkled precipitation in last 24 hours.

A Growling Grass Frog metamorph.
Photo: Marion Shadbolt

3.2 Season 2, Survey 2: 14 December 2011

There was just one Growling Grass Frog observed at this survey activity. The adult frog was not able to be identified as male or female. A number of GGF's were recorded calling with an estimate of 15 - 20 across the site. There were no recorded tadpoles, metamorphs or sub-adults.

Section 3 was the only section to record an adult unknown GGF (see fig. 6 for map). Calling frogs were recorded in all 4 sections; Section 1 an estimated 1 to 10 calling adults, section 2 recorded 3 calling adults, section 3 recorded 11 calling adults and section 4 and estimated 2 to 3 calling adults.

There were four Spotted Grass Frogs (Limnodynastes tasmaniensis) and a single Banjo Frog (Limnodynastes dumerili) observed during this survey event. There was also a single Common Froglet (Crinia Signifera) heard calling.

There was no vegetation survey conducted on this monitoring activity (only 1 vegetation survey is required per season).

The weather conditions on this evening were:

- Air temp 14.5°C.
- Water temp18°C.
- Wind strength 1.4km/h.
- Cloud cover 70%.
- No precipitation in the last 24 hours.
- Humidity 75.5.

3.3 Season 2, Survey 2: 21 January 2012

A total of 5 adult Growling Grass frogs were recorded during the fourth survey event. This included 1 adult

Banjo Frogs proved a surprise for NatureWatch volunteers surveying Growling Grass Frogs. Photo: Marion Shadbolt

female, 2 adult males and 2 unknown GG frogs. Only adult GGF's were observed with no tadpoles, metamorphs or sub-adults recorded. There were 1 to 10 calling adults recorded at the site.

Section 1 and 4 both recorded 2 adult Growling Grass frogs. The 2 GGF's in section 1 were not identified as male or female while the 2 GGF's in section 4 were identified as male. Both sites 1 and 4 also recorded calling adult GGF's with 1-10 (site 1) and 2 (site 4) adults observed calling. Section 2 recorded the only female GGF's found during the survey and 1-10 calling GGF's. Section 3 did not record any GGF's nor were there any heard calling.

Other frog species observed on the night included Spotted Marsh frogs (1), Common Froglets (1) and Pobblebonks (74 calling, 1 observed). There was also a Microbat (mouse bat?) observed in section 1 of the study site as well as a long neck turtle in section 3. Two large brown frogs were also observed but unidentified.

Terrestrial vegetation was observed at the site with a dominant cover of rocks/logs (average 70%) and grass (average 40%) surrounding the quarry. There was a smaller percentage of shrub cover observed with 2% cover in section 2 and 10% cover in section 4. No bare ground was recorded at the site. The dominant rock type was basalt. Weed species were observed in the grass cover with no other species identified however previous studies have identified Grass/herb species at the site as wild mustard, canary grass (Phalaris aquatica), deadly night shade (Solanum sp.) and artichoke thistles (Cynara cardunculus). The shrub cover consisted of Black wattle (Acacia mearnsii), native willow (Geijera parviflora), red gum (Eucalyptus camaldulensis) and black woods (Acacia melanoxylon).

Aquatic vegetation averaged 21% across the site with all sites averaging above 10% aquatic vegetation.

Section 1 recorded the highest level of submergant vegetation (80%) and low levels of emergent (1%) and floating (1%) vegetation. Section 2 had the highest average cover of aquatic vegetation (34%) but low levels of floating vegetation (1%). Section 3 lacked any submergant vegetation and contained 35% emergent vegetation and 10% floating vegetation with an average aquatic vegetation cover of 12%. Site 4 had the lowest average aquatic vegetation cover (11%) with roughly even numbers of all submergant (10%), emergent (13%) and floating (10%) vegetation cover. Aquatic vegetation species included algae and Pondweed as floating vegetation. Algae and Macrophyte species were identified as submergant vegetation present.

The weather conditions on this evening were:

- Air temp 21 degrees C.
- Wind strength 5-10knots, gusty, South Easterly.
- No cloud cover.
- No precipitation in last 24 hours.

