Northern Territory Government

Department of Health and Community Services

Biting Insect Survey and Assessment

Blacktip Project

Supplementary Trapping September 2004

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Study undertaken on behalf of EcOZ Environmental Services
for
Woodside Energy Ltd

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1. Introduction

As part of the biting insect assessment for the Blacktip Project, traps were required to be set during the peak pest biting midge season months of either August, September, October or November. The month of September was to sample peak season numbers of the main human pest biting midge in coastal areas of Northern Australia, *Culicoides ornatus.* Peak abundance of *C. ornatus* occurs around the time of the full moon each month, with numbers generally elevated over a four-five day period. Numbers of *C. ornatus* can vary dramatically over this four-five day period, although previous studies have shown highest numbers generally occur one day before the full moon and on the day of the full moon. To define the peak numbers of *C. ornatus* in September, trapping was proposed to occur over a three day period around the full moon, which was to include trapping one night before the full moon, the night of the full moon, and the night after the full moon. This trapping was also likely to indicate peak mosquito numbers for this month, with the exception of *Ochlerotatus vigilax*, which generally occur 10 days after the monthly high tide.

The ensuing report discusses the new findings and recommendations derived from the September 2004 trapping period, and is to be used as a supplement to the Biting Insect Survey and Assessment report for the Blacktip Project, which was produced in July 2004. The new findings provided in this report can supersede the equivalent findings in the July 2004 report.

2. Methods

The trapping methods and equipment that were used for biting insect sampling at the Blacktip Project site in June 2004 were also utilised in September. The same nine trap sites that were located and flagged with tape in June 2004 were again used, which were re-located using a hand held GPS unit. Both mosquitoes and biting midges were collected for identification.

3. Results

3.1 Habitat survey

Further investigations of Swamp 1 were conducted to further evaluate the potential of the swamp as a mosquito breeding site. Salinity samples were taken at some sites in Swamp 1 (Table 9). Larval survey results are provided in Table 9. Photos were taken at selected sites at the north section of the swamp (Appendix 1), which had previously been unsurveyed.

The tidal section of Swamp 1 was still flooded, and significant areas of flooding still remained in the south section of the Paperbark area (Figure 3a). Significant flooding was also located in the north section of the Paperbark area, as well as in the tidal reed areas. Much of the vegetation pattern of the swamp has now been roughly determined (Figure 4a).

The salinity sample taken in the *Shoenoplectus* reed area on the south-west edge of Swamp 1 (PKL6, Figure 3a) revealed a reading of 38.2 *m*s/cm, indicating the area was flooded with mainly tidal water (Table 9). *Culex sitiens* was found breeding in concentrations of 2 larvae per ladle dip.

The salinity sample taken in flooded areas of the *Paperbark* forest (PKL9, Figure 3a) on the south-east edge of Swamp 1 revealed a salinity reading of 1 *ms*/cm, indicating freshwater pooling (Table 9). No mosquito breeding was located. The salinity sample taken in the flooded *Eleocharis* reed area (PKL8, Figure 3a) on the tidal flat adjacent to the paperbark forest fringe revealed a reading of 1.3 *ms*/cm, indicating the area was flooded with freshwater. No mosquito breeding was located.

The salinity sample taken at the flooded tidal area sparsely vegetated with reeds on the north edge of Swamp 1 (PKL18, Figure 3a) revealed a reading of 7.5 *ms*/cm, indicating the area was flooded with slightly brackish water (Table 9). No mosquito breeding was located.

Culex annulirostris larvae were found breeding in concentrations of 1 larvae per 5 ladle dips in the flooded *Eleocharis* reed area (PKL19, Figure 3a) east of PKL18.

No larvae were found in the flooded paperbark forest (PKL21), or at the flooded Paperbark fringe (PKL20) (Figure 3a). Only limited sampling occurred in the paperbark forest due to the presence of feral pigs in the area.

3.2 Adult Biting midge trap results

A total of 23,333 adult female biting midges were collected at the nine trap sites during trapping from September 28 to September 30, representing at least 12 species (Tables 1-4). Trap locations and the spatial abundance of selected important biting midge species are shown in Figure 2.

Culicoides austropalpalis was the most abundant species collected, representing 37.38% of all biting midges trapped. The next most abundant species were *Culicoides ornatus* (25.68%) and *Culicoides ?immaculatus* (11.97%). (Table 4).

The highest number of females of various species from a single trap was *C. austropalpalis* (4,800) (Table 1), followed by *C. ornatus* (3200) (Table 1), *C. cordiger* (1000) (Table 1) and *C. ? immaculatus* (1000) (Table 2).

Trap Site 6 caught the most biting midges over the three day trapping period (13,500), representing 57.86% of all biting midges trapped. This was followed by Trap Site 8 (2,752 & 11.79%), Trap Site 9 (2,654 & 11.37%), Trap Site 4 (1,603 & 6.87%), Trap Site 1 (1,105 & 4.74%), Trap Site 5 (952 & 4.08%), Trap Site 3 (500 & 2.14%), Trap Site 7 (135 & 0.58%) and Trap Site 2 (132 & 0.57%)(Table 4). Trap Site 2 is under-represented for the three day trapping period, as the trap failed during sampling on the night of the 28th of September, 2004.

Trap Site 6 caught the most *C. ornatus* over the three day trapping period (3,980), followed by Trap Site 8 (960), Trap Site 5 (504), Trap Site 4 (416), Trap Site 9 (73), Trap Site 2 (26), Trap Site 3 (24), Trap Site 7 (9) and Trap Site 1 (1). (Table 4).

Trap Site 9 caught the most *C. ?immaculatus* (1,398), followed by Trap Site 8 (570), Trap Site 4 (568), Trap Site 1 (107) and Trap Site 5 (87) (Table 4). The other trap sites recorded very low numbers of this species.

Trap Site 4 caught the most *Culicoides* sp nr *subimmaculatus* (northern Form) (460), followed by Trap Site 6 (200), Trap Site 9 (153) and Trap Site 5 (112) (Table 4). Other trap sites recorded minimal numbers of this species.

3.3 Adult mosquito trap results

A total of 9,075 adult female mosquitoes were collected at the nine trap sites during trapping from September 28 to September 30, representing 15 species (Tables 5-8). Trap locations and the spatial abundance of selected important mosquito species are shown in Figure 1.

Coquillettidia xanthogaster was the most abundant species collected, representing 53.41% of all mosquitoes trapped. The next most abundant species were *Culex annulirostris* (17.86%) and *Culex sitiens* (11.98%). (Table 8).

The highest number of females of various species from a single trap was *Cq. xanthogaster* (463) (Table 5), followed by *Cx. sitiens* (365) (Table 6), *Cx. annulirostris* (222) (Table 5) and *Cx. vishnui*

group (179) (Table 7). The highest number of female *Anopheles farauti s.l.* from a single trap was 77 (Table 7), while the highest number of female *Ochlerotatus vigilax* was 53 (Table 6).

Trap Site 5 caught the most mosquitoes over the three day trapping period (2,030), representing 22.37% of all mosquitoes trapped (Table 8). This was followed by Trap Site 4 (1,281 & 14.11%), Trap Site 6 (1,268 & 13.97%), Trap Site 9 (895 & 9.86%), Trap Site 1 (889 & 9.8%), Trap Site 2 (871 & 8.61%), Trap Site 8 (681 & 7.5%), Trap Site 7 (668 & 7.36%) and Trap Site 3 (583 & 6.42%) (Table 8).

Trap Site 5 caught the most *An. farauti s.l.* (217), followed by Trap Site 8 (87), Trap Site 7 (73), Trap Site 1 (72) and Trap Site 6 (31) (Table 8), with minimal numbers of this species recorded in the other traps.

Trap Site 6 caught the most *Cx. annulirostris* (355), followed by Trap Site 5 (340), Trap Site 4 (253), Trap Site 7 (215), Trap Site 9 (164) and Trap Site 1 (155) (Table 8), with minimal numbers recorded elsewhere.

Trap Site 4 caught the most *Cq. xanthogaster* (831), followed by Trap Site 2 (690), Trap Site 6 (668), Trap Site 1 (597), Trap Site 9 (534), Trap Site 3 (506), Trap Site 8 (504), Trap Site 5 (311) and Trap Site 7 (207) (Table 8).

Trap Site 6 caught the most *Oc. vigilax* (118) followed by Trap Site 5 (84), with minimal numbers recorded at the other trap locations (Table 8).

4. Discussion

4.1 Biting midges

4.1.1 Species present

Of all biting midge species present, *Culicoides ornatus* was the most significant species trapped, and was the second most abundant biting midge species collected during the 3-day trapping period. Another potentially significant species, *Culicoides* sp nr *subimmaculatus* (northern form), was recorded in low numbers.

Culicoides austropalpalis was the most abundant species trapped but is not considered a human pest species in Australia.

Culicoides ?immaculatus was the third most abundant species trapped, although the specimens collected may have been either of two species, *Culicoides immaculatus* or *Culicoides* undescribed sp. (nr. *C. immaculatus*). These two species are best identified by looking at male specimens (Glen Bellis pers.comm.), none of which were collected and hence no conclusive identification was reached. Both species do have distinct breeding sites, with *C. immaculatus* breeding sites generally being sandy beaches with rocks (Whelan 1998b), while *Culicoides* undescribed sp. (nr. *C. immaculatus*) breed in the lower reaches of mangrove creeks (Shivas 1999). It is therefore possible that the specimens collected were in fact *C. immaculatus.*

Other biting midge species of little human significance were trapped in minor numbers during the three day trapping period, some of which were briefly discussed in the July 2004 Blacktip Project Biting Insect Report.

4.1.2 Probable breeding sites for important biting midge species

Breeding sites for *C. ornatus* were discussed in the July 2004 Blacktip Project Biting Insect Report. Breeding sites for the other potential human pest biting midge species in the Blacktip Project area, *Culicoides* sp nr *subimmaculatus* (northern form), have been located in open sandy estuarine flats in

Queensland (Reye 1992). The presence of this species in highest numbers in those traps set nearby to Yelcher beach suggests breeding sites for this species occurs in the Yelcher Beach area, probably in the open sandy areas associated with the Yelcher Beach creek, and in the open sandy beach area nearby to the proposed onshore pipe crossing.

The presence of *C. ?immaculatus* in highest numbers at Trap Sites 4, 8 and 9 indicate the most productive breeding sites are probably located in the rocky/sandy beach area nearby to the trap sites, with the most productive area possibly being nearby to Trap Site 9.

