

MS 5371
IMPACT OF BITING MIDGES ON RESIDENTIAL PROPERTY VALUES IN
HERVEY BAY, QUEENSLAND, AUSTRALIA.

Running head: Biting midge impact on property values

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ABSTRACT. Biting midges (*Culicoides* spp.) are an important environmental health issue in Hervey Bay, an area of rapid population growth in Australia. It is also the gateway to a World Heritage area (Great Sandy Strait) and a destination for tourists. The spread of housing developments into suburbs close to midge breeding habitats has led to a problem for the local government responsible for managing biting insects in its area. Suburbs with a severe biting midge problem were found to have significantly lower residential property values than less affected suburbs. The gross reduction in value in due to the midge problem was estimated to range from over AUS\$ 25 million, based on actual sale price, to over AUS\$ 55 million, based on the perceptions of the most severely affected residents.

KEYWORDS economic impacts, housing value, biting midges, *Culicoides*

INTRODUCTION

Biting midges (genus *Culicoides*) are creating social, economic and environmental problems in many parts of the world. Blackwell and Page (2003:178) note that biting midges are "... absent from only the southern most areas of South America". Given that biting midges and their problems are widespread it is curious that very little has been written about their impacts. What has been written is typically of an anecdotal nature with little or no quantitative analysis. This paper contributes to the biting midge literature by describing a quantitative study that examines the impacts of biting midges on both perceived and actual residential property values in Hervey Bay, Queensland, Australia.

Hervey Bay City is a sub-tropical city located on the east coast of Australia (24° 43`S, 153° 12`E), in an area of rapid population growth. It is a tourist destination and service centre for those visiting the World Heritage Great Sandy Strait region. The coastline at Hervey Bay contains a diverse range of habitats including rocky headlands, sandy beaches, mangroves and mudflats. The latter two also provide habitat for biting midge. The main species are *Culicoides ornatus* Taylor, associated with mangroves, and *Culicoides* sp. nr. *subimmaculatus* Undescribed, associated with estuarine flats and muds or sandy muds (Shivas 2001). Figure 1 shows the distribution of biting midge habitats along the Hervey Bay coast. Although biting midges are not known to transmit human diseases, they are perceived as a nuisance and are a public health concern in Hervey Bay (Neller 2005). Increased property development, with leisure activities and settlements close to midge breeding habitats have increased human-midge interactions leading to a severe problem that demonstrably reduces the health of the local population to below Australian standards, as measured on a standard survey instrument (SF-36, referred to in Neller 2005). The absence of reliable information on costs associated with the midge problem makes it difficult to formulate cost-effective strategies for managing the issue. This research identified the economic impact of biting midges on one such cost: values of residential property within the Hervey Bay coastal area.

MATERIALS AND METHODS

Identifying the midge problem areas

The biting midge problem does not affect the entire Hervey Bay coastal area, as some of the coastline has rocky headlands and other non-midge breeding areas (Fig. 1). To check if midge problems were restricted to suburbs close to the midge breeding sites identified by Shivas (2001) or whether people were affected in other suburbs, an advertisement was published in local newspapers, *The Hervey Bay City Independent* and *Fraser Coast Chronicle*, inviting people (who had been harassed by biting midges) to express their willingness to participate in a midge study and identify their residential address.

Survey subjects

There were 2 groups of respondents. The first (Group 1) was randomly selected from 2,090 households located within 500 meters of the known midge habitats. Since population density varied across suburbs, a simple stratified random sampling technique was used to select households, such that greater numbers of participants were randomly selected from suburbs with greater population density. Contact information (home telephone numbers) was extracted from the Australian Residential Phone Directory (July 2002). Twenty-nine of the 42 selected agreed to participate.

The second group (Group 2) was selected randomly from the 157 residents who responded to the newspaper advertisement regarding the biting midge problem in Hervey Bay area. Forty respondents were selected using a simple random sampling technique, again stratified by population density, and excluding those already sampled from Group 1. As requested, they had provided their residential address and home telephone number.