	Season 1	Season 2			
Age Class	**27-1-2011**	**17-11-2011**	**14-12-2011**	**21-1-2012**	**S2 Average**
Late Stage Tadpoles	0	0	0	0	**0**
Metamorphs	41	0	0	0	**0**
Sub-adults	33	0	0	0	**0**
Adult Males	4	0	0	2	**1**
Adult Females	8	0	0	1	**0**
Adults Unknown	**15**	**6**	**1**	**2**	**3**
Calling Adults	**1**	**2**	**1-10**	**1-10**	**1-10**
Total	**101**	**6**	**1**	**5**	**4**

Table 1 Number of Growling Grass Frogs in each age class.

4.0 DISCUSSION

Season 1: The inaugural Growling Grass Frog NatureWatch monitoring activity night at the CoW Quarry site confirmed a successful Growling Grass Frog breeding event at the site for the 2010/11 season. The large numbers of sub-adult and metamorph frogs recorded indicate that the environmental conditions have been optimal for GGF reproduction. No GGF tadpoles were recorded indicating that the majority of tadpoles had metamorphosed prior to the time of our survey. This is consistent with the observations of Homan (2010) who found hundreds of late stage tadpoles in December 2010.

The relatively low number of adults recorded by our systematic search of the quarry site could be due to the survey being conducted quite late in the breeding season. Toward the end of the season, adult Growling Grass Frogs are thought to hibernate in soil cracks and under rocks or logs to avoid the cold winter (DEWHA 2009). The weather conditions on the night of the survey were cool and only one adult frog was heard calling. Post-breeding the adults spend progressively less time at the waterbody and disperse widely throughout the landscape.

A survey completed at the quarry in December 2010, at the peak of the GGF breeding season, did however estimate a similar adult population size (30 compared with our 27) (Homan 2010). In previous years a larger population of adult GGFs has been recorded at the quarry. For example Homan estimated a population of 70 adult frogs at the site in the 09/10 breeding season – more than twice the number recorded this year. The likely reason for this decline in adult frog numbers is the higher than average summer rainfall this season compared with the drier conditions of previous seasons. As a consequence other suitable GGF breeding sites were available in the local area this season, enabling adult frogs to disperse rather than be concentrated at a few sites (Homan 2010). This indicates that maintaining the CoW Quarry as a GGF breeding habitat/refuge/source population will be very important in drier years. This is particularly the case if further sites in the region become degraded or are destroyed.

Further monitoring of GGFs at this site in the future will provide important data on population fluctuations and the breeding activity of this species in relation to climatic conditions. It may also be worthwhile monitoring GGF population change at nearby waterbodies such as O'Hern's Swamp as a comparison with the CoW Quarry population.

It is interesting that the sections of the quarry where the highest numbers of metamorphs and sub-adult frogs were recorded also had very few adult frogs (sections 1 and 4). This data suggests that smaller frogs may actively avoid the adult frogs which are known to prey upon their own kind.

Emergent, submergent and floating aquatic vegetation are recognised as important microhabitats for GGFs (DEHWA 2009). All three types of aquatic vegetation were recorded in each of the four sections of the quarry in varying degrees of dominance. Overall however, the mean aquatic vegetation cover across the waterbody was low. Heard and Scroggie (2010) recommend a mean aquatic vegetation cover of 40% for optimum GGF habitat and according to our estimates the cover at the quarry was only 15%. We did not find any correlation between the number of GGFs recorded in each survey section and the cover of aquatic vegetation. For example, section 4 had the lowest mean cover (10%) and the highest number of individual GGFs recorded (43). It is possible that aquatic vegetation is of greater importance during the breeding season when the males call from vegetation to attract the females.

Additionally, the cover of aquatic vegetation within a waterbody varies with season and rainfall. Aquatic vegetation cover is highest during the peak growing season in late spring and early summer and submergent vegetation, in particular pondweeds (*Potamogeton* spp.), die back in late summer and autumn, resulting in reduced vegetative cover. Above-average summer rains also elevated the water levels within the quarry and this is likely to have inundated areas of vegetation, leading to a lower estimate of cover. The quarry is a large waterbody with a naturally high percentage of non-vegetated open water and this also results in a lower overall estimate of aquatic vegetation cover compared to other, smaller GGF waterbodies such as small farm dams.

It is important to note that the observers in this survey had widely varying experience and skills in relation to visual encounter frog surveys, and this undoubtedly influenced the number of frogs recorded in each section of the waterbody.

