ARDC National Fire History Project – 2021 to 2023

Work Package 1 (Part B)
Fire History Mapping and Feeds

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1. Executive Summary

The ARDC Bushfire Boundary project has completed a gap analysis for the fire and land management agencies in all jurisdictions across Australia which compile fire history.

It has identified 4 states requiring a joint agency mapping system to be built so a single state or territory fire history feed can be compiled. These states are Tasmania, Queensland, Western Australia and South Australia.

All states compile some fire history data, but there is uplift needed across the states to align every jurisdiction with the new AFAC Fire History Data Dictionary. The recommendations for each agency and what is required, has been identified at a high level.

It is recommended that every state maps the data flows from each agency in their current systems, and where there are gaps identified a proposed new data model be produced in consultation with the joint agencies to identify a suitable system to create a single maintainable fire history dataset that allows the data to be shared with other jurisdictions and nationally.

2. Gap Analysis focusing on Fire History

2.1 Gap Analysis: Fire History feed and attributes

Following the 2019-20 'Black Summer' EMSINA undertook an initial gap analysis of current bushfire and fire history data capture and provision capability across Australia. This analysis provided a base line of capability to the Commonwealth and helped initiate this project. EMSINA Gap Analysis - April 2020

The updated gap analysis for 2021-22 identifies the jurisdictions unable to either create a fire history dataset or provide it as a webservice for national aggregation. Some jurisdictions are missing key attributes in their current feed. While other jurisdictions need uplift to provide consolidated multi-agency state-wide bushfire boundaries.

The primary objective of this part of the project (WP1B) is to enable all Australian states and territories to be able to create and supply a single Fire History data feed based on the data dictionary agreed by AFAC.

Table 1 looks at some of the attributes included in the fire history dataset for each jurisdiction and whether they conform to the data dictionary as well as the different ways jurisdictions supply and licence fire history data.

Table 1: **Summary of jurisdiction fire history data supply**

Jurisdiction and Lead Agency	Single Data Supply	Conform to Data Dictionary X Fields (12)	Publicly searchable	Public download	Public webservice	Licence
ACT (PCS)	Yes	4	No	No	No	CC-BY 4 AU
NSW (RFS)	Yes	8	No	No	No	No
NT (PFES)	Yes	2	No	No	No	No
QLD (QFES)	No	5	Partial	Partial	Partial	CC BY 4 AU
SA (DEW)	Yes	6	Yes	Yes	No	CC-BY 4 AU
TAS (NRE)	Yes	10	Yes	Yes	Yes	CC-BY 4 AU
VIC (DEECA)	Yes	5	Yes	Yes	Yes	CC-BY 4 AU
WA (DFES)	No	6	Yes	Yes	No	CC-BY 4 AU

Most states can supply a single dataset for fire history but, a majority of jurisdictions don't conform to the data dictionary and work will need to be done to align their attributes or provide them in a suitable format for data aggregation nationally.

Only some states have the capability for their fire history to be searchable and available for public download through open data catalogues. The jurisdictions which don't have a publicly downloadable version usually don't provide the data as a publicly available webservice. Nearly all states and territories licence their data as CC BY 4.0 AU with the exception, of NSW and NT. Landgate still has to resolve data sharing with other agencies, data is not CC BY 4.0 AU and there is licencing and costs that need to be managed.

Table 2 identifies the states which currently provide a fire history dataset that has attributes which align closely to the format recommended in the data dictionary.

Table 2: Current status of jurisdictions fire history attributes against AFAC Data Dictionary

Data Dictionary Field	NSW (RFS)	ACT (PCS)	NT (PFES)	QLD (QFES)	SA (DEW)	TAS (NRE)	VIC (DEECA)	WA (DFES)
Fire_id	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Fire_name	Yes	No	No	No	Yes	Yes	Yes	Yes
Ignition_date	Yes	No	No	Yes	Yes	Yes	No	No
Capture_date	No	No	Yes	Yes	No	Yes	No	No
Extinguish_date	Yes	Yes	No	No	No	Yes	No	Yes
Fire_type	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Ignition_cause	Yes	Yes	No	No	No	Yes	Yes	No
Capt_method	Yes	No	No	Yes	Yes	Yes	No	Yes
Area_ha	No	No	No	Yes	Yes	Yes	Yes	No
Perim_km	No	No	No	Yes	Yes	No	No	No
State	No	No	No	No	No	No	No	No
Agency	Yes	No	No	No	No	Yes	No	Yes

Some attributes like Fire_id and Fire_name and fire_type will align closely and will need little work on the data format or structure. The attributes Area_ha, Perim_km and State can all be autogenerated during the collation process. Attributes like Ignition_Date, Capture_Date, Extinguish_Date, Ignition_Cause and Capture_Method differs between the jurisdictions and do not necessarily align in the data format currently being provided.

Table 3 identifies the states which have the attributes for the new data dictionary, but the attributes will need to be renamed or provided in a different data format.

Table 3: Current status of jurisdictions fire history attributes where the data is available, but work is required

Data Dictionary Field	NSW (RFS)	ACT	NT (PFES)	QLD (QFES)	SA (DEW)	TAS (TFS)	VIC (DEECA)	WA (DFES)
Fire_id	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Fire_name	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Ignition_date	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Capture_date	Yes	Yes	Yes	Yes	No	Yes	Yes	No
Extinguish_date	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Fire_type	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Ignition_cause	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Capt_method	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Area_ha	No	No	No	Yes	Yes	Yes	Yes	No
Perim_km	No	No	No	Yes	No	Yes	No	No
State	No	No	No	No	Yes	No	No	No
Agency	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes

Some data attributes are maintained in another system such as the agencies incident management system and will need to be joined on the fire_id to link it back to the polygon data. Some states maintain both bushfire and prescribed burning management systems, so the data may need to be exported for both types of data, then joined by scripting processes prior to the data being supplied.

All states are providing some form of Fire history, but the level of detail differs between jurisdictions, around how the data is compiled, how timely it is and the amount of work to get the attributes to align with the data dictionary. Even for the states such as Tasmania, Victoria and NSW which have quite mature fire history datasets, there is still work needed to provide the feed with the new attribute names as well as including some of the missing attributes which involves accessing data from other systems. All states provide a feed to the national aggregator.

Below is a summary of the capability gaps around the attributes identified for the states and territories which are not currently supplying fire history.

New South Wales:
- NSW produces a single fire history dataset. It currently is not available to the public in any format. The data being created aligns with all the attributes in the data dictionary except for capture date and the system generated fields (Area, Perimeter and State).

Australian Capital Territory:
- ACT produces a single fire history. The data is currently not available to the public in any format, but it is licenced for CC BY 4.0 AU and is made available on request.

- ACT data only has a few attributes that currently align with the data dictionary, but several attributes are available under different attribute names. Uplift has started to align them with the national standard.

Northern Territory:
- NT currently does not have a near real time current bushfire incident extent or data feed. Only a bushfire incident point is available to be shared nationally and these are only fires coming through the Computer Aided Dispatch (CAD) system. Not all fires are captured in the CAD system.

- NT has an ignition date which comes from the CAD system and could be integrated for those fires.

- NT does not have a naming convention, so few fires are named. CAD ID is the unique identifier if the fire goes through 000.

- NT captures fire scars by remote sensing at different scales across the territory, the whole Territory has 250m raster MODIS imagery, and some areas have finer scale image capture dependent on funding. This data could be integrated with other fire history data.

Queensland:
- QFES capture operational fire boundaries for some incidents and provide this feed for national aggregation. QFES has not aligned with the fire history data dictionary for all attributes currently.
- This dataset focuses on populated areas and fires in the remote parts of the state are not captured. Fires are prioritised on level of risk to life and property.
- Only fires that have a response by QFES are captured for fire history. Fires in remote areas are rarely captured other than by satellite imagery capture.
- All fires are captured by remote sensing by Department of Environment and Science (DES) on a monthly capture cycle.
- Queensland Parks and Wildlife Service and Partnerships (QPWS&P) capture some fires in the Parks estate, the fire history data they now provide aligns to the new data dictionary.
- Data interoperability could be improved between the different fire management agencies and there are also gaps in the creation and editing abilities of the different agencies.

South Australia:
- SA produces fire history as a searchable and downloadable product, but it is not provided as a webservice that is publicly available. Licencing would allow the data to be shared if made public.

- The current fire history product is missing some attributes required in the data dictionary around capture date and extinguish data.
- Need to integrate the Ignition_Date and Extinguish_Date from the CFS IMS system (CRIMSON). The CRIMSON_ID is the attribute that would link the two systems, this would then allow several data attributes to be joined to the fire History dataset. The DEW Fire_id is different to the CFS CRIMSON_ID, currently DEW incorporate the CRIMSON _ID as a label for some incidents.

Tasmania:
- Tasmania produces a single aggregated dataset, including restricted commercial-in-confidence data not for public release. This data is made available to approved agencies and users via data supply agreements and access-restricted web services.
- A declassified version of the data is searchable and downloadable publicly via open data and web services. CC BY 4.0 AU licencing allows the public data to be shared.
- Most attributes match the data dictionary. The amalgamated fire history feed is supplied nationally.

Victoria:
- Victoria currently provides a single data supply; it produces a searchable and downloadable product, and a feed is also available. Licencing allows the data to be shared.
- It currently has a number of attributes that match the data dictionary and there are several attributes that need renaming to match the dictionary.
- Extinguish date needs to be provided from the Incident management system from the status field and the fire cause needs to be extracted from DEECA's Fireweb or CFA's IMS system. Data manipulation will need to occur to bring this data into the new fire history format required.
- A stocktake of fire history needs to occur to improve the fire shapes with no names or exact start dates and matched to Fireweb historical records.

