TWEED SHIRE COUNCIL

A6 - BITING MIDGE AND MOSQUITO CONTROLS

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A6 - BITING MIDGE & MOSQUITO CONTROL

A6.1 INTRODUCTION

A6.1.1 Aims of this Section

- Highlight the problems associated with biting midge and mosquitoes to residential and tourist developments generally within the coastal areas of the Tweed Council area;
- Provide desired guidelines for proposed and existing residential and tourist developments in Tweed Council coastal areas to minimise and control the problem of biting midge and mosquitoes;
- Inform, guide and assist applicants, developers, consultants, Council and general public of Council's guidelines for the control of biting midge and mosquitoes, particularly in relation to the preparation and submission of development applications and form a basis for negotiations should a departure from this provision of this plan be requested.

A6.1.2 Land to which this Section applies

This Section shall apply to all proposed and existing developments, including subdivisions, relating to residential and tourist development within The Tweed Council area.

A6.1.3 How does this Section relate to other Sections and Environmental Planning Instruments?

Within Part A

This Section is generally consistent with the other Sections from Part A of this DCP. Where there is an inconsistency then the higher standard/requirement shall prevail.

Between Part A and Part B

In the event of any inconsistency between this Section and a Section from Part B of this DCP, the provisions of the Section from Part B shall prevail.

This Section contains development objectives, provisions and guidelines in respect of existing and proposed residential and tourist developments generally within the Tweed Council coastal areas.

Where any inconsistency arises between this plan and any environmental planning instrument applying to the same land the provision of the Environmental Planning instrument prevails. An Environmental Planning Instrument means a State Environmental Planning Policy, Regional Environmental Plan and Local Environmental Plan.

A6.1.4 How to use this Section

Where a development is proposed in respect of land to which this Section applies, Council shall take the provisions of this plan into consideration in determining the application.

Compliance with the provisions of this Section does not necessarily imply that Council will grant consent to an application. Council must, in relation to

development applications, also take into consideration those matters listed under Section 90(1) of the Environmental Planning and Assessment Act, 1979 and any relevant planning instruments and other Sections of this Development Control Plan.

In preparing an application for development there are a number of specific steps that should be followed:

Step 1: Check the zoning of the site under Tweed LEP 2000 to ensure that the proposed development is permissible and to determine what related provisions apply.

Step 2: Establish what other Sections or Policies apply to the site.

Step 3: Familiarise yourself with the guidelines for control of Biting Midge and Mosquitoes in Tweed.

A6.1.5 Consultation with Council Staff

Applicants are strongly advised to consult Council staff prior to preparing and submitting development applications. Where there is a possible likely problem with biting midge or mosquitoes, consultation with Council's Entomological Control Officer within Council's Environmental and Health Services is recommended.

A6.2 AN OUTLINE OF THE PROBLEM

A6.2.1 Background

Mosquitoes and biting midge belong to the insect order *Diptera* which include many common and familiar insects such as mosquitoes, midges and house flies.

Some are important pests or vectors of disease while others are beneficial, and by virtue of their parasitic or predatory nature play an important role in regulating populations of many plants and animals that adversely affect human welfare.

Mosquitoes *(Culicidae)* and biting midge *(Ceratopogonidae)* sometimes erroneously called sandflies are abundant in this region of Australia. The female mosquito and biting midge adults generally require a blood meal to effectively develop their eggs. A meal of protein in the form of blood is required to complete the reproductive process. These insects are opportunists feeders that will feed on many species of birds and mammals. Humans tend to be the most abundant source of food in many local areas close to wetland breeding areas favoured by these insects.

Problems therefore arise where human activities or habitation, occur in proximity to these insect breeding areas. The extensive areas of wet low-land and intertidal areas along the Tweed coastal districts represent extensive breeding areas for both mosquitoes and biting midge. As a result of the proximity of these low-land areas and urban development in the Tweed Council area, biting insect nuisance is likely to occur in many areas within this district from time to time.

As a general rule, the areas where biting midge and mosquito problems will regularly be a nuisance to our human populace will be within 1km of extensive biting insect breeding areas. Twelve (12) maps of mosquito and biting midge breeding areas have been produced for most of the Tweed coastal districts. These are attached at the end of this Section. This information can be used to estimate those areas where potential biting insect problems will most likely occur. It should be noted that the areas of the Tweed River above Stotts Island, the

Clothiers Creek Valley and the upper reaches of the Mooball, Cudgen and Cudgera Creeks have not yet been mapped for breeding grounds for biting insects. As well, habitat changes caused by some forms of development, such as creation of canal estates, reduced water quality through nutrient load or acidic runoff**,** altered drainage systems and siltation problems may expand biting insect problems.

A direct impact on human health caused by biting midge is due to allergens in midge saliva reacting on people of varying degrees of sensitivity and immunity. Most people find the bites from biting midge uncomfortable and distressing with the irritation leading to scratching and sometimes infected sores (Alloway & Reye, 1990). Because of their small size (1-2mm) these insects are hard to detect and enter households through conventional fly screens.

Mosquitoes are an important group of blood sucking insects, not only because of the nuisance and annoyance of their bite but also because of the possibility of disease transmission to humans and other warm blooded animals. It is as vectors of disease that mosquitoes are often of most concern. An insect that transmits a disease-causing organism from one vertebrate host to another is called a disease vector. An example of a disease transmitted locally by mosquitoes is Ross River fever.

A6.2.2 Biting Insect Species and Habitat in the Tweed Council Area

Biting Midge

Culicoides molestus

This species is most commonly found breeding in clean flocculated sand, in the open or under light mangrove cover between mean tide level and mean high water springs. C. molestus has colonised the beaches of artificial canal developments on the Tweed River. They can also be found breeding on most sandy river foreshores and suitable river sand bars. Larval densities can be extremely high in suitable habitat. The large sand bar off Tony's Island at Banora Point is high in trapped nutrient from roosting birds. This has supplied midge with a very favourable habitat that may support over 30,000 midge larvae per square metre on parts of the sand bar. C. molestus also breeds on the lower reaches of Cudgen Creek, Cudgera Creek and Mooball Creek. Adult C. molestus midge will travel at least 1km from their breeding areas. Residents living on hill tops overlooking these breeding areas are often affected more adversely by these midge than residents at lower elevations close to the breeding sites. C. molestus bites most actively during the week following full and new moon.

Culicoides subimmaculatus

This species, or more likely a complex of species yet to be determined, breeds in clean to muddy sand in the open or under light mangrove cover between mean high water neap and mean high springs. C. subimmaculatus breeds along much of the Tweed River, particularly near stormwater outflows and along the fringe of mangrove growth on Tweed River islands. The species is also abundant along the middle reaches of Cudgen, Cudgera and Mooball Creeks. C. subimmaculatus adults are generally only a pest within 500m of their breeding areas. This range may double around extensive breeding areas such as the Ukerebagh passage area and the upper Terranora passage islands. C. subimmaculatus bites most actively around the half moon period.

Culicoides longior

This species breeds under tree cover, usually amongst heavy fibrous muds, between mean high water neap and mean high water spring tide zone. The Tweed River islands are the major breeding source for this species, particularly on parts of Ukerabagh and Womgin islands. C. longior will travel in excess of 1km from its breeding areas. This species is the major midge pests around West Tweed Heads and parts of South Tweed Heads. C. longior bites most actively during the week leading up to the new and full moon. A typical life cycle of biting midge is shown in Figure 1.

Mosquitoes

Ochlerotatus vigilax

This common salt marsh mosquito breeds in temporary salt to brackish water pools left by the highest monthly tides. Eggs of this species are laid around the drying margins of these pools and may lie dormant for many months. Hatches may be triggered by tides or rainfall. Eggs may hatch in instalments as various environmental conditions in the breeding pools such as salinity and specific dissolved oxygen levels are met. Breeding areas are found amongst poorly flushed mangroves surrounding Cobaki and Terranora Lakes, open tidal salt marshes around Cobaki Lake and on low lying agricultural pastures that receive occasional tidal flooding along the length of the Tweed River and parts of Cudgen Creek. Oc. vigilax is a savage biter by day or night and an effective carrier of Ross River virus. Oc. vigilax is the species causing most complaints throughout Tweed coastal areas. This mosquito disperses widely from its breeding areas and appears attracted to the hill and ridgetops overlooking tidal flats, often many kilometres from its breeding source. Areas badly affected at times are Cobaki inlet, Piggabeen, Bilambil Heights, Terranora and parts of West Tweed Heads.

This species often reaches plague numbers late summer, particularly when a long dry spell or drought has recently been broken by rainfall. Abnormally high tides caused by storm surges may also cause extensive vigilax hatches.

Verrallina funerea

This species breeds in shaded fresh to brackish ponds, often with emergent reed vegetation or under the cover of mangrove, casuarina, tea tree or palm thickets. Like the previous species, it is a savage biter by day or night, often biting in large numbers, though it tends not to travel far from well shaded areas surrounding its breeding sites. V. funereal is often found breeding in areas slightly more elevated than Oc. vigilax breeding sites, particularly where springs or creeks feed into brackish water habitats. Eggs are laid around the drying margins of pools and may remain dormant for many months awaiting hatching stimuli.

Extensive breeding sites exists surrounding parts of Cobaki Lake, the western surrounds of Terranora Lake, Chinderah, Tumbulgum, Stotts Island and tea tree swamps surrounding Cudgen Lake and Pottsville.

Residential areas in close proximity to these sites are often affected by these mosquitoes several weeks following heavy rainfall, particularly if corridors of thick vegetation are continuous between breeding sites and residential areas.

Culex sitiens

The third major salt marsh mosquito pest in the district is Cx. sitiens which breeds in fresh to brackish ponds in similar habitat to Oc. vigilax, though it prefers a lower salinity to vigilax. This species usually reaches population peaks during

late summer when rainfall has diluted salinity in tidal salt marsh pools and flooded lowland agricultural flats. Eggs of this species are deposited in rafts on the surface of the water. Cx. sitiens is slower than the two (2) previous ochlerotatus species to build up population peaks, due to the fact that the ochlerotatus mosquitoes eggs are already awaiting hatching stimuli in their preferred larval habitat prior to the pool flooding.

Breeding areas are well scattered throughout the Tweed Council area with extensive breeding often found behind Cobaki and Terranora Lakes.

Cx. sitiens is principally a night feeder and may disperse widely from its breeding areas. Residential areas around Cobaki inlet, Terranora and Tumbulgum are often affected by this mosquito.

Typical lifecycle of mosquitoes shown in Figure 2.

Insect borne diseases

Ross River virus is endemic in this region. This virus may cause outbreaks of an epidemic polyarthritis in humans in some years. While the disease has no associated mortality, the symptoms can be extremely debilitating resulting in substantial economic loss. The mosquito suspected of being the major vector of this disease in this area is *Ochlerotatus vigilax*. Ross River virus has also been isolated from *V. funerea* and *Culex sitiens*, however, they are not considered major vectors. In recent years, Barmah Forest virus has become an increasing problem in the region. BFU symptoms in humans are similar to RRU.