The terrestrial environment surrounding the waterbody is also considered to be an important indicator of ideal GGF habitat. The frogs may also be choosing sites with a higher cover of rock on the margins of the waterbody. Growling Grass Frogs are known to bask on the banks on rocks or bare ground during the day and also forage in the terrestrial environment at night (DEWHA 2009). The CoW Quarry site was found to have a good combination of rocky habitat and grass cover within each survey section. The high level of grass cover in all sections of the site likely provides protection for the GGF from predators both during the day and night. The rocky outcrops and boulder piles around the edge of the water would provide basking and foraging habitat as well as ideal shelter sites for the frogs for winter aestivation (dormancy).

Although the terrestrial habitat was found to be largely dominated by weed species this is unlikely to affect the abundance of the GGF. The CoW has implemented rehabilitation and revegetation works which should support a higher proportion of indigenous flora species at the site in the future.

Season 2 recorded a significant decline in the adult population of growling grass frogs and no evidence of breeding observed. An average of 4 adults were observed over the 3 study dates compared to 101 in season 1, with Survey 1 observing a total of 6 adults, Survey 2 a total of 1 adult, and Survey 3 a total of 5 adults. Slightly higher numbers of individuals were observed calling; 12 on average, with Survey 1 observing 2 calling adults, Survey 2 observing 22 calling adults and Survey 3 observing 12 calling adults. Of most concern is the lack of metamorphs, tadpoles and subadults representing a lack of breeding in Season 2 (Nov 11-Jan 12). Previous studies done during December have shown this month to be the height of the breeding season and previous have recorded hundreds of late stage tadpoles in December (Homan 2010). The December study of Season 2 in contrast recorded no tadpoles during this month. These findings are consistent with Homan (2011).

The significantly lower levels of adults GGF's could be attributed to another season of high rainfall, as observed in 2010/2011. Average monthly rainfall for the months November 2011-Jan 12 was 92.9mm compared with the mean monthly rainfall over the same period of 54.9mm (BOM 2012). As listed in section 5.1 other suitable GGF breeding sites would have been available in the local area, resulting in adult frogs being able to disperse to other sites (Homan 2010). It is also notable that the rainfall of January Season 1 (78.2mm) was over four times higher than the rainfall of January Season 2 (17.4mm). During season 1 this would have resulted in higher water level and as such inundating more vegetation within the quarry site. The resulting higher levels of submergant vegetation would increase the amount of habitat available for egg deposition and tadpole foraging and as such this seasonal flooding event would have provided high quality breeding habitat (DEWAH 2009). In contrast, the lower rainfall in January season 2 may not have resulted in a higher seasonal inundation and as such may have reduced the quality and amount of breeding habitat.

While mean aquatic vegetation has increased in Season 2 since Season 1 (See figure X) we have not seen an increase in GGF populations. Submergant vegetation increased around 17% in Season 2 while emergent vegetation increased around 6%. Floating vegetation was the only aquatic vegetation type to decrease, season 1 observed 7.5% cover which reduced by 3.5% to season 2 cover (4%). It would be expected that an increase in the mean aquatic vegetation cover provides more breeding and foraging habitat and therefore an increase in frog population. However Season 2 has seen a dramatic decrease in the GGF population observed in Season 1. There also appears to be a negative trend since 2010 figures (Homan 2010).

The terrestrial vegetation at the quarry appears to have decreased overall from Season 1, with a change from 71% cover (grass & shrub) to 46% cover. The most significant change was grass cover, reduced from 70% cover to 40% cover. This may be attributed to the high rainfall inundating grass around the quarry. There was also a significant increase in the cover of rocks/ logs (56% increases). This may be due to a reduced grass cover exposing more rocks. Bank side rocks and other debris close to water bodies are important for shelter for the Growling Grass Frogs so this increase in rock cover would not be detrimental to the species (Wassens 2005). There was a slight increase in shrub cover (5% +) which may be a result of vegetation maturing and a wet summer increasing growth. Overall there appears to be no correlation between the change in vegetation from Season 1 to Season 2 and frog populations. It is important to note the significant differences in peoples perceptions of vegetation and ground cover, therefore some change in cover may be as result of multiple observers.

As listed in section 5.1, surveys in season 2 were also conducted by volunteers and therefore there was a wide variety of skills in relation to the visual frog surveys. This could have limited the amount of frogs that were identified. However both season 1 and 2 was conducted with the help of and ecologist and the same amount of information was provided before each survey was conducted.

