Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Aviation Research and Analysis Report – AR-2008-044(2)
Final

Safety in the vicinity of non-towered aerodromes

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Postal address: PO Box 967, Civic Square ACT 2608
Office location: 62 Northbourne Ave, Canberra City, Australian Capital Territory, 2601
Telephone: 1800 020 616, from overseas +61 2 6257 4150
Accident and incident notification: 1800 011 034 (24 hours)
Facsimile: 02 6247 3117, from overseas +61 2 6247 3117
Email: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

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Author(s)

Taylor, R. P.

Prepared By

Australian Transport Safety Bureau
PO Box 967, Civic Square ACT 2608 Australia
www.atsb.gov.au

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Abstract

Most aerodromes in Australia are located in uncontrolled airspace and do not have an air traffic control presence. At these non-towered aerodromes, and in the vicinity of them, pilots are responsible for making themselves aware of nearby aircraft and maintaining separation. This report aims to give pilots an appreciation of the types of safety events that have been associated with operations at non-towered aerodromes and provide education on expected behaviours to assist pilots in being prepared for the risks.

Generally, operations at non-towered aerodromes can be considered to be safe, but this relies on all pilots maintaining awareness of their surroundings and of other aircraft, and on flying in compliance with procedures, while being observant, courteous and cooperative. Most of the 709 airspace-related safety occurrences reported to the ATSB between 2003 and 2008 at, or in the vicinity of non-towered aerodromes, were incidents, but they also included 60 serious incidents and six accidents (mid-air and ground collisions). Most of the occurrences involved conflicts between aircraft, or between aircraft and ground vehicles. The most common types of occurrences involved ineffective communication between pilots operating in close proximity, separation issues, incorrect assessment of other aircraft's positions and intentions, relying on the radio as a substitute for an effective visual lookout, or a failure to follow published procedures.

This report also documents changes in the number of aircraft movements and changes in the traffic mix into 20 non-towered aerodromes since 2003. Aerodromes experiencing significant growth could potentially be exposed to higher risk. Port Macquarie, Kununurra, Ballina, and Mt. Gambier all have experienced a recent increase in large passenger transport aircraft movements.

This report looked only at incidents and accidents prior to the introduction of changes by the Civil Aviation Safety Authority (CASA) to Civil Aviation Regulation (CAR) 166 on 3 June 2010, which affected procedures at all non-towered (non-controlled) aerodromes. Although the CAR 166 changes may in time be shown to reduce incidents and accidents, a number of issues highlighted by the occurrences documented in this report are likely to persist at non-towered aerodromes, but associated risks can be minimised through greater awareness of the importance of clear and concise communications, effective visual lookout and adherence to published procedures.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

Contributing safety factor: a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which 'saved the day' or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Risk level: The ATSB's assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

EXECUTIVE SUMMARY

The Australian Transport Safety Bureau (ATSB) proactively monitors aviation safety through the analysis of accident and incident data, collectively termed occurrence data, to determine whether important trends are emerging. In recent years, the ATSB has received an increasing number of occurrence reports from pilots regarding operations at non-towered aerodromes. This extends to the associated use of the radio frequencies allocated for communication between pilots using non-towered aerodromes to establish situational awareness and separation (Common Traffic Advisory Frequencies (CTAF), and formerly CTAF(R) (prior to 3 June 2010) and Mandatory Broadcast Zones (MBZs) (prior to 24 November 2005)).

Non-towered aerodromes are those where a continuous air traffic control presence does not exist, or is temporarily not available (such as outside of air traffic control (ATC) or control tower operating hours). Aircraft are specifically considered to be in the vicinity of a non-towered aerodrome if they are in uncontrolled airspace, within a horizontal distance of 10 NM (18.5 km) from the aerodrome, and at a height which could conflict with operations at a non-towered aerodrome.

The purpose of this study was to review occurrences in the vicinity of all non-towered aerodromes in Australia in order to explore the types of safety events that occur, and the concerns raised by some pilots and industry stakeholders regarding operations at non-towered aerodromes. The focus was particularly on occurrences related to airspace use, procedures, and operations.

A total of 709 such occurrences were reported to the ATSB between 1 January 2003 and 31 December 2008. This period was chosen for analysis in order to look at occurrences prior to and after the procedural and airspace changes introduced by NAS 2C on 24 November 2005 at all non-towered aerodromes in Australia.

The bulk of the 709 occurrences illustrate the need for good communication and both awareness of, and adherence to procedures when operating in the vicinity of non-towered aerodromes.

Occurrence types in the vicinity of non-towered aerodromes

The most common airspace use and operational-related occurrence types at non-towered aerodromes were related to communication breakdowns or insufficient communication between pilots. Many of these led to reduced situational awareness of the pilot, and reduced separation between aircraft or conflicts. Conflicts are situations where the actions of an aircraft or ground vehicle interfered with the flight of another aircraft. Conflicts do not necessarily result in reduced separation. Non-compliance with published information, notices to airmen (NOTAMs) and procedures also occurred frequently (approximately 20 per cent of occurrences).

Types of errors contributing to non-towered aerodrome occurrences

An analysis of the errors that contributed to all occurrences showed that both procedural errors (action and decision-related) and communication errors (information and action-related) were most prevalent (about 30 per cent of cases for each), followed by situational awareness and position/proximity errors (separation-related). All these occurrence types contributed to the 501 conflicts recorded at non-towered aerodromes between aircraft or aircraft and ground vehicles.

Airproxes and other separation issues (air-air and air-ground)

Airproxes[1] and other situations where a separation issue occurred between two aircraft were also very common. Conflicts between aircraft and other aircraft or vehicles occurred in 71 per cent of occurrences. Most conflicts were due to reduced separation between aircraft in the circuit, conflicts between aircraft on base, final approach, or runway incursions. Airproxes accounted for almost all serious incidents (55 of 60) in the vicinity of non-towered aerodromes. Separation issues generally occurred between general aviation (GA) aircraft, or involved a GA aircraft and a passenger transport aircraft. There were very few conflicts involving two passenger transport aircraft. Most runway incursions involved a backtracking aircraft coming into conflict with an aircraft on landing or final approach to the same runway.

See-and-avoid conflicts

See-and-avoid conflicts where situational awareness errors were involved (also contributed to by inadequate or no communications in some cases) made up about one-seventh of all occurrences. These types of conflicts led to almost all of the six accidents recorded in the vicinity of non-towered aerodromes between 2003 and 2008, four of which were mid-air collisions, and two of which were runway incursions leading to a collision on the ground. Furthermore, there were 60 serious incidents in which an accident almost occurred. Once again, these were mostly due to a lack of communication between pilots or an insufficient awareness of nearby traffic, leading to an airprox. In 87 occurrences, a Traffic Collision Avoidance System (TCAS) alert occurred due to a potential separation issue. In over half of these cases however, the TCAS alert was the only indication that pilots of an aircraft had of the other traffic.

In approximately 20 per cent of all conflicts, the pilot of one or more aircraft took avoiding action to prevent a collision or an airprox. In a further 17 per cent, one aircraft made a precautionary diversion from its intended flight path in order to maintain safe separation with another aircraft that was not communicating or aware of other nearby aircraft.

Inadequate communication between aircraft

Insufficient communication and broadcasts between pilots, radio failures or misunderstandings were the biggest contributors to occurrences in the vicinity of non-towered aerodromes between 2003 and 2008 (388 of 709 occurrences). Communication issues accounted for 38 per cent of all information errors and 31 per cent of all action errors for these occurrences.

Good communication between pilots on the CTAF is critical to creating a safe operating environment in uncontrolled airspace, especially in higher traffic density locations such as at non-towered aerodromes. Despite this, in almost a third of all occurrences, it was known (or likely) that the pilot was operating within the vicinity

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[1] An airprox is defined in the Transport Safety Investigation Regulations 2003 as an occurrence in which two or more aircraft come into such close proximity that a threat to the safety of those aircraft exists or may exist, in airspace where the aircraft are not subject to an air traffic separation standard or where separation is a pilot responsibility.

(10 NM) of a non-towered aerodrome and not monitoring the CTAF effectively. In 146 occurrences, the pilot did not have their radio tuned to the correct CTAF at all.

Procedural errors and circuit operations

Procedural errors were the second most common occurrence group at non-towered aerodromes (after communication issues). While not all of these occurrences happened in circuit areas, the proximity of aircraft and workload of pilots in this phase of flight reduces the margin of safety if procedural errors occur, or pilots do not make the positional and intentional broadcasts on the CTAF as required by CAR 166.

In one-seventh of occurrences, the pilot of an aircraft did not make a broadcast prior to taxi or entering a runway, and in 28 occurrences, a pilot did not broadcast before entering the circuit. Not making these broadcasts reduces the situational awareness of all other pilots in the circuit, as they are not aware of what aircraft are in the air, where they might be in the circuit, or if they are using or taxiing on an active runway.

Within the circuit, most incidences of reduced separation between aircraft were due to at least one aircraft being operated in the circuit in a contrary direction to other circuiting aircraft (i.e. aircraft coming head-on in the circuit), or aircraft on base leg conflicting with those on final. This finding was supported by previous ATSB research into mid-air collisions, which found that 80 per cent of collisions occur in the circuit area, and two-thirds of these happen on the base-final turn.

Radio frequency (CTAF) congestion and interference/shielding problems

There were not many occurrences in which broadcast congestion on the CTAF (and formerly, on MBZ frequencies) was cited. Some issues involving an overlapping of broadcasts from two nearby aerodromes using the same CTAF were raised in confidential reports to the ATSB (through the Confidential Reporting (REPCON) and Confidential Aviation Incident Reporting (CAIR) schemes), and from Minutes of Regional Airspace and Procedures Advisory Committee (RAPAC) meetings in different states.

Terrain shielding problems were generally not apparent from the occurrence data, with some evidence from REPCON and CAIR reports that there may have been some terrain shielding at Newcastle (RAAF Williamtown) Aerodrome (NSW) and in the vicinity of Cooma (NSW).

In all instances, pilots experiencing radio frequency problems should gather as much information on the location, source, and nature of the interference, and refer these issues to Airservices Australia for further investigation and resolution.

Occurrences by aerodrome

As readers might expect, most occurrences related to airspace use and operations occurred in the vicinity of the busiest non-towered aerodromes where radio carriage was required – Newcastle, Avalon, Geraldton, Broome, Port Macquarie, Dubbo, Mildura, and Wagga Wagga. However, the actual number of occurrences between 2003 and 2008 at each aerodrome was relatively small (the highest number of occurrences recorded at any aerodrome was 26), and occurrences were distributed

across many aerodromes and aircraft landing areas (ALAs) (n = 231), all of varying sizes, locations and activity level.

A review of movement data and traffic mix at 20 of the busiest aerodromes found that Ballina/Byron Gateway, Mount Gambier and Kununurra are experiencing a shift in their passenger transport services from smaller to larger aircraft. Port Macquarie Aerodrome had the most passenger transport movements over the period, and also a greater proportion of large jet transport aircraft operating these services.

A review of the occurrences at these 20 aerodromes showed that Ballina/Byron Gateway, Dubbo, Geraldton, Hervey Bay, Horn Island, Karratha, Orange, and Wagga Wagga had a disproportionate number of occurrences involving passenger transport aircraft, relative to the proportion of all movements at those aerodromes that are passenger transport aircraft. However, it was not possible to determine how much influence the better reporting culture that generally exists within passenger transport operators had on this finding.

Comparison with previous ATSB studies

There were some common themes in the analysis of the 709 occurrences between 2003 and 2008 presented in this report, and the previous reports published by the ATSB (2003 and 2006) into non-towered aerodrome operations:

- Approximately two airspace-related occurrences occurred in the vicinity of a non-towered aerodrome and were reported to the ATSB each week, and this has remained the case since 1994.
- Passenger transport aircraft were involved in a large proportion of the occurrences; however, this was likely to be due to more active reporting behaviours rather than an increased risk within this sector.
- Radio communication issues and reduced situational awareness due to pilots not broadcasting or not following the standard broadcast procedures were the most common factors contributing to airspace and operations-related occurrences.
- The rate of occurrences remains low across all individual non-towered aerodromes.
- The number of occurrences reported to the ATSB at non-towered aerodromes remains small as a proportion of all occurrences reported to the ATSB over the reporting period.

A change was noted since the 2003 report regarding the non-towered aerodromes that recorded the greatest number of airspace-related occurrences. Between 1994 and 2003, Bundaberg, Ayers Rock, Devonport and Jandakot had the highest number of reported occurrences. Between 2003 and 2008, the most occurrences were reported at Newcastle, Avalon, Geraldton and Dubbo.

Changes to procedures at non-towered aerodromes

On 3 June 2010, the Civil Aviation Safety Authority (CASA) made changes to procedures at non-towered aerodromes. From this date, all aircraft operating into all registered, certified, military and other non-towered aerodromes as specified by CASA require a radio to be carried and used. Part of the reason these changes were introduced by CASA was to address the types of communication and separation-

related occurrences raised in this report that have occurred frequently at non-towered aerodromes.

However, the actions of individual pilots always dictate the overall safety of operations at these aerodromes. The ATSB reiterates the need for pilots to:

- improve their situational awareness, and ensure awareness of their presence by others using these aerodromes
- reduce the frequency of common occurrence types in the vicinity of these aerodromes such as:
  - ineffective communication between pilots
  - reduced separation between aircraft
  - incorrect assessment of other aircrafts' positions and intentions
  - relying on the radio as a substitute for an effective visual lookout
  - failing to follow published procedures
- be aware of their responsibilities when operating in the vicinity of non-towered aerodromes by being familiar with the CAR 166 non-towered aerodrome procedures, through CAAPs 166-1 and 166-2.

Non-towered aerodromes and the use of CTAF have been, and will continue to be a central component to the Australian airspace system. Operations to, from, and in the vicinity of these aerodromes will remain safe and efficient with good airmanship, use of see-and-avoid strategies, and effective monitoring/broadcasting on the CTAF by pilots. Ongoing monitoring by CASA of the effectiveness of non-towered aerodrome procedures and radio/broadcast requirements also plays an important role; as does investigation by the ATSB in cases where accidents and serious incidents occur at non-towered aerodromes.

ABBREVIATIONS

AAIS	Automatic Aerodrome Information Service
ACAS	Airborne Collision Avoidance System
ACMA	Australian Communications and Media Authority
ADS-B	Automatic Dependent Surveillance - Broadcast
AFRU	Aerodrome Frequency Response Unit
AGL	Above ground level
AIP	Aeronautical Information Publication (Airservices Australia)
ALA	Aircraft landing area
AM	Amplitude modulation
AMSL	Above mean sea level
ARM	Airspace Risk Model (CASA)
ASRS	Aviation Self-Reporting Scheme (ATSB)
ATC	Air traffic control
ATS	Air traffic services
ATSB	Australian Transport Safety Bureau
BASI	Bureau of Air Safety Investigation (succeeded by the ATSB)
CAAP	Civil Aviation Advisory Publication (CASA)
CA/GRS	Certified air/ground radio service
CAIR	Confidential Aviation Incident Reporting (ATSB)
CAR	Civil Aviation Regulation (CASA)
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation (CASA)
CENSAR	Australian Search and Rescue (AusSAR) database
COM	Communications
CTA	Controlled airspace
CTAF	Common Traffic Advisory Frequency
CTAF(R)	Common Traffic Advisory Frequency (radio carriage required)
DME	Distance measuring equipment
EEZ	Exclusive Economic Zone
ERSA	En Route Supplement Australia (Airservices Australia)
ESIR	Electronic Safety Incident Report (Airservices Australia)
FAF	Final approach fix
FIR	Flight Information Region
FM	Frequency modulation
ft	Feet
FTC	Failure to comply
GA	General aviation
GAAP	General Aviation Aerodrome Procedures (replaced by Class D aerodrome

	procedures from 3 June 2010)
GPS	Global positioning system
HF	High frequency
HLS	Helicopter landing site
ICAO	International Civil Aviation Organization
IFR	Instrument flight rules
IMC	Instrument meteorological conditions
IRM	Immediately reportable matter
m	Meters
kg	Kilograms
kts	Knots
LOSA	Line Operations Safety Audit (ICAO)
MBZ	Mandatory Broadcast Zone
MHz	Megahertz
MTAF	Mandatory Traffic Advisory Frequency
MTOW	Maximum take-off weight
n	Number of occurrences
NAS	National Airspace System
NM	Nautical miles
NOTAM	Notice to airmen
NSW	New South Wales
OAR	Office of Airspace Regulation (CASA)
PAL	Pilot activated lighting
Qld	Queensland
QNH	Aerodrome reference air pressure
RA	Resolution advisory
RAAF	Royal Australian Air Force
RAPAC	Regional Airspace and Procedures Advisory Committee (CASA)
REPCON	Confidential Reporting (ATSB)
RIS	Radar information service
RNAV/GNSS	Required navigation / global navigation satellite system
RPT	Regular public transport
SA	South Australia
SARTIME	Search and rescue scheduled reporting time (AusSAR)
SIIMS	Safety Investigation Information Management System (ATSB)
TA	Traffic advisory
Tas.	Tasmania
TCAS	Traffic Collision and Avoidance System
TSI Act	*Transport Safety Investigation Act 2003* (ATSB)
UNICOM	Universal Communications

VFR	Visual flight rules
VHF	Very high frequency
Vic.	Victoria
VMC	Visual meteorological conditions
WA	Western Australia

1 INTRODUCTION

1.1 Background

The Australian Transport Safety Bureau (ATSB) proactively monitors aviation safety through the analysis of accident and incident data, collectively termed occurrence data, to determine whether important trends are emerging. In recent years, the ATSB has received an increasing number of comprehensive occurrence reports from pilots regarding operations at non-towered aerodromes, and the associated use of Common Traffic Advisory Frequencies (CTAF, and formerly CTAF(R)[2]). This report also includes those occurrences in Mandatory Broadcast Zones (MBZs) prior to 24 November 2005.

1.1.1 What is a non-towered aerodrome?

Civil Aviation Regulation 2 defines a non-towered (also known as non-controlled) aerodrome as an aerodrome at which an air traffic service is not operating. CASA (2010a) further explains that this can be either:

- an aerodrome that is always in Class G airspace, including those provided with Flight Information Service or a ground-based information service[3]
- an aerodrome with a control tower where no air traffic control (ATC) service is currently provided
- an aerodrome which would normally have ATC services, but such services are presently unavailable.

For non-towered aerodromes which have a partial Class C or D air traffic control service at some times of the day, operating hours are published in the current En Route Supplement Australia (ERSA), and in any notices to airmen (NOTAMs) that may be issued.

Under the present rules (Civil Aviation Regulation (CAR) 166), aircraft are specifically considered to be in the vicinity of a non-towered aerodrome if they are in uncontrolled airspace, within a horizontal distance of 10 NM (18.5 km) from the aerodrome, and at a height above the aerodrome's reference point that could result in conflict with operations at the aerodrome (CASA, 2010a). This can include aircraft overflying, transiting nearby, or arriving via a circling approach at a non-towered aerodrome, depending on their intended flight path and other nearby traffic.

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[2] The CTAF(R) designation indicated that carriage and use of radio was required in the vicinity of a non-towered aerodrome. From 3 June 2010, the CTAF(R) designation no longer applied following changes to the regulations that govern non-towered aerodromes (CAR 166). While this report does not analyse occurrences after 31 December 2008, more information about the current non-towered aerodrome rules can be found in section 1.1.6. For further information on the changes to CAR 166, contact the Civil Aviation Safety Authority (CASA), or visit their website (www.casa.gov.au).

[3] See section 6.3 for more information on Flight Information Service, UNICOM, and CA/GRS services.

What challenges do pilots face at non-towered aerodromes?

As non-towered aerodromes are by their very nature uncontrolled, there is a reliance on pilots using them (or operating in the vicinity) to act in a safe, professional, sensible and pragmatic manner in order to maintain separation between their aircraft and other airspace users, including other aircraft (aeroplanes, helicopters, gliders, balloons) or parachutists. For this reason, specific non-towered aerodrome procedures exist to maintain order in the air, and improve the situational awareness of all pilots.

Operations at non-towered aerodromes can present challenges to pilots that they might not encounter when operating to some aerodromes where an ATC service is provided. These can include:

- different operating procedures that are specific to non-towered aerodromes
- fitting into the circuit traffic
- communicating with other aircraft to arrange separation
- a mixture of aircraft types, operation types, and performance levels
- dealing with threats and hazards that might be encountered, such as unannounced traffic, or unexpected manoeuvres by nearby aircraft.

Over the course of this study, two regimes of non-towered aerodrome procedures have applied. Prior to 24 November 2005, non-towered aerodromes were surrounded by defined volumes of airspace called CTAF areas (radio carriage and use not required) or MBZ areas[4] (radio required) in which non-towered aerodrome procedures applied. In MBZ areas, positional broadcasts were required to be made on the assigned MBZ frequency. As part of the introduction of the National Airspace System (NAS) Stage 2C, CTAFs and MBZs were abolished from 24 November 2005, and replaced with a common, standardised set of procedures that applied to all non-towered aerodromes.

When MBZs were abolished in 2005, pilots were still expected to adhere to the non-towered aerodrome procedures and maintain separation within the vicinity of all non-towered aerodromes (within 10 NM) by monitoring and broadcasting on the assigned CTAF or CTAF(R) frequency . Only pilots flying radio-equipped aircraft were allowed to operate in the vicinity of aerodromes that were designated as CTAF(R)[5].

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[4] MBZs were first introduced in December 1995, following a legislative name change from Mandatory Traffic Advisory Frequency (MTAF) areas. The change resulted from a desire to highlight and reinforce the mandatory requirements to make certain radio broadcasts. While the majority of MTAFs became MBZs, some areas were changed to other airspace procedures, including CTAFs. There were no major procedural alterations association with the name change from MTAFs to MBZs (ATSB, 2006a).

[5] From 3 June 2010, pilots must both be equipped with a radio and be appropriately trained and qualified to use it before operating at all certified, registered, military, or other specified non-towered aerodromes. The appropriate licence must be issued or recognised by CASA. Licensing requirements are specified in CAR 166.

1.1.2 Why is the ATSB looking into non-towered aerodrome safety?

The reports of occurrences at non-towered aerodromes received by the ATSB from 2003 to 2008 have raised a number of concerns relating to aircraft separation, poor communication, situational awareness, adherence to circuit and approach procedures, and airmanship. Furthermore, the ATSB has investigated several occurrences at non-towered aerodromes in recent years.

This report looked only at incidents and accidents prior to the introduction of changes by the Civil Aviation Safety Authority (CASA) to CAR 166, which affected procedures at Class D and non-towered aerodromes. These changes came into effect from 3 June 2010, and are discussed further below. However, the non-controlled operating nature of non-towered aerodromes remains fundamentally the same, and pilots must still be aware of their responsibilities when flying in their vicinity.

This report intends to review occurrences in the vicinity of all non-towered aerodromes in Australia in order to explore the types of safety events that occur based on the occurrences reported to the ATSB, and the concerns raised by pilots and industry regarding operations at non-towered aerodromes.

In December 2005, the ATSB published a discussion paper following an examination of airspace-related occurrences involving regular public transport (RPT) and general aviation (GA) aircraft in MBZ areas between 2001 and 2004. This followed on from a similar study published in 2003, which examined incident and accident data for airspace-related occurrences in MBZs between 1994 and 2001.

1.1.3 Typical aircraft using non-towered aerodromes

Non-towered aerodromes can have a mix of passenger-carrying aircraft, instrument (IFR) or visual (VFR) flight rules aircraft, smaller general aviation aircraft or amateur-built aircraft, VFR agricultural aircraft, VFR sport and recreational aircraft such as balloons and gliders, and other airspace users such as parachutists, all operating at any one time. In the future, unmanned air vehicles may also contribute to the number of movements at some non-towered aerodromes.

Some non-towered regional aerodromes in Australia have grown significantly in the last decade, from small regional airstrips with few daily movements into busy regional hubs. This has particularly been the case with Port Macquarie, Hervey Bay, and Ballina/Byron Gateway, but also with other aerodromes such as Karratha and Kununurra, where the resources boom in Queensland and Western Australia has seen an increased demand for high capacity jet charter and passenger transport services. Often, the limited infrastructure of fast-growing regional aerodromes has led to an increase in traffic congestion, and demand for services has seen a changed traffic mix, with a greater number of larger and faster aircraft using these aerodromes.

A factor in the frequency of occurrences at some non-towered aerodromes may be changes in the typical aircraft mix operating at those aerodromes. Industry concerns regarding the aircraft mix at non-towered aerodromes are not new. In 1993, the former Bureau of Air Safety Investigation (BASI)[6] received reports that airline pilots had considerable concerns over the safety of RPT operations in Mandatory Traffic Advisory Frequency (MTAF) areas, which were the predecessors of today's non-towered aerodrome procedures (BASI 1993).

Source: photo courtesy of Phil Vabre

1.1.4 Changes to the Australian airspace environment

Australian airspace underwent significant reform between 2002 and the end of 2005. Known as the National Airspace System (NAS), the reforms occurred as a phased approach, with Stage 1 implemented in November 2002, and Stages 1A, 2A, 2B and 2C implemented in March 2003, July 2003, November 2003, and November 2005 respectively. The purpose of the NAS has been to simplify the Australian airspace system, while increasing safety, efficiency and operational flexibility for users.

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[6] On 1 July 1999, BASI merged with the Federal Office of Road Safety and the Marine Incident Investigation Unit to form the ATSB. The ATSB is Australia's national independent aviation, rail, and marine investigation agency.

The then Department of Transport and Regional Services identified the following key changes introduced by NAS (a summary of airspace classes is provided in Appendix A):

- some uncontrolled airspace (Class G) became controlled airspace (Class E)
- improved services for aircraft operating under visual flight rules (VFR) in radar Class G and E airspace, such as access to radar based information services
- lowering the base of Class A airspace to 18,000 ft in areas with radar coverage
- a proportion of en route Class C airspace was changed to Class E
- an expansion of mandatory transponder carriage to include all aircraft operating above 10,000 ft
- the introduction of standardised operating procedures at all non-towered aerodromes (Department of Transport and Regional Services, 2007a; 2007b).

In July 2007, CASA established the Office of Airspace Regulation (OAR) to regulate airspace under the *Civil Aviation Act 1988*, *Airspace Act 2007*, and *Airspace Regulations 2007*. The OAR has responsibility for the regulation of airspace consistent with the Australian Airspace Policy Statement.

In relation to non-towered aerodrome operations, the OAR is involved in activities such as:

- facilitating the reduction of Common Traffic Advisory Frequency congestion and interference problems in consultation with state-based Regional Airspace and Procedures Advisory Committees (RAPACs); and
- conducting aeronautical studies of a diverse range of aerodrome types to identify risks related to airspace or operations, their likelihood and consequences, and ways in which they can be best managed.

1.1.5 Common Traffic Advisory Frequency (CTAF/CTAF(R)) and the replacement of Mandatory Broadcast Zones (MBZs)

Prior to the introduction of NAS 2C on 24 November 2005, three different sets of rules and procedures applied at Australian aerodromes in Class G airspace[7]. The NAS replaced these with a single, North American-style CTAF procedure, with some changes to enhance suitability for Australian operations.

A CTAF is the common radio frequency used for air-to-air and air-to-ground communication in the vicinity of non-towered aerodromes in Australia, the United States and Canada. The purpose of the CTAF is for pilots to have a common frequency to communicate and establish situational awareness, and if required, arrange mutual separation between their aircraft and other nearby traffic or aviation activities (such as parachute drops, ballooning, or gliding). While some aerodromes have specific CTAF (as noted on aeronautical charts and in the ERSA), the most commonly used CTAF in Australia is 126.7 MHz.

As a result of the NAS 2C introduction, MBZs and defined CTAFs were abolished, and replaced with radio-alerted procedures, known as CTAF(R). While MBZs were conceptually similar to the current non-towered aerodrome procedures, it has been

[7] In Australia, non-controlled airspace is classified as Class G airspace. Appendix A provides a summary of airspace classification in Australia.

suggested that they ignored the limitations of radio as an alerting tool, and increased the risk of pilot complacency by creating the impression that all traffic was known to all pilots in the MBZ area (Department of Transport and Regional Services, 2006). The change to non-towered aerodrome procedures using CTAF and CTAF(R) simplified operations for all pilots with the aim of improving situational awareness for those pilots using non-towered aerodromes, by:

- standardising and simplifying broadcast phraseology
- standardising the positions where broadcasts were made
- introducing broadcast requirements inbound at 10 NM (18.5 km) for all approaches, and additional broadcasts for straight-in approaches
- reducing unnecessary chatter and broadcasts
- separating high/medium/low performance aircraft into different circuit heights (Department of Transport and Regional Services, 2006).

Broadcasting on and monitoring of the CTAF is a key way for pilots to establish situational and traffic awareness at non-towered aerodromes. At busier aerodromes, the requirement to carry and use a radio is very important for all pilots to achieve radio-alerted 'see-and-avoid'.

Another major change introduced in NAS 2C was the replacement of a marked MBZ area with a defined radius from an aerodrome in which non-towered aerodrome procedures (CAR 166) apply. Aircraft are now considered to be in the vicinity of a non-towered aerodrome if they are within 10 NM of the aerodrome reference point. Unlike MBZs (which were both a set of procedures and a radio frequency), CTAF (and formerly CTAF(R)) is simply a radio frequency which allows pilots to communicate with the ground and other aircraft when operating in the vicinity of a non-towered aerodrome. It is intended to be used to support the operating procedures (CAR 166) which pilots must adhere to at all non-towered aerodromes – for positional and intentional broadcasts, and for providing air-ground radio services. The requirements of pilots in CAR 166 are supported by Civil Aviation Advisory Publications (CAAPs), and the relevant sections of the Aeronautical Information Publication (AIP) and ERSA (see below).

From 3 June 2010, some refinements were made to the NAS 2C non-towered aerodrome procedures. Radio carriage requirements were changed significantly – all aircraft operating in the vicinity of all registered, certified, military and other non-towered aerodromes now must carry a radio and use the CTAF (the term CTAF(R) was removed from use). These changes are discussed further below.

1.1.6 Recent changes to non-towered aerodrome procedures

On 3 June 2010, CASA made some changes to the regulations governing operations at and near non-towered aerodromes (CAR 166 *Operations in the vicinity of non-towered (non-controlled) aerodromes*). The purpose of these changes was to mandate the carriage of radio at all certified, registered, and military non-towered aerodromes, as well as making some adjustments to circuit entry procedures, circuit heights, and broadcast procedures. The driver behind these changes was the enhanced safety benefits provided by using radio-alerted 'see-and-avoid' principles in maintaining situational awareness of, and separation between, aircraft operating into and from non-towered aerodromes.

The non-towered aerodrome procedures (CAR 166) apply to aircraft in the vicinity of all non-towered aerodromes, which is defined by CASA as within 10 NM of the aerodrome reference point and at a height which could conflict with operations at a non-towered aerodrome.

There are five parts to the new CAR 166.

- CAR 166A General requirements for aircraft on the manoeuvring area or in the vicinity of a non-controlled aerodrome
- CAR 166B Carrying out a straight-in approach
- CAR 166C Responsibility for broadcasting on VHF radio
- CAR 166D Designation of non-controlled aerodromes
- CAR 166E Requirements for operating on or in the vicinity of certified, military, registered or designated non-controlled aerodromes

Due to the CAR 166 refinements, pilots using non-towered aerodromes will notice several major changes in how they must operate at these aerodromes:

- abolition of CTAF(R) designations for aerodromes:
  - At all non-towered aerodromes that are registered, certified, are for military use, or are specified by CASA, a radio must now be carried and used in order for the aircraft to use that aerodrome (requirement of CAR 166A). These aerodromes are identified with a plain white background in the ERSA.
  - As a result, use of radio is mandatory at all other airfields that are within 10 NM vicinity of a registered/certified/military aerodrome (even if not apparent from the ERSA).
  - At other uncertified or unregistered aerodromes, aircraft landing areas (ALAs), or helicopter landing sites (HLSs), a radio is not required in order to use that aerodrome. However, if the aircraft is fitted with a radio, radio use is mandatory (requirement of CAR 166.1). These are identified with a grey background in the ERSA.
- changes to circuit height levels for low, medium, and high-performance aircraft
- additional circuit joining options.

As a result of the 3 June 2010 changes, there are now approximately 300 aerodromes in Australia where a radio is required to be carried and used at all times. The CTAF(R) designation has been removed from use in the AIP, ERSA, and issues of charts since this date. In order to check whether radio carriage is required at a particular non-towered aerodrome, pilots should consult the ERSA and CAAP 166-1 (see below).

There are two new Civil Aviation Advisory Publications (CAAPs), which summarise the changes to the CAR 166 regulations. All pilots who use non-towered aerodromes should read and familiarise themselves with the following CAAPs:

- CAAP 166-1(0) Operations in the vicinity of non-towered (non-controlled) aerodromes
- CAAP 166-2(0) Pilots' responsibility for collision avoidance in the vicinity of non-towered (non-controlled) aerodromes using 'see-and-avoid'.

These CAAPs are the authoritative benchmark of operating procedures at these non-towered aerodromes. They also provide a code of conduct to reinforce good

airmanship principles, and to allow greater flexibility for pilots using non-towered aerodromes.

Following the new procedures should assist pilots to reduce the likelihood and risk of many of the safety occurrences and conflicts discussed in this report.