Biting midge are not known to transmit human disease in Australia.

A6.3 GUIDELINES FOR CONTROL OF BITING MIDGE AND MOSQUITOES IN TWEED

Biting insect problems can be avoided if human activities are far enough removed from major midge and mosquito breeding areas. However, due to the extensive widespread breeding areas of these insect pests throughout the coastal Tweed area, as shown on maps attached, this may severely restrict development. The general amenity of much of the Council area in close proximity to these breeding areas has created a high demand for residential and tourist development in biting insect zones.

Avoidance measures against biting midge and mosquitos can be divided into:-

1. Developed areas of the Shire;
2. Proposed areas for development.

A6.3.1 Presently Developed Areas

Council control measures

Tweed Shire Council carries out abatement measures against biting midge and mosquitoes throughout extensive areas within the Council boundaries. These practices include:

i. The use of biological chemicals such as the soil bacteria Bacillus thuringiensis var israelensis and the insect growth regulator Methoprene.

   Bacillus thuringiensis var israelensis, commonly called Bti is mixed with water and sprayed onto mosquito breeding areas. Mosquito larvae ingest the bacteria and are killed within 24 hours due to an endotoxin causing swelling and bursting of their gut wall.

Methoprene can be sprayed as a liquid or applied as a slow release granule or briquet to mosquito breeding areas. This chemical is an insect growth regulator that interferes with normal growth and development of the mosquito larva. Mosquito larvae treated with this chemical will not emerge as adult mosquitoes. One application with slow release formulations of this chemical may control mosquitoes for up to six months.

Both these biological larvicides are non-toxic to other aquatic organisms such as fish, crustaceans, amphibians and most non-target insects.

i. The use of conventional chemical larvicides. The relatively low toxic chemicals Temephos and Maldison are used in certain areas for biting midge and mosquito control where use of these chemicals is appropriate. Both these chemicals kill the larval stages of the tartet insects quickly with high safety margins for non-target organisms when applied correctly.

ii. The use of pyrethroid adulticides. Synthetic pyrethroids are used at times in ultra low volume formulations and as thermal fogs to control adult mosquito and biting midge populations in harbouring areas close to residential areas and caravan parks.

iii. Larvivorous fish stocking. Local mosquito feeding fish have been stocked by Council in new waterbodies and into semi-permanent ponds that require re-stocking following long periods of drought.

iv. Habitat modifications have been carried out to some of Council's biting insect breeding areas that lend themselves to these techniques. The following techniques are briefly outlined:

Runnelling. This technique was pioneered by Tweed Council in the mid 1980s and has been applied in selected open saltmarsh areas that were prolific saltmarsh mosquito breeding areas. The technique interconnects open saltmarsh pools with shallow hand dug channels or "runnels", back to the estuary. This flushes mosquito larvae from the marsh, allows mosquito feeding fish access to mosquito larvae and reduces the sites attractiveness to egg laying mosquitoes.

Improved backwater flushing. Several sites adjacent to naturally bunded lower estuary creek overflows, that flooded following very high tides or heavy rain, had tidal channels dug to bring daily tidal flushing to the area. This has resulted improved water quality in these once stagnant areas that are now more favoured to fish life and less favourable to mosquitoes.

Partial impoundment. A semi-permanent brackish swamp that dried out during extended dry periods was once a prolific mosquito breeding area. This site had a low barrage placed towards its entrance with the estuary. The barrage maintains a more static water level in the wetland while still allowing tidal flushing. This modification has lowered wetland salinity and allowed stable predator populations of fish and other organisms to build up that generally control mosquito breeding.

Sandbar excavation. Several trials have been carried out to evaluate the effect of removing the top sand layer from tidal river sandbars breeding biting midge. These trials have shown long term reductions in midge breeding at these sites.

These control techniques have been more fully explained, see references, Easton 1990, 1 and 2.

Despite these control measures there will always be periods when the biting insect populations in suitable areas are above many residents' nuisance thresholds. In addition abatement measures impose an economic cost to Council which it does not wish to exacerbate if possible.

Guidelines for the Householder and others to reduce the problem

Following are some suggestions for existing householders and other developments affected by biting midge and mosquito nuisance to help alleviate or minimise the problem:-

1. Keep vegetation surrounding the house to a minimum. This reduces insect harbouring areas and increases air flow surrounding the house. Also keep lawns well mowed as any activity that reduces sheltering sites and lowers humidity surrounding the house will help to deter mosquitoes and biting midges.
2. Keep insect screens well maintained. If biting midge are a problem entering through fly screens, smaller mesh sizes such as found in products like "Solar Mesh" may stop entry. Screens can also be sprayed with insecticide barriers to deter midges. The newer lower toxic surface sprays containing synthetic pyrethroids can be very effective.
3. It is most likely that biting midge will enter dwellings on the leeward side of the dwelling where lower air pressures and wind speed are created by the wind blowing over the dwelling. It will also be from this side of the dwelling that carbon dioxide respired by the inhabitants (a strong attractant to midge) will emanate. Close leeward windows or keep more window area on the windward side of the dwelling open as this will tend to pressurise the dwelling and increase draft from the leeward side reducing the midges ability to enter. As midges do not like to seek blood meals when a moderate breeze is blowing, ceiling fans or other air circulation devices that increase air flow inside the dwelling may also decrease midge nuisance indoors. Mosquito coils burning in the house may be necessary during periods of severe midge nuisance. (See Figure 3).
4. Activities such as water hosing and digging soil attracts biting midge. Avoid outdoor activities like car washing and gardening during the early morning and late afternoon when midge are most active.
5. Biting midge are biologically linked with the lunar cycle and related tidal cycles. The three major pests species in the Tweed area have different emergence periods. One species is at its peak just following the new and full moon, another species around half moon period and the other during the period leading up to the new and full moon. If residents take note of the major attack periods in the area, they may be able to better plan their outdoor activities. If for example you live around a canal estate, you will most likely be affected by the midge species *Culicoides molestus*. This species peaks just following the new and full moon, so planning an evening barbecue around this time would not be wise. Council's Health Department can assist residents to identify their local midge species.
6. Wear light long sleeve clothing when outdoors during midge activity periods to minimise exposure to these insects. Heavier clothing is required to protect from mosquito bites due to their much longer biting parts. Personal repellents such as "rid" applied as per directions usually gives satisfactory relief from biting insects. Care is necessary to cover all of exposed body parts. Sensitive individuals and young children can use liberal amounts of baby oil applied to exposed skin to stop biting midge attack. Oil does not repel the midge but causes them to become stuck in the oil.

7. Insect trapping devices using ultra violet light as the attractant are generally useless for decreasing biting midge numbers in suburban yards. It is also unlikely they do much to reduce mosquito numbers in the yard. These traps will attract a broad spectrum of night flying insects to the light from some distances away. The problem, particularly with biting midge, is that the midge are too small to arc across the electrocuting grid so are brought into the area but not disposed of. Many beneficial insects are also killed by these devices.

8. Biting midge have a histamine like substance in their saliva which can cause intense itching in sensitive individuals. To prevent acute allergic reaction and allow the body to develop its own immunity to midge bites, Dr Eric Reye, who for many years has studied biting midge, suggests vitamin B1 (thiamine) can be used. This vitamin has an anti-histamine action. Dr Reye suggests an adult dose of 200mg twice a day with meals, preferably starting two (2) weeks before exposure to midge. As immunity is developed this dose can be reduced. The development of personal immunity generally comes with a regular exposure to low numbers of midge bites, not occasional heavy exposure. Persons who have a more acute reaction to midge bites will require a different medicine, (Reye, 1992).

9. The practice of carrying out maintenance dredging of canal beaches every few years to restore eroded beaches unfortunately exacerbates biting midge problems around the canals. Nutrient rich sand when dredged back onto canal beaches provides the midge adult with a favourable egg laying site around the high spring tide level and provides the larval midge with a nourishing substrate in which to complete their development. Canal residents could consider replacing their eroded sand beaches with course pebbles or other materials that are unsuitable for midge breeding and less likely to erode from the beach.

A6.3.2 Areas of Proposed Development

The first and most important action to take to minimise future biting insect nuisance in the Tweed Council area is to allow as greater open buffer area around the known and mapped insect breeding areas as is possible (see A6 Maps). As mosquitoes and midges prefer to travel along well vegetated routes, keeping an open, lightly treed buffer is preferable to heavily foliaged buffers. Developers are advised, however, that Council is guided by other statutory requirements regarding clearing of vegetation. This includes clearing restrictions in various land use zones under Tweed Local Environmental Plan 2000 and the provisions contained in State Environmental Planning Policies and Regional Environmental Planning Policies. Other planning objectives contained within these planning instruments may be inconsistent with the guidelines for alleviating and minimising biting insect nuisance. Examples include clearing restrictions in environmental protection zones and in areas mapped by the Department of Planning under State Environmental Planning Policy No 14 - Wetlands. It is therefore important that landowners and/or developers contact Council prior to the clearing of vegetation.

Following are some suggestions by Council's Entomological Control Officer that may be incorporated into development proposals that will help minimise biting insect nuisance on and surrounding the development site.

Housing Subdivision

To help minimise biting insect nuisance in housing subdivisions proposed near biting midge or mosquito breeding areas the following is suggested:-

1. Specified open buffer zones between insect breeding areas and dwelling houses. This zone will vary widely with circumstances, from as little as 50m to 1km. This zone can usually be determined by a field survey during the warmer months of the year and by consulting the attached biting insect breeding area distribution maps. Due to the difficulty in controlling biting midge populations from extensive breeding areas, buffer zones around these areas will usually need to be greater than for mosquitoes.
2. Biting insects, particularly biting midge, will follow vegetated corridors from breeding areas to residential areas. It is therefore suggested that breaks are provided in any continuous vegetation lines leading to residential areas.
3. Land fill operations to elevate subdivisions above flood height should be carried out with due regard to minimising impedance of surrounding drainage systems.
4. Roadway embankment construction should be designed to eliminate (if possible) any standing water impoundment or redirection of water flows into potential mosquito breeding areas.
5. Consideration of stormwater drainage design and route. Drains should be designed to avoid silt accumulation and be free draining. Exit points from drains into waterways or wetlands should be designed to avoid habitat changes at discharge points such as will occur if organically enriched drainage from urban areas is directed into mangrove areas or tea tree wetlands. Misdirected stormwater into these habitats can create new midge and mosquito breeding sites or increase existing breeding by favouring certain aquatic and semi aquatic vegetation species that restrict drainage flow. Silt accumulation at stormwater estuary discharge points, combined with regular low flow water discharge particularly suit the biting midge species *C. sumimmaculatus*. Care must be taken to avoid increasing tidal influence back up drains into freshwater wetlands as this increases saltmarsh mosquito favourability.