Western Australia:
- In WA there is no mandate to capture the fire extent of all fires. Data for fires come from four different sources – CAD incidents (DFES); Tactical Fire shapes (DFES); burns in conservation estate (DBCA) and Bushfire History for Modelling and Predictions (DFES).
- DFES produces a mapped Bushfire History for the purposes of Modelling and Predictions, but it is not provided as a publicly available webservice. This licencing issue is under review.
- Bushfire History data is produced for Aurora (a fire prediction tool) and uses data from satellite capture. This tool is predominantly for larger fires and may miss small scale fires. The data provided is fit for purpose for fire modelling, and the agencies need to determine if there is a need for the capture of small-scale fire scars for a fire history product.
- The current Bushfire History product is missing some attributes defined in the data dictionary. Ignition date, cause, and capture method are either not captured or are in disparate databases and will require significant work to integrate.
- DBCA capture fires on the conservation estate, and any fires DBCA staff attend. DFES may not capture some of these fires in their feed.
- DFES will have an incident start time created in their CAD system, burn scars from satellite imagery often wont correlate with the start time and are dependent on when the satellite pass is. As a result, not every fire will be able to link the CAD details to the data derived from satellite imagery.
- DBCA Parks and DFES data have an incident start time.
- There are licencing issues for Landgate around provision of data without costs and CC BY 4.0 AU access. This issue needs to be resolved with the agency but this is due to Landgate's current Act, some work is going on in this space currently to review the Act.

Recommendation:

To achieve a complete national fire history feed, it is recommended that:
- All states should be encouraged to work towards alignment with the national fire history data dictionary.
- Assist states where necessary to align their data for a national feed.

2.2 Fire History Information review

The following section reviews all states and territories and their ability to capture, edit, create, and provide fire history information. This work continues from the gap analysis which occurred immediately after the Black Summer fires. Some jurisdictions have started work to improve data capture. Some of the information captured below was discussed in depth in the Current Bushfire Incident Mapping and Feeds Gap Analysis Report (Work Package 1 – Part A).

The information captured provides additional context on states capabilities and will directly influence the tranche of work on fire history and improving data capture. These areas include:
- Near real-time linescan availability and satellite imagery use;
- Emerging technology: Near real-time airborne vector data;
- Field data integration into systems;
- Need for software / data processing improvements for mapping systems;
- Need for hardware / network updates to improve performance;
- Need for additional staff to maintain layers;

Additional interviews were carried out with all jurisdictions to capture the current state of each agencies systems and clearly identify the specific gaps in their systems and business processes. This information is captured in the discussion and tables below for each jurisdiction.
Some of the topics explored were:
- Jurisdictional arrangements and challenges
- Systems
- Interoperability
- Satellite Imagery
- Editing tools
- Web based mapping
- Data sharing
- Training

WP3 involves working with the identified jurisdictions to enhance their systems, with the initial work scoping the requirements to identify improvements to the systems, tools or additional resources for providing a fire history feed. Work will look at the interoperability of systems and data sharing between agencies within each jurisdiction and ensure the datasets created will incorporate the structure developed in WP2 (Continuation of the AFAC fire history dataset review to identify and agree on the proposed national framework) and WP4 (Curating and harmonising fire history data form state agencies) for the minimum viable product (MVP) for the fire history feed.

2.2.1 Current fire history: Minimal viable product

The MVP for fire history is a webservice providing fire history. In WP2 a data dictionary was developed for the MVP for the fire history web feed, its attributes and data formats and these were agreed by the jurisdictions and signed off by AFAC.

2.2.2 Uses of fire history

There are a range of uses of fire history and its associated products.

They relate to:

- Operational response, risk planning for bushfire and planned burns
- Research on bushfires and fire ecology
- Use in predictive models such as Phoenix, Spark and AFDRS

- Recovery
- Insurance assessments
- Carbon accounting
- National reporting

2.2.3 Governance

All jurisdictions could clearly identify the governance of their fire history datasets. Each jurisdiction had different complexities associated with data flow, collation, and governance. Some jurisdictions use private (fee for service) data suppliers to supplement part or all, of their fire history dataset.

Recommendation
- Greater cooperation between agencies and clearer governance in the agencies around data collection, storage, compilation, dissemination could improve fire history collation in all jurisdictions.

2.2.4 Data Collection

In general fire history comes from multiple capture methods and processes, these include: Linescan, Aerial Information Gathering (AIG), other field data collection tools and a range of satellite imagery.
Most states have defined data collection processes with varying levels of documentation. Fire history is compiled from bushfire incident mapping, prescribed burn extents, fire scar mapping and severity mapping derived from satellite imagery post an event.

3. State Current Capabilities

3.1 New South Wales (NSW)

Jurisdictional arrangements:
NSW RFS is the lead fire agency.

NSW Parks manage bushfires and prescribed burns on the Parks estate.

Forest Corporation NSW manage bushfires and prescribed burns in State Forest and Plantations.

Table 4 – NSW agency fire incident feed capabilities

Agency	RFS	NSW NPWS	Forestry Corporation
Systems	● ESRI 10.9.1 Server and Portal (AWS CICD Infrastructure) ● ArcPro ● ArcMap ● Noggin – Guardian (Prescribed Burn system) ● Overwatch (Airborne Intelligence Gathering) ● ICON (Incidents online) ● MapDesk (IMT mapping tool custom ArcEngine) ● Athena (Incident Intelligence tool) ● HERE advanced map	● ESRI ● MapDesk ● ArcMap ● ArcPro ● Elements – Noggin OCA (Prescribed Burn Management & Bushfire Reporting etc) ● ICON	● ESRI ● Geocortex ● ICON ● Guardian ● AGOL
Inter-operability	● Map and feature services ESRI ArcGIS Server Enterprise	● Webservices from ICON to Elements	● Feature Services from Arc Server

Agency	RFS	NSW NPWS	Forestry Corporation
		● Feature services to capture fire history from Elements to corporate fire history in SDE	
Inter-operability Tools	● FME Server and Desktop ● ESRI Data Interoperability Extension	●	● FME
Field Collection	● Firemapper ● Avenza ● Collector ● Survey123/FieldMaps	● FireMapper ● Avenza ● Collector (using RFS instance for fire) - seldom used.	● Drone capability ● In house software (MapApp and custom drone software)
Desktop Editing	● ArcGIS ArcMap/ArcPro ● MapDesk - ArcEngine	● ArcGIS ● MapDesk ● ArcPro (limited staff)	● ArcGIS
Web Based mapping	● AGOL ● Survey123	● Elements ● Geocortex (ParkMap)	● Geocortex ● AGOL
Timeliness of data capture	● Near real time	● Final burnt area KPI within 2 weeks of fire OUT.	● variable
Operational fire boundaries	● Most RFS Fire History attributes captured in mapping operational boundaries through Mapdesk/ICON	● All in RFS ICON	● Not included in current Fire History collation ● Drone data capture ● Internal systems used to update ICON and Guardian linework
Linescan capability and integration	● Linescan capability ● Overwatch AIG (multi banded) automated Geoserver into COP as cloud optimised GeoTIFFS ● AWS	● Linescan capability by RFS	● Linescan capability by RFS
Satellite data capture	● Landsat ● Sentinel-2 ● Himawari 8	● Landsat ● Sentinel-2 ● Himawari 8	● Landsat ● Sentinel-2 ● Himawari 8
Lead Agency	● Y	● N	● N
Training	● Y	● Y	● Y

Fire History:

NSW fire history is managed by NSW RFS. Bushfires are sourced from the ICON history dataset and incorporated manually in an annual QA/QC process to improve the accuracy and alignment of the dataset. There is no automated update process from the incident management system - Guardian into the state-wide fire history dataset. Currently the data is manually added to the fire history layer. Permit burns and other burn types are shown as point locations and are stored within Guardian as well. The RFS publishes map services of all the prescribed burn activity data into Guardian from a replicated enterprise geodatabase.

NPWS validates boundaries of bushfires and prescribed burns deemed relevant (i.e. on NPWS managed lands or some NPWS involvement) into its own fire history. There is currently no feedback loop for the validated boundaries to be added to the state-wide fire history dataset managed by RFS.

NSW is currently undertaking a project to deliver a semi-automated state-wide bushfire and prescribed burn Fire Extent and Severity Mapping (FESM) dataset. Each agencies data will be validated and integrated into this single dataset. The solution architecture has been finalised for the project and is ready for the implementation stage. The agencies involved are RFS, NPWS, Forestry Corporation, NSW Department of Planning and Environment (DPIE).

Airborne Intelligence Gathering (AIG) is a project delivering both improved step and scan airborne images but also auto derived fire extent boundaries. The AIG Overwatch system can produce vector files and transmit those from the aircraft "minutes" after image capture, although still trialling this capability it is hoped we can incorporate those boundaries into our incident mapping systems.

Capture_date is the only major attribute missing from the current fire history dataset for NSW, other than a few system-generated attributes (area, perimeter and state). Fire agencies will need to review how this source data is captured and look at integrating into the automated creation process.

The combined agency fire history goes back several decades, but data quality and completeness decreases for older data, compared with the data captured post 2010. Historic data capture programs in NPWS and RFS are using Sentinel and Landsat satellite imagery to improve the accuracy of spatial extents and attributes for historic fire extents.

NSW fire history metadata needs to be updated to meet ISO requirements. NSW will need to filter out ACT managed bushfires and prescribed burns as these will be supplied by ACT agencies.

All agencies will need to determine the most appropriate method for calculating area across their systems to ensure consistency in the IMS and spatial systems. Documentation on the fire history collation and QA process will need to be updated as well as governance arrangements for the combined dataset.

Data Sharing:
The licencing of the fire history data needs to be changed to CC-BY 4.0 AU to allow public data sharing. The data will be publicly available via the NSW spatial collaboration portal.

NPWS fire history is publicly searchable and available to download from the DPiE open data portal.

Interoperability:
Noggin OCA has been implemented as the Prescribed Burn Planning System for NSW Parks (called Elements) and RFS (called Guardian). Currently these systems have not been integrated to supply post burn extents into the fire history collation process.

Satellite data capture:
All fire agencies in NSW use satellite data to build their fire history.
An automated process in ICON identifies fire boundaries larger than 10Ha and with a status of "out", it then creates a geojson file which is sent to FESM. This final boundary and the "out" date are used to identify suitable cloud free Sentinal-2 imagery from which the fire severity and the fire extent are determined. Once the FESM algorithm has run, the ESRI gridded file is sent back to RFS, and the fire severity and extent are stored in Geoserver and served as webservices to the RFS Common Operating Picture and Athena.

Field data Collection:
ESRI Collector is used for field data capture by RFS and is incorporated into ICON, in the future field maps and other ESRI products will be used. RFS are looking into Firemapper as a lower cost highly available tool for the volunteer field-based firefighter. Forestry Corporation use their own purpose build app. Avenza is also another source of field intelligence for fire boundaries and is primarily used by aviation.

