A survey of the work and sleep patterns of Great Barrier Reef Pilots

Summary of Results

This survey represents one of a number of investigations designed to provide information on the work practices of Great Barrier Reef pilots and to identify those aspects of their work that have the potential to cause fatigue. In this investigation a questionnaire was designed to acquire general information on the work and sleep patterns of the pilots, and to assess how these patterns impact on their well-being, fatigue levels and work performance. Information gained from the questionnaire will be used to supplement data from other phases of the project, thereby generating a more complete picture of the fatigue issue.

Questionnaire items sought information on demographics, industry experience, health and lifestyle topics, as well as the extent and impact of any fatigue on bridge performance. Sections on job satisfaction and psychosocial issues were also included. Respondents were also given the opportunity to provide additional comments and elaborate on any issues which may or may not have been raised in the questionnaire. The survey was completed by 35 pilots giving a response rate of 60% and the following is a brief summary of the major findings in each category included in the questionnaire.

Demographics

- Seventy percent of respondents were aged between 41 and 60 years, while 20% were over 60 years of age. The average age of the sample was 53.2 (+ sem 1.64) years.
- The majority of pilots were currently married.

Industry Profile

- On average, pilots had 36 years of general maritime experience and had served for 9.5 years as Great Barrier Reef pilots. These findings would seem to suggest that there is a high level of stability within the pilotage workforce.
- Home port locations were predominantly in the South East Queensland and North Queensland regions.

Recent work history - Previous 6 months

- On average, tours lasted ~ 17 days in duration while breaks between tours were around 11 days.
- Just over 60% of work assignments were performed on the Inner Route.
- Forty seven percent of work was undertaken at night.
- The majority of respondents spent breaks between work assignments in pilot accommodation houses located at Mackay and on Thursday Island.

- Twenty percent of the sample had not taken a holiday in the previous 12 months.

These findings based on self-reported work history given by the pilots were generally consistent with data from the analysis of 4310 work assignments performed between Jan 1 1996 and June 30 1997 and reported earlier.

Health and Lifestyle Habits

Irregular work patterns have the potential to impact on health and lifestyle habits. For instance, engaging in regular exercise and maintaining healthy dietary habits are additional challenges for those working outside normal hours, particularly when extended periods of time are spent away from home.

- The majority of pilots rated their general health as ‘good to excellent’, while physical fitness ratings ranged between ’fair and excellent’.
- Body Mass Index ratings indicated that 15% of the sample were overweight and 56% obese.
- Thirty percent of respondents smoked.
- All respondents reported drinking caffeinated beverages.
- Smoking frequency and caffeine consumption were significantly higher while at sea compared with at home.
- All respondents reported drinking some alcohol, however no alcohol was consumed at sea.
- Pilots reported lower levels of chronic fatigue than normative data based on emergency and industrial shiftworkers.

That a large percentage of respondents were either overweight or obese may warrant closer investigation, particularly in light of the age of the respondents and their increased risk of cardiac stress associated with the varying physical demands of pilotage work.

Sleep and Nap Patterns at sea, ashore and at home

The work patterns of pilots require them to alternate between living at home, working at sea and resting ashore between work assignments. In this section, the questions were designed to gain a general impression of sleep habits in these locations and respondents were asked to report their average sleep habits over a 24-hour period.

- While at sea, pilots reported obtaining 5.5 hours of daily sleep, comprising of ~ 2.5 sleeps periods of 2.2 hours duration. In contrast, at home pilots reverted to a normal sleeping pattern of a single sustained block of sleep.
- A daily sleep debt of 2.3 hours was incurred while at sea.
- Pilots tended to nap more frequently while at sea, compared with ashore and at home.
- Sleep latency (time to fall asleep) was shorter at sea, but longer ashore, compared with at home.
- The time taken to feel alert after waking did not differ between the 3 locations.

- Sleep difficulties (falling and staying asleep) were not affected by location, however sleep was more frequently disturbed at sea and ashore than at home.
- Pilots reported needing less sleep at sea.
- In all three locations, the most frequently used strategy to promote sleep was reading.

Circadian Characteristics

The normal biological rhythms of the human body are designed to facilitate work in the daytime and sleep at night. The irregularity of the work/rest schedules of Great Barrier Reef pilots ensures that they frequently work outside of these basic parameters and risk the effects of 'circadian desynchronisation' which may be characterised by changes in sleep patterns, behaviour, alertness and mental capacity. The impact of shiftwork may be partially moderated by individual differences to cope with working or sleeping outside of the normal awake/ sleep cycles. As a measure of the impact of pilotage on these functions 'The Circadian Type Inventory ' was used to identify the sleep characteristics, and the ability of the pilots to overcome drowsiness in addition to information which characterised them as being morning or evening orientated.

- Compared with normative data based on emergency and industrial shiftworkers, pilots reported being significantly more flexible in sleeping habits and less able to overcome drowsiness.
- Overall, the sample described themselves as being more ‘morning’ than ‘evening’ orientated.

Feelings while working on the Bridge

The purpose of items in this section was to gain a general impression of the presence of tension and fatigue while working on the bridge, to distinguish factors which most often contribute to fatigue and to identify strategies used by pilots to reduce fatigue. Additional items were included to assess the extent and degree of performance decrement and periods of vulnerability to reduced performance levels across the 24-hour cycle. Pilotage specific experiences were also addressed.

- There was strong evidence that the frequency of tiredness and/or decreased alertness while working on the bridge was greater at the end of a work assignment than at the beginning. Moreover, the onset of fatigue occurred earlier during bridge periods performed at the end of a work assignment.
- Most pilots considered that boredom, lack of sleep, workload and time of day contributed to fatigue at least sometimes.
- Active, rather than passive strategies were more frequently used to combat fatigue, with stretching and performing light exercise and taking a shower being the most frequently used strategies.
- A number of respondents indicated performance decreased to varying degrees while working on the bridge. In particular, performance decrements manifested as an increased difficulty in concentrating and maintaining attention and memory problems.
- The majority of the sample reported being most vulnerable to performance decrements between the hours of 2400 and 0800.
- Correct judgment and optimal alertness levels were factors identified by most respondents as being highly relevant to pilotage work.

Job Satisfaction

To gain an impression of job satisfaction, respondents were asked to rate the five best and five worse features of working as a Great Barrier Reef pilot.

Satisfaction

- Satisfaction associated with a job well done at the completion of a work assignment was the most frequently rated best feature of pilotage work. The high level of responsibility, mental stimulation and challenges involved in navigating ships through the Great Barrier Reef region were also favourably rated by pilots.
- The variability of ship types, crew and weather encountered during pilotage duties was appealing.
- A further rewarding feature of the work was being part of a group sharing the same professional background, and meeting and working with other professional seafarers.

Dissatisfaction

- Dissatisfaction with pilotage work chiefly related to factors extrinsic to the actual act of piloting. For example, financial concerns since the commercial changes in the structure of Great Barrier Reef pilotage operations was the most frequently expressed factor leading to job dissatisfaction. Pilots also expressed concern over the impact of competition on safety.
- Time away from family and the disruption caused by pilotage work to family life were also unattractive features of the job.
- The unhygienic conditions on board some foreign ships and the attitude of AMSA were a source of job dissatisfaction.

Dyadic Adjustment

Given the important relationship between a stable home life and work performance, particularly in home and away occupations, items were included to assess dyadic adjustment. The measures used were based on previous work on -----and developed by Spanier (1967).

- The distribution of responses to the series of questions on dyadic adjustment was skewed towards the end of the scale indicating satisfaction with one's dyadic relationship. Eighty-six per cent of pilots indicated thing went well between themselves and their partner 'most to all' of the time.
- Seventy-five per cent of respondents reported a high level of marital satisfaction.

Miscellaneous Comments

Pilots were given the opportunity to provide additional comments on issues that may or may not have been included in the Questionnaire. In this analysis, comments fell under three broad areas related to 1) general industry issues; 2) work at sea; and 3) the home situation. Within these broad areas, themes were identified and comments then coded as negative, positive, suggestions or other. Of the 35 respondents to the questionnaire, 29 pilots (83%) offered additional comments ranging from a few paragraphs to several pages.

Negative comments

On general industry topics, over half the negative comments related to the impact of competition on: income, stress and anxiety levels, job security, increased workloads/decreased rest breaks and the manipulative position in a competitive environment of company managers, infrastructure providers and shipping agents.

While working at sea, respondents raised considerable concern regarding the impact of competition on safety issues. Additionally, concerns were raised regarding competency levels of many bridge teams.

At home, commentaries from pilots indicated that competition in pilotage operations has impacted negatively on home and family life.

Positive comments

From an industry perspective, comments indicated that pilots perceive pilotage as a service to the community and protection for the environment.

While at sea, competent bridge teams provided good back up for pilots and considerably reduced stress levels experienced by pilots.

Periods at home were considered to be valuable time for relaxing with family.

Suggestions

Several suggestions were received and these chiefly related to:

- A review of the practice of pilots being on ships for some days prior to, or after the compulsory pilotage region.
- Charting of alternative shipping channels. For example, the use of the Fairway Channel region of the Inner Route would eliminate one of the most difficult sections of this route and permit more extensive rest and sleep periods.

Although based on self-report data, the results of the survey identified a number of factors which have the potential to impact directly or indirectly on the development of fatigue in GBR pilots. Most measures demonstrated consistency with earlier findings on this population with respect to factors conducive to fatigue. Sleep patterns were highly compromised at sea which occurred as a function of the irregularity of the work and rest schedules, relatively long periods of sustained work, frequently at night, and the necessity to work and sleep at times incompatible with the normal biological rhythms of the body. Pilots experienced fatigue while working on the bridge particularly towards the end of work assignments and the contributing factors included boredom, lack of sleep and workloads. The potential for a decrement in performance was further substantiated by difficulty experienced by some pilots in maintaining concentration and attention and in memory lapses.

In conformity with research on other workers the results suggest that fatigue in GBR pilots is multifactorial involving a range of work related and personal factors which in part reflect the unique characteristics of working at sea in a 24 hour industry. Pilots are satisfied with the challenges and responsibilities associated with their work but rate factors such as competition in pilotage operations and insecurity as being the least satisfying aspects of pilotage. The potential for some of these concerns to impact on safety was identified by some pilots.

The survey results provide further evidence of the strong potential for fatigue among GBR pilots and the need for appropriate and well monitored work/rest guidelines.

1.0 INTRODUCTION

In the past, research examining the fatigue contribution to transportation accidents has been constrained by a number of issues. For one, human fatigue generally leaves no tell tale signs and hence, can only be inferred from circumstantial evidence (Brown 1994; Lauber & Kayten 1988; Transportation Safety Board 1997). Secondly, there has been a lack of a universally accepted definition of fatigue (McCallum et al. 1996; Transportation Safety Board 1997). Thirdly, accident investigation procedures were not standardised (McCallum et al. 1996; Transportation Safety Board, 1997). As a consequence, the role of fatigue in past accidents has more than likely been under-reported (Lauber & Kayten 1988; McCallum et al. 1996; Transportation Safety Board 1997).

More recent work however, has enabled greater insight into the relationship between both fatigue and vehicle and personnel accidents. For instance, by developing a 'fatigue index', the US Coast Guard Research and Development Centre identified that 16 percent of critical vessel casualties and 33 percent of personnel injury casualties occurring in US coastal waters between 1 July and 31 December 1995, had some fatigue contribution (McCallum et al. 1996). These figures were more than 10 times greater than figures based on data collected in 1993 (1.2 percent and 1.3 percent for vessel casualties and personnel injuries respectively) (McCallum et al. 1996) Additionally, it has been recognised that the relative risk of accident is greatest when work is carried out during the circadian troughs in alertness (Brown 1994; Couper 1996; Folkard 1997; Sanquist et al. 1996) and as time on task increases (Folkard 1997; Seafarers International Research Centre 1996).

While there is a growing body of evidence indicating fatigue contributes to a significant number of marine accidents, little is known about the extent and aetiology of fatigue in marine pilots. Results from earlier phases of the present project (Parker et al. unpublished data) and data collected from other groups of marine pilots (Berger 1984; de Vries-Grierer 1982; Shipley & Cook 1980; Sparks 1992) suggests a high presence of potential fatigue factors in the work practices of pilots. For example, the irregularity of work schedules, long on-duty periods, night work and poor sleep associated with marine pilotage work are but a few of the factors which could impact on the fatigue status of pilots. Additionally, that pilots engage in substantial amounts of work-related travel and are frequently separated from family and friends while staying in alternative accommodation, may also contribute to increased levels of fatigue.

Given that high levels of fatigue can have a significant impact on work performance and personal well-being (Griffiths 1993; Monk & Folkard 1992; Scott & Ladou 1990), this survey was undertaken to seek information concerning the demography, and general work history of GBR pilots and any personal and industry specific factors which may impact on the development of fatigue in this population. The survey is part of a larger investigation concerned with the fatigue aspects of GBR pilots, the results of which will provide the basis for the development of work scheduling guidelines and fatigue management programs.

2.0 METHODOLOGY

The methodology applied in this phase of the investigation involved the development, distribution and analysis of a questionnaire which was designed to acquire general information on the work and sleep patterns of Great Barrier Reef pilots. The information was also used to assess how these patterns impact on pilot well-being, fatigue levels and work performance. The final questionnaire contained 63 questions (211 items) and was distributed to all Great Barrier Reef pilots (n=58). A Pilot Advisory Group consisting of one pilot from each of the three pilotage companies consulted with the research group during the development of the instrument and subsequent phases of the project.

2.1 Development of the questionnaire

Questions addressing issues which are experienced by most workers involved in unconventional work hours were based on the 'Shiftwork Index' developed by Barton and colleagues (1995). Industry specific questions relating to pilotage work were based on previous studies of Great Barrier Reef pilots (Parker et al.1997) and other seafaring and marine pilot groups (Berger 1984; British Columbia/States Oil Spill Task Force 1997; Sanquist et al.1996; Couper 1996; Shipley 1978). A draft copy of the questionnaire was circulated to Pilot Advisory Group members, and then modified on the basis of their feedback.

2.2 Pilot testing

The questionnaire was trialed by administration to two recently retired Great Barrier Reef pilots. The pilots completed the document and commented on content, suitability and acceptability. Their comments were incorporated into the questionnaire before it was distributed to the pilot group. A copy of the questionnaire is shown in Appendix 6.

2.3 Questionnaire distribution and reminder system

The questionnaire (including a stamped addressed envelope for ease of return) was distributed by the three pilot companies operating in the Great Barrier Reef region and posted to the home address of each pilot. The diverse location of participants in a number of Queensland coastal areas and interstate made personal administration of the questionnaires impractical. An information package sent with the questionnaire fully explained the purpose of the study and all aspects of confidentiality. A reminder system consisting of two individual reminders to pilots as well as facsimile messages to the pilot accommodation house on Thursday Island, was implemented to encourage project participation and maximise responses.

2.4 Measures

The final questionnaire totalled 211 items and explored the broad nature of fatigue in marine pilots. It sought information on: (i) demographic characteristics (age, marital status and number of children under 18 years of age; (ii) industry experience and recent work history; (iii) sleep patterns at sea, ashore and at home; (iv) ratings of health, fitness and chronic fatigue; (v) illnesses, sleep apnea and sea sickness; (vi) lifestyle habits (smoking, caffeine and alcohol consumption); (vii) circadian characteristics and morningness/eveningness; (viii) feelings while working on the bridge (tension, fatigue, performance levels, vulnerability to performance decrements, impact of performance decrements); (ix) factors contributing to fatigue; (x) strategies to combat fatigue; (xi) pilotage specific experiences; (xii) job satisfaction and (xiii) dyadic adjustment.

Space for additional comments was provided to enable pilots to elaborate on issues or to raise other pertinent points not addressed by the questionnaire. Further details of each of the measures including index and scale construction have been shown in Appendix 1.

3.0 DATA ANALYSIS

3.1 The Quantitative Data

The quantitative data was analysed using SAS-PC. Standard univariate statistics were used to describe responses. Repeated measures Analysis of Variance (ANOVA) was undertaken to compare mean aggregate scores at sea, ashore and at home. Comparisons of tension and fatigue at the beginning and end of work assignments were also tested by ANOVA. For dichotomised variables, Friedman's two way ANOVA test based on ranks was used. When there was evidence of significant differences, post-hoc tests were used to clarify the nature of those differences.

In order to exercise some control over the overall experimentwise error rate (type I error rate) and minimise the number of spuriously significant results, a cut-off value of 0.01 was used to assess the statistical significance of p-values.