Tourist Complexes and Integrated Residential Development

The above considerations contained in Sub-Section 3.2.1 will apply equally to these developments. However due to the more planned nature of these developments some considerations can be taken further. These are as follows:-

1. Daytime recreation areas such as golf courses and parkland or car parking areas can be situated between insect breeding areas and accommodation areas.
2. On site habitat modification of lowlands may be possible to reduce biting insect breeding. Free draining wetland regeneration of degraded lowland cattle pasture is being planned for one current development.
3. Consideration of dominant prevailing winds that may distribute biting insects, particularly biting midge, when siting accommodation and evening recreation areas.
4. Landscape layout and vegetation species should be selected to minimise insect harbourage and corridors. Tall lightly foliaged species with a high canopy such as eucalypts and palms tend not to harbour biting insects and allow good air circulation at ground level. Native shrubs such as grevillea, banksia and casuarinas planted not too densely are suitable for further landscape or screening use. Heavily

foliaged plants, particularly those requiring frequent watering as used in "Hawaiian style" well shaded gardens should be avoided near accommodation areas or evening recreation areas.

New Waterbodies Close to Residential Areas

Many developments are now incorporating either freshwater or tidal waterbodies as part of the overall development of the site. These waterbodies may be created as part of the drainage system of the site, to obtain fill for development, for flood control and/or recreation purposes. The following guidelines are suggested to reduce the biting insect problem:-

1. Tidal waterbodies should have a high percentage of their foreshore revetted to a level below that suitable for biting midge breeding. This will exclude the inter-tidal zone favoured by biting midge. Small areas may be left as sandy beach for recreation providing human recreational activities on these beaches is sufficient to keep the sand well trampled to deter midge breeding. Regular weekly raking of these beaches throughout the warmer months of the year may also deter midge colonisation of the beaches. Consult Council's Entomological Control Officer for further details of this technique.
2. Water quality of lakes and lagoons should be suitable for mosquito eating larvivorous fish to breed.
3. Water to be stocked with suitable native larvivorous fish. Council will advise and assist with this.
4. Waterway design to avoid the potential for extensive emergent aquatic plant growth. Generally this will require the majority of the water body to be deeper than 2m, though shallow ingress and egress points supporting aquatic growth to act as sediment and nutrient traps are favoured. If water-lillies colonise waterbodies extensively, regular removal may be necessary to reduce the breeding potential of several opportunistic mosquito species that spend their larval stages attached to the stems of these plants.

Development Applications

Upon receipt of a development application by Tweed Council, where it has been identified as having a biting insect problem, the developer is required to outline in detail how the problem will be minimised. Where insect problems are considered severe, the development application must be accompanied by a report from a person qualified in addressing the biting insect problem in detail.

REFERENCES CITED

Alloway D Reye E 1990, The impacts of biting midges on human health and lifestyle. Proc Nat. Conf. on Biting Midge. Feb. 1990 Surfers Paradise

Easton C 1990(1), Integrated saltmarsh mosquito management with cost savings by environmentally compatible habitat modification in Tweed Shire NSW, Bull. Mosq. cont. Assoc. of Aust. 2:2 p31-38

Easton C 1990(2), Abatement practices and associated problems for three pest species of biting midge in Tweed Shire. Proc Nat Conf on Biting Midge Feb. 1990, Surfers Paradise

Reye E 1992, General measures for midge management. Bull. mosq. Cont. Assoc. of Aust. 4:2 p4-7

Figure 1

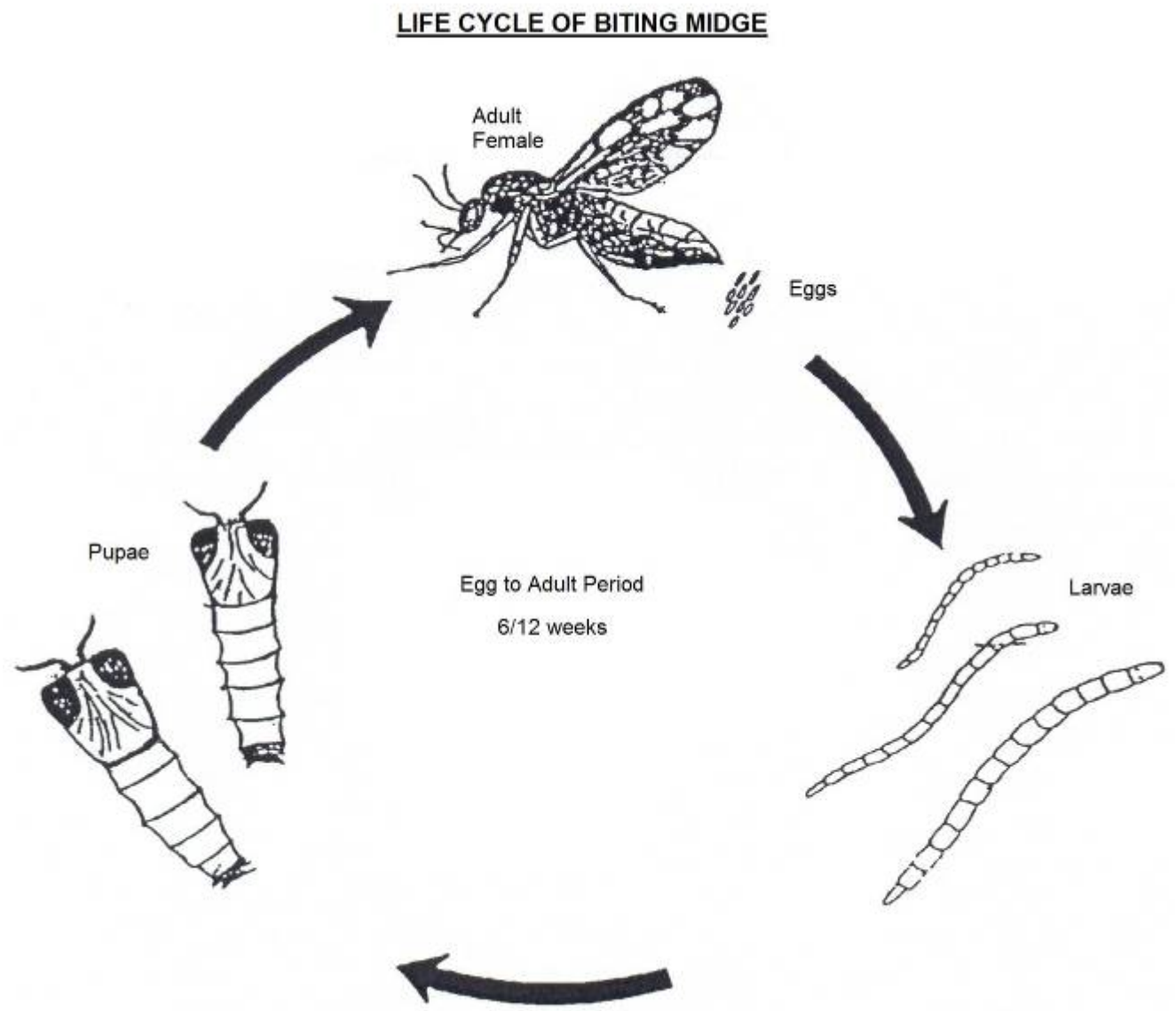

LIFE CYCLE OF BITING MIDGE
Adult
Female
Eggs
Larvae
Egg to Adult Period
6/12 weeks
Pupae

Figure 2

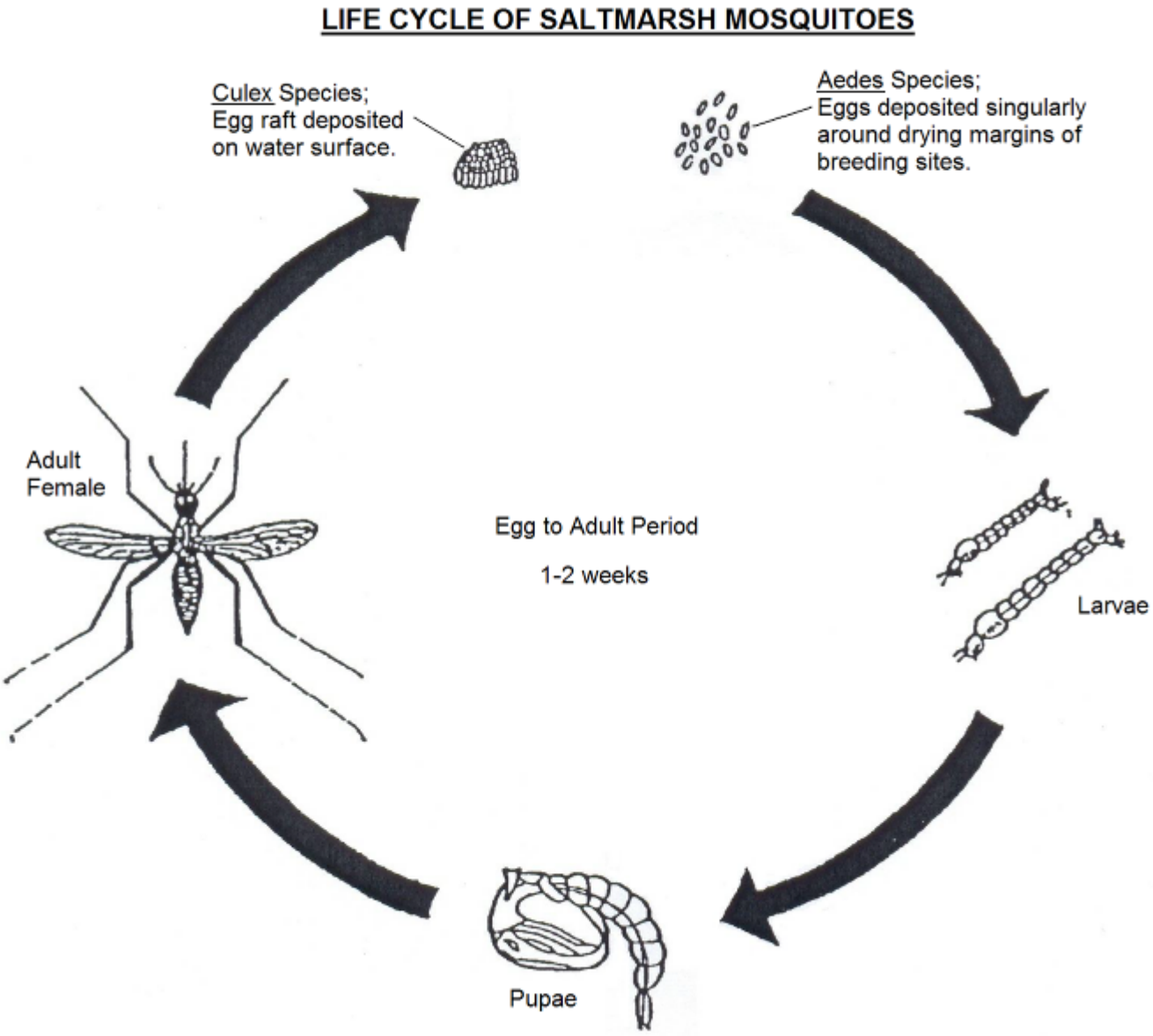
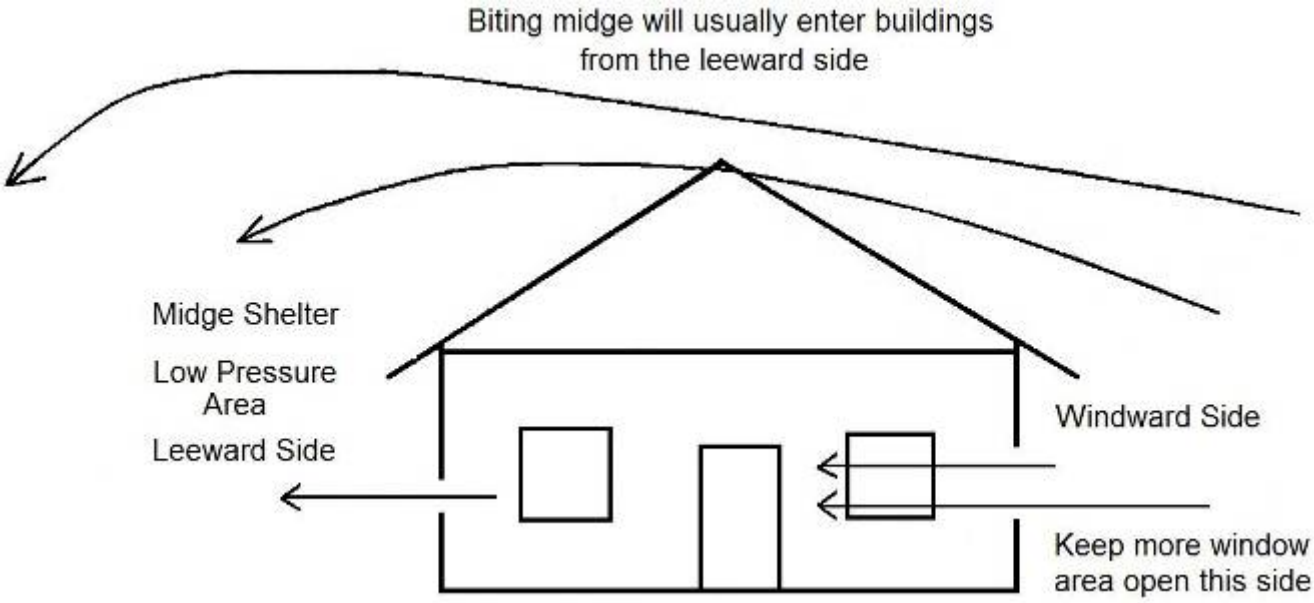