4.1.3 Spatial abundance and dispersal

Most *C. ornatus* were recorded at Trap Site 6, indicating the adjacent neap tide mangrove area is the largest source of this species to the Blacktip Project area. The second highest numbers of this species was recorded at Trap Site 8, which was located on high ground adjacent to a cliff face at the southern end of Injin Beach. The major source of *C. ornatus* to Trap Site 8 may have been the mangrove foreshore area adjacent to the trap site, with some dispersal from the upper mangrove areas of Swamp 2. Trap Site 5 was the third most productive site for *C. ornatus*, which is adjacent to the mangroves associated with the Yelcher Beach Creek, indicating this species had dispersed to the trap site from their breeding sites in the adjacent mangrove area. Trap Site 4 was the next most productive site, indicating either dispersal to this site from the adjacent foreshore mangrove area, dispersal to this site from the Yelcher Beach Creek neap tide mangrove areas, or a combination of both. The remaining sites recorded minor numbers of *C. ornatus*, indicating minor dispersal had occurred to these areas from the neap tide mangrove areas of the Yelcher Beach Creek, and the foreshore breeding sites adjacent to the Blacktip Project site. Trap Site 3 recorded low numbers of this species, which is located more than 4km from the nearest potential breeding site, indicating the wide dispersal range for this species.

Culicoides sp nr *subimmaculatus* (northern form) was most abundant at the trap sites located nearby to Yelcher Beach, with little dispersal to the trap sites further inland. It is mentioned by Reye (1992) that the pest range for this species is generally around 400m from their breeding sites. The low numbers of this species recorded at Trap Site 3 is likely to have been the result of wind dispersal from their breeding sites on Yelcher Beach.

Culicoides ?immaculatus was most abundant at the three trap sites located near the headland north of the proposed pipe shore crossing. The trap location with the fourth highest concentration of this species was Trap Site 1, located on the centre of the north boundary of the proposed plant site, indicating probable wind dispersal from their breeding sites on Yelcher and Injin Beach, as *Culicoides immaculatus* generally do not disperse more than 400m from their breeding sites (Reye 1992), and *Culicoides* undescribed sp. (nr. *C. immaculatus*) does not leave its mangrove habitat (Shivas 1999). This species was also found in low numbers in other trap sites located near the coast, indicating small breeding sites probably exist along most of the shoreline associated with Injin and Yelcher Beach.

4.1.4 Seasonal fluctuations

Trapping in September 2004 was designed to coincide with the peak seasonal abundance of *C. ornatus*, which generally occur in the months of August to November. Trap results indicated only slightly higher numbers than those recorded in June 2004. The reason for this is unknown, but it could have been due to an unseasonal decrease in numbers during the peak season months (See Appendix 2, Oct 96 results). Wind can disrupt dispersal of this species, but probably only when wind speeds are greater than 7km/hr (Shivas and Whelan 2001), which do not tend to occur for extended periods during the late September build up period. No wind was evident during the mornings of the trapping period, while afternoon sea breezes were minimal by sunset and not enough to disrupt mosquito biting at the camp area, indicating wind would not have been a major contributing factor to the lower than expected *C. ornatus* catches. It is likely that the trapping may have missed the monthly peak at the sites nearby to the Yelcher Beach Creek neap tide mangrove area and the foreshore mangrove areas, as

a large proportion of adults may have already dispersed into the nearby hinterland in the preceding days.

Culicoides sp nr *subimmaculatus* (northern form) are most abundant in the mid dry season and taper off by the late dry season (Whelan 1998b), indicating the late September trapping would have indicated numbers as they were coming off the peak period.

Culicoides immaculatus generally reach peak numbers in the mid to late dry season and early wet season, while the seasonal variation in *Culicoides* undescribed sp. (nr. *C. immaculatus*) numbers is not known or has not been published. If the *C.?immaculatus* samples collected were in fact *C. immaculatus,* then the September trapping would have indicated peak season numbers.

4.1.5 Limitations

Limitations for *C. ornatus* during this trapping episode are similar to the limitations that were described in Section 5.1.5 of the report by Warchot et al 2004. Monthly trapping for 12 months around the period of the full moon would be required to give a better indication of most other biting midge species and numbers likely to affect the development area, while monthly trapping around the half moon periods would be required to more effectively sample *Culicoides* sp nr *subimmaculatus* (northern form) populations.

4.1.6 Pest problems and public health

Trapping in the peak season month of September failed to locate pest numbers of *C. ornatus* within the proposed plant site. It is therefore likely that this species will only cause minor nuisance problems within the proposed gas plant site, due to the distance of this area from major *C. ornatus* breeding sites. Minor nuisance numbers were recorded at the trap sites nearby to the onshore pipe crossing, and could reach minor pest numbers in the months of August to November due to the nearby potential foreshore breeding sites. Biting from this species will be mostly noticed in the 2 hours either side of sunset and sunrise.

No information is published or known about approximate pest levels in regards to CO_2 trap catches for *Culicoides* sp nr *subimmaculatus* (northern form) and *Culicoides ? immaculatus* (*Culicoides immaculatus* or *Culicoides* undescribed sp. (nr. *C. immaculatus*)). However, it can be presumed from pest levels for *C. ornatus* that the trap results indicate that *Culicoides* sp nr *subimmaculatus* (northern form) may cause at least a minor nuisance problem at the onshore pipe crossing site, with biting possibly occurring all day in or close to breeding sites, but crepuscular (biting around sunset and sunrise) away from breeding sites. *Culicoides* Sp nr *subimmaculatus* bites most actively around the half moon period (Tweed Shire Council, 2004).

Culicoides undescribed sp. (nr. *C. immaculatus*) bite viciously in mangrove areas, although peak monthly abundance is not clearly known, as Shivas (1999) recorded peaks in adult catches of this species in tidal areas around the time of both the neap tide and spring tides on different occasions. It is not known what periods of the month that *Culicoides immaculatus* will be most abundant. From the September 2004 trap catches, it can be assumed that *C. ?immaculatus* is likely to cause a minor to moderate pest problem during some periods of the month at the onshore pipe crossing site. As the *C. ?immaculatus* specimens collected were most likely *C. immaculatus,* biting is likely to occur from dusk to sunrise, most notably in the late dry and early wet season.

4.1.7 Measures to reduce biting midge pest problems

As mentioned in the July 2004 Blacktip Project Biting Insect Survey Report, personal protection is the only real solution to reduce any *C. ornatus* biting midge pest problem. The same principal applies for the other potential pest biting midge species in the Blacktip Project, *Culicoides* Sp nr *subimmaculatus* and *Culicoides ?immaculatus.*

4.2 Mosquitoes

4.2.1 Species present

Three potential pest and vector mosquito species were recorded in significant numbers during the three day trapping period. They were *Culex annulirostris, Ochlerotatus vigilax* and *Anopheles farauti s.l.* Another potential pest mosquito species, *Coquillettidia xanthogaster,* was also recorded in significant numbers during the three day trapping period.

4.2.2 Mosquito breeding sites

Swamp 1

Swamp 1 was still significantly flooded when surveyed on September 28, 2004, due to the higher than average rainfall in that region for that year, and due to late rainfall (45mls over 5 days) at the end of May and in early June 2004 (Bureau of Meteorology Data). A high salinity reading taken from a *Shoenoplectus* reed area (Site PKL6, Table 9) of the swamp indicates recent high tides had pushed salt water into the area. The other *Shoenoplectus* reed areas in Swamp 1, as well as any mudflat areas, would also have recorded high salinity readings.

Anopheles farauti s.l. are likely to breed anytime the *Shoenoplectus* reed areas in Swamp 1 are flooded with brackish water, with peak season numbers occurring from March to June when the *Shoenoplectus* reed areas are most conducive to mosquito breeding. *Culex sitiens* are likely to breed anytime the *Shoenoplectus* reed areas and adjacent mudflat areas are flooded with brackish or tidal water. *Ochlerotatus vigilax* are likely to breed in high numbers in the *Shoenoplectus* reed areas and adjacent mudflat areas after they have partially or fully dried out and then become inundated with tide or rainwater, mainly in the months of September to January inclusive.

An extensive *Eleocharis* reed area located in the upper tidal zone of Swamp 1 was still flooded with freshwater (Site PKL8). The site was found to be a productive breeding site for *Culex annulirostris* in June 2004 (Warchot et al 2004). No larvae were located during limited sampling, indicating the productivity of the site as a source of *Cx. annulirostris* was lower than that in June 2004. This site, as well as other *Eleocharis* reed areas located within the tidal areas of Swamp 1 are likely to be *Cx. annulirostris* breeding sites whenever they are flooded, with the highest productivity likely to be from January to August. The *Eleocharis* reed areas would be highly productive *Oc. vigilax* breeding sites after they partially or fully dry out and then become inundated with tide or rainwater, mainly in the months of September to January inclusive.

The paperbark forest located on the south-east section of Swamp 1 (PKL9) still contained areas of pooling, mainly in pig wallows and other depressions. The northern section of the paperbark forest (PKL12) also contained many flooded pools, many of which where vegetated with the semi-aquatic reed *Eleocharis*. Traditional Owners from Port Keats advised that there are permanent areas of water located within the paperbark swamp area of Swamp 1. The permanent water would be perennial sources of mosquitoes, in particular *Cx. annulirostris* and *Cq. xanthogaster*.

Swamp 2

The section of Swamp 2 north of the freshwater creekline was dry during the time of visit. No surveys were conducted at the freshwater creekline or south of the freshwater creekline, due to the distance of this area from the Blacktip Project site.

4.2.3 Spatial abundance and dispersal

The highest numbers of mosquitoes trapped over the three-day trapping period were collected at Trap Site 5. The majority of mosquitoes trapped at this site were *Culex sitiens,* indicating a productive

breeding site occurs in a tidal area within 2km of the trap site, most likely nearby to the freshwater creekline. Trap Site 5 also caught the most *An. farauti s.l.* over the three day trapping period, indicating a probable *Shoenoplectus* reed habitat exists downstream of the freshwater creekline. This indicates that the unsurveyed area of Swamp 2 nearby to the freshwater creekline is a significant source of mosquitoes, although being over 3km away prevents it from being a major source of *An. farauti s.l.* to the development site. The freshwater creek area may be a source of stronger flying mosquitoes such as *Cx. annulirostris, Cq. xanthogaster* and *Oc. vigilax* to the development area.