AIG Overwatch
Aerial information gathering (AIG) has been successfully trialled across the 2022/23 fire season. The image products are of high quality and provide an alternative to Linescan. The image capture is flexible and can also be used for flood mapping. Issues such as satellite transmission and mission planning will be improved during the coming months as well as investigating improved vector file generation.

Recommendation:

NSW is recommended to:
- Implement the delivery phase of the fire history project to create an automated process to build fire history across the fire management agencies in NSW.
- NSW will need to filter out ACT managed bushfires and prescribed burns as these will be supplied by ACT.

- Determine the best way to label and manage fires outside of jurisdiction boundaries and if clipping is required to get the best representation of the fire boundaries for NSW.
- Ensure the FESM project using satellite imagery to update fire history extents and the historic fire review is appropriately resourced to allow the proper attribution of historic fires.
- Update the ISO standard and metadata to allow fire history to be discoverable by the public.
- Change the licencing requirements for fire history data to open data under the CC-BY 4.0 AU data licence.
- Provide a webservice and downloadable version of fire history to be accessible to the public via NSW Spatial Collaboration portal.
- NSW RFS need to integrate the capture_date and capture source from ICON into Fire History dataset.
- NSW RFS need to investigate adding Fire investigation cause to the data feed as fire_cause where appropriate.
- Keep other jurisdictions informed as to AIG progress and demonstrated capability.

3.2 Australian Capital Territory (ACT)

Jurisdictional arrangements:
In the Australian Capital Territory (ACT) fire history data is collated & jointly managed by ACT Parks & Conservation Service (ACT PCS) & ACT Emergency Services Agency (ACT ESA).

Table 5 – ACT agency fire incident feed capabilities

Agency	ACT Parks	ESA
Systems	- ArcPro - ESRI Portal & AGOL - Mapdesk	- ESRI - ArcMap - ArcPro - Mapdesk - AGOL - CAD
Inter-operability	Requirement to get observation data from ICON for fire history compilation	- Requirement to get observation data from ICON for fire history compilation - ICON API needs to be automated
Inter-operability Tools	FME	FME
Field Collection	- FireMapper - Avenza - Field Maps - Survey123	- FireMapper - Avenza
Desktop Editing	- ArcMap - ArcPro - Mapdesk	- ArcMap - ArcPro - Mapdesk
Web Based mapping	ESRI Portal & AGOL	AGOL
Timeliness of data capture	Prescribed burn boundaries are captured daily and stored in a corporate database	Burnt Area captured as soon as practical (via SIG, Linescan, Field Capture)
Operational fire boundaries	Prescribed burn boundaries are captured daily and stored in a corporate database	- RFS ICON (when ICON Incident created) - ACT Fire History
Linescan capability and integration	Access to Linescan through NSW RFS	Access to Linescan by NSW RFS
Satellite data capture	Satellite used for severity only	No

Agency	ACT Parks	ESA
Lead Agency	● Jointly managed layer	● Jointly managed layer
Training	● Avenza, Mapdesk & ArcPro	● Mapdesk and Avenza training provided to all users

Fire History:

ACT produces a single fire history. The data is currently not available to the public in any format, but it is licenced for CC BY 4.0 AU and can be made available on request.

It only has a few attributes that currently align with the data dictionary, but several attributes are available under different attribute names. Some data cleaning will need to occur on the dataset before it can be provided nationally.

Different fire Identifiers are used for Prescribed burns and Bushfires. These identifiers originate in Coordinated Aided Dispatch (CAD), ICON or the (PCS) Prescribed Burn System. These separate identifiers make it difficult to track back the fire history records to the different systems, to obtain operational information. Having a universal identifier could potentially improve the traceability of fire history records across these systems.

Bushfire ignition date comes from CAD, these records need to be combined with the spatial extent from ICON. And the PCS Burn dataset contains the prescribed burn ignition dates.

The bushfire and prescribed burn capture date could be integrated from the capture date in ICON and PCS Burn dataset.

Interoperability:

FME could be used to calculate, validate, or populate the necessary fire history fields from various sources including ICON, Prescribed Burn System, the PCS Post Burn Assessment Tool and CAD.

Field Data Collection:

ACT Parks and the ESA use a variety of tools to capture field data. These include Specialist intelligence gathering (SIG), ESRI Web Applications and Avenza.

SIG aircraft have specialised camera and software systems for capturing visible and infrared video and data. The SIG is a web-based system that allows for live streaming of the SIG imagery and stores the imagery and data being captured. These data can be downloaded, edited and displayed in the Incident Management Team near real time and the data pushed up to the NSW ICON system and to the Fire History table.

Avenza is also used to capture the fire boundary. Avenza is generally used when SIG is either not activated or unavailable. Data is captured then exported, edited and either pushed up to ICON and/or the Fire History table.

PCS has developed a Post Burn Assessment Tool using Survey123 to capture the burnt area, this has been developed to conform with the fire history data dictionary.

Recommendation:

ACT, as a collaborative effort between PCS and the ESA and where appropriate the NSW RFS, is recommended to:

- Review all existing fire datasets to identify fields required to populate the fire history table, including:
  - Ignition Date and Capture date - Review existing historic bushfires and prescribed burns
  - CAD number to be used as the unique Fire_ID.
  - Utilise the ICON API to populate necessary fields
- Work with RFS NSW to develop a coordinated approach for cross border fires and prescribed burns managed by PCS in NSW.
- Make the fire history available in the ACT data catalogue with appropriates ISO compliant metadata.

- Agree a coordinated method between PCS and the ESA RFS for data capture (ie. both agencies use the same tool and methodology to ensure all fields are captured in a consistent manner).
- Improve the fire history documentation and process map.

3.3 Northern Territory (NT)

Currently the ARDC project WP1A is looking at providing uplift to Northern Territory in the provision of a current operational bushfire boundary. WP1B is looking at the creation, management and provision of a fire history data feed. This project will investigate whether this data can be incorporated into the current fire scar compilation process to enhance the data being captured for fire history and the various associated products.

Jurisdictional arrangements:
In NT, there are multiple agencies involved with fire management. NT Police, Fire and Emergency services (PFES) who are a tri-service organisation. The NT Fire and Rescue Service (NTFRS) provides urban and bushfire response predominantly around major urban centres within the NT Emergency Response Areas (ERAs). Bushfire NT is the lead agency for rural bushfire response and is part of larger Department of Environment, Parks and Water Security.

The majority of NT land area and bushfire responsibility falls on private land managers. Australian National Parks, Indigenous land management agencies and corporations and Department of Defence (DoD) are all major land managers. None of these organisations either map bushfires or provide data back to a central system. Carbon capture projects (in the Kimberley and Cape Yorke Peninsula) carry out wide-spread prescribed burning, but the mapped extents are not supplied to fire management agencies. Bushfire NT provides support to these projects in planning their prescribed burn programme, provision of this data would allow a more holistic and coordinated approach to prescribed burn planning.

Northern Australia Fire Information (NAFI) is a federally and state funded body, that captures fire scars and hot spots from satellites.

Table 6 – Northern Territory agency fire incident feed capabilities

Agency	PFES	Bushfires NT	DIPL
Systems	▪ ESRI ▪ AGOL ▪ Use hosted Gov't shared services NT Land Information Systems ▪ PFES has separate service for sensitive information. ▪ PFES domain ring fenced ▪ Bushfires Emergency Management System (BEMS) (WebEOC) is fire management system used for warnings. ▪ Plan to integrate Motorolla system for tracking radios in vehicles ▪ Look at Apple Carplay	▪ ESRI ▪ Bushfires Emergency Management System (BEMS) (WebEOC) creates incident points and ability to draw in polygon or warning area. ▪ Fire Incident Map (PFES) ▪ All aviation resources managed by BushfireNT ▪ Staff can access Himawari 8 from WA firewatch.	▪ DIPL is the central IT agency which provides data and geospatial services across government. It is central to the future solution for NT. ▪ Oracle Database ▪ ESRI Enterprise ▪ Building a production environment (end 2022) ▪ ArcPro ▪ ArcMap ▪ Centralised management of licencing ▪ FME server ▪ Business hours support
Inter-operability	▪ NT LIS infrastructure services could be used by BushFires NT and PFES	▪ FireMapper – Can export operational markups in a range of formats. ▪ FireMapper uses national standard symbology ▪ BEMS – Can't export between FireMapper or ESRI software to BEMS directly. ▪ Firemapper Polygons redrawn in BEMS.	▪ Common spatial data infrastructure for foundation data – internal dissemination database which publishes data daily. ▪ Some data is restricted in this database ▪ Active directory manages login. ▪ DCDD manage Data.net (public data access) ▪ DCDD manage feed from ICAD to public facing fire incident map

Agency	PFES	Bushfires NT	DIPL
			▪ DIPL can publish services to the public
Inter-operability Tools	▪ NT LIS have access to FME not currently utilised by PFES. ▪ FireMapper API could be shared with other agencies. ▪ PFES and Bushfires NT share data in FireMapper.	▪ Upload fire extent via API (BEMS to Fire Incident Map) – within 10 minutes	
Field Collection	▪ FireMapper capability in IMT. ▪ Different enterprise agreement to Bushfires NT. ▪ Data captured but no direct feed into AGOL, download data into ESRI	▪ FireMapper is limited to areas where you can get reception to upload. ▪ FireMapper used to capture fire incident boundaries – some accuracy issues. ▪ BushfireNT staff create maps in Firemapper and volunteers edit data. ▪ Different enterprise agreement to PFES.	
Desktop Editing	▪ Using a desktop version of FireMapper. ▪ Hotspots annotated on screen.	▪ Need for direct export and edit functionality between FireMapper, desktop mapping products and BEMS. ▪ ArcMap ▪ Google Earth	
Web Based mapping	▪ Dashboard for fire scars from NAFI. ▪ FireMapper.	▪ BEMS ▪ Firemapper	
Timeliness of data capture	▪ Remote areas fires are not captured. ▪ Some data needs sign off to be released.	▪ Remote area fires rarely captured. ▪ In Fire Protection Zone based on resourcing availability and remoteness.	
Operational fire boundaries	▪ Only attended fires are mapped. ▪ Urban areas (ERAs). ▪ NAFI data shared into FireMapper.	▪ Extents are drawn based on resource availability by ground or air operations. ▪ Permit burns rarely captured as polygons. ▪ Bushfires NT rely on NAFI to map fire scars. ▪ Some fire scars mapped by ranger if small scale otherwise active fire edge tend to be mapped during response. ▪ Fire scars can be exported out of BEMS at the end of the fire season.	
Linescan capability and integration	▪ Using drones with RPAS in some responses. ▪ Provides good operational assistance to hotspots. ▪ No linescan or AIG capability.	▪ No capability currently.	
Non-operational fire boundaries	● Using Firemapper for Prescribed Burns. ● Other Land Managers including commercial operations capture data for carbon credits. ● This data is not currently shared.	▪ NAFI captures fire scars	
Satellite data capture	▪ Satellite imagery major source of fire shapes. ▪ NAFI capture data every couple of days in fire season (Sentinel-2, Modis).	▪ Dependent upon Satellite imagery. ▪ There is little incident mapping outside of priority areas. ▪ Hotspots from Landgate (from NOAA and NASA satellites) and DEA (GA)	