1.1.7 What is the relevance of this research following the CAR 166 changes on 3 June 2010?

This report reviews occurrences in the vicinity of all non-towered aerodromes in Australia between 2003 and 2008 in order to explore the types of safety events that occur at or near non-towered aerodromes, based on the occurrences reported to the ATSB. It is intended to highlight and act as a point of discussion about the inherent differences (and limitations) of operations into aerodromes where there is no air traffic service, particularly in terms of pilots' situational awareness and making their presence and intentions known.

Safety incidents that have occurred in the vicinity of non-towered aerodromes during this period by and large reflect a lack of awareness of these operational differences and limitations by some pilots. Most of the occurrences studied involved separation issues, ineffective communication between pilots operating in close proximity, incorrect assessment of other aircraft's positions and/or other pilot's intentions, or a failure to follow published procedures. These types of occurrences have been the source of concerns raised by pilots, industry, CASA, and the ATSB regarding operations at non-towered aerodromes.

The refinements made by CASA to non-towered aerodrome procedures on 3 June 2010 were designed to reduce these sorts of safety events from occurring. However, operations in the vicinity of non-towered aerodromes have, and always will, come with a higher level of risk due to their reliance on all pilots having to:

- be aware of their proximity to other aircraft
- actively make other pilots aware of their presence and intentions
- operate their aircraft in accordance with their responsibilities under CAR 166 at all times.

In such environments, where responsibility for safe flight rests entirely with the pilot, some pilots will inevitably make mistakes in their decisions, slips or lapses in their actions, or will incorrectly judge a situation based on the information provided to them from other aircraft or ground operators. Air-ground radio services, procedures, and assistance from other pilots exist to help pilots pick up and rectify some of these mistakes. However, the inherent uncontrolled nature of non-towered aerodromes means that pilots must still remain vigilant of the safety risks of operating in the vicinity of these aerodromes.

The ATSB and CASA suggest that the best way for all pilots to operate safely in the vicinity of non-towered aerodromes is to be aware of their responsibilities under CAR 166. The CAAPs released to support the 3 June 2010 changes (CAAP 166-1 and 166-2) give straightforward and clear advice on these responsibilities. In addition, having an appreciation of both the common and serious types of incidents and accidents documented in this report will assist pilots, operators and CASA understand and be prepared for the risks involved in operating into non-towered aerodromes.

While the procedural changes introduced by CASA on 3 June 2010 were designed to reduce safety events, it is unlikely that they will eradicate all of the types of airspace

and operational-related incidents that have occurred in the vicinity of non-towered aerodromes between 2003 and 2008. The ATSB looks forward to a post-implementation review of the 3 June 2010 changes in terms of their impact on reducing the frequency of the most common safety occurrences that are raised in this report.

1.2 Objectives

The purpose of this study was to review occurrences at all non-towered aerodromes over a 6-year period that were related to airspace use and operational procedures.

More specifically, the first objective was to identify the underlying factors that contribute to safety occurrences such as:

- airproxes and other separation issues[8]
- see-and-avoid related conflicts between aircraft
- inadequate communication between pilots of aircraft
- procedural errors, particularly relating to circuit operations
- radio frequency congestion and interference at, or in the vicinity of, these aerodromes.

A secondary objective of this study was to look at the changes in the mix of aircraft using major regional aerodromes that do not have a permanent ATC presence, and compare this with any changes in the frequency or types of occurrences reported. This was especially pertinent at aerodromes such as Port Macquarie and Ballina/Byron Gateway, where significant new RPT services utilising large jet aircraft have begun in the last 5 years.

The third objective was to inform pilots of their responsibilities when operating in the vicinity of non-towered aerodromes. This report does this by highlighting the central role that actions of individual pilots have on the overall safety of operations at these aerodromes, and by identifying ways in which pilots can:

- improve their situational awareness and the awareness of others using these aerodromes
- reduce the frequency of common occurrence types in the vicinity of these aerodromes

[8] An airprox is defined in the Transport Safety Investigation Regulations 2003 as an occurrence in which two or more aircraft come into such close proximity that a threat to the safety of those aircraft exists or may exist, in airspace where the aircraft are not subject to an air traffic separation standard or where separation is a pilot responsibility.

1.3 Scope

This report focused only on occurrences at/near non-towered aerodromes which were deemed to be related to airspace use, separation, communication or procedures when those aerodromes were under CTAF/CTAF(R), or MBZ procedures.

The reporting period for occurrences in this report was 1 January 2003 to 31 December 2008. The intention of selecting this period was to analyse occurrences at non-towered aerodromes across an ample time prior to and after the procedural and airspace changes introduced by NAS 2C on 24 November 2005 at all non-towered aerodromes in Australia. Readers should note that this 6-year period was prior to the 3 June 2010 changes to non-towered aerodrome procedures.

Specific occurrence types that were reviewed were:

- airspace occurrences related to:
  - aircraft separation (airprox, mid-air collision, traffic collision and avoidance system (TCAS/ACAS) alerts and other separation-related events)
  - ATC procedural errors (information errors, failure to pass traffic)
  - failures to comply (FTC) (published instructions for VFR/IFR traffic, verbal instructions for enroute IFR traffic)
- operational occurrences related to:
  - communications (air-to-ground, air-to-air, callsign confusion, radio or transponder-related and other events)
  - navigation or flight preparation (lost or unsure of position, pre-flight planning, VFR flight into instrument flight conditions (IMC) and other events)
  - ground operations (collisions on ground, groundprox[9])
  - runway events (incursions, depart/approach/landing on wrong runway)

Consequential events (such as missed approaches, go-arounds and diversions) were also considered.

Only occurrences that occurred within 15 NM (27.8 km) from a non-towered aerodrome were considered in this report's analysis. While the current CAR definition for 'in the vicinity of' a non-towered aerodrome includes a 10 NM radius, the higher value was used as the reporting period for this study contained both occurrences that occurred in MBZ/CTAF areas (pre-NAS 2C, where the MBZ airspace boundary was set as 15 NM) and under post-NAS 2C non-towered aerodrome procedures, where CTAF (and formerly CTAF(R)) is used and a 10 NM vicinity limit applies in place of a bounded airspace area.

[9] A groundprox is defined by the ATSB as an occurrence requiring immediate braking action by the pilot, flight crew, or vehicle driver in order to avoid a collision (ATSB, 2010a).

Some types of occurrences in uncontrolled airspace were excluded from this study, even if they were related to airspace use. Major areas outside the scope of this report were:

- mechanical issues with aircraft while in the vicinity of a non-towered aerodrome, unless they led to an airprox, loss of separation assurance, or another type of airspace-related occurrence
- violations of controlled airspace, and occurrences on the boundaries of Class D (known as General Aviation Aerodrome Procedures (GAAP) during the period of study) areas, or at the reporting points of GAAP/Class D aerodromes (such as 2RN at Bankstown)
- breakdowns of co-ordination between ATC services when handing over responsibility for aircraft conducting IFR operations between Flight Information Regions (FIRs)
- CENSAR search and rescue related issues (such as maintenance of, or failure to cancel SARTIME)
- ATC service errors (such as a failure to pass traffic information) where no aircraft were affected by the error, or it was unlikely that there was any potential for a conflict between two aircraft due to the error
- approaches to towered aerodromes where an aircraft descended beneath the approach path into uncontrolled Class G airspace
- conflicts with kites and model radio-controlled aircraft (this is discussed further in Chapter 9 in an analysis of voluntarily reporting to the ATSB through the REPCON and CAIR schemes).

2 METHODOLOGY

This study is based on the analysis of occurrences reported to the Australian Transport Safety Bureau (ATSB) for the 6-year period 1 January 2003 to 31 December 2008.

2.1 Data sources

Occurrence data

The occurrence data was sourced from the ATSB aviation occurrence database known as SIIMS (Safety Investigation Information Management System). A search of the SIIMS database was conducted to identify occurrences involving operations into or near:

- non-towered aerodromes
- aircraft landing areas (ALAs)
- other landing areas in Australia, her territories, and territorial waters
- at which Mandatory Broadcast Zone (MBZ) procedures applied or Common Traffic Advisory Frequency (CTAF/CTAF(R)) was used, between 1 January 2003 and 31 December 2008.

This search applied to all aircraft registered in Australia (on civil/VH-, military, and recreational registers) and foreign registered aircraft.

The majority of the reporting period was subsequent to the introduction of the *Transport Safety Investigation Act 2003* (TSI Act) on 1 July 2003, and many of the occurrence types extracted are immediately reportable matters (IRMs) under the TSI Act. However, it was determined that the lack of specified reportable matters under the previous *Air Navigation Act 1920* legislation was unlikely to have had a significant influence on the occurrence types reported. It has been observed in a number of ATSB investigations and research studies that the number of occurrences reported to the ATSB since 1 July 2003 has increased significantly due to the improved reporting requirements of the TSI Act.

The extracted occurrences were reviewed and further sorted into the sub-categories presented in this report. In particular, safety factors were coded for each occurrence in terms of the type of pilot and/or air traffic service error that was the primary contributor to the occurrence. The error types defined were:

- **Information errors –** individual actions that result from a failure to perceive something, perceiving something incorrectly, or by not understanding the situation correctly (i.e. situational awareness problems, and visual or other perceptual illusions).
- **Action errors –** actions that deviate from the individual's plans. These include error types commonly termed as 'skill-based' slips and lapses. Actions involving a lack of precision during continuous control of an aircraft are also deemed to be action errors (e.g. attempting to, but not succeeding in manually maintaining a target speed or altitude).
- **Decision errors -** individual actions that result when an individual's plans are not adequate for the situation.

- **Violations –** any individual action involving a deliberate intention to deviate from procedures or standards (intentional non-compliance).

Movements data

In order to look at the changes in the mix of aircraft using major regional aerodromes that do not have a permanent air traffic control (ATC) presence, aircraft movements data was required for a sample of non-towered aerodromes. To determine which aerodromes would be included in the sample group, several activity and operational characteristics were considered – frequency of occurrences, frequency of passenger transport services, total passenger throughput, and total number of landings.

An Airservices Australia movement dataset for all certified aerodromes for the 12 months ending December 2006 was used to identify the busiest non-towered aerodromes in Australia. Following a formal submission from the Civil Aviation Safety Authority (CASA) Office of Airspace Regulation (OAR), some of this movement data was refined to reflect more up-to-date counts of movements gained through data from aeronautical studies of particular aerodromes.

Many non-towered aerodromes use monitoring equipment provided by Avdata Australia to identify individual aircraft operating into that aerodrome and charge landing fees accordingly. A de-identified dataset was purchased from Avdata to provide movements information for 16 non-towered aerodromes of interest from 1 January 2003 to 31 December 2008. This dataset included:

- total number of movements per month
- number of regular public transport (RPT) landings per month
- number of movements by aircraft make and model per month
- number of movements by aircraft maximum take-off weight (MTOW) per month, grouped into the following categories:
  - below 2,200 kg
  - 2,200 kg – 5,700 kg
  - 5,700 kg – 8,618 kg
  - 8,618 kg – 30,000 kg
  - above 30,000 kg.

The intention of selecting these MTOW categories was to roughly group movements into operation types, as specific operation type data was not available for each movement. These categories corresponded to private and aerial work general aviation, light charter and low capacity passenger transport, heavy low capacity passenger transport, turboprop high capacity passenger transport, and jet high capacity passenger transport respectively.

Aerodromes in the intended study group not using the Avdata system[10], or those that did not collect landing fees for general aviation (GA) aircraft generally, did not collect movement information to the same level of fineness and quality to allow

[10] Some airports were not selected in the study group for this reason, even though they were among the busiest non-towered aerodromes: Wynyard, Ayers Rock, Hervey Bay, Mount Isa, Toowoomba, Port Hedland, Devonport, and Emerald aerodromes.

comparison with data collected by the Avdata service. Generally, aerodromes where Avdata movement data was not available were not included in the movement group.

However, in some cases where Avdata was not available, but a large number of occurrences warranted inclusion of the aerodrome in the comparison group, the aerodrome operators were approached directly by the ATSB to provide either collected or estimated movement data for the January 2003 to December 2008 period (Karratha[11], Broome, Geraldton, and Hervey Bay[12] aerodromes).

Using a combination of these movements data sources (from Airservices, further movements data provided from the OAR, datasets purchased from Avdata Australia, data provided by aerodrome operators, and movements data from individual CASA aeronautical studies of non-towered aerodromes), a final set of 20 non-towered aerodromes was established for further analysis of the relationship between traffic mix and occurrence types.

In the interests of data reliability, transparency and impartiality, these 20 aerodromes were selected for the movement group if they satisfied one or more of the following criteria:

- were among the top 25 busiest non-towered aerodromes[13] in terms of total movements (and complete movement information was available)
- were permanently non-towered for the period of the study (GAAP/Class D aerodromes, and aerodromes such as Newcastle and Avalon where a partial ATC presence exists were excluded)
- had a diverse mix of aircraft and operation types, including passenger transport services utilising large aeroplanes
- had more than the expected number of occurrences reported to the ATSB between 1 January 2003 and 31 December 2008 that related to airspace use and procedures, based on their estimated number of annual movements.

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[11] Karratha Aerodrome (YPKA) currently uses Avdata Australia to collect movement information; however this arrangement began late in the reporting period. As a result, more complete movement data was sourced directly from the Shire of Roebourne (WA).

[12] Fraser Coast Regional Council (the operators of Hervey Bay Aerodrome) were unable to provide detailed movements data from 2003 to 2008, and hence were excluded from a detailed traffic analysis.

[13] Excluding Class D/GAAP aerodromes, military, and other partially towered aerodromes (such as Avalon, Pearce and Newcastle) which operate under non-towered aerodrome procedures outside of ATC operating hours.

Table 1: Movements for 20 selected non-towered aerodromes in Australia, twelve months ending December 2009[14]

Broome (WA)	37,200	Dubbo (NSW)	18,564
Wollongong (NSW)	27,993	Bundaberg (Qld)	15,492
Kununurra (WA)	24,853	Orange (NSW)	15,395
Wagga Wagga (NSW)	24,439	Ballina/Byron Gateway (NSW)	15,299
Horn Island (Qld)	23,533	Armidale (NSW)	14,728
Bathurst (NSW)	23,230	Port Lincoln (SA)	13,290
Port Macquarie (NSW)	21,872	Mildura (Vic.) †	12,428
Geraldton (WA) †	21,100	Griffith (NSW)	12,088
Karratha (WA)	19,566	Groote Eylandt (NT) †	10,100
Gove (NT)	18,944	Mount Gambier (SA)	8,831

Movements data were not complete for some of these 20 aerodromes, for example Mount Gambier Aerodrome, at which movement data was only available from October 2005 onwards. In these cases, comparisons involving the number of occurrences per 10,000 movements were adjusted so that the only occurrences counted in any analysis were those that occurred after the start of movement data collection.

An abbreviated summary of the movements dataset for each of the final 20 aerodromes selected in the movement group (16 Avdata aerodromes, plus four non-Avdata aerodromes for which useful movement data could be obtained) is provided in Appendix B.

REPCON and CAIR data

Reports were extracted from the ATSB's voluntary reporting system databases, Aviation Confidential Reporting (REPCON) and Confidential Aviation Incident Reporting (CAIR) for the period 1 January 2003 to 31 December 2008. The extracted reports were selected based on a keyword search, and were de-identified of all personal information, names, operators, and aircraft registrations. Keywords used included CTAF, MBZ, frequency, congestion, near miss, traffic, separation, circuit, approach, procedures, calls, broadcast, airspace, tower, busy, radio, UNICOM.

The confidential reporting schemes operated by the ATSB are intended for people to report safety concerns and hazards, not occurrences. A further discussion of REPCON and CAIR is provided in Chapter 9.

[14] Data validated by CASA OAR with Avdata Australia or individual airport operators, with the exception of aerodromes marked with a †, which are CASA or Airservices Australia estimates only.

RAPAC data

Information from Regional Airspace and Procedures Advisory Committee (RAPAC) meetings was used in this report to identify issues relating to safety matters in the vicinity of non-towered aerodromes not linked to an occurrence, such as frequency congestion and terrain shielding, leading to radio frequency interference.

Meetings of RAPACs (which are state-based) are usually convened by the OAR, with the frequency of meetings dependent upon on the location[15]. The Minutes of the RAPAC meetings between July 2009 and June 2010 that were published by the OAR on their website (via www.casa.gov.au) were reviewed in order to identify safety issues of concern to some aerodrome users at particular aerodromes. They are discussed further in Chapter 9.

2.2 Data limitations

Occurrence data

The nature of non-controlled airspace makes it difficult from an occurrence analysis perspective to identify occurrences where aircraft came into close proximity with each other, especially where aircraft operating under visual flight rules (VFR) are involved. The inherent lack of separation service means that reports of aircraft proximity at the time of an occurrence are often not reported, or if they are, are subjective estimates only provided by the reporting pilot or flight crew. If the identity of the other aircraft involved is known, the ATSB will endeavour to contact both pilots to verify what happened, and how far apart the aircraft were.

The lack of a separation standard also introduces difficulties in defining what constitutes an 'incorrect presence', and who was involved in the error that led to it. Situations which raise the possibility of an incorrect presence include an aircraft entering a runway while another aircraft is occupying it for the purposes of taking off or landing, activities being undertaken on a runway by ground vehicles or personnel while an aircraft is on approach, or an aircraft on approach to one end of a runway while another aircraft is on approach to the reciprocal runway end.

Furthermore, there was and is likely to be underreporting of incidents, as not all of the occurrence types selected for analysis in this report were considered to be immediately reportable matters (IRMs) or routinely reportable matters (RRMs) at the time of the occurrence for all operation types under the provisions of the Transport Safety Investigation Regulations 2003, and formally under the *Air Navigation Act 1920*.

Minimal information exists for many of the 709 occurrences identified during the reporting period in the vicinity of non-towered aerodromes. In over half of the occurrences, it was not known what types of aircraft or operations were involved. Safety factor coding for airspace-related incidents was sparse, and cannot provide a comprehensive view of what contributes to each occurrence. Instead, error types were coded to provide a broad means of establishing the reasons behind each occurrence, based on the summary information provided to the ATSB at the time of notification. A qualitative analysis of the reporter's summary text of the occurrence was an important component to analyse occurrence data in this report. It is important to note

[15] A full schedule of RAPAC meetings for each state is provided on the CASA OAR website (www.casa.gov.au).

that the level of detail and the type of information provided by reporters varies between occurrences.

Movement data

It was intended that this report would also compare the prevalence of airspace separation breakdowns between aircraft at Class D (formerly General Aviation Aerodrome Procedures (GAAP)) aerodromes where non-towered aerodrome (CTAF(R)) procedures apply only outside of ATC operating hours, and non-towered aerodromes where CTAF or CTAF(R) was always used. This was not deemed to be possible, as a large proportion of traffic at non-towered aerodromes is VFR, and non-towered procedures using CTAF(R) usually only apply at Class D/GAAP aerodromes at night when only Night VFR and instrument rules (IFR) flight are permitted. The clear exception to this is Camden aerodrome, where the ATC service does not operate during weekdays.

This caused a problem in conducting a traffic mix analysis on movements at Class D/GAAP aerodromes, and other aerodromes such as Avalon and Newcastle, which are sometimes not controlled by ATC. While these aerodromes recorded a significant number of occurrences, the inability to determine the proportion of traffic operating when the aerodrome was not controlled by ATC during the reporting period prevented an analysis of occurrences compared to traffic mix.

REPCON and CAIR data

The inherent confidential nature of reports held in the REPCON and CAIR schemes means that in many cases, information regarding the location, aircraft, or operation types involved is de-identified. This makes trend comparison with occurrence data difficult.

The completeness of REPCON and CAIR data is unknown due to the voluntary nature of reporting. Some reports also share commonalities with, or are duplicates of, occurrences that have been reported to the ATSB as reportable matters, and were therefore included in the 709 occurrences analysed.

3 GENERAL OCCURRENCE TRENDS

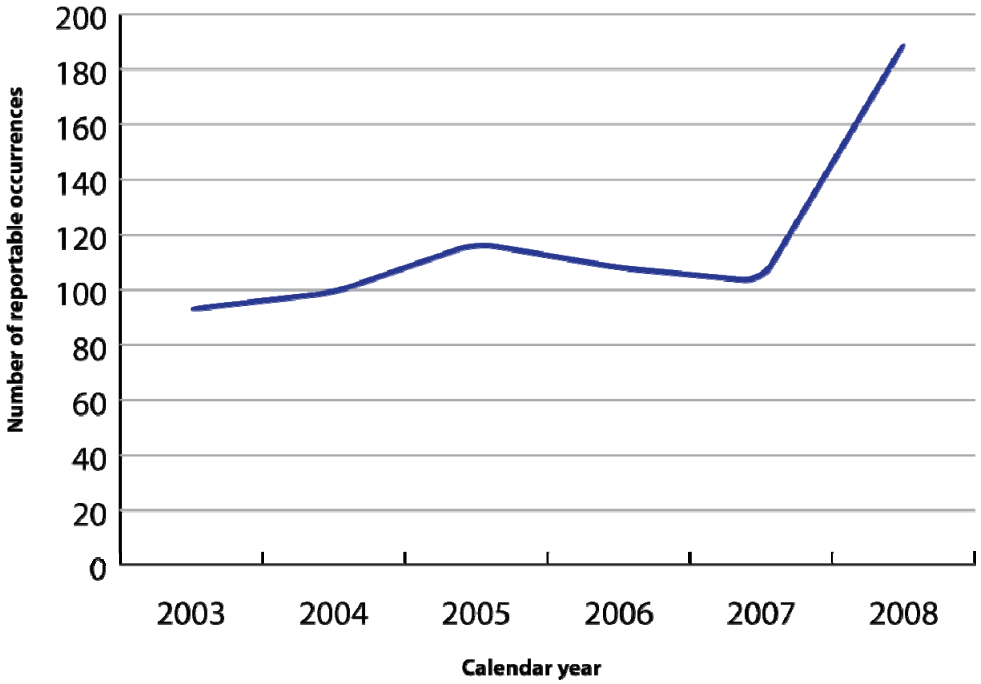
There were 709 occurrences in the vicinity of non-towered aerodromes in Australia related to airspace use and procedures over the reporting period of 1 January 2003 to 31 December 2008. This figure also includes occurrences in Australia's external territories (including Norfolk Island), and ships and offshore platforms within her Exclusive Economic Zone (EEZ) where non-towered aerodrome procedures apply.

Since the beginning of the reporting period, the Australian Transport Safety Bureau (ATSB) has received an increasing number of comprehensive occurrence reports from pilots regarding airspace use and procedural compliance in the vicinity of non-towered aerodromes (including the use of Common Traffic Advisory Frequency (CTAF, and formerly CTAF(R)) frequencies and non-towered aerodrome broadcast procedures) (Figure 1).

Airspace use and operational-related occurrences included:

- reduced separation between two or more aircraft
- mid-air collisions
- air traffic control (ATC) procedural errors
- failures to comply (FTC) with published instructions (such as standard operating procedures) or verbal instructions
- unclear or insufficient communications to maintain separation with or situational awareness of other aircraft
- navigation or flight preparation issues (lost or unsure of position, inadequate pre-flight planning, or visual flight rules (VFR) into instrument flight conditions (IMC))
- ground collisions or near misses involving aircraft, or ground vehicles and aircraft
- runway incursions, or operations from an incorrect runway.

Figure 1: Airspace-use and operational-related occurrences in the vicinity of non-towered aerodromes in Australia, 2003 to 2008



There was a significant increase in occurrences in 2008 (as shown in Figure 1). Further investigation of the data revealed that as a proportion of total occurrences in 2008 compared to earlier years, there were no significant changes in the most common five occurrence types, the location of occurrences, or the involvement of RPT aircraft in occurrences. The reason for this spike could not be determined, but it is at least partially due to an increase in reporting levels of airspace-related and operational-related incidents by pilots.

It is also interesting to note that the introduction of the National Airspace System (NAS 2C) non-towered aerodrome procedures in November 2005 did not affect the number of occurrences reported to the ATSB. Any effects of the introduction of NAS 2C would expect to have been seen within 18 months of November 2005; however, there was no significant change in the number of occurrences reported.

3.1 Accidents, incidents, and serious incidents near non-towered aerodromes

Almost all of the occurrences during the reporting period were incidents. No injuries were reported in any of the occurrences classified as incidents. However, a proportion of these incidents were serious in nature (n=60) and were classified as serious incidents. Serious incidents are incidents where circumstances indicated that an accident nearly occurred.

There were six accidents related to airspace use and separation in the vicinity of non-towered aerodromes. Four of these accidents were mid-air collisions – two involved collisions between agricultural aircraft or gliders conducting manoeuvring near the aerodrome (crop spraying, soaring etc.) The remaining two mid-air collisions occurred between general aviation (GA) aircraft on approach or operating in the circuit.

Three of the mid-air collisions resulted in fatal injuries to the pilot of one of the aircraft involved.

The remaining two accidents were runway incursions. In one accident, two aircraft collided at taxi speed after landing on opposite ends of the same runway. In the other accident, one aircraft collided during its take-off roll with another aircraft that was landing on an intersecting runway.

3.2 What types of occurrences were most common?

Of the 709 occurrences during the reporting period, the most common types were[16]:

- conflicts where an aircraft or ground vehicle interfered with the flight of another aircraft (501 occurrences)
- reduced aircraft separation not resulting in an airprox or collision (181 occurrences)
- Traffic Collision and Avoidance System (TCAS/ACAS[17]) alerts (87 occurrences, at least 73 being resolution advisories (RAs))
- missed approaches and go-arounds (59 occurrences)
- airprox events (55 occurrences)
- runway incursions (32 occurrences)
- air-to-air and air-to-ground communication breakdowns (388 occurrences)
- non-compliance with published information (139 occurrences)
- air traffic service procedural errors (27 occurrences).

The major types of occurrences found are summarised in Figure 2.

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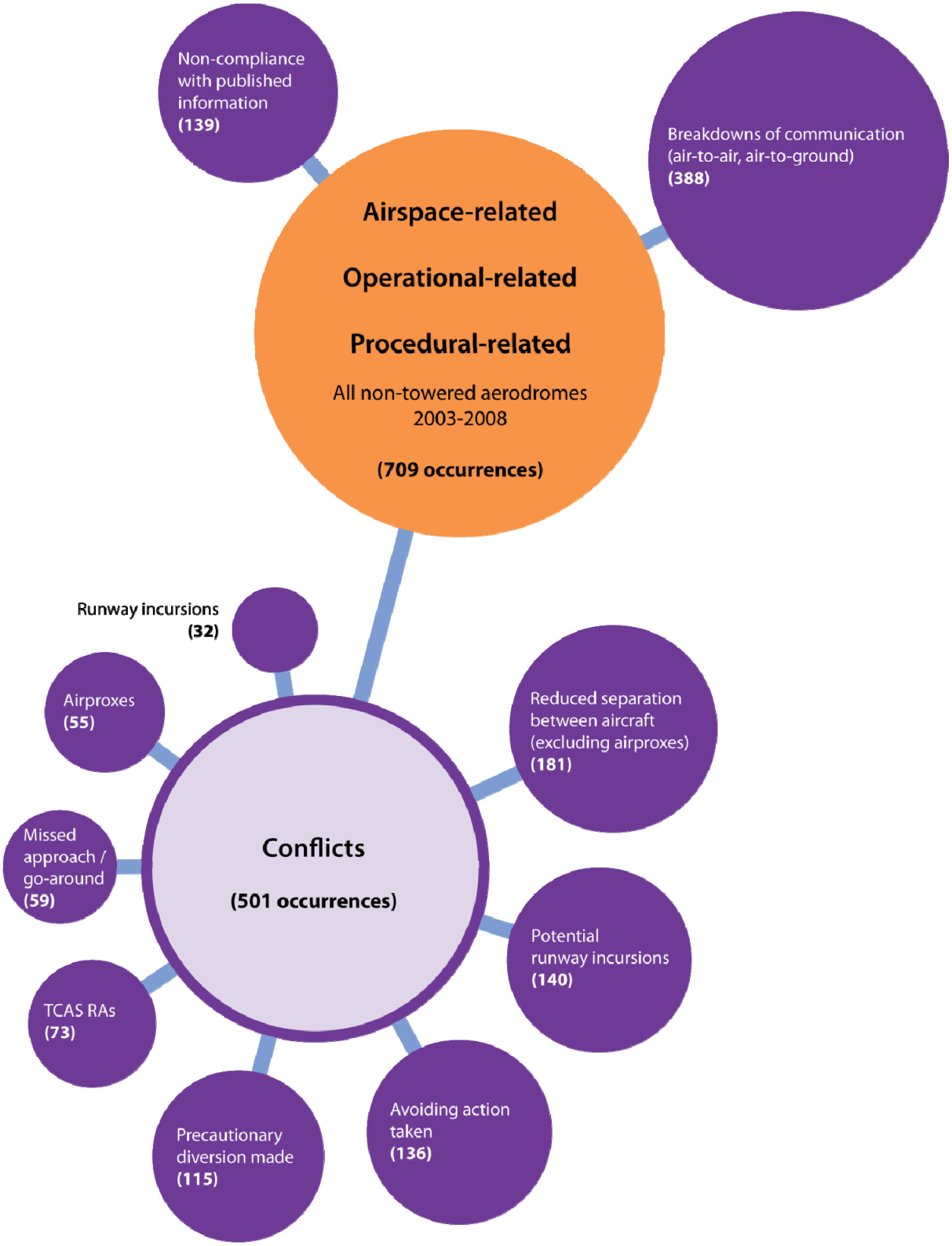
[16] As occurrences can have multiple occurrence types recorded, the sum of occurrence types is greater than the number of occurrences.

[17] Airborne collision avoidance systems (ACAS) are a type of warning device fitted to commercial aircraft and some smaller aircraft that alert pilots to the potential of a mid-air or near mid-air collision between their aircraft and another aircraft. ACAS II gives both traffic advisories (TAs) and resolution advisories (RAs) in the vertical direction, compared with the earlier ACAS I standard, which only provided traffic advisory information to pilots and flight crews. ACAS serves as a last line of defence against a collision, irrespective of any separation standards. TCAS II version 7.0 is currently the only implementation of the ACAS II standard (EUROCONTROL, 2010).

Figure 2: Most common types of occurrences in the vicinity of non-towered aerodromes in Australia, 2003 to 2008



Airproxes were significantly represented in serious incidents and accidents. An airprox is defined in the Transport Safety Investigation Regulations 2003 as an occurrence in which two or more aircraft come into such close proximity that a threat to the safety of those aircraft exists or may exist, in airspace where the aircraft are not subject to an air traffic separation standard or where separation is a pilot responsibility.

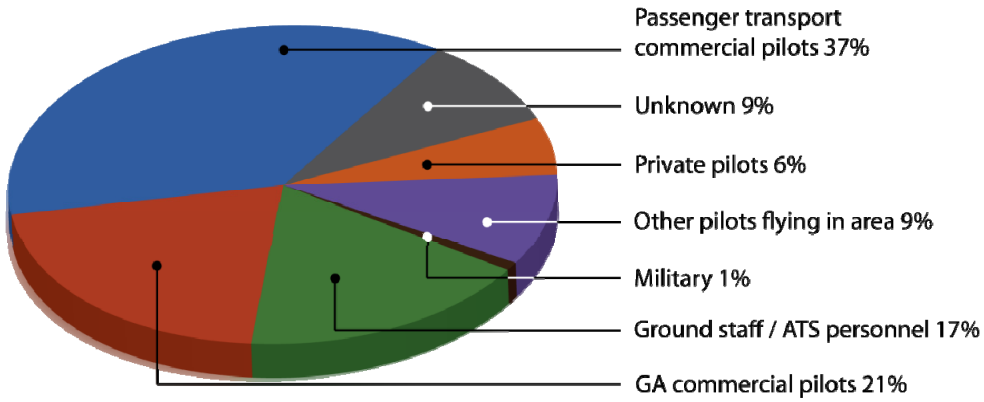
Of the 66 serious incidents and accidents that were reported, the *most common occurrence types* were:

- airprox events (55 occurrences)
- air-to-air and air-to-ground communication breakdowns (19 occurrences)
- TCAS/ACAS alerts (7 occurrences, all being RAs due to an airprox)
- missed approaches and go-arounds (6 occurrences)
- other communication issues (5 occurrences)
- mid-air collisions (4 occurrences)
- departing, approaching, or landing on the wrong runway (4 occurrences)
- non-compliance with published information (4 occurrences)
- other aircraft separation issues (4 occurrences)
- collisions on ground (3 occurrences)
- runway incursions (3 occurrences).

3.3 Who reported the occurrence?

Approximately three-fifths of the 709 occurrences were self-reported by the pilot/flight crew of a commercial aircraft (including aircraft conducting charter operations, aerial work, and flying training) (Figure 3).

Figure 3: Reporting sources of safety events at non-towered aerodromes, 2003 to 2008



3.4 Where were the most occurrences?

Most occurrences were in operations to and from an aerodrome, and within 10 NM from the aerodrome reference point (n=538). Aircraft that were assessed to be enroute were involved in 169 occurrences.