The second most productive trap was Trap Site 4, located in the coastal vine thicket north of proposed onshore pipe crossing site. The closest breeding area to this trap site is Swamp 1, indicating the densely vegetated vine thicket is a suitable harbourage and dispersal area. Mosquitoes from this trap may also have been sourced from the Swamp 2 freshwater creek area, although Swamp 1 would have been by far the greater contributor.

Trap Site 6 was the third most productive site, once again indicating the freshwater creek area in Swamp 2 appears to be a productive source of mosquitoes. All other trap sites recorded similar numbers of mosquitoes over the three-day trapping period, indicating the active dispersal of mosquitoes.

Coquillettidia xanthogaster were recorded in similar numbers at all trap sites, indicating this species had dispersed widely over the general area from their breeding sites in Swamps 1 & 2.
Culex annulirostris had also dispersed fairly widely over the general area from Swamps 1 & 2.
Anopheles farauti s.l. was most common at Trap Site 5, with Trap Sites 1, 7 & 8 displaying similar numbers over the three day trapping period, and other trap sites recording minimal numbers. It appears that the major source of *An. farauti s.l.* to the development area is Swamp 1, as the trap sites closest to Swamp 1 recorded the highest numbers (except for Trap Site 5). It appears that the *An. farauti s.l.* breeding sites in Swamp 2 are too far away from the development site to be a major source.
Ochlerotatus vigilax were recorded in highest numbers at Trap Sites 5 & 6, and were absent or recorded in only minimal numbers elsewhere.

4.2.4 Seasonal fluctuations

It appears that *An. farauti s.l.* could be present within 2km of Swamp 1 and Swamp 2 in significant numbers from at least March to September, at least during some years. This phenomenon has been recorded in the past at Nhulunbuy (Appendix 3). It is possible that high numbers of *An. farauti s.l.* could occur over many months in above average rainfall years, as above average rainfall years may allow the *Shoenoplectus* reed areas in Swamp 1 and Swamp 2 to be flooded for extended periods after the wet season, with additional high tides in the dry season maintaining flooding of the reed areas for most of the year. Peak numbers of this species are still likely to occur in the months of March to June, with high numbers possibly continuing until August in wet years.

Culex annulirostris could be present all year due to the presence of permanently flooded Paperbark areas in Swamp 1 providing a continual breeding site. It appears that significant and long lasting breeding sites are also present in Swamp 2, associated with the freshwater creekline. Highest numbers of this species are likely to be encountered from January to August inclusive.

Coquillettidia xanthogaster could be present all year due to the presence of permanently flooded Paperbark areas in Swamp 1 providing a continual breeding site. It appears that significant and long lasting breeding sites are also present in Swamp 2, associated with the freshwater creekline. Highest numbers of this species are likely to be encountered from March to August inclusive.

Ochlerotatus vigilax are likely to follow usual trends observed in Darwin and other coastal towns, and be present in highest numbers from September to January inclusive each year, with minor numbers sometimes noticed in February. Minor numbers of this species may also be present in the dry season

months of May to August in some years, depending on whether higher than normal monthly high tides occur in these months.

Other mosquito species trapped are of low significance and are not discussed.

4.2.5 Limitations

Limitations with ad hoc mosquito trapping are discussed in the July 2004 Blacktip Project Biting Insect Report.

4.2.6 Pest problems and public health

Low pest numbers of *Oc. vigilax* were trapped at Swamp 2 ten days after the secondary high tide event in September (Based on Darwin tide information, 2004). The monthly high tide occurred in early September and would have lead to much greater numbers, indicating high pest numbers of this species would have bred in the tidal areas of Swamp 1 and Swamp 2 and dispersed to the project area. As discussed in the June 2004 Blacktip Project Biting Insect Report, *Oc. vigilax* generally occurs in highest numbers 10 days after the monthly high tide or significant rainfall in the months of September to January inclusive. Lower pest problems can be present 10 days after the secondary high tide in those months. High to severe pest numbers of this species are likely to be noticed in the Blacktip Project area for at least 10 days in the months of September to January inclusive.

The findings in regards to the *An. farauti s.l.* pest and potential public health issues have changed from the original findings in June 2004. The original findings mentioned high numbers of this species are likely to be encountered from April to June each year, with no significant problem likely after June. The September 2004 trap results indicated that low numbers still existed in September 2004 at the northern boundary of the proposed plant site, and indicates that low numbers may exist during most other months of the year outside of the April to June peak period in some years. The implication of this new finding means that a risk period for potential malaria transmission probably exists for all months of the year at the development site, with the highest risk period being the months of March to June, and a low to moderate risk for the remaining months. The potential for malaria transmission within 500m of Swamps 1 & 2 is probably moderate to high for most months of the year. The main source of this species to the development site is Swamp 1, with Swamp 2 possibly being a minor source, although being more than 3km away, Swamp 2 appears outside of the effective flight range of this species. As mentioned in the July 2004 Biting Insect Report, 10 or more female *An. farauti s.l.* in a CO_2 trap represents a risk for local malaria transmission, if there are people infected with malaria present and unprotected from mosquito bites.

The September 2004 trapping period also located low nuisance numbers of *Cx. annulirostris* at the northern and southern boundary of the proposed plant site, with slightly higher numbers located at the northern boundary, and low pest numbers near the onshore pipe crossing. The presence of extensive freshwater flooding at Swamp 1 in September indicates this species may be perennially present at the development site, with highest numbers in the months of January to August inclusive, and nuisance to minor pest numbers for the remaining months of the year. This species also appears to be breeding in freshwater areas of Swamp 2 during the late dry season and dispersing to the development site. This species represents a minor risk for Ross River virus (RRV), Barmah Forest virus (BFV), and Murray Valley encephalitis virus (MVEV) transmission outside of the peak risk months. Peak risk months for RRV and BFV transmission are the months of January to March, while the peak risk months for MVEV transmission are the months of March to May.

The September 2004 trapping located low to moderate pest numbers of *Cq. xanthogaster* at the northern and southern boundary of the proposed plant site, with higher numbers at the southern boundary. Moderate pest numbers were also recorded near the onshore pipe crossing. These new findings indicate minor to moderate pest problems may occur in the development area for all months of the year, with high pest numbers likely in the months of March to August inclusive.

The September 2004 trapping results located minor nuisance numbers of the saltwater *Culex* mosquito *Culex sitiens* at the monitoring sites nearby to the onshore pipe crossing. This species has been proven to be a competent vector of RRV disease under laboratory conditions, although extensive virus screening has failed to isolate this virus from specimens collected in the wild from different North Queensland localities (Lee et al 1989). This species is generally found in low numbers only away from saltwater breeding sites, therefore this species is probably of little significance to the development area.

Other potential pest mosquito species mentioned in the June 2004 biting insect report were not located in significant numbers during the September 2004 trapping period and are not discussed further. No other potential pest species were located or trapped in significant numbers during the September 2004 trapping period.

5. Findings

The major new findings of the September 2004 trapping period were:

5.1 Biting midges

a) Species

- *Culicoides austropalpalis* was the principal species of biting midge collected, representing 37.4% of all biting midges recovered. This was followed by *C. ornatus* (25.7%) and *C. ?immaculatus* (12%). The potentially important biting midge species *Culicoides* sp nr *subimmaculatus* (northern form) was recovered in low numbers during trapping.

b) Source

- *Culicoides ornatus* breeding sites appear to be located in the neap tide mangrove area of the Yelcher Beach Creek, and in the foreshore mangrove areas associated with Yelcher and Injin Beach.

- *Culicoides ?immaculatus* breeding sites appear to be located in the rocky/sandy beach areas nearby to Trap Sites 4, 8 & 9.

- *Culicoides* sp nr *subimmaculatus* (northern form) breeding sites appear to be located in the open sandy areas associated with the Yelcher Beach tidal creek, and the open sandy beach nearby to Trap Site 4.

c) Pest problem

- *Culicoides ornatus* will be the most common potential pest species in the Blacktip Project development area. Nuisance problems may be encountered at the proposed onshore plant site, mainly in the months of August to November, and nuisance to minor pest problems may be encountered at the onshore pipe crossing site, mainly in the months of August to November. Biting will be most notable around the full and new moon periods, in the 2 hours either side of sunset and sunrise.

- *Culicoides* sp nr *subimmaculatus* (northern form) may cause minor nuisance problems at the onshore pipe crossing site, but is not likely to be noticed at the proposed plant site. Peak biting periods are likely to be the around the half moon, with biting possibly occurring all day near breeding sites, and crepuscular away from breeding sites.

- *Culicoides ?immaculatus* may cause minor nuisance problems at the onshore pipe crossing site from dusk till dawn. Trapping also revealed minor nuisance problems at the proposed onshore plant site. This species is most likely to be noticed in the late dry season and early wet season months.

d) Mitigation measures

- The development is not likely to affect biting midge breeding sites.

- It is highly unlikely that biting midge numbers will reach sufficient numbers at the proposed onshore gas plant site, or proposed onshore pipe crossing site, to warrant fogging with insecticides or cause a disruption to the workforce.

5.2 Mosquitoes

a) Species

- The species occurring in highest numbers during the September 2004 trapping period were, in decreasing order of prevalence, *Cq. xanthogaster, Cx. annulirostris, Cx. sitiens, Cx. vishnui group* and *An. farauti s.l.*

- The most important mosquito species affecting the development area will be *An. farauti s.l., Cx. annulirostris, Oc. vigilax* and *Cq. xanthogaster.*

b) Source

- The major sources of mosquitoes to the development site (as mentioned in the July 2004 Blacktip Project Biting Insect Report) will be Swamp 1 and Swamp 2, with Swamp 1 being the major contributor as it is closer to the development site. Both swamps will be sources of *Oc. vigilax, Cx. annulirostris* and *Cq. xanthogaster* to the development site. Swamp 1 will be a source of *An. farauti s.l.* to the development site, while Swamp 2 appears outside of the effective flight range of this species. *Coquillettidia xanthogaster* readily disperses over wide distances, and as indicated in the September 2004 trapping, Swamp 2 appears to be an equal source of this species to the development site compared to Swamp 1. The dunal areas associated with the Coastal Vine Thickets are likely sources of high numbers of *Oc. vigilax.*

c) Pest and potential disease problem

- *Culex annulirostris* are likely to be present in nuisance to minor pest numbers from September to December inclusive, and in high pest numbers from January to August inclusive, with the highest pest problems likely to be encountered from April to August. The high risk period for RRV and BRV transmission from this species are the months of January to March, and the high risk period for MVEV transmission are the months of March to May. The latest trapping also reveals that a minor risk for disease transmission from this species also exists during the other months of the year outside of the peak periods.