Some modification of existing scales was undertaken to improve reliability and validity of responses. These changes mostly involved the use of more response categories than were included in the original scales to allow respondents greater flexibility in their answers. In all cases, the aggregate scores were rescaled so that they had the same maximum and minimum as the original scales, thereby enabling comparisons with data from other occupational groups to be made (Barton et al.1995; Sanquist et al.1996). Factor analysis, using the principal components method to extract the initial factors and a promax (oblique) rotation method, was used to help identify constructs underlying a series of questions dealing with knowledge, attitudes and beliefs. Further item analysis involving assessment of the reliability of scales and their interpretability was undertaken before the scales were finalised.

Cronbach's alpha coefficients were calculated to assess the reliability of the aggregate scales used in the questionnaire. Appendix 5 shows the alpha coefficients for the scales.

3.2 The Qualitative Data

To facilitate interpretation of responses to the questionnaire and provide a clearer understanding of the context within which responses were made, participants were given the opportunity to include additional comments about questionnaire items or other relevant issues. This qualitative data was analysed by examining the comments for recurrent patterns and themes and the frequency of responses within these themes. The data has been incorporated within the relevant sections of the write up and a synopsis of the comments has been included in Appendix 2. Because of the small sample size and to preserve anonymity, no identifying information has been included.

Results and Discussion

4.0 General Characteristics

4.1 The Sample

A total of 35 useable questionnaires were returned, giving a response rate of 60%. This level of participation was more favourable than the 50% response rate from Great Barrier Reef pilots in a survey of Australian seafarers (Parker et al. 1997), and is comparable with other studies on marine pilots. For example, Shipley (1978) and de Vries-Grierer (1982) reported response rates of 53 and 62 percent respectively, when surveying UK and Dutch pilots, while a 64% response rate was achieved from pilots in the British Columbia and West Coast region of the United States (British Columbia/States Oil Spill Task Force 1997). Participation in the present study was entirely voluntary.

Table 4.0 shows the distribution of scores on the socio-demographic characteristics of the sample. Nine percent of pilots were aged between 31-40 years, approximately 70% were between 41 and 60 years of age while the remaining 20% were aged between 61 and 70 years. The mean age of the sample was 53.2 (+ 1.64) years. The average age of the present pilot group was slightly older than previous data reported for Great Barrier Reef pilots (52.6 years) (Parker et al. 1997), Port Phillip Sea pilots (48.8 years) (Berger 1984), UK pilots (49 years) (Shipley 1978) and American masters and marine pilots (44 years) (Sparks 1992).

Previous work has documented that compared with younger workers, older workers often experience greater difficulty coping with change (Legge et al. 1996). Hence, given the relatively older age profile of the present pilot group, it could be anticipated that the recent changes in the commercial structure of Great Barrier Reef pilotage may act as a significant source of stress. Qualitative data seems to confirm this suggestion, as an overwhelming number of comments were made by pilots with regards to the impact of the commercial changes on their personal wellbeing, their workplace and their families.

The majority of the sample (85%) were currently married, while a small number of pilots were divorced or in a de-facto relationship. This finding is consistent with results previously documented for the same group of pilots (Parker et al. 1997). Fifteen pilots (42%) reported having one or more children under 18 years of age.

Table 4.0 The distribution of scores across the items comprising the demographics of the sample.

Item	Frequency (No.)
Age (yrs): 31-40	3
41-50	11
51-60	13
61-70	7
Over 70	0
Age [Mean (sem)]	53.2 (1.64)
Current marital status: Never married	0
Married	29
Defacto	1
Separated	2
Divorced	2
Separated	0

4.2 Industry experience

On average, pilots had served 36 years in the general maritime industry and had 9.5 years of service as pilots (Table 4.1). The long years of industry service were not unexpected considering the extensive amount of maritime and command experience required of personnel prior to entering marine pilotage. Years of service as a Great Barrier Reef pilot ranged from 11 months to 27 years, with a median figure of 7 years. The findings suggest a high level of stability within the Great Barrier Reef pilotage workforce.

The home port regions for Great Barrier Reef pilots were chiefly located in the coastal areas of Queensland. As depicted in Table 4.1, the majority of pilots resided in South East Queensland (19), somewhat fewer pilots lived in North Queensland (10) and minority groups were based in Central Queensland (3) and interstate (2).

Table 4.1 The distribution of scores across the items comprising the industry experience scale.

Item	Mean (sem)
Years in maritime industry	36.4 (1.50)
Years in Great Barrier Reef pilotage Range:	9.5 (1.29) 11 months –- 27 years 50% > 7 years 50% < 7 years
Home port region: Torres Strait Island North Queensland Central Queensland South East Queensland Interstate	Frequency (No.) 0 10 3 19 2

4.3 Recent work history

The purpose of this section was to develop a general impression of the work patterns of pilots across the previous 6 months (Jan – June 1998). Items assessed key measures of potential fatigue such as the number and duration of tours of duty and work assignments, duration of breaks between tours of duty, percentage of work performed on the various shipping routes and percentage of night work performed. It is fully acknowledged that work patterns vary considerably depending on ship movements and work availability. However, by developing a general description of the nature of Great Barrier Reef pilotage work during the previous 6 months, it was possible to make comparisons between this information and data obtained from an earlier analysis of the work schedules (which covered all work assignments performed between Jan 1 1996 and June 30 1997.

The results of recent work history reports from pilots are shown in Table 4.2. On average, pilots indicated that just over 9 tours of duty were performed during the past 6 months, with each tour lasting approximately 17 days, followed by a break of around 11 days. When compared with data from the work schedules analysis, the figures given by pilots for tour duration and duration of breaks between tours were comparable, however the figure for the number of tours performed was somewhat greater (9.6 versus 5.6). This result suggests that there was either an increase in work availability during the past 6 months or that pilots may have slightly over-estimated the number of tours undertaken.

When examining the percentage of work performed on the various shipping routes, the finding that most work was performed on the Inner Route, followed by Hydrographers Passage and then the Great North East Channel (Table 4.2) is consistent with work schedule data. Similarly, that pilots estimated approximately 48% of work to be performed at night (Table 4.2) is comparable with the 50% figure calculated from the work schedules. Hence, with the exception of the number of tours undertaken, other indicators from the self-reports were consistent with work schedule results.

Given the importance of breaks between work assignments for sleep and recuperation, an item was included to assess where pilots generally spent their time ashore between assignments. For just over 40% of the sample, time between work assignments was generally spent in pilot accommodation houses (provided by the pilot companies and located on Thursday Island and at Mackay), approximately 32% of pilots spent their time at home, while 24% usually stayed in hotels/motels (Table 4.2).

Hence, some 65% of Great Barrier Reef pilots tend to spend their time between work assignments separated from family and friends and living in alternative accommodation. It is possible that such arrangements may have a negative impact on the recuperative value of the break. Data from on tour log books should provide greater insight into this issue. Pilots who generally spend their assignment breaks at home include those personnel who live in the immediate vicinity of their work region.

Table 4.2 also shows that seven pilots or approximately 20% of the sample had not taken a holiday in the previous 12 months. Commentaries from pilots indicated that since 1993 when the changes in the commercial structure of Great Barrier Reef pilotage occurred, it had become necessary to undertake more work, and experience shorter breaks in order to maintain income levels. Such reports are disconcerting given that greater workloads in the absence of extended leave periods may leave personnel more vulnerable to fatigue.

Table 4.2 Work history in the previous 6 months.

Item	Mean (sem)
Number of tours	9.6 (1.7)
Duration of tours (days)	17.4 (2.13)
Duration of breaks between tours (days)	11.1 (1.26)
Number of work assignments	22.1 (1.86)
Percentage of work on: Inner Route Great North East Channel Hydrographers Other	Mean % (sem) 61.1 (4.97) 8.3 (1.71) 19.7 (3.33) 2.7 (1.16)
Percentage of night work (%)	47.8 (2.95)
Location of breaks between assignments: At home Pilot accommodation Hotels/motels Other	Frequency (No.) 11 14 8 1
Have taken a holiday free of pilotage work in the past 12 months	Frequency (No.) 27
Have not taken a holiday free of pilotage in the past 12 months	Frequency (No.) 7

4.4 Summary

In summary, the demographic data indicated that the majority of Great Barrier Reef pilots were aged 41 years or older, married and residing in South-East Queensland. The workforce appeared to be relatively stable, based on the long years of service in the maritime industry and as pilots.

Information from the self-reported work history for the previous 6 months was generally consistent with results calculated from the earlier work schedule analysis. While the majority of pilots had taken a holiday during the past 12 months, that approximately 20% of the pilots had not taken any annual leave may be cause for concern in terms of potential fatigue development.

5.0 HEALTH AND LIFESTYLE

Occupations involving irregular work and sleep have the potential to negatively impact on health (Barton et al. 1995). Additionally, poor levels of physical fitness can reduce one's ability to handle the stress associated with irregular working hours (Harma 1993). Given the varying physical and mental demands associated with pilotage work, issues of health, fitness and lifestyle habits are highly relevant when examining the fatigue potential of marine pilotage work. In the following section, questions were designed to gain an overall impression of the general health, fitness and lifestyle habits of Great Barrier Reef pilots. Caution should be used when interpreting these results however, as subjective ratings of health and fitness can sometimes be unreliable (Embree & Whitehead 1991).

5.1 General Health and Fitness

The distribution of scores given by pilots when asked to subjectively rate their general level of health and fitness are shown in Table 5.0. Over 90% of pilots rated their general health as good or excellent, while 9% indicated it was fair. No pilot felt they had a poor level of general health. Physical fitness ratings were reported as being good or excellent for 65% of pilots, fair for 33% of pilots and poor for 1 pilot (3%).

That over half the sample rated their fitness as good or excellent is not completely consistent with results of an earlier study on the present pilot group (Parker et al. 1997). When exercise habits of Great Barrier Reef pilots were assessed from self-reports, 72% of pilots failed to meet National Heart Foundation recommended guidelines for aerobic exercise prescription to develop and maintain cardiovascular health (Parker et al. 1997).

Table 5.0 Distribution of scores for ratings of general health and fitness.

Item	Poor No.	Fair No.	Good No.	Excellent No.
Description of general health	0	3	18	13
Rating of physical fitness	1	11	18	4

5.2 Body Mass Index

From responses to questions relating to height and weight, the Body Mass Index (BMI) for the present sample was calculated. Body Mass Index is a simple and quick method of estimating body composition. It is not equally applicable to all populations however, and thus, data should be interpreted cautiously (Rosato 1994).

The distribution of scores based on BMI classification are shown in Table 5.1. Eighteen pilots representing 56% of the sample were classified as obese, with 5 pilots in the overweight category (Table 5.1). Twenty eight percent of the sample (9 pilots) were assessed as being of a normal weight.

In men, there is an increased risk for cardiovascular disease when BMI scores are greater than 27.3 (Rosato 1994). The finding that ~56% of the sample had scores greater than this figure is a cause for some concern. Several earlier investigations have shown that marine pilots tend to have an increased susceptibility to coronary disease as evidenced by significantly higher levels of coronary mortality compared with the general population (Berger 1984; Harrington 1972; Shipley 1978; Zorn et al. 1977). Furthermore, a recent survey of Australian seafarers revealed that Great Barrier Reef pilots self-reported a higher incidence of elevated cholesterol and blood pressure than other seafarers (Parker et al. 1997).

While the high incidence of obesity amongst Great Barrier Reef pilots is undesirable from a health perspective, it is consistent with results from previous studies on marine pilots. For instance, 35% of Port Phillip Sea Pilots (Berger 1983) and 30% of UK pilots (Shipley 1978) were classified as being clinically obese. Additionally, it was noted that the condition tended to be more pronounced amongst the senior pilots (Berger 1983). In light of the older age profile of the present sample, this latter finding may partly explain the higher incidence in Great Barrier Reef pilots relative to the other two groups. It is possible that the irregular hours and resultant circadian dissociation associated with marine pilotage work may contribute to the high prevalence of obesity in pilots, as these conditions make it difficult to maintain healthy dietary habits (Berger 1983).

Table 5.1 Distribution of scores on the BMI* rating system.

Body Mass Index Classification	Frequency (No.)
Normal	9
Overweight	5
Obese	18
Morbidly obese	0

5.3 Illnesses and Sleep Apnea

To further examine the health status of Great Barrier Reef pilots, respondents were asked a question on present illnesses and whether they experienced breathing difficulties during sleep. At the time of the survey, nine pilots (26%) reported receiving treatment for an illness while fifteen pilots (44%) indicated they suffered from breathing difficulties during sleep. With regards to the latter finding, it is possible these breathing difficulties could be representative of an underlying sleeping disorder.

For example, sleep apnea is a condition in which sufferers experience involuntary breathing disorders (20-30 per hour) during sleep. These breathing disorders are often caused by airway obstructions preventing adequate respiration, and can reduce the restorative value of sleep and cause daytime sleepiness (National Centre on Sleep Disorders Research 1995).

The potential impact of sleep disorders on work performance can be substantial. A study of 165 Sydney metropolitan taxi drivers revealed that approximately 20% of drivers reported sleeping disorders or problems, and of these drivers, 50% had fallen asleep at the wheel at least once during their career. In contrast, only 18% of drivers without sleeping disorders had done likewise (Dalziel & Job 1998). Thus, the finding that 44% of the present pilot group self-reported breathing difficulties during sleep could be potentially problematic in terms of increased risk of fatigue development and/or impaired work performance. Further investigation into this issue may therefore be warranted in pilot medical screenings.

5.4 Lifestyle Habits

Pilotage work in the Great Barrier Reef region involves alternating between working at sea, resting ashore between work assignments and returning home at the end of a tour of duty. As it is possible that health related behaviour may be influenced by location, respondents were asked about their smoking habits and levels of caffeine and alcohol consumption while at sea, ashore and at home. Figure 5.0 illustrates these results while Table 5.2 shows an analysis of this data in terms of the effects of location on lifestyle habits.

Figure 5.0 Mean number of cigarettes, cups of coffee and alcoholic drinks per day, at sea, ashore and at home.

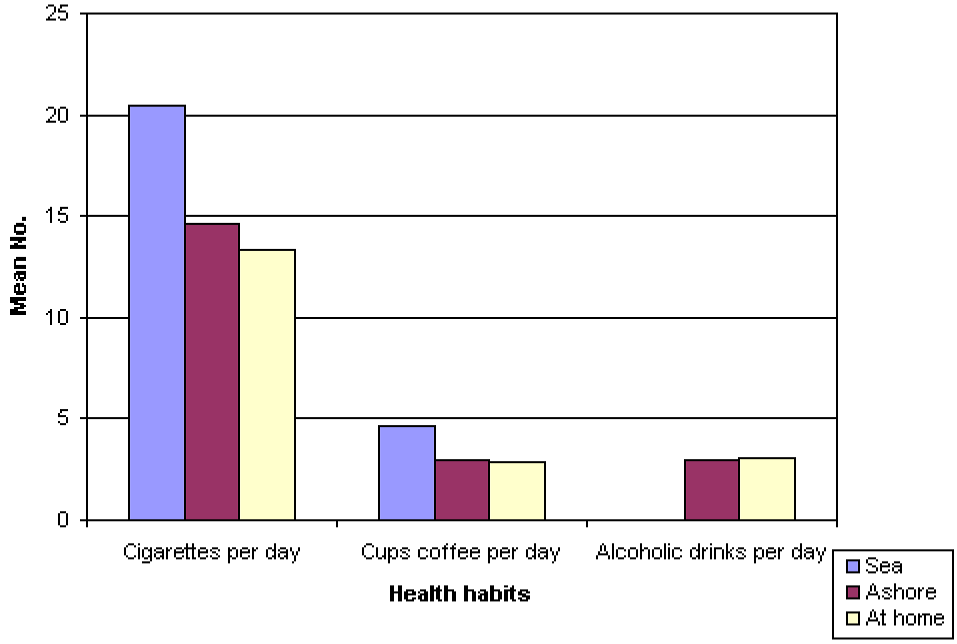

Table 5.2 Analysis of health and lifestyle habits: smoking, caffeine and alcohol consumption at sea, ashore and at home (1)

Effect	Post hoc results (2)	Mean (sem)	F Statistics	p-value
No. of cigarettes per day Sea Ashore At home	Sea vs home**	20.5 (3.98) 14.6 (2.95) 13.3 (3.05)	11.61	=0.005
No. of cups of coffee per day Sea Ashore Home	Sea vs home**	4.6 (0.45) 3.0 (0.29) 2.9 (0.32)	15.25	< 0.001
No. of cups of tea per day Sea Ashore	n/a n/a	1.8 (0.28) 1.6 (0.29)	0.49	= 0.542

Home	n/a	1.8 (0.31)		
No. of alcoholic drinks per day Sea Ashore Home	Sea vs home**	0.0 (0.0) 3.0 (0.26) 3.1 (0.32)	0.00	< 0.001

1. Results of full two-way Analysis of Variance (ANOVA) model. $p < 0.01$ considered statistically significant.
2. Results of Tukey's Studentised Range test for post-hoc differences (Type 1 Error Rate = .01)

** = $p < 0.01$ for differences between locations from post-hoc

n/a = Post hoc testing not performed when main effects not significant

5.4.1 Smoking habits

Ten pilots or approximately 30% of the present sample were smokers. This result is comparable with data from other groups of marine pilots indicating that 33% of Port Phillip Sea pilots (Berger 1983) and 29% of American masters and pilots (Sparks 1992) were smokers. However, the current figure was slightly higher than population data showing 24-26% of Australian men smoked (ABS 1989-90; National Heart Foundation 1989).