The intent from an occurrence analysis perspective was to look at safety trends in all occurrences across all non-towered aerodromes, rather than looking in detail at specific aerodromes. This was largely due to the limited amount of available data at the aerodrome level. A traffic mix analysis was however completed for the non-towered aerodromes with the most movements, in order to investigate patterns between occurrence types, operation types, and aircraft sizes. This analysis is discussed further in Chapter 8.

Occurrences relative to aerodromes

There were eight non-towered aerodromes in Australia that each recorded over 15 occurrences related to airspace use and operations between 2003 and 2008. Not all of these aerodromes were included in the movements analysis group of 20 non-towered aerodromes:

- Newcastle (RAAF Williamtown), NSW (26 occurrences)
- Avalon, Vic. (23 occurrences)
- Geraldton, WA (23 occurrences)
- Dubbo, NSW (23 occurrences)
- Broome, WA (23 occurrences)[18]
- Port Macquarie, NSW (19 occurrences)
- Mildura, Vic. (19 occurrences)
- Wagga Wagga, NSW (15 occurrences)

Newcastle and Avalon, as well as Class D aerodromes that were designated as General Aviation Aerodrome Procedures (GAAP) during the period of this study, have been excluded from further analysis as a full air traffic control service is provided at those aerodromes at some times of the day[19].

- Camden Aerodrome, while operating as a non-towered aerodrome during weekdays, did not have sufficiently complete movement data available for the non-towered time periods (as a proportion of total movements) to allow a fair comparison of occurrence rates with other non-towered aerodromes.

Occurrence rates for the 20 non-towered aerodromes analysed (outlined in section 2.1) were normalised by the estimated number of movements across the reporting period. The highest occurrence rates were at:

- Geraldton (2.7 per 10,000 movements)
- Mildura (2.4 per 10,000 movements)

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[18] While Broome was a non-towered aerodrome during the period of this study (Jan 2003 – Dec 2008), a certified air/ground radio service (CA/GRS) was in operation. A CA/GRS provides a limited air traffic service to pilots upon request. These services are discussed further in section 6.3.

[19] Operating hours for air traffic control services at Australian aerodromes (where provided) are shown in the En Route Supplement Australia (ERSA).

- Dubbo (1.7 per 10,000 movements)
- Wagga Wagga (1.5 per 10,000 movements)
- Port Macquarie (1.4 per 10,000 movements)[20].

Occurrences relative to flight services provided

A limited analysis was performed on occurrence rates at aerodromes providing a ground-based information service to pilots operating in the vicinity of non-towered aerodromes.

The two non-towered aerodromes providing a certified air/ground radio service (CA/GRS) between 2003 and 2008, Ayers Rock and Broome Aerodromes, had 33 occurrences related to airspace use and operations, and an estimated 1.1 occurrences per 10,000 movements[21].

Five non-towered aerodromes provided a universal communications (UNICOM) service throughout some parts of the reporting period. At these aerodromes for the periods where the UNICOM trial was operating, there were a total of 25 occurrences related to airspace use and operation, and an estimated 3.3 occurrences per 10,000 movements[22]. There were no reports of airproxes or near misses during the hours of the trials at these five aerodromes reported through Electronic Safety Incident Reports (ESIRs) to Airservices Australia (Airservices Australia, 2010a).

These figures should be treated with caution, given the small numbers of occurrences involved. The role of UNICOM and CA/GRS in improving safety is discussed further in section 6.3.2.

Furthermore, at all of the 20 non-towered aerodromes selected in the movements analysis group for the entire 2003 to 2008 period, there were 224 occurrences related to airspace use and operations, with an estimated 1.1 occurrences per 10,000 movements. This group includes both Broome Aerodrome (which had a CA/GRS) and three of the five UNICOM trial aerodromes (Port Macquarie, Dubbo and Wagga Wagga).

It was not possible to determine occurrence rates at all aerodromes where radio carriage was required between 2003 and 2008 (Mandatory Broadcast Zone (MBZ) and CTAF(R)–designated aerodromes) due to incomplete or unreliable movements information.

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[20] Estimate of annual movements only over the period 1 January 2003 to 31 December 2008, based on an average of Avdata and airport operator-supplied movement information.

[21] Based on movements data estimates from the Civil Aviation Safety Authority (CASA) Office of Airspace Regulation, and from Broome International Airport and Ayers Rock Airport (via the May 2009 and November 2008 CASA Aeronautical Studies respectively). For the entire six-year period, total movements at Broome were estimated to be 185,370, and at Ayers Rock were estimated to be 112,200 (CASA, 2008a; CASA, 2009).

[22] Based on movements data estimates from Avdata, CASA Office of Airspace Regulation, and Airservices Australia data from December 2007 to March 2009 (for Dubbo and Wagga Wagga aerodromes), and from October 2008 to March 2009 (for Hervey Bay, Olympic Dam, and Port Macquarie aerodromes).

Occurrences relative to flight rules and conditions

There were slightly more aircraft operating under IFR that were involved in occurrences in the vicinity of non-towered aerodromes (56 per cent of all occurrences) than those operating under VFR (45 per cent of all occurrences).

Most incidents occurred in visual meteorological conditions (n=501). Very few (n=13) occurred in instrument conditions – these generally involved a conflict with another aircraft during the initial climb after takeoff, or during descent prior to the approach. There were an additional 187 occurrences in which the flight conditions at the time were unknown.

Source: Department of Transport and Regional Services, 2005

4 CONFLICTS AT NON-TOWERED AERODROMES

Of the 709 occurrences reported to the ATSB between 2003 and 2008 in the vicinity of non-towered aerodromes that were related to airspace use, operations and procedural compliance[23], the majority (71 per cent) involved a reported conflict between two aircraft. The remainder of occurrences involved either a conflict with a ground vehicle or person (2 per cent), or only involved a single aircraft that was not in conflict (29 per cent). Each of these types of conflicts is explored below.

4.1 Aircraft/aircraft conflicts

In 475 occurrences, two or more aircraft came into conflict with each other. The vast majority (n=431) involved fixed-wing aircraft conflicting with other fixed wing aircraft. In 36 cases, fixed-wing aircraft conflicted with helicopters; however, there were only two cases of a helicopter-helicopter conflict at a non-towered aerodrome during the reporting period. In 11 cases, a conflict occurred involving two or more aircraft, but it was not reported if they were fixed or rotary-wing.

In addition, there were a number of conflicts that occurred between sport aviation aircraft and fixed/rotary-wing aircraft. Sixteen of these conflicts involved ultralights, and 15 conflicts occurred with balloons, gliders or parachutists. Twelve occurrences involved conflicts between civil and military aircraft, generally operating at joint use airfields.

Most conflicts involving two aircraft were due to runway incursions or reduced aircraft proximity on approach or in the circuit.

4.1.1 On the ground

A runway incursion is defined in the Transport Safety Investigation Regulations 2003 as any intrusion of an aircraft, vehicle, person, animal or object on the ground within a runway strip or helicopter landing site that creates a collision hazard or results in a reduction of safety for aircraft.

While only 32 runway incursions were recorded at non-towered aerodromes (about 7 per cent of all conflicts), the potential existed for significantly more (about 28 per cent of all conflicts) because in many cases, aircraft came into situations where they conflicted with each other (such as an aircraft entering a runway when another aircraft was on final approach), but the actions of one or more of the pilots prevented a high potential for a collision.

Some potential incursion situations were particularly common at non-towered aerodromes between:

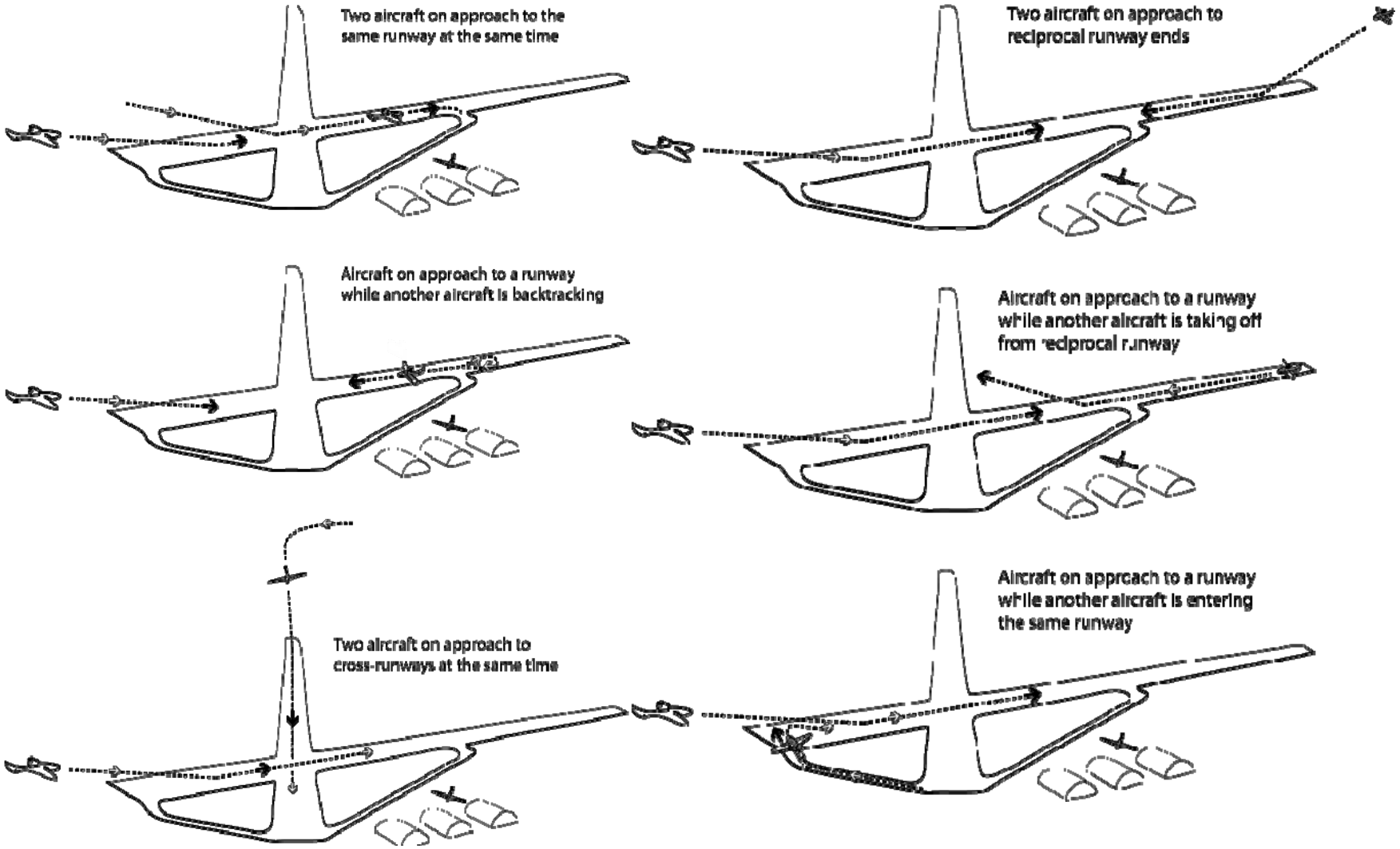
- an aircraft taxiing on a runway, or preparing to enter a runway, and another aircraft on final approach, short final, or on its landing roll (61 occurrences):

[23] Readers should note that the occurrences analysed in this report happened prior to the introduction of changes to non-towered aerodrome procedures introduced by the Civil Aviation Safety Authority (CASA) on 3 June 2010. These changes affect circuit joining procedures, radio carriage requirements, and broadcasts on the Common Traffic Advisory Frequency (CTAF), and intend to reduce this likelihood of these types of conflicts occurring. They are discussed further in section 4.4.

  - 23 occurrences where the aircraft was taxiing by backtracking down the active runway
  - 24 occurrences where the aircraft was entering the runway from a taxiway, or was lining up
  - 9 occurrences where the aircraft had landed, but was taxiing off the runway
  - 5 occurrences where the aircraft was on a taxiway while the other aircraft landed or was about to land, but the taxiing aircraft held short to prevent an incursion
- two aircraft on short final and landing, where the aircraft came too close (32 occurrences)
- an aircraft commencing takeoff at the same time as another aircraft was on short final or was rolling out after landing (31 occurrences)
- an aircraft taxiing on a runway at the same time as another aircraft commencing take off from the opposite runway end (17 occurrences).

Some of these situations are shown in Figure 4 below. Other runway incursion situations were less common, such as aircraft landing at the same time on cross-runways.

Figure 4: Runway incursion possibilities



Source: adapted from Department of Aviation, 1981

Runway incursions can have serious outcomes at non-towered aerodromes. The following accident in the United States in 1996 is a good example of the importance of maintaining situational awareness of aircraft near the runway through good radio communication, phraseology, and monitoring of the CTAF.

Case study: Fatal runway collision, Beech 1900C and Beech A90 King Air, Quincy, Illinois, United States

What happened?

On 19 November 1996, a Beech 1900C aircraft was landing on runway 13 at Quincy, Illinois, United States at the completion of a regular public transport flight. At the same time, a Beech A90 King Air aircraft entered runway 4, and begun its takeoff roll. The two aircraft collided at the intersection of the two runways. Both aircraft were destroyed, and all four crew and 10 passengers on both aircraft were fatally injured.

Source: NTSB, 1998

How did it happen?

The flight crew of the Beech 1900C had made appropriate efforts to coordinate the approach and landing through radio communications and visual monitoring; however they mistook another aircraft (a Piper Cherokee) pilot's transmission (that he was holding for departure on runway 4) as a response from the Beech King Air pilots to their request for the that pilot's intentions. As a result, they mistakenly believed that the pilot of the Beech King Air was not planning to take off until after the Beech 1900C had cleared the runway.

Why did it happen?

The failure of the Beech King Air pilot to announce over the CTAF his intention to take off created a potential for collision between the two airplanes.

Source: NTSB, 1998

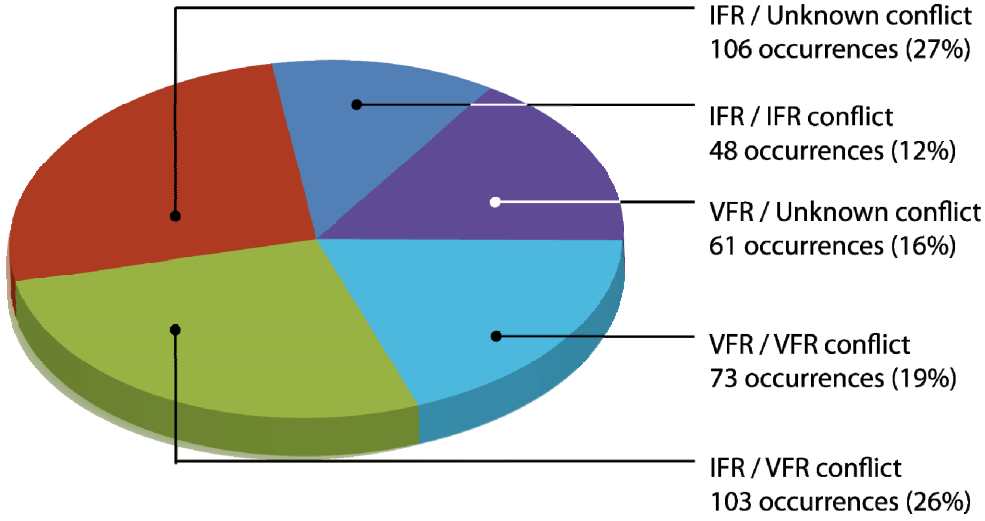
4.1.2 In the air

Another common type of conflict was where a reduced margin of separation between two aircraft was reported on final approach and landing. Thirty-two incidents involved aircraft coming close to each other when both were on final approach, aircraft turning early off base leg and cutting in front of other aircraft on final approach, or landing on the runway at the same time after approaching from reciprocal runway ends.

Also common were circuit separation issues, where aircraft came too close in the circuit, or an aircraft entered a circuit incorrectly and caused a reduced margin of separation safety with other aircraft already in the circuit (30 incidents). Circuit conflicts related to broadcasting are discussed further in section 6.1.

Over two-thirds of conflicts between two aircraft involved at least one aircraft operating under IFR. However, the proportion of conflicts between two VFR aircraft was greater than the proportion of conflicts between two IFR aircraft (Figure 5).

Figure 5: Operating rules for conflicting aircraft at non-towered aerodromes, 2003 to 2008



4.2 Aircraft/ground vehicle conflicts

In 15 occurrences, one or more aircraft conflicted with ground personnel or vehicles. The majority involved passenger transport operations. In most cases, a vehicle was occupying the runway strip or surface while an aircraft was on final approach. Usually, the vehicle driver was not tuned to the CTAF, and hence did not hear broadcasts by the pilots of aircraft intending to use the runway. In one case, a radio dead spot prevented the driver of a safety car on the runway from hearing the broadcasts from the pilot of an approaching aircraft.

4.3 Occurrences with no conflicts

In 207 occurrences (29 per cent), a single aircraft was involved, with no direct conflict with other aircraft or vehicles. These were usually instances where an aircraft was witnessed (by other pilots in the circuit, or by air traffic services (ATS) or ground personnel) departing from, or arriving at an aerodrome without the transmission of the pilot's intentions, but which was not in conflict with them. Other incidents involved

ATS errors in passing traffic information to IFR aircraft transiting through uncontrolled airspace in the vicinity of non-towered aerodromes, or aircraft operating onto closed runways in breach of a current notice to airmen (NOTAM).

4.4 Making your presence and intentions known

As aviation has developed, increasing performance, traffic density, and flight in non-visual conditions has limited the effectiveness of total reliance on the 'see-and-avoid' principle for maintaining safe margins of separation between aircraft (see BASI (1991) for a comprehensive review of the limitations of see-and-avoid). The need to enhance situational awareness of pilots, particularly where no ground-based air traffic control and/or information service is provided, has led to the principle of 'alerted see-and-avoid'.

Radio is the primary tool of 'alerted see-and-avoid' common across aviation from sport and recreational flying to air transport. Radio allows for the communication of information (in this instance traffic information) to the pilot from the ground (air traffic control or an air-ground radio operator) or other aircraft (CASA, 2010b). Other tools of 'alerted see-and-avoid' include ground radar, automatic dependent surveillance broadcast (ADS-B), and Traffic Collision Avoidance System (TCAS/ACAS).

Previous ATSB research has found that the effectiveness of a search for other traffic is eight times greater under alerted see-and-avoid circumstances compared to un-alerted (BASI, 1991). For this reason, CASA has developed a standard phraseology and set of basic, common positional broadcasts that pilots should make on the CTAF when operating into, out of, over, and in the vicinity of non-towered aerodromes. Pilots should always carry a radio and learn how to use it correctly, irrespective of whether they are flying into a registered/certified aerodrome or not.

The intent of CASA specifying minimum level of broadcasts and a standard phraseology is to improve situational awareness for all pilots operating in the vicinity of any particular non-towered aerodrome. These broadcasts and the appropriate phraseology are specified in Civil Aviation Regulation (CAR) 166C and the Aeronautical Information Publication (AIP), and also in the supporting Civil Aviation Advisory Publications (CAAPs).

Changes to recommended broadcasts since 3 June 2010

The recommendations for broadcasts when operating at or near a non-towered aerodromes changed on 3 June 2010. Since the introduction of the National Airspace System (NAS) 2C procedures in November 2005, CASA has conducted a post-implementation review process of the procedures in order to refine and optimise broadcast and radio carriage requirements in the interests of operational efficiency and safety.

While CASA no longer defines any mandatory broadcasts in the circuit, there are six recommended broadcasts that pilots are expected to make covering departing and approaching a non-towered aerodrome and joining the circuit. An additional broadcast is suggested for pilots conducting instrument approaches.

These changes have been made by CASA in the interests of providing pilots with more flexibility about making the broadcasts that they deem necessary. The intention is to improve operations at non-towered aerodromes, and improve situational

awareness by reducing the potential for many of the types of conflicts raised in this report to occur.

From 3 June 2010, CASA recommend pilots to make the following six broadcasts at a minimum when operating into non-towered aerodromes:

	Situation	Radio broadcast required
1.	Pilot intends to take off	Immediately before/during taxiing
2.	Pilot intends to enter the runway	Immediately before entering a runway (with intentions)
3.	Pilot is inbound	No less than 10NM from the aerodrome (with an estimated time of arrival) (pilots should consider making an inbound broadcast earlier if they are operating a high performance aircraft)
4.	Pilot wishes to enter the circuit	Immediately before joining the circuit
5.	a). Pilot intends to make a straight-in approach; or	On final approach, no less than 3 NM from the runway threshold
	b). Pilot intends to join the circuit on base leg	Prior to joining on base
6.	Pilot intends to fly through the vicinity of a non-towered aerodrome (but not land), i.e. within 10 NM or at a height over the aerodrome which could conflict with operations	When the aircraft enters the vicinity of the aerodrome, as defined in CAR 166

Source: adapted from CASA, 2010a

The AIP (21.13) also advises pilots conducting an instrument approach to make a broadcast when departing the final approach fix (FAF) or established on the final approach segment inbound, or when terminating an approach and commencing a missed approach.

The ATSB strongly suggests that pilots who operate in the vicinity of these aerodromes take advantage of the information provided by CASA in CAAP 166-1 and 166-2 relating to broadcasting and phraseology in order to help themselves and all other pilots maintain good situational awareness.

Making additional broadcasts

It is important to note that these are only the minimum recommended broadcasts that all pilots are expected to make. The CAAPs provided by CASA for non-towered aerodrome operations encourage pilots to make more positional broadcasts where they feel it will improve situational awareness of other pilots, or reduce the risk of a collision (CASA, 2010a). Such broadcasts might include:

- turning downwind
- turning base
- turning final (with intentions)
- backtracking (if applicable)
- clear of the runway.

In particular, pilots' broadcasting their intentions when turning onto final is especially important. Seeing objects on the runway is difficult from the air, and these may include stationary or backtracking aircraft, aircraft lining up for takeoff, ground vehicles or maintenance personnel. Seeing other aircraft in the air, such as aircraft on straight-in approaches, is equally difficult. A 2004 review by the ATSB of the 37 mid-air collisions involving general aviation (GA) aircraft in Australia between 1961 and 2003 found that almost 80 per cent (n = 29) occurred in or near the circuit area, with a third of these involving aircraft on final approach or the base-to-final turn. Most of these collisions occurred where a faster aircraft descended upon the aircraft in front. Ground collisions (which contributed to several accidents at non-towered aerodromes between 2003 and 2008) can also occur on runways after landing. The risk of both ground collisions and mid-air collisions can be reduced by making a turning final broadcast as a warning to other pilots on approach or on the runway.

The necessity for the other circuit broadcasts depends upon the amount and type of traffic in the circuit or approaching the circuit, as well as their separation and flow. They are a matter of judgement for the pilot. If the traffic flow is established, frequency congestion might be a consideration when deciding on which circuit broadcasts to make. In comparison, if no other aircraft are heard or seen in the circuit, the pilot should consider making every possible broadcast in the off chance that there is another aircraft operating in their vicinity that they are unaware of.

In situations where one or more pilots do not broadcast appropriately, or are experiencing radio difficulties, there is the potential for a breakdown in situational awareness. This may result in an airprox or some form of conflict or reduced safety margin between an aircraft and other aircraft, ground vehicles, or parachutists.

For this reason, it is essential to maintain a vigilant lookout, even when appropriate broadcasts have been made on the CTAF.

While broadcasts should be made where a pilot deems they will improve situational awareness and reduce the risk of a collision, making unnecessary broadcasts that have no safety value (radio chatter) contributes to frequency congestion on the CTAF, and can be a source of distraction for other pilots. The following occurrence is a good example of the risks of unnecessary radio chatter.

Occurrence number 200506849

As the aircraft was taxiing for departure, the pilot of an arriving aircraft persisted in asking the female pilot of a departing aircraft questions of a personal nature over the radio. The female pilot reported that the chatter distracted her from the task of taxiing, resulting in the left wing striking the `Welcome' archway of the aerodrome as she was manoeuvring to avoid the arriving aircraft. The impact resulted in a hole in the leading edge of the aircraft wing approximately 60 cm inboard from the wingtip.

5 WHY CONFLICTS OCCURRED – CONTRIBUTING ERRORS

Errors (including violations) are observable individual actions or inactions by pilots, flight crew, or air traffic services (ATS) personnel that increase the likelihood of a safety occurrence and/or the severity of the adverse consequences associated with an occurrence.

When undetected, unmanaged or mismanaged, errors may lead to further errors occurring, or to an undesired aircraft state, which increases the risk of an accident or incident (Cheng, Inglis & Godley, 2009).

There are four broad error types recognised by the ATSB (information errors, action errors, decision errors, and violations – see section 2.1 for definitions), for which subcategories have been defined for this analysis.

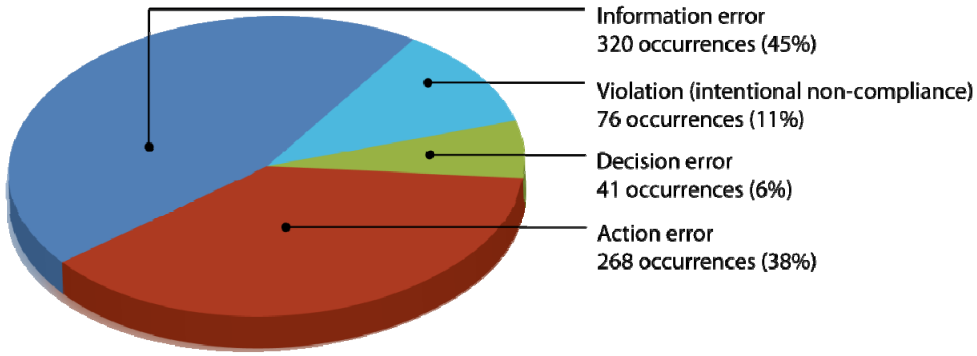
Information Errors	Decision Errors
Communication-related	Procedural
Situational awareness	Deviation from intentions
Position/proximity assessment	
ATS-related	
Action Errors	**Violations**[24]
Communication-related	Intentional non-compliance
Procedural	Poor airmanship
Other	Landing on occupied runways

Contributing error types were coded for each of the 709 occurrences in the reporting period based on the summary information provided to the ATSB at the time of notification. Error types allow occurrences to be categorised based on the primary reason that contributed to the occurrence. In some cases, more than one error increased safety risk; for example, an aircraft entering a circuit incorrectly, and not making the recommended broadcasts.

[24] Occurrences are only considered violations if these acts are committed intentionally.

Information errors were the most common type of error that occurred in airspace, operational and procedural-related occurrences in the vicinity of non-towered aerodromes (Figure 6).

Figure 6: Types of errors contributing to 709 non-towered aerodrome occurrences, 2003 to 2008

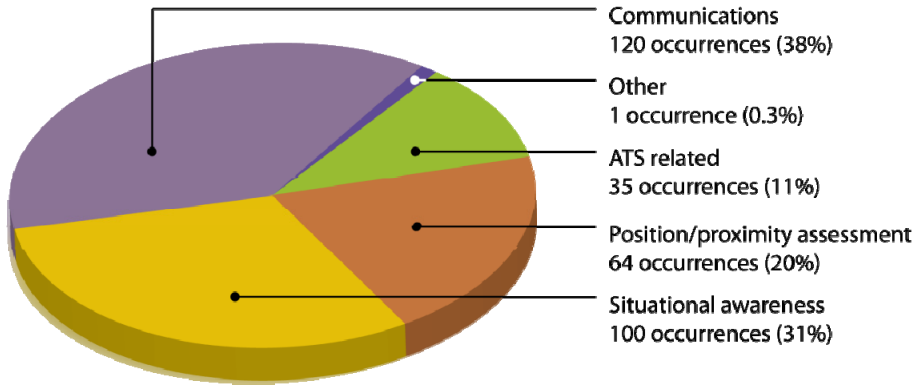


5.1 Information errors

Information errors were the most common contributor to occurrences at non-towered aerodromes (320 occurrences). Information errors were either:

- communication-related
- related to situational awareness of other aircraft
- due to an incorrect assessment of position or proximity to other aircraft
- due to actions by ATS personnel (Figure 7).

Figure 7: Sources of information errors in non-towered aerodrome occurrences



Communication-related information errors (two-fifths of cases) involved situations where the pilots of one or more aircraft did not hear or receive broadcasts from the pilots of another aircraft who had probably made a broadcast. This could be due to frequency congestion, radio frequency interference, or for some unknown reason outside of the control of the pilot. Radio and microphone failures were also coded as communication-related information errors. While not known, some of these errors

may have been due to action errors by one of the pilots (such as not tuning the radio to the correct Common Traffic Advisory Frequency (CTAF) being used in the vicinity of that aerodrome). Situations where a pilot reported their location differently from their actual position were also coded as communication-related errors. This occurred in 13 cases.

Source: photo courtesy of Alex Gagiero (Temora Aerodrome, NSW)

Situational awareness-related information errors (almost one-third of cases) were related to situations where one or more pilots had a less than adequate awareness of nearby traffic. For example, a situation where a pilot taxied across an active runway without broadcasting and it was known that he did not look to see if any aircraft were on approach or takeoff was coded as a situational awareness error. Situational awareness errors also included pilots landing on an incorrect runway.

Position/proximity assessment-related information errors (one-fifth of cases) occurred when a pilot incorrectly assessed the position or intentions of the pilot of another aircraft that they were aware of (leading to a reduced safety margin between those two aircraft), or came too close to another aircraft that they were aware of on approach or operating in a circuit. In 47 occurrences, the pilots were maintaining separation with the assistance of radio alerting (or in some cases, the flight crew of one aircraft were maintaining visual separation with a non-broadcasting aircraft); however, the assessment of separation was found to be incorrect (due to a Traffic Collision Avoidance System (TCAS) traffic advisory (TA)[25], or because of a manoeuvre by one of the aircraft).

---

[25] A traffic alert (TA) is the first level of warning provided by a TCAS/ACAS to pilots and flight crews that the margin of separation between two aircraft is reduced, and that the aircraft are coming into conflict. TAs are intended to assist the pilot to visually acquire the conflicting aircraft, and prepare the pilot for a potential resolution advisory (RA) if the TCAS/ACAS determines that there is a risk of a collision. TCAS/ACAS operates on relatively short time scales. The maximum generation time for a TA is 48 seconds before the point of collision. For an RA, the time is 35 seconds. The time scales are shorter at lower altitudes (where aircraft typically fly slower). Unexpected or rapid aircraft manoeuvres may cause an RA to be generated with much less lead time. It is possible that an RA will not be preceded by a TA if a threat of collision is imminent (EUROCONTROL, 2010).

A number of reports (n=40) indicated that see-and-avoid was a pilot's only indication of conflicting traffic, resulting in reduced separation between their aircraft and another. Only a third of these were considered to be position/proximity/intentions assessment errors, as in most cases the reporting pilot or flight crew was not aware of the aircraft's existence until seeing it in close proximity. The majority of these occurrences involved an aircraft on approach with the other aircraft on takeoff/initial climb on a reciprocal track. Estimates of separation at the time of the occurrence provided by the reporting pilot/flight crew demonstrated the high potential for a mid-air collision where good awareness of nearby traffic is not maintained, and intentions and position are not broadcast properly and accurately – in no less than 18 cases, margins of less than 300 ft vertical and 500 m lateral separation existed.

In some of these occurrences (n=52), a TCAS TA provided the pilot's first warning of a reduced safety margin between their aircraft and another aircraft (see section 6.3.1 for a further discussion of TCAS events).

The remaining information errors occurred due to ATS actions. These involved situations where an enroute controller advised the pilot of an instrument flight rules (IFR) aircraft of nearby traffic, but gave an incorrect altitude or position, or had not passed on pertinent traffic details, leading to an airprox or other separation issue. There were 35 occurrences involving ATS errors, of which most were failures to pass on correct or timely IFR traffic information. About a third of these (n=12) were temporary lapses which were picked up before there was a reduced separation margin between aircraft.

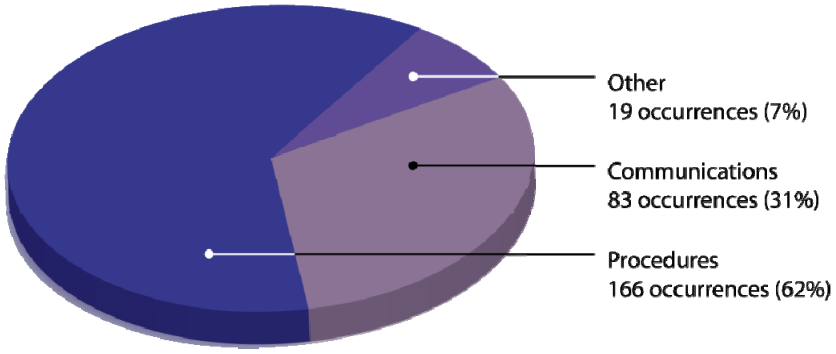
Very few ATS errors (n=7) led to a legitimate conflict between two aircraft. In these cases, the flight crew of each aircraft was aware of each others' presence through the use of see-and-avoid, and/or correct broadcast procedures and mutually arranged separation.

In one occurrence, there was a miscommunication between ATS and several enroute passenger transport aircraft as a result of errors associated with the read-back of callsigns.

5.2 Action errors

Action errors were the second most common type of error involved in occurrences at non-towered aerodromes (268 occurrences). Action errors were largely either procedural-related or communication-related (Figure 8).