Agency	PFES	Bushfires NT	DIPL
	▪ Hotspots from Landgate (from NOAA and NASA satellites) and DEA (GA) ▪ Looking at Arora Tech and micro satellites.		
Lead Agency	▪ No	▪ Yes	
Training	▪ Informal Training for volunteers. ▪ No training packages. ▪ Training for Firemapper for Vols	▪ Informal training provided for FireMapper users. ▪ No further formal training established for this capability within Bushfires NT. ▪ Build capability through the 'spatial support group' peer-supported training. ▪ NAFI provide training to landholders, indigenous groups and rangers. ▪ No GIS or remote sensing staff	

Operational Fire Boundaries:

A majority of fires around Darwin, Kakadu and Arnhem land tend to run for a few hours during the day, few extend to overnight. While in central Australia fires can become multi day events.

There is limited data being captured during bushfires and when prescribed burns are being carried out, FireMapper has only recently been made an operational tool for both PFES and Bushfires NT. A majority, of fire history data is sourced from satellite imagery provided by NAFI. BEMS the Bushfires NT system, currently isn't able to ingest ESRI data or Firemapper data directly, users are required to draw or upload fire shapes. Interoperability between systems needs to be improved to allow more accurate fire shapes to be captured.

PFES are downloading some archived NAFI fire history data and loading it back into AGOL to share into Firemapper for situational awareness.

Bushfires NT carry out prescribed burns on vacant crownland, while PFES issue permits for burns around Darwin, but none of these burns are mapped by the operators.

Work Package 3 (WP3) has mapped the data flows between the systems for the current burnt area and this will inform the fire history process and this uplift provide improvements to fire history creation.

Satellite data capture:

NAFI is the main agency for satellite data capture for bushfires across NT. The fire agencies rely on NAFI to produce their fire history and it is usually converted to a 'Time Since Fire' raster product for use in fire behaviour analysis and fire management.

High resolution imagery is captured only for Northern Australia (Sentinel-2) in specific areas, while lower resolution imagery (MODIS 250m raster) is captured over the whole of NT. A weekly capture is created from the best daily images. Long-term fire frequency is available from 2000 while some of the other products are only available for the last 10 years.

NAFI automate their fire scar mapping and have a dashboard for fire scar analysis. NAFI data is publicly available. NAFI is also capturing fine scale fire scars for carbon capture projects.

The carbon capture projects are also capturing fine scale satellite imagery 2-3 times per week, but currently this data isn't being shared back to the fire agencies for collation into the fire history product.

The burnt area archive is available as wms, shapefiles, raster and can be downloaded from the website. The SMERF website allows fire frequency to be downloaded as well as some other products such as time since last fire and identifying areas which haven't been burnt from 2 to 5 years for biodiversity values. This database looks at late and early burnt areas for the tropical savannahs. Fire frequency has been captured for the last 22 years. NAFI does QA to ensure all the rasters from the different sources align. The data from SMERF isn't currently downloadable.

NAFI also access NOAA and MODIS hotspots. False positives are reviewed and edited daily. NAFI manually edit all their remote sensing data both MODIS and Sentinel-2.

DES satellite imagery capture is provided to Bushfire NT remote sensing, but is not currently used in any products.

Data Sharing:

A single agency Department of Infrastructure, Planning and Logistics (DIPL) supports the whole of NT government ICT infrastructure. NAFI provide hotspots and fire scars to other agencies.

Field data Collection:

FireMapper is being used to capture fire information from ground and aerial observation. This system allows users to view the data on the app and on a desktop version. There is currently no integration back into any corporate spatial systems.

Interoperability:

There is a need for a central data repository for where the historic fire information can be stored. Currently there is no shared data framework for fire data to be collected by all agencies and then stored in a similar framework. The Firemapper historic data also needs a location for it to be stored and accessed. PFES is currently in a separate domain, and the ability to share data needs to be explored.

Recommendations:

The Northern Territory has had their data flows mapped for current burnt area in the agencies systems. Funding is being provided to allow uplift for their current burnt area data to be created and provided as a single feed.

The recommendations for the next stage of this project to compile fire history and develop a fire history feed are:

- WP3 fund a resource which will enable Bushfires NT to develop a state-wide burnt area feed that will be the basis for the bushfire feed
- Investigate hosting options and targeted data collection.
- Investigate current infrastructure and interoperability between agency systems to improve data sharing.
- Investigate improvements to security to allow data sharing and access to enterprise systems.
- Investigate opportunities to increase the use of desktop mapping in the department.
- WP3 is funding the resource to help develop mapping officer training program across the wider NT government agencies.
- Automate daily capture of satellite imagery and processing the fire scars.
- Investigate integration of field data collection and satellite imagery into incident management or mapping systems.
- Integrate prescribed burn data from all agencies across the NT including carbon capture projects.
- Upgrade BEMS to allow Firemapper or ESRI data to be ingested directly into the system.
- Investigate other agencies providing fire history data eg Parks Australia, NT Parks
- NT fire history needs to be reconciled on the different spatial accuracies which is dependent on the satellite resolution. The different capture areas need to be merged to provide a seamless dataset for the jurisdiction.
- Ring fenced data - challenges for data sharing around the tri-service.
- Need for a central environment for fire data to be stored centrally.
- Uplift SMERF so the data can be downloaded.
- Look at NAFIs funding options into the future.

3.4 Queensland

Jurisdictional arrangements:

In Qld there are multiple agencies capturing fire extent. QFES is the lead agency for bushfire response. QPWS&P is responsible for fire management on the Parks estate and manage prescribed burns and bushfire response. HQ Plantations (HQP) manage fires within commercial plantations.

Queensland Fire and Emergency Services (QFES) and Queensland Parks and Wildlife Service & Projects (QPWS&P) collaborate to provide a single state bushfire history dataset. Qld Remote Sensing Centre is part of the Department of Environment and Science (DES).

Table 7 - Queensland agency fire incident feed capabilities.

Agency	QFES	QPWS&P	HQP	DES
Systems	▪ ESRI enterprise environment ▪ 3 agencies Ambulance, Police and QFES share ESRI licencing contract. ▪ QFES maintains its own enterprise environment for emergencies. ▪ ESRI image server not available ▪ ArcGIS Pro ▪ Geocortex ▪ All feeds coming into FME viewed in ESRI stack	▪ Flame is ESRI based tool with database integrated with ESRI server. ▪ FTP process to upload nightly. ▪ Desktop being upgraded from 10.7.1-10.9.1 ▪ FireOps web app ▪ DES manage portal licencing. ▪ New product Park Connect being built	▪ ESRI ▪ Geocortex ▪ SDE ▪ AGOL ▪ Incident management room using AGOL data ▪ Transition to portal in future	▪ ESRI enterprise
Inter-operability	▪ Operational boundaries are shared between QFES for QPWS&P via web services. Available across platforms. ▪ AGOL data sharing group for all members of Queensland Disaster Management Arrangements (State Government agencies, all 78 Local Governments, Federal Government agencies)	▪ Process running on server for a daily sync from Flame ▪ DES process data to include ignition date, safe date. ▪ Use RSS feeds to supply QFES. ▪ Access to AGOL through DES. ▪ Use AGOL sharing groups with all agencies ▪ Use airdrop to share screen grabs and maps in offline locations	▪ Supply fire shapes to QFES fortnightly ▪ Data stored in SDE ▪ Ability to share a mapservice with QFES	▪ Webservice through Q spatial soon ▪ Currently other format available. ▪ Tifs provided to QFES
Inter-operability Tools	▪ Use FME and ETL tasks. ▪ QPWS supply burnt area data nightly. ▪ QFES FME runs check every 5 minutes for data.	▪ ArcPy scripts on ArcServer. ▪ Future plan for FME in cloud.	▪ SDE	▪ Provide rest end point of fire history data to QFES
Field Collection	▪ Collector ▪ Avenza ▪ QFES uses Collector (burnt area collection tool) ▪ 800 windows tablets deployed with Collector. ▪ Used by air observers and some ground observers. ▪ No AIG capacity ▪ Multiple platforms used for hot spot detection / observation ▪ Avenza ▪ Field data used to validate sentinel imagery capture. ▪ Aussie Explorer (some brigades)	▪ Wide use of Avenza on tablets ▪ Convert Avenza data to GPX and ingest into FLAME.	▪ Drones used to capture fire boundaries post incident ▪ Collector used to capture fire fronts ▪ Transitioning to portal and field maps	▪ Don't undertake field data collection