LIFE CYCLE OF SALTMARSH MOSQUITOES
Culex Species;
Egg raft deposited
on water surface.
Aedes Species;
Eggs deposited singularly
around drying margins of
breeding sites.
Adult
Female
Egg to Adult Period
1-2 weeks
Larvae
Pupae

Figure 3

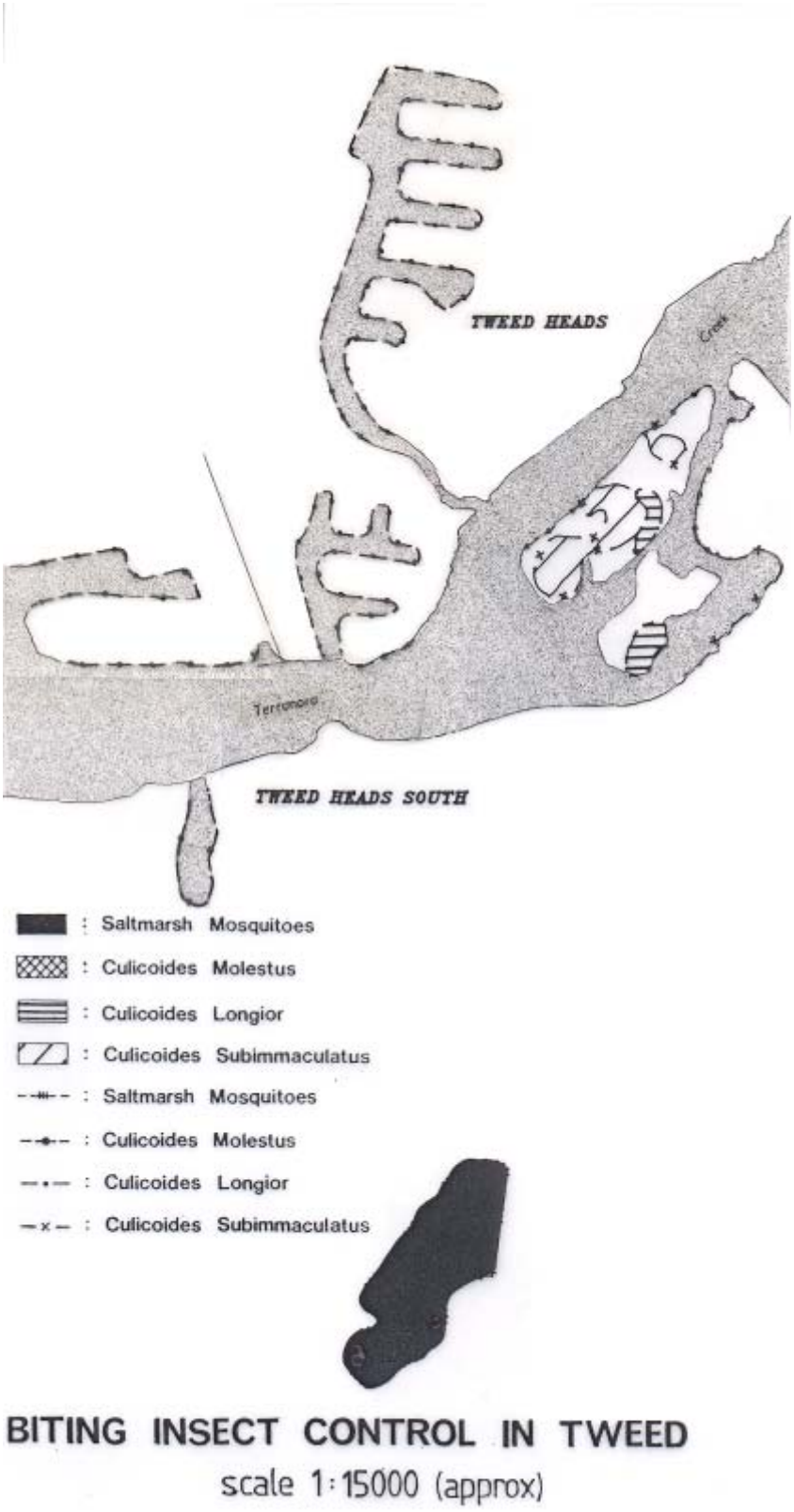


BITING MIDGE AND MOSQUITO

MAPS 1 AND 2

(Please note that the areas of the Tweed River above Stotts Island, the Clothiers Creek Valley and the upper reaches of the Mooball, Cudgen and Cudgera Creeks have not yet been mapped for breeding grounds for biting insects).

Figure 4



BITING INSECT CONTROL IN TWEED

scale 1:15000 (approx)

Figure 5

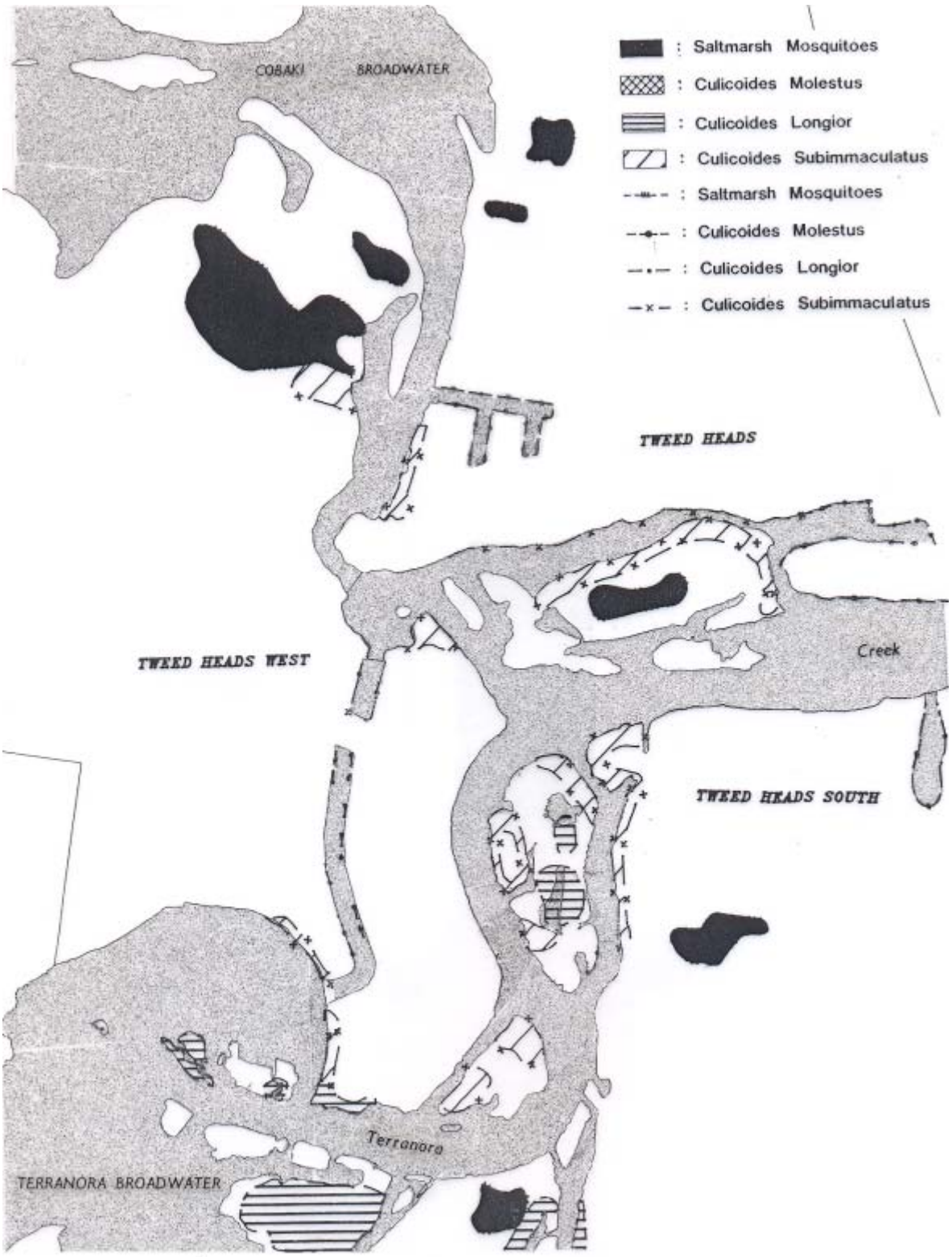

COBAKI
BROADWATER
: Saltmarsh Mosquitoes
: Culicoides Molestus
: Culicoides Longior
: Culicoides Subimmaculatus
: Saltmarsh Mosquitoes
: Culicoides Molestus
: Culicoides Longior
: Culicoides Subimmaculatus
TWEED HEADS
TWEED HEADS WEST
Creek
TWEED HEADS SOUTH
Terranora
TERRANORA BROADWATER
BITING INSECT CONTROL IN TWEED
scale 1:15000 (approx)