- *Anopheles farauti s.l.* could possibly be present in significant numbers at the Blacktip Project site for most months of the year, representing a year round potential malaria transmission risk period should a person infected with malaria be exposed to mosquito bites. The highest risk period will be the months of March to June.

- *Coquillettidia xanthogaster* are likely to be present in minor to moderate pest numbers for most months of the year, due to the active dispersal characteristics of this species, with high pest problems occurring in the months of March to August.

d) Mitigation measures

- Mitigation measures are the same as mentioned in the July 2004 Biting Insect Report. The most important mitigation measures will still personal protection, preventing the creation of new mosquito breeding sites from development activities, preventing the importation of exotic dengue carrying mosquitoes from North Queensland or overseas, and screening overseas acquired employees for malaria, to prevent the infection of local mosquitoes with the malaria parasite.

6. References and further reading material

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FIGURES

Figure 1: Blacktip Project Biting Insect Survey, 28-30 September 2004
Spatial abundance of selected mosquito species collected in CO2 baited EVS traps over the three night trapping period

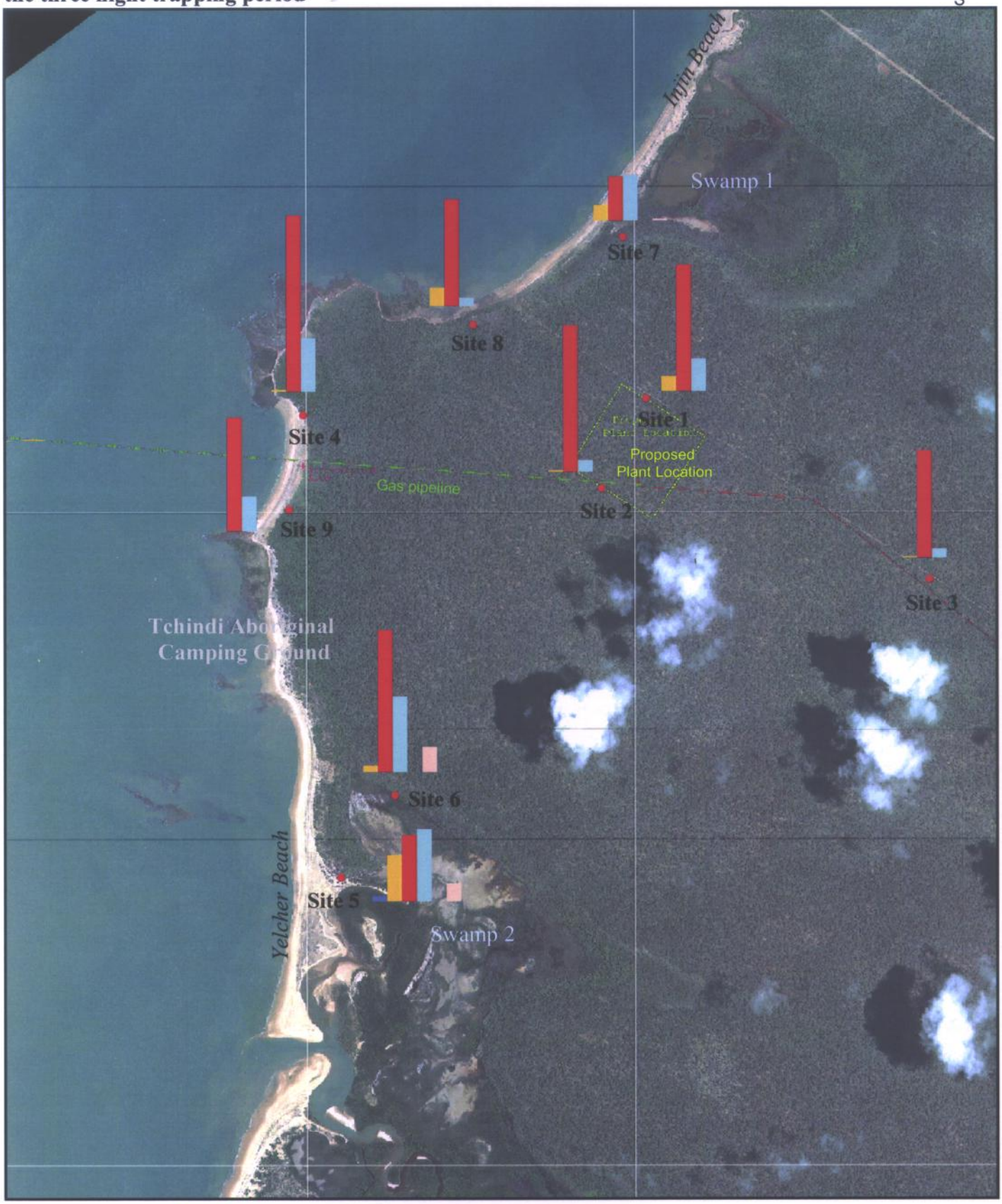
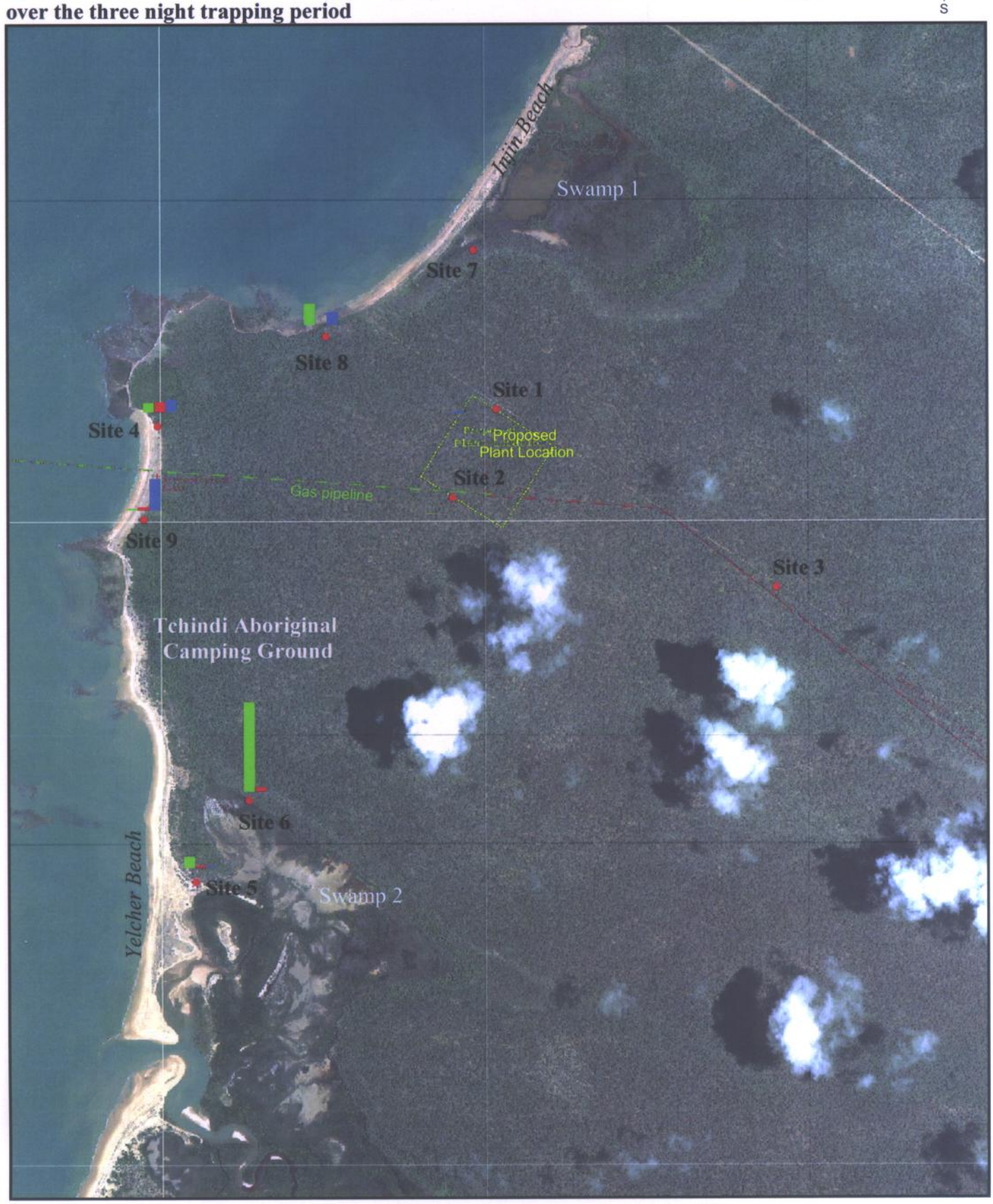


Figure 2: Blacktip Project Biting Insect Survey, 28 - 30 September 2004
Spatial abundance of selected biting midge species collected in CO2 baited EVS traps over the three night trapping period



Legend

2,000 bar length represents 2000 adult biting midges

C. ornatus

C. sp nr subimmaculatus

C. ?immaculatus

CO2 EVS trap site

0 500 1,000 1,500 Metres

Figure 3a: Blacktip Project Biting Insect Survey, 28-30 September 2004
Mosquito larval sampling locations, Swamp 1