Agency	QFES	QPWS&P	HQP	DES
	• Survey123 for pre-burn assessments • Starting to use FLIR (night fire edge capture)			
Desktop Editing	• Can edit fire shapes in ArcGIS Pro	• Only specialists have access to ArcGIS Pro.	• ESRI products	• ArcPro
Web Based mapping	• Geocortex • ESRI	• ArcGIS Portal • Fire observations web mapping app, twice daily capture for large fires. • FLAME land management tracker with an ESRI mapping interface.	• Geocortex • ESRI	
Timeliness of data capture	• Most fires captured • Some remote fires are not captured • Fire boundary updates at 6am, 12pm and 9 pm, shared publicly	• Dependent upon fire risk. • Fire shapes aren't published until the fire report is published. Nightly update to draft and approved.	• Fortnightly update	• Monthly compilation of fire shapes • On request for bigger incidents
Operational fire boundaries	• QFES maintain their own fire history • QLD PWS create their own fire history for bushfires, planned burns for protected areas and forests • Intel layer -managed by Bushfire safety officer • Current fire boundary feed contains bushfire and other data types such as warnings. • Each agency uses different data attributes, FME transformers are used to bring them into a common format. • Remote fires only captured in near real-time when aircraft with appropriate technology deployed. • DES scars converted from raster back to vector for ingestion into system.	• QPWS&P maintain their own layer. • Dependent upon risk. • Flame is ESRI based tool, fires are digitised from aerial imagery and the data exported as GPX. • Rangers digitise from supplied imagery. They also import GPX files from Avenza App. • Used for Situation reports, planned burns and wildfire response. • Data is live and synchronised daily. • Rangers map both fires and planned burns. • Some rangers use tools in ArcPro for change detection or the Sentinel Hub, dependent on skill levels. • Final burn boundaries in fire report usually provided 1-3 months post fire.	• Boundary shown on system for 3 months then archived • Prescribed burns shown for 5 years	• Data created as vector, turned into raster to be provided to agencies.
Linescan capability and integration	• QFES use linescan data for some fires • Linescan process is not automated due to the lack of an image server. • First used in 2019 and now have ongoing capacity. • Processing done in ArcPRO at HQ.	• Use QFES capability • Supplied data integrated in FLAME. • Linescan image used on maps. • Look at integrating DES remote sensing scar data into Parks Fire History.	• No linescan capability	
Non-operational fire boundaries / data	• Operational boundaries are not collected when there is no response.	• Remote areas fires are captured by DES	• Manage a clearfelling layer, fortnightly update.	

Agency	QFES	QPWS&P	HQP	DES
	▪ Work needed between LGAs, private and industry to collect areas. ▪ Time since last burn and Fire History are key datasets for fire planning. ▪ There is no fire severity capability. ▪ Fire boundaries for remote fires are captured retrospectively from remote sensing.			
Satellite data capture	▪ Sentinel-2 data – monthly and yearly scars supplied by DES ▪ Landsat Fire scar series (1987-2000xxx) ▪ MODIS ▪ Himawari-8, (Plumes, hotspots). ▪ VIIRS hotspots ▪ Last time burnt uses (Landsat, Modis , Sentinel, ArcGIS) ▪ No burn severity tool.	▪ Planet imagery for smaller burns. ▪ DES capture Sentinel 2 imagery and create a monthly fire scar dataset published as web feature service. ▪ NAFI and SMERF project provide actual burnt area		▪ Create Sentinel-2 data – monthly and yearly scars ▪ Landsat Fire scar series (1987-20) ▪ Create scars on request for major events ▪ Sentinel backlog from 2021-2016. Still process 2018 for historic scars. ▪ Automated algorithm using fractional cover, false positive heavy to capture all fires. Each month several days of editing to remove false positives.
Lead Agency	▪ Y	▪ N	▪ N	▪ N
Training	▪ Set up training for ground observers.	▪ Priority in South-East Qld. ▪ IMT Resourcing issues especially for mapping specialists		▪ Run extensive training for staff

Operational fire boundaries:

QFES collates the state fire history data, but it captures only events where there is an operational response. Boundaries of unattended remote fires are not captured. QPWS&P capture bushfire and prescribed burn boundaries for the parks estate and provide this feed to QFES for incorporation in the fire history dataset.

For QPSW&P fire scars are often sourced from field observations, digitised aerial imagery or vegetation layers. Burn scars often don't match the satellite imagery extent as many fires are low intensity and are harder to delineate under the tree canopy.

Attributes on start and end dates are also variable as not all fires have these dates recorded, or fires may burn for extended periods. For some fires these dates are estimated and usually populated with month and year. Planned burns may occur over several stages, so only the final date is recorded for these burns.

Defence, local government, other State agencies (including Energy Qld, Water Authorities, Dept Transport, Dept. of Resources) and private landholders have some fire management responsibilities. Some of these agencies can provide feeds of their prescribed burn extents, while many LGAs don't have the staff or software to collect and share this data. The data that is captured will be aggregated through to QFES for inclusion in the state's fire history.

Several fields in fire history are not currently being collected or are maintained in separate systems. IGNITION_CAUSE is collected by QPSW&P but not actively by QFES. QFES show all the field data from different sources coming into their system and there is a hierarchy for which dataset takes precedence in creating the operational boundary.

Some of the National All Hazard Symbology was being used in an ad hoc manner across the agencies, but the full symbology set was not being used across QFES or QPSW&P systems.

The incident point for QPSW&P fires is different to the incident point from QFES fires, the QFES point is based on the reported access location (road). This needs to be reviewed, to determine whether the ignition point, access point or centroid should be used preferentially.

Systems:
Each agency runs their own ESRI enterprise environment, with QPWS&P utilizing DES's portal.
QFES use the ESRI platform to capture fire boundaries in conjunction with the FME platform for data processing and data sharing. FME is used to filter out the non-bushfire boundaries such as warnings from the current data feed as well as bringing the field data in and showing it in a similar format. FME is used to create the single state feed provided by QFES.
QPWS&P use the vendor product FLAME which is their land management system, this system provides some mapping capability.

Data Sharing:
All agencies share incident locations and fire extents via web services.
QPWS&P publish fire extents to QFES nightly through various data translation processes both in-house and through FLAME. QPWS&P burnt area data contains current and historical fires.

Linescan capability and integration:
Utilization of linescan data is a manual process, data is emailed from the contractor to QFES and then uploaded into the GIS system, to allow sharing with other agencies.

Satellite Data Capture:
QLD Remote Sensing Centre (DES - Q Spatial) use satellite imagery from Sentinel-2 to capture fire extents for the whole of Queensland. This imagery is processed each month and a monthly cut of the fire history scars are provided to other agencies. When major incidents are occurring fire scars can be provided on request. Q Spatial allows the fire scars to be shared as a webservice. DES is currently working through the remote sensing archive to capture historic fire boundaries. After the last 5 years of Sentinel imagery have been processed, DES will review the algorithm to improve its accuracy and reduce false positives.

Recommendation:

Queensland is recommended for funding to support standardising field capture and capacity building in the development of a fire history feed that meets the requirements of a minimal viable product.
- QFES lead the development, automation and ongoing maintenance of a combined near real time feed.
- Investigate a centralised fire mapping capability for QFES which can integrate and be utilised by other agencies and local governments across Qld.
- Investigate current infrastructure and interoperability between agency systems to improve data sharing.
- Investigate improvements to security to allow data sharing and access to enterprise systems.
- Investigate cloud-based mapping solution.
- QPWS&P investigate an alternative solution for providing timely operational fire boundaries.
- ARDC funding was approved in WP3 to develop a training program for IMT mapping officers and ground-based observers for prescribed burns and bushfire incidents.
- Investigate collecting and integrating FIRE_TYPE attributes.
- Investigate building the capability to collect IGNITION_CAUSE in the agencies fire management systems.
- Requirement for an image server for storing and processing imagery.
- Investigate looking at satellite imagery (Landsat and Sentinel-2) to capture historical fire extents for inclusion in the Fire history dataset.
- Finding and training champions in the field data collection tools eg (field maps).

- Work package 3 (WP3) is funding some work on the training packages for mapping officer, this data will feed into the fire history p[process.
- Determine the definition of an incident point and whether it is based on – the ignition point, access point (point of first response) or centroid of the polygon, providing a consistent approach for all agencies.

3.5 South Australia (SA)

Jurisdictional arrangements:
The lead fire agency in South Australia is the Country Fire Service (CFS).

Department of Environment and Water (DEW) and the National Parks and Wildlife Service South Australia (NPWS) manage bushfires and prescribed burns on public land.

Table 8 –SA agency fire incident feed capabilities

Agency	CFS	DEW
Systems	• ESRI • Links to portal for ArcGIS. • CRIMSON, custom bespoke system land management system. It is not designed for incident mapping. • ESRI based web map used for warnings. No fire shapes are captured.	• Portal for ArcGIS, Hosted on AWS. • Hooks and duplicated to a spatial warehouse, SDE. • ESRI
Inter-operability	• WFS from DEW of current burnt area • Fire history comes through Location SA Portal - WFS • CFS provide incident point	• DEW provides WFS (area burnt) into Location SA platform which is then amalgamated with the CFS incident data and CFS share onward.
Inter-operability Tools	• CFS may modify attribution of current burnt area for distribution • S3 Bucket	• Py scripting. Don't need conversion as using the same attribution and mapping system
Field Collection	• Firemapper is being used by Air Observers (lead). • Firemapper licence managed by CFS	• Firemapper is being used by Air Observers. • Incident Mapping system captures ground observations and other sources as either GPX or KML files • Importing line data into ArcGIS complicated due to unstructured linework • Manually copying Firemapper data into corporate systems. • Avenza for burns
Desktop Editing	• ArcPro leveraging Geohub (location SA portal for ArcGIS).	• ArcPro leveraging Geohub (location SA portal for ArcGIS). • Compliments the web-based system used for advanced editing. Directly editing same feature class (FC).
Web Based mapping	• Crimson 3D is web mapping tool hosted by Location SA • Used for public information and warnings	• Mappers use a web-based system
Timeliness of data capture	• Current burnt area timely. • If no aircraft at fire, areas not mapped.	• Map fires as data becomes available. • Immediate for attending incidents. • Min once a day.