Smoking frequency was clearly affected by location, with the average number of cigarettes smoked per day at sea, ashore, and at home being 20.5, 14.6 and 13.3, respectively. The difference between the sea and home figures was statistically significant. It is possible that the potentially higher levels of stress and/or boredom associated with the at sea environment may have contributed to this finding as a study of US navy personnel also documented increased rates of cigarette consumption when at sea (Cronan et al. 1991). Similarly, the slightly higher number of cigarettes smoked while ashore between work assignments compared with at home may be associated with the waiting periods between work assignments and shipping delays.

Compared with population data, the number of cigarettes smoked by Great Barrier Reef pilots was greater when at sea, but less when ashore and at home than the 18 cigarettes smoked per day by the average Australian male smoker (ABS 1989-90; National Heart Foundation 1989).

5.4.2 Caffeine consumption

Caffeine, which is contained in coffee, tea, cocoa, hot chocolate and cola drinks, is a known stimulant which has the potential to increase endurance and alertness (Davis et al. 1988). Hence, it is often used by people as a means of maintaining appropriate levels of alertness during periods of sustained wakefulness.

All Great Barrier Reef pilots reported consuming some caffeinated beverages. Significantly, more cups of coffee were consumed at sea than at home, whereas the number of daily cups of coffee consumed ashore between work assignments and at home were similar (Table 5.3). It can be noted that compared with other groups of marine pilots, Great Barrier Reef pilots consumed less coffee while at sea (4.6 cups/day) than UK pilots (5.5 cups/day) (Shipley 1978) and Port Phillip Sea pilots (7 cups/day) (Berger 1984).

There was no significant location effect on the number of cups of tea or cola consumed.

5.4.3 Alcohol consumption

Thirty-two pilots (91%) reported drinking alcohol. As depicted in Figure 5.0 and Table 5.2, alcoholic drinks were not consumed at sea, whereas the number of daily alcoholic drinks consumed ashore between work assignments (3.0) and at home (3.1) were similar.

The absence of alcohol consumption by pilots while at sea is consistent with the on-call nature of their duties and the relatively short periods of time (compared with other seafaring personnel) spent at sea. Previous results indicated that the drinking habits of Great Barrier Reef pilots were more favourable than other Australian seafarers (Parker et al. 1997) and age-matched population figures (National Heart Foundation 1989).

5.5 Sea sickness

Respondents were asked to indicate whether or not they experienced sea sickness, and if so, whether this occurred during transfer on the pilot launch to the ship or on the ship. As detailed in Table 5.3, eight pilots (23% of the sample) indicated they experienced sea sickness. This figure was somewhat greater than the 12% incidence rate of sea sickness reported amongst UK pilots (Shipley 1978). Additionally, there was a greater incidence of sea sickness on pilot launch trips than on ships. This finding is reasonable given the constant pitching and rolling of small vessels such as those used during launch trips. In view of some of the long launch transfers (2-3 hours) undertaken by Great Barrier Reef pilots, sea sickness may be problematic for some individuals.

Table 5.3 Distribution of the scores on the sea sickness scale.

Item	Frequency (No)
Experience sea sickness	8
Experience sea sickness: Pilot launch On the ship	6 1

5.6 Chronic fatigue

Chronic fatigue arises when the amount of rest achieved by a person is unable to completely restore arousal and as a consequence, fatigue accumulates. It is associated with feelings of weariness and lethargy prior to, during and following activity and requires a prolonged period of rest in order to completely recover (Barton et al.1995). Given the irregular work hours, irregular rest periods and high levels of workload experienced by the present pilot group, an assessment of chronic fatigue was warranted.

Respondents were asked to rate "the degree to which statements regarding chronic fatigue applied to them". Table 5.4 shows a comparison of the chronic fatigue scores for Great Barrier Reef pilots with normative data. A higher score indicated greater chronic fatigue.

Compared with normative group data, pilots reported lower levels of chronic fatigue with the difference between the two groups being marginally significant (p=0.0174). The chronic fatigue score for pilots was within the range of scores (20-29) reported by 80% of the normative group (Barton et al. 1995). This finding is broadly comparable with data from 141 US mariners who also recorded chronic fatigue scores within normal values (Sanquist et al. 1996).

Table 5.4 Chronic fatigue scores for pilots and normative groups

Item	Great Barrier Reef pilots	Normative group#
Chronic fatigue score (Mean + SD)	21.92 (+ SD 7.27).	25.04 (+ SD 7.58)

Normative data based on 1864 emergency and industrial shiftworkers (Barton et al.1995).

5.7 Summary

In summary, when asked to give a general indication of their health and level of physical fitness, the majority of Great Barrier Reef pilots gave ratings of either good or excellent. However, this result may be somewhat misleading given that a substantial proportion of the present pilot group were classified as being obese or overweight when BMI scores were calculated.

In terms of lifestyle behaviours, a significant location effect existed, with smoking frequency (amongst the 30% of smokers in the sample) and caffeine consumption both increasing when pilots were at sea as compared to at home. These findings could be related to the higher levels of stress and/or boredom associated with the at sea environment. Additionally, that pilots totally refrained from drinking alcohol while at sea is consistent with the on call nature of their work.

The incidence of sea sickness amongst the present group of pilots was higher than previous data on marine pilots and tended to occur more frequently during transfer launch trips. Great Barrier Reef pilots reported less chronic fatigue than normative groups.

6.0 SLEEP PATTERNS AT SEA, ASHORE AND AT HOME

Occupations involving work outside normal hours can have a profound effect on sleep (Akerstedt 1991, 1995; Folkard 1996, Knauth & Costa 1996). For instance, sleeping at times which conflict with the normal circadian rhythms of the body significantly reduces the quantity and quality of the sleep period (Folkard & Barton 1993; Kecklund et al. 1997; Tilley et al. 1982). As the maritime industry, and pilotage work in particular, is characterised by irregular work and rest patterns, it is possible that personnel may be especially susceptible to compromised sleep. Earlier findings documented for Great Barrier Reef pilots revealed reduced quality and duration of sleep while working at sea (Parker et al. 1997). Similarly, poor sleeping patterns have been reported for other groups of marine pilots (Berger 1984; de Vries-Grierer 1982; Shipley & Cook 1980; Sparks 1992). While the functional significance of sleep continues to be a source of some contention, it is clearly established that sleep is a vital component of a healthy lifestyle and optimal work performance (Reinhart 1995).

Given that the work patterns of Great Barrier Reef pilots involve alternating between home, sea and ashore, it was deemed important to assess whether location had an effect on sleep patterns. Pilots were asked to respond to questions relating to general sleep habits in each of the locations. Questions addressed issues such as the number of sleeps and naps, sleep requirements, and sleep difficulties and disturbances.

6.1 Total Sleep duration per 24 hours

The mean total duration of sleep periods at sea, ashore and at home are shown in Figure 6.0. An analysis of this data in terms of a location effect is shown in Table 6.0. There was a significant location effect on total sleep duration with significantly less sleep being experienced per 24 hours while working at sea (5.5 hours) compared with at home (7.8 hours). Sleep duration at home and ashore between work assignments were similar and of a ‘normal’ duration (7.8 to 8 hours). These findings are comparable with data previously collected by the present researchers indicating that the sleep of Great Barrier Reef pilots was compromised when working. Sleep duration, as reported in this earlier work, averaged 4.6 hours while at sea and 7.4 hours while ashore (Parker et al.,1997).

In comparison with other groups of seafarers, the work practices of Great Barrier Reef pilots appear to have a greater impact on sleep at sea. For instance, Sanquist and colleagues (1996) examined the sleep of US merchant marine personnel while at sea and reported an average sleep duration of 6.6 hours per day, while Rutenfranz et al (1988) reported an average of 7.5 hours of daily sleep for European merchant marine watchkeepers. These group differences may be related to the shorter periods of time pilots spend on board vessels and the on call nature of pilotage work.

By calculating the difference between the amount of sleep Great Barrier Reef pilots receive while at home and at sea, it was evident that when at sea a daily sleep debt of 2.3 hours existed. This figure is comparable with the 2.8 hour daily sleep debt previously calculated for this group (Parker et al. unpublished data), and is almost double the figure calculated for other Australian seafarers (1.4 hours) (Parker et al. unpublished data) and US merchant marine personnel (1.3 hours) (Sanquist et al. 1996).

While the average amount of sleep Great Barrier Reef pilots achieved at home and at sea were similar (Figure 6.0, Table 6.0), it is highly probable that the quality of sleep achieved in these two locations differed. Data from the analysis of the work schedule files indicated that breaks between work assignments began at all times across the 24 hour cycle. As a consequence, sleep would be taken at irregular hours. Evidence from the literature suggests that sleep taken outside normal sleeping hours tends to be significantly inferior in terms of quantity and quality (Folkard & Barton 1993; Kecklund et al. 1997; Tilley et al. 1982). This in turn could diminish the recuperative value of the pilot's sleep when ashore between work assignments. Additional data concerning specific details of the nature of sleep and rest patterns is required to substantiate this suggestion.

Estimated recovery values of sleep following a period of normal wakefulness have been established for sleep duration. For instance, it has been suggested that 8 hours of sleep provides 100% recovery, whereas 2.8 hours of sleep gives 67% recovery. However, one expert has questioned these values indicating that recovery may be more linear (Simon Folkard - Personal Communication, June 1998). Furthermore, it is difficult to speculate on the recovery value of a marine pilots' sleep as the irregular work hours do not result in 'normal periods of wakefulness' and cause sleep to be taken at times which oppose normal circadian patterns.

Figure 6.0 Mean duration of sleep and the number of sleep periods per 24 hours at sea, ashore and at home.

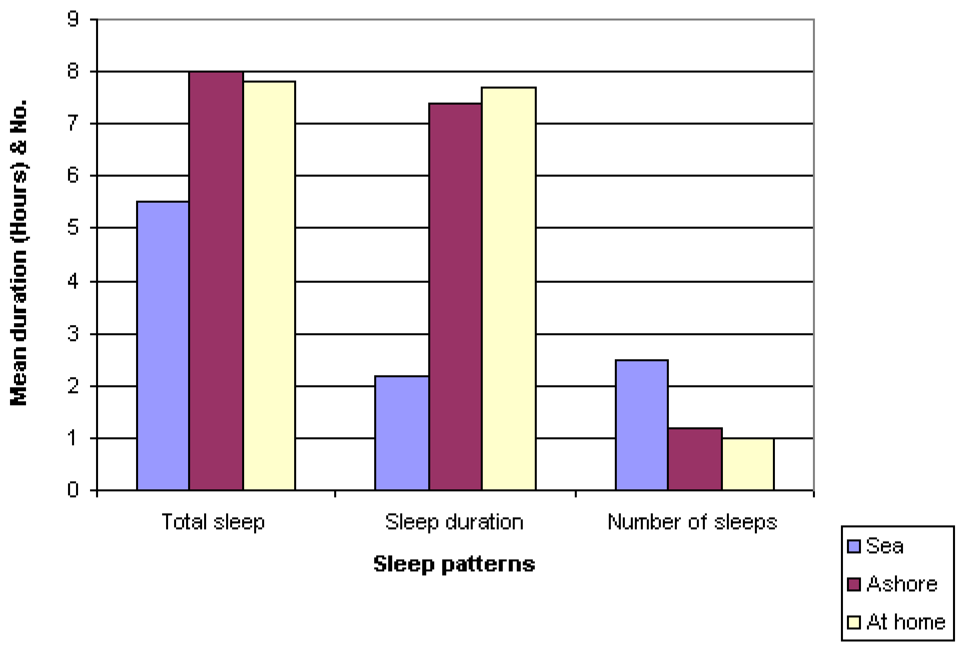

Table 6.0 Analysis of the mean total duration of sleep, number of sleeps and duration of each sleep period per 24 hours, at sea, ashore and at home (1)

Effect	Post hoc results (2)	Mean (sem)	F Statistics	p-value
Total duration of sleep per 24 hours Sea Ashore	Sea vs home **	5.5 (0.38) 8.0 (0.35) 7.8 (0.29)	40.40	< 0.001

Home				
No. of sleeps per 24 hours Sea Ashore Home	Sea vs home ** Ashore vs home **	2.5 (0.19) 1.2 (0.07) 1.0 (0.03)	51.56	< 0.001
Duration of each sleep period per 24 hours Sea Ashore Home	Sea vs home **	2.2 (0.10) 7.4 (0.27) 7.7 (0.19)	243.46	< 0.001

1. Results of full two-way Analysis of Variance (ANOVA) model. p < 0.01 considered statistically significant.
2. Results of Tukey's Studentised Range test for post-hoc differences (Type 1 Error Rate = .01)

** = p < 0.01 for differences between locations from post-hoc

6.2 Number and duration of sleeps per 24 hours

To gain further insight into the sleep patterns of Great Barrier Reef pilots, respondents were asked to indicate the average number and duration of sleep periods taken per 24 hours while at sea, ashore and at home. Figure 6.0 illustrates the mean number and duration of sleeps per 24 hours, while Table 6.0 presents an analysis of the data in terms of a location effect. A significant location effect was evident with the greatest number of sleep periods being taken at sea (2.5), followed by ashore (1.2) and then at home (1.0). Additionally, sleep periods were reported as being significantly shorter at sea (2.2 hours) compared with ashore (7.4 hours) and at home (7.7 hours). These findings indicate that sleep patterns vary depending on the pilot's location. Sleep at sea seems to comprise of several shorter sleep periods being taken at various times throughout the 24 hour cycle, whereas sleep ashore between work assignments consisted of just over one sleep period per day. At home, pilots reported being able to revert to normal sleep patterns involving a single block of sustained sleep.

That the sleep of Great Barrier Reef pilots is compromised while working at sea could give rise to performance decrements. For example, sleep deprivation has been associated with a slowed response speed to new and previously encountered stimuli (Dinges 1992; McCarthy & Waters 1997), an increased tendency for false positive responding; that is, responding when no signal is present (Dinges 1992), memory problems and time on task decrements (Dinges 1992; Dinges & Kribbs 1991). Additionally, 'lapsing' or 'microsleep' is frequently displayed by sleep deprived individuals, thereby resulting in greater variability in performance and increased errors of omission (Dinges 1992; Dinges & Kribbs 1991; Krueger 1989; Rosekind et al. 1996). Such performance decrements could potentially have serious implications on piloting performance and may jeopardise ship safety.

6.3 Nap patterns – number and duration

Although the findings are inconclusive, there is some evidence suggesting that naps may be a possible countermeasure against the fatigue, mood deterioration and performance decrements associated with periods of sleeplessness. Studies have shown reduced levels of fatigue and mood and performance improvements in sleep deprived subjects following a nap (Angus et al. 1992; Bonnet 1991; Dinges 1992; Gillberg et al. 1996; Naitoh et al. 1992; Rogers et al. 1989). However, naps should not be considered as a replacement for normal nocturnal sleep, as mood and performance after naps generally remained somewhat impaired compared to baseline levels (Angus et al. 1992; Naitoh et al. 1992; Rogers et al. 1989) and in some studies, beneficial effects were only evident for relatively short periods of time (Gillberg et al. 1996).

Given that irregular work hours and long periods of wakefulness are an integral part of pilotage work, an examination of the use of naps as a potential countermeasure against fatigue was relevant to the present investigation. In order to assess napping habits, items were included to determine the number and duration of naps taken by pilots in each 24 hour period when at sea, ashore and at home. Naps were defined as sleep periods less than 1.5 hours in duration.