Legend

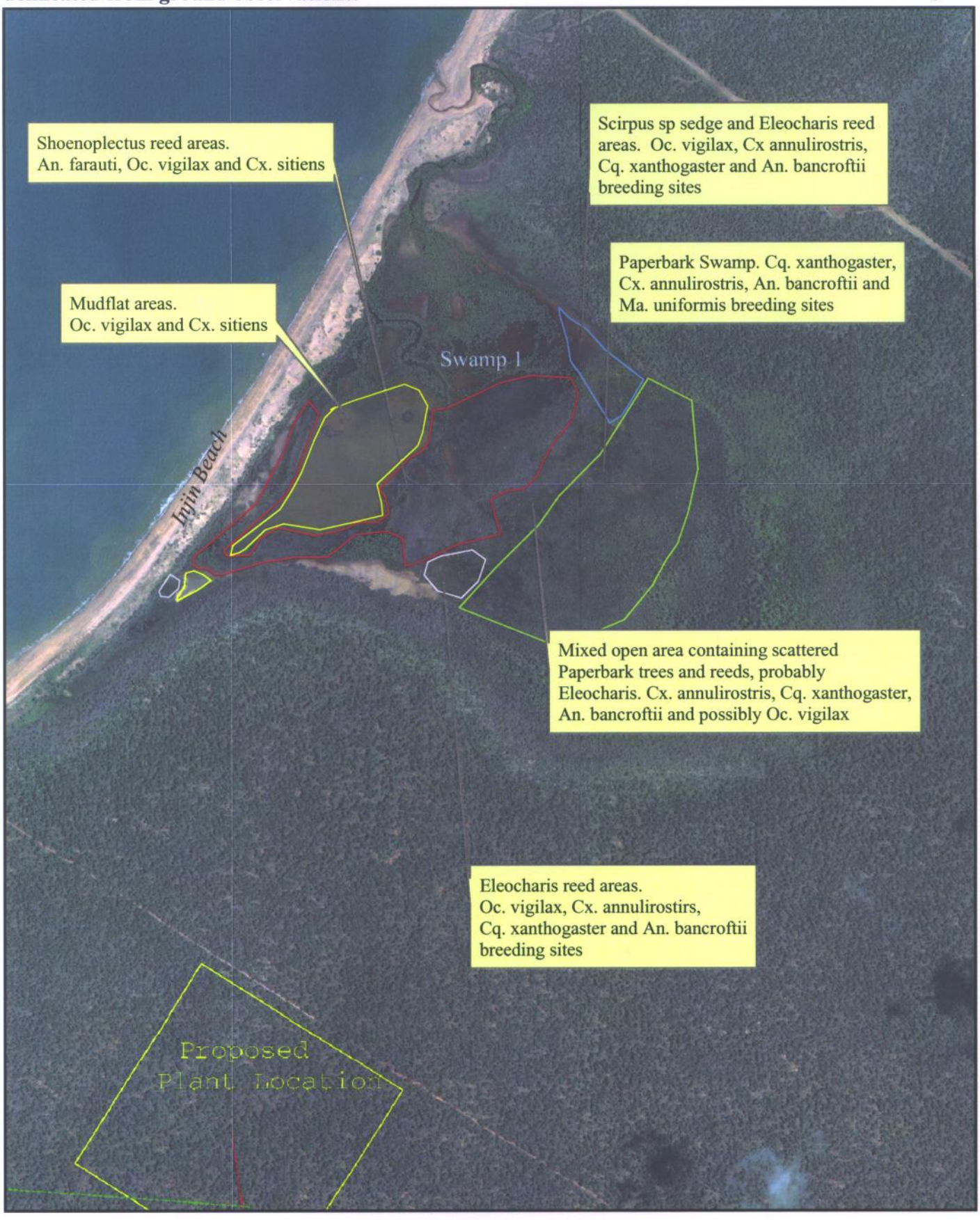
- Mosquito Larval Sampling Locations 28 September 2004

Figure 3b: Blacktip Project Biting Insect Survey, 28-30 September 2004
Mosquito larval sampling locations, Swamp 2 and southern coastal vine thicket

Legend

- **Mosquito larval sampling locations**

Figure 4a: Blacktip Project Biting Insect Survey, 28 - 30 September 2004
Potential mosquito breeding habitat Swamp 1. Different habitats were roughly delineated from ground observations.



Legend

- Approximate major Shoenoplectus reed areas
  Approximate major Eleocharis reed areas
- Approximate major mudflat areas
- Approximate major Paperbark forest
- Aproximate major Scirpus sp sedge and Eleocharis reed area

Meters
0 300 600 900 1,200 1,500

Figure 4b: Blacktip Project Biting Insect Survey, 28 - 30 September 2004
Potential mosquito breeding sites

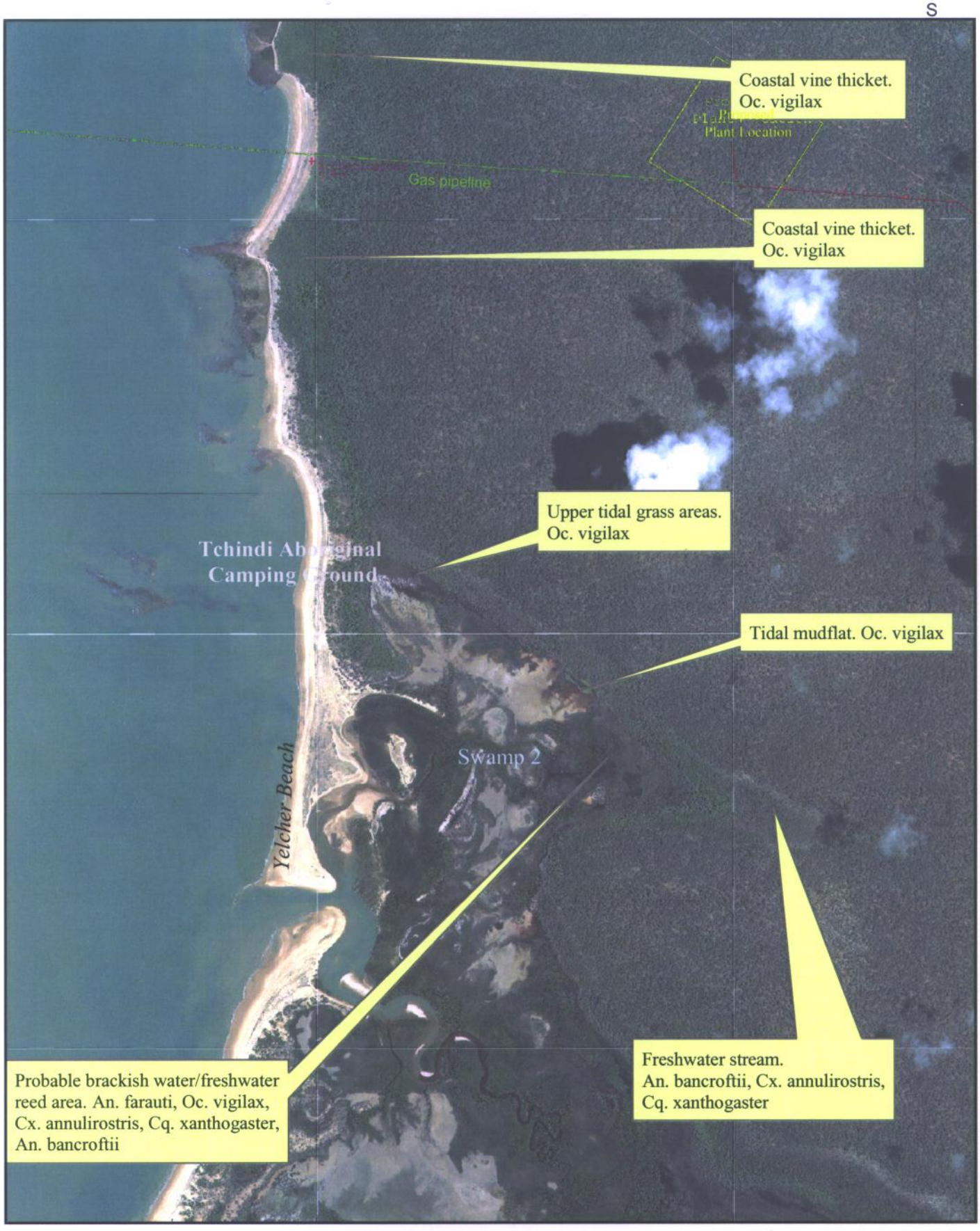
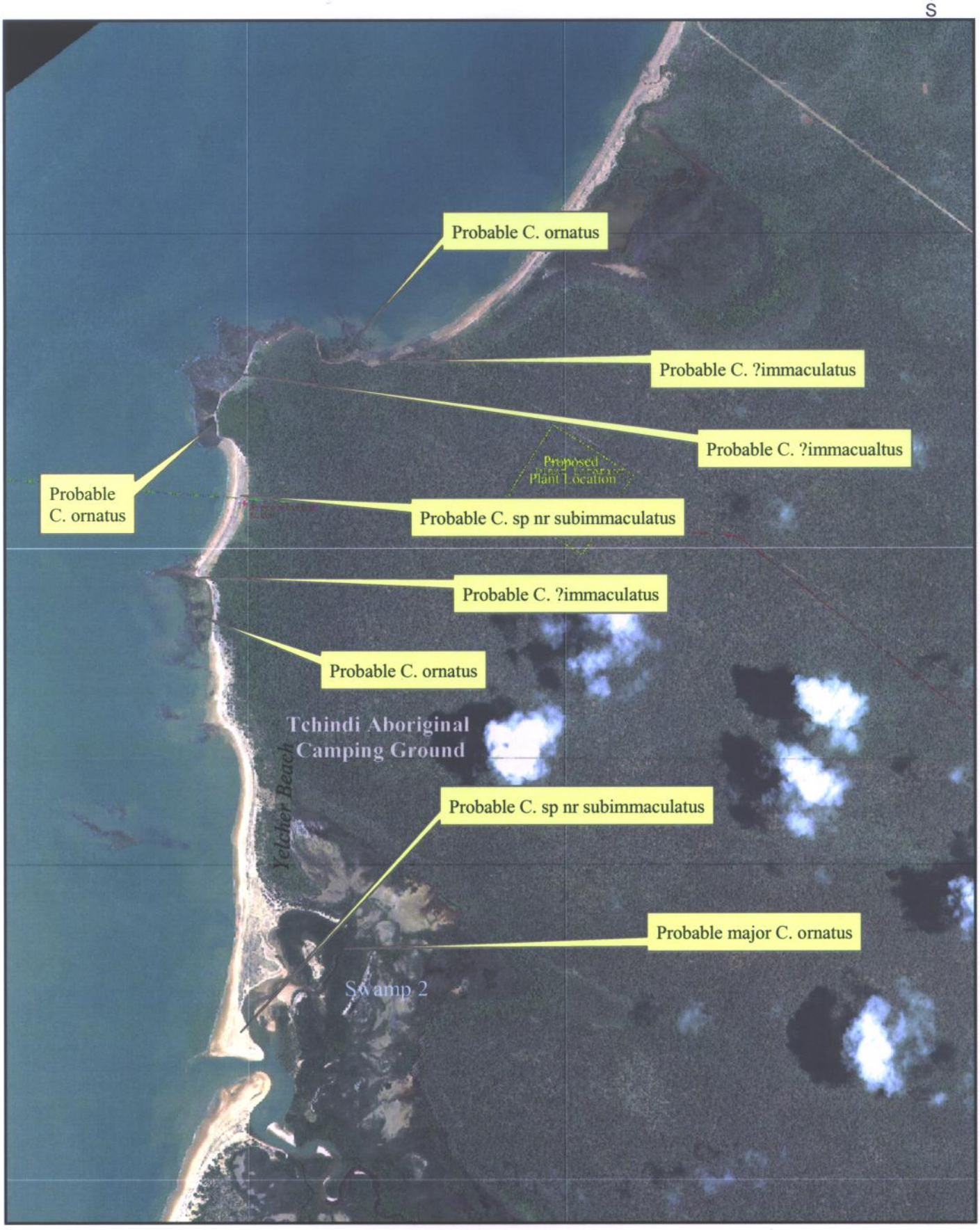