Agency	CFS	DEW
Operational fire boundaries	• All Hazards mapping function. • CFS only map fires if they attend them. • If no aircraft attend a fire usually it wont be mapped. • Isolated fire mapping depends on risk to life, infrastructure assets.	• NPWS map fires on Parks estate. • For bigger fires, historical imagery is processed to create fire shapes.
Linescan capability and integration	Future trial of a product with Fire Flight. Not a true linescanner but an infra-red camera. Stitched infrared images. • CFS setting up a S3 bucket automation for linescan data. • NAFC agreement with NSW and Vic for access to Air Affairs Linescan plane •	• Linescans come through CFS provided by VIC DEECA. • Issues with receiving unreferenced JPGs. • Not automated process to publish, load, provision via email and sharing to users Need / use is currently limited. • Would like automated workflows and business process
Non-operational Boundaries		• 'Landscape Boards' in the western part of SA capture fire scars but they are not timely due to limited resources and need.
Satellite data capture	• Use hotspots, Himawari 8 and Sentinel to monitor isolated fires • Planet trial	• Manually publish individual images and also use web services where possible. Dependent upon budget.
Lead Agency	• Y	• N
Training	• Air observers trained in Firemapper	• Internal agency issue • Recently did ArcPro training.
Year to date burnt are a data set	• CFS provide a year to date fire boundary.	

Fire History:

NPWS map fires on the Parks estate; while CFS only map fires they attend, and usually mapping only occurs if it's an aerial response. In aircraft the Firemapper app is used to capture fire boundaries, but Firemapper is not used for ground data capture. This then limits data capture for crews responding to fires on the ground.

Currently IGNITION DATE, CAPTUREDATE, IGNITION CAUSE are the fields currently not captured or integrated into the fire history creation process. They are in a separate CFS system, but these attributes are not automatically joined to the fire history data. Date time format also needs to be reviewed to ensure it correlates with the MVP format.

Fire History is only collected by DEW in the southern half of South Australia in the pastoral zone and it is not collected in the arid zone. If a fire extends beyond the state border, there is a need to include a state field and potentially the polygon needs to be clipped.

Systems:

CFS has a bespoke system called CRIMSON, which links to portal for ArcGIS. CRIMSON is not an IMS system but a land management system and is not designed for incident mapping. Crimson 3D is the web mapping system.

DEW have Portal for ArcGIS which is hosted on AWS. It hooks into a spatial data warehouse through SDE.

Location SA provide the infrastructure, systems for data sharing and web mapping for all agencies and to the public. There are dependencies on Location SA to provide services 24/7 and support the emergency management IT systems.

SAFECOM provides the shared service for all EM agencies which includes IT infrastructure (servers), software and geospatial services.

Interoperability:
Fire History is supplied by Data SA to other SA agencies. CFS provide incident points from the CRIMSON 3D. Current Burnt area is captured by DEW for incident response, this is provided as WFS (area burnt) via a python script into Location SA's platform, which is then amalgamated with the CFS incident data, this amalgamated dataset is shared by CFS to other users. Both DEW and CFS capture the same attributes for fire history.

Data Sharing:
Location SA provides the infrastructure to share data between agencies. An S3 Bucket is used for data sharing.

Field data Collection:
Firemapper is the main tool for field data collection across both agencies.

Satellite data capture:
Arid Zone satellite imagery capture is covered by NAFI, this data is not currently integrated into the Fire History collation process.

Recommendation:

South Australia is recommended to:

- Look at integrating or capturing the fields IGNITION DATE, CAPTUREDATE, IGNITION CAUSE into the fire history creation process.
- Review Date Time format to ensure it correlates with the MVP format.
- Include a state field to allow attribution of data beyond the border.
- Update the metadata and EM-LINK.
- Provide data in a range of formats for easier ingestion into systems.
- Look at a field data collection tool to map burns and fires which aircraft do not attend.
- Look at field collection tool for capturing fire origins.
- Look at integrating an AVL feeds into the incident management or mapping system.
- Look at a joint fire history collation tool which can provide feeds in different formats.
- Look at need for integrating NAFI data (for arid zone) into fire history.
- Look at integration of linescan data into mapping systems for larger incidents.
- Look at providing an accessible archived fire history dataset.

3.6 Tasmania (TAS)

Jurisdictional arrangements:
There are three key fire management agencies in Tasmania, The Tasmania Fire Service (TFS), the Parks and Wildlife Service (PWS), and Sustainable Timber Tasmania (STT). These agencies work together under the *Inter-Agency Fire Management Protocol* and are responsible for responding to wildfires and undertaking year-round fire management. There are several Acts which the agencies work under. Local councils and private landholders also have a responsibility for managing fire hazards on their land.

Table 9 – Tasmanian agency fire incident feed capabilities

Agency	NRE	TFS	Parks	STT
Systems	- ESRI ELA - ArcGIS Pro - ArcGIS Server - Oracle with SDE - FME	- ESRI - ArcPro - FME - Geocortex - PostGres	- ESRI - ArcPro - Arcmap - AGOL - PBAM (planned burn activity manager)	- ESRI Infrastructure being implemented (ELA) over the next few years - Oracle spatial database - ArcGIS desktop
Inter-operability	- Web services for publishing annual releases (ESRI REST & WMS) - Annual releases available publicly in LISTmap - Additional, restricted data available within COP - Editable feature service for each agency to maintain interim boundaries (also available within COP for registered users) - Open data portal for downloadable versions of annual releases (Shapefile, File Geodatabase, MapInfo TAB)	- Local councils - Private operators - FireComm - TFS staff - TFS volunteers	- Sharing shapefiles at end of fire season - Supplementary feature service to supply fire history during the season only for bushfires - LISTmap presents spatial data captured (historical and fire boundaries as they occur). - The current burn area from FireComm is pulled into LISTmap (going fires) - Scheduled task records latest boundaries, records changes to the shape.	- Shapefiles - GDB
Inter-operability Tools	- Email for inward supply - FME for ETL tasks - FTP for outgoing supply to STT & TFS - One drive for ad-hoc data supply requests	- FME - Email - Data feeds - GDB	Postgres database for PBAM	- FME - Email - Dropbox
Field Collection	- Avenza Maps - OruxMaps - SIG	- Firemapper - GPS - Avenza - Field Maps - SIG	- Firemapper - Orux - Avenza - SIG - Survey123 and collector custom apps	- Avenza - Survey grade GPS
Desktop Editing	- ArcGIS Pro - ArcMap (available but deprecated in favour of ArcPro)	- ArcPro - Arcmap	- ArcPro - ArcMap	- MapInfo (primary tool) - ArcGIS Desktop - QGIS
Web Based mapping		- GEE tool - Geocortex	- AGOL - GEE tool	- GEE Tool - Internal web map browser (consumes WFS from LISTmap)
Timeliness of data capture	- Near real time - Satellite data processed for previous release (ie. 2 years behind)	- Near real time for field data - Depending on incident timeliness varies	- Captured in near real time - Supplied in 15-20 min of completion - Remote data capture can take hours - Mobile data capture impacted by poor connectivity and coverage	- Small fires captured in the proceeding days - Planned burns often easier to capture - Use drones and GPS for burn boundary capture - Collate prior to collation by ESGIS
Operational fire boundaries	Collated in ArcGIS Pro	- ArcPro - SIG - Firemapper kmls	- Shapefiles for bushfire history. - Planned burns from PBAM database	- Drones - GPS - Mudmaps
Linescan capability and integration	- Access via email or google drive - Automated process for capturing boundary and heat	- No integration - Access via email or google drive	Access via email or google drive, synced around state	Not accessed

Agency	NRE	TFS	Parks	STT
	signature in ArcMap (has not been migrated to ArcPro) ● No direct integration with linescans into system.	● TFS orders Linescan (state intelligence and duty FBans, duty GIS)	● Issues with sensitivity of some data	
Non-operational fire boundaries	● Private landholder burns ● Cultural burns on islands ● Captured through annual satellite imagery programme	● Permit burns submitted to FireComm, assessed and entered, usually a point location ● Planned fire boundaries from private companies and local councils. Some used to verify boundaries ● Ground Proof Mapping supply boundaries for all their contracted burns.	● Private land burns are rarely captured	● Shapefiles from lead agency
Satellite data capture	● GEE severity ● Sentinel 2 ● Google imagery ● Landsat	● GEE severity ● Sentinel 2 ● Google imagery ● Range of ways to access data	● GEE tool ● Sentinel 2 ● Himawari 8 ● Platform - Ororotech - provide fire boundaries and estimated fire severity	● No inhouse skills ● GEE tool
Lead Agency	● Y	● N	● N	● N
Training	● Run mapping training for agencies on request	● Training with NRE ● Train some staff prior to fire season – ad hoc	● Training for ESRI platforms and mobile platforms (eg OruxMap, Firemapper, Avenza) training ● Preseason briefing on new enhancements etc	● No training currently

Fire History:
The TFS, PWS, and STT each capture Fire History records within their own agency databases, under agency specific requirements. Often there is duplication of Fire History records between agencies and subsequent boundary and attribute conflicts occur regularly.

The Emergency Services GIS (ESGIS) team within NRE is contracted by the fire management agencies (TFS, PWS, and STT) to annually collate and disseminate Tasmania's state-wide Fire History datasets. Additional inputs are also provided by private forestry companies (eg Forico), and NRE's Natural Values Science Services Branch provide annual satellite-based detection corrections to previously captured Fire History scars, as well as additional Fire History records not previously captured.
Parks collect both fire points and polygons. Small fires and campfires are recorded as points, which are supplied to the state fire history as a buffered location and this data also includes ignition cause.

TFS Fire History is composed of bushfire and planned burn data compiled in different ways:
● Bushfires - collated by State Operations FireCOMM
● Planned burns
   ○ Fuel Reduction Unit (FRU) prepare planned burning data, this is primarily derived from the works program dataset:
      ▪ In the cases where TFS completed 100% of the Fire Management Unit (FMU) – the boundary from FMU layer is used as the burn extent.
      ▪ If a burn over-achieves, the boundary comes from FireCOMM.

- Partial burns (<100% complete) are entered as a burn shape if the operation is complete, while for incomplete burns a boundary of the completed area is submitted, or it is supplied the following season when the burn is complete.

Some additional fire history data comes from a range of industries (Defence contractors, Paper mills and several councils).

TFS capture TFS managed burns on private property, but they don't capture private property burns outside of this program. Large number of private property burns are not captured. Parks tend to capture burns extents in the off season due to resource constraints.

Systems:

ESGIS (NRE) operate within an ESRI environment comprising ArcGIS Pro on top of an Oracle enterprise geodatabase. Web services are provided via ArcGIS Server (standalone) into LISTmap & COP web-mapping client. LISTmap/COP is a bespoke client built on OpenLayers. FME Workbench is used for ETL processes to harmonise data inputs from TFS, PWS and STT, and for pushing data between environments (eg. staging to production).