Figure 6.1 illustrates the number and duration of naps per 24 hours at sea, ashore and at home. An analysis of the data in terms of a location effect is shown in Table 6.1. The number of naps taken by pilots while at sea, ashore and at home were 2.5, 1.1 and 0.7, respectively. The difference between these figures was statistically significant, with more naps being taken at sea than at home.

The average duration of naps at sea, ashore and at home were 12.8, 2.5 and 7.4 minutes, respectively. Nap duration did not exhibit a statistically significant location effect, most likely due to the large standard error of the sea and home figures. The shorter nap periods reported ashore between assignments may be related to waiting periods, shipping delays and the on call nature of these situations. Although pilots reported longer naps at sea, commentaries from pilots have highlighted that the dubious skill levels of some bridge teams substantially reduces the pilots' confidence in leaving the bridge for naps.

From the reported number and duration of naps taken by pilots while at sea, naps would total approximately 32 minutes of daily sleep. Compared with if no naps were taken, this extra 32 minutes of sleep may help to moderate the impact of the daily sleep debt incurred by pilots while working at sea.

Figure 6.1 Mean number and duration of naps, at sea, ashore and at home.

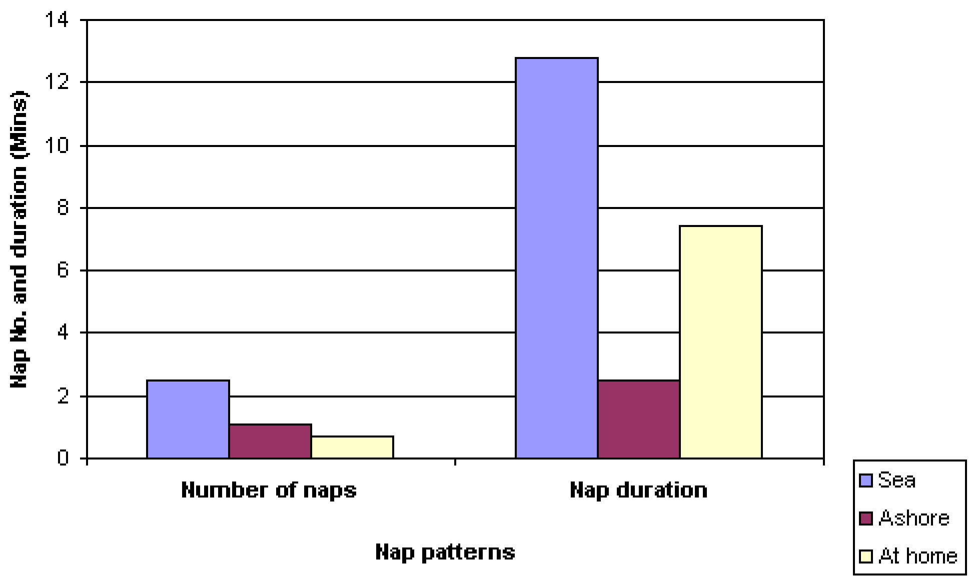

Table 6.1 Analysis of the mean number and duration of naps per 24 hours, at sea, ashore and at home (1)

Effect	Post hoc results (2)	Mean (sem)	F Statistics	p-value
Number of naps per 24 hours Sea Ashore Home	Sea vs home **	2.5 (0.21) 1.1 (0.09) 0.7 (0.14)	16.22	= 0.002
Duration of each nap per 24 hours Sea Ashore Home	n/a n/a n/a	12.8 (3.21) 2.5 (1.31) 7.4 (4.27)	3.02	=0.103

1. Results of full two-way Analysis of Variance (ANOVA) model. $p < 0.01$ considered statistically significant.
2. Results of Tukey's Studentised Range test for post-hoc differences (Type 1 Error Rate = .01)

** = $p < 0.01$ for differences between locations from post-hoc

n/a = Post hoc testing not performed when main effects not significant

6.4 Sleep latency and time to feel alert

By examining the time taken to fall asleep (that is, the sleep latency), it is possible to get some indication of fatigue levels. Sleep latency has been shown to decrease following periods of restricted sleep, with a latency of 5 minutes or less being associated with a fatigued state (Roth et al. 1989). Similarly, the time taken to feel alert after waking tends to increase as a person becomes more fatigued. To assess whether there was a location effect on sleep latency and time taken to feel alert, pilots were asked to indicate how long, on average, it took to fall asleep and feel alert after waking when at sea, ashore between work assignments and at home.

Figure 6.2 depicts the mean time taken to fall asleep when at sea, ashore and at home, while Table 6.2 presents the analysis of this data in terms of location effect. The number of minutes taken to fall asleep at sea, ashore and at home were 10.5, 14.4 and 11.6 minutes, respectively. There was a significant location effect on sleep latency; however, post hoc testing failed to reveal the source of the differences. By visually inspecting Figure 6.2 and Table 6.2, it is evident that compared with at home, pilots fell asleep more quickly at sea and took longer to fall asleep ashore. The shorter time to fall asleep at sea could be associated with the altered sleep patterns and reduced amounts of daily sleep experienced by pilots in this location. However, the 10.5 minute sleep latency reported by pilots is over twice as long as the 5 minutes or less time span reported as representing a fatigued state (Roth et al. 1989). It is possible that other factors such as the irregular timing of sleep and disruptive or uncomfortable sleeping environments may also contribute to this result. Pilot commentaries indicated that sleeping accommodation on ships was frequently located adjacent to large noise sources and sometimes lacked air conditioning.

In contrast, the longer latency associated with sleep periods ashore could be related to pilots arriving ashore in a mentally alert state after having completed a work assignment. This would tend to inhibit sleep onset as time is required to 'wind down' and relax before being able to sleep. Additionally, breaks between work assignments begin at all times across the 24 hour cycle thereby resulting in sleep often being taken outside normal sleeping hours. This would also hinder sleep onset and contribute to longer sleep latency times.

In a broad comparison with the current findings, measures of sleep latency amongst US merchant marine personnel showed that watchkeepers who worked the 0400 to 0800 hour and 0800 to 1200 hour shifts exhibited a higher incidence of sleep latencies < 5 minutes than other work categories (Sanquist et al. 1996).

Also illustrated in Figure 6.2 is the mean time taken to feel alert after waking when at sea, ashore and at home. An analysis of this data in terms of a location effect is shown in Table 6.2. There was no significant location effect on the time taken to feel alert; this may be partially related to the large standard errors for the ashore and at sea values. When at sea however, pilots reported that it only took them approximately half as long to feel alert after waking, as compared with the time taken when ashore and at home. This may be due to apprehension associated with being on call while at sea and pilots being aware of the need to respond quickly.

Figure 6.2 Mean sleep latency and time taken to feel alert (mins) at sea, ashore and at home.

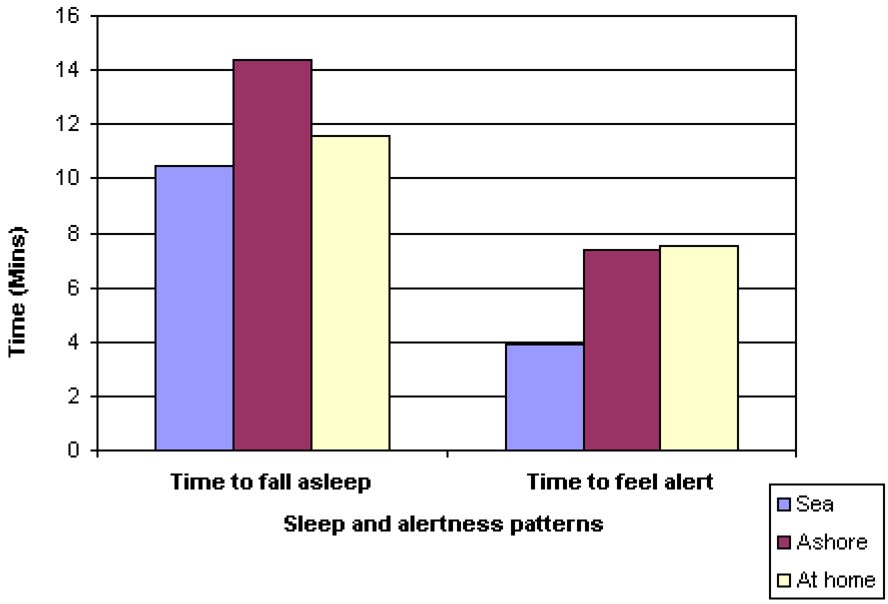

Table 6.2 Analysis of the mean scores (mins) for sleep latency and time to feel alert, at sea, ashore and at home (1).

Effect	Post hoc results (2)	Mean (sem)	F Statistics	p-value
Sleep latency (mins) Sea		10.5 (1.42)	6.84	= 0.002
Ashore		14.4 (1.85)		
Home		11.6 (1.30)		
Time to feel alert (mins) Sea	n/a	3.9 (0.54)	4.96	= 0.023
Ashore	n/a	7.4 (1.32)		
Home	n/a	7.5 (1.35)		

1. Results of full two-way Analysis of Variance (ANOVA) model. $p < 0.01$ considered statistically significant.
2. Results of Tukey's Studentised Range test for post-hoc differences (Type 1 Error Rate = .01)

** = $p < 0.01$ for differences between locations from post-hoc

n/a = Post hoc testing not performed when main effects not significant

6.5 Sleep difficulties and disturbances

Sleep difficulties and disturbances are a common feature of jobs involving unconventional work hours. For instance, 60-70% of shiftworkers complain of sleep disruption (Barton et al. 1995). These disruptions are in part, due to the fact that the shiftworker's sleep is displaced from normal sleeping hours and hence, out of phase with the natural circadian rhythms of the body. This, in turn, can result in workers experiencing problems falling and staying asleep (Akerstedt 1995; Folkard 1996, Lavie 1986). Additionally, exogenous factors such as outside noise and activity, increasing temperatures and natural sunlight may further compromise sleep (Akerstedt 1995; Rutenfranz et al. 1988).

To assess sleep difficulties and disturbances in the three locations, pilots were asked to: (I) rate how frequently they found it difficult to fall asleep, stay asleep and wake up; and (ii) rate how frequently environmental factors (noise, light, heat or cold, ships motions) disturbed their sleep. Figure 6.3 depicts the mean scores for sleep difficulties at sea, ashore and at home, while an analysis of this data in terms of location effect is presented in Table 6.3. A higher score indicated greater difficulties or disturbances.

There was no difference in the mean scores for sleep difficulties across the locations, thereby indicating that the at sea environment did not increase the difficulty associated with falling asleep, staying asleep or waking up. This finding may reflect the more flexible sleeping habits reported by pilots in comparison to other groups as identified by the circadian characteristics of the present subjects (Section 7.1).

Sleep disturbances however, showed a significant location effect with disturbances being experienced more frequently at sea (28.38), followed by ashore (22.99) and then at home (17.8). This finding was not unexpected given that sleep at sea and ashore is often taken during unconventional hours of the day and in unfamiliar surroundings.

Figure 6.3 Mean scores for ratings of sleep difficulties and sleep disturbances, at sea, ashore and at home.

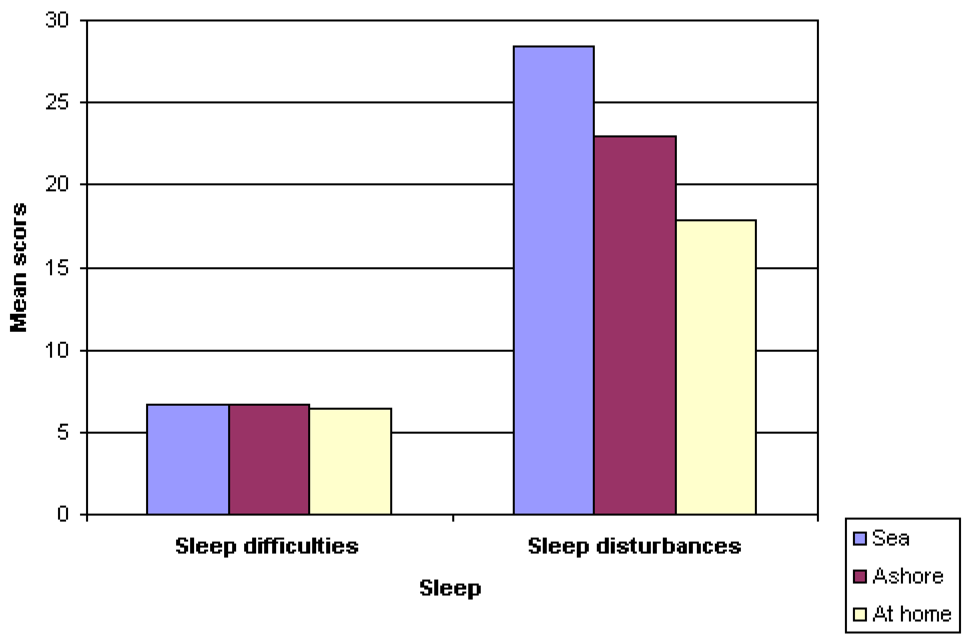

Table 6.3 Analysis of the mean scores for ratings of sleep difficulties and disturbances, at sea, ashore and at home (1)

Effect	Post hoc results (2)	Mean (sem)	F Statistics	p-value
Sleep difficulties Sea Ashore Home	n/a n/a n/a	6.65 (1.47)# 6.68 (1.72) # 6.45 (1.60) #	0.46	0.570
Sleep disturbances Sea Ashore Home	Sea vs home ** Ashore vs home **	28.38 (7.58) # 22.99 (7.33) # 17.80 (3.75) #	28.12	< 0.001

1. Results of full two-way Analysis of Variance (ANOVA) model. $p < 0.01$ considered statistically significant.
2. Results of Tukey's Studentised Range test for post-hoc differences (Type 1 Error Rate = .01)

** = $p < 0.01$ for differences between locations from post-hoc;

n/a = Post hoc testing not performed when main effects not significant;

= Standard Deviation

6.6 Sleep Requirements

In an attempt to gain an impression of the pilots perception of their sleep requirements, respondents were asked to indicate how much sleep they thought they required per 24 hours when at sea, ashore and at home.

The mean duration of sleep pilots believed they required per 24 hours in the three locations is depicted in Figure 6.4. Table 6.4 presents the analysis of this data in terms of location effect. The duration of sleep pilots believed they required at sea, ashore and at home was 5.5, 7.5 and 7.7 hours, respectively. These figures are very similar to the figures reported by pilots for how much sleep they achieved in the three locations (Section 6.1). The fact that all data in the questionnaire was self-reported may have contributed to these distinct similarities.

A significant location effect was found, with pilots believing they required significantly less sleep at sea than at home. While the underlying reasons for this belief are not known, one possible suggestion is that pilots may believe that their work environment is stimulating enough to reduce their sleep needs. When considered over a 24 hour period pilots reported requiring similar sleep needs ashore and at home.

Figure 6.4 Mean duration of sleep and naps periods required per 24 hours, at sea, ashore and at home.

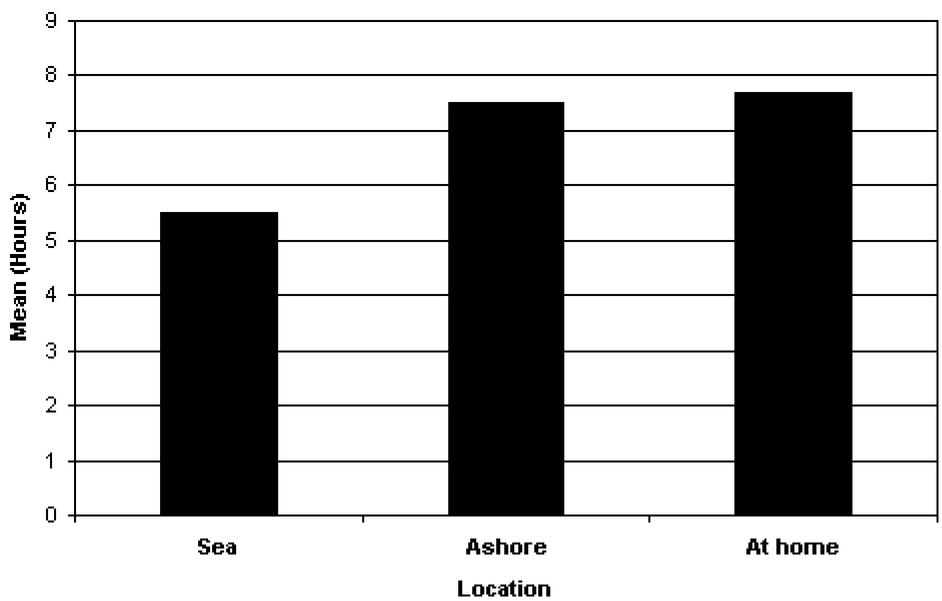

Table 6.4 Analysis of the mean duration of sleep and naps required by pilots per 24 hours, at sea, ashore and at home 1.