Figure 8: Sources of action errors in non-towered aerodrome occurrences



Procedural action errors (three-fifths of cases) were largely situations where a pilot did not, or was not heard to make all of the recommended broadcasts. Some of these errors may have been a result of intentional non-compliance with broadcast rules, but based on the information reported to the ATSB, it is generally impossible to determine whether the errors were intentional (violations) or unintentional. In some cases, a broadcast was made during the take-off roll, or on final approach, however this was the first communication that had been heard from the aircraft by other pilots operating in the vicinity of the aerodrome.

Communication-related action errors (one-third of cases) occurred when a pilot did not hear/receive/transmit broadcasts as their radio was not tuned to the CTAF, the radio volume was turned down to an inaudible level, the wrong radio was selected, or generally the radio was used incorrectly. To prevent these types of errors from occurring in areas where CTAF is used, pilots should listen out for the 'beep back' from Aerodrome Frequency Response Units (AFRUs) that *may* be installed at the aerodrome. These facilities provide an automatic response to pilots' radio transmissions on the CTAF. They provide a safety benefit to pilots as they confirm the operation of the aircraft's radio transmitter and receiver, the volume setting, and that the pilot has selected the correct frequency for use at that aerodrome.

As of June 2010, about 100 non-towered aerodromes in Australia were equipped with an AFRU.

For example, at Hervey Bay Aerodrome, the AFRU provides a response when:

- there has been no transmission on the CTAF for at least 5 minutes, and a pilot made a transmission of more than 2 seconds (automated response would be 'Hervey Bay CTAF'); and
- a pilot made a transmission of more than 2 seconds within the last 5 minutes, a 300 millisecond tone would be automatically transmitted by the AFRU facility (ATSB, 2007a).

5.3 Decision errors

Decision errors were the primary contributor to only 41 occurrences. Decision errors were mostly procedural-related, however, some were due to a deviation from the pilot or flight crew's previously established plans.

Procedural decision errors (37 cases) involved unintentional non-compliance with notices to airmen (NOTAMs) (such as landing on a closed runway), entering the circuit incorrectly, or operating against the published circuit direction.

Deviation-related decision errors (four cases) involved pilots deviating from track, or changing their broadcasted intentions (such as landing on a different runway to the one they had advised).

5.4 Violations (intentional non-compliance)

Seventy-six occurrences were classified as violations.

Occurrences considered to be a violation of safe operating procedures were limited to displays of poor or unprofessional airmanship or unsafe behaviour, such as:

- cutting in front of other aircraft during leg turns in a circuit
- operating in the vicinity of aerodromes requiring radio carriage without serviceable radio equipment (those aerodromes formerly designated as CTAF(R), and in Mandatory Broadcast Zones (MBZs))
- dropping parachutists over an active runway without broadcasting
- continuing to operate contrary to circuit procedures after acknowledging advice on correct procedures from other nearby aircraft
- transiting a non-towered aerodrome at circuit height or below the minimum safe altitude
- landing or taking off from occupied runways
- operating at night without lights.

Because airspace surrounding non-towered aerodromes is often uncontrolled and separation standards are not applied, pilot actions leading to airprox occurrences were generally not coded as violations in this analysis (rather, they were coded as position/proximity assessment-related information errors). In many cases, an estimate of lateral and vertical separation between aircraft at the time of the occurrence was not reported to the ATSB, making it difficult to determine whether a reported 'near-miss' constituted an airprox.

There were seven instances where the pilot did not carry serviceable very high frequency (VHF) radio equipment when operating in the vicinity of CTAF(R)/MBZ aerodromes where radio carriage was required, or when conducting IFR flight as required by the regulations.

6 MONITORING AND AWARENESS

Better situational awareness and greater safety is gained by all pilots monitoring the Common Traffic Advisory Frequency (CTAF) in the vicinity of an aerodrome, and by making the recommended broadcasts. The Civil Aviation Advisory Publications (CAAPs) for non-towered aerodrome operations reinforce the importance of making broadcasts and monitoring the CTAF to help all pilots in the vicinity of a non-towered aerodrome achieve radio-alerted see-and-avoid.

The most hazardous phases of flight (takeoff and climb, and approach and landing) are within 5 NM of an aerodrome, and at an altitude below 3,000 ft above ground level (AGL). Within this area, there is a higher traffic density, and it is possible to find pilots who have inadvertently selected the wrong frequency or have not made positional broadcasts, and pilots operating in non-radio equipped aircraft flying circuits or manoeuvring. Within the 10 NM vicinity of non-towered aerodromes, there may be other aircraft above the circuit height that are transiting overhead the aerodrome, but are at a height which could conflict with circuit operations or inbound/outbound aircraft. Not all of these overflying pilots may be aware of their responsibilities under Civil Aviation Regulation (CAR) 166 to make broadcasts and monitor the CTAF, or may not even be aware that they are overflying a non-towered aerodrome at all.

A visual lookout supported by CTAF broadcasts is also important because it seems some pilots do not always behave professionally and follow procedures. Pilots are expected to operate in a courteous and professional manner at all times. Aviation safety relies upon a cooperative approach between all pilots, particularly on and in the vicinity of aerodromes in times of busy traffic (CASA, 2010b).

The following report was received by the ATSB through the Aviation Confidential Reporting (REPCON) scheme about a pilot flying into a Victorian non-towered aerodrome, and is an example of the elevated collision risk that exists when pilots do not observe good airmanship principles:

> A Piper Cherokee aircraft was on late downwind for runway 09 when the pilot of a Cessna 206 called joining base for runway 27. Before entering the circuit, the Cherokee pilot had called inbound and joining upwind for runway 09 on the CTAF, but had not heard any transmissions from the Cessna pilot prior to the base broadcast.
>
> The Cherokee pilot called the Cessna twice to report that the Cherokee was on the downwind leg for runway 09, but did not receive a readable response. The Cessna landed on runway 27, forcing the Cherokee to go around and make an additional circuit and landing on runway 09.
>
> When queried on his actions, the Cessna pilot informed the Cherokee pilot that he was running a commercial operation and did not have time to waste on procedures.
>
> The Cherokee pilot later commented that although there was no collision risk, the Cessna pilot's disregard for circuit procedures and radio procedures indicated a very unprofessional attitude.

A 2004 ATSB review of all 37 mid-air collisions in Australia between 1961 and 2003 (ATSB, 2004) identified that radio problems, use of the wrong frequency, or failure to make the standard positional broadcasts led to many of these collisions.

- In at least six of the aeroplane/aeroplane collisions, one or both pilots did not hear a required radio broadcast made by the other pilot.
- In three of the aeroplane/glider collisions, neither pilot was using the radio.
- In two of the aeroplane/glider collisions, one of the pilots did not make the standard positional broadcasts.
- In one of the aeroplane/glider collisions, one of the pilots used the wrong frequency to make the standard broadcasts.
- In one of the aeroplane/aeroplane collisions at a non-towered aerodrome, the pilot did not make a required broadcast due to radio frequency congestion.

These occurrences show clearly that having a radio is no guarantee of safety. See-and-avoid is a defence that is always available in visual conditions and sometimes is the only defence available. However, you may not realise it is the only defence available to you until it is too late, so continual use of unalerted see-and-avoid in the vicinity of an aerodrome is essential.

Furthermore, pilots should be mindful that transmission of information by radio does not guarantee receipt and complete understanding of that information. Pilots may not be tuned to the radio frequency allocated for CTAF, have the radio volume turned down, or have radio problems. Many of the worst aviation accidents in history have their genesis in misunderstanding of radio broadcasts, over-transmissions, or poor language/phraseology, which undermined the value of the information being transmitted. Without understanding and confirmation of the transmitted information, the ability to achieve alerted see-and-avoid is reduced (CASA, 2010b).

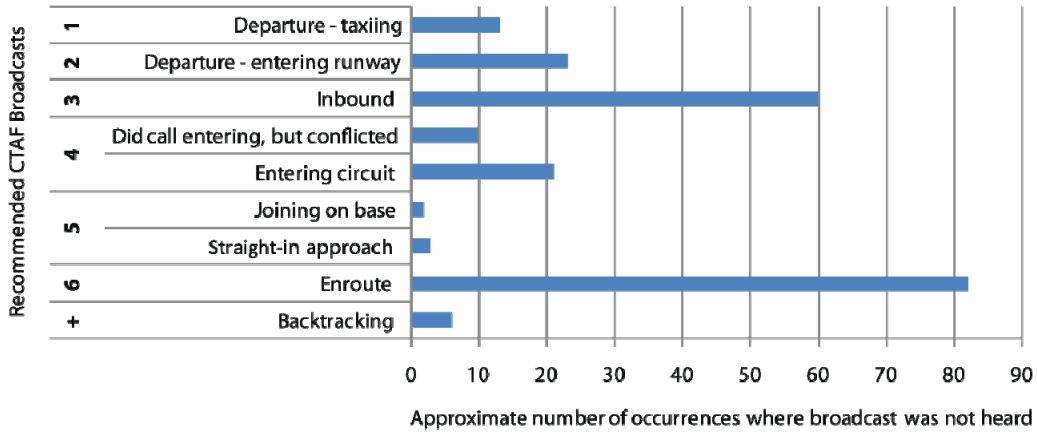
6.1 Occurrences involving non-broadcasts

As discussed in section 4.4, pilots operating at non-towered aerodromes are expected to make a series of standard broadcasts regarding their position and intentions. The aim of these broadcasts is to improve situational awareness for all pilots operating in the circuit, on approach, or transiting in the vicinity of the aerodrome.

A review of the 709 occurrences between 2003 and 2008 suggested slightly over 200 cases where pilots flying within 10 NM of a non-towered aerodrome may not have been broadcasting or maintaining a continuous watch of the CTAF. This included instances of not being tuned to the correct frequency, having the radio volume turned down, faulty radio equipment, not making broadcasts, or through other distractions.

It was generally difficult to determine from the reported information exactly why a broadcast was not heard - because it was not made, because a pilot did not hear it due to distraction or radio interference, because of a radio problem, or if it was for some other reason. Figure 9 gives an approximation of how frequently each of the recommended broadcasts was not heard, based on a review of these 200 or so occurrences. It also provides an indication of situations where backtracking broadcasts (while not required) were not made, leading to a breakdown in situational awareness and reduced separation between two aircraft.

Figure 9: Frequency of recommended broadcasts not being heard or made by pilots, 2003 to 2008



The need for good airmanship and broadcasting by pilots is central to safety in the non-towered aerodrome environment, and will continue to be following the 3 June 2010 changes. This section discusses each phase of a flight where it is good practice to make broadcasts, and the prevalence of non-broadcasting by aircraft at each which led to an occurrence (sometimes causing a conflict).

Departure - before taxiing / entering the runway

Taxiing and standing aircraft were involved in 106 occurrences at non-towered aerodromes between 2003 and 2008. Thirteen of these occurred at the start of the taxi. Twelve occurrences involved an aircraft departing an aerodrome without making any taxiing broadcasts. In one occurrence, the aircraft made the correct broadcasts, but on the wrong frequency.

Aircraft entering an active runway without the pilot stating their intentions on the CTAF were involved in 23 incidents.

In both cases, the pilots of most of these aircraft did not make a start of taxi or entering runway broadcast. About a third did make the appropriate broadcasts, but could not be heard by other pilots (due to a low radio volume level, or because they were broadcasting on an incorrect frequency).

Approaching the aerodrome

There were 60 occurrences identified where the 10 NM inbound broadcast that is recommended for pilots intending to land at a non-towered aerodrome was not heard by other pilots operating in the vicinity.

The CAAP 166-1 regulations and the Aeronautical Information Publication (AIP) recommend that pilots should be monitoring the CTAF and have made a positional broadcast when inbound to a non-towered aerodrome at a distance of 10 NM (18.5 km) or earlier of that aerodrome. This is also reflected in the En Route Supplement Australia (ERSA). This has been the situation both prior to, and after the 3 June 2010 changes to CAR 166.

Despite this recommendation, over 200 incidents were identified within this 10 NM limit where pilots were probably not appropriately monitoring the CTAF and/or not making broadcasts, and hence were unaware or only partially aware of nearby traffic and their intentions.

Straight-in approaches

Following the National Airspace System (NAS) 2C changes in November 2005, pilots of any radio-equipped aircraft have been permitted to conduct straight-in approaches at all non-towered aerodromes (unless otherwise specified in the ERSA) – providing that they broadcast their intentions correctly by radio. Although permissible, straight-in approaches should only be made where it does not disrupt the flow of arriving and departing traffic.

Between 2003 and 2008, aircraft conducting straight-in approaches were only involved in 16 conflicts, of which half were passenger transport aircraft. In almost all of these occurrences, the actions of the pilot of the other aircraft (in the circuit, or lined up to takeoff) involved led to the conflict. In one occurrence, a GA aircraft made a straight-in approach which was not allowed under local aerodrome procedures. In another occurrence, it was alleged that the crew of a regular public transport (RPT) aircraft reported an incorrect arrival time in order to gain first position to land, coming into conflict with another circuiting aircraft.

There were only three occurrences identified where an aircraft conducted a straight-in approach without making the required broadcast on the CTAF.

Entering the circuit

Under non-towered aerodrome procedures, a pilot may approach an aerodrome for landing by entering the circuit for the runway they are intending to use (Figure 10). Aircraft entering the circuit generally do so by joining the crosswind or downwind legs of the circuit in accordance with the circuit entry requirements specified in CAR 166.

The 3 June 2010 changes to CAR 166 have provided some new options for pilots to enter the circuit. Straight-in approaches and entry at base leg (while no longer prohibited) are not recommended standard entry procedures. Aircraft may only

conduct these approaches if the aircraft is radio-equipped, they are qualified to use the radio[26], they make the required broadcasts, and give way to aircraft already established in the circuit.

There are many different methods of approaching the aerodrome and entering the circuit (Figure 10), and at these points there is a risk of conflict between entering aircraft, arriving or departing aircraft, and aircraft already established in the circuit if situational awareness of traffic is not maintained. For this reason, all entry methods involve specified entry broadcasts– whether circuit entry is a straight-in approach, on base, on downwind, on a 45 degree angle to downwind, or on crosswind. For straight-in approaches (only permitted for radio-equipped aircraft), broadcasts should be made at no less than 3 NM on final with intentions. In all cases, pilots conducting straight-in approaches must give way to other aircraft operating in the circuit.

A review of the 709 occurrences between 2003 and 2008 revealed only 21 occurrences where a pilot did not broadcast their intentions to enter the circuit. There were very few occurrences (n=7) where a failure to report entering a circuit led to a conflict with another aircraft established in the circuit.

However, Figure 9 shows that there were 10 occurrences where the appropriate circuit joining broadcasts were made, but a conflict still occurred with an aircraft already established in the circuit. These may have been due to distractions, low radio volume, one of the aircraft being tuned to an incorrect frequency, radio equipment problems, or other situational awareness issues.

There were only two reports of an aircraft entering a circuit on base leg (which was not allowed prior to 3 June 2010) without making the necessary broadcasts.

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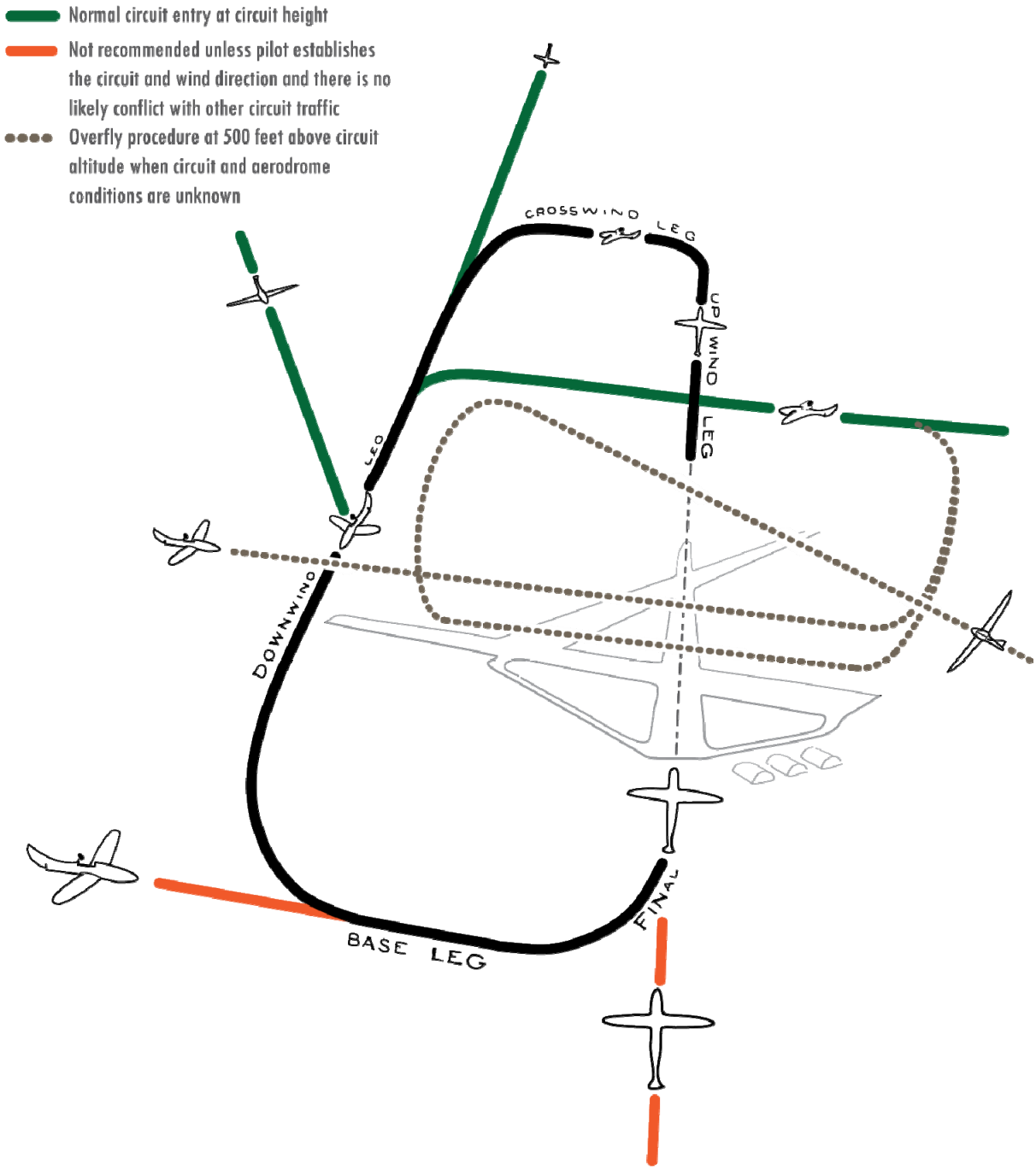
[26] As part of the 3 June 2010 changes to CAR 166, pilots are now required to be qualified to use the radio in their aircraft. Applicable licences are the Flight Radiotelephone Operator Licence or the Aircraft Radio Telephone Operator Certificate of Proficiency. Readers can find out more about the qualifications needed to gain this licence in CAR 5.61.

Figure 10: Typical circuit entry methods at Australian non-towered aerodromes since 3 June 2010



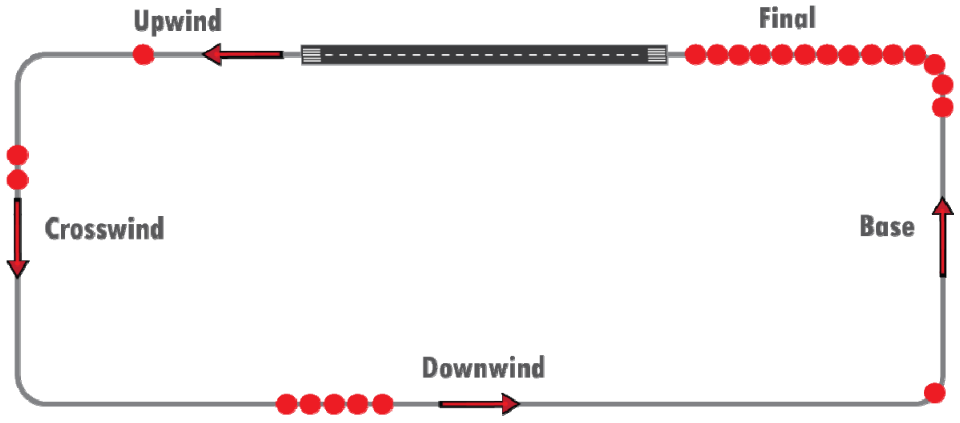
Source: adapted from CASA, 2010a, CAA 1981

Circuit operations

Making appropriate broadcasts in the circuit area is important so that all pilots can maintain awareness of other traffic. While the CAR 166 non-towered aerodrome procedures do not require pilots to make specific broadcasts when operating in the circuit, they are a positive and proactive way to help all pilots in the circuit at an aerodrome to maintain awareness of their position and the position of other aircraft in the circuit.

Mid-air collision data from 1961 to 2003 (ATSB, 2004) found that almost 80 per cent (n = 29) of mid-air collisions occurred in or near the circuit area, with two-thirds of these involving aircraft on final approach or the base-to-final turn (Figure 11). That study also determined that 59 per cent of these collisions occurred outside the major GA aerodromes (those that were formerly General Aviation Aerodrome Procedures (GAAP)); however, only one collision had ever occurred in a Mandatory Broadcast Zone (MBZ)[27] where radio carriage was required (ATSB, 2004).

Figure 11: Location of mid-air collisions in the circuit (constituting 29 of the 37 mid-air collisions in Australia between 1961 and 2003)



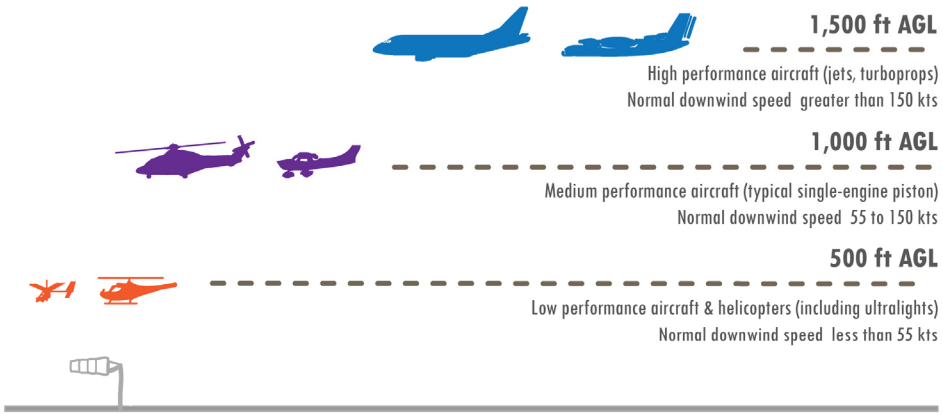
Source: ATSB, 2004

[27] MBZs were introduced in 1991, and were replaced in 2005 by CTAF(R) procedures following the NAS 2C implementation. CTAF(R) themselves were abolished from 3 June 2010, when radio carriage and use became mandatory at all registered, certified, military, and other specified non-towered aerodromes. While CTAF(R) did not have a specified airspace boundary like MBZs did, they had comparable radio carriage and broadcast requirements.

At non-towered aerodromes, circuits are conducted at different heights depending on the performance of the aircraft (Figure 12). The purpose of prescribed circuit heights is to separate fast moving aircraft from slow moving aircraft in the interests of situational awareness and separation.

Further recommendations about circuit entry and height procedures are provided by CASA in CAAP 166-1.

Figure 12: Standard circuit heights depend on aircraft performance since 3 June 2010



Source: adapted from CASA, 2010a; Department of Transport and Regional Services, 2005

There were 61 conflicts between 2003 and 2008 involving aircraft operating in a circuit, including the occurrences discussed earlier where entering aircraft conflicted with other aircraft established in the circuit. The most common types of conflict were:

- aircraft head-on in the circuit (n=20)
  - due to an aircraft contravening the circuit direction (n=13)
  - an aircraft on final approach on a runway conflicting with an aircraft on upwind for the reciprocal runway (n=7).
- conflicts between aircraft on base and on takeoff or final approach (n=14)
- enroute aircraft crossing the aerodrome and descending into the circuit level inadvertently (n=7)
- reduction of separation between aircraft following each other in the correct circuit direction (n=6)
- reduced vertical separation between aircraft at different circuit heights (n=4).

Enroute

Only about 20 per cent (n = 169) of occurrences at non-towered aerodromes involved aircraft that were enroute in the vicinity of the aerodrome (either transiting, or manoeuvring within 10 NM), and were at a height that could have conflicted with operations at that aerodrome.

When enroute, CAR 166 recommends that pilots make a broadcast where they intend to fly through the vicinity of a non-towered aerodrome (but not land), either within 10 NM, or at a height over the aerodrome which could conflict with operations.

Half of these enroute occurrences (n = 82) involved situations where other pilots in the vicinity of a non-towered aerodrome did not hear the recommended 'enroute' broadcast on the CTAF from an enroute pilot. This may have been due to the broadcasts not being made by the enroute pilot. However, distractions, low radio volume, one of the aircraft being tuned to an incorrect frequency, radio equipment problems, or other situational awareness issues may have contributed to these broadcasts not being heard.

Clear of runway

In 31 occurrences, an aircraft on final either landed with, or was forced to conduct a go-around due to, an aircraft backtracking on the active runway. In some of these cases, it was likely that the pilot of the landing aircraft had assumed that the preceding aircraft had cleared the runway at the end of its landing roll, even though a 'clear of runway' broadcast was not made (as recommended by CAR 166), or a 'backtracking' broadcast had not been made. A review of the 709 occurrences between 2003 and 2008 found that aircraft that backtracked down a runway without making an appropriate 'backtracking' broadcast led to a loss of separation assurance between two aircraft on six occasions. These situations reinforce the importance of listening to the CTAF and being aware of the position and intentions of other operating aircraft. While backtracking broadcasts are not required, they help to reduce the chance of runway incursions by improving the situational awareness of pilots on approach, or who are intending to enter the runway.

From the information provided to the ATSB in occurrences reports, there was not enough detail to establish whether pilots had made broadcasts on the CTAF indicating that they had cleared the runway.

Source: Thinkstock Images

6.2 Why weren't pilots monitoring the CTAF or making broadcasts?

Almost all of the occurrences in the reporting period involved aircraft that were equipped with a radio. While there is flexibility in what broadcasts can be made when operating at non-towered aerodromes, it is important that all pilots with a radio actively monitor the specified CTAF and make at least the standard broadcasts at a minimum using the correct phraseology. Effective use of the radio makes the job of seeing other aircraft in the circuit and approach areas easier for all pilots.

In 146 of the 709 occurrences, pilots had tuned their aircraft's communications (COM) radio to a frequency which was not the CTAF frequency (often the area frequency, or a CTAF frequency that was no longer current), or did not hear or respond to broadcasts for an unknown reason.

Almost all of these occurrences (96 per cent) happened within the 10 NM (18.5 km) area defined by CAR 166 and the CAAPs in which broadcasts should be made.

In 52 occurrences, a pilot operating at or near a non-towered aerodrome reported that they could not transmit or receive broadcasts due to a radio problem. Only 24 of these occurrences involved instances where a pilot was unable to communicate on the CTAF due to a suspected radio failure. In these cases, CAR 166(E) and the ERSA EMERG procedures require pilots to rock their aircraft's wings from side to side, turn on any external landing or navigation lights, broadcast intentions as if the radio transmitter was working (prefixing broadcasts with 'TRANSMITTING BLIND'), turn on their transponder (if fitted) to Mode C squawk 7600, and land at the nearest suitable aerodrome. In these cases, circuit entry should only be made on crosswind.

The remainder of these occurrences were generally due to the radio volume being turned down so that broadcasts from other nearby aircraft were not audible. There were three instances of language difficulties contributing to a breakdown in communication between pilots and other pilots or air traffic services (ATS) personnel.

Some of these occurrences were due to reported congestion on the CTAF (two aircraft transmitting at the same time, radio chatter), or confusion between pilots of aircraft operating into two different aerodromes in close proximity using the same frequency allocation.[28] This has the potential to occur at places such as Lismore and Ballina. While sharing of a single CTAF at nearby aerodromes has the potential to ensure situational awareness of other aircraft is gained, pilots need to be especially vigilant that they broadcast their location and intentions accurately.

[28] The ATSB was not able to determine from the reported information whether the pilots involved in these occurrences were following the correct CAR 166 broadcast phraseology, in which the pilot must start and end all broadcasts with their location.

Terrain, buildings, or other man-made or natural features can also cause radio frequency interference or isolated dead zones that can prevent clear transmissions on the CTAF if an aircraft is transiting through that area. For example, a radio interference problem was recently addressed at Broken Hill Aerodrome:

> Recently Broken Hill area had a hash problem on 126.7 MHz in the vicinity of the airfield, but aircraft could not hear the interference on the ground. The fault was reported by Royal Flying Doctor Service aircraft and local flyers as occurring in the Northwest sector only. Airservices with the aid of this information was able to find the faulty transmitter, which was located near a large slag heap close to the airfield, thus causing a dead zone of hearing on the airfield. The lack of interference occurring on the airfield was a contributing factor in analysing where the source emanated from. The transmitter was turned off until repairs were carried out.
>
> Source: CASA, 2010c

In instances where interference is occurring, pilots should report the issue to Airservices Australia for further investigation, and provide the following information if possible:

- the type of interference, the signal strength, hash (electrical or mechanical sounding) and tone (continuous or broken, and the repetition rate)
- if broken or garbled audio can be distinguished (AM/FM radio stations, ATC or taxi broadcasts)
- the location of the aircraft at the time of interference (latitude/longitude, bearing, time, distance from distance measure equipment (DME) or runway threshold, altitude)
- if other pilots were able to confirm the interference
- whether the interference could be heard on the ground.

This information allows Airservices Australia to identify the type, source, and location of the interference, and resolve the issue quickly.

6.3 Other alerted 'see-and-avoid' tools

6.3.1 Traffic Collision Avoidance System (TCAS/ACAS)

There were 87 occurrences where flight crew were alerted about a potential conflict with another aircraft through a TCAS/ACAS traffic advisory (TA) or resolution advisory (RA).[29] Of these TCAS alerts, at least 73 were RAs, and 18 of these indicated that an airprox had occurred.

This does not necessarily indicate that the flight crews/pilots of each aircraft were not aware of each others' presence and position, either visually, by radio, and/or by proximate aircraft paints on the TCAS/ACAS plan position display. There were, however, 52 occurrences where the other aircraft was not visually sighted or in communication prior to a TCAS/ACAS TA or RA being issued to at least one of the flight crews/pilots.

Due to the airspace design around Avalon Aerodrome, there were a large number of TCAS/ACAS alert events that occurred on aircraft operating on approach or circuiting Avalon where traffic advisories were provided on aircraft transiting in the vicinity of Avalon, or conducting circuits at Point Cook Aerodrome.

6.3.2 Air-ground radio services

Air-ground radio services exist at some non-towered aerodromes to provide further operational information to pilots, and to support broadcasts on the CTAF. Certified Air-Ground Radio Services (CA/GRS), Universal Communications (UNICOM) and Flight Information Service operators can provide the following information at some aerodromes via broadcasts on the CTAF:

- confirmation of the CTAF radio frequency allocation being used
- estimated times of arrival and departure for aircraft operating to/from that aerodrome
- aerodrome and runway information
- unscheduled landings by aircraft
- general weather reports
- advice to emergency services regarding aircraft in need of assistance
- fuel requirements
- maintenance and servicing of aircraft, including the ordering of urgently required parts and materials
- passenger requirements.

In addition, CA/GRS and Flight Information Service are also authorised by CASA to provide basic traffic information to pilots. These air-ground radio services exist only as a tool to help enhance pilots' situational awareness, and are not a traffic separation service. Unlike CA/GRS, UNICOMs are not designed to provide any traffic information. In both services, information is provided on pilot request. The

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[29] The ATSB only records TCAS TAs and RAs as safety occurrences if they occurred as the result of another safety issue (such as an airprox, reduced separation between aircraft, missed approach, or a communication breakdown).

information provided depends on the type of operation (VFR or IFR), radar coverage, and what type of radio equipment is being carried onboard the aircraft.

Safety improvements related to CA/GRS and UNICOM services

While it is difficult from ATSB occurrence data to quantify the effectiveness of air-ground radio services in improving safety, a limited comparison of situational awareness and communication-related occurrences was performed between those non-towered aerodromes providing CA/GRS and UNICOM service, and all non-towered aerodromes in Australia.

At non-towered aerodromes where CA/GRS services were provided (Broome and Ayers Rock), information provided by the CA/GRS operator was not a contributing factor in any of the 33 airspace/communication/procedures-related occurrences between 2003 and 2008. An analysis of the types of errors contributing to these occurrences at Broome and Ayers Rock aerodromes (compared to all other non-towered aerodrome locations where CA/GRS was not provided) found that there were less than the average number of occurrences related to communication problems (24 per cent compared to an average of 29 per cent for all non-towered aerodromes), but more procedural mistakes (37 per cent compared to an average of 28 per cent for all non-towered aerodromes). There were no occurrences reported to the ATSB where information provided by the CA/GRS operator negatively influenced situational awareness of pilots operating in the vicinity of Broome and Ayers Rock Aerodromes.