During Season 2 there was a record taken of the number of individuals of other amphibian species present. Other amphibian species may have had an influence on the reduced abundance and breeding of the Growling Grass frog. Species recorded included Spotted Grass Frogs (Limnodynastes tasmaniensis), Banjo Frog (Limnodynastes dumerili), Common Froglet (Crinia Signifera) and Striped Marsh Frog (Limodynastes peronii). Competition for resources from frogs with similar traits could have had impacts on the breeding success of the Growling Grass Frog However due to a lack of longitudinal data from Season 1 we are unable to draw conclusions. These surveys have not actively targeted these other observed species of frogs, so this theory would need to be further investigated.

Feral pests could have also had an impact on the reduced numbers of adult GGF's recorded and in turn the breeding success of Season 2. Foxes and

cats are know to prey on juvenile and adult frogs (DEHWA 2009) and the ongoing increase in residential developments in the Epping area could have increased the number of feral cats and foxes. Urbanisation increases cover, food and den sites available to foxes and as such increases population (Hume City Council 2010). Hume City Council has identified a high number of foxes near the Hume Highway in Craigieburn which is connected to the Epping Quarry by the Merri Creek and open grassland/agricultural areas (Hume City Council 2010).

Chytrid fungus is an ongoing concern for the Growling Grass Frog and is know to be present in the Merri Creek Catchment. The fungus infects the skin of the frogs and has been attributed to the extinction of native frog populations in Australia (DEH 2006). Further studies are required to determine if Chytrid fungus is playing a major role in the decline of the population at CoW quarry; however it is highly likely to be present as the quarry is functionally connected to other populations along the Merri Creek (D. Gilmore, Biosis Research, pers. comm.).

4.1 Recommendations

Our surveys collected systematic data that has helped confirm that there was a successful GGF breeding season at the CoW Quarry in 2010/11 and that there were very low frog numbers in the 2011/2012 season.

In 2010, the species appeared to be thriving at this site, with high recruitment levels. However, given the very significant decline in Growling Grass Frog numbers in the 2011/2012 season, ongoing monitoring to understand the possible causes are recommended. VNPA supports the continued monitoring of the GGF population and protection of this site as key breeding habitat for Growling Grass Frogs. The quarry site lies in an important area along the Merri Creek catchment and is linked with other key breeding sites for the species.

4.2 Future Surveys

Ongoing monitoring of the GGF population at theCoW Quarry is a key recommendation of the management plan for the site (Gilmore 2009). As urbanisation and land use change increases in the Epping area, it is important to monitor Growling Grass Frog populations. The VNPA's NatureWatch program is very interested in continuing to work with the City of Whittlesea to run community-based Growling Grass Frog monitoring at the site. We would be willing to undertake up to three population counts in future seasons.

The continued involvement of the community through the NatureWatch progam will increase public awareness of the endangered GGF. Community participants will also be made more aware of the CoW environmental programs and initiatives.

REFERENCES

DEWHA (2009) Significant impact guidelines for the vulnerable growling grass frog (Litoria raniformis) – Background paper to the EPBC Act policy statement 3.14. Department of the Environment, Water, Heritage and the Arts, Canberra.

DSE (2007a) Advisory List of threatened vertebrate fauna in Victoria. The State of Victoria Department of Sustainability and Environment, East Melbourne.

DSE (2007b) Growling Grass Frog Litoria raniformis: A Nationally Vulnerable frog species. The State of Victoria Department of Sustainability and Environment, Warnambool.

Gilmore, D. (2009) Growling Grass Frog Management Plan: City of Whittlesea Quarry, Cooper Street, Epping, Victoria, Biosis Research Pty Ltd, Port Melbourne.

Heard, G.W., and Scroggie, M.P. (2010) Guidelines for managing the endangered Growling Grass Frog in urbanising landscapes. Arthur Rylah Institute for Environmental Research Technical Report Series No. 208. Department of Sustainability and Environment, Heidelberg.

Homan, P. (2010) Monitoring of Growling Grass Frog Litoria raniformis population and survey of vertebrate fauna at 490 Cooper St, Epping. (Unpublished Report to City of Whittlesea) NOTE this is an addition report to the 2010 one.