Effect	Post hoc results (2)	Mean (sem)	F Statistics	p-value
Duration of sleep/naps needed per 24 hours Sea Ashore Home	Sea vs home **	5.5 (0.35) 7.5 (0.27) 7.7 (0.18)	24.72	< 0.001

1. Results of full two-way Analysis of Variance (ANOVA) model. p < 0.01 considered statistically significant.
2. Results of Tukey's Studentised Range test for post-hoc differences (Type 1 Error Rate = .01)

** = p < 0.01 for differences between locations from post-hoc

6.7 Rating of sleep obtained

In order to determine whether respondents felt that their sleep in the three locations was adequate, an item was included asking pilots to indicate whether they obtained 'too little', 'enough' or 'too much' sleep . Ninety percent of respondents indicated they obtained 'enough' sleep in all three locations.

By analysing the data and determining the mean value of sleep ratings (Table 6.5) it was evident that a significant location effect existed. Significantly poorer ratings for the amount of sleep obtained were given by pilots for the at sea environment (3.68) compared with the ashore (4.32) and at home (4.32) environments, which were the same. This finding is consistent with the earlier result showing total sleep duration was significantly shorter at sea (Section 6.1), but raises question over the previous finding (Section 6.6) in which pilots indicated that they believed 5.5 hours of sleep was sufficient when at sea.

Table 6.5 Analysis of the rating of sleep obtained at sea, ashore and at home (n = 34) (1)

Effect	Post hoc results (2)	Mean (sem)	F Statistics	p-value
Rating of sleep obtained per 24 hours Sea	Sea vs home **	3.68 (0.13) 4.32 (0.11)	12.78	< 0.001

Ashore Home		4.32 (0.11)		

Results of full two-way Analysis of Variance (ANOVA) model. $p < 0.01$ considered statistically significant.

Results of Tukey's Studentised Range test for post-hoc differences (Type 1 Error Rate = .01)

** = $p < 0.01$ for differences between locations from post-hoc

6.8 Use of strategies to promote sleep

Given that irregular sleeping patterns may inhibit an individuals ability to sleep, items were included to assess the use of strategies to promote sleep at sea, ashore and at home. Strategies examined included the use of sleeping tablets, relaxation methods, listening to music, alcohol consumption, watching television and reading. Respondents were required to indicate those strategies which they used.

Table 6.6 shows the distribution of scores for the various strategies used to help promote sleep in the three locations. Clearly evident from this table is that reading was the most frequently used strategy to promote sleep in all three locations. When ashore and at home, watching television was also a popular strategy used by respondents. The least frequently used strategy for inducing sleep were sleeping tablets, followed by relaxation methods.

Further analysis showed some significant location effects in the use of sleep promoting strategies. Listening to music (marginal significantly at $p=0.02$) and alcohol ($p = 0.01$) were both used more at home than at sea.

Table 6.6 Distribution of scores on the strategies used to promote sleep, at sea, ashore and at home.

Item	Sea No.	Ashore No.	Home No.
Sleeping tablets	0	1	1
Relaxation methods	4	2	2
Listening to music	6	12	12
Alcohol consumption	0	9	6
Watching television	0	20	21
Reading	26	20	24
Other	1	3	3

6.9 Summary

While at sea, pilots reported an average of 5.5 hours of daily sleep, comprising of approximately 2.5 sleep periods of 2.2 hours duration. This pattern of sleep was significantly different from the pattern adopted when ashore between work assignments, which tended to consist of fewer sleep periods of longer duration. When at home, pilots reverted to normal sleep patterns involving a single sustained block of sleep. Naps were also more frequently taken by pilots at sea, compared with ashore or at home.

The difference between the amount of sleep achieved by pilots when at sea and at home resulted in a daily sleep debt of 2.3 hours. This level of sleep debt was greater than that calculated in previous work on other Australian seafarers and US merchant marine personnel.

Compared with the home environment, sleep latency was shorter at sea, but longer ashore between work assignments. Sleep difficulties were not affected by location, however sleep was more frequently disturbed at sea and ashore than at home. Pilots reported needing less sleep while at sea. In all locations, the most frequently used strategy to promote sleep was reading.

7.0 CIRCADIAN CHARACTERISTICS

7.1 Circadian Type

In the present investigation, the Circadian Type Inventory (Barton et al. 1995) was used to rate pilots on two factors: languidity and flexibility. Languidity refers to one's ability to overcome drowsiness while flexibility refers to the degree of flexibility of one's sleeping habits. Previous work has shown that the ability to overcome drowsiness and flexibility of sleeping habits are associated with better tolerance to shiftwork (Barton et al. 1995). Table 7.0 presents the mean scores for the two scales. A higher score was associated with a greater degree of either languidity or flexibility.

Table 7.0 A comparison of scores on languidity and flexibility between pilots and normative data

Circadian characteristic	Great Barrier Reef pilots	Normative group#
Languidity (Mean + SD)	25.71 (+5.09)	31.60 (+ 6.52)
Flexibility (Mean + SD)	31.36 (+3.67)	26.02 (+5.47)

Normative group data based on 1864 emergency and industrial shiftworkers (Barton et al.1995).

Compared with a large sample of shiftworkers (n = 1864) (Barton et al. 1995) pilots reported significantly less ($p<0.0001$) ability to overcome drowsiness, but significantly greater ($p<0.0001$) flexibility of sleeping habits. The greater level of flexibility in sleeping habits reported by pilots would be beneficial in dealing with unfamiliar sleeping environments and irregular sleeping hours associated with pilotage work, and may have contributed to the finding reported previously indicating no location effect for sleeping difficulties (Section 6.5). However, that pilots were significantly less able to overcome drowsiness suggests there may be a need to educate pilots on effective strategies for maintaining high levels of alertness.

To examine how individual differences may serve to modify the impact of shiftwork, Barton et al. (1995) constructed a correlation matrix. The results indicated that less flexibility of sleeping habits and less ability to overcome drowsiness were associated with more health-related problems, sleep difficulties and more social and domestic disruption.

7.2 Morningness/eveningness

The individual characteristics of morningness/eveningness can play a moderating role in the amount of stress experienced as a function of irregular work hours. Morning people are more alert during the morning and have slightly earlier peaks in their temperature rhythm than evening people (Barton et al. 1995; Folkard 1983; Harma 1993; Monk & Folkard 1983, 1992). As a consequence, the former group tend to adapt less well and have a lower tolerance for night work (Barton et al. 1995; Folkard 1983; Harma 1993; Monk & Folkard 1983, 1992). Eveningness, however, has been found to be associated with more physical and psychological ill-health, more chronic fatigue, and more sleep, social and domestic difficulties (Barton et al. 1995).

To assess whether Great Barrier Reef pilots were more morning or evening orientated, respondents were asked to describe themselves in terms of morningness/eveningness. The item content and distribution of scores across the five response categories is shown in Table 7.1.

No respondents reported being ‘definitely evening’ types whereas 7 pilots (21%) rated themselves as ‘definitely morning’ types. Slightly more pilots (32%) reported being ‘more morning than evening’ than the reverse (24%). Eight pilots (24%) reported being ‘neither morning nor evening’ types. Overall, the present group considered themselves to be more morning types. This finding is in contrast to results from a survey of 141 US merchant marine personnel who considered themselves more evening than morning orientated (Sanquist et al. 1996). The variation between the two groups in terms of average age (43 years for the US merchant marine personnel versus 53 years for Great Barrier Reef pilots) may partly account for the different findings, as individuals tend to become more morning oriented as they age (Harma 1993; Parkes 1994).

Table 7.1 Distribution of scores across the five items comprising the morningness/eveningness scale.

Item	Frequency (No.)
Definitely morning	7
More morning than evening	11
Neither morning nor evening	8
More evening than morning	8
Definitely evening	0

7.3 Summary

Overall, pilots reported more flexibility of sleeping habits but less ability to overcome drowsiness than other shiftworkers. The sample described themselves as more morning than evening oriented.

8.0 FEELINGS WHILE WORKING ON THE BRIDGE

The potential impact of fatigue on performance and accidents has been highlighted by several recent reports. For instance, the US Coast Guard Research and Development Centre identified that 16 percent of critical vessel casualties and 33 percent of personnel injury casualties occurring in US coastal waters between 1 July and 31 December 1995, had some fatigue contribution (McCallum et al. 1996). The Japan Maritime Research Institute (1993) documented that 'lack of alertness' and 'dozing during navigation' accounted for approximately 53 percent of groundings and strandings and 38 percent of collisions occurring between 1985 and 1991. Additionally, while official statistics indicate 9.2 percent of shipping casualties occurring in Australian waters between January 1994 and January 1998 were fatigue-related, some authors have suggested that a figure closer to 30 percent would be more realistic when performance impairments due to chronic fatigue are considered (Filor 1998). These, and other findings (Sanquist et al. 1996), seem to indicate that fatigue is a widespread problem in the maritime industry and that a significant number of marine accidents are fatigue-related. Thus, the examination of experiences of fatigue during bridge work was highly relevant to the present study.

The purpose of this section was to gain a general impression of the experiences of Great Barrier Reef pilots while working on the bridge. Where appropriate, comparisons between the beginning and end of work assignments were made. Items addressed feelings of tension and fatigue, factors contributing to fatigue, strategies used by pilots to reduce fatigue, the extent of fatigue-related performance decrements and periods of vulnerability to performance decrements across the 24 hour cycle. While it is acknowledged that a high degree of variation exists from one pilotage assignment to another, respondents were encouraged to provide responses based on average experiences.

8.1 Tension

Respondents were asked to rate how frequently they experienced feelings of tension while working on the bridge, at the beginning and end of a work assignment. Table 8.0 shows the item content and distribution of scores for this measure. Approximately half the sample reported 'never' or 'almost never' feeling tense at the beginning and end of a work assignment. Most of the other pilots reported that they 'seldom'; or 'sometimes' felt tense during bridge work, while a small minority (9%) reported 'usually' or 'almost always' feeling tense at the beginning or end of a work assignment. Further analysis of the data revealed no significant time effect in the frequency of tension and/or anxiety between the beginning and end of a work assignment ($p = 0.062$).

Commentaries from pilots indicated that feelings of tension on the bridge increased when bridge teams demonstrated poor navigational skills and low competency levels. Additionally, the competitive environment in which Great Barrier Reef pilotage operations are now performed was also reported as contributing to greater levels of stress and tension during bridge work.

8.2 Fatigue

Also presented in Table 8.0 is the distribution of scores for the frequency of experiencing fatigue while working on the bridge. At the beginning of a work assignment, approximately 71% of the sample reported 'never' or 'almost never' experiencing fatigue or tiredness, while the remaining 29% of the sample reported experiencing fatigued 'seldom' or 'sometimes'. However, at the end of a work assignment, approximately 24% reported ‘never’ or ‘almost never’ feeling fatigued, 56% reported they ‘seldom’ or ‘sometimes’ felt fatigued and 21% indicated they ‘usually’ or ‘almost always’ felt fatigued. These changes across time were statistically significant ($p < 0.001$) and indicate that feelings of tiredness and fatigue are more frequently experienced during bridge work at the end of work assignments than at the beginning.

Table 8.0 Distribution of scores across the items comprising tension and fatigue on the bridge

Variable	Never	Almost never	Seldom	Sometimes	Usually	Almost always	Always
	No.	No.	No.	No.	No.	No.	No.
Tension/anxiety							
At the beginning	7	9	9	6	1	2	0
At the end	9	12	8	2	3	0	0
Fatigue/tiredness							
At the beginning	11	13	8	2	0	0	0
At the end	1	7	8	11	6	1	0

8.3 Onset of fatigue

To gain further understanding about the onset of feelings of tiredness and fatigue during bridge work, respondents were asked to indicate how long after beginning work on the bridge they experienced fatigue. Table 8.1 shows the distribution of scores for this measure.

The majority of respondents indicated that fatigue was experienced either ‘towards the end’ or ‘never’ at the beginning of a work assignment. However, at the end of a work assignment, most pilots experienced fatigue ‘towards the end’ or ‘midway’ through the bridge period. Further analysis of the frequency data revealed strong evidence ($p = 0.002$) that fatigue on the bridge occurred earlier at the end, than the beginning of a work assignment.

The present findings of reported fatigue were not unexpected given the knowledge of work and sleep patterns of pilots. Depending on the shipping route, work assignments of Great Barrier Reef pilots can vary from 12 to 60 hours in duration, with around 50% of ship time being undertaken at night. These findings, combined with the fact that sleep patterns and duration are significantly compromised while at sea, most likely contribute to increased fatigue towards the end of work assignments. Specific details of Great Barrier Reef pilotage work and sleep across the 24 hour cycle is required to confirm this association.

Table 8.1 Distribution of scores for the onset of fatigue at the beginning and end of a work assignment

Item	Immediately	Midway	Towards end	Never
	No.	No.	No.	No.
At the beginning of a work assignment	0	7	11	14
At the end of a work assignment	1	9	15	6

8.4 Factors contributing to fatigue on the bridge

The following items were designed to examine the extent to which a number of pilotage work specific factors contributed to fatigue on the bridge. The factors have been previously identified as potential contributors to fatigue, decreased alertness, and performance decrements (Couper 1996; Sanquist et al. 1996). Respondents were asked to rate the degree to which each of the 13 factors contributed to their levels of fatigue. Factor analysis did not provide a clear grouping so the items have been treated singly.

Table 8.2 shows the item content and distribution of scores across the 13 items. Approximately 30% of respondents indicated items such as the length of time on task, length of tour, tour route, crew competency, sleeping facilities and environmental conditions contributed 'very much' to feeling fatigued while on the bridge.

For 65% of respondents, factors such as boredom, lack of sleep, workload, and time of day contributed 'a little' to 'quite a bit' to fatigue. Issues such as poor bridge team competency and poor sleeping facilities have also been reported as contributors to fatigue levels in comments from pilots.

Interestingly, two thirds of the group reported that weather and sea conditions did not contribute to fatigue. This finding may be due to the fact that pilots are well accustomed to poor weather, and their time spent at sea is relatively short. Previous survey results of Australian seafarers have also shown that poor weather and rough seas do not greatly impact on stress levels (Parker et al. 1997).

That no single contributing factor was clearly identifiable as contributing to fatigue highlights the multi-factorial nature of this condition. Most respondents reported that many of the factors contributed 'a little' to 'quite a bit' to fatigue.

Table 8.2 Distribution of scores across the thirteen items comprising the contributing factors to fatigue scale

Item	Not at all		A little		Quite a bit		Very much
	No.	No.	No.	No.	No.	No.	No.
Length of time on task	4	4	9	4	5	4	4
Length of tour	4	5	9	3	7	4	2
Tour route	6	5	9	3	3	3	5
Boredom	6	5	8	8	4	2	1
Lack of sleep	2	8	8	6	9	1	0
Weather	8	11	6	3	4	1	1
Equipment problems	7	7	5	3	6	5	1
Workload	8	5	8	6	6	1	0
Sea conditions	15	11	5	1	2	0	0
Time of day	3	7	10	6	6	2	0
Crew competency	2	7	6	2	7	4	6
Sleeping facilities	3	6	7	0	9	6	3

8.5 Strategies used to combat fatigue

Items in this section covered six strategies used to combat fatigue. Respondents were asked to rate "how effective the strategies were in combating fatigue during bridge work". Factor analysis did not provide a clear grouping so the items have been treated singly. Table 8.3 shows the item content and distribution of scores across the six items.

Of the strategies listed, respondents indicated that stretching and performing light exercise was the most useful technique for combating fatigue. Ninety-four percent of the sample rates this strategy as either being ‘quite a bit’ or ‘very’ effective. Another popular strategy was taking a quick shower, with 80% of respondents rating this as being ‘quite a bit’ to ‘very’ effective. At the other end of the scale, rotating duties and tasks was not considered by many as being very effective in alleviating fatigue. The two strategies of ‘drinking coffee/soft drinks; eating candy/sweets’ and ‘keeping busy’ were considered as being somewhat effective, with 76% of the sample rating these strategies as being between ‘a little’ to ‘quite’ effective. Pilot’s use of caffeine to combat fatigue was similar to caffeine consumption by long haul truck drivers for this purpose (Arnold & Hartley 1998; Williamson et al. 1992). Overall, the majority of pilots considered that most strategies were effective to varying degrees in overcoming fatigue. Active rather than passive strategies were perceived to be more effective.