Airservices Australia provided a modified UNICOM service for a trial period between 2007 and 2009 at a handful of non-towered aerodromes (Dubbo and Wagga Wagga from December 2007 to March 2009; Hervey Bay, Port Macquarie and Olympic Dam from October 2008 to March 2009). Under this trial, the UNICOM operators were permitted to provide basic traffic information in addition to the normal operational and aerodrome information they provide – effectively making them equivalent to a CA/GRS. During these periods, a total of 25 safety incidents were reported to the ATSB relating to airspace use, communications, separation, and procedural compliance at the UNICOM trial aerodromes. In more than half of these 25 incidents, the ATSB assessed that the information provided to the pilots by the UNICOM operator appeared to positively affect the situational awareness of pilots, or could have altered their situational awareness of other aircraft. In three instances, situational awareness was negatively influenced by UNICOM information due to operators providing an incorrect traffic statement.

Very few of the incidents that did occur at CA/GRS and UNICOM trial aerodromes involved airproxes or Traffic Collision Avoidance System resolution advisories (TCAS RAs). Situational awareness-related information errors were rare at CA/GRS or UNICOM aerodromes; in both cases, situational awareness-related errors were involved in less than 15 per cent of occurrences.

The requirements for air-ground radio operators and services are established in CASR Part 139 Manual of Standards (CASA, 2002). Further information on these services and the Airservices UNICOM Trial is provided in Appendix C.

Not a substitute for maintaining an effective lookout

While Flight Information Service, CA/GRS and UNICOM are important third-party services that provide an additional level of information to pilots operating in the vicinity of aerodromes without an active air traffic control service, there is a risk that pilots could become too dependent on these services as a means of gaining situational awareness. Even where available, these services are not designed to provide complete traffic information or a separation service, and do not operate at all hours. These types of information services, while useful tools, are never a substitute for monitoring the CTAF, making appropriate broadcasts, and maintaining a vigilant lookout. Flight Information Service, UNICOM and CA/GRS communications always take second place to pilot-to-pilot communications.

The operators of CA/GRS and UNICOM services are not air traffic controllers, and therefore they do not provide conflict avoidance advice or direction. Conflict avoidance responsibility remains entirely with the pilot, and it is the pilot's responsibility to validate the accuracy of information received from these services and identify situations where they need to take action to ensure separation. The responsibility for the safety of an aircraft always remains with the pilot (CASA, 2007a).

Mid-air collisions have occurred in Australia due to a lack of situational awareness of other traffic even when an air-ground radio service was operating:

In February 2002, a Cessna 172 Skyhawk aircraft and a TL Sting ultralight converged and collided at low altitude in the vicinity of the threshold of runway 24 right at Jandakot Aerodrome, WA. Both aircraft were attempting to land at the time of the accident. The occupants of both aircraft were uninjured, but the TL Sting was substantially damaged and the Cessna sustained minor damage.

Jandakot Tower was active until a short time before the collision, and both aircraft had conducted their arrival to the aerodrome under General Aviation Aerodrome Procedures (GAAP). The GAAP control zone was deactivated at the scheduled time (1800 local time), and the aircraft were operating under MBZ procedures for the final stages of their flights.

At the time of the collision, a CA/GRS operator was providing operational information to pilots. Although the CA/GRS used the facilities of the control tower to provide this service, this did not include any function of air traffic control.

The investigation by the ATSB determined that the pilot of the Cessna had probably sighted the wrong aircraft to follow when provided with sequencing instructions by the aerodrome controller. The pilot of the Cessna did not see the TL Sting during his base and final approach. This task was made more difficult by a number of factors, including the lack of contrast between the TL Sting and the background terrain, the relative position between the two aircraft during the final stages of the approach, and possibly the effects of sun glare. This was compounded by the pilot's perception that the aircraft ahead had already landed. A short time after the collision, the aerodrome operator withdrew the CA/GRS service. The tower operator subsequently reviewed the provision of air traffic services, and extended tower hours of operation.

Source: ATSB, 2004

7 OUTCOMES OF CONFLICTS

7.1 Accidents and serious incidents

7.1.1 Accidents with fatal injuries and aircraft damage

While almost all occurrences across the reporting period were incidents in which no injuries or damage occurred, seven accidents and serious incidents did result in damage and/or injuries.

In April 2004, a formation of three de Havilland DH-82 Tiger Moth aircraft was on approach to land at Torquay Aerodrome, Vic., when weather conditions deteriorated to heavy drizzle with reduced visibility. One of the aircraft landed on an all-over field[30], while the other two aircraft inadvertently approached and landed on opposite ends of runway 18/36. The thresholds of this runway are not visible from the opposing threshold due to a crest in the runway. While at taxi speed, the aircrafts' wingtips collided due to a lack of forward visibility in the taxi attitude. Radio difficulties also contributed to the accident. There were no injuries.

In March 2005, two Rolladen-Schneider LS7 gliders collided in mid air while manoeuvring near Dookie Aerodrome, Vic. The pilot of one glider sustained a serious injury, but was able to parachute to safety. The pilot of the second glider was fatally injured. Both gliders were destroyed.

In December 2005, two Piper PA-28 Warrior aircraft collided 2 km north-east of Coldstream Aerodrome, Vic. The instructor and student on board one of the aircraft were conducting circuit training at Coldstream Aerodrome; the instructor and student on board the other aircraft were returning to nearby Lilydale Aerodrome from a local training area, overflying the Coldstream Aerodrome circuit area at above 2,000 ft above mean sea level (AMSL). The instructor of the aircraft operating at Coldstream reported that the aircraft had climbed above the nominated circuit height of 1,500 ft AMSL, but was not certain of the maximum altitude their aircraft reached. That aircraft sustained substantial damage, but was able to return to Coldstream Aerodrome (Figure 13). The transiting aircraft sustained minor damage, and continued on to Lilydale Aerodrome. There were no injuries.

[30] A graded (usually grass) area designated for landing, but without defined runways. Aircraft generally approach all-over fields from the most favourable heading for the prevailing wind.

Figure 13: Damage to Piper PA-28 Warrior aircraft after mid-air collision in circuit at Coldstream Aerodrome, Vic.

Source: ATSB, 2006b

In February 2007, a Cessna A188B Ag Truck aircraft collided during takeoff from Leongatha Aerodrome, Vic. with a Piper PA-28R-180 Arrow aircraft that had landed on the intersecting runway. The takeoff was aborted and the aircraft was landed straight ahead. There were no injuries.

In December 2007, a Cessna 172M Skyhawk aircraft collided with an Avid Flyer ultralight in mid air near Latrobe Valley Aerodrome, Vic. While the Cessna Skyhawk landed safely, the ultralight collided with the ground and the pilot was fatally injured.

In February 2008, two Air Tractor AT-502 agricultural aircraft collided in mid air about 200 ft above ground level near Wee Waa Aerodrome, NSW. One aircraft was involved in crop spraying while the other had just departed from a nearby airstrip. Neither pilot was aware of the other aircraft. Both aircraft were destroyed, and one of the pilots was fatally injured.

In December 2008, a Cessna 172 Skyhawk aircraft collided on the ground with a Skyfox aircraft at Caloundra Aerodrome, Qld. The Cessna Skyhawk was backtracking on runway 05, and was crossing the intersection with runway 12/30 when the Skyfox that had just landed collided with its tail. The Skyhawk pilot reported that he had not heard any radio broadcasts from the Skyfox pilot. There were no injuries.

7.1.2 Serious incidents

Other conflicts between aircraft at non-towered aerodromes had the potential to be accidents. In fact, almost 10 per cent of the reported 709 occurrences were serious incidents, in which an accident almost occurred. Below are a few examples of close calls involving commercial aircraft between 2003 and 2008:

- At about sunrise, the pilot of a Fairchild Metroliner aircraft took off from Mackay Aerodrome. At the same time, the flight crew of another Metroliner was conducting a backtrack on the same runway. The crews of both aircraft took avoiding action. Confirmation that the runway was clear prior to commencing the departure was attempted, but not obtained, by the departing pilot.

- During the descent into Karratha, the crew of the Sikorsky S76 took avoiding action when they observed a Eurocopter Super Puma climbing towards them. The helicopters were 200 m laterally and 100 ft vertically apart. The crew of the Super Puma was operating on the incorrect frequency.

7.2 Consequential events

In the 70 occurrences where consequential events were known, there were 59 missed approaches and go-arounds, and 11 rejected takeoffs. These types of precautionary avoiding action were generally taken when another aircraft was sighted on the runway strip during final approach, when another aircraft was observed during final approach to be on final approach to the reciprocal runway, or when two aircraft came into close proximity on base leg or final. In addition to these occurrences (where the consequential event was due to a precautionary act), there were eight[31] other occurrences in which a collision occurred (four collisions on ground, four mid-air collisions).

More than half of the occurrences where a consequential event was recorded (n = 58) involved at least one passenger transport aircraft; however, only one of the eight collisions involved passenger transport aircraft (both conducting charter operations). In total, occurrences involving passenger transport aircraft led to 48 missed approaches and go-arounds, nine rejected takeoffs, and one collision.

[31] Seven of these occurrences were the seven accidents and serious incidents involving damage and/or injury discussed in section7.1. The additional occurrence was an incident which involved a collision on ground between two taxiing de Havilland DH.82 Tiger Moth aircraft at Heck Field (ALA), Qld. This collision did not involve any injuries and resulted in only minor damage to both aicraft, and hence is coded as an incident.

7.3 Avoiding action taken and collision risk

In occurrences where a collision did not occur, the collision risk was still studied, based on the information provided by the pilots/flight crews involved.

7.3.1 Avoiding action

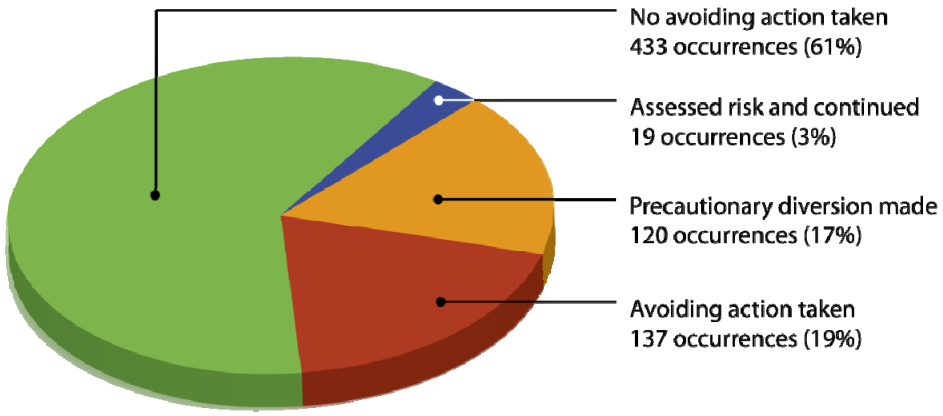
For each of the 709 occurrences in the reporting period, an avoiding action rating was coded based on summary information provided by the reporting pilot/flight crew. Not all avoiding action involved two aircraft in the air – many occurrences involved missed approaches and go-arounds of aircraft on final approach when seeing that the active runway was occupied by a ground vehicle or a backtracking aircraft.

Avoiding action was not necessary in about 60 per cent of occurrences, either because the aircraft was not in conflict with any other aircraft, or because conflicting aircraft communicated with each other and changed their intentions to avoid reduced separation (Figure 14).

In order of increasing collision risk, the avoiding action ratings assigned were:

- no action taken/no conflict
- one or both pilots/flight crews assessed the collision risk, determined the risk was low, and continued on course/intentions
- one or both pilots/flight crews made a precautionary diversion from course/intentions to reduce the risk of a separation issue or airprox from occurring
- evasive avoiding action taken where a collision was imminent.

Figure 14: Avoiding action taken in 709 non-towered aerodrome occurrences, 2003 to 2008



7.3.2 Collision risk

Apart from the four mid-air collisions described above, there were 55 airprox occurrences at non-towered aerodromes between 2003 and 2008.

For each airprox occurrence, the ATSB makes a collision risk assessment based on information provided by the reporters about aircraft proximity, relative tracks and relative speed. In 51 of the 55 airprox occurrences, a collision risk assessment could be made, as an estimate of aircraft proximity was reported.

Airproxes classified as a high collision risk generally involved both reduced lateral and vertical separation. In high collision risk airproxes, the separation between the conflicting aircraft at the time of the occurrence was an average of 200 m laterally and 55 ft vertically. In some of the occurrences at non-towered aerodromes, the separation was significantly less.

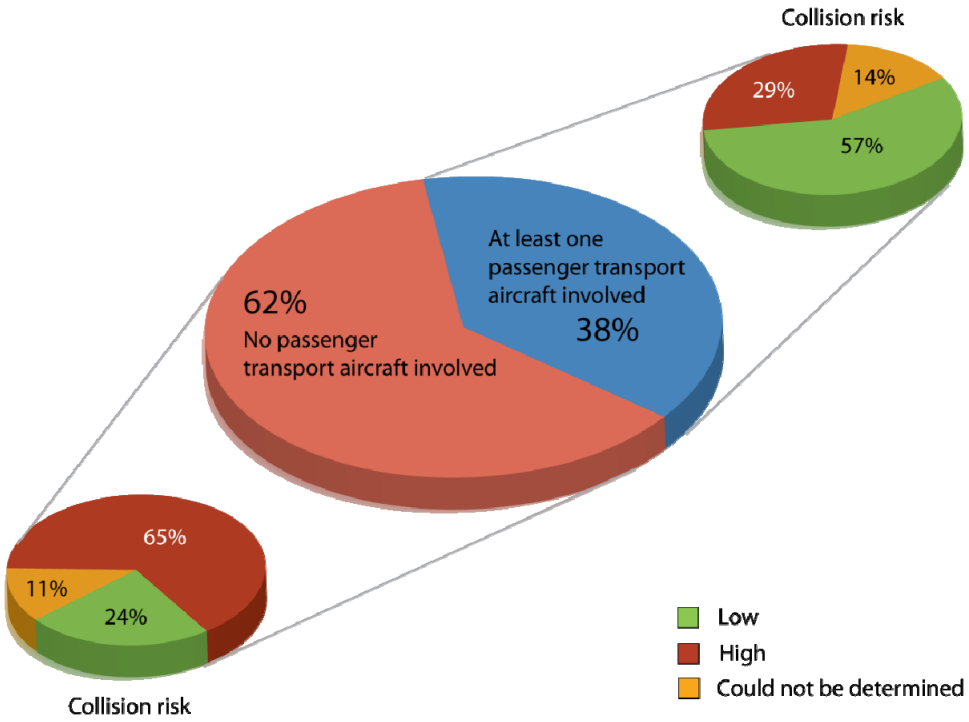
Occurrence number 200803375

The Jabiru aircraft was conducting circuits on runway 32 at West Sale Aerodrome, Vic. All the appropriate radio broadcasts were made. A Victa Airtourer aircraft was inbound from the southwest, but did not make a 5 NM inbound broadcast. On the downwind leg of the circuit, the Victa was observed less than 150 m away and slightly above the Jabiru. There was no time to take avoiding action, and the aircraft passed each other with 6 m lateral and 15 ft vertical separation. The other pilot then gave a joining crosswind broadcast for runway 09, but they did not seem to receive any radio broadcasts from the Jabiru.

In low collision risk airproxes, separation was usually reduced only in one axis (either reduced horizontal or vertical separation).

When operation types were considered, occurrences involving a passenger transport aircraft (regular public transport or charter operations) were involved in fewer airproxes where the risk of collision was deemed to be high (Figure 15). This was likely due in part to the effectiveness of TCAS and ACAS systems, and to a greater awareness by passenger transport pilots of the relatively high performance of their aircraft compared with others operating in the vicinity of non-towered aerodromes.

Figure 15: Collision risk assessments by operation type, airproxes in the vicinity of non-towered aerodromes, 2003 to 2008



One airprox occurred between two passenger transport aircraft operating at non-towered aerodromes where a high collision risk existed:

Occurrence number 200705097

At 0755 local time on 26 July 2007, a Fokker 50 aircraft was completing a turn on to final for runway 24 at Olympic Dam Aerodrome, SA at about 850 ft above ground level (AGL) when the flight crew were alerted by the Traffic Collision Avoidance System (TCAS) to a Fairchild Metroliner aircraft departing from runway 06. The crew estimated that the distance between the two aircraft was about 200 ft laterally and 30 ft of vertically.

The Fokker 50 was on a scheduled flight from Adelaide to Olympic Dam with 32 passengers and five crew on board. The Metroliner was departing Olympic Dam for Adelaide on a charter flight with 11 passengers and one pilot.

An investigation of this occurrence by the Civil Aviation Safety Authority (CASA) determined that the Fokker 50 made the required circuit broadcasts on the Common Traffic Advisory Frequency (CTAF), and that these were heard by another inbound aircraft, but not by the Metroliner pilot. The pilot-in-command of the Metroliner claimed to have made the required broadcasts on the CTAF at the commencement of taxiing, entering, backtracking along the runway, and rolling. None of these broadcasts were received by the Fokker 50 or the other inbound aircraft.

The investigation also noted that it would have been difficult for the Metroliner pilot to see the approaching Fokker 50 as he was looking into the rising sun, and that it would have been difficult for the Fokker 50 crew to see the Metroliner while it was on the ground, as the Fokker 50 was turning away from the runway as it joined the circuit on downwind.

It could not determine why the pilot of the Metroliner was unable to receive the broadcasts from the Fokker 50 aircraft.

Source: CASA, 2007c

8 MOVEMENTS AT NON-TOWERED AERODROMES

Australia's population, while concentrated on the coastal fringe, is dispersed, and many regional population centres exist to support agricultural, mining, and tourist industries. These centres act as transport hubs, with an increasing number being serviced by airlines and other air transport operators. Many of these aerodromes are located in uncontrolled airspace, and hence are non-towered (Airservices Australia, 2008).

While safety incidents generally occur at non-towered aerodromes due to action, information, and decision errors by pilots, the traffic mix and density has the potential to increase the risk of reduced safety margins between aircraft. This could be through:

- a large variety of aircraft with higher and lower performance operating into the same aerodrome
- a higher proportion of non-radio equipped recreational aircraft (such as ultralights and gliders) operating at the aerodrome
- multiple active runways
- a greater number of charter or regular public transport (RPT) flights being operated to/from the aerodrome
- the presence of military aircraft, nearby areas where aerial agriculture work is conducted (such as seeding, spraying and dusting), or a high volume of helicopter operations.

Extensive educational material has been developed by the Civil Aviation Safety Authority (CASA) to help pilots be aware of these situations and operate their aircraft safely. The Civil Aviation Advisory Publications (CAAPs) that support the 3 June 2010 changes to Civil Aviation Regulation (CAR) 166 have also been developed in part to encourage pilots to look out for these risks.

The complexity of operations at non-towered aerodromes can vary depending on their use, and the infrastructure available to pilots - from single-strip aircraft landing areas (ALAs) to large multi-runway flight training centres and regional airline hubs. Good examples of three such aerodromes are Jerilderie, Mangalore, and Mildura (Figure 16).

8.1 Major non-towered aerodromes in Australia

The group of 20 non-towered aerodromes selected in Chapter 2 were analysed in terms of the types of aircraft movements that occur at these locations, and how this has changed between 2003 and 2008. Aerodromes which are partially towered (such as joint use airfields and those Class D aerodromes under General Aviation Aerodrome Procedures (GAAP) during the study period) were excluded from this selection. Some other aerodromes which were not as well trafficked, but had a significant number of occurrences, were also included.

The movement data elements[32] collected for these aerodromes were:

- total number of landings per month
- number of landings per month, by aircraft model
- number of landings per month, by aircraft maximum take-off weight (MTOW)
- total number of RPT landings per month.

The final comparison group consisted of the following 20 non-towered aerodromes.[33]

- Armidale, NSW (YARM)
- Ballina/Byron Gateway, NSW (YBNA)
- Bathurst, NSW (YBTH)
- Broome, WA (YBRM)
- Bundaberg, Qld (YBUD)
- Dubbo, NSW (YSDU)
- Geraldton, WA (YGEL)
- Gove (Nhulunbuy), NT (YPGV)
- Griffith, NSW (YGTH)
- Groote Eylandt, NT (YGTE)
- Horn Island, Qld (YHID)
- Karratha, WA (YPKA)
- Kununurra, WA (YPKU)
- Mildura, Vic. (YMIA)
- Mount Gambier, SA (YMTG)[34]
- Orange, NSW (YORG)
- Port Lincoln, SA (YPLC)
- Port Macquarie, NSW (YPMQ)
- Wagga Wagga, NSW (YSWG)
- Wollongong (Shellharbour), NSW (YWOL).

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[32] Most aerodromes in the selected group used Avdata monitoring equipment to identify individual aircraft operating into that airport, and charge landing fees accordingly. A de-identified dataset from Avdata was used to provide movements information for these. Airport operators not using the Avdata system, or those that did not collect landing fees for general aviation (GA) aircraft (such as Mildura), generally did not collect movement information to the same level of fineness to allow comparison with the Avdata movement data.

[33] Occurrence information is also provided for Hervey Bay (YHBA) Aerodrome; however, detailed movement information could not be obtained from the airport operator.

[34] Movements data for YMTG only available from July 2005 onwards.

Figure 16: Aerial views of Jerilderie, NSW (YJER), Mangalore, Vic. (YMNG) and Mildura, Vic. (YMIA) Aerodromes (clockwise from top left)

Source: photos courtesy of Phil Vabre

In November 2009, following an airspace review by the Office of Airspace Regulation (OAR), CASA announced that Broome Aerodrome was to receive a permanent air traffic service. A certified air/ground radio operator (CA/GRS) currently provides limited air traffic services (ATS) to pilots at Broome Aerodrome. Airservices Australia has also determined that Karratha Aerodrome will receive a permanent air traffic service. As a result, Broome and Karratha will become controlled aerodromes on 18 November 2010 (Airservices Australia, 2009).

8.2 Traffic mix at comparison group aerodromes

Different purposes for different aerodromes

Different aerodromes in the comparison group have different purposes, and hence different movement patterns and traffic mixes. Some, such as Horn Island and Kununurra, display seasonal variations in movements, due to prevailing weather conditions, mining activities and resultant fly-in fly-out demand, and demand for air services in the wet season.

Most aerodromes in the comparison group have seen a relatively steady number of RPT movements since 2003, with some exceptions. Avdata Australia movements information for the 6-year period showed that Groote Eylandt Aerodrome had approximately four times as many RPT movements in 2008 than in 2003, and Port Macquarie had a twofold increase. Conversely, Mount Gambier Aerodrome had approximately half as many RPT movements at the end of the 6-year reporting period. Armidale Aerodrome saw a twofold increase in RPT movements between mid-2004 and mid-2006, before reducing to the long term average.

A summary of movements by operation type and MTOW for each of the final 20 aerodromes selected in the movement group (16 Avdata aerodromes, plus four non-Avdata aerodromes for which useful movement data could be obtained) is provided in Appendix B.

Notable changes in traffic mix between 2003 and 2008

Some regional aerodromes in Australia have grown significantly within the study period, from small regional airstrips with few daily movements through to busy regional hubs. The largest rate of growth in scheduled air travel since 2000 has been outside the capital city airports, which provide for full controlled separation of aircraft by Airservices Australia[35].

This has resulted in once relatively quiet regional aerodromes, like Port Macquarie, Ballina/Byron Gateway, or Hervey Bay, attracting rapid rates of growth from sport aviation flying, sky divers, ultralight enthusiasts and flying schools, as well as their traditional roles in hosting private planes, agricultural and helicopter services (Sandilands, 2009). The growth of tourism through low-cost airlines and their use of some non-towered regional aerodromes for jet passenger transport services add to the mix. Often, the limited infrastructure of fast-growing regional aerodromes leads to an increase in traffic congestion. At these three aerodromes, there is a single sealed runway with no full-length taxiway. This requires aircraft to backtrack along the active runway in order to taxi, placing the runway out of use for several minutes, and increasing the risk of runway incursions or approaching aircraft landing on an occupied runway (Faulkner, 2009).

At Ballina/Byron Gateway Aerodrome, heavy (over 30,000 kg MTOW) high-capacity RPT movements have increased over the reporting period from zero in mid-2004 to 20 per cent by late 2008 – though the total proportion of RPT services compared to all movements has remained static. This suggests that larger high capacity aircraft are being used by airline operators.

At Mount Gambier Aerodrome, light/medium (8,618 to 30,000 kg) RPT movements have significantly increased from about zero (early 2005) to 50 per cent of all movements (late 2008), although total RPT movements have declined significantly. This suggests that higher capacity aircraft are being used by regional airline operators.

At Kununurra Aerodrome, heavy high capacity RPT movements increased from a few percent (2003-2006) to 10 to 15 per cent of all movements in 2007, but total RPT movements dropped slightly. This suggests that higher capacity aircraft are being used by airline operators.

Port Macquarie Aerodrome also increased in heavy high capacity RPT movements from zero in November 2007 to 10 per cent of all movements in December 2008. Total RPT movements have increased from 250 to a new long-term average of 500 per month since early-2005.

[35] At Darwin Airport, air traffic service is provided by the Royal Australian Air Force (RAAF).

8.3 Occurrences and operation types at comparison group aerodromes

Occurrences at the aerodromes in the movement comparison group were reviewed based on their operation type (passenger transport or general aviation), and their frequency compared to the expected frequency of occurrences for that operation type based on the average traffic mix of the aerodrome between 2003 and 2008. In order to make this comparison, it was assumed that aircraft below or equal to 2,200 kg MTOW were most likely to be used for general aviation (GA) operations (private, aerial work, flying training, or agricultural). Those aircraft with an MTOW greater than 2,200 kg were determined to be used more often for charter or RPT operations.

Almost all of the occurrences involving aircraft in the passenger transport group were conflicts with an aircraft in the GA group, or a sports aircraft (including balloons, gliders, and ultralights). It was not possible to determine if these conflicts generally occurred where one aircraft was conducting a straight-in approach, as the approach type was usually not reported to the ATSB.

Figure 3 in section 3.3 showed that flight crews of passenger transport aircraft were the most frequent reporters of airspace use-related safety issues at non-towered aerodromes. This suggests that higher than expected numbers of occurrences involving RPT and charter aircraft are due to better reporting of airproxes and other separation issues compared to GA pilots.

- In occurrences where the passenger transport aircraft flight crew reported the conflict, most were in relation to the flight crew identifying (visually or through Traffic Collision and Avoidance System (TCAS/ACAS) alerts) another aircraft in the circuit area that was not broadcasting as required, and did not reply to broadcasts directed to them by the flight crew or by other aircraft.
- In occurrences where a GA pilot reported the conflict, most were in relation to the GA pilot (or other aircraft in the circuit) misjudging the performance of the RPT aircraft relative to their own aircraft. Some occurrences were also related to GA aircraft not expecting a passenger transport aircraft to conduct a straight-in approach.

Some aerodromes in the comparison group showed a disproportionate number of occurrences involving aircraft in the passenger transport group. Some of these may be related to better reporting of occurrences by flight crews of RPT and charter aircraft.

- **Ballina/Byron Gateway –** 6 of 9 occurrences involved jet high capacity RPT aircraft. Based on the average traffic mix over the reporting period, aircraft of above 30,000 kg MTOW should only be involved in about one-fifth of occurrences.
- **Dubbo –** 14 of 16 passenger transport occurrences involved heavy low capacity RPT aircraft (Saab 340, de Havilland Canada/Bombardier DHC-8). Based on the average traffic mix, aircraft of above 8,700 kg MTOW should only be involved in one-quarter of occurrences.
- **Geraldton –** 8 of 23 occurrences involved high capacity turboprop (Fokker 50) or jet (Embraer E-170) RPT aircraft. Based on the average traffic mix, aircraft of above 8,700 kg MTOW should only be involved in 27 per cent of occurrences.
- **Hervey Bay –** 8 of 10 occurrences involved RPT aircraft (six low capacity, two jet high capacity). Movement data was not available to make a comparison with the

expected number of occurrences; however, the proportion of RPT movements was likely to be significantly less than 80 per cent of all movements.

- **Horn Island –** 4 of 6 occurrences involved high capacity RPT aircraft (DHC-8). Based on the average traffic mix, aircraft of above 8,700 kg MTOW should only be involved in 13 per cent of occurrences.
- **Karratha –** 5 of 12 occurrences involved jet high capacity RPT aircraft (Fokker 100, Boeing 737). Based on the average traffic mix, passenger transport aircraft should be involved in less than 20 per cent of occurrences.
- **Orange –** 6 of 7 occurrences during the reporting period involved low capacity RPT aircraft (Saab 340). Based on the average traffic mix, passenger transport aircraft should only be involved in slightly under half of all occurrences, and aircraft of above 8,700 kg MTOW in less than 20 per cent of occurrences.
- **Wagga Wagga –** 12 of 15 occurrences involved heavy low capacity RPT aircraft (Saab 340 and DHC-8). Based on the average traffic mix, aircraft of above 8,700 kg MTOW should be involved in 45 per cent of occurrences. Three cases of conflict were recorded between two RPT aircraft (one due to an ATS error, one related to radio congestion on the CTAF, and one runway incursion).

A full comparative table is provided in Appendix D.

Source: photo courtesy of Phil Vabre (Bundaberg Aerodrome, Qld)

8.4 Investigated occurrences at comparison group aerodromes

Several investigations have been conducted by the ATSB into safety occurrences at non-towered aerodromes since the current National Airspace System non-towered aerodrome procedures came into effect in November 2005. All of these occurred at aerodromes in the sample group. Most of these occurrences involved a conflict between an RPT and a GA aircraft.

These investigations have raised a number of concerns relating to issues such as aircraft separation, poor communication, situational awareness and circuit procedures.

8.4.1 Port Macquarie Aerodrome

Investigation number 200700231

A Piper Arrow aircraft was approaching the aerodrome to join the circuit on left crosswind for runway 03. At about the same time, a de Havilland Canada Dash 8 aircraft and a Piper Mojave aircraft were preparing to depart the aerodrome. All aircraft operating at Port Macquarie were required to carry and use a very high frequency (VHF) radio, as non-towered procedures using CTAF(R) applied.

On short final for runway 03, the pilot of the Arrow reported seeing the Dash 8 enter the runway. The pilot immediately broadcast his position, and prepared to initiate a missed approach. The crew of the Dash 8 saw the approaching aircraft at the same time as this broadcast. They advised that they would vacate the runway without delay, and the pilot of the Mojave manoeuvred his aircraft to assist the Dash 8 to depart the runway. The Arrow continued his approach and landed safely.

The investigation determined that the following safety factors contributed to the incident.

- The Dash 8 taxied onto the runway unaware of another aircraft on final approach for the same runway.
- The procedures used by the Dash 8 crew did not ensure an effective active listening watch on the CTAF to ensure that they had received radio notification from all other circuit aircraft before entering the runway.
- The TCAS display in the Dash 8 did not indicate the presence of the Arrow when the Dash 8 entered the runway, despite the transponder in the Arrow operating normally and in the correct mode.
- The Dash 8 crew's visual lookout prior to entering the runway did not detect the Arrow on final approach.
- Frequency congestion on the CTAF occurred as the Dash 8 entered the runway, reducing the opportunity for the Arrow pilot to broadcast his position and intentions.

Following this occurrence, the Dash 8 operator issued a safety alert notice (SAN) to all of its flight crew to highlight the importance of monitoring the Aerodrome Frequency Response Unit (AFRU) for a 'beep-back' during CTAF operations.

Source: ATSB, 2008b

Investigation number AO-2007-006

With no communications, an Aeroprakt Foxbat ultralight aircraft was reported to have entered runway 21 and taken off while a Beech Baron aircraft was on approach to runway 03. The Foxbat continued in the circuit and joined final approach for runway 21 while a de Havilland Canada Dash 8 aircraft was on short final for runway 03. The crew of the Dash 8 did not hear any broadcasts by the crew of the Foxbat on the CTAF and elected to go around.

The investigation determined that the following safety factors contributed to the incident.

The Foxbat's radio volume was selected to a low setting, which did not allow the pilot to hear the broadcasts made by the Dash 8 and Baron pilots on the CTAF.

The pilot of the Foxbat was aware of the AFRU at Port Macquarie aerodrome, but did not hear a response from the AFRU due to his low radio volume level. The AFRU, or 'beep-back' unit, allows the pilot to confirm that the aircraft radio is transmitting on the correct frequency. The AFRU does this by automatically transmitting a voice identification of the aerodrome name in response to any transmission on the CTAF. The pilot had not fully considered the safety implications of a lack of response from the AFRU.

Source: ATSB, 2008a

In addition to these two events at Port Macquarie, the ATSB investigated a traffic confliction near this aerodrome in 1999 involving a Piper Chieftain, a de Havilland Canada Dash 8, and two Beech 1900 aircraft. At this time, Port Macquarie was a non-towered aerodrome within a Mandatory Broadcast Zone (MBZ).

In this event, the investigation cited a number of significant factors including frequency congestion and a failure by the crew of several of the aircraft involved to make the appropriate position and intention broadcasts. This resulted in a lack of situational awareness of traffic on the part of the crews and an airprox event occurring between two RPT aircraft (ATSB, 1999).