NPWS (2001) Hygiene protocol for the control of disease in frogs. Threatened Species Management Information Circular Number 6. Hurstville NSW, NSW National Parks and Wildlife Service.

APPENDICES

APPENDIX 1

Data sheet page 1

Victorian National Parks Association

City of Whittlesea Quarry Growling Grass Frog Monitoring Data Sheet

City of Whittlesea Quarry GGF Monitoring (NatureWatch)

Project: ..... Date:.....

Quadrant Number: .....

Start time: ..... End time: .....

Observers: .....

Weather (Only one team to complete this section)

Temperature: ..... Wind strength: .....

Cloud cover: ..... Wind direction: .....

Precipitation in last 24 hours? Yes/No

Water depth (read from water gauge): ..... m

Waterbody habitat data for each quadrant

Aquatic vegetation (See attached diagram for information on how to complete this section)	*Species (if known)*
Emergent vegetation cover .....%	.....
Floating vegetation cover .....%	.....
Submergent vegetation cover .....%	.....
Total aquatic vegetation cover (see diagram to see how to calculate this) .....%	.....

* Emergent vegetation is any aquatic macrophyte rooted below the water with foliage emerging above the water-surface, submergent vegetation is any aquatic macrophyte rooted below the surface with foliage below the water-surface, and floating vegetation is any rooted or unrooted aquatic macrophyte or alga with foliage floating on the water-surface.

Terrestrial habitat data for each quadrant

Fringing vegetation on dry land (within 5m of edge of waterbody)	*Species (if known)*
Grass cover .....%	.....
Shrub cover .....%	.....
Rock/log .....%	.....

NatureWatch

Data sheet page 2

Frog data to be collected at each transect

Growling Grass Frog numbers will be estimated through call playback and visual estimation counts. Call playback will be conducted prior to commencement of quadrant counts and the number of male Growling Grass Frogs responding to the elicitation will be recorded. While undertaking visual counts of frogs, each team will also record the number of males calling in their quadrant, taking care not to count frogs calling in the quadrant of adjacent teams.

Estimated # Growling Grass Frogs heard calling (circle) 0 1-10 11-20 21-50 50+

A scan of the waterbody and within 5m of the water's edge needs to be undertaken in each quadrant. A total count of all Growling Grass Frogs should be made, ensuring individual frogs are not double counted. Where possible estimate the size of all frogs within one of four size classes: **late-stage tadpole** (full tail, may or may not have legs), **metamorph** (<30mm Snout-Groin Length (SGL) +/- tail-stub), **sub-adult** (< 30-50mm SGL) or **adult** (> 50 mm SGL), or otherwise count as **unknown** (it will be difficult to estimate the size of frogs well out in the water, where you are only likely to see eye shine). An attempt should also be made to determine the sex of each frog. This will only be possible where good views of the frogs are obtained. If unsure count as unknown. Tally the total number of frogs within each sex/size class. Each team should spend 30 minutes counting frogs within their quadrant.

	Male	Female	Unknown
Late-stage tadpoles			
Metamorph			
Sub-adult			
Adult			
Unknown			

Notes: (e.g. Record other frog species heard calling or seen, and other rare or notable species observed. Predators such as cats and foxes etc should also be recorded.

Project developed by the Victorian National Parks Association's NatureWatch program and Biosis Research with support from Port Phillip and Westernport Catchment Management Authority and the City of Whittlesea Council.

APPENDIX 2

Table A2.1 Number in each age class of Growling Grass Frogs found within each section of the quarry

Section of the Quarry

Age class	1	2	3	4	Total
Late Stage Tadpoles	0	0	0	0	**0**
Metamorphs	17	0	6	18	**41**
Sub-adults	6	4	7	16	**33**
Adult Males	1	0	1	2	**4**
Adult Females	1	3	1	3	**8**
Adults Unknown	1	1	13	0	**15**
Total	**27**	**10**	**31**	**43**	**101**

Table A2.2 Terrestrial vegetation cover in each section of the quarry

Section of the Quarry

Terrestrial Vegetation Type	1	2	3	4	Mean
Grass Cover	50	70	75	85	**70**
Shrub Cover	1	0	1	0	**0.5**
Rock/Log	20	20	1	15	**14**
Remaining	29	10	23	0	**15.5**