Figure 6

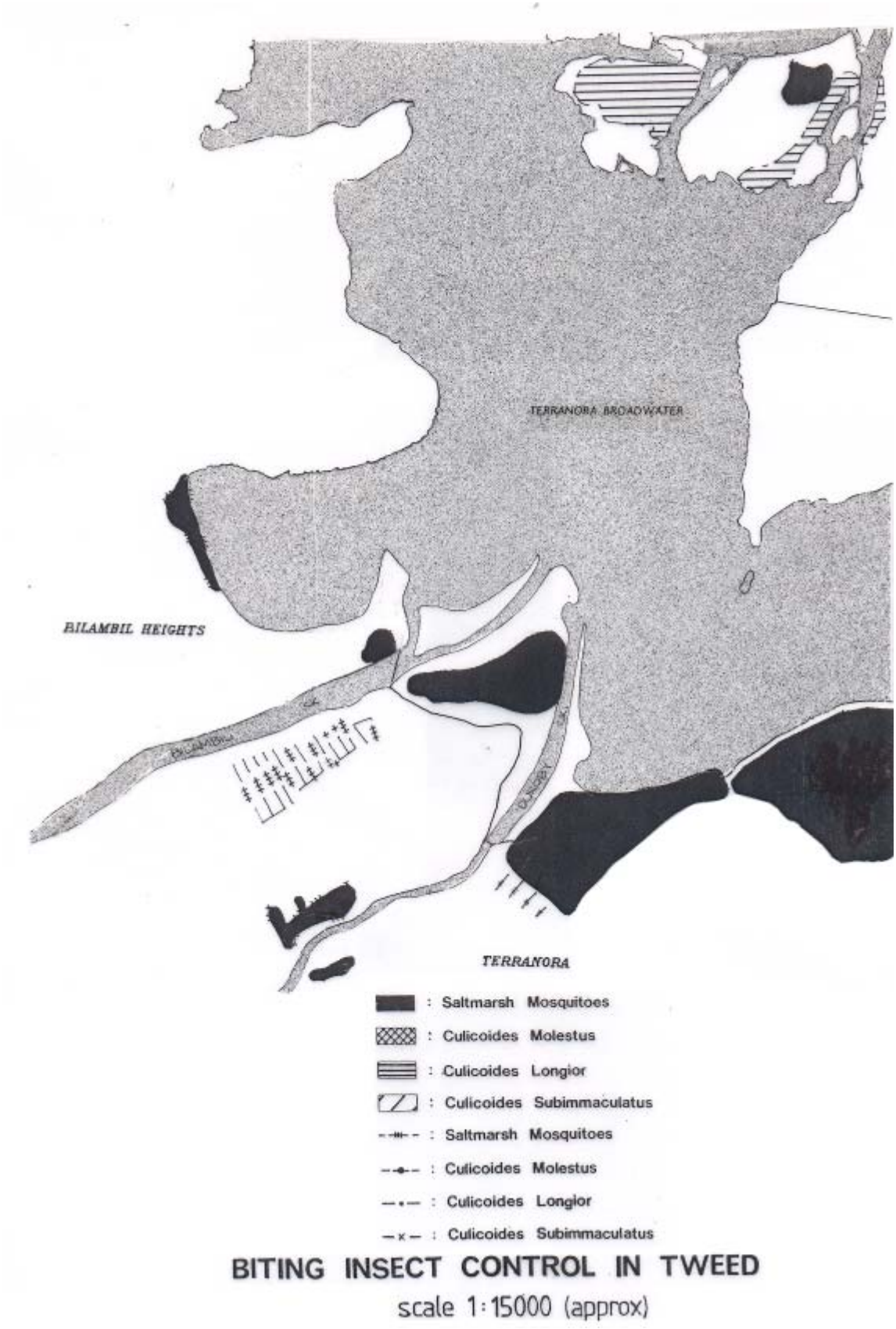

TERRANORA BROADWATER
BILAMBIL HEIGHTS
TERRANORA
: Saltmarsh Mosquitoes
: Culicoides Molestus
: Culicoides Longior
: Culicoides Subimmaculatus
: Saltmarsh Mosquitoes
: Culicoides Molestus
: Culicoides Longior
: Culicoides Subimmaculatus
BITING INSECT CONTROL IN TWEED
scale 1:15000 (approx)

Figure 7

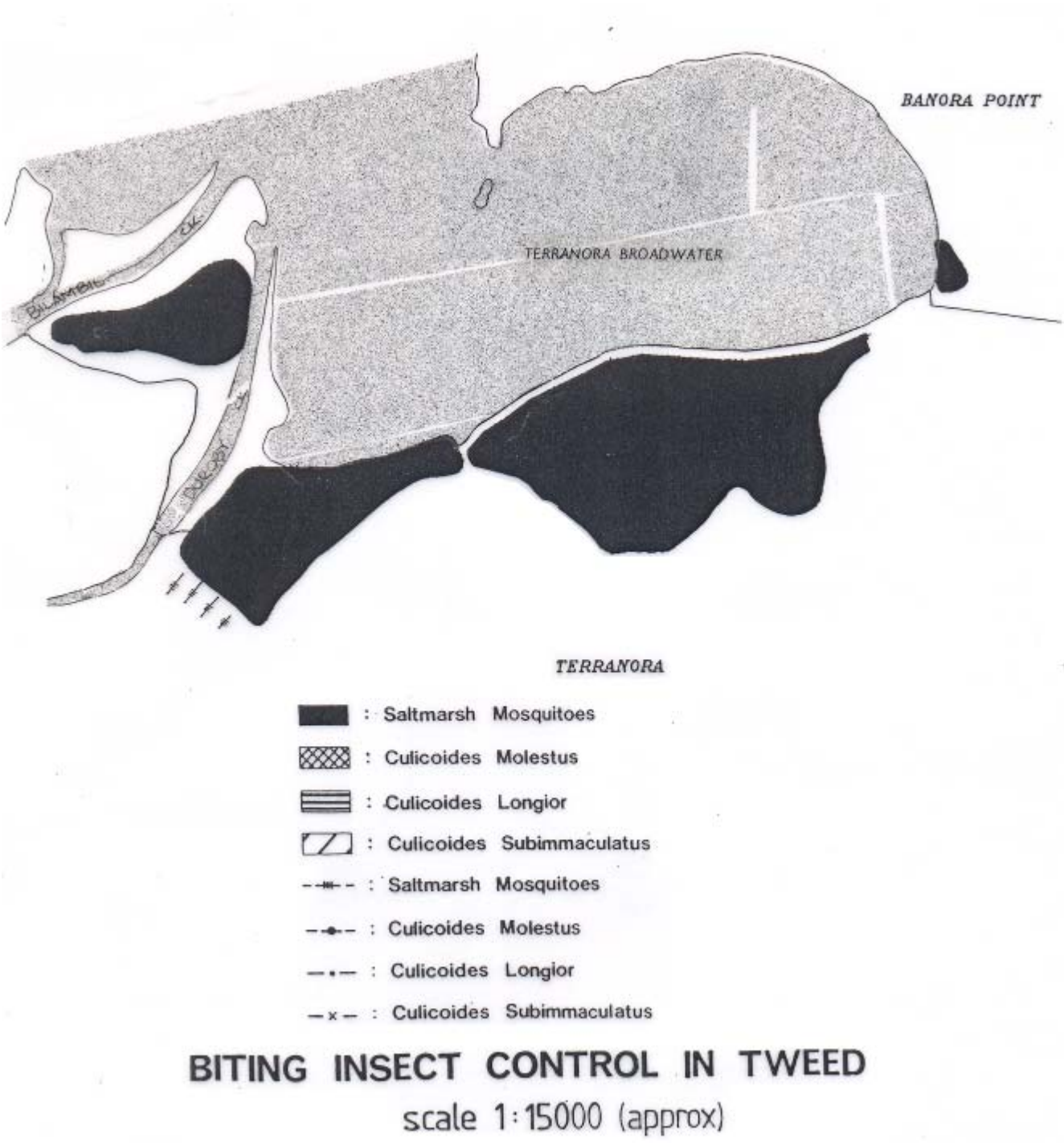

BANORA POINT
TERRANORA BROADWATER
BILAMBIL CK
PUMICESTONE CK
TERRANORA
: Saltmarsh Mosquitoes
: Culicoides Molestus
: Culicoides Longior
: Culicoides Subimmaculatus
: Saltmarsh Mosquitoes
: Culicoides Molestus
: Culicoides Longior
: Culicoides Subimmaculatus
BITING INSECT CONTROL IN TWEED
scale 1:15000 (approx)