Source: photo courtesy of Jonathan Rankin (Dubbo Aerodrome, NSW)

8.4.2 Orange Aerodrome

Investigation number 200604222

A Beech Baron aircraft was conducting a global positioning system (GPS) approach from the west of the aerodrome. At the same time, a Saab 340 aircraft was conducting a straight-in area navigation global navigation satellite system (RNAV/GNSS) approach to runway 29. The two aircraft had the same estimated time of arrival at the aerodrome.

At the missed approach point of the GPS arrival procedure, the pilot of the Baron had not become visual with the aerodrome. He commenced the missed approach procedure as published, and made a transmission of his intentions on the CTAF. The captain of the Saab advised the pilot of the Baron that he would have to manoeuvre his aircraft in order to maintain separation. As a result, the Baron pilot turned to the right and deviated from the published missed approach procedure, turning towards the Saab.

The investigation determined that the following safety factors contributed to the incident.

Neither flight crew considered their self-separation requirements if they or the other aircraft were required to conduct a missed approach.

Source: ATSB, 2007b

8.4.3 Hervey Bay Aerodrome

Investigation number 200605091

A Fairchild Industries Metroliner aircraft commenced its take-off roll on runway 29 on an RPT service to Brisbane. After reaching 60 kts, and while still on the runway, the pilot-in-command observed a Eurocopter EC135 helicopter on final approach to land on runway 11. The pilot of the Metroliner rejected the takeoff.

Both pilots reported making all of the recommended position and intention broadcasts on the correct CTAF frequency. Neither pilot reported hearing any radio transmissions on the CTAF from any other aircraft, until communications were established between the Metroliner and EC135 during the backtrack. Neither pilot indicated any problems with the radio equipment on their respective aircraft, and the pilot of the EC135 had made no change to the frequency selection or volume setting on his radio between the time he made an inbound broadcast at 3 NM and the backtrack.

The investigation was unable to determine the reason for the crews' inability to establish radio communications prior to the backtrack. The occurrence reinforces the need for pilots to remain especially vigilant when operating in the vicinity of CTAF aerodromes. This includes 'see-and-avoid' vigilance.

Source: ATSB, 2007a

8.4.4 Other recent investigations involving non-towered aerodrome operations

Latrobe Valley Aerodrome (Vic.)

Investigation number AO-2007-065

An Avid Flyer ultralight aircraft and a Cessna 172 Skyhawk aircraft collided in mid air within the circuit area of Latrobe Valley Aerodrome (non-towered). The pilot in the Avid Flyer was fatally injured and the Cessna 172 landed safely.

Wee Waa Aerodrome (NSW)

Investigation number AO-2008-014

Two Air Tractor AT-502 agricultural aircraft collided in mid air whilst conducting spraying operations near Wee Waa Aerodrome, which did not have an air traffic service presence at the time of the accident. Both aircraft were seriously damaged, and one of the pilots was fatally injured. The other pilot sustained serious injuries.

One aircraft was conducting aerial spraying over a field 10 km northeast of the aerodrome. The other aircraft had just taken off from the aerodrome, and was climbing to altitude. The aircraft were at an altitude of 200 ft AGL when they collided.

The aircraft collided because of the proximity of the area being sprayed by the first aircraft to the runway, and the climb gradient of the second aircraft after takeoff.

Until immediately before the accident, neither pilot was aware of the other aircraft, although visibility at the time was reported to be good. The investigation determined that no radio broadcasts were made on the appropriate frequency by the aircraft, and that the pilots had no knowledge of each other's intended operations. This, combined with the reliance on a visual traffic scan (unalerted see-and-avoid) contributed to the pilots' inadequate situational awareness.

Source: ATSB, 2010b

Figure 17: Wreckage of one of the Air Tractor aircraft

9 OTHER SAFETY INFORMATION SOURCES

There are other data sources available that can provide valuable safety information about non-towered aerodrome operations.

Since January 2007, the Aviation Confidential Reporting (REPCON) scheme has been available to the public as a voluntary system that allows any person who has an aviation safety concern to report it to the Australian Transport Safety Bureau (ATSB) confidentially. Protection of the reporter's identity is a primary element of the scheme. Any matter may be reported if it endangers, or could endanger the safety of an aircraft where it falls outside of the matters that are required to be reported to the ATSB under the *Transport Safety Investigation Act 2003*. Between 1988 and February 2004, the ATSB also managed a voluntary incident reporting system named Confidential Aviation Incident Reporting (CAIR).

In a search of the REPCON and CAIR databases, 91 reports were found over the reporting period that related to procedures, frequencies, occurrences, and general issues of airspace use around non-towered aerodromes.

The Civil Aviation Safety Authority (CASA) Office of Airspace Regulation (OAR) also convenes state-based Regional Airspace and Procedures Advisory Committees (RAPACs) to allow airspace users to discuss any matters of concern relating to airspace and related procedures in Australia, and specifically on a state level. The Minutes of each meeting are published and available for public review on the CASA website (www.casa.gov.au). As part of this study, the Minutes of all RAPAC meetings nationwide in the preceding 12 months were reviewed to identify any common safety themes.

9.1 Trends from the data

Many of the 91 reports retrieved from the REPCON and CAIR databases showed common themes to the 709 airspace use-related occurrences in the ATSB database between 2003 and 2008.

- 62 reports involved a conflict between two or more aircraft (fixed-wing aircraft, helicopters, hot air balloons, gliders, military aircraft or ultralights).
- In 21 of these cases, one of the aircraft was required to take avoiding action to prevent a collision. In 14 of these cases, one of the aircraft made a precautionary diversion to maintain separation.
- In 27 conflicts, at least one of the aircraft involved was known or thought to be conducting passenger transport (regular public transport (RPT) or charter) operations.

Some common safety themes stood out from the REPCON and CAIR reports, as well as from RAPACs. These are discussed in the following sections.

9.1.1 Parachuting operations

A number of reports were raised regarding parachuting operators at non-towered aerodromes, particularly in the Sunshine Coast area (Qld) and near Geelong (Vic.). In seven cases, it was reported that parachutists were dropped over an active circuit area, coming into conflict with helicopters or GA aircraft. These cases raised issues of situational awareness of other aircraft in the circuit, due to a combination of not monitoring the Common Traffic Advisory Frequency (CTAF), not making positional and intentional broadcasts, and in some cases not being aware of the regulations regarding parachute drops.

Civil Aviation Safety Authority Instrument 405/09 and Australian Parachute Federation Operations Regulations 5.2.15 (a) and 5.2.15 (b) provide direction to parachute operators about how they must safely release parachutists, the radio broadcasts they must make at non-towered aerodromes, and how they must give way to passenger transport aircraft operations at all times.

9.1.2 Frequency congestion and interference

There are practical limits on how much voice traffic very high frequency (VHF)-band frequencies such as those used for CTAF can efficiently carry. For this reason, frequency congestion issues can occur at non-towered aerodromes at times of high circuit traffic. Interference issues can be due to aircraft operating at nearby aerodromes using the same CTAF frequency allocation, other ground-based radio transmitters, or due to shielding by natural features.

Eight REPCON and CAIR reports were received between 2003 and 2008 relating to congestion and interference issues on CTAF/CTAF(R) and MBZ frequencies in the vicinity of the following locations:

- Mount Oxley (NSW)
- Lizard Island (Qld)
- south of Kempsey (NSW)
- Port Lincoln (SA)
- northeast of Cooma (NSW)
- south of Wagga Wagga (NSW)
- south of Broome (WA).

Forums such as RAPACs also allow airspace users to raise issues such as frequency congestion at their local aerodromes on the standard 126.7 MHz frequency usually allocated for CTAF. Congestion issues often raised in these meetings relate to pilots operating into a smaller aerodrome near a busy aerodrome where the same CTAF frequency allocation is being used, or interference from relatively distant aerodromes using the same frequency (e.g. Goolwa and Port Lincoln in South Australia).

Another issue that has been raised through RAPAC meetings was the absence of a mechanism to allocate discrete CTAFs to non-registered aircraft landing areas (ALAs), further increasing congestion on the existing CTAF for that area (CASA, 2010d). One solution that has been suggested to relieve this issue is to allocate unique CTAF frequencies to busier non-towered aerodromes. This however may reduce the situational awareness of transiting pilots, as they would be required to monitor more than one CTAF to be fully aware of nearby traffic.

A review of the Minutes of all RAPAC meetings nationwide in the 2009-2010 financial year has revealed frequency congestion or interference concerns on the area and CTAFs at the following aerodromes:

- Bathurst Island (congestion with Port Keats, Jabiru, other Arnhem Land aerodromes)
- Coffs Harbour (radio frequency interference in circuit area - airborne aircraft only, not audible on ground)
- Gold Coast (at Heck Field, congestion with Archerfield and other nearby aerodromes)
- Lake Eyre (congestion with Leigh Creek, William Creek and Coober Pedy aerodromes)
- Lilydale (congestion with Coldstream, Phillip Island, Geelong and Bendigo aerodromes)
- Moorabbin (radio frequency interference on approaches to runways 17L and 17R)
- Narrandera (congestion with nearby aerodromes)
- Narromine (congestion with Dubbo Aerodrome)
- Portland (congestion with nearby aerodromes)
- Roma (congestion with nearby aerodromes).

Frequency changes/allocation of discrete frequencies have occurred or are intended to occur at the following non-towered aerodromes:

- Busselton (YBLN) (WA) – congestion with nearby aerodromes
- Northern Peninsula (YNPE) (Qld) – congestion with Horn Island Aerodrome
- Port Macquarie (YPMQ) (NSW) – congestion with Kempsey and Taree aerodromes.

Following a formal review of a draft of this report in August 2010, CASA indicated that Northern Peninsula and Horn Island Aerodromes are likely to return to a single CTAF (due to the nature of incidents experienced in the vicinity of those aerodromes), Kempsey Aerodrome is likely to be allocated a discrete CTAF, and that Port Macquarie and Taree Aerodromes will continue to share the same frequency.

9.1.3 Model aircraft and kite flying

Three REPCON and CAIR reports were received involving a conflict between an aircraft and a kite or model radio-controlled aircraft being flown (not as part of an organised event) at altitude in the circuit areas or final approach paths of Port Macquarie (NSW) and Moorabbin (Vic.) aerodromes.

In addition, four reportable occurrences were identified in the ATSB database where kites and radio-controlled aircraft interfered with aircraft near Benalla (Vic.), Sellicks Beach (SA), Jandakot (WA), and Wantirna (Vic.).

If you see a kite or model aircraft flying in a location that might pose a safety risk to aircraft, you should contact CASA and the local government authority in the first instance.

9.1.4 Avoiding landing charges

There were three REPCON and CAIR reports involving pilots allegedly either making muffled, or no broadcasts on the CTAF, with the suspected intention of avoiding landing charges. The firm Avdata Australia has been contracted to manage and collect landing fees at over 130 non-towered aerodromes in Australia. Avdata does this by installing a proprietary computer system at each participating aerodrome that records audio transmissions on the allocated frequency for the CTAF. It identifies which aircraft land at the aerodrome by their callsign, and then uses this to appropriately bill aircraft owners based on their use of the aerodrome.

There is a clear elevated risk of degraded situational awareness when pilots do not clearly broadcast their location or intentions on the CTAF. Two of the three cases reported involved two aircraft coming into conflict, in which one was required to take avoiding action.

10 CONCLUSIONS

10.1 Summary of findings

10.1.1 Findings from occurrence reporting data

The need for good communication and awareness of procedures when operating in the vicinity of non-towered aerodromes is shown by the bulk of the 709 airspace use and operations-related occurrences at non-towered aerodromes in Australia between 1 January 2003 and 31 December 2008.

While this report looked only at incidents and accidents prior to the introduction of the 3 June 2010 changes to Civil Aviation Regulation (CAR) 166, the non-controlled operating nature of non-towered aerodromes remains fundamentally the same. Pilots must still be aware of the types of occurrences that are likely to happen in the vicinity of non-towered aerodromes, and what their responsibilities are when flying in their vicinity to help avoid these situations.

Occurrence types in the vicinity of non-towered aerodromes

The most common airspace use and operational-related types of occurrences at non-towered aerodromes were related to communication breakdowns or insufficient communication between pilots. Many of these led to reduced situational awareness of the pilot, and reduced separation or conflicts between aircraft. Non-compliance with published information, notices to airmen (NOTAMs), and procedures also occurred frequently (approximately 20 per cent of occurrences).

Types of errors contributing to non-towered aerodrome occurrences

An analysis of the errors that contributed to all occurrences showed that both procedural errors (action and decision-related) and communication errors (information and action-related) were most prevalent (about 30 per cent of cases for each), followed by situational awareness and position/proximity errors (separation-related).

Conflicts and separation issues (air-air and air-ground)

Conflicts and other situations where a separation issue occurred between two aircraft (such as airproxes) were also very common. Conflicts are situations where the actions of an aircraft or ground vehicle interfered with the flight of another aircraft. Conflicts do not necessarily result in reduced separation At non-towered aerodromes, there were 501 conflicts between aircraft and other aircraft or vehicles (71 per cent of occurrences). These were mostly due to reduced separation between aircraft in the circuit, conflicts between aircraft on base, approach and final, or runway incursions. Airproxes accounted for almost all serious incidents (55 of 60) in the vicinity of non-towered aerodromes. Separation issues generally occurred between general aviation (GA) aircraft, or involved a GA aircraft and a passenger transport aircraft. There were very few conflicts involving two passenger transport aircraft. Most runway incursions involved a backtracking aircraft coming into conflict with an aircraft on landing or final approach to the same runway.

See-and-avoid conflicts

See-and-avoid conflicts where situational awareness errors were involved (also contributed to by inadequate or no communications in some cases) made up about one-seventh of all occurrences. These types of conflicts led to almost all of the six accidents recorded in the vicinity of non-towered aerodromes between 2003 and 2008, four of which were mid-air collisions, and two of which were runway incursions leading to a collision on the ground. Furthermore, there were 60 serious incidents in which an accident almost occurred. Once again, these were mostly due to a lack of communication between pilots or an insufficient awareness of nearby traffic, leading to an airprox. In 87 occurrences, a Traffic Collision Avoidance System (TCAS) alert occurred due to a potential separation issue. In over half of these cases however, the TCAS alert was the only indication that pilots of an aircraft had of the other traffic.

In approximately 20 per cent of all conflicts, one or more aircraft took avoiding action to prevent a collision or an airprox. In a further 17 per cent, one aircraft made a precautionary diversion from its intended flight path in order to maintain safe separation with another aircraft that was not communicating or aware of other nearby aircraft.

Inadequate communication between aircraft

Insufficient communication and broadcasts between aircraft, radio failures or misunderstandings were the biggest contributors to occurrences in the vicinity of non-towered aerodromes between 2003 and 2008 (388 of 709 occurrences). Communication issues accounted for 38 per cent of all information errors and 31 per cent of all action errors for these occurrences.

Good communication between pilots on the Common Traffic Advisory Frequency (CTAF) is critical to creating a safe operating environment in uncontrolled airspace, especially in higher traffic density locations such as at non-towered aerodromes. Despite this, in almost a third of all occurrences, it was known (or likely) that the pilot was operating within the vicinity (10 NM) of a non-towered aerodrome and not monitoring the CTAF effectively. In 146 occurrences, the pilot did not have their radio tuned to the correct CTAF at all.

Procedural errors and circuit operations

Procedural errors were the second most common occurrence group at non-towered aerodromes (after communication issues). While not all of these occurrences happened in circuit areas, the proximity of aircraft and workload of pilots in this phase of flight reduces the margin of safety if procedural errors occur, or pilots do not make the positional and intentional broadcasts on the CTAF as required by CAR 166.

In one-seventh of occurrences, an aircraft did not make a broadcast prior to taxi or entering a runway, and in 28 occurrences, a pilot did not broadcast before entering the circuit. Not making these broadcasts reduces the situational awareness of all other pilots in the circuit, as they are not aware of what aircraft are in the air, where they might be in the circuit, or if they are using or taxiing on an active runway.

Within the circuit, most incidences of reduced separation between aircraft were due to at least one aircraft conducting circuits in a contrary direction to other circuiting aircraft (i.e. aircraft coming head-on in the circuit), or aircraft on base leg conflicting with those on final. This finding was supported by previous ATSB research into mid-

air collisions, which found that 80 per cent of collisions occur in the circuit area, and two-thirds of these happen on the base-final turn.

Radio frequency (CTAF) congestion and interference/shielding problems

There were not very many occurrences in which broadcast congestion on the CTAF (and formerly, on Mandatory Broadcast Zone (MBZ) frequencies) was cited. Some issues involving an overlapping of broadcasts from two nearby aerodromes using the same CTAF were raised in confidential reports to the ATSB (through the Confidential Reporting (REPCON) and Confidential Aviation Incident Reporting (CAIR) schemes), and from Minutes of Regional Airspace and Procedures Advisory Committee (RAPAC) meetings in different states.

Terrain shielding problems were generally not apparent from the occurrence data, with some evidence from REPCON and CAIR reports that there may have been some terrain shielding at Newcastle (RAAF Williamtown) Aerodrome (NSW) and in the vicinity of Cooma (NSW).

In all instances, pilots experiencing radio frequency problems should gather as much information on the location, source, and nature of the interference, and refer these issues to Airservices Australia for further investigation and resolution.

10.1.2 Findings from movements data

As readers might expect, most occurrences related to airspace use and operations in the vicinity of non-towered aerodromes occurred at the busiest aerodromes where radio carriage was required. However, the actual number of occurrences between 2003 and 2008 at each aerodrome was relatively small (the highest number of occurrences recorded at any aerodrome was 26), and occurrences were distributed across many aerodromes and aircraft landing areas (ALAs) (n = 231), all of varying sizes, locations, and activity level.

A review of movement data and traffic mix at 20 of the busiest aerodromes found that Ballina/Byron Gateway, Mount Gambier, and Kununurra are experiencing a shift in their passenger transport services from smaller to larger aircraft. Port Macquarie Aerodrome had more passenger transport movements over the period, and also a greater proportion of large jet transport aircraft operating these services.

A review of the occurrences at these 20 aerodromes showed that Ballina/Byron Gateway, Dubbo, Geraldton, Hervey Bay, Horn Island, Karratha, Orange, and Wagga Wagga had a disproportionate number of occurrences involving passenger transport aircraft, relative to the proportion of all movements at those aerodromes that are passenger transport aircraft. However, it was not possible to tell how much of an influence the better reporting culture of passenger transport operators had on this finding.

10.2 Previous ATSB studies into non-towered aerodrome safety

It was not possible to draw firm conclusions about the difference in findings between the two previous ATSB reports into occurrences at MBZs, and the findings presented here. This report considers all airspace use and procedural-related issues at non-towered aerodromes, rather than specifically at those where MBZ and CTAF procedures have applied.

Furthermore, this report does not compare the perceived level of safety between CTAF and CTAF(R)/MBZ aerodromes. This topic has been studied in significant detail by the Civil Aviation Safety Authority (CASA) Office of Airspace Regulation (OAR) in their *CTAF versus CTAF(R)* study, conducted by The Ambidji Group in August 2008. The findings of that study (and the post-implementation review of the National Airspace System (NAS) 2C introduction) supported the change to the requirement for mandatory radio carriage and use at all certified, registered, military, and other designated non-towered aerodromes from 3 June 2010.

There were some common themes in the analysis of 709 occurrences between 2003 and 2008 presented here, and the previous MBZ reports published by the ATSB (2003 and 2006):

- Approximately two airspace-related occurrences occurred in the vicinity of a non-towered aerodrome and were reported to the ATSB each week, and this has remained the case since 1994.
- Passenger transport aircraft were involved in a large proportion of the occurrences; however, this was likely to be due to more active reporting behaviours rather than an increased risk within this sector.
- Radio communication issues and reduced situational awareness due to pilots not broadcasting or not following the standard broadcast procedures were the most common factors contributing to airspace-related occurrences.
- The rate of occurrences remains low across all individual non-towered aerodromes.
- The number of occurrences reported to the ATSB at non-towered aerodromes remains small as a proportion of all occurrences reported to the ATSB over the reporting period.

A change was noted since the 2003 report regarding the non-towered aerodromes that recorded the greatest number of airspace-related occurrences. Between 1994 and 2003, Bundaberg, Ayers Rock, Devonport, and Jandakot had the highest number of reported occurrences. Between 2003 and 2008, the most occurrences were reported at Newcastle, Avalon, Geraldton, and Dubbo.

The quality of the occurrence data recorded for airspace-related occurrences has increased in recent years, making comparisons with historical data difficult. This has been driven by improved aviation safety legislation and a greater level of prescribed reporting since 1 July 2003 under the *Transport Safety Investigation Act 2003*, compared to its predecessor, the *Air Navigation Act 1920*. The ATSB's Aviation Statistics and biannual Australian Aviation Safety in Review publications indicate that reporting rates for aviation accidents and incidents have increased since this time.

10.3 Maintaining safe operations in the vicinity of non-towered aerodromes

What airspace regulators are doing

The efficacy of airspace design, circuit and other non-towered aerodrome procedures, and the allocation and organisation of CTAFs at individual aerodromes is always being improved through a continuous review process undertaken by CASA. This is done through an extensive community consultation process (via surveillance, pilot safety workshops and RAPACs) as well as through systemised aeronautical studies of non-towered aerodromes.

On 3 June 2010, CASA made changes to procedures at non-towered, Class D, and General Aviation Aerodrome Procedures (GAAP) aerodromes. From this date, all aircraft operating into all registered, certified military and other non-towered aerodromes as specified by CASA[36] require a radio to be carried and used. Part of the reason these changes were introduced by CASA was to address the types of communication and separation-related occurrences raised in this report that have occurred frequently at non-towered aerodromes.

To this end, a significant education campaign has been undertaken by CASA through road shows and consultation with recreational aviation associations to inform pilots of their responsibilities under CAR 166. Two important Civil Aviation Advisory Publications (CAAPs) have been released by CASA to support these changes, and reinforce safe flying practices in the vicinity of non-towered aerodromes. All pilots who use non-towered aerodromes should read the following CAAPs:

- CAAP 166-1(0) Operations in the vicinity of non-towered (non-controlled) aerodromes; and
- CAAP 166-2(0) Pilots' responsibility for collision avoidance in the vicinity of non-towered (non-controlled) aerodromes using 'see-and-avoid'.

Both of these CAAPs are available for download on the CASA website.

Readers can find more information on aeronautical studies and changes to the airspace system, at the CASA OAR website (www.casa.gov.au).

What the ATSB is doing

The ATSB will continue to review routinely reportable and immediately reportable matters related to non-towered aerodrome safety that are reported by pilots and operators under the requirements of the *Transport Safety Investigation Act 2003*. These include airproxes, air-to-ground and air-to-air communication problems, non-compliance with published procedures, breakdowns of separation, runway incursions, and air traffic control (ATC) procedural errors.

For more information about what you need to report to the ATSB, and how to report it, visit http://www.atsb.gov.au/mandatory/asair.aspx.

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[36] Radio carriage may also be mandated at other aerodromes as designated by CASA on a case-by-case basis (such as for air shows).

10.4 What you need to do if you fly at non-towered aerodromes

Wherever you fly, into either non-towered or controlled aerodromes, maintaining a vigilant lookout at all times is important. See-and-avoid is still a defence against collisions, and good airmanship dictates that all pilots should be looking out and not be solely reliant on the radio for traffic separation (CASA, 2010b). Being aware of other nearby aircraft and their intentions is important. Remember that there may be a variety of aircraft of different sizes, flight rules, and performance levels all operating at the same time in the same airspace.

Source: photo courtesy of Alex Gagiero (Wagga Wagga Aerodrome, NSW)

Continued safety at non-towered aerodromes is inherently a pilot responsibility. You need to do your bit by broadcasting your position and intentions to other pilots where it will help improve situational awareness, by following circuit and other non-towered aerodrome procedures, and by flying sensibly and with due care. Civil Aviation Advisory Publication 166-1 provides advice to pilots about how to do this, and reiterates CASA's expectation that all pilots will operate in a courteous and professional manner at all times. Aviation safety relies upon a cooperative approach between all pilots, particularly in the vicinity of aerodromes in times of busy traffic (CASA, 2010b).However, responsibility for ensuring your aircraft does not create a hazard to other aircraft rests solely with you as the pilot-in-command (Department of Transport and Regional Services, 2005).

The aim at all times is to achieve radio-alerted see-and-avoid to be aware of other traffic and position your aircraft appropriately to prevent conflicts with that traffic. Observing these simple points will help to keep you and your fellow pilots safe at non-towered aerodromes (Department of Transport and Regional Services, 2005):

• Maintain a lookout for other aircraft at all times.	• Get a radio, and always make the standard broadcasts – even when you think there is no nearby traffic.
• Achieve radio alerted see-and-avoid by making all of the standard broadcasts within 10 NM of a non-towered aerodrome.	• Use the same procedures at all non-towered aerodromes, unless otherwise stated in the En Route Supplement Australia (ERSA).
• Be aware that any radio-equipped aircraft can conduct straight-in approaches at non-towered aerodromes	• Avoid overflying aerodromes where possible, and take note of instrument flight rules (IFR) inbound and outbound routes.

There is really no reason to fly without a radio. Even the smallest ultralight can have an aircraft band hand-held radio with a headset. While the International Civil Aviation Organization (ICAO) airspace classifications state that a radio is not required for visual flight rules (VFR) aircraft in Class E or G airspace, this does not mean that a radio is unnecessary. Without a radio, see-and-avoid is a pilot's only defence against a mid-air collision (Department of Transport and Regional Services, 2002).

The Civil Aviation Safety Authority (CASA) reminds pilots that they need to be aware of current non-towered aerodrome procedures in the ERSA, as well as any changes to circuit procedures at the aerodromes they use. The CAAPs and notices to airmen (NOTAMs) are useful sources of this information and you should be familiar with them (CASA, 2010a).

If you have a safety concern that you think endangers, or may endanger the safety of an aircraft, we encourage you to report it confidentially to the ATSB via the REPCON scheme. Reporting can be done online at http://www.atsb.gov.au/voluntary/repcon-aviation.aspx.

Issues such as frequency congestion or interference at a particular aerodrome should, in the first instance, be raised to your local RAPAC or to Airservices Australia so that they may be reviewed.

10.5 Further research required

Throughout this study, a number of areas were identified that would benefit from further research to assist in improving safety at non-towered aerodromes:

- Conducting an in-depth study (line-oriented safety audit (LOSA) style) to look at operational threats at individual non-towered aerodromes (as opposed to the approach historically taken by aeronautical studies conducted by the CASA Office of Airspace Regulation and consultant groups).
- The effectiveness and reach of pilot education material and CASA workshops on pilot awareness related to the revised CAR 166 non-towered aerodrome procedures.
- Ascertain the effectiveness of the new 3 June 2010 changes to non-towered aerodrome procedures in reducing the frequency and types of occurrences that were most prevalent at these aerodromes between 2003 and 2008. At the time of

writing, data does not exist to evaluate safety improvements from these changes to CAR 166.

- A comparison of the frequency of occurrences related to separation of aircraft (airprox, breakdown of separation, and other separation events) at aerodromes which are always non-towered, and those that are non-towered for only some time periods (those Class D aerodromes that were formerly operating under GAAP).
- Reviewing non-towered aerodrome occurrences over a greater study period to allow an in-depth quantitative comparison between traffic mix and occurrence numbers at specific aerodromes.
- The effect of air-ground radio services on situational awareness of other traffic operating in the vicinity of non-towered aerodromes, and on the general rate and types of safety occurrences – in particular, a comparison of having a UNICOM service versus a CA/GRS service.

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12 APPENDICES

12.1 Appendix A – Airspace classifications in Australia

Airspace within the Brisbane and Melbourne Flight Information Regions (FIRs) is generally established as follows:

Class of airspace	Application
A	• within radar coverage – lower limit above FL180 and upper limit FL600; • outside radar coverage – lower FL245 and upper limit FL600; • an area extending from 90 NM south of Melbourne to Launceston and Hobart, lower limit FL180 and upper limit FL600; and • active military Restricted areas above FL285.
B	*Not used*
C	• within radar coverage south of Sydney, lower limit FL125 and upper limit FL180 under Class A airspace; • in the control area steps associated with controlled aerodromes, excluding control area steps classified as Class D airspace; • in control zones of defined dimensions; and • active military Restricted areas at and below FL285 unless otherwise specified.
D	Control zones of defined dimensions, and associated control area steps, upper limit 4,500 ft.

Class of airspace	Application
E	• within radar coverage: - south of Sydney, lower limit 8,500 ft and upper limit FL125 under Class C airspace. - north of Sydney, lower limit 8,500 ft and upper limit FL180 under Class A airspace. • in the vicinity of Williamtown (Newcastle): coincident with the lateral limits of R578A-E above A045 – when R578 is not active; • outside radar coverage within continental Australia, lower limit FL180 and upper limit FL245 under Class A airspace; • an area extending from 90 NM south of Melbourne to Launceston and Hobart, lower limit FL125 and upper limit FL180 under Class A airspace; and • in two corridors, under en route Class E airspace: - Sydney to Dubbo, lower limit FL125 and upper limit FL180. - Melbourne to Mildura, lower limit FL125 and upper limit FL180.
F	*Not used*
G	• non-controlled airspace; • no separation services provided for VFR or IFR aircraft; • Common Traffic Advisory Frequency (CTAF) and associated procedures apply in the vicinity of non-towered aerodromes; and • VHF radio required for operations above 5,000 ft AMSL, in reduced VMC, and at aerodromes where carriage and use of radio is required.

Source: AIP ENR 1.4 (Airservices Australia, 2010)

12.2 Appendix B – Traffic mix for 20 selected non-towered aerodromes, 2003 to 2008

Aerodromes with Avdata Australia movements data

For 16 of the 20 aerodromes in the movements sample group, a full complement of movement data was available for 1 January 2003 to 31 December 2008 from Avdata Australia. Full movements data was also provided by Geraldton Aerodrome, even though Avdata recording equipment was not used at that aerodrome during the reporting period.

A summary of this data is presented in the graphs below, ordered alphabetically by aerodrome. On the left hand side (line graphs), total general aviation (GA) and regular public transport (RPT) movements are shown by month, represented by a red line and a blue line respectively. On the right hand side (stacked area graphs), the proportion of total monthly aircraft movements by different categories of aircraft are shown, grouped by maximum takeoff weight (MTOW). In these graphs:

- **Orange** – aircraft above 30,000 kg MTOW (e.g. Boeing 737, Airbus A320, Fokker 100, Embraer E-170)
- **Blue** – aircraft between 8,618 kg and 30,000 kg MTOW (e.g. Saab 340, de Havilland Canada DHC-8, Shorts 360, Embraer EMB-120 Brasilia)
- **Purple** – aircraft between 5,700 kg and 8,618 kg MTOW (e.g. Fairchild Metroliner, Cessna Citation, Beechcraft Super King Air, Beechcraft 1900)
- **Green** – aircraft between 2,200 kg and 5,700 kg MTOW (e.g. de Havilland Canada DHC-6 Twin Otter, Cessna 414, Piper PA-31 Navajo, Aero Commander 500)
- **Red** – aircraft below 2,200 kg MTOW (e.g. Cessna 172 Skyhawk, de Havilland DH.82 Tiger Moth, Beechcraft Bonanza, Piper PA-28 Cherokee)

These groups roughly correspond to private and agricultural general aviation, light charter and low capacity passenger transport, heavy low capacity passenger transport, turboprop high capacity passenger transport, and jet high capacity passenger transport.

Data for the remaining three aerodromes for which detailed movements information was not available can be found at the end of this Appendix.