Table 8.3 Distribution of scores across the six items comprising strategies used to combat fatigue

Item	Not at all		A little		Quite a bit		Very much
	No.	No.	No.	No.	No.	No.	No.
Drinking coffee/soft drink or eating candy/snacks	3	1	11	5	10	2	2
Stretching, performing light exercise walking around	1	1	0	0	15	9	8
Taking rest breaks	0	3	1	6	10	5	9
Keeping busy, working on projects	1	4	5	4	17	3	0
Taking a quick shower	0	1	1	5	8	5	14
Rotating duties and tasks	4	4	9	4	6	3	1

8.6 Performance decrement on the bridge

To gain an impression of the degree to which fatigue related performance decrements are experienced, pilots were asked: (I) whether fatigue caused their performance to decrease; and (ii) how severely their performance decreased. Table 8.4 presents the distribution of scores for these two items.

The majority of respondents (71%) indicated that fatigue contributed to performance decrements ‘a little’ to ‘quite a bit’. This finding appears to be consistent with the fact that there are a number of potential fatigue factors present in pilotage work. For example, the work schedule analysis highlighted factors such as irregular work hours, irregular breaks, long on-duty periods, night work and disrupted sleep. Two respondents indicated tiredness did not contribute to performance decrements at all.

With regard to the severity of performance decrements, 18 pilots (53%) gave ratings between ‘a little’ to ‘quite a bit’, while 3 respondents (9%) indicated performance did not decrease ‘at all’.

Table 8.4 Distribution of scores for the two items relating to the extent of performance decrement on the bridge

Item	Not at all		A little		Quite a bit		Very much
	No.	No.	No.	No.	No.	No.	No.
Does your performance decrease due to tiredness?	2	7	11	7	6	1	0
How severely does it decrease?	3	12	15	2	1	0	0

8.7 Factors affecting performance levels on bridge tasks

Respondents were asked a series of 10 questions which examined to what extent fatigue-related factors affected bridge performance. The factors examined have previously been associated with fatigue (Couper 1996; Dinges 1992; McCallum et al. 1996). For example, impaired decision making, narrowing of attention, lowered levels of vigilance and memory problems are but a few of the ways in which fatigue related performance decrements may manifest (Couper 1996; Dinges 1992). On the basis of factor analysis, three sub-scales were identified.

8.7.1 Performing tasks and making decisions

This sub-scale comprised of three items. Table 8.5 shows the item content and distribution of scores across the response categories. The majority of respondents reported that trouble making decisions and trouble with simple tasks did not affect performance during bridge work, while a minority group considered that these tasks affected performance ‘a little’. The reliability of the index as determined by Cronbach’s alpha was 0.88.

Table 8.5 Distribution of scores and item content for the three items comprising the performing tasks and making decisions scale

Item	Not at all		A little		Quite a bit		Very much

	No.	No.	No.	No.	No.	No.	No.
1.Trouble making decisions	19	12	3	0	0	0	0
2. Trouble with simple tasks	23	8	3	0	0	0	0
3. Other	20	1	1	0	0	0	0

8.7.2 Concentration

This sub-scale comprised of two items. The items and their content are shown in Table 8.6. Trouble concentrating and maintaining attention was considered by approximately 71% of pilots as affecting bridge performance to some extent, while memory problems were rated by 66% of the sample as contributing 'a little' to decreased performance levels. The remaining respondents did not believe either of these factors caused performance decrements. The reliability of the index as determined by Cronbach's alpha was 0.75.

Table 8.6 Distribution of scores and item content for the two items comprising the concentration scale

Item	Not at all		A little		Quite a bit		Very much
	No.	No.	No.	No.	No.	No.	No.
1.Trouble concentrating/ maintaining attention	10	6	12	6	0	0	0
2. Trouble with memory	15	10	7	2	0	0	0

8.7.3 Physical effects

The third sub-scale identified comprised of five items. These items and their content are shown in Table 8.7. In general, most pilots considered that the physical tasks listed within the sub-scale did not affect bridge performance at all, while a minority group indicated 'a little' effect. The only exception to these results were for the items 'body motions' and 'problems with sense of balance', with 1 pilot rating these items as affecting bridge performance 'quite a bit'. The reliability of the index as determined by Cronbach's alpha was 0.85.

The absence of any notable impact on physical tasks is consistent with findings showing that cognitive tasks display greater effects from fatigue and performance decrements than motor tasks (Rosekind et al. 1996; Sanquist et al.,1996).

Table 8.7 Distribution of scores and item content for the six items comprising the physical effects scale

Item	Not at all		A little		Quite a bit		Very much
	No.	No.	No.	No.	No.	No.	No.
1.Body motions	19	6	6	2	1	0	0
2. Problems with sense of	24	7	2	0	1	0	0

balance							
3. Problems with hand coordination	30	2	2	0	0	0	0
4. Problems with vision	23	8	2	1	0	0	0
5.Feeling weak and shaky	29	2	3	0	0	0	0

8.8 Vulnerability to performance decrements across 24 hours

Alertness and performance exhibit distinct circadian rhythms, with both of these attributes falling off during the early morning hours, and to a lesser extent, in mid afternoon. As a consequence, working during these time periods is associated with an increased risk of performance decrements and accidents (Brown 1994; Folkard 1997; Summala & Mikkola 1994).

To assess whether Great Barrier Reef pilots were aware of any changes in performance over time, respondents were asked to rate their vulnerability to performance decrements while working on the bridge. Table 8.8 shows the item content and distribution of scores across the six four-hour periods.

The majority of respondents indicated they were 'not at all' vulnerable to performance decrements during the hours between 0800 and 2000 (i.e. predominantly day time hours). However, between the hours of 2400 and 0800, approximately 50% of respondents indicated their vulnerability to performance decrements ranged from 'a little' to 'quite a bit', while 2 respondents (6%) indicated that they were ' very' vulnerable to performance decrements between the hours of 2400 and 0400. This pattern in results is consistent with established circadian variations in performance.

That at least half of the group reported being vulnerable to performance decrements during the early hours of the morning suggests educating personnel about fatigue symptoms and how to minimise its impact could be beneficial.

Table 8.8 Distribution of scores across the six time periods comprising the vulnerability to performance scale

Item	Not at all		A little		Quite a bit		Very much
	No.	No.	No.	No.	No.	No.	No.
2400-0400	5	8	10	3	5	0	2
0400-0800	8	5	13	3	4	0	0
0800-1200	20	10	2	2	1	0	0
1200-1600	13	9	7	2	2	0	0
1600-2000	18	12	2	0	1	0	0
2000-2400	12	3	7	0	0	1	0

8.9 Pilotage specific experiences

The 10 items included in this section were designed to assess the prevalence of specific experiences in Great Barrier Reef pilotage work. These experiences were included after consultation between Pilot Advisory Group members and the research team. In general, the items addressed issues specific to pilotage duties and the changing technological and operational conditions encountered by pilots.

Respondents were asked to rate "how frequently each of the situations arose in pilotage work". On the basis of factor analysis four sub-scales were identified.

8.9.1 Boredom

This sub-scale comprised of two items. The item content and distribution of scores across the response categories are shown in Table 8.9. Twenty two pilots representing 65% of the sample indicated that the nature of pilotage work was 'never to seldom' conducive to falling asleep, while 11 pilots (32%) considered pilotage work as 'sometimes' being conducive to falling asleep. One pilot indicated pilotage work was 'usually' conducive to falling asleep.

With regards to the prevalence of boredom in pilotage work, 11 pilots (32%) gave ratings of 'never to seldom', 50% indicated pilotage work was 'sometimes' boring and 6 pilots (18%) indicated it was 'usually or almost always' boring. The reliability of the index as determined by Cronbach's alpha was 0.69.

Studies have shown that situations of work underload typically result in reduced levels of arousal and boredom. The high levels of vigilance, watchkeeping, and monitoring required of pilots requires their constant attention but these functions may provide minimal task variety. Consequently, additional effort is required to maintain appropriate levels of arousal (Costa 1993; Dyer-Smith 1983) and this in turn causes greater fatigue levels. The situation is exacerbated during night work where light workloads increase pre-existing fatigue from other factors such as circadian dissociation or long working hours (Luna 1997).

Table 8.9 Distribution of scores across the two items comprising the boredom scale

Item	Never	Almost never	Seldom	Sometimes	Usually	Almost always	Always
	No.	No.	No.	No.	No.	No.	No.
1. Is the nature of a pilots work conducive to falling asleep?	7	8	7	11	1	0	0
2. Is boredom prevalent in pilotage work?	1	3	7	17	5	1	0

8.9.2 Critical need to be alert

The second sub-scale identified in the factor analysis comprised of three items. The item content and distribution of scores across the response categories are shown in Table 8.10. Almost all pilots (97%) considered that pilotage work was 'usually to always' dependent upon not making errors in judgement. Judgments are based on local knowledge of the shipping region, tides and weather, combined with high levels of skill and experience in navigation and ship handling tasks. Similarly, all respondents indicated that the alertness level of the pilot and bridge team was 'usually' to 'always' an important factor in ship safety.

Almost 60% of pilots indicated that assumptions about the role of technological advances 'sometimes' led to complacency among the bridge team, with approximately 30% reporting that complacency was 'usually' to 'always' associated with the reliance on high-technology equipment. Commentaries from pilots indicated that in some cases bridge teams rely almost totally on equipment and fail to perform basic skills such as lookout duties. The reliability of the index as determined by Cronbach's alpha was 0.57.

Table 8.10 Distribution of scores across the three items comprising the critical need to be alert scale

Item	Never	Almost never	Seldom	Sometimes	Usually	Almost always	Always
	No.	No.	No.	No.	No.	No.	No.
1. Is the nature of a pilots work dependent upon not making errors in judgement?	0	0	0	1	6	12	15
2. Is the alertness level of the pilot and bridge team an important factor in ship safety?	0	0	0	0	2	8	24
3. Do the assumptions about the role of technological advances in navigational equipment in accident prevention lead to complacency among the bridge team?	0	2	1	20	6	3	2

8.9.3 Ship safety

This sub-scale comprised of two items. Table 8.11 shows the item content and distribution of scores across the two items. Forty-seven percent of respondents indicated risk taking strategies were 'sometimes' to 'usually' prevalent in pilotage work, while 6% of respondents indicated they were 'almost always' to 'always' prevalent. The remaining 47% reported that risk taking prevailed 'never' to 'seldom'. The majority of the sample (82%) considered that boredom impacted on ship safety between 'sometimes and always'. The reliability of the index as determined by Cronbach's alpha was 0.42.

Table 8.11 Distribution of scores across the three items comprising the ship safety scale

Item	Never	Almost never	Seldom	Sometimes	Usually	Almost always	Always

	No.	No.	No.	No.	No.	No.	No.
1. Are calculated risk taking strategies prevalent in pilotage work?	5	10	1	10	6	1	1
2. Does boredom impact on ship safety?	1	2	3	10	8	9	1

8.9.4 Common fatigue

The fourth sub-scale identified comprised of three items. The item content and distribution of scores across the three response categories is shown in Table 8.10. Nineteen pilots (56%) considered fatigue to be 'sometimes to always' widespread in pilotage work, while 15 respondents (44%) indicated that the prevalence of fatigue ranged between 'seldom and never'. The analysis of the work schedule files highlighted the presence of a number of potential fatigue factors within the work of Great Barrier Reef pilots, thereby suggesting that fatigue may be prevalent at least some of the time.

With regards to the impact of economics on shipping safety, pilots responses were fairly evenly spread across the categories. Thirty-two percent of the sample felt that economic and commercial pressures 'never to seldom' impacted on safety, 35% believed it 'sometimes to usually' impacted on safety while 32% indicated these issues 'almost always to always' impacted on safety.

Since 1993, competition between pilotage companies has become an integral part of pilotage work in the Great Barrier Reef region. Each company is trying to secure enough work to make their operation economically viable. Comments from pilots strongly indicated that commercialisation of pilotage had negatively affected safety. For example, respondents reported that in some instances substandard ships, equipment and safety breaches were not reported for fear of the pilotage company losing a client. Competition between pilotage operators has also resulted in pilots having to work more in order to maintain an adequate income, which in turn could negatively affect safety. Additionally, international data has suggested that some shipping companies are reducing running costs by minimising the amount of maintenance and upgrading work being performed on their vessels (National Research Council 1994).

Some authors have advocated against competition in marine pilotage operations. For example, Sparks (1998) has indicated that competition is incompatible with compulsory pilotage; it is bad for the public, for the shipping industry and the pilotage profession. Competition may compromise safety, particularly when pilots are expected to exercise independent judgment and resist pressures which are inconsistent with the interests of safety (Sparks 1998).

The third item included in the common fatigue sub-scale related to pilotage management's role in developing work schedules which promote pilot well-being and ship safety. Most pilots (65%) reported that pilotage management 'usually to always' considered pilot well-being and ship safety; however 7 respondents (21%) indicated this was 'never to seldom' the case. Pilotage management is directly responsible for allocating work to pilots in such a way that there is equality between pilots in workload, rest breaks and income. Thus, while pilots are often questioned about fatigue following an incident, it should be remembered that pilots follow instructions from management personnel in terms of the number of work assignments to be performed across a tour.

Table 8.12 Distribution of scores across the three items comprising the common fatigue scale

Item	Never	Almost never	Seldom	Sometimes	Usually	Almost always	Always
	No.	No.	No.	No.	No.	No.	No.
1. Is fatigue widespread in pilotage work?	1	6	8	12	4	2	1
2. Do the economics /commercial pressures of shipping take precedent over safety issues	4	5	2	8	4	6	5
3. Do pilotage management consider the impact of work schedules on pilot well being and ship safety	2	2	3	5	9	4	9

8.10 Summary

Feelings of tension were not particularly problematic for the current group of pilots, as most respondents reported feeling tense only 'seldom to sometimes' during work assignments. Fatigue, however, was somewhat more prevalent, especially towards the end of work assignments. The analysis of factors contributing to fatigue highlighted the multi-factorial nature of this condition. Boredom, lack of sleep, workload and time of day were common factors considered by pilots as contributing to fatigue 'a little' to 'quite a bit'. Active strategies were more frequently used to combat fatigue, with 'stretching and performing light exercise' and 'taking a shower' the most frequently used techniques.

Fatigue was felt by most pilots to contribute to bridge performance decrements 'a little' to 'quite a bit'; however the severity of the performance decrements were not reported as being especially great. In particular, performance decrements seemed to manifest in the form of experiencing increased difficulty in concentrating and maintaining attention and memory problems. Physical tasks were generally not affected to any significant extent. Pilots reported being most vulnerable to reductions in performance levels between 2400 and 0800 hours.

Pilotage work was considered by approximately half the sample as being boring some of the time, while most pilots indicated that boredom impacted on ship safety 'sometimes to always'. Correct judgment and high levels of alertness were considered to be important factors in pilotage work and ship safety. Fatigue was considered by around half the respondents as 'sometimes to always' being prevalent in pilotage work. Most pilots felt that economic and commercial pressures had some impact on safety issues.

9.0 JOB SATISFACTION

Two items were included in the questionnaire to provide information on the level of job satisfaction/dissatisfaction experienced by Great Barrier Reef pilots. The questions required respondents to list the five best and worst features of working as a Great Barrier Reef pilot. Pilots were also asked whether, with hindsight, they would join the Great Barrier Reef pilotage service.

9.1 Best Features of Great Barrier Reef pilotage work

A listing of the common themes representing the best features of Great Barrier Reef pilotage work are shown in Table 9.0.

Table 9.0 Frequency of the best features of working as a Great Barrier Reef pilots

Item	Frequency (%)
Job satisfaction: (responsibility, interesting work, interesting regions, mental stimulation, challenge of difficult navigational problems)	22.9
Variety: ships, crew, weather	21.1
Member of a group with same professional background	8.2
Using maritime expertise, vessel handling, navigation skills	6.4
Independent, work for self, independent of shipboard routine and superiors	6.4
Licensed in elite pilotage	5.5
Meeting with other professionals	4.6

Job satisfaction (which encompassed comments revolving around satisfaction with a job well done) was the most frequently rated best feature of pilotage work. The satisfaction level with pilotage work was related to the level of responsibility, mental stimulation and challenges associated with navigating ships through the Great Barrier Reef region. Pilots also enjoyed the variability of ship types, crew and weather associated with pilotage duties.