Survey instruments and data collection

Data was collected from the respondents and also from residential property sale prices. A telephone questionnaire was used to collect the respondent data. The structured questionnaire was designed to collect information about the respondents' perceptions of the severity of the midge problem as well as perceived impacts on real estate value and investment. Based on responses about the perceived severity of the problem, the suburbs were categorised as having a 'high' or 'lower' midge problem.

Housing sale price data were obtained for 2000-2001 for properties within 500 meters of the coast (Queensland Valuation and Sales, 2002).

Data analysis

The JMP statistical package was used to analyse the data. Data were compiled and analysed to assess residents' perception of the effect of the biting midge problem on housing value and investment. Where there were no significant differences between Groups 1 and 2, assessed using Chi squared analysis, the results were combined. Expected cell frequencies were < 5 in $> 20\%$ of cells in the contingency table and so the Likelihood ratio test was used, as this is the appropriate tool in this case Agresti (1990). To extrapolate any perceived reduction in housing value to all the affected properties we multiplied the mean perceived difference by the 2090 properties in the midge-prone area.

Student's t-test was used to assess if there were significant differences in the actual sale price of residential properties related at a general level to the two midge categories (high or lower). In more detail, ANOVA was used to investigate if there were significant differences between between suburbs and, if so, if these were related to the severity of the midge problem. An extended t-test was used to identify where any specific significant differences occurred.

To extrapolate any difference in sale price of housing in the two categories of midge status to the population of households in the potential problem area (500 meters from the coast and midge-breeding areas), the average actual difference in price was multiplied by the 2090 properties, as above.

RESULTS

The location of respondents from the newspaper survey (Group 2) was generally consistent with the *Culicoides* breeding areas as identified by Shivas (2001).

Impact on housing value

When residents were asked about their perception of the effect of midges generally on housing values in their suburbs there was no significant difference between the groups, with 53% agreeing that there was either a minor or major impact (Table 1). Around 30% of residents were of the view that biting midges have no

impact on housing value and 16% were not sure about it. However, when asked if the presence of midges would be an important factor in their own housing choice, there were differences between the groups. Group 2 (selected from the newspaper responses) clearly considered the issue to be more severe than did Group 1 (selected from suburbs within the midge affected zone) (Table 2). Midge presence would be a major factor in housing choice for 75% of Group 2 whereas the majority of Group 1, nearly 52%, responded that it would have no impact. The 27 respondents who indicated that biting midge had a major impact on house value (Table 1) were also asked to estimate the magnitude of the impact on housing value and this is shown in Table 3. Although the percentage values given in Table 3 are based on subjective estimates, they do indicate that housing value depreciation is perceived to be substantially greater in the River Heads, Booral and Pialba suburbs than in others. An average perceived percentage depreciation for a specific and common type of housing was calculated as 17.6% on a base price of AUS \$150,000 (Table 3). Multiplying 17.6% of \$150,000 by 2090 residences provides an estimated reduced housing value of AUS\$55,176,000 were all residences to be similarly affected.

The reduced value perceived by residents is supported to some extent by the analysis of actual sale prices in 2000 and 2001 by the category of midge problem and by individual coastal suburb. Analysis of sale price by midge status of suburbs revealed that average house price, independent of other factors such as type and size of house, was significantly lower (\$12,328 per residence) in high midge problem suburbs (mean AUS\$103,926) than in lower midge problem suburbs (mean AUS\$116,254) ($t=2.256$, $df 1016$, $P<0.05$). As a conservative estimate of the gross lower value of housing in high midge status suburbs, multiplying \$12,328 by 2090 leads to an estimated reduction of AUS\$ 25,765,520, again based on residences being similarly affected. At the suburb level Table 4 shows that house sale prices at Pialba and River were significantly lower than in other suburbs and also that prices were variable.