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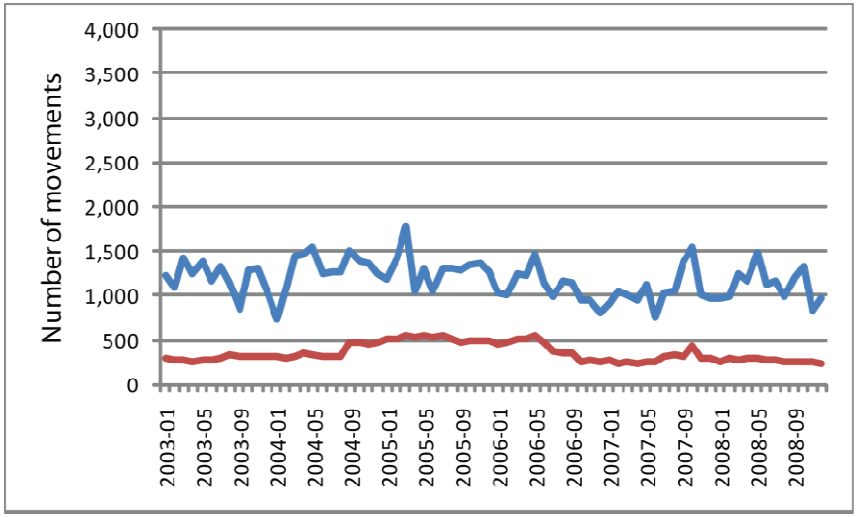
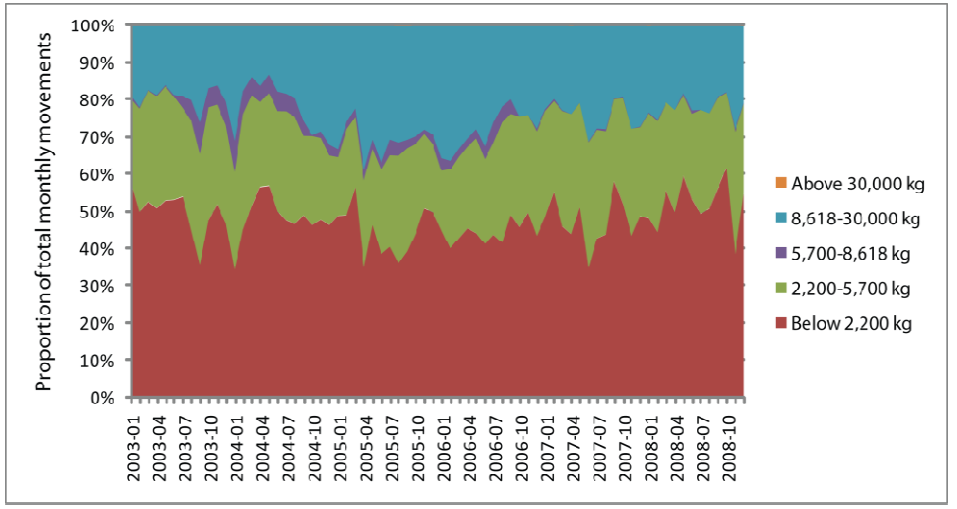
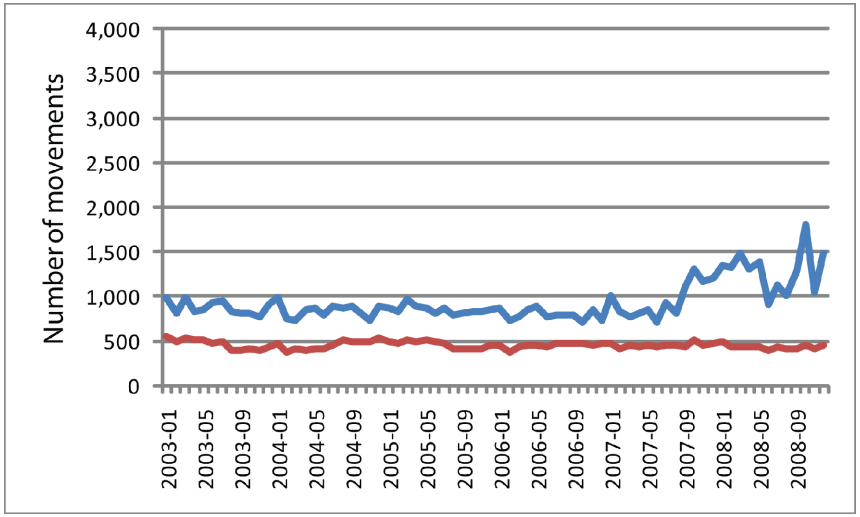
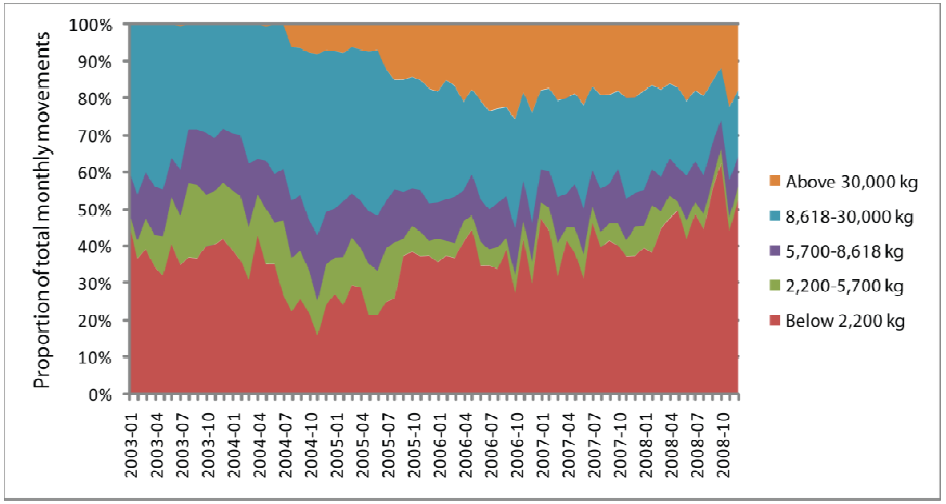


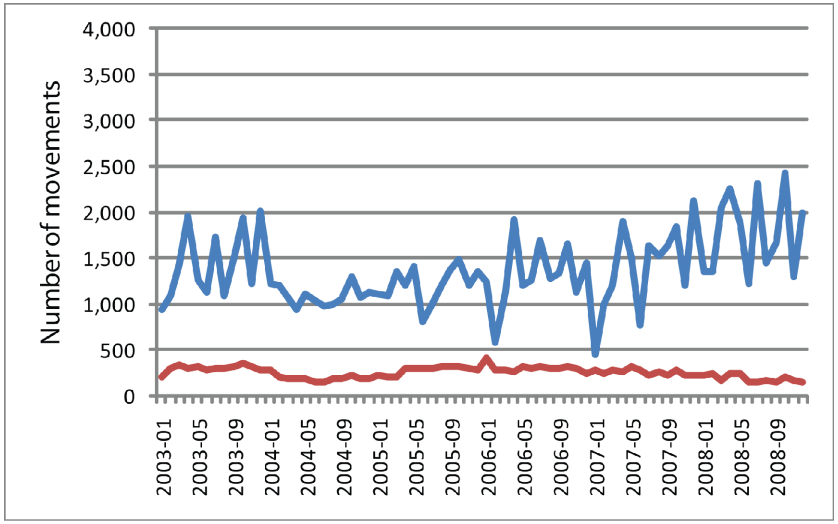


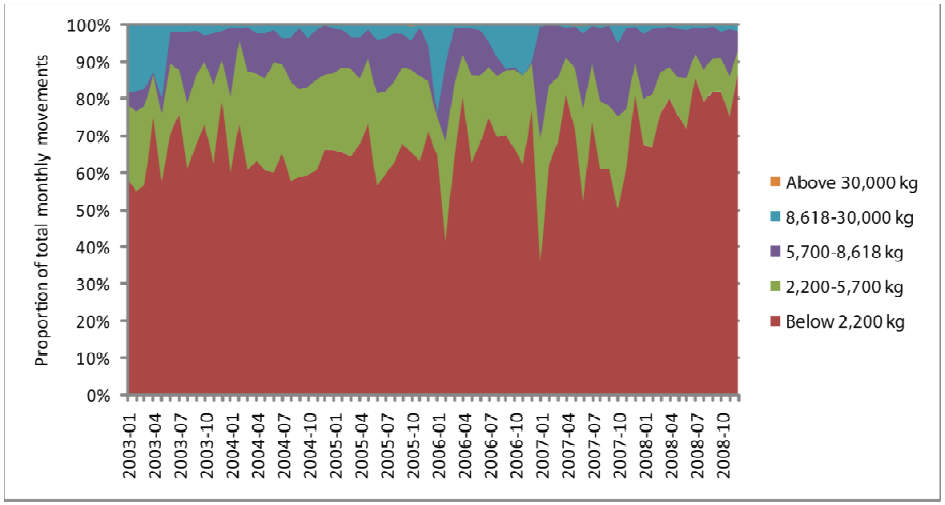
Ballina/Byron Gateway (YBNA)



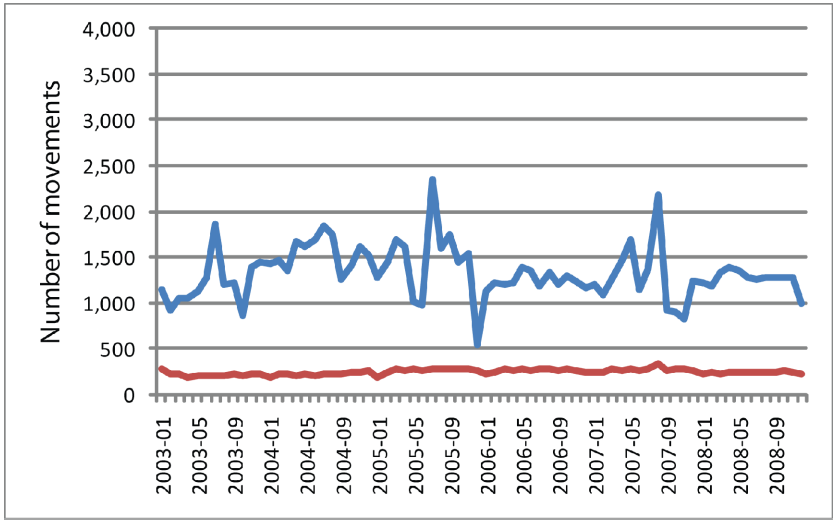


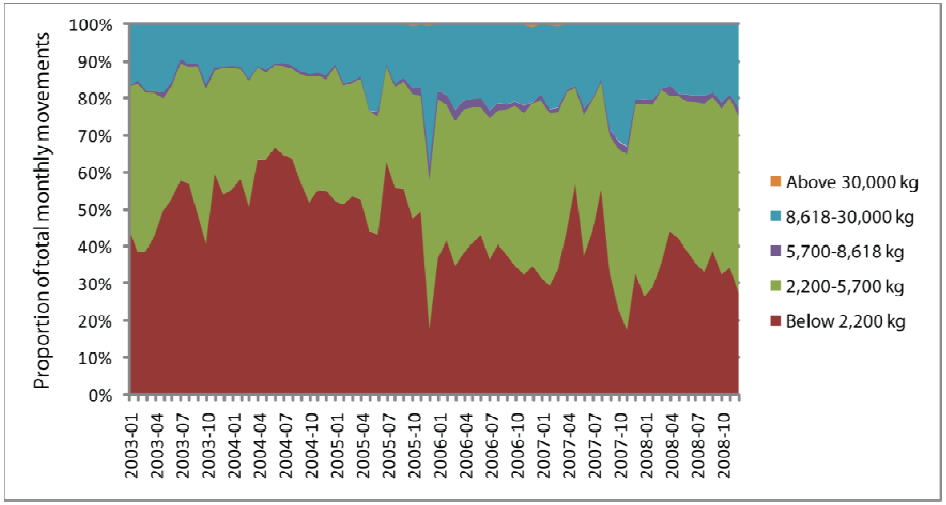
Bathurst (YBTH)



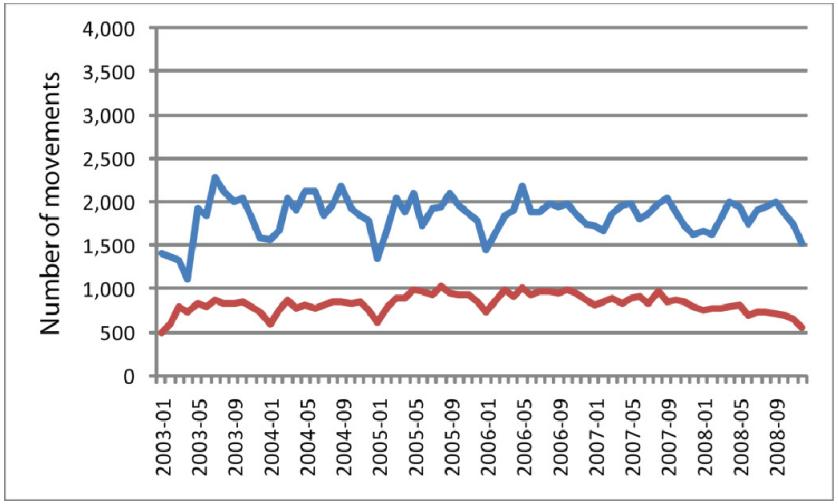


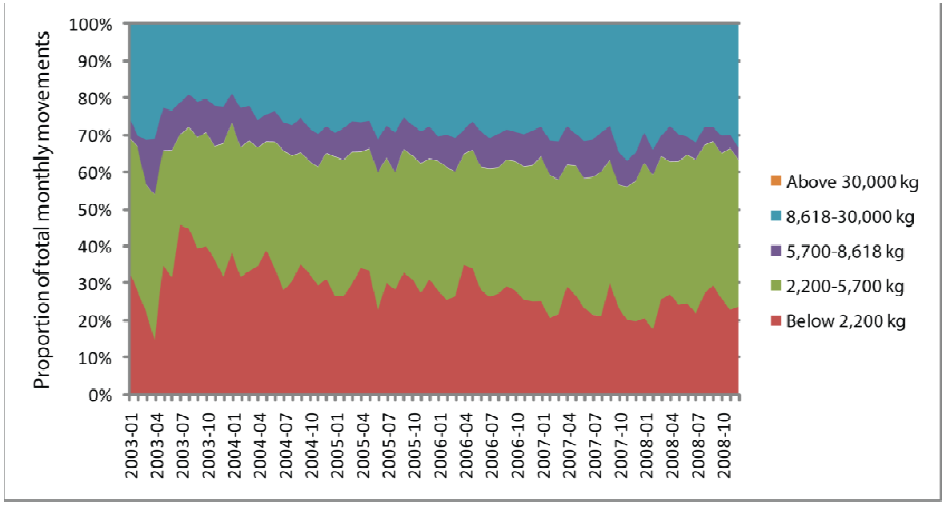
Bundaberg (YBUD)



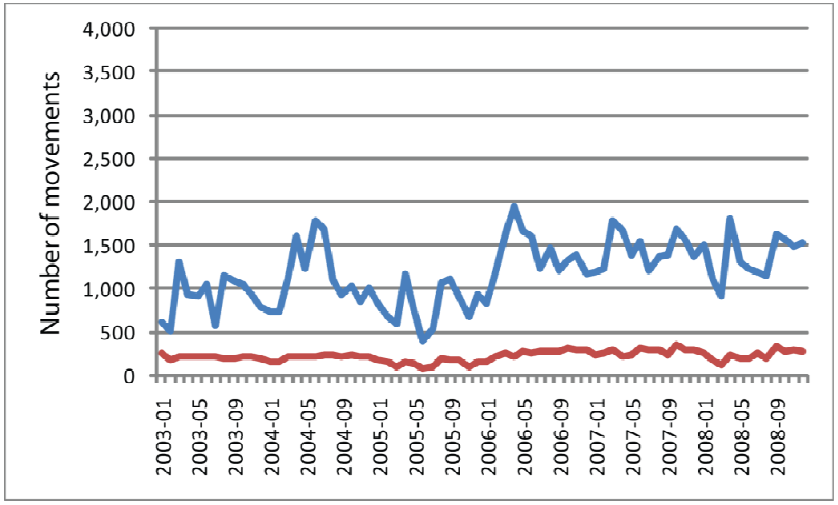


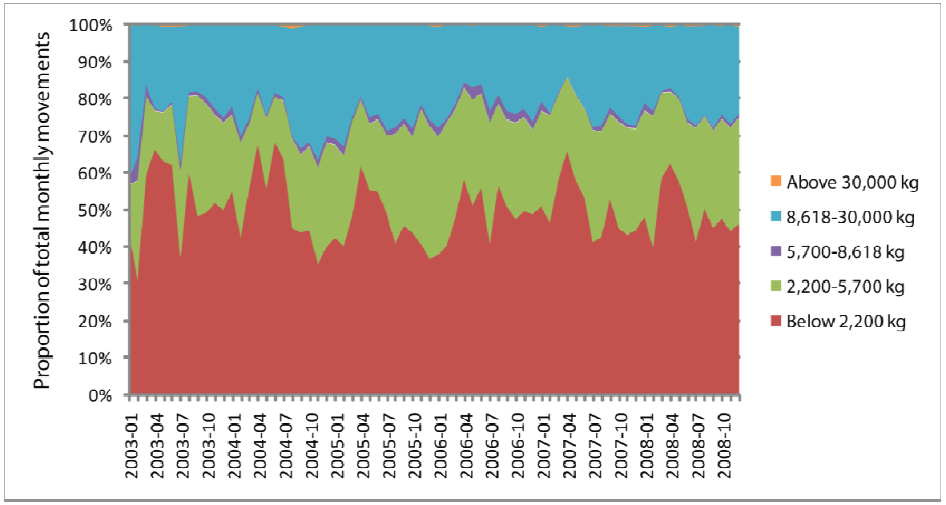
Dubbo (YSDU)



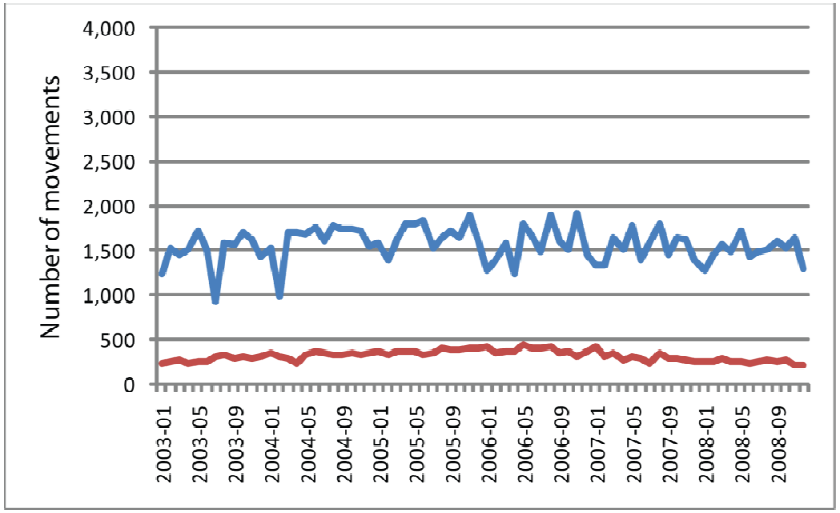


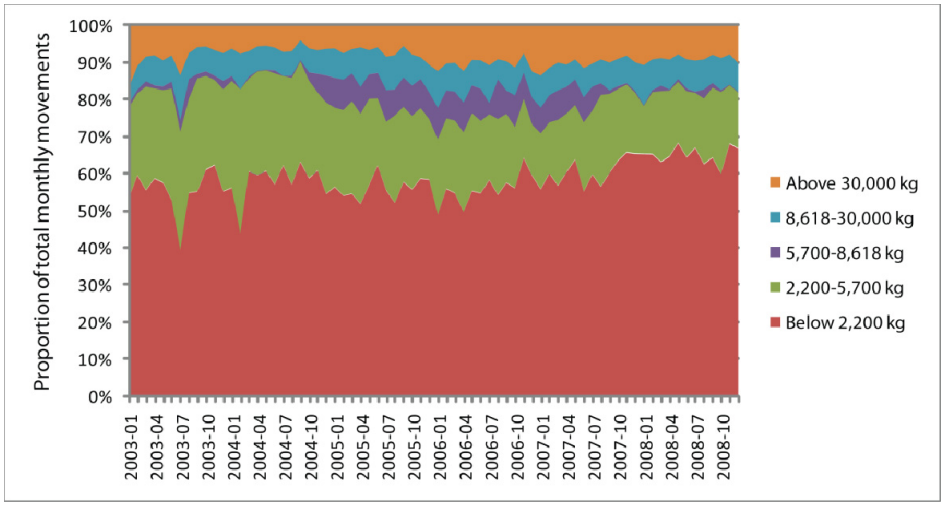
Geraldton (YGEL)





Gove (YPGV)





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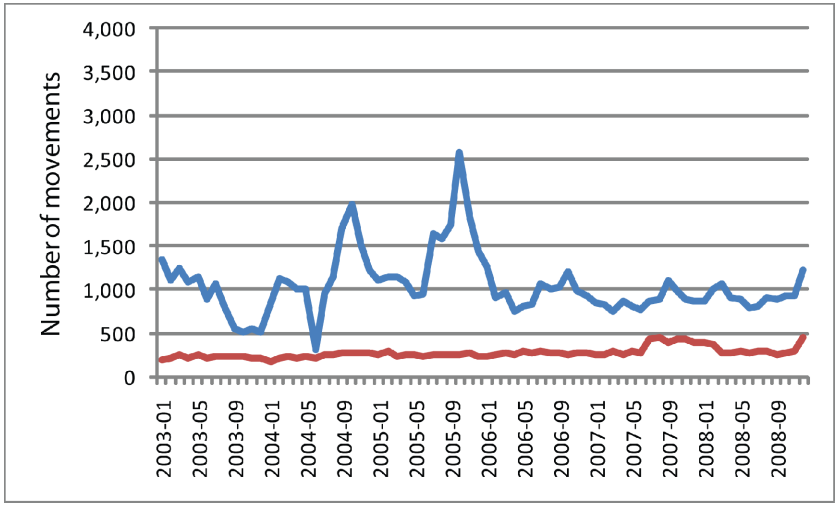
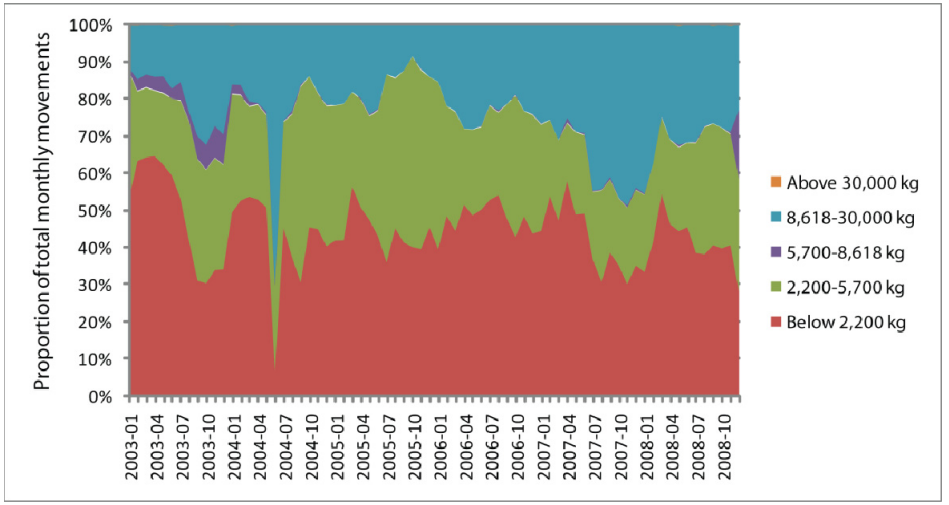
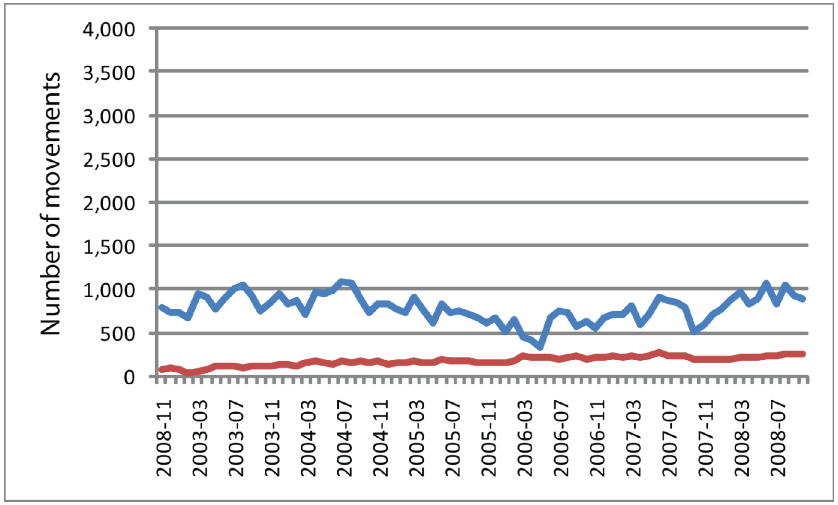
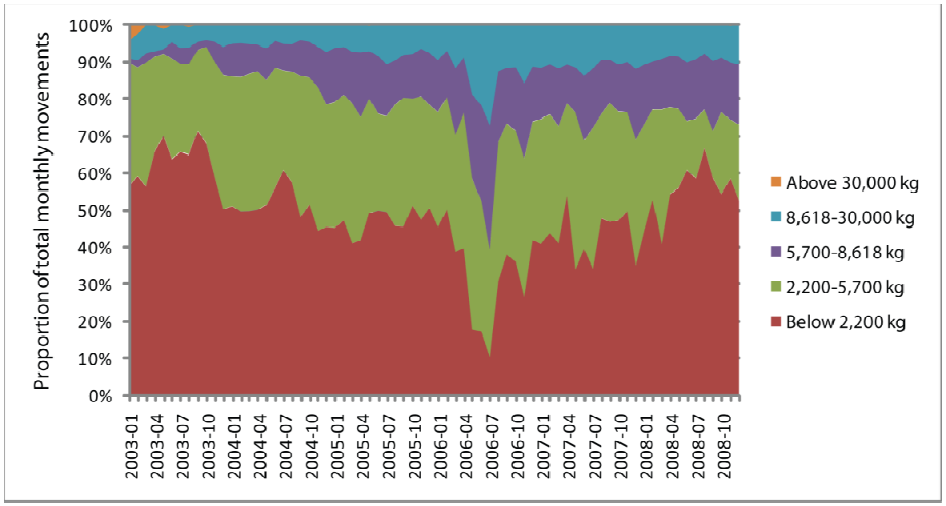


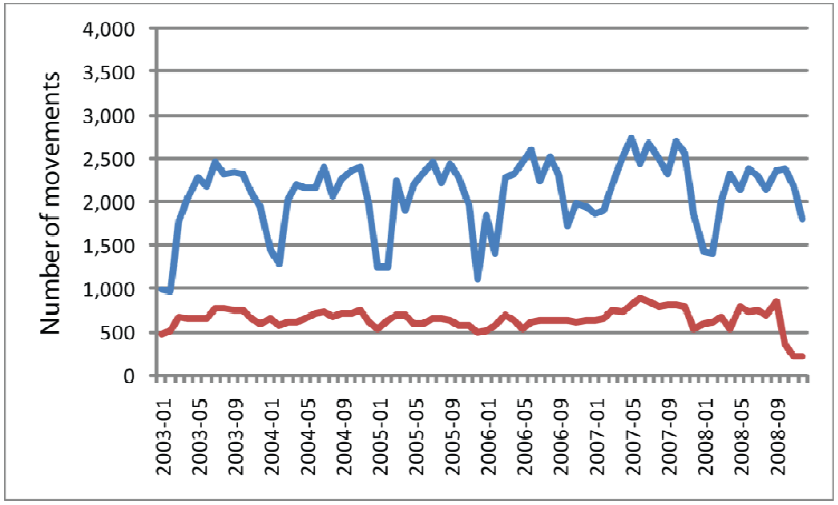


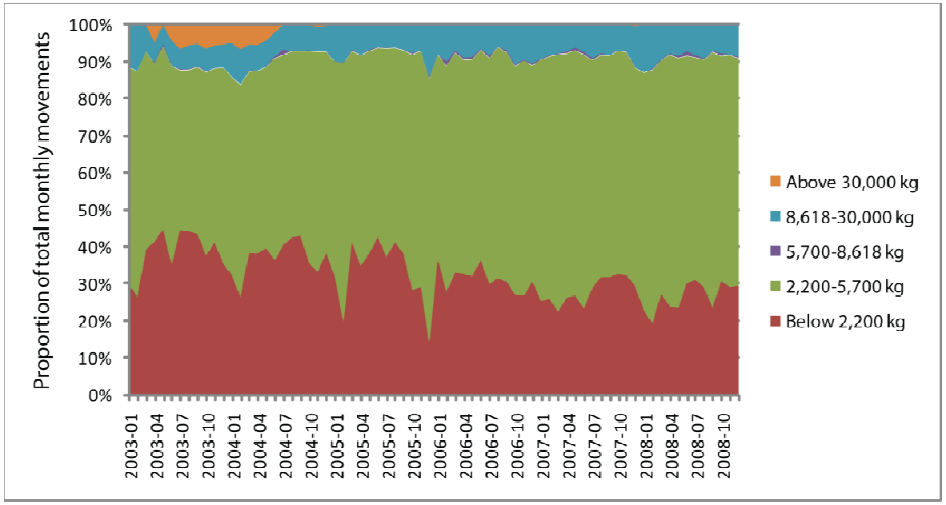
Groote Eylandt (YGTE)



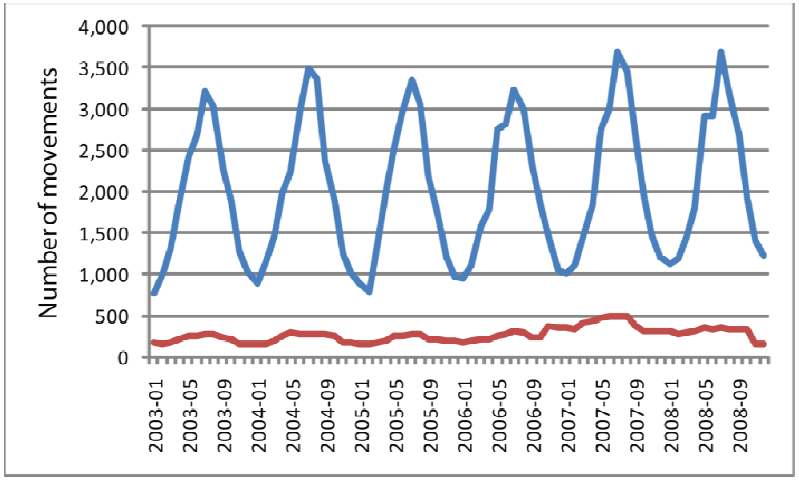


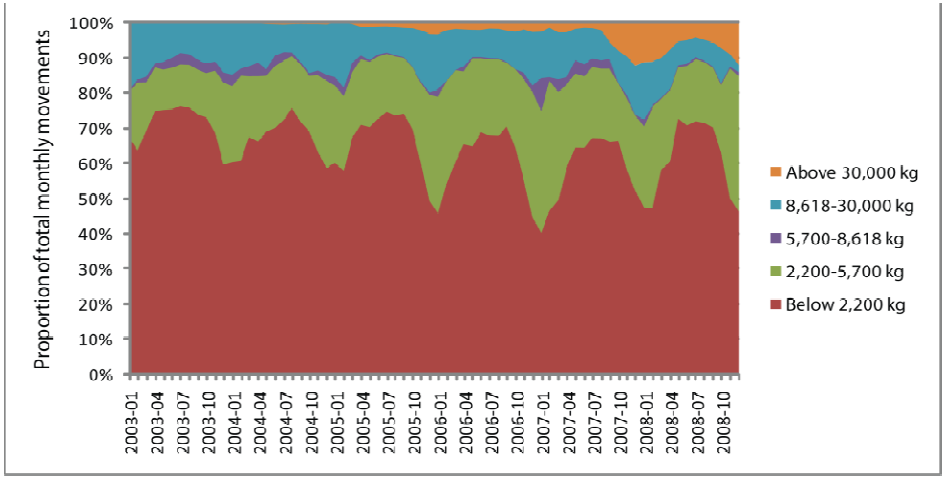
Horn Island (YHID)



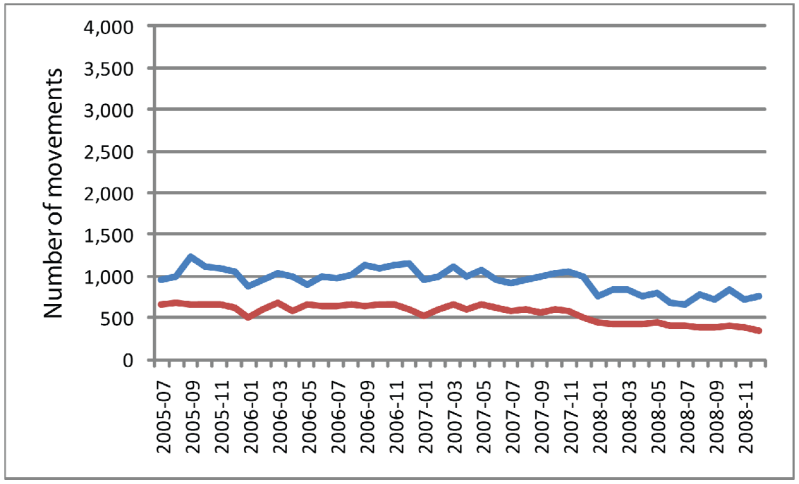


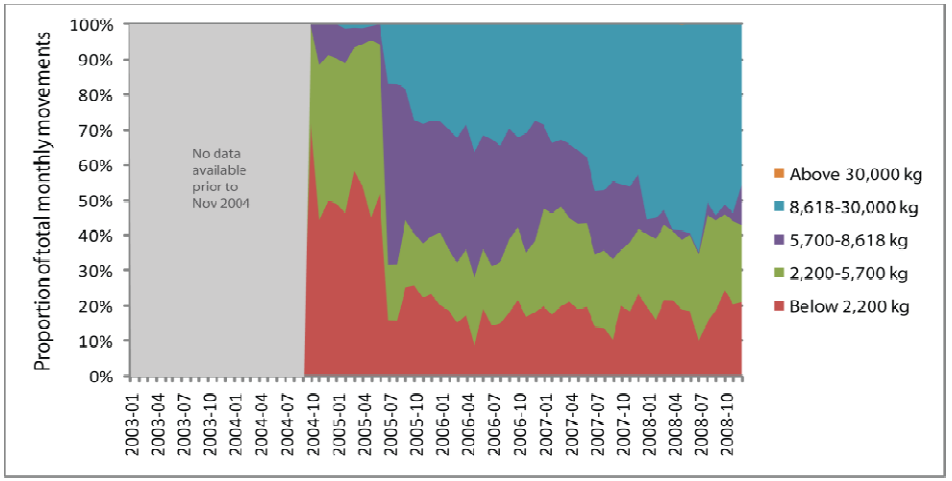
Kununurra (YPKU)





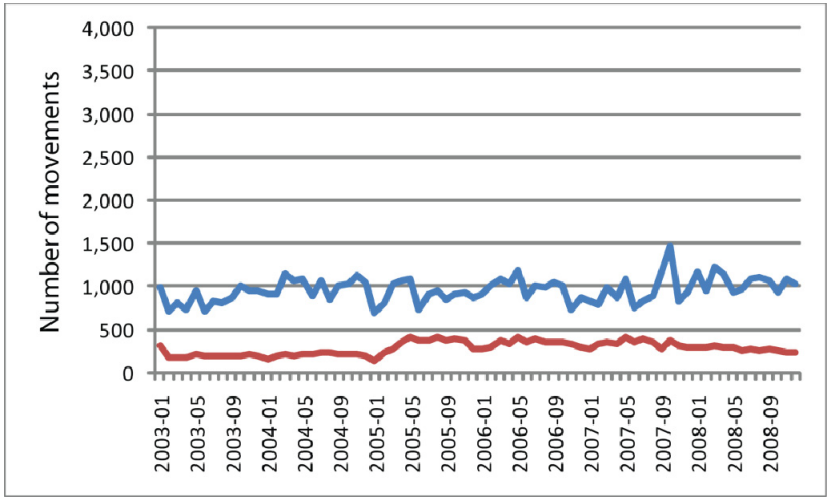
Mount Gambier (YMTG)[1]

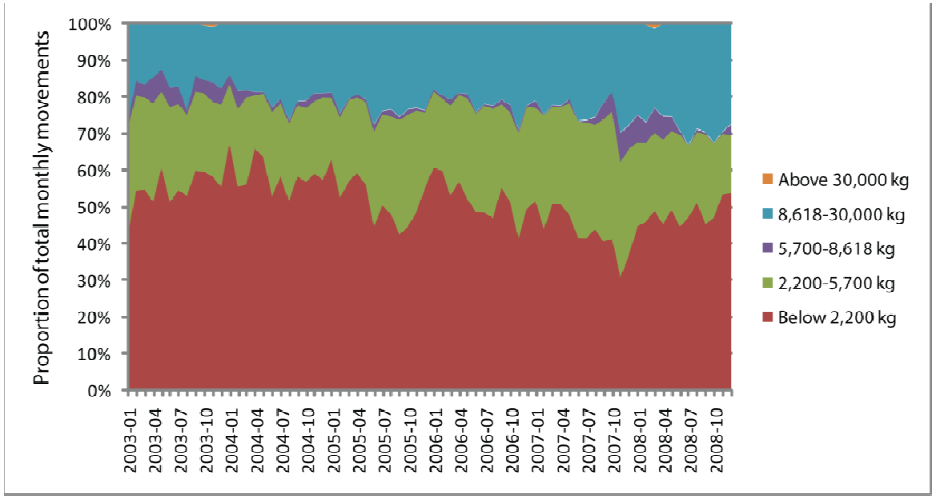




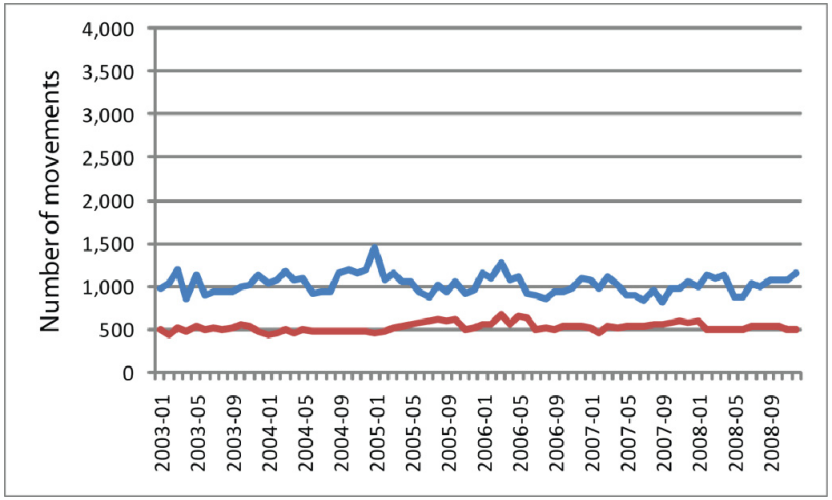
[1] Movements data for Mount Gambier (YMTG) is only available from July 2005-December 2008.