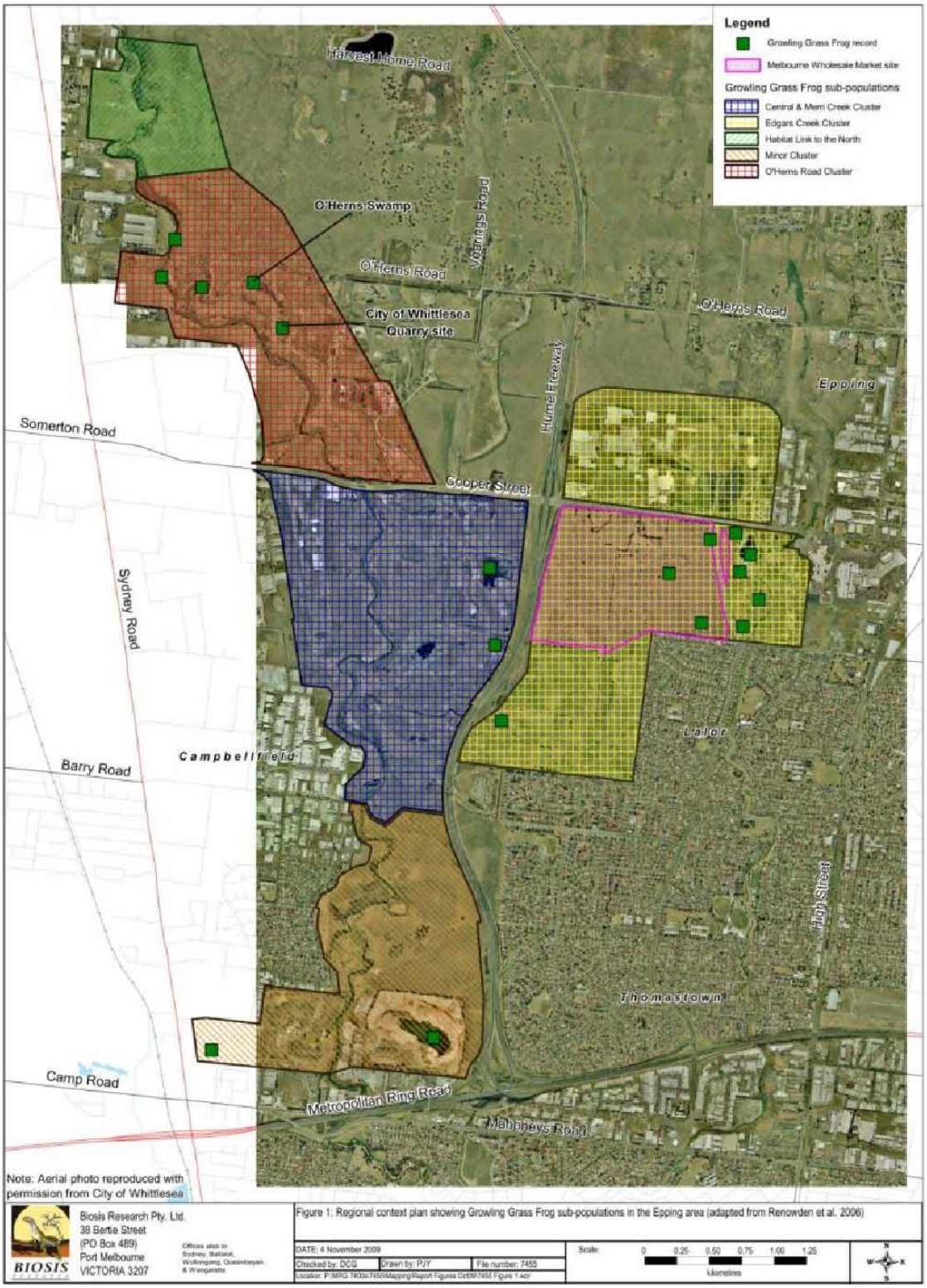
Table A2.3 Cover of emergent, floating and submergent aquatic vegetation within each section of the waterbody

Section of the Quarry

Aquatic vegetation type	1	2	3	4	Mean
Emergent	5	20	30	20	**18.75**
Floating	10	5	10	5	**7.5**
Submergent	60	5	5	5	**18.75**
Mean Total aquatic vegetation cover	**25**	**10**	**15**	**10**	**15**