Figure 8

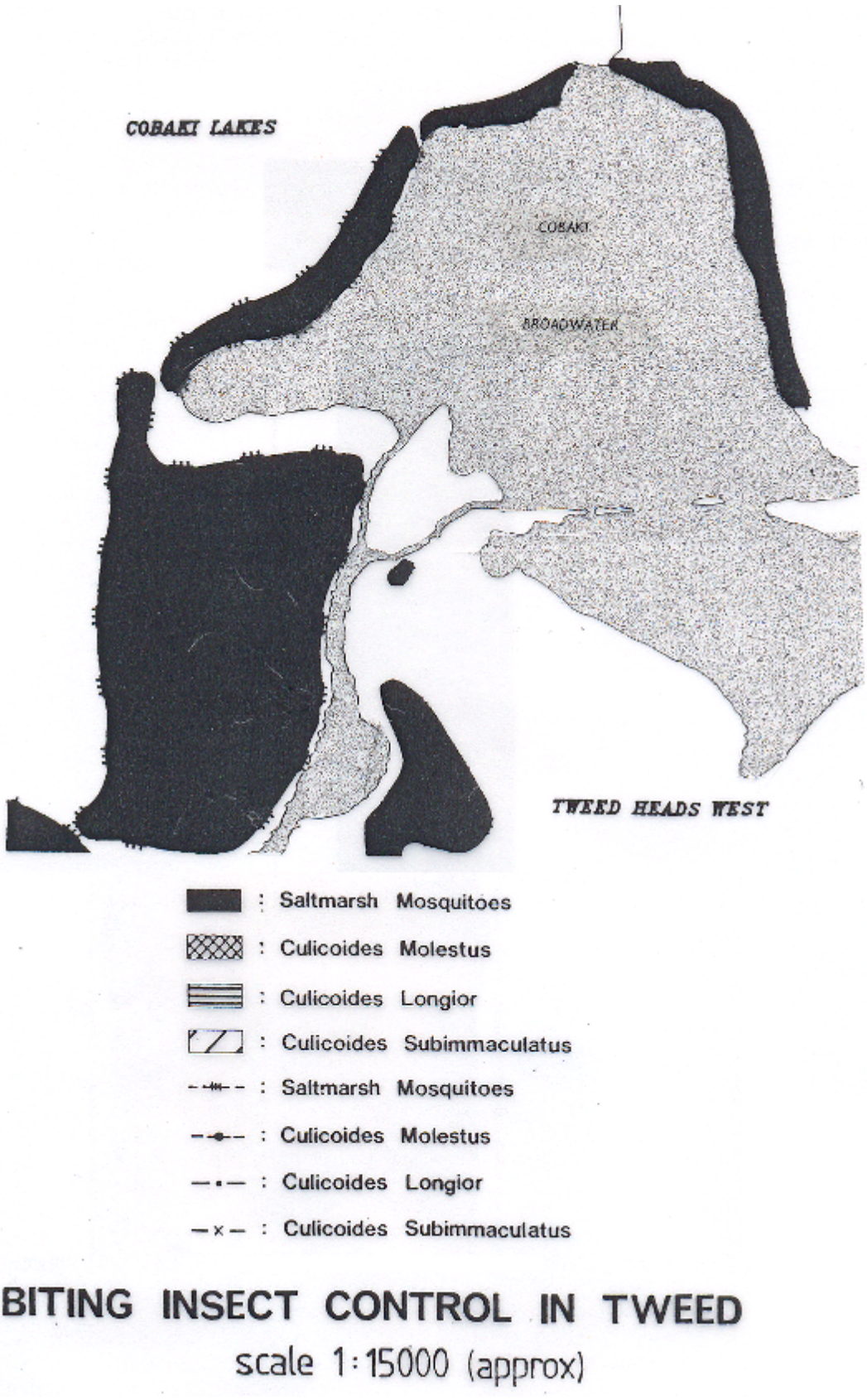

COBAKI LAKES
COBAKI
BROADWATER
TWEED HEADS WEST
: Saltmarsh Mosquitoes
: Culicoides Molestus
: Culicoides Longior
: Culicoides Subimmaculatus
: Saltmarsh Mosquitoes
: Culicoides Molestus
: Culicoides Longior
: Culicoides Subimmaculatus
BITING INSECT CONTROL IN TWEED
scale 1:15000 (approx)

Figure 9

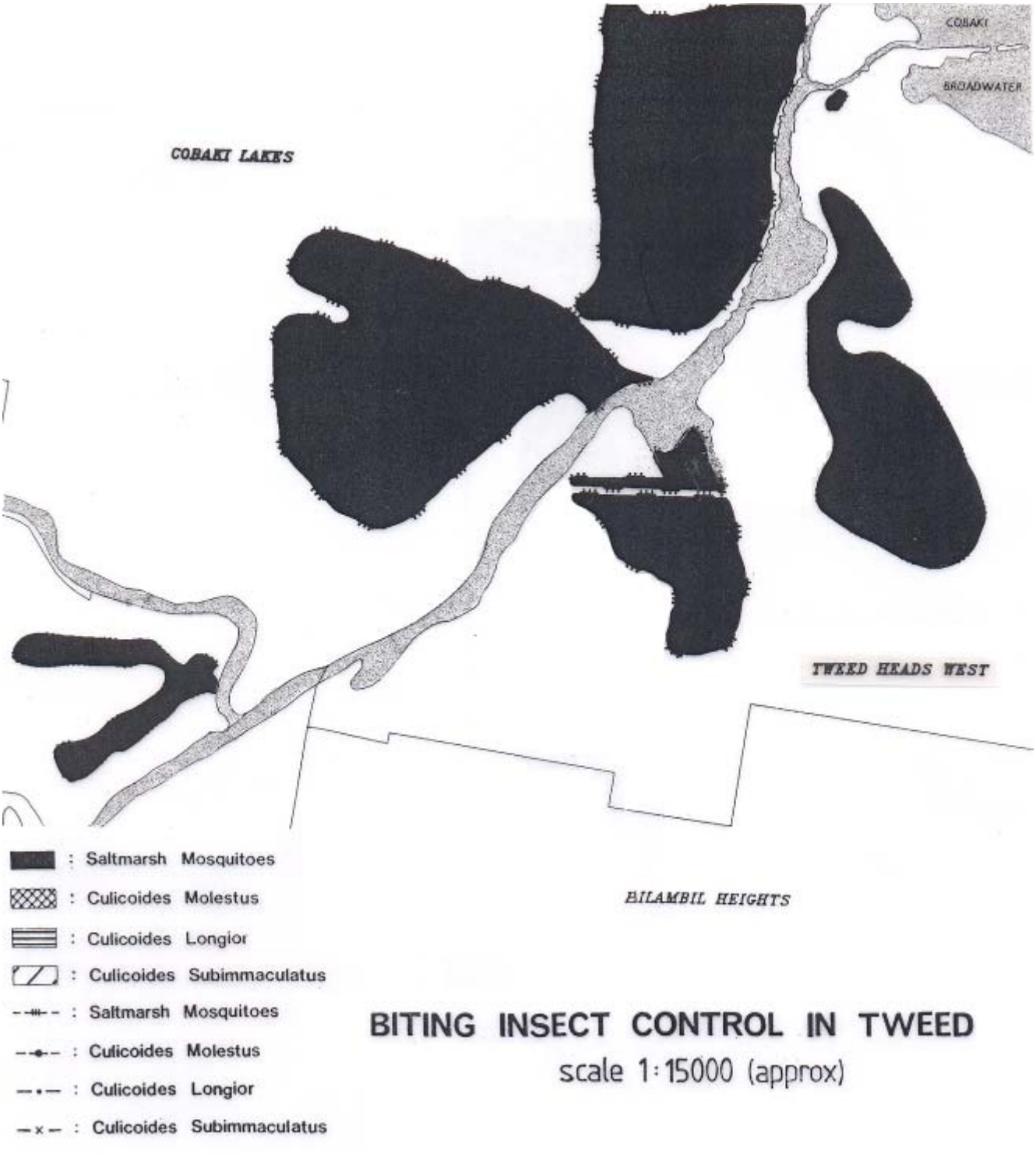

COBAKI
BROADWATER
COBAKI LAKES
TWEED HEADS WEST
BILAMBIL HEIGHTS
: Saltmarsh Mosquitoes
: Culicoides Molestus
: Culicoides Longior
: Culicoides Subimmaculatus
: Saltmarsh Mosquitoes
: Culicoides Molestus
: Culicoides Longior
: Culicoides Subimmaculatus
BITING INSECT CONTROL IN TWEED
scale 1:15000 (approx)

Figure 10

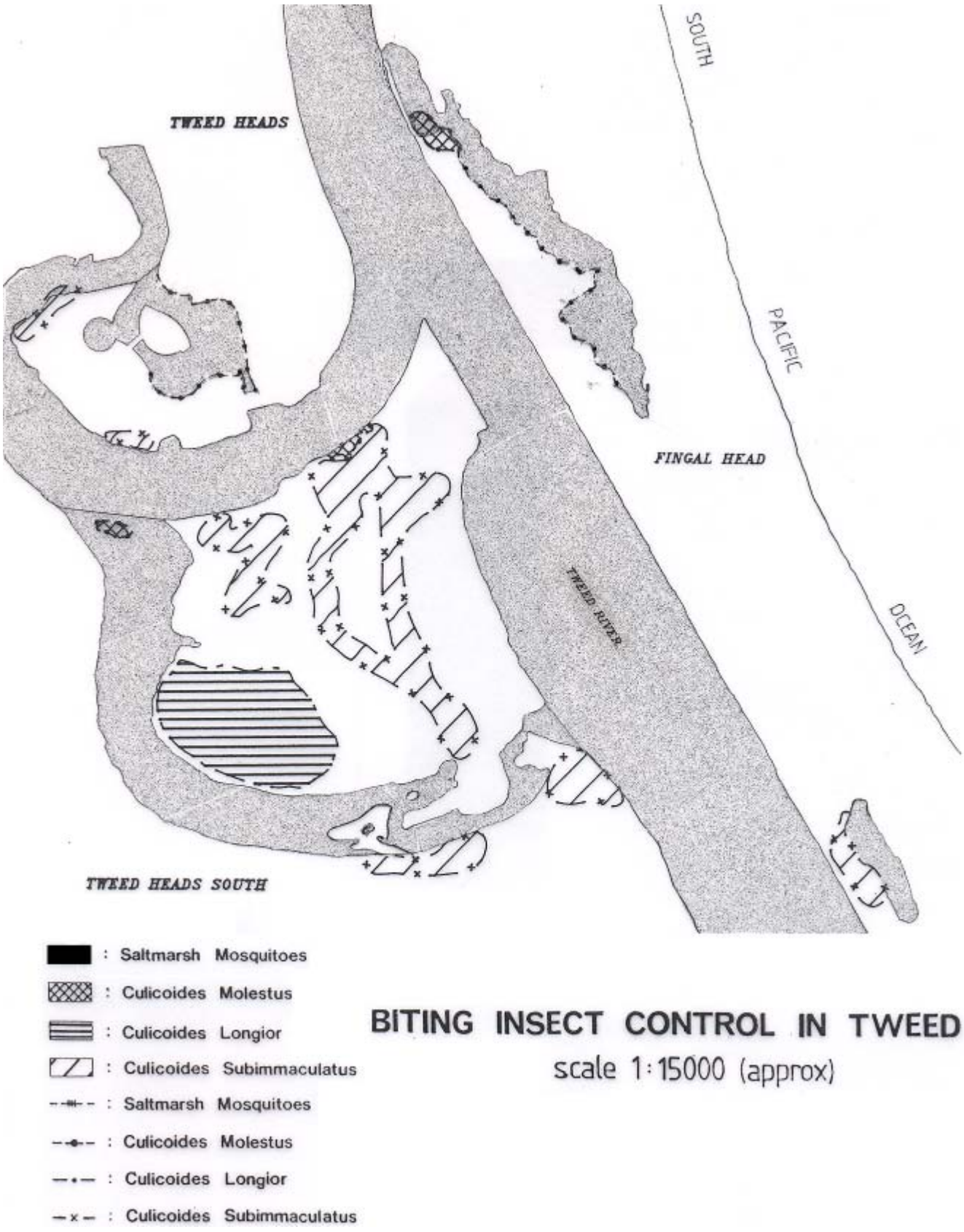

TWEED HEADS
SOUTH
PACIFIC
OCEAN
FINGAL HEAD
TWEED RIVER
TWEED HEADS SOUTH
: Saltmarsh Mosquitoes
: Culicoides Molestus
: Culicoides Longior
: Culicoides Subimmaculatus
: Saltmarsh Mosquitoes
: Culicoides Molestus
: Culicoides Longior
: Culicoides Subimmaculatus
BITING INSECT CONTROL IN TWEED
scale 1:15000 (approx)