STT currently are in an Oracle database. STT will move from MapInfo to the ESRI Enterprise platform over the next few years, under a separate ELA from the other agencies.

TFS use an FME workbench that accesses data from a ESRI Enterprise environment with a PostGIS database.

Interoperability:

Annual data updates are supplied by contributors to ESGIS by emailing file-based datasets – generally File Geodatabase or Shapefile. Annual Fire History releases are disseminated to fire management agencies and authorised agencies via a mixture of technologies but supplied as ESRI shapefiles. TFS and STT are supplied via authenticated FTP, which is also a supply mechanism for other NRE-managed data. Groups within NRE are supplied data via the internal network drive.

Restricted-access data is also made available via web services (ArcGIS Rest) to be consumed within LISTmap and COP.

Public data releases are provided via an open data portal in a range of formats. Public web services are available as ArcGIS Rest or OGC WMS specification and made available in the public/unrestricted LISTmap client.

Fire agencies ingest the fire shapes from FireComm into their incident management systems or GIS systems. The final fire shape from FireComm is often used for the final bushfire extent.

Data Sharing:

There are two sets of the Fire History datasets produced, a publicly available CC-BY 4.0 AU licenced version, and a restricted version released back to the fire management agencies. The restricted version is released to others with the approval of the fire management agencies on an 'as-requested' basis.

The restricted versions of Fire History contain all records and attributes provided by the public version, and in addition also contain boundary capture attribution (capture date, method, and author), the source agency for the record and a coupe status applicable to forest industry provided records.

Records provided by forest industry and identified as coupe burns (e.g. regeneration) are stipulated as commercial-in-confidence and are not made available in the public Fire History datasets. Consultation with forest industry organisations would be required to determine whether restricted records are provided to the national feed.

Field data Collection:

The Tasmanian fire agencies use a range of tools to capture field data.

These include SIG (specialist intelligence gathering) aircraft which have specialised software systems for capturing visible and infrared imagery, as well as drone capability. SIG is a web-based system which allows the data to be downloaded, edited, then pushed to FireComm as the final fire shape.

Parks have several drones which are mainly used for capturing planned burns and some small fires. These drones are line of sight capture, and their capability is limited due to licencing requirements. Drones are mainly used for pre and post burn assessment, using aerial imagery to build orthomosaics.

NRE, Parks and TFS use Firemapper, Avenza or OruxMaps for capture of fire boundaries in the field. Data can be emailed to the incident and then distributed to duty FBans for update, then provided to FireCOMM. This then allows all agencies to access this data.

STT has several cameras on fire towers for capturing fires starts, but these cameras are not used for capturing fire scars.

Satellite data capture:
Satellite data is utilised to validate, supplement and improve all the fire scar data contributed by fire agencies. Revision of contributor-submitted data is conducted each year by NRE's Natural Values Science Services Branch for the previous annual fire history release. Corrections, including capture of missing burn scars and adjustment to existing boundaries and attribution, are then integrated into the following annual data release, thus satellite-based QA is always one release behind. This process is essential in identifying the extent of landholder reduction burns. Landholders require a permit to burn during fire season, however there is no restriction outside of the fire season hence the location is not known.

STT has no skills in using satellite imagery. Project based severity capture for large fires is coordinated through NRE, with some satellite imagery capture across agencies.

Recommendation:

Tasmania is recommended to:

- Scope and establish a centralised contribution system for intra-seasonal and seasonal capture of Fire History data, in order to reduce/eliminate duplication and conflicting data.

- As far as possible, improve the accuracy of records (spatial and attribute) prior to 2012 by analysis of historical satellite imagery.

- Use the GEE tool (or its replacement) to capture and collate historical burn severity data.

- Continue to work towards integrating the GEE tool and its extent and severity products into the Fire History processes.

- Identify, via revised policy or alternative data sources, mechanisms to allow public release of commercial-in-confidence forest industry regeneration burn boundary data.

- Capture of private burns. Investigate an automated process using satellite imagery.

- Set up a training programme for STT staff which aligns with Statewide incident training.

- Need consistency in data capture in the field and build and provide a consistent training package. Refresher Training could help maintain competencies.

- Once ESRI environment established at STT, access the field data collection tools built by NRE.

- Explore drone technology and different cameras for capturing planned burn extents and some smaller bushfire extents.

- For unbounded burns in the SW and North: To capture burn extent, fly perimeter in a helicopter to capture via a tablet. This will increase the capability for burn scar capture accuracy.

- Look at expanding the use of FME for processing data.

- Sharing linescan data – need for restrictions on access to some datasets.

3.7 Victoria (VIC)

Jurisdictional arrangements:

Country Fire Authority (CFA) is the lead fire agency, while Department of Energy, Environment, and Climate Action (DEECA), Parks Victoria (PV), Melbourne Water (MW) and VicForests (VF) make up Forest Fire Management Victoria (FFMVIC) who manage bushfires and planned burns on public land.
Fire Rescue Victoria (FRV) manage fires in the urban areas in Melbourne and the larger regional cities.

Emergency Management Victoria (EMV) is the overarching agency that leads emergency management in Victoria.

Table 10 – Vic agency fire incident feed capabilities

Agency	VIC DEECA	VIC CFA	EMV	FRV
Systems	• ESRI licencing • Geocortex • ArcServer • ArcMap • ArcGIS Pro (not fully rolled out)	• ESRI licencing - incl. use of ArcGIS Pro • Geocortex • ArcServer	• ESRI licencing • ArcGIS Pro • EM-COP	• ESRI licencing • ArcGIS Pro
Inter-operability	• Operational boundaries created in emap and the data can be shared as rest endpoint, AGOL and kmz	• Operational boundaries created in eMap for CFA and DELWP fires	• Rest end points and S3 bucket used to provide data to EMV. Incident points provided via CFA	
Inter-operability Tools	• Use ETL tasks to supply data. • Starting to look at FME	• ETL tasks as required		
Field Collection	• Avenza • Collector • Joint use of Firemapper for Air observations, managed by CFA • Firemapper pilot for FFMVIC in conjunction with Firemapper being rolled out for CFA field obs • Need to get Firemapper as an integrated cross agency tool for Bushfire and planned burning observations (DELWP and CFA).	• Collector • Avenza • Firemapper – used for Brigade and Impact Assessment Collection	• Not relevant	• RPAS
Desktop Editing	• ArcGIS 10.8 and Pro in use in pockets Pro not being used in TSU yet for systems. ArcPro won't be rolled out for another season as training needs to occur.	• ArcGIS 10.8 and ArcGIS Pro in use. • CFA build/maintain the mxds for fire and flood operational response.	• ArcGIS Pro	• ArcGIS Pro
Web Based mapping	• eMap suite built in Geocortex and ArcServer	• eMap suite, some CFA specific Geocortex sites or AGOL sites for specific needs	• eMap suite built in Geocortex and ArcServer • EM-COP is Common Operating Picture	
Timeliness of data capture	• Data capture is near real time for AIG, Firemapper and linescan.	• Data capture is near real time for AIG, Firemapper and linescan.		
Operational fire boundaries	• Captured in eMap, through AIG, Firemapper and Avenza.	• Captured in eMap, through AIG, Firemapper and Avenza.	• Captured in eMap, through AIG,	

Agency	VIC DEECA	VIC CFA	EMV	FRV
			Firemapper and Avenza.	
Linescan capability and integration	● Integrated into Fireweb and then in to eMap through ETL tasks.	● ArcGIS 10.8 using the operational mxds managed by CFA.		
Satellite data capture	● Use of Google Earth Engine tool for severity analysis	● CFA capturing historic fire extents in short term project focusing on CFA fires		
Lead Agency	● Y	● N	● N	● N
Training	● Mapping training courses jointly run	● Mapping training courses jointly run		

Fire History:
Current bushfire incidents are captured in eMap Bushfire, which is a joint agency mapping system. This has incidents from all agencies IMS systems feeding into it, allowing fire shapes to be linked to the lead agency managing the bushfire. Only bushfires and grassfires are captured for bushfire history, though peat fires are also included.

Planned burn extents are mapped in eMap Fuel management which is a joint agency mapping tool showing all planned burns across public and private land, except for some small roadside burns. Fire permits for both CFA and DEECA are shown in eMap, but no extents are mapped, a point location is shown.

The incident points created in DEECA's Fireweb are the fire known location and are often adjusted after the crews arrives on scene. The incident points are used to create a Fire_origin dataset yearly, although it is the point of first response, and a separate tool in eMap is being trialled to capture fire origins post fire investigation.

Systems:
ESRI ArcServer, Geocortex and FME are used by the different agencies with uptake for FME at different levels of maturity. eMap is run on ArcGIS server backend with Geocortex and SQL. APIs feed in from CFA and Fireweb and there are feeds from eMap to feed into EM-COP and CFA systems.

Interoperability:
The different agency systems have different levels of interoperability. EM-Drive allows agencies to share files across all agencies. But bushfire and planned burn polygons are compiled by DEECA and provided to CFA and regional staff at the end of the fire season for validation and quality assurance. The state-wide fire history is then compiled and loaded into the corporate library and DataVic where it can be accessed and downloaded in different formats. The fire history data and observation data collected during the season can be accessed by AGOL, map services, Kml or shapefiles.

Data Sharing:
Data is available from DataVic and from the corporate library. Data formats are gdb or shapefiles. Data Vic is the public facing data sharing portal. An AGOL instance of current active incidents is available for EM-LINK. Data is also available from Fireweb for agencies with appropriate access, to download the archived fire feeds, observation point, line and polygon for fires and the kml file for google earth. This data is updated every few minutes, while data downloaded through the eMap is a snapshot in time of the observation data.

Field data Collection:
Firemapper is used by aviation for capturing aerial information and a tablet is available in every aircraft which is on contract. A pilot project for ground field information is being trialled over next season. Avenza is widely used for capturing and sharing maps and information. Some collector apps have also been developed.

Linescan:

Victoria uses Linescan data for capturing fire boundaries. On request, the raw multispectral images can be provided for fire severity analysis. The linescan data is automatically ingested into Fireweb and eMap and the georectified image is available to view in the web mapping system allowing quick interpretation.