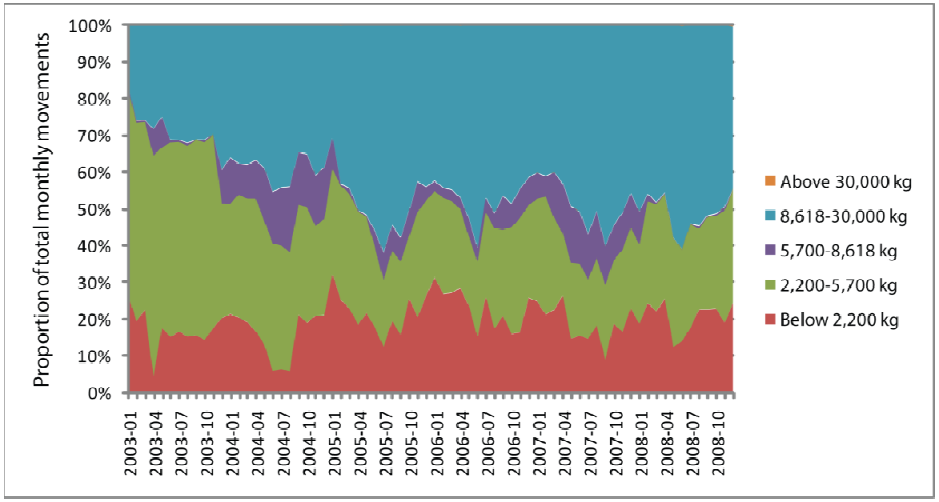
Orange (YORG)



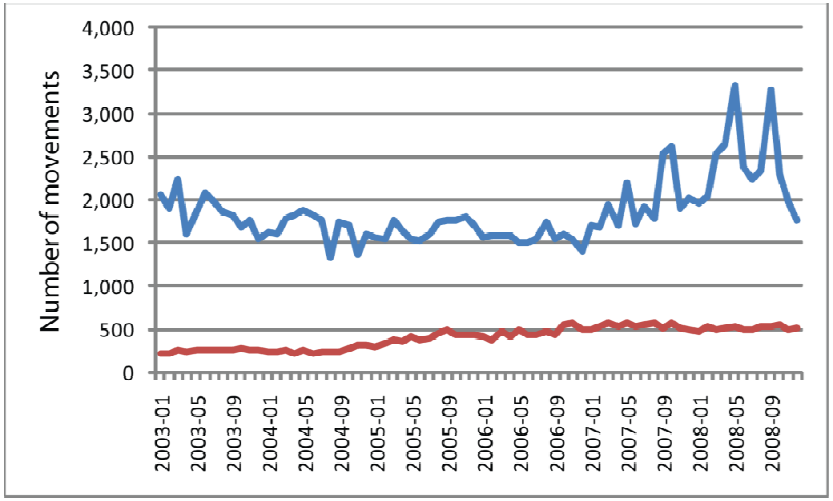


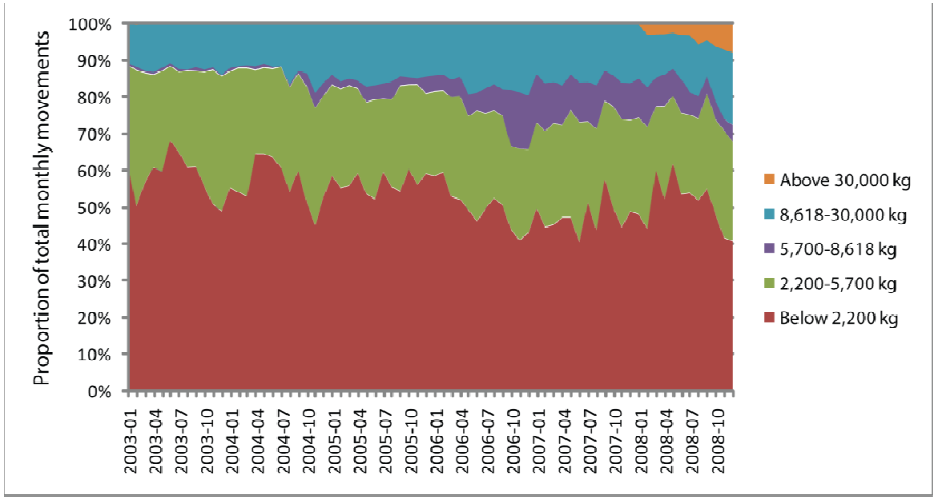
Port Lincoln (YPLC)



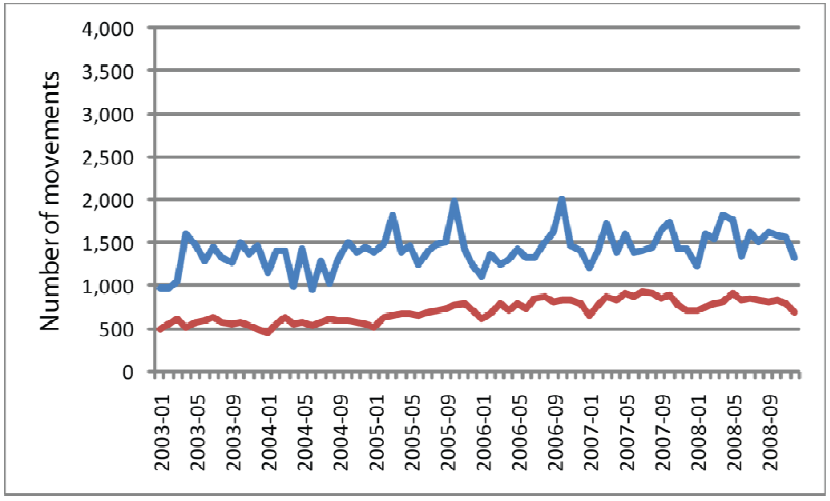


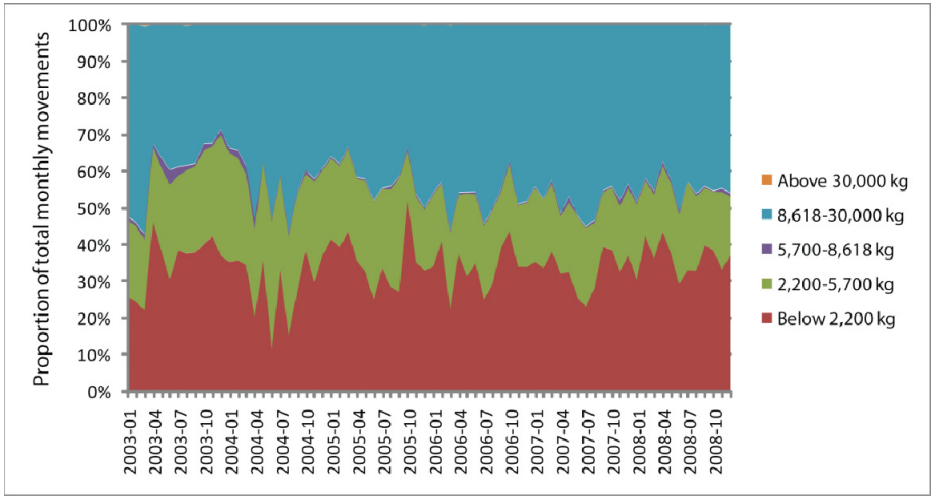
Port Macquarie (YPMQ)



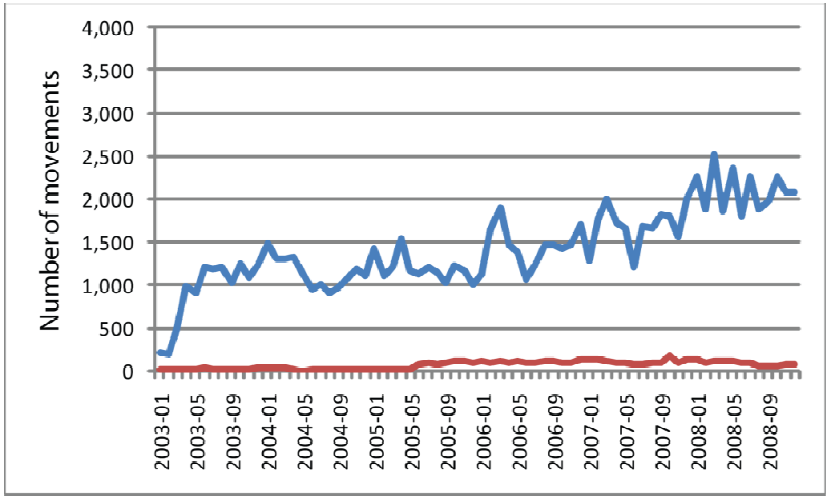


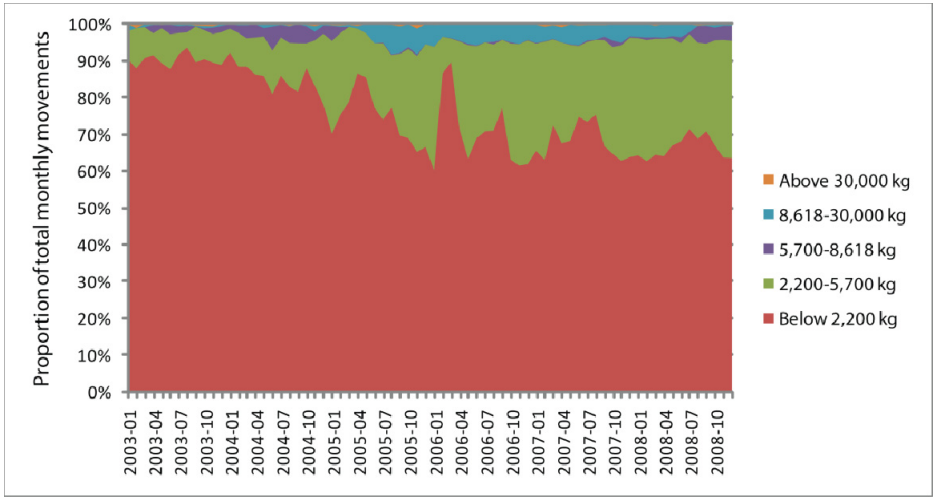
Wagga Wagga (YSWG)





Wollongong (Shellharbour) (YWOL)





Other aerodromes

Full movement data was not available for Broome (YBRM), Karratha (YPKA), or Mildura (YMIA) aerodromes for the entire six-year reporting period. However, for these aerodromes, data estimates were requested directly from the aerodrome operators (Shire of Roebourne and Mildura Airport Pty Ltd respectively), or in the case of Broome Aerodrome, from the CASA Office of Airspace Regulation. These estimates are provided below. Estimations of total movements are based on analysis by the ATSB for the purpose of this report. Useable movements data was not available at all from Hervey Bay Aerodrome (YHBA).

Broome (YBRM)

Broome Aerodrome reports in the May 2009 CASA Aeronautical Study that in 2008-09, approximately 74.5 per cent of movements were made by VFR and IFR light aircraft (considered for the purposes of this report to be GA), and 25.5 per cent of movements were made by IFR medium and heavy aircraft (considered for the purposes of this report to be passenger transport). The following information for the period 2002-03 to 2008-09 is estimated from the May 2009 Aeronautical Study on this basis:

Year	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09[2]
Total passengers	U/K	U/K	U/K	U/K	U/K	U/K	U/K
Passenger growth	U/K	U/K	U/K	U/K	U/K	U/K	U/K
Passenger transport movements	5,578	6,056	6,840	7,095	8,571	9,221	9,486
PT movements growth	U/K	U/K	U/K	U/K	U/K	U/K	U/K
GA movements (est.)	16,516	17,930	20,252	21,007	25,377	27,302	28,086
GA movements growth	*U/K*	*U/K*	*U/K*	*U/K*	*U/K*	*U/K*	*U/K*
TOTAL GROWTH	**U/K**	**8.56%**	**12.95%**	**3.73%**	**20.80%**	**7.59%**	**2.87%**
TOTAL MOVEMENTS (est.)	**21,876**	**23,748**	**26,824**	**27,824**	**33,612**	**36,162**	**37,200**

Source: CASA, 2009; CASA Office of Airspace Regulation

[2] Movements information from 2008-2009 is an estimate based on the movements data provided by CASA OAR for the twelve months to the end of December 2009.

Karratha (YPKA)

Karratha Aerodrome reports that at February 2010, regular public transport (RPT) aircraft landings were approximately 272 per month, and general aviation (GA) aircraft movements were approximately 1,100 per month. Movement information for other years was estimated as follows:

Year	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
Total passengers	161,346	187,401	221,052	281,825	310,467	389,406	U/K
Passenger growth	*11.40%*	*16.10%*	*18.00%*	*18.40%*	*18.50%*	*25.40%*	*U/K*
RPT movements	2,885	2,907	3,475	3,428	3,016	3,765	3,264
RPT movements growth	*15.70%*	*0.08%*	*19.50%*	*-10.90%*	*-12.00%*	*24.80%*	*U/K*
GA movements (est.)	13,200	13,200	13,200	13,200	13,200	13,200	13,200
GA movements growth	*U/K*	*U/K*	*U/K*	*U/K*	*U/K*	*U/K*	*U/K*
TOTAL MOVEMENTS (est.)	**16,085**	**16,107**	**16,675**	**16,628**	**16,216**	**16,965**	**19,728**

Source: Shire of Roebourne, 2010

Mildura (YMIA)

Mildura Aerodrome reported the following movement information for the period 1 July 2003 to 30 June 2009:

Year	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
Total passengers	U/K	126,300	149,350	154,000	168,000	170,031	186,232
Passenger growth	*U/K*	*U/K*	*U/K*	*U/K*	*U/K*	*U/K*	*U/K*
RPT landings	U/K	U/K	U/K	3,659	4,207	3,114	N/A
RPT landings growth	*U/K*	*U/K*	*U/K*	*U/K*	*U/K*	*U/K*	*U/K*
GA landings (est.)	U/K	U/K	3,100	3,100	3,100	3,100	3,100
GA landings growth	*U/K*	*U/K*	*U/K*	*U/K*	*U/K*	*U/K*	*U/K*
TOTAL MOVEMENTS (est.)	**U/K**	**U/K**	**U/K**	**13,518**	**14,614**	**12,428**	**U/K**

Source: Mildura Airport Pty Ltd, 2010

12.3 Appendix C – Air-ground radio information services available at non-towered aerodromes

Flight Information Service

In Class G (uncontrolled) airspace, Flight Information Service is provided to IFR and military aircraft about other IFR or military aircraft that are in conflict (as per AIP GEN 2.15.5). Air traffic services cease providing traffic information to these aircraft when the pilot has reported changing to the CTAF (Airservices Australia, 2010b).

For VFR flights, a radar information service (RIS) is available (on request) when operating in Class E and G airspace within ATS surveillance system coverage. If ATS is able to provide a RIS, information available to pilots includes:

- advisory traffic information (may be incomplete[1])
- position information
- navigation information.

Radar information services are only available to aircraft in direct very high frequency (VHF) communication with ATS, and equipped with a serviceable transponder (for a radar-based service) or automatic dependent surveillance-broadcast (ADS-B) transmitter (for an ADS-B based service).

Further information on RIS for pilots wishing to use this service is provided in AIP GEN 2.16.

Certified air-ground radio services (CA/GRS)

Certified air/ground radio services (CA/GRS) are ground-based aerodrome radio information services that operate on the CTAF frequency at some aerodromes which are always non-towered, or out of operating hours at aerodromes which usually have an ATS presence. These services must be operated by a person who has been approved by CASA.

A CA/GRS is a safety enhancement facility which provides pilots with operational information relevant to that particular aerodrome via broadcasts on the CTAF, in particular, providing relevant traffic information. Local meteorological and weather conditions at the aerodrome must also be provided, including:

- wind speed and direction
- the preferred runway for use considering noise abatement requirements and wind direction
- runway surface conditions
- aerodrome air pressure (QNH) and temperature
- present weather conditions (cloud base, visibility, precipitation)
- a time check for departing aircraft

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[1] A RIS can only provide information about other ATS surveillance system-observed traffic. Due to the nature and range of coverage in many parts of Australia, not all aircraft will be detected, and not all aircraft are equipped with transponders or ADS-B equipment. This reinforces the importance of keeping a good visual lookout for traffic at all times (Airservices Australia, 2010b).

- organisation of aerodrome emergency services response
- provision of aerodrome information to pilots who telephone the CA/GRS.

The requirements for CA/GRS operators and services are established in Civil Aviation Safety Regulations (CASR) Part 139 Manual of Standards (CASA, 2002).

The CA/GRS operator does not provide any separation service. It is not an Airservices or Royal Australian Air Force (RAAF)-provided air traffic service, however, CA/GRS operators have been certified to meet a CASA standard of communication technique and aviation knowledge appropriate to the services being provided, and can provide limited traffic information.

Meteorological and aerodrome weather information is provided by means of the Aerodrome Radio Information Services, which depending on the aerodrome and time of operations, can include:

- CA/GRS
- Automatic aerodrome information service (AAIS)
- Universal communication (UNICOM) service
- the Aerodrome frequency response unit (AFRU) ('beep-back' unit)
- an AFRU with a pilot-activated lighting (AFRU+PAL) option.

Introduced by a legislative requirement in 1999, CA/GRS services stemmed from concerns about the potential for aircraft conflicts with the increasing volume and mix of air traffic at some non-towered aerodromes. The aerodromes where CA/GRS is intended to be provided are those with a high traffic movement density where high and low capacity passenger transport aircraft operations are mixed with GA operations (CASA, 2005; ACMA, 2009).

At the time of writing, there were only two non-towered aerodromes that provided a CA/GRS service (Broome and Ayers Rock aerodromes). At these aerodromes, the CA/GRS is provided within a 30 NM radius of the aerodrome, and to a height at which other aircraft may conflict with those aircraft operating to or from the aerodrome (CASA, 2005). This broadcast area has the benefit of allowing aircraft outside of the immediate vicinity (10 NM) of a non-towered aerodrome to have access to pertinent aerodrome and traffic information.

Broome Aerodrome is set to receive a permanent ATC service from November 2010 to supplement its CA/GRS service.

Universal communication (UNICOM) services

A UNICOM is similar to CA/GRS, however, it is a non-ATS ground-to-pilot radio services provided at some non-towered aerodromes by private commercial or community operators. At some aerodromes, the UNICOM operator may be a dedicated person, at others it might be other aerodrome personnel. The intention of the UNICOM is to increase the situational awareness of pilots by providing supplemental information, providing an intermediary level of service between CTAF (no ATS) and CA/GRS (limited ATS).

Stations providing a UNICOM service are required to be licensed by the Australian Communications and Media Authority (ACMA), but unlike CA/GRS operators, they are not licensed by CASA.

In the past, UNICOM services were generally limited to providing information such as weather forecasts. Presently, UNICOM operators can provide (on pilot request) the following information via broadcasts on the CTAF:

- confirmation of the CTAF radio frequency allocation being used
- estimated times of arrival and departure for aircraft operating to/from that aerodrome
- aerodrome and runway information
- unscheduled landings by aircraft
- general weather reports
- advice to emergency services regarding aircraft in need of assistance
- fuel requirements
- maintenance and servicing of aircraft, including the ordering of urgently required parts and materials
- passenger requirements.

The requirements for UNICOM operators and services are also established in CASR Part 139 Manual of Standards (CASA, 2002).

Like CA/GRS, UNICOM (where provided) is intended only to be a tool to help enhance pilots' situational awareness, and is not a traffic separation service. Unlike CA/GRS, UNICOMs are not designed to provide any traffic information (Airservices Australia, 2007).

From December 2007 to March 2009, UNICOM services were trialled by Airservices Australia at a number of non-towered regional aerodromes where CTAF(R) was used (Dubbo, Hervey Bay, Port Macquarie, Wagga Wagga, Olympic Dam). During this trial, a special dispensation under CASR 139 also allowed these UNICOM services to provide basic traffic information to pilots.

Analysis of the UNICOM trial data by Airservices Australia found that the UNICOM services:

- reduced the risk of a potential close proximity event between two aircraft through timely and appropriate dissemination of relevant traffic statements, particularly with respect to known VFR aircraft operating in the vicinity of the aerodrome
- assisted flight crew planning through the provision of numerous weather advisories on request from aircraft, particularly in inclement weather
- improved radio procedures and compliance with CTAF(R) procedures, including appropriate frequency management
- were able to deliver comparable services and safety enhancements to a CA/GRS, at a lower cost basis , considering both establishment and operating costs (Airservices Australia, 2010a).

Reports from industry following the trial did suggest that UNICOM operators may have contributed to a higher level of frequency congestion on the CTAF due to unnecessary broadcasts. Airservices believes that the introduction of a more refined and relevant traffic statement for UNICOM operators would address most frequency congestion issues (Airservices Australia, 2010a).

Feedback from pilots and stakeholders operating at the trial aerodromes during the Airservices Australia UNICOM trial suggested both positives of the UNICOM service, as well as areas for improvement:

- Positive
  - specific safety enhancements due to the service being provided by the UNICOM operators (such as the reduced potential for an airprox or other reduced separation event between two aircraft);
  - receiving weather advisories; and
  - ensuring aircraft were operating on the designated CTAF frequency.
- Areas for improvement
  - managing frequency congestion on the CTAF;
  - ensuring UNICOM operators have visibility of the circuit and manoeuvring areas of the aerodrome;
  - understanding IFR cockpit workload and procedures;
  - Enhancing meteorological weather services;
  - Enhancing traffic advisory information; and
  - Refining hours of service to match the traffic requirements (Airservices Australia, 2010a).

Some of these areas for improvement are functions that would be provided by an equivalent CA/GRS service (if available).

12.4 Appendix D – Traffic mix analysis vs. Occurrence types by aerodrome

Table D.1: Average traffic mix by MTOW group, movement data comparison group aerodromes, 2003-2008

Aerodrome	Occurrences 2003-2008	Below 2,200 kg	GA ESTIMATED PROPORTION	2,200 - 5,700 kg	5,700 - 8,618 kg	8,618 - 30,000 kg	Over 30,000 kg	PT ESTIMATED PROPORTION
		Expected		*Expected*	*Expected*	*Expected*	*Expected*	
Armidale (YARM)	8	45%	45%	30%	3%	22%	0%	55%
Ballina (YBNA)	9	36%	36%	6%	10%	28%	20%	64%
Bathurst (YBTH)	9	67%	67%	20%	10%	3%	0%	33%
Broome (YBRM)[1]	23	75%	75%	13%		12%		25%
Bundaberg (YBUD)	9	20%	20%	0%	45%	35%	0%	80%
Dubbo (YSDU)	23	25%	25%	43%	7%	25%	0%	75%
Geraldton (YGEL)	23	50%	50%	23%	0%	27%	0%	50%
Gove (YPGV)	4	60%	60%	20%	3%	7%	10%	40%
Griffith (YGTH)	3	45%	45%	30%	0%	25%	0%	55%
Groote Eylandt (YGTE)	8	50%	50%	25%	15%	10%	0%	50%
Hervey Bay (YHBA)[1]	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Horn Island (YHID)	6	30%	30%	57%	0%	10%	3%	70%
Karratha (YPKA)[2]	12	83%	83%	17%				17%

[1] Hervey Bay is also included in this table, however, movements data for Hervey Bay (YHBA) was not available.

[2] Passenger Transport and GA movement data for Karratha (YPKA), Broome (YBRM), and Mildura (YMIA) is an estimate only based on approximate data provided by those aerodrome operators.

Kununurra (YPKU)	14	60%	60%	20%	3%	10%	7%	40%
Mildura (YMIA)[2]	19	40%	40%	60%				60%
Mount Gambier (YMTG)[3]	1	15%	15%	25%	20%	40%	0%	85%
Orange (YORG)	7	55%	55%	20%	5%	20%	0%	45%
Port Lincoln (YPLC)	7	15%	15%	25%	5%	55%	0%	85%
Port Macquarie (YPMQ)	19	50%	50%	25%	5%	15%	5%	50%
Wagga Wagga (YSWG)	15	35%	35%	20%	0%	45%	0%	65%
Wollongong (YWOL)	3	70%	70%	22%	3%	5%	0%	30%

[3] As movements data for Mount Gambier (YMTG) is only available from July 2005-December 2008, only occurrences during this period are tabulated.

Table D.2: Airspace-use related occurrences, movement data comparison group aerodromes, 2003-2008

Aerodrome	Occurrences 2003-2008	Involving GA		Involving PT		Comments
		Expected	*Actual*	*Expected*	*Actual*	
Armidale (YARM)	8	4	7	4	7	PT conflicts were half high capacity, half low capacity. Related to private/agricultural aircraft not broadcasting, or reporting correct position.
Ballina (YBNA)	9	3	6	6	7	6 of 7 PT occurrences involved jet high capacity aircraft. Review of traffic mix suggests 30,000+ kg MTOW aircraft should only contribute 20% of occurrences.
Bathurst (YBTH)	9	6	8	3	7	4 of 7 PT occurrences involved heavy low capacity RPT aircraft (Saab 340 size). Review of traffic mix suggests 8,618+ kg MTOW aircraft should only contribute 3% of occurrences.
Broome (YBRM)[4]	23	17	21	5	7	No disproportionate representation of PT aircraft.
Bundaberg (YBUD)	9	2	7	7	3	No disproportionate representation of PT aircraft.
Dubbo (YSDU)	23	6	14	17	16	14 of 16 PT occurrences involved low capacity RPT aircraft.
Geraldton (YGEL)	23	12	18	12	13	8 PT occurrences involved high capacity RPT aircraft – aircraft over 8,618 kg MTOW should only contribute to 27% of occurrences based on average traffic mix.
Gove (YPGV)	4	2	1	2	3	Small numbers prohibit comparative analysis.
Griffith (YGTH)	3	1	2	2	3	No disproportionate representation of PT aircraft.
Groote Eylandt (YGTE)	8	4	2	4	7	Of the PT occurrences, 3 involved low capacity RPT aircraft (Cessna 404 sized).
Hervey Bay (YHBA)[4]	10	N/A	8	N/A	8	2 of 8 PT occurrences involved jet high capacity RPT aircraft. The remainder involved low capacity RPT aircraft.

[4] Movements data for Hervey Bay (YHBA) was not available.

Horn Island (YHID)	6	2	4	4	6	No disproportionate representation of PT aircraft. All PT occurrences involved high capacity RPT aircraft conflicts with Private GA or Charter aircraft.
Karratha (YPKA)[5]	12	10	9	2	7	5 of 7 PT occurrences involved RPT aircraft, mostly conflicts with GA aircraft.
Kununurra (YPKU)	14	8	11	6	11	Most of the PT occurrences involved low capacity RPT aircraft (EMB-120 sized) or smaller Charter aircraft which have an MTOW below 2,200 kg.
Mildura (YMIA)[5]	19	8	14	11	14	No disproportionate representation of PT aircraft. Several occurrences involved hot air balloons on the runway 27 final approach path conflicting with RPT aircraft.
Mount Gambier (YMTG)[6]	1	0	0	1	1	Small numbers prohibit comparative analysis.
Orange (YORG)	7	4	5	3	6	6 of 7 occurrences involved low capacity RPT aircraft. Review of traffic mix suggests RPT aircraft should only contribute to no more than 50% of occurrences.
Port Lincoln (YPLC)	7	1	5	6	6	No disproportionate representation of PT aircraft.
Port Macquarie (YPMQ)	19	10	17	10	12	No disproportionate representation of PT aircraft. No PT occurrences involved jet high capacity RPT aircraft since start of ops in Oct 2007.
Wagga Wagga (YSWG)	15	5	11	10	12	All PT occurrences involved heavy low capacity RPT aircraft (DHC-8 and Saab 340) – should only contribute to 45% of occurrences based on average traffic mix.
Wollongong (YWOL)	3	2	3	1	0	Small numbers prohibit comparative analysis.

[5] Passenger Transport and GA movement data for Karratha (YPKA), Broome (YBRM), and Mildura (YMIA) is an estimate only.

[6] As movements data for Mount Gambier (YMTG) is only available from July 2005-December 2008, only occurrences during this period are tabulated.

12.5 Appendix E – Sources and submissions

12.5.1 Sources of information

The primary sources of information used during this investigation were:

- the Australian Transport Safety Bureau (ATSB) aviation occurrence database;
- the ATSBs current and former voluntary reporting schemes; Aviation Confidential Reporting (REPCON) and Confidential Aviation Incident Reporting (CAIR);
- Avdata Australia;
- Australian aerodrome operators;
- Civil Aviation Safety Authority (CASA) publications and workshops;
- Airservices Australia En Route Supplement Australia (ERSA), Aeronautical Information Publication (AIP), movements data, and other publications; and
- accident investigation reports published by the ATSB.

12.5.2 Submissions

A draft of this report was provided to the Civil Aviation Safety Authority (CASA) (incorporating the Office of Airspace Regulation (OAR)) and Airservices Australia.

The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Safety in the vicinity of non-towered aerodromes.