Figure 11

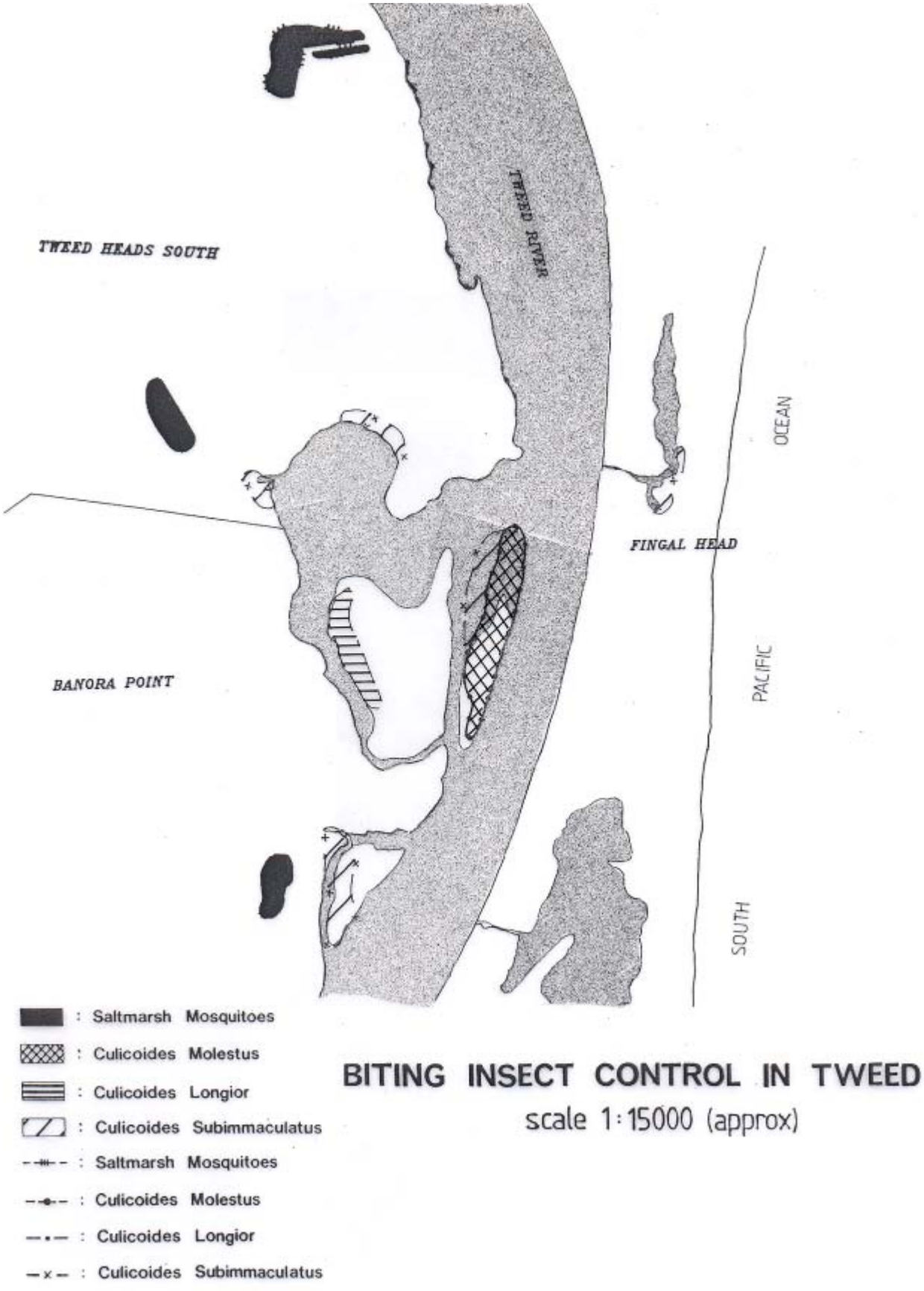

TWEED HEADS SOUTH
TWEED RIVER
FINGAL HEAD
OCEAN
PACIFIC
SOUTH
BANORA POINT
: Saltmarsh Mosquitoes
: Culicoides Molestus
: Culicoides Longior
: Culicoides Subimmaculatus
: Saltmarsh Mosquitoes
: Culicoides Molestus
: Culicoides Longior
: Culicoides Subimmaculatus
BITING INSECT CONTROL IN TWEED
scale 1:15000 (approx)

Figure 12

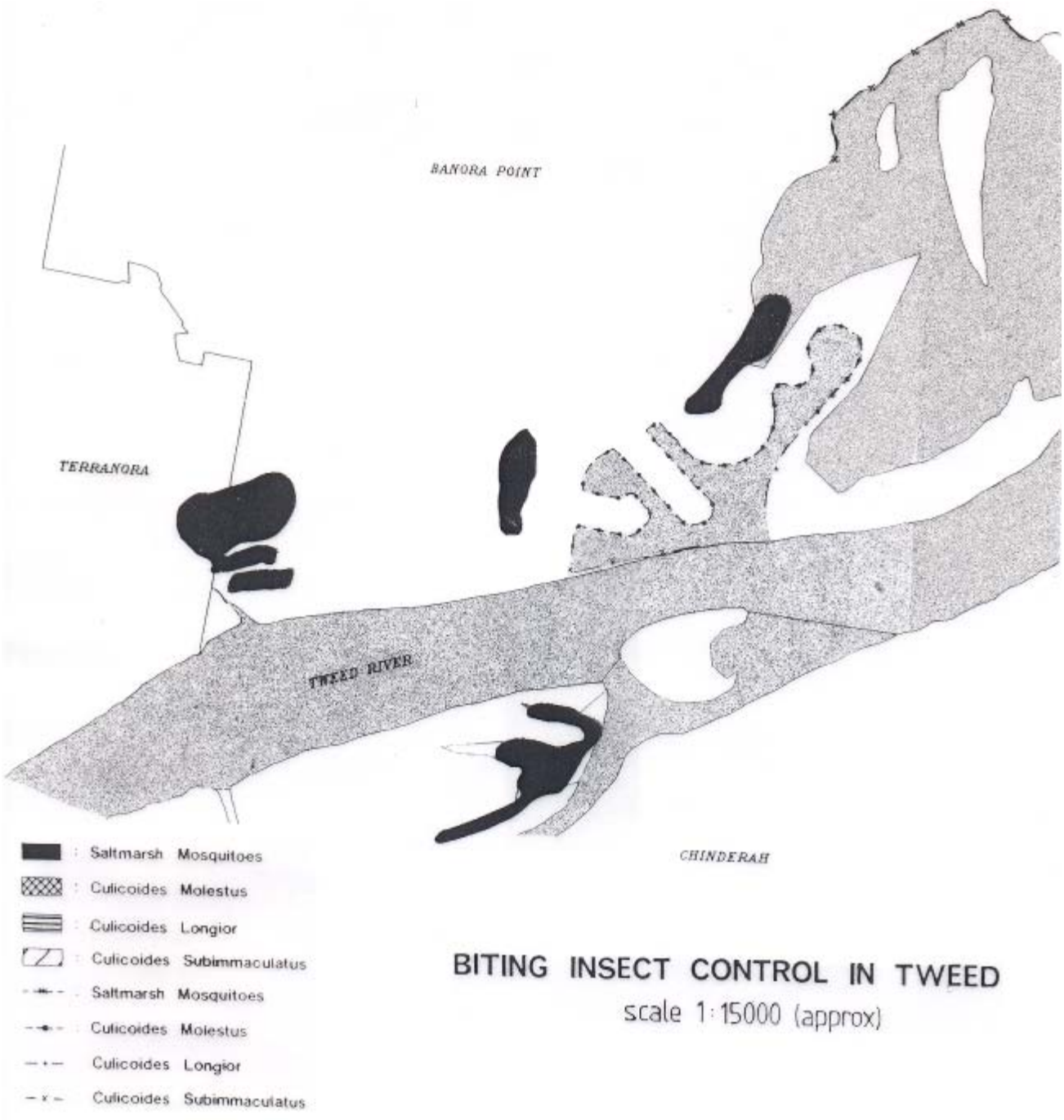
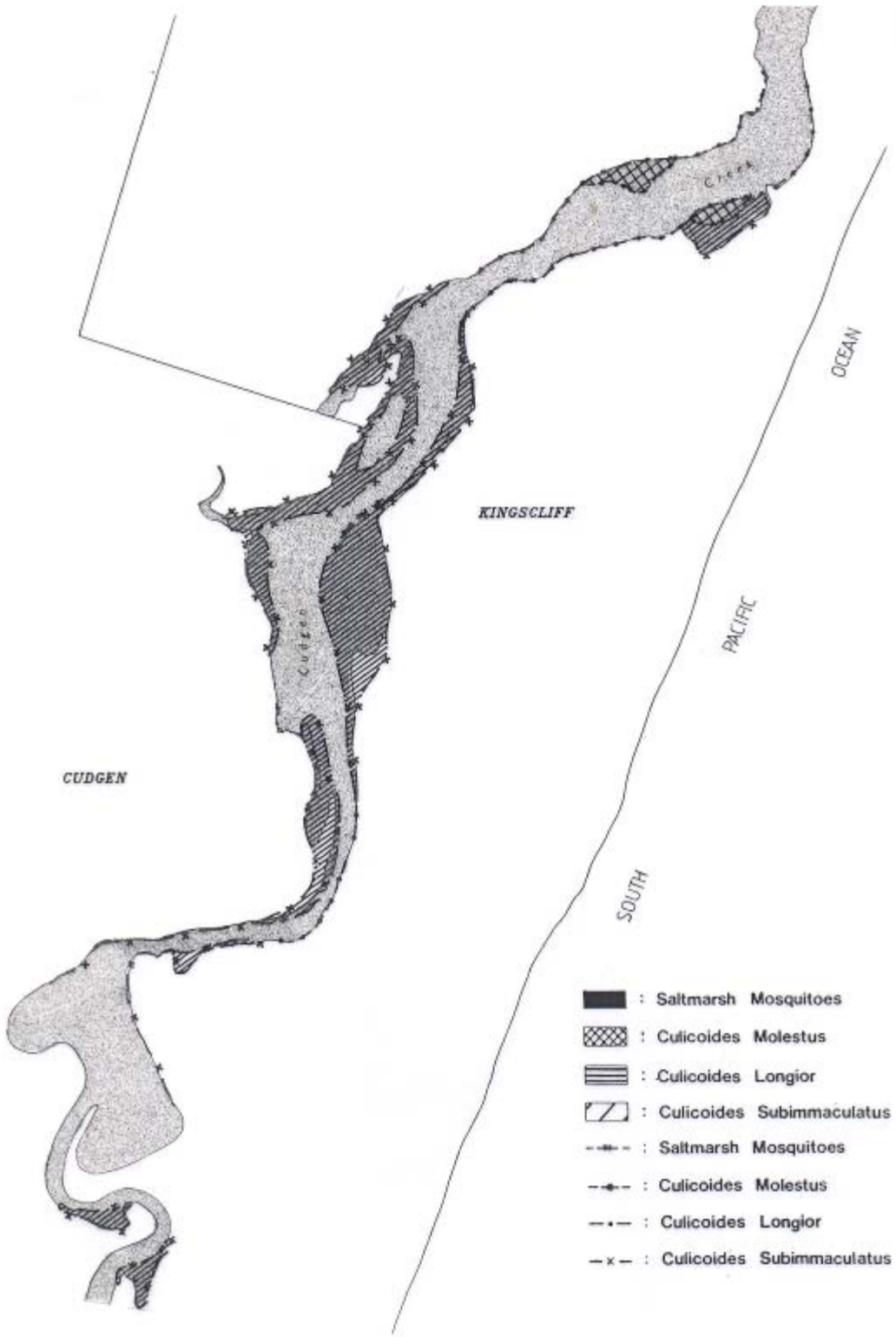