Satellite data capture:

Sentinel and Landsat data is used for fire severity mapping. A user-friendly GUI front end has been built for Google Earth Engine which uses an algorithm trained on Victorian vegetation data, to determine fire severity. This tool is being shared with Tasmania, and they have their own sentinel training data for their vegetation communities. Victoria had some training data created for Sentinel and this was integrated in 2023.

There are some issues with loading bulk datasets and easily finding cloud free images especially with Tasmania during burn season. Currently we are investigating the potential to move this tool and algorithm to the Digital Earth Australia (DEA) site, so we can benefit from DEAs development and a more robust environment. The algorithm would be loaded with the training data for Landsat and Sentinel. A user-friendly interface and a way to view thumbnails of sentinel imagery is being proposed.

Victoria has a mature capability in Fire History. The Standard operating Procedure (SOP) needs to become a Joint Standard operating Procedure (JSOP) to allow all agencies to collect and QA data to the same standards. A stocktake is required of current Fire History data, as some of the historic records need fire names, dates, as currently some of this data is missing. This makes it difficult to use in modelling by researchers.

The data attributes for the data dictionary will need some work. Several attributes have a different name and the new feed will need to have these names aligned, and 2 attributes; fire cause and extinguish date are not recorded currently with the spatial layer, but are associated with the fire record in the incident management system. Work will need to be done to link this information to the DSE_ID and CFA_IDs. These separate identifiers make it difficult to track back the fire history records to the different systems to obtain operational information. Having a universal identifier could potentially improve the traceability of fire history records across these systems.

There is a critical need to review and do a stocktake on historical fires, to capture missing data such as dates, names, and extents. CFA is undertaking some work on historical grassfires, but there is still a significant amount of work to do on existing bushfires especially on public land and identifying these missing attributes.

Recommendations:

- Undertake a comprehensive review of the existing fire history data to bring the data quality up in key fields such as name, start date.
- Look at integrating fire cause from CFA IMS and DECCA Fireweb (or replacement) with the fire history polygon data.
- Integrate Firemapper for Planned burn and operational bushfire response for field data collection (ground based).
- Use satellite imagery to identify missing historical fires both on public and private land.
- Improve the training and use of GEE tool to bring consistency to the data collection for planned burning.
- Adjust the SOP to a JSOP for Fire history for both DEECA and CFA.
- Training for staff in the use of the GEE tool or new tool and fire history capture for planned burning staff.
- Use GEE potentially to look at historical severity and extent mapping
- Move the GEE platform to DEA sandbox - to allow for larger areas to be processed and benefit from a managed environment especially for accessing Landsat Collection2 and up to date code base.
- Build thumbnails of sentinel imagery to allow easier selection of cloud free images.
- Look at bulk processing of fires and burns.
- Look at hot spot data to enable the ability to determine start and end date of planned burns and bushfires.

3.8 Western Australia (WA)

Jurisdictional arrangements:

There are multiple agencies involved in fire management in WA. DFES is the lead fire response agency for the state, while Department of Biodiversity, Conservation, and Attractions (DBCA) is responsible for fire management on the conservation estate (both bushfire response and prescribed burns). DFES are also responsible for fire mitigation (prescribed burns) on Unallocated Crown Lands (UCL). Landgate under agreement with DFES and DBCA provide spatial information processing and data management for operational response.

Table 11 – WA agency fire incident feed capabilities

Agency	DFES	DBCA	Landgate
Systems	● ESRI ● ArccMap ● Geocortex ● Firemapper (pilot)	ESRI ArcMap 10.6 QGIS SSS (open source software)	● ESRI ● Remote Sensing
Inter-operability	● Active incidents shapes through Secured WMS/WFS ESRI services via SLIP (State Location Information Platform)	● GDB to Landgate to be compiled ● WMS and WFS feeds shared to DFES	● Via Aurora application ● WMS feeds
Inter-operability Tools	● FME / Python	● none	● Aurora ● Python programming ● MapServer
Field Collection	● Firemapper (pilot) ● Avenza	Avenza Trial of Firemapper OziExplorer	● nil
Desktop Editing	ArcMap 10.6 Geocortex (web Browser)	ArcMap 10.6 QGIS	● ESRI ● ArcPro/ArcMap ● QGIS ● ERMapper
Web Based mapping	Custom Geocortex Viewers (FESMaps Incident Mapper)		● Aurora ● FireWatch
Timeliness of data capture	Variable (Some in near realtime/ others after fact).	Field data capture used at campaign fires Day to day collection – around 4 weeks (district staff collect) State compiles twice a year	● Satellite is weekly ● Joint agency data variable
Operational fire boundaries		● Field GPS ● Avenza ● Stream from DFES – air intel (heli) ● Linescan from DFES feeds and from FTP site ● Satellite imagery – Landsat or Sentinel ● Himawari 8 ● DEA hotspots ● Mudmaps ● Vehicle tracking	● Provision of satellite imagery for capture of fire boundaries ● Automated MODIS products ● Automated VIIRS products
Linescan capability and integration	● Near Realtime mapping from FLIR video ● Fixed wing thermal linescan imagery shared with DBCA	● Linescan from DFES ● Provide feeds WMS ● FTP site	● As supplied from DFES contractor ● Automate the integration of linescan

Agency	DFES	DBCA	Landgate
		• Integrated into SSS system • Aurora prediction software – integrated • ArcMap	data into agency systems • Into AWS S3 bucket and provisioned as webservices back to agencies
Satellite data capture	• Adhoc for remote fires (generally not mapped unless close to main roads, towns or mine sites)	• Satellite imagery – Landsat or Sentinel • Remote sensing section process satellite imagery – monthly especially around burning	• Satellite imagery – Landsat or Sentinel • MODIS • VIIRS • AVHRR • Himawari
Lead Agency	• All fires except for conservation estate L1 and L2 fires	• On conservation estate for L1 and L2 fires	• No
Training	• Internal training. • Most ICV are trained in using corporate capture tools • Maps volunteers	• Internal training – incident mapping • Day to day learn on job (help documentation) • Joint session with DFES (once a year)	• Inhouse needs only

Fire History:

Western Australian has large scale bushfire history dataset for the purpose of fire prediction. It is constructed to facilitate the predictive and modelling aspects of bushfire response. The data is not complete for every fire but is satisfactory for the use it was created for. The sources of inputs to fire history are predominately Tactical fire shapes (DFES), Satellite interpretation of burn areas (Landgate) and managed fires on conservation estate (DBCA). Local government managed fires are not included.

DBCA does not capture all of its bushfire boundaries 'live'. Large campaign fires have dedicated mappers who update and capture the boundary regularly. This may occur either in a standalone environment or working alongside DFES in combined teams. This info can be published externally in WMS/WFS feeds via State Location Information Platform (SLIP), either via DFES channels or through DBCAs own SLIP service. Smaller level 1 and 2 DBCA fires rarely have dedicated mapping staff. Instead, boundaries are captured after the fire (usually within 1 month) and uploaded to the departments Bushfire Reporting System (BFRS).

Completed prescribed burn information is captured twice per year (after Spring burning season and at the end of the financial year). District staff manually email in shp and gdb files which are then amalgamated by head office and incorporated into DBCAs fire history & fuel age datasets (gdb format, also updated twice per year). This information is published to the dept SLIP feeds and is also sent to Landgate to be amalgamated into a state-wide dataset.

Burn severity information is also captured monthly for each prescribed burn in the southwest forest region. This info is currently only shared via shapefiles and tif files and is not available publicly.

Landgate capture satellite imagery, have an archive of all imagery captured. Automatically map from VIIRS satellite imagery to produce a national fire history at 500m pixel size. This a long-term fire history product that originated from AVHRR data (1989 - current).

A joint agency product is also produced by Landgate that combines data from DFES, DBCA, NAFI and Landgate. This dataset is provided into Aurora and the AFDRS products and back to the source agencies.

A joint project underway between Landgate, DBCA, DFES for mapping fire scars from Sentinel 2 imagery.

Systems:

DFES manages fire shape information across and ecosystem that encompasses desktop mapping and web application (Geocortex). Fire shape boundaries are expected to be fed into the database and available to all tactical responders, combat agencies and the public via the Departments' EmergencyWA website.

DBCA use ESRI ArcMap in head office, and to a limited extent in regional/district offices. Note however DBCA have an open first policy; we use and actively develop open-source software. Consequently, the majority of the regional/district GIS users use QGIS and do not have an ArcMap license.

DBCAs main spatial viewing platform, the Spatial Support System (SSS) is a cloud based, open layers system.

Landgate has a system called Aurora (DFES approves access to system) and Firewatch (My Firewatch (public facing general use) and Firewatch Pro (public facing but advanced user)) which are used by the fire agencies, land managers and the public. All systems are built on OpenLayers, mapserver and PostGresSQL and custom code.

Interoperability:
DFES and DBCA systems are separate and cannot link into each other but can ingest data services that are published from each agency. Data sharing outside of published webservices is manual via emails, FTP and filesharing services. DBCA is heavily constrained by departmental security policies, restricting access to DBCA staff only.

Landgate supply data via WMS to DFES and DBCA and provide download capability.

Data sharing:
DFES restricts access to published services of current fire shapes.

DBCA publish feeds in a variety of formats using SLIP via Landgate (ie WMS, WFS). Data feeds include Going Bushfires (when they are being mapped), fire history, fuel age, and the planned prescribed burn program. Access to the data varies - some are open to the public for example fire history, whilst others require approval to view and download.

Landgate provide provide viewing access to fire history via the firewatch systems. Aurora provide viewing capability to the joint agency fire history. Time of Last Burnt is another key product supplied.

Field Data collection:
DBCA field data is captured via Avenza or OziExplorer. DBCA has recently commenced trailing FireMapper, the trial is expected to run until March 2024.

Linescan:

Linescan data is only available via DFES and is rarely undertaken for level 1/2 DBCA fires. Level 3 fires are joint managed by DFES and DBCA, so Linescan capacity becomes available. DBCA ingest Linescan data via an FTP site or via wms feeds into our SSS or ArcMap sessions.

Landgate automate the integration of the Linescan data into webservices which are provided back to DFES and DCBA and Aurora.

Non-Operational Fire Boundaries:
Fires in remote parts of the state are not mapped by DFES or DBCA, especially