Figure 5: Blacktip Project Biting Insect Survey, 28 - 30 September 2004
Potential biting midge breeding sites



TABLES

Table 1: Blacktip Project. Total number of female biting midges collected in CO2 baited EVS traps set on the afternoon of September 28, 2004 (one night before the full moon) and collected the following morning. Refer to Figure 1 for trap locations

	Biting midge species													
Trap location	*C. (Cor grp) coronalis*	*C. (Mol grp) nr subimmaculatus (Northern Form)*	*C. (Orn grp) cordiger*	*C. (Orn grp) ornatus*	*C. (Orn grp) papuensis*	*C. (Orn grp) undescribed sp No 6*	*C. (Vic grp) bundyensis*	*C. (Wil grp) austropalpalis*	*C. (Wil grp) narrabeenensis*	*C. (Wir) ? immaculatus*	*Culicoides unidentifiable*	*Trap failure biting midges*	**Total**	**% of Total**
PK1 - Port Keats Site 1, Centre of northern margin of proposed Gas plant	0	0	0	1	0	0	0	1	0	0	1	0	3	0.02
PK2 - Port Keats Site 2, Centre of southern margin of proposed Gas Plant	0	0	0	0	0	0	0	0	0	0	0	1		
PK3 - Port Keats Site 3, 2 km from north east corner of proposed Gas Plant on access track	0	12	0	18	0	0	24	126	120	0	0	0	300	2.36
PK4 - Port Keats Site 4, Vine thicket near sand dunes on western beachline	0	420	12	36	1	0	0	12	12	108	0	0	601	4.73
PK5 - Port Keats Site 5, 100m north of northern mangrove margin of Tidal inlet south of Tchindi Aboriginal Camping Ground	0	0	15	195	5	5	0	0	5	25	0	0	250	1.97
PK6 - Port Keats Site 6, Northern edge of paperbark/mangrove swamp	0	200	1000	3200	0	0	800	4800	0	0	0	0	10000	78.76
PK7 - Port Keats Site 7, South west edge of Injin Beach Swamp, in paperbark margin	0	0	14	2	1	0	1	2	0	19	0	0	39	0.31
PK8 - Port Keats Site 8, West end of Injin Beach, 100m back from cliff edge	0	0	102	20	160	60	0	200	40	420	0	0	1002	7.89
PK9 - Port Keats Site 9, Vine thicket near sand dunes on western beachline	10	50	10	40	1	0	0	1	40	350	0	0	502	3.95
Total	10	682	1153	3512	168	65	825	5142	217	922	1		12697	100
% of Total	0.08	5.3713	9.08	27.7	1.3	0.5	6.5	40.5	1.7	7.3	0		100	

Table 2: Blacktip Project. Total number of female biting midges collected in CO2 baited EVS traps set on the afternoon of September 29, 2004 (night of full moon) and collected the following morning. Refer to Figure 1 for trap locations

	Biting midge species												
Trap location	*C. (Cor grp) coronalis*	*C. (Mar grp) marksi*	*C. (Mol grp) nr subimmaculatus (Northern Form)*	*C. (Orn grp) cordiger*	*C. (Orn grp) ornatus*	*C. (Orn grp) papuensis*	*C. (Orn grp) undescribed sp No 6*	*C. (Vic grp) bundyensis*	*C. (Wil grp) austropalpalis*	*C. (Wil grp) narrabeenensis*	*C. (Wir) ? immaculatus*	**Total**	**% of Total**
PK1 - Port Keats Site 1, Centre of northern margin of proposed Gas plant	0	30	0	0	0	0	30	100	270	40	30	500	8.40
PK2 - Port Keats Site 2, Centre of southern margin of proposed Gas Plant	0	0	0	0	16	0	4	26	26	24	4	100	1.68
PK3 - Port Keats Site 3, 2 km from north east corner of proposed Gas Plant on access track	0	2	0	0	0	0	0	36	18	42	2	100	1.68
PK4 - Port Keats Site 4, Vine thicket near sand dunes on western beachline	2	0	20	40	200	0	0	0	0	20	220	502	8.43
PK5 - Port Keats Site 5, 100m north of northern mangrove margin of Tidal inlet south of Tchindi Aboriginal Camping Ground	0	0	112	13	29	8	0	0	8	0	32	202	3.39
PK6 - Port Keats Site 6, Northern edge of paperbark/mangrove swamp	0	0	0	100	280	0	0	20	560	20	20	1000	16.80
PK7 - Port Keats Site 7, South west edge of Injin Beach Swamp, in paperbark margin	0	0	1	14	0	1	1	0	29	0	2	48	0.81
PK8 - Port Keats Site 8, West end of Injin Beach, 100m back from cliff edge	0	0	0	270	930	30	30	0	180	0	60	1500	25.20
PK9 - Port Keats Site 9, Vine thicket near sand dunes on western beachline	0	0	40	40	0	440	0	0	400	80	1000	2000	33.60
Total	2	32	173	477	1455	479	65	182	1491	226	1370	5952	100
% of Total	0.03	0.54	2.91	8.01	24.45	8.05	1.09	3.06	25.05	3.80	23.02	100	

Table 3: Blacktip Project. Total number of female biting midges collected in CO2 baited EVS traps set on the afternoon of September 30, 2004 (one night after the full moon) and collected the following morning. Refer to Figure 1 for trap locations

	Biting midge species													
Trap location	*C. (Cor grp) coronalis*	*C. (Mar grp) marksi*	*C. (Mol grp) nr subimmaculatus (Northern Form)*	*C. (Orn grp) cordiger*	*C. (Orn grp) ornatus*	*C. (Orn grp) papuensis*	*C. (Orn grp) undescribed sp No 6*	*C. (Vic grp) bundyensis*	*C. (Wil grp) austropalpalis*	*C. (Wil grp) narrabeenensis*	*C. (Wir) ? immaculatus*	*Culicoides unidentifiable*	**Total**	**% of Total**
PK1 - Port Keats Site 1, Centre of northern margin of proposed Gas plant	0	1	0	1	0	0	12	96	384	36	72	0	602	12.85
PK2 - Port Keats Site 2, Centre of southern margin of proposed Gas Plant	0	1	1	2	10	0	8	0	6	3	1	0	32	0.68
PK3 - Port Keats Site 3, 2 km from north east corner of proposed Gas Plant on access track	0	0	6	0	6	0	0	20	22	38	8	0	100	2.13
PK4 - Port Keats Site 4, Vine thicket near sand dunes on western beachline	10	0	20	10	180	0	0	0	0	40	240	0	500	10.67
PK5 - Port Keats Site 5, 100m north of northern mangrove margin of Tidal inlet south of Tchindi Aboriginal Camping Ground	0	0	0	80	280	30	0	0	80	0	30	0	500	10.67
PK6 - Port Keats Site 6, Northern edge of paperbark/mangrove swamp	0	0	0	450	500	0	0	0	1550	0	0	0	2500	53.37
PK7 - Port Keats Site 7, South west edge of Injin Beach Swamp, in paperbark margin	0	0	0	14	7	0	0	0	6	2	13	6	48	1.02
PK8 - Port Keats Site 8, West end of Injin Beach, 100m back from cliff edge	0	0	10	65	10	35	0	0	40	0	90	0	250	5.34
PK9 - Port Keats Site 9, Vine thicket near sand dunes on western beachline	0	0	63	3	33	0	0	0	2	3	48	0	152	3.25
Total	10	2	100	625	1026	65	20	116	2090	122	502	6	4684	100
% of Total	0.21	0.04	2.13	13.34	21.90	1.39	0.43	2.48	44.62	2.60	10.72	0.13	100	

Table 4: Blacktip Project. Total number of female biting midges collected in all CO2 baited EVS traps 28-30 September 2004. Refer to Figure 1 for trap locations

	Biting midge species														
Trap location	*C. (Cor grp) coronalis*	*C. (Mar grp) marksi*	*C. (Mol grp) nr subimmaculatus (Northern Form)*	*C. (Orn grp) cordiger*	*C. (Orn grp) ornatus*	*C. (Orn grp) papuensis*	*C. (Orn grp) undescribed sp No 6*	*C. (Vic grp) bundyensis*	*C. (Wil grp) austropalpalis*	*C. (Wil grp) narrabeenensis*	*C. (Wir) ? immaculatus*	*Culicoides unidentifiable*	*Trap failure biting midges*	**Total**	**% of Total**
PK1 - Port Keats Site 1, Centre of northern margin of proposed Gas plant	0	31	0	1	1	0	42	196	655	76	102	1	0	1105	4.74
PK2 - Port Keats Site 2, Centre of southern margin of proposed Gas Plant	0	1	1	2	26	0	12	26	32	27	5	0	1	132	0.57
PK3 - Port Keats Site 3, 2 km from north east corner of proposed Gas Plant on access track	0	2	18	0	24	0	0	80	166	200	10	0	0	500	2.14
PK4 - Port Keats Site 4, Vine thicket near sand dunes on western beachline	12	0	460	62	416	1	0	0	12	72	568	0	0	1603	6.87
PK5 - Port Keats Site 5, 100m north of northern mangrove margin of Tidal inlet south of Tchindi Aboriginal Camping Ground	0	0	112	108	504	43	5	0	88	5	87	0	0	952	4.08
PK6 - Port Keats Site 6, Northern edge of paperbark/mangrove swamp	0	0	200	1550	3980	0	0	820	6910	20	20	0	0	13500	57.86
PK7 - Port Keats Site 7, South west edge of Injin Beach Swamp, in paperbark margin	0	0	1	42	9	2	1	1	37	2	34	6	0	135	0.58
PK8 - Port Keats Site 8, West end of Injin Beach, 100m back from cliff edge	0	0	10	437	960	225	90	0	420	40	570	0	0	2752	11.79
PK9 - Port Keats Site 9, Vine thicket near sand dunes on western beachline	10	0	153	53	73	441	0	0	403	123	1398	0	0	2654	11.37
Total	22	34	955	2255	5993	712	150	1123	8723	565	2794	7		23333	100
% of Total	0.09	0.15	4.09	9.66	25.68	3.05	0.64	4.81	37.38	2.42	11.97	0.03		100	