FIGURES

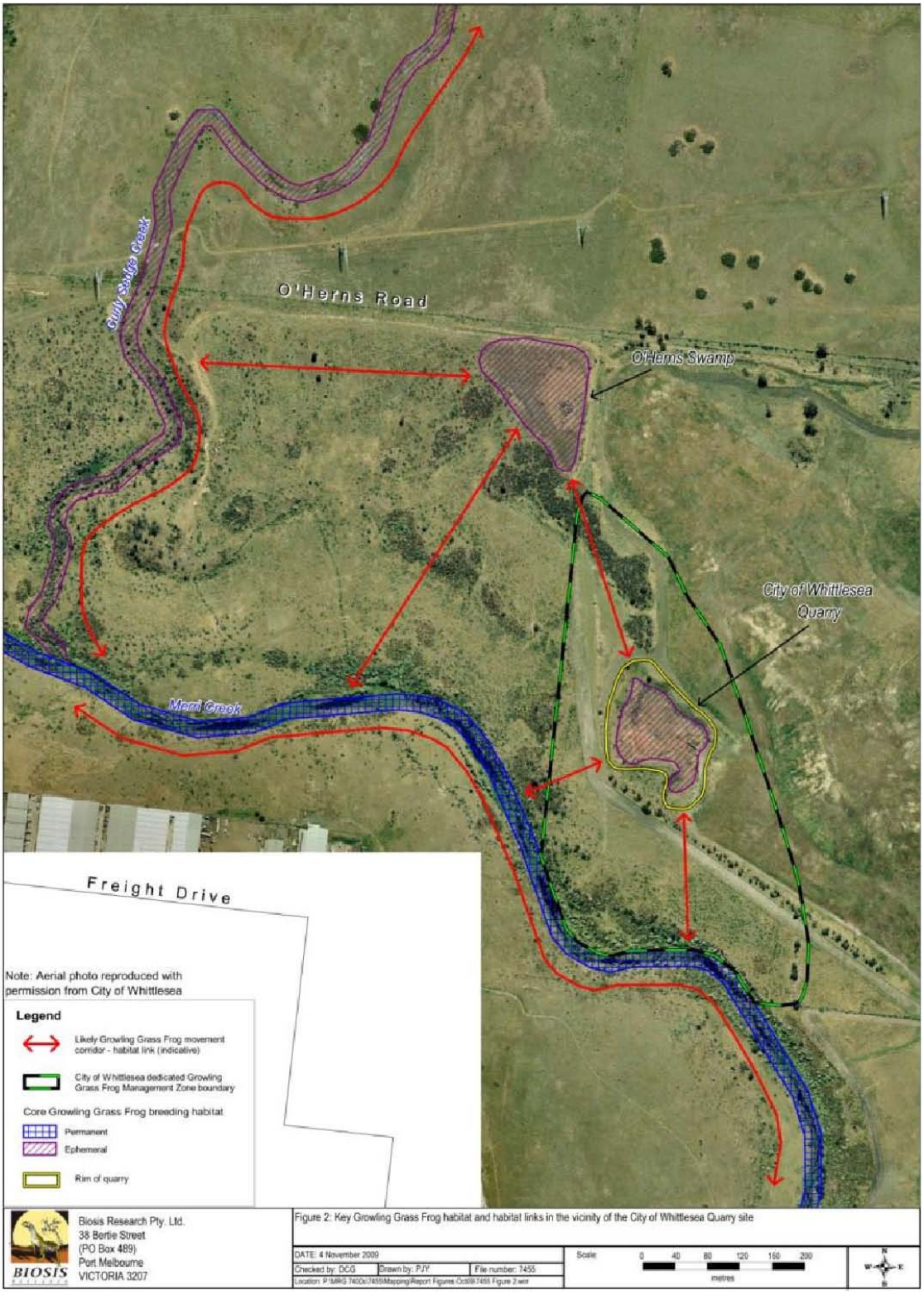
1 Location of study area



Source: Gilmore, D 2009 'Growling Grass Frog Management Plan: City of Whittlesea Quarry, Cooper Street, Epping, Victoria.' Biosis Research Pty Ltd, Port Melbourne