Further rewarding features of the work included being part of a group that shared the same professional background, utilising one's ship handling and navigational skills and meeting and working with professional international seafarers. Moreover, being self-employed and independent from the usually daily shipboard life were also rated highly.

The current job satisfaction levels are consistent with previous reports of job satisfaction in a sample of the present pilots. In a recent investigation of Australian seafarers, Great Barrier Reef pilots reported higher levels of job satisfaction than other seafaring groups (Parker et al. 1997). Specifically, job satisfaction in this earlier data was related to the level of responsibility, status and authority associated with marine pilotage work.

Other pilotage groups have also indicated high job satisfaction levels. For example, pilots from the United Kingdom (Shipley 1978), the Port Phillip region of Australia (Berger 1984) and the United States (Sparks 1992) have indicated high levels of job satisfaction relating to the status, authority, responsibility and utilisation of their high levels of technical skills.

9.2 Worst Features of Great Barrier Reef Pilotage Work

Presented in Table 9.1 are a listing of common themes representing the worst features of working as a Great Barrier Reef pilot.

Table 9.1 Distribution of the worst features of working as a Great Barrier Reef pilot

Item	Frequency (%)
Pilot income levels, irregularity, fees not indexed, responsibility levels not commensurate with fees, payment delays, difficulties with allocation of funds for superannuation	23.4
Time away from family, difficult to plan leisure time, little warning of work	9.7
AMSA's attitude causes fatigue and stress, not pilotage duties	8.9
Uncertainty created by competition, uncertainty of future of work assignments and pilotage generally	8.1
Lack of training by ships crew increase risks	6.5
Impact of competition on safety	6.1
Commercial parameters of deregulation	6.1
Personal habits / living conditions of foreign crew/ships	6.1

The most frequently expressed factor causing dissatisfaction amongst Great Barrier Reef pilots related to financial issues arising directly or indirectly from the recent commercial changes in the structure of pilotage operations. This factor totalled just over 23% of all comments within this section. Some common financial concerns included the level and irregularity of income, absence of indexation, and allocation of sufficient funds for superannuation.

Time away from family and the disruption pilotage work causes to family life were also an unattractive feature of the job. This finding is consistent with the results of previous studies in which pilots documented discontent over the home and away nature of their work (Berger 1984; de Vries-Grierer 1982; Parker et al.1997; Shipley 1978; Shipley & Cook 1980; Sparks 1992).

The frequency analysis highlighted that most of the unsatisfactory features of Great Barrier Reef pilotage work related to extrinsic aspects of the job rather than intrinsic factors. Pilots indicated factors associated with changes in pilotage had negatively impacted on job satisfaction. For example, the role and attitude of the Australian Maritime Safety Authority in implementing changes, and the commercial parameters of deregulation have resulted in feelings of uncertainty relating to pilotage work and career stability. Similarly, previous research indicated that structural changes in the airline industry negatively affected career satisfaction of airline pilots (Little et al. 1990).

Other negative features of Great Barrier Reef pilotage related to substandard ships and bridge teams, unhygienic conditions on board some vessels and concern over the impact of competition on safety issues.

9.3 Rejoining the Great Barrier Reef pilotage service

Very few pilots indicated they would definitely join the Great Barrier Reef pilotage service if they were to start their pilotage careers again. Approximately a third of the sample considered they would have second thoughts, while the remaining pilots reported they would definitely not join. These findings highlight that a certain level of discontent currently exists amongst members of this service.

9.4 Summary

The best feature of working as a Great Barrier Reef pilot was the job satisfaction associated with a job well done at the completion of a work assignment. The level of responsibility, mental stimulation and utilisation of high level navigational and ship handling skills were also rated highly and related to the overall satisfaction levels. Job dissatisfaction revolved around the impact of competition on income levels, irregular payment for work and safety issues. Time away from family also caused some dissatisfaction.

10.0 DYADIC ADJUSTMENT

The quality of interpersonal relationships and particularly the relationship with a spouse or partner can substantially influence quality of life and the ways in which people cope with their working and private lives. The Spanier Dyadic Adjustment Scale was designed to assess the quality of a relationship for both married and cohabiting couples. The item content and distribution of scores across the seven items is detailed in Table 10. Respondents were asked "How well do the following statements describe the relationship between you and your partner"?

The distribution of responses to this series of questions was skewed towards the end of the scale indicating satisfaction with the dyadic relationship. Twenty-seven pilots (86%) indicated things went well between themselves and their partner ‘most to all of the time’. Only 1 respondent (3%) believed things were never going well, and one respondent (3%) was considering divorce. A further 5% expressed difficulty confiding in their partners. Just over 30% of respondents felt that they ‘got on each others nerves’ at least some of the time. In contrast to the other aspects of the questionnaire, there were no qualitative comments on the quality of marital relationships, perhaps suggesting that respondents found it difficult to comment on personal aspects of their life.

For the purposes of this study the level of dyadic satisfaction was treated as a dichotomous variable. A scale score of between 10 and 40 was considered to represent a low to moderate level of satisfaction with the relationship. A score between 41 and 50 was considered to indicate a high level of satisfaction. On this basis, seven respondents (approximately 25% of the sample) reported a moderate to low level of satisfaction with their relationship, while 21 respondents (75% of the sample) reported a high level of satisfaction

Stressful interpersonal relationships can have a profound affect on personal well-being and workplace performance. Previous studies on maritime pilots (Berger 1984; de Vries-Grierer 1982; Parker et al. 1997; Shipley & Cook 1980;) and other Australian Seafarers (Parker et al. 1997) have highlighted the important role of a stable home life in a mariner's work. Similarly, literature from the aviation industry has shown that the pilot's spouse is a key figure in promoting flight safety. A stable marriage with a supportive spouse or partner enables the aviator to perform more reliably and effectively (Cooper & Sloan, 1985; Karlins et al. 1989). These authors have also shown that when a home and away pattern of work exists, there are considerable positive or negative interactions between a pilot's home life, work situation, work performance and well-being (Cooper & Sloan 1985; Karlins et al. 1989).

Table 10.0 Distribution of scores across the seven items comprising the marital satisfaction scale

Item	All the time	Most of the time	Some of the time	Rarely	Never
	No.	No.	No.	No.	No.
1. In general, would you say things between you and your partner are going well	15	10	2	1	1
2. How often do you think about divorce, separation or termination of the relationship	1	0	1	9	18
3. How often do you or your partner leave the house after a fight	0	0	0	4	25
4. Do you find it easy to confide in your partner	13	12	2	1	1
5. Do you ever regret that you married or lived together	0	0	0	7	22
6. How often do you and your partner quarrel	0	2	7	16	3
7. How often do you and your partner get on each others nerves'.	0	2	7	19	0

11.0 OVERALL SUMMARY

The purpose of the survey was to seek information concerning the demography, and general work history of Great Barrier Reef Pilots, and any personal and industry-specific factors which may have a bearing on their potential for the development of fatigue. Together with other measures of the work practices of pilots the information from the survey is part of a larger investigation of the work practices of Great Barrier Reef pilots designed to evaluate the nature and extent of fatigue associated with this population and to assess the adequacy of existing fatigue management procedures. Topics in the questionnaire included sleep patterns at sea, ashore and at home, bridge work and the factors contributing to fatigue and/or decreased alertness and performance. Psychosocial issues such as marital adjustment were also included.

The sample consisted of 35 pilots giving a response rate of 60%. The results indicated a relatively older but relatively stable pilotage workforce as reflected by long years of general maritime and pilotage experience.

The majority of pilots reported 'good' to 'excellent' levels of general health and fitness; however, BMI scores classified a high percentage of respondents as being overweight or obese. Lifestyle habits differed according to the location with smoking frequency and caffeine consumption increasing while at sea. Consistent with the on-call nature of pilotage work, alcohol was not consumed at sea. A small group of respondents reported suffering sea sickness mostly during the transfer to the ship by the pilot launch. Pilots reported less chronic fatigue than normative groups comprising emergency and industrial shiftworkers.

Sleep patterns varied substantially between the sea, ashore and home environments. At sea, pilots reported an average of 5.5 hours of daily sleep comprising of a number of shorter sleep periods which were taken throughout the day. In contrast, sleep taken ashore between assignments in company accommodation was characterised by fewer sleep periods of longer duration giving a total of approximately 8 hours sleep. When at home, pilots reverted to a single block of sustained sleep. Sleep latency was shorter at sea but longer ashore compared with at home, and sleep was more disrupted at sea and ashore than at home. In all locations, reading was the most frequently used strategy to promote sleep.

Circadian characteristics revealed that pilots were more 'morning' than 'evening oriented This finding could partly be related to the older age profile of the present group. Pilots also displayed greater flexibility in sleep habits, but less ability to overcome drowsiness than normative groups of shiftworkers.

Feelings of tension during bridge work did not appear to be particularly problematic for the current group of pilots however fatigue was somewhat more prevalent, especially towards the end of work assignments. Many factors were identified by pilots as contributing to fatigue including boredom, lack of sleep, workloads and time of day. Active, rather than passive strategies were more frequently used by pilots to combat fatigue.

Fatigue-related performance decrements were experienced to varying degrees while working on the bridge, and were most evident as increased difficulty concentrating and maintaining attention and memory problems. Respondents were most vulnerable to performance decrements between the hours of 2400 and 0800.

The most satisfying aspects of Great Barrier Reef pilotage work related to the intrinsic characteristics of the job. In particular, pilots highlighted the high level of responsibility, mental stimulation, challenge and high levels of navigational and ship handling skills as being especially rewarding. In contrast, extrinsic factors such as the impact of competition on income level, the irregularity of income, the absence of indexation and the role and on going attitude of AMSA were rated as being the worst features of the work.

Miscellaneous comments from pilots indicated that changes in the structure of pilotage in the Great Barrier Reef region had caused considerable difficulties. For instance, comments from pilots chiefly referred to the impact of competition on income levels, regularity of income and compromised safety in the competitive pilotage environment. The overall impression from the comments indicated an ongoing degree of hostility between the pilots and AMSA and also between the pilotage companies.

In summary, this investigation was designed to provide self-report information of the general work practices of GBR pilots and their perception of aspects of their work and lifestyle which may have a bearing on fatigue. The results extended and generally supported earlier research on the work practices of GBR pilots and were consistent with research on fatigue and work practices in other maritime groups and shiftworkers. There was strong evidence of the high potential for fatigue among GBR pilots which was demonstrated in response to questions which were related directly or indirectly to the development of fatigue.

Sleep patterns were highly compromised at sea which occurred as a function of the irregularity of the work and rest schedules, relatively long periods of sustained work often at night, and the necessity to work and sleep at times incompatible with the normal biological rhythms of the body.

Pilots experienced fatigue while working on the bridge particularly towards the end of work assignments and the contributing factors included boredom, lack of sleep and high workloads. The potential for a decrement in performance was further substantiated by difficulty experienced by some pilots in maintaining concentration and attention and in memory lapses.

As found in other groups the results suggest that fatigue in GBR is multifactorial involving a range of work related and personal factors which are operating within the context of a unique working environment and a 24-hour industry. Pilots are satisfied with the challenges and responsibilities associated with their work but rate factors as competition in pilotage operations and insecurity as being the least satisfying aspects of pilotage. The potential for some of these concerns to impact on safety was identified by some pilots.

While this study provides further evidence of the strong potential for fatigue among GBR pilots, further research is required to provide more detailed knowledge of the nature and extent of both work and rest periods and their impact on fatigue.

Appendix 1

DETAILS OF METHODS

Information in this appendix provides details of measures used in the questionnaire.

1. Demographics

Items in this section included: age, current marital status and number of children.

2. Industry experience

Topics in this section included general maritime and pilotage experience, and the location of respondents home port region.

3. Recent work experiences

The questions in this section were designed to describe the general work patterns of Great Barrier Reef pilots in the previous six months. Questions related to:

- the number and duration of tours of duty and work assignments;
- the duration of breaks between tours of duty;
- the percentage of night work performed;
- the percentage of work on the three shipping routes;
- usual place of accommodation when ashore between assignments; and
- whether or not annual leave (away from pilotage work) had been taken in the past 12 months.

4. Sleep

The purpose of the questions in this section was to generally assess the sleep patterns of Great Barrier Reef pilots while at sea, ashore between work assignments and at home. Items were based, with some modification, on a previous assessment of sleep patterns in US merchant marine personnel (Sanquist et al. 1996).

Questions related to:

- total sleep across a 24 hour period;
- the number and duration of sleep and nap periods;
- sleep requirements and satisfaction;
- time to fall asleep and wake up;
- frequency of sleep difficulties;
- factors contributing to disrupted or delayed sleep; and
- strategies used to promote sleep.

For items v (sleep difficulties) and vi (sleep disturbances) participants were asked to rate the frequency of experiencing sleep difficulties and how frequently certain factors contributed to disrupted or delayed sleep. Ratings were given on a seven point Likert scale ranging from never (scale = 1) to always (scale = 7). On both scales, items were summed and a total score was computed for sleep difficulties and disturbances; a higher score indicated more difficulties or disturbances.

5. Health

Items included in this section included:

a general rating of health and fitness;

- Body Mass Index ratings;
- present illness or injury and the use of medications;
- breathing difficulties during sleep;
- lifestyle habits including smoking, alcohol and caffeine consumption;
- sea sickness;
- morning or evening orientation; and
- chronic fatigue.

Participants were asked to rate items vi, and viii on Likert scales ranging from the most negative response (scale = 1) to the most positive response (scale = 5 or 7).

Construction of the chronic fatigue scale

The original chronic fatigue scale contained 10 items relating to general feelings of vigour, energy, tiredness and lack of energy (Barton et al. 1995). The present scale is a modification of this original scale and contains two items relating to vigour and one relating to tiredness. The items were scored (positive items being reverse scored), on a five point Likert scale with a single total score being computed. A higher score indicated greater feelings of chronic fatigue. The reliability of the scale as determined by Chronbach's alpha was 0.75.

6. Circadian Type Inventory

This inventory was designed to assess circadian type in relation to preferred sleeping, waking and alertness habits. The scale consists of 18 items; 10 items related to the ability to overcome drowsiness (languidity/vigorousness) and 8 items related to flexibility of sleeping habits (flexibility/rigidity).

Construction of the scale

The Circadian Type Inventory is a progression from the former Circadian Type Questionnaire developed by Folkard et al. (1979). Originally, the inventory was developed through factor analysing the scores of 600 oil refinery workers on 72 items. Further development has reduced the subscales to 8 items relating to the flexibility of sleeping habits, and 10 items concerned with the ability of an individual to overcome drowsiness (languidity). The reduced inventory includes items with a factor loading > 0.30, suggesting that these items discriminate well.

Respondents were asked to rate their responses on a five point Likert scale ranging from 'almost never' (scale = 1) to 'almost always' (scale = 5). The scale for the inventory was created by summing the scores on the individual questions loading the flexibility and languidity factors. Total scores were computed for flexibility and languidity. Higher scores were associated with greater flexibility or languidity.

7. Feelings while working on the bridge

This section included questions designed to gain an overall impression of the pilot's experiences of fatigue and decreased alertness during bridge work, the nature of factors contributing to this state and strategies adopted by pilots to moderate the effects of fatigue and decreased alertness.

Tension and fatigue

The first two items were designed to assess the frequency of experiencing levels of tension, fatigue and tiredness while working on the bridge at the beginning and end of a work assignment. Respondents were asked to rate their responses on a seven point Likert scale ranging from 'never' (scale = 1) to 'always' (scale = 7).

Onset of fatigue

A further question was designed to assess the length of time taken to feel tired or fatigued after beginning work on the bridge. Responses to this item were rated on a four point Likert scale ranging from 'immediately' (scale = 1) to 'never' (scale = 4).

Factors contributing to fatigue

An item was included to assess the degree to which various factors contributed to fatigue and/or decreased alertness during bridge work. Issues addressed related to industry-specific factors such as the weather and sea conditions, sleep state, time of day, crew competency and equipment problems. Responses were rated on a seven point Likert scale range from 'not at all' (scale = 1) to 'very much' (scale = 7).

On the basis of factor analysis no discernible pattern emerged so the items were treated singly and frequencies discussed.