BANORA POINT
TERRANORA
TWEED RIVER
CHINDERAH
Saltmarsh Mosquitoes
Culicoides Molestus
Culicoides Longior
Culicoides Subimmaculatus
Saltmarsh Mosquitoes
Culicoides Molestus
Culicoides Longior
Culicoides Subimmaculatus
BITING INSECT CONTROL IN TWEED
scale 1:15000 (approx)

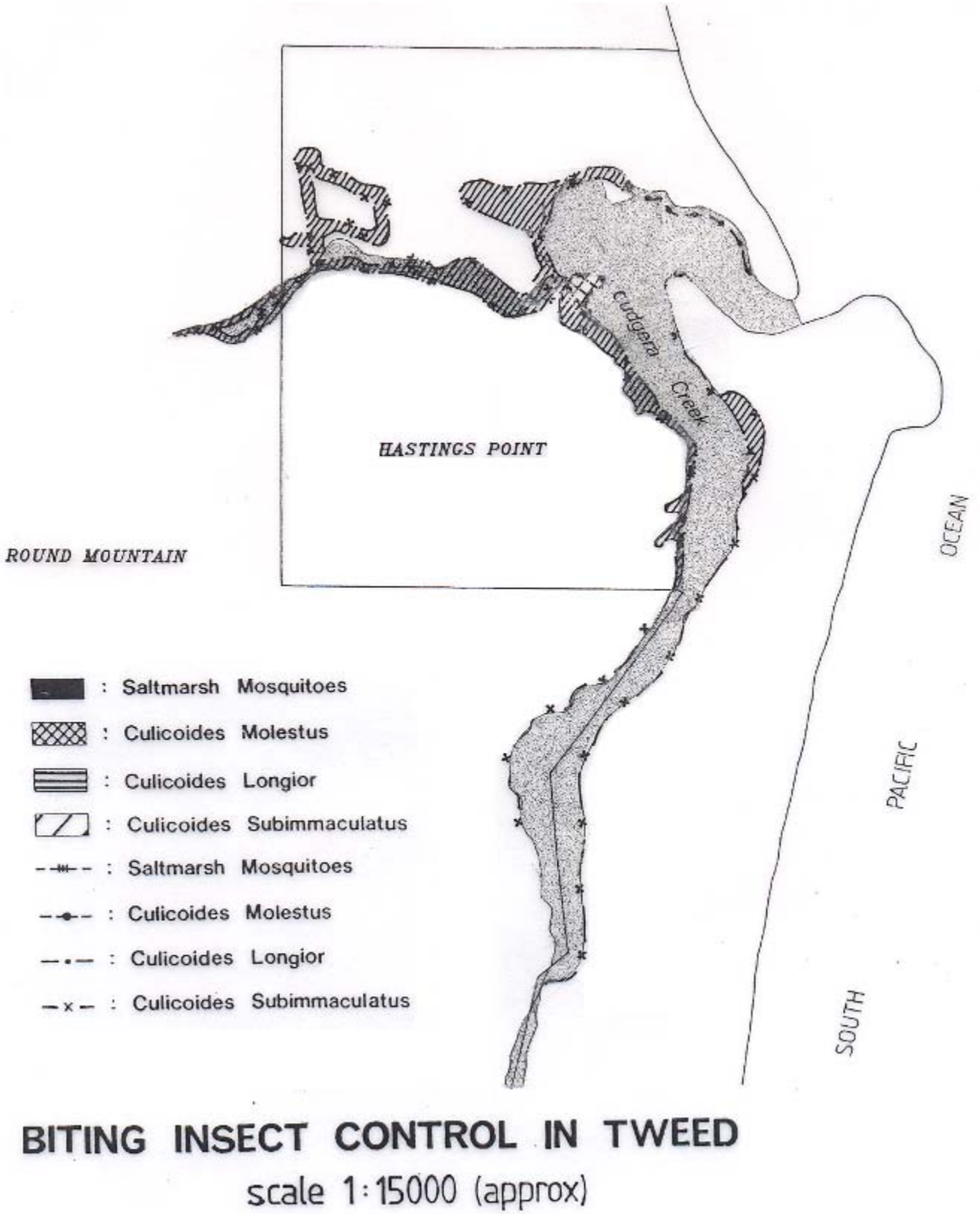
Figure 13



BITING INSECT CONTROL IN TWEED

scale 1:15000 (approx)

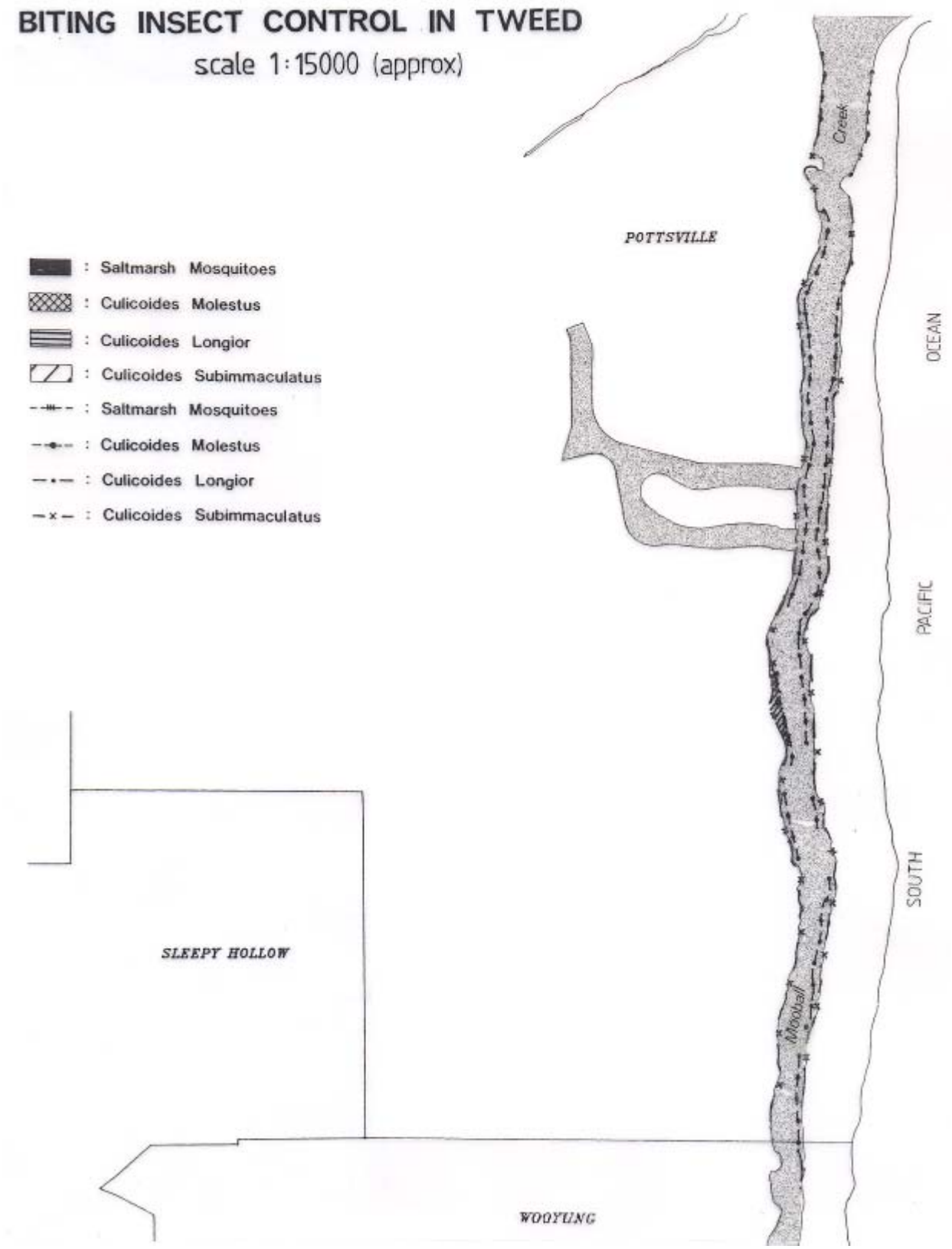
Figure 14



BITING INSECT CONTROL IN TWEED

scale 1:15000 (approx)

Figure 15


BITING INSECT CONTROL IN TWEED
scale 1:15000 (approx)
: Saltmarsh Mosquitoes
: Culicoides Molestus
: Culicoides Longior
: Culicoides Subimmaculatus
: Saltmarsh Mosquitoes
: Culicoides Molestus
: Culicoides Longior
: Culicoides Subimmaculatus
POTTSVILLE
SLEEPY HOLLOW
WOOYUNG
Creek
OCEAN
PACIFIC
SOUTH

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