Table 5: Blacktip Project. Total number of female Mosquitoes collected in CO2 baited EVS traps set on the afternoon of September 28, 2004 (one night before the full moon). Refer to Figure 1 for trap locations

	Mosquito species													
Trap location	*Ad. (Ady) catasticta*	*An. (Ano) bancroftii*	*An. (Cel) farauti s.l.*	*An. (Cel) hilli*	*Cq. (Coq) xanthogaster*	*Cx. (Cux) annulirostris*	*Cx. (Cux) palpalis*	*Cx. (Cux) sitiens*	*Cx. (Cux) Vishnui group*	*Oc. (Cha) elchoensis*	*Oc. (Och) vigilax*	*Trap failure mosquitoes*	**Total**	**% of Total**
PK1 - Port Keats Site 1, Centre of northern margin of proposed Gas plant	0	0	20	2	136	56	10	2	3	1	0	0	230	7.82
PK2 - Port Keats Site 2, Centre of southern margin of proposed Gas Plant	0	0	0	0	0	0	0	0	0	0	0	1	1	0.03
PK3 - Port Keats Site 3, 2 km from north east corner of proposed Gas Plant on access track	0	0	2	0	233	33	6	0	2	0	0	0	276	9.38
PK4 - Port Keats Site 4, Vine thicket near sand dunes on western beachline	1	0	2	0	463	222	0	19	60	0	0	0	767	26.07
PK5 - Port Keats Site 5, 100m north of northern mangrove margin of Tidal inlet south of Tchindi Aboriginal Camping Ground	0	4	74	2	142	155	0	182	151	0	40	0	750	25.49
PK6 - Port Keats Site 6, Northern edge of paperbark/mangrove swamp	1	2	12	1	206	96	0	4	4	0	15	0	341	11.59
PK7 - Port Keats Site 7, South west edge of Injin Beach Swamp, in paperbark margin	0	0	6	27	64	72	0	9	2	0	2	0	182	6.19
PK8 - Port Keats Site 8, West end of Injin Beach, 100m back from cliff edge	1	0	32	10	112	20	0	0	5	0	0	0	180	6.12
PK9 - Port Keats Site 9, Vine thicket near sand dunes on western beachline	0	0	2	0	160	27	0	2	24	0	0	0	215	7.31
Total	3	6	150	42	1516	681	16	218	251	1	57	1	2942	100
% of Total	0.10	0.20	5.10	1.43	51.53	23.15	0.54	7.41	8.53	0.03	1.94	0.03	100	

Table 6: Blacktip Project. Total number of female Mosquitoes collected on CO2 baited EVS traps set on the afternoon of September 29, 2004 (on the night of the full moon). Refer to Figure 1 for trap locations

	Mosquito Species														
Trap location	*An. (Ano) bancroftii*	*An. (Ano) powelli*	*An. (Cel) farauti s.l.*	*An. (Cel) hilli*	*Cq. (Coq) xanthogaster*	*Cx. (Cux) annulirostris*	*Cx. (Cux) palpalis*	*Cx. (Cux) sitiens*	*Cx. (Cux) Vishnui group*	*Cx. (Lop) species 167*	*mosquitoes unidentifiable (damaged)*	*Oc. (Cha) elchoensis*	*Oc. (Och) vigilax*	**Total**	**% of Total**
PK1 - Port Keats Site 1, Centre of northern margin of proposed Gas plant	0	0	37	0	225	37	21	7	0	3	2	0	0	332	10.32
PK2 - Port Keats Site 2, Centre of southern margin of proposed Gas Plant	1	1	4	0	368	11	12	2	0	0	5	0	0	404	12.55
PK3 - Port Keats Site 3, 2 km from north east corner of proposed Gas Plant on access track	0	1	1	1	200	5	8	0	0	0	0	1	0	217	6.74
PK4 - Port Keats Site 4, Vine thicket near sand dunes on western beachline	0	0	2	0	208	3	0	65	0	0	0	0	1	279	8.67
PK5 - Port Keats Site 5, 100m north of northern mangrove margin of Tidal inlet south of Tchindi Aboriginal Camping Ground	10	0	66	0	127	48	0	356	0	0	0	0	26	633	19.67
PK6 - Port Keats Site 6, Northern edge of paperbark/mangrove swamp	0	0	10	9	255	123	0	54	0	0	3	0	53	507	15.76
PK7 - Port Keats Site 7, South west edge of Injin Beach Swamp, in paperbark margin	0	0	54	24	49	48	0	37	0	0	0	0	1	213	6.62
PK8 - Port Keats Site 8, West end of Injin Beach, 100m back from cliff edge	0	0	55	0	133	4	6	10	0	0	0	0	0	208	6.46
PK9 - Port Keats Site 9, Vine thicket near sand dunes on western beachline	1	0	0	0	237	93	0	89	4	0	0	0	1	425	13.21
Total	12	2	229	34	1802	372	47	620	4	3	10	1	82	3218	100
% of Total	0.37	0.06	7.12	1.06	56.00	11.56	1.46	19.27	0.12	0.09	0.31	0.03	2.55	100	

Table 7: Blacktip Project. Total number of female Mosquitoes collected in CO2 baited EVS traps set on the afternoon of September 30, 2004 (one night after the full moon). Refer to Figure 1 for trap locations

	Mosquito species														
Trap location	*An. (Ano) bancroftii*	*An. (Ano) powelli*	*An. (Cel) annulipes s.l.*	*An. (Cel) farauti s.l.*	*An. (Cel) hilli*	*Cq. (Coq) xanthogaster*	*Cx. (Cux) annulirostris*	*Cx. (Cux) palpalis*	*Cx. (Cux) sitiens*	*Cx. (Cux) Vishnui group*	*Oc. (Cha) elchoensis*	*Oc. (Och) vigilax*	*Ur. (Ura) lateralis*	**Total**	**% of Total**
PK1 - Port Keats Site 1, Centre of northern margin of proposed Gas plant	2	0	0	15	4	236	62	7	1	0	0	0	0	327	11.21
PK2 - Port Keats Site 2, Centre of southern margin of proposed Gas Plant	0	0	1	5	0	322	45	1	0	1	1	0	0	376	12.89
PK3 - Port Keats Site 3, 2 km from north east corner of proposed Gas Plant on access track	0	0	0	3	0	73	6	0	7	1	0	0	0	90	3.09
PK4 - Port Keats Site 4, Vine thicket near sand dunes on western beachline	0	0	0	6	0	160	28	1	19	20	0	0	1	235	8.06
PK5 - Port Keats Site 5, 100m north of northern mangrove margin of Tidal inlet south of Tchindi Aboriginal Camping Ground	11	0	0	77	2	42	137	0	181	179	0	18	0	647	22.19
PK6 - Port Keats Site 6, Northern edge of paperbark/mangrove swamp	0	0	0	9	7	207	136	1	7	3	0	50	0	420	14.40
PK7 - Port Keats Site 7, South west edge of Injin Beach Swamp, in paperbark margin	0	0	0	13	43	94	95	0	21	1	0	6	0	273	9.36
PK8 - Port Keats Site 8, West end of Injin Beach, 100m back from cliff edge	0	1	0	0	1	259	15	14	1	2	0	0	0	293	10.05
PK9 - Port Keats Site 9, Vine thicket near sand dunes on western beachline	0	0	0	0	0	137	44	0	12	62	0	0	0	255	8.74
Total	13	1	1	128	57	1530	568	24	249	269	1	74	1	2916	100
% of Total	0.45	0.03	0.03	4.39	1.95	52.47	19.48	0.82	8.54	9.22	0.03	2.54	0.03	100	

Table 8: Blacktip Project. Total number of female Mosquitoes collected in all CO2 baited EVS traps 28-30 September 2004. Refer to Figure 1 for trap locations

	Mosquito species																		
Trap location	*Ad. (Ady) catasticta*	*An. (Ano) bancroftii*	*An. (Ano) powelli*	*An. (Cel) annulipes s.l.*	*An. (Cel) farauti s.l.*	*An. (Cel) hilli*	*Cq. (Coq) xanthogaster*	*Cx. (Cux) annulirostris*	*Cx. (Cux) palpalis*	*Cx. (Cux) sitiens*	*Cx. (Cux) Vishnui group*	*Cx. (Lop) species 167*	*mosquitoes unidentifiable (damaged)*	*Oc. (Cha) elchoensis*	*Oc. (Och) vigilax*	*Trap failure mosquitoes*	*Ur. (Ura) lateralis*	**Total**	**% of Total**
PK1 - Port Keats Site 1, Centre of northern margin of proposed Gas plant	0	2	0	0	72	6	597	155	38	10	3	3	2	1	0	0	0	889	9.80
PK2 - Port Keats Site 2, Centre of southern margin of proposed Gas Plant	0	1	1	1	9	0	690	56	13	2	1	0	5	1	0	1	0	780	8.60
PK3 - Port Keats Site 3, 2 km from north east corner of proposed Gas Plant on access track	0	0	1	0	6	1	506	44	14	7	3	0	0	1	0	0	0	583	6.42
PK4 - Port Keats Site 4, Vine thicket near sand dunes on western beachline	1	0	0	0	10	0	831	253	1	103	80	0	0	0	1	0	1	1281	14.12
PK5 - Port Keats Site 5, 100m north of northern mangrove margin of Tidal inlet south of Tchindi Aboriginal Camping Ground	0	25	0	0	217	4	311	340	0	719	330	0	0	0	84	0	0	2030	22.37
PK6 - Port Keats Site 6, Northern edge of paperbark/mangrove swamp	1	2	0	0	31	17	668	355	1	65	7	0	3	0	118	0	0	1268	13.97
PK7 - Port Keats Site 7, South west edge of Injin Beach Swamp, in paperbark margin	0	0	0	0	73	94	207	215	0	67	3	0	0	0	9	0	0	668	7.36
PK8 - Port Keats Site 8, West end of Injin Beach, 100m back from cliff edge	1	0	1	0	87	11	504	39	20	11	7	0	0	0	0	0	0	681	7.50
PK9 - Port Keats Site 9, Vine thicket near sand dunes on western beachline	0	1	0	0	2	0	534	164	0	103	90	0	0	0	1	0	0	895	9.86
Total	3	31	3	1	507	133	4848	1621	87	1087	524	3	10	3	213		1	9075	100
% of Total	0.03	0.34	0.03	0.01	5.59	1.47	53.42	17.86	0.96	11.98	5.77	0.03	0.11	0.03	2.35		0.01	100	