DISCUSSION

As would be expected, survey responses of the newspaper respondents (Group 2) were different from the responses of Group 1 that was randomly selected, but

nevertheless living in midge range. Group 2 were motivated to initiate their participation in the research (by responding to the advertisement) and this indicates that they perceived the problem to be severe enough to warrant their time and effort. Although both groups perceived that a biting midge problem leads to depreciation of property value and may deter investment in an affected area, this was marked for the Group 2 respondents and much less so for Group 1. However, if there was a reduction in housing value, both agreed on its magnitude (Table 3). That there is an actual depression in property sale price has been established. It was variable in some suburbs and this might be explained by a differential exposure to biting midges in those suburbs, perhaps related to local effects such as wind direction and house aspect, or housing quality (screens and air conditioning may reduce the severity of the perceived problem). This has not been established in this research but may provide an area for further evaluation, including relating the variables to midge prevalence. Other factors may also influence perception of the biting midge problem including the periods when residents are at home, related to midge emergence patterns and biting activity times. This would be a matter for further and more in-depth research.

CONCLUSION

Biting midges are an important social, economic and environmental health issue in the Hervey Bay area. This preliminary study has estimated the economic costs in the housing stock of biting midges on the 2090 households that were within the midge problem area at the time of the survey (500 meters from the midge habitats). The estimates of gross reduction in value due to the midge problem range from over AUS\$ 25 million, based on actual sale price, to over AUS\$ 55 million, based on the perceptions of the most severely affected residents.

The study was conducted in suburbs adjacent to midge-breeding habitats and within 500 meters of the Hervey Bay coast. However, the midge dispersal range varies from 500 to 1,500 meters and is influenced by surrounding vegetation and climatic factors. Therefore, the actual number of households affected could be far greater than this and the cost in reduced housing value could be a great deal more.

ACKNOWLEDGEMENTS

We thank an anonymous reviewer for helpful comments and suggestions for the revision of the manuscript. We wish to express our gratitude to Hervey Bay City Council for providing resources to conduct this study. In particular, we appreciate the assistance of Ian Fanning and Marlene Dennis (Council's Environmental Services Unit), and Martin Shivas. Also we extend our thanks to participating Hervey Bay residents, local newspapers and members of the Biting Midge Investigation Committee for their support.

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Table 1. Perception of the biting midge impact on housing value (no significant difference between groups).

		Do not know									
		No impact		Minor impact		Major impact		Total			
		<i>n.</i>	%	<i>n.</i>	%	<i>n.</i>	%	<i>n.</i>	%	<i>n.</i>	%
Groups	1	11	16.0	21	30.4	10	14.5	27	39.1	69	100
	and 2										

Table 2. Perception of the effect of biting midge on the decision to buy housing (housing investment).

Group	Do not									
	know		No effect		Minor effect		Major effect		Total	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Group 1	6	20.7	15	51.7	3	10.3	5	17.2	29	100
Group 2	0	0.0	4	10.0	6	15.0	30	75.0	40	100
Total	6	8.7	19	27.5	9	13.0	35	50.7	69	100

Source: Hervey Bay Resident Survey

(Likelihood Ratio Chi Square 34.17, df 3, P<0.001)

Table 3. Perception of the % reduction in housing value due to the presence of biting midge ($n = 27$).

Suburb	Perceived reduced value% ^a
Booral	20
Pialba ^b	17
River Heads	32
Toogoom	10
Urangan ^c	9
Overall mean	17.6

Source: Hervey Bay Resident Survey

- a Housing value assumed: Single storey 2/3 beds (\$150,000).
- b According to the local council, Pialba is not as seriously affected by biting midges as the other locations, and the depreciation may be related also to quality of housing (poorer and older housing).
- c Only a small area of Urangan is midge-affected.

Table 4. Mean real estate sale prices by suburb and midge status, 2002.

Places not connected by the same letter are significantly different (Data source: Queensland Valuation and Sales, 2002; Hervey Bay Resident survey for midge status).

Place	Extended t- test	<i>n</i>	Midge problem status	Mean AUS\$	Std Dev
Toogoom	A	61	Lower	120,943	72387
Urangan	A	304	High	120,293	110704
Torquay	A	319	Lower	117,984	274270
Scarness	A	162	Lower	111,082	46337
Booral	A	42	High	108,619	97033
Pialba	A B	17	High	101,824	37637
River Heads	B	113	High	58,464	32854

(ANOVA F=8.2607,df 6,1011, P<0.001)

Figure caption

Fig. 1. Location of midge habitats and coastal suburbs in Hervey Bay (Source: Shivas, 2001)