Strategies to combat fatigue

A item was included to rate the degree of effectiveness associated with various strategies for combating fatigue during bridge work. Strategies assessed included eating and drinking, moving around, taking rest breaks, rotating tasks and taking a shower. Responses were rated on a seven point Likert scale ranging from 'not at all' (scale = 1) to 'very much' (scale = 7). No discernible pattern emerged from the factor analysis so items were treated singly.

Extent and degree of performance decrement

Items were included to assess the extent of performance decreases while on the bridge and the severity of the performance decrements. Responses to these items were rated on a seven point Likert scale ranging from 'not at all' (scale = 1) to 'very much' (scale = 7).

Effects of performance levels on tasks

Questions in this section related to the effects of performance on both cognitive and motor tasks. Responses to these questions were rated on a seven point Likert scale range from 'not at all' (scale = 1) to 'very much' (scale = 7).

On the basis of factor analysis three sub-scales were identified. These were:

- performing tasks and making decisions;
- concentration; and
- physical effects.

Vulnerability to performance decrements across the 24 hour cycle

Items were included to assess the vulnerability of pilots to performance decrements across the 24 hours. Responses to these questions were rated on a seven point Likert scale range from 'not at all' (scale = 1) to 'very much' (scale = 7).

8. Pilotage experiences

This section was designed to assess the prevalence of pilot specific situations during pilotage work. Similar issues have been addressed in a previous investigation of marine pilots (British Columbia/States Oil Spill Task Force, 1997) and Pilot Advisory Group members involved in the study stressed the importance of the inclusion of this section.

Items were designed to assess the prevalence of pilotage experiences related to:

- errors in judgment;
- boredom;

- alertness;
- economic and commercial issues overriding safety decisions;
- complacency by the bridge due to advances in electronic navigational equipment;and
- the role of pilotage management in safety and pilot well-being.

Respondents were asked to rate the frequency of occurrences of these situations on a seven point Likert scale ranging from ‘never’ (scale = 1) to ‘always’ (scale = 7).

On the basis of factor analysis four sub-scales were identified. These were:

- boredom;
- critical need to be alert;
- risk to ship safety; and
- common fatigue.

9. Job satisfaction

Questions relating to job satisfaction asked respondents to list the five best and worst features of Great Barrier Reef pilotage. In addition respondents were asked, given the experience of hindsight, whether or not they would still join the pilotage service. Ratings for this question was on a five point Likert scale ranging from definitely join (scale = 1) to definitely not join (scale = 5).

10. Marital satisfaction: Spanier Dyadic Adjustment Scale

The Spanier Dyadic Adjustment Scale (Spanier, 1976) is designed to assess the quality of the relationship of either married or cohabiting couples and comprises four interrelated sub-scales (Dyadic Consensus, Dyadic Cohesion, Dyadic Satisfaction and Affection Expression). Seven items assessing Dyadic Satisfaction were used. Previous reports indicate sub-scales can be used independently without losing confidence in either the reliability or the validity of the measure. Using Cronbach’s alpha as the reliability estimate Spanier (1976) reports an overall scale reliability of 0.96 with a reliability score of 0.94 for the Dyadic Satisfaction. Respondents were asked to rate their responses on a five point Likert scale ranging from ‘all of the time’ (scale = 1) to ‘never’ (scale = 5).

Construction of the Scale

A scale of marital satisfaction was created by summing the scores across the seven items. The scale had a potential range of 10 to 50. The actual scale range was from 17 to 50. The reliability of the scale was determined using Cronbach’s alpha, this was acceptable 0.86. Despite the wide usage of the Dyadic Adjustment Scale few firm guidelines, as to cutoffs which can be taken to represent marital distress, exist. According to Spanier and Filsinger (1983: 164) "given the continuum or possible scores, it is inadvisable to recommend a fixed cutoff point".

11. Suitability of the questionnaire

This item was designed to assess the suitability of the questionnaire as a tool for evaluating general work and sleep patterns. Participants were asked to rate the suitability of the questionnaire on a five point Likert scale ranging from very acceptable (scale = 1) to very unacceptable (scale = 5).

12. Miscellaneous comments

Respondents were asked to note issues relevant to work, sleep and fatigue that had not been addressed by the structured questions, or to elaborate on some of the structured questions. The section was divided into three categories: general industry, at sea and at home.

Appendix 2

MISCELLANEOUS COMMENTS

After completing the questionnaire, respondents were invited to offer further comments regarding additional sources of stress.

The purpose of the miscellaneous comments was to capture information on sources of stress across the industry, at sea or at home not addressed in the structured questions. Additionally, comments enabled the wide variation within pilotage work to be recorded. Of the 35 respondents, 29 (83%) offered additional comments ranging from a few paragraphs to a number of pages.

For analysis, comments were divided into the following broad areas: general industry, at sea and at home. Within these broad areas, themes were identified and comments then coded as negative, positive, suggestions or other.

The following section shows the percentage of comments on issues relating to the general industry, at sea and at home that account for 5% or more of total comments. A synopsis of the comments indicating underlying issues on each topic has also been shown.

Table 2a Percentage of negative comments: general industry, at sea and at home

General industry	At sea	At home
Competition (59%) - impact on: Financial/income/ slow payment (21%) > Stress and anxiety levels (10%) Job security (8%) Increased work, decreased rest breaks (9%)	Safety issues including the competency of bridge teams (83%)	Impact of changes in pilotage services on home life (92%)

Safety (6%) Manipulative position in a competition industry of managers, infrastructure providers and shipping agents (5%)		

Table 2b Percentage of positive comments: general industry, at sea and at home

General industry	At sea	At home
Pilotage: a service to the community and protection for the environment (11%)	Stress decreased when bridge teams are competent, provides good back up for pilot (8%)	Valuable time with family, relaxing (6%)
Pilotage work itself is not stressful. Pilots well trained for intrinsic stress from the job (5%).		

Table 2c Suggestions: general industry, at sea

General industry	General industry
Appointment of an ombudsman to oversee the industry. This person would be independent of all parties	Review of practice of pilots on board ships out of the compulsory region. To optimise the potential for sleep at sea, the charting of alternative shipping channels should be undertaken. For example, the use of the Fairway Channel region of the Inner Route would eliminate one of the most difficult sections of this route and permit more extensive rest and sleep periods – develop charts and Differential Global Position (DGP) facilities for this region. Extend navigation aids and DGP facilities to other pilotage regions. This process would enable an improved quality of the short duration sleep periods at sea.

GENERAL INDUSTRY

The 276 comments on general industry issues consisted of 32 positive, 242 negative, 1 suggestion and 1 other. The highest percentage of negative comments related to the impact of competition on various aspects of the industry. The following sections provide some insight into the nature of miscellaneous comments regarding general industry issues.

Positive comments

The number of positive comments received was fairly evenly spread across the following issues:

- Pilots perceive their role is one of service to the community and consider their major role as that of protecting the environment.

Issues of competition must be addressed jointly by the pilotage companies.

Negative comments

Detail on the nature of negative comments relating to general industry issues is shown below. Over 50% of negative comments related to the impact of competition on financial issues. Respondents indicated that:

- Competition has resulted in a decrease in income levels by at least 50%. Additionally, cost cutting and no increase in pilotage fees leads to difficulties in preparing for retirement. Issues such as concerns over superannuation, refinancing of loans have all occurred since deregulation.
- A continuing problem has been the slow payment by shipping companies for work already completed.
- Competition has impacted on the levels of pilot stress, anxiety and performance. Frustration existed among the pilots because AMSA refused to acknowledge that this was happening.
- Competition in a safety-based industry would lead to a disaster.
- Managers, infrastructure providers and shipping agents have consolidated their position in a deregulated market place and scoop the profits.
- Competition had led to a feeling of uncertainty about job security and career prospects. Given the age group of the present pilots and the difficulty of returning to general shipping many respondents indicated this was of considerable concern.
- Competition has resulted in pilots undertaking more work with shorter breaks to enable same standard of living to be maintained – this leads to fatigue.

The remainder of negative comments drew attention to other topics such as:

- Bureaucratic interference in pilotage work.
- AMSA's perceived attitude to pilots, frustrations that AMSA refuse to listen to points of view and dismiss problems as "that's a commercial issue, not our problem".
- AMSA are considered to have wrecked a perfectly good service with little consideration given to changes experienced by pilots. Public servants on large indexed salaries, and government funded superannuation push for changes to pilotage work.
- The lowering of entry standards into pilotage service. Respondents considered that pilotage will not attract the quality of personnel required. High level applicants are forewarned due to well-publicised difficulties in the industry.

- Level of anxiety between pilots and pilotage service managers where verbal and contractual agreements not always met.
- Bad feelings between pilotage companies, not appropriate in a high profile industry.
- At no time during the change over to commercial pilotage operations were pilots made aware of the Seafarers Assistance Service for counselling on coping with these changes. Human Resources areas were largely ignored. Conflict developed in the pilotage service with resulting disunity and pilots moving to another company. Pilots suddenly found themselves in a hostile, competitive environment which was completely alien to them and many felt unable to cope.

Suggestions

One suggestion indicated that an ombudsman should be appointed to oversee the pilotage industry.

AT SEA

The 100 comments on issues at sea consisted of 19 positive, 77 negative, 2 suggestions and 2 on other issues. The following section shows some of the underlying topics relating to miscellanous comments regarding issues at sea.

Positive Comments

The highest number of positive comments at sea related to bridge teams and improvements in navigational equipment.

- Competent bridge teams: A considerable number of positive comments related to experiencing reduced stress on well-run ships with competent bridge teams providing excellent back up skills. This issue positively impacts on the quality of rest pilots achieve while at sea and smooth bridge operations.
- Improved electronic navigation equipment: Additionally, positive comments referred to the improvements in electronic navigational equipment and the reduced stress due to these advances, particularly in bad weather.
- Pilotage duties: Pilotage duties are not stressful, pilots are well trained to handle stress intrinsic to the job. It is the stress from extrinsic sources (bureaucracy) that is causing the additional problems. Pilots feel they can exert no control over stress from bureaucratic sources.

Negative Comments

The highest number of negative comments concerned safety issues. Safety issues raised by respondents related to:

- Safety being compromised due to commercial pressures.

- An increase in the number of incidents in the last 5 years.
- Breaches of safety and poorly maintained equipment on ships and unhygenic accommodation are not reported for fear of the pilotage company losing clients.
- Even though STCW 95 is supposedly being implemented, in many cases poorly trained bridge teams fail to undertake basic tasks such keeping lookout and checking compass bearings, vessels are off course in a short time; therefore increased stress on pilots particularly during rest breaks.
- Pilots not communicating with colleagues from the opposition company re passing manoeuvres, weather and traffic – safety may be compromised.
- Pilots lacking concentration while on the bridge, thinking of extraneous matters such as commercialisation, bureaucratic interference and uncertainty of the future of pilotage.
- Fishing traffic is not policed and vessels are often in shipping channels without lookouts or navigational lights.

Suggestions

A number of respondents suggested that the practice of pilots being on ships for some days prior to, or after the compulsory pilotage region is inappropriate and should be reviewed. One suggestion stated that if vessels required a pilot out of the compulsory area, a change of pilots in Cairns would relieve the pilot who had navigated the vessel through the compulsory region. A similar pattern would apply to northbound vessels, with a change of pilot in Cairns.

An attachment from one of the pilotage groups indicated that there were a number of topics to be considered with the practice of having pilots on vessels in non-compulsory areas. Some of these issues included:

- incurring fatigue prior to the actual compulsory area;
- remuneration and additional expenses incurred in extra travel;
- better use of personnel in busy periods in compulsory areas;
- pilots are not required and are therefore in an awkward situation;
- pilot scheduling could be improved with shorter time away from home;

A review of this practice by pilotage providers appears to be very much warranted.

- To optimise the potential for sleep at sea, the charting of alternative shipping channels should be undertaken. For example, pilots have commented that the official use of the Fairway Channel region of the Inner Route would eliminate one of the most difficult sections of this route and permit more extensive rest and sleep periods. At present, the channel has been surveyed but no charts or Differential Global Position (DGP) facilities for this region have been developed. Therefore, development of these facilities should be undertaken urgently.
- The process of extending navigation aids and DGP facilities to other pilotage regions should also occur. This process would enable an improved quality of the short duration sleep periods at sea.

Other

Other points raised in the miscellaneous comments on issues at sea referred to:

- The Midway section of the Inner Route (Magpie Reef to Rye Reef) is much easier during the day than at night in the same sea conditions. Sleep is therefore more recuperative and fits circadian pattern.
- Rest time during pilotage varies greatly with the ships speed, environment and competence of bridge teams.

AT HOME

The 35 comments on home issues consisted of 2 positive, 32 negative comments and 1 suggestion. The highest percentage (92%) of negative comments related to the impact on home life of changes since deregulation of pilotage services.

Positive comments

Positive comments about the impact of pilotage work on home life related to the importance of time with the family at home and the recuperative benefits of this period.

Negative comments

Almost all negative comments focused on the impact of the changes in pilotage services on home life. Issues raised by respondents related to:

- Uncertainty of job/career and present and future financial security, ongoing anxiety and depression associated with this issue all affecting family life;
- Shorter time spent at home due to increased work assignments and shorter breaks to make sufficient income;
- Long delays in payment for pilotage work increased strain at home;
- Tension in marriages and breakdowns of family life due to changes in lifestyles since deregulation.

Summary

Most of the concerns regarding additional sources of stress related to either general industry problems or issues at sea. In contrast, few comments referred to additional sources of stress concerning the home.

From a general industry viewpoint, the highest percentage of comments related to the negative impact of competition on all aspects of pilotage work including income, job security, safety and the increased workload required to maintain income levels and stress and anxiety levels. The positive aspect of general industry issues was that pilots felt they served the community and were protectors of the environment. Additionally, there was an underlying tone that AMSA were ill-advised in the implementation of competition, showed little concern for hardships, particularly personal ones, and dismissed well-founded complaints regarding safety as 'commercial matters'.

At sea, a considerable degree of concern was raised regarding the increased stress on pilots when bridge teams were not properly trained and offered unreliable backup. In contrast, highly competent bridge teams and improvements in electronic navigation equipment greatly reduced stress levels on pilots. Also, it was evident that since competition, in order to maintain shipping clients, pilots were reluctant to report unsafe ships, breaches of safety, faulty equipment and unhygenic accommodation.

Pressures at home were mostly associated with the changed income levels leading to reassessment of present mortgage situations and future plans for retirement including superannuation arrangements.

Suggestions from pilots related to a review of the existing practice of pilots being on ships outside the compulsory region; development/extension of charts and navigational aids to improve the opportunities for sleep not only during Inner Route assignments and also in other areas. Additionally, it was indicated that the appointment of a pilotage ombudsman or independent watchdog group to oversee the industry would be an appropriate path to follow.

The comments created the impression that Great Barrier Reef pilots enjoyed the challenges and responsibility of pilotage work and carried out their work with a high level of professional pride. However, pilots considered that the once elite Great Barrier Reef pilotage service established over 100 years ago, has been reduced to just another commercial operation. From the comments it was clear that most pilots have struggled personally and financially in making the transition from a one-provider situation to a hostile competitive environment. Moreover, pilots felt that since deregulation they are not reimbursed adequately for their skills and responsibility.

Overall, it would seem that the process by which competition was introduced has led to bitter divisions in the pilotage workforce, between pilotage companies and between both these groups and AMSA. The authority is perceived to have a contemptuous attitude towards Great Barrier Reef pilots; as a result AMSA's role in pilotage matters is met by a considerable degree of animosity from many pilots. The ongoing conflict certainly raises the question whether this situation is appropriate in a safety-based industry servicing a unique environment.

Appendix 3

LIST OF TABLES

Appendix 4

LIST OF FIGURES

Appendix 5

CRONBACH'S ALPHA VALUES

Cronbach's alpha coefficients were calculated to assess the reliability of each of the aggregate scores. The procedure is widely used for this purpose since it uses a range of statistical characteristics from the raw data. An alpha coefficient of over 0.65 is generally acceptable.

Table 2a shows the values for Cronbach's alpha coefficients for scale items

Item	Cronbach's coefficient alpha
Dyadic Adjustment Scale	0.86
Circadian Type Inventory Languidity Flexibility	0.61 0.63
Chronic Fatigue	0.75
Sleep difficulties At sea Ashore	0.72 0.69 0.75

Home	
Sleep disturbances At sea Ashore Home	0.72 0.85 0.48
Performance decrement on the bridge	0.92
Performing tasks and decision making	0.88
Concentration	0.75
Physical effects	0.85
Boredom	0.69
Critical need to be alert	0.57
Risk to ship safety	0.42
Common fatigue	
Marital adjustment	0.86