Table 9: Larval mosquito survey results. Blacktip Project Biting Insect Study September 2004. (Refer to Figures 3a & 3b for site locations)

Site number	Date	Site description	Water presence	Specific conductivity us/cm	Species	Comments
PKL1	28-Sep-04	Injin beach tidal/freshwater swamp. Grassy area near *Eleocharis* reeds, south-west edge of swamp, west of mudflat (Swamp 1)	Dry	n/a	*Nil mosquitoes*	
PKL2	28-Sep-04	Injin beach tidal/freshwater swamp. *Eleocharis* reed and *Sporobolus* grass area south-west edge of swamp, west of mudflat and south of mangroves (Swamp 1)	Dry	n/a	*Nil mosquitoes*	
PKL3	28-Sep-04	Injin beach tidal/freshwater swamp. *Shoenoplectus/* mangrove interface (Swamp 1)	Flooded	38.2	*Cx. sitiens 1 x 1st, 2 x 2nd, 7 x 3rd (2/dip)*	Extensive flooding still present.
PKL4	28-Sep-04	Injin beach tidal/freshwater swamp. Tidal mudflat, south-east end of swamp (Swamp 1)	Dry	n/a	*Nil mosquitoes*	
PKL5	28-Sep-04	Injin beach tidal/freshwater swamp. *Shoenoplectus/* mangrove interface, SE edge of reed area (Swamp 1)	Flooded	n/c	*n/c*	Extensive flooding still present.

PKL6	28-Sep-04	Injin beach tidal/freshwater swamp. *Shoenoplectus* reed area between two mangrove areas, south margin of swamp (Swamp 1)	Flooded	n/c	*n/c*	Extensive flooding still present.
PKL7	28-Sep-04	Injin beach tidal/freshwater swamp. *Schoenoplectus* reed area, south-west margin of swamp (Swamp 1).	Flooded	n/c	*n/c*	Extensive flooding still present.
PKL8	28-Sep-04	Injin beach tidal/freshwater swamp. Extensive *Eleocharis* reed area, south edge of swamp (Swamp 1)	Flooded	1.3ms	*Nil mosquitoes*	Extensive flooding still present. No larvae located in 30 dips.
PKL9	28-Sep-04	Injin beach paperbark swamp. Pigrooted area south of *Eleocharis* reed area (Swamp 1).	Pooling	1ms	*Nil mosquitoes*	Extensive flooding still present. No larvae located in 15 dips.
PKL10	28-Sep-04	Large tidal mudflat north of freshwater creekline (Swamp 2)	Dry	n/a		
PKL11	28-Sep-04	Narrow tidal grass area between mangroves and Paperbark fringe, including flowline from paperbarks to tidal area (Swamp 2)	Dry	n/a		

PKL12	28-Sep-04	Large tidal grass plain (Swamp 2)	Dry	n/a		
PKL13	28-Sep-04	Depressions in vehicle track along upper tidal margin of tidal grass swamp, and depressions in mudflat (Swamp 2)	Dry	n/a	*Nil mosquitoes*	
PKL14	28-Sep-04	Depression in sand dune	Dry	n/a	*Nil mosquitoes*	
PKL15	28-Sep-04	Paperbark swamp behind beach dune, in-between coastal vine thicket	Dry	n/a	*Nil mosquitoes*	
PKL 16	28-Sep-04	Coastal vine thicket. Restricted flowlines in vine forest	Dry	n/a	*Nil mosquitoes*	
PKL17	28-Sep-04	Coastal vine thicket. Restricted flowlines in vine forest	Dry	n/a	*Nil mosquitoes*	
PKL18	28-Sep-04	Injin Beach Tidal/Freshwater Swamp. Flooded tidal sedge area between mangroves and grassy margin.	Flooded	n/c	*Nil mosquitoes*	
PKL19	28-Sep-04	Injin Beach Tidal/Freshwater Swamp. Flooded *Eleocharis* reed and *Scirpus sp* sedge area.	Flooded	n/c	*Cx. annulirostris 3 x 3rd (1 larvae per 5 ladle dips))*	
PKL20	28-Sep-04	Injin Beach Tidal/Freshwater Swamp. Flooded Paperbark margin with *Eleocharis* reeds.	Pooling	n/c	*Nil mosquitoes*	
PKL21	28-Sep-04	Injin Beach Tidal/Freshwater Swamp. Flooded Paperbark swamp with *Eleocharis* reeds.	Pooling	n/c	*Nil mosquitoes*	Pooling mainly in pig wallows. The presence of feral pigs restricted further surveying.

APPENDICES

Photo 1: Swamp 1, looking south east from Larval Site PKL18. All sedge areas visible in this picture were flooded, and the adjacent mangrove area on the right hand side of this picture was also flooded.

Photo 2: Swamp 1. Larval Site PKL19. Picture taken from Paperbark fringe, looking south west. Extensive *Scirpus sp.* sedge and *Eleocharis* reed area.

Photo 3: Swamp 1. Larval Site PKL19, photo taken looking south east from paperbark fringe. Extensive *Scirpus sp* sedge and *Eleocharis* reed area in foreground, mangroves in background, *Shoenoplectus* reeds bordering mangroves in top right hand corner of picture.

Photo 4: Swamp 1. Larval Site PKL19. Photo taken from Paperbark margin looking south east. Extensive *Eleocharis* reeds in middle right hand side of picture, *Scirpus sp* sedge in foreground, Paperbark margin in background.

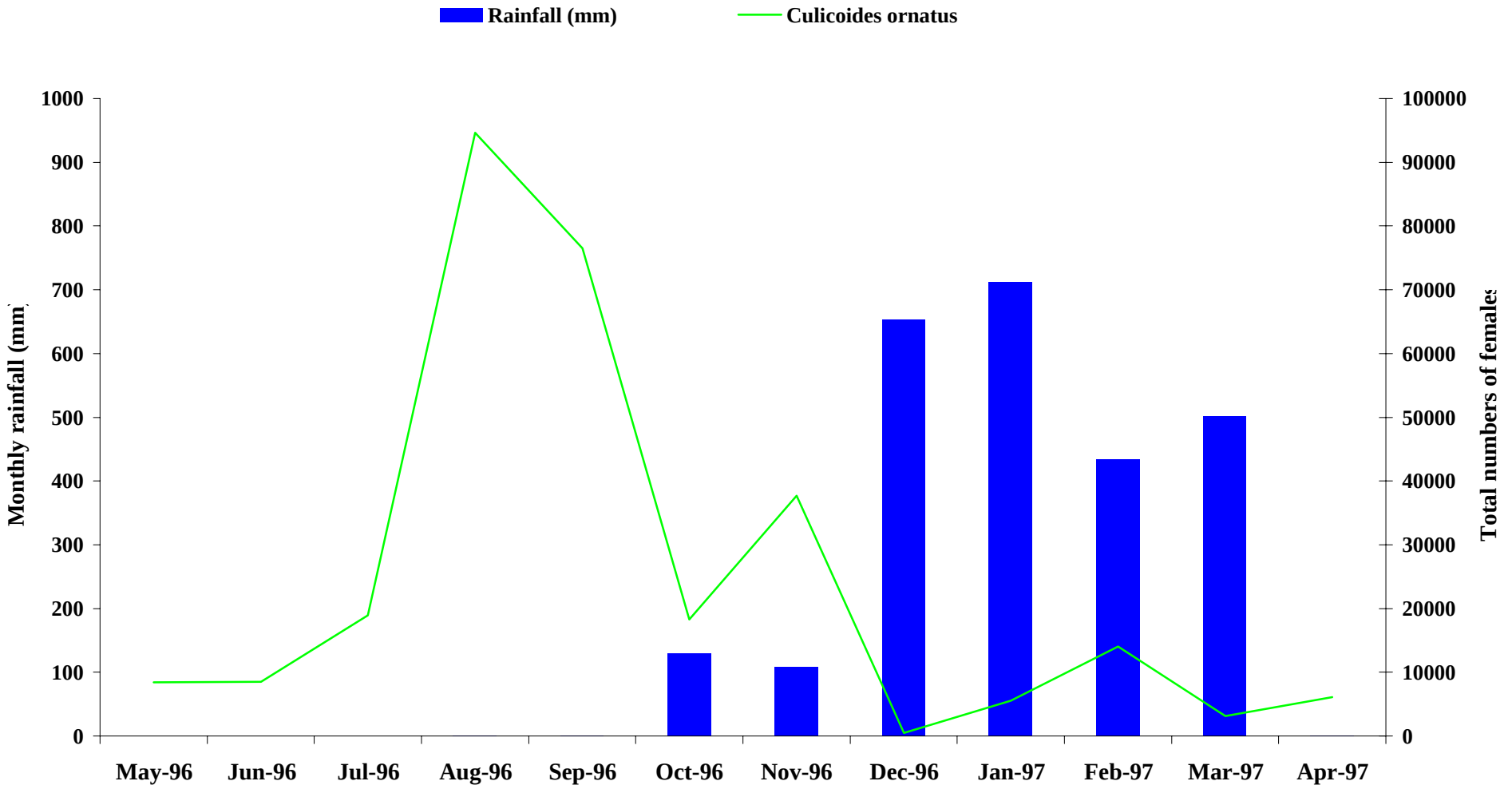
Photo 5: Swamp 1. Larval Site PKL20, looking south from Paperbark margin. Extensive *Eleocharis* reed area. The extensive Paperbark margin bordering Swamp 1 can be seen starting from the middle left hand side of the picture.

Photo 6: Swamp 1. Approximately 20m south east of larval site PKL20. *Eleocharis* reeds growing in conjunction with sunlit areas of the Paperbark forest.

Photo 7: Swamp 1. Approximately 50m south east of larval site PKL20. Green area under Paperbark trees are flooded *Eleocharis* reeds. Photo taken from Paperbark/woodland margin.

Appendix 2

Biting midge investigations "Fairway Waters" Palmerston May 1996 to April 1997
Seasonal trend of *C. ornatus* collected from all sites on all monthly trap nights,
and total monthly rainfall.



Appendix 3

NHULUNBUY ADULT MOSQUITO MONITORING PROGRAM - RESULTS FROM CO2 BAITED EVS TRAPS SET WEEKLY AT THE REAR JASPER TRAP SITE, 1991/94