2 Key Growling Grass Frog habitat and links in the vicinity of the City of Whittlesea Quarry site

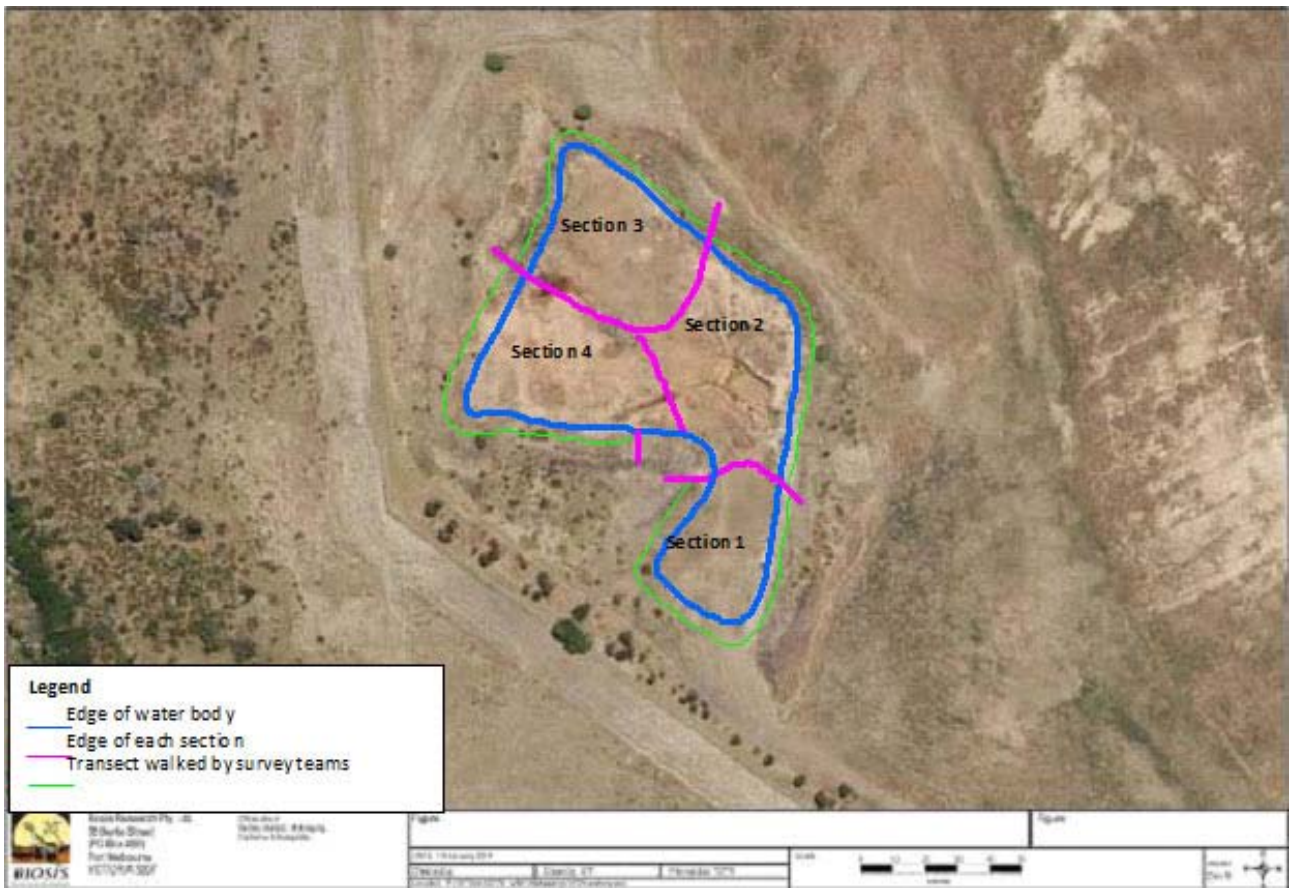
Source: Gilmore, D 2009 'Growling Grass Frog Management Plan: City of Whittlesea Quarry, Cooper Street, Epping, Victoria.' Biosis Research Pty Ltd, Port Melbourne



3 Satellite photo of the quarry site on 26th February 2010 showing the quarry hole partially filled with water (PhotoMap by nearmap.com)

4 Satellite photo of the quarry site on 22nd December 2010 showing the quarry hole filled with water (PhotoMap by nearmap.com)

5 Satellite photo of City of Whittlesea quarry site showing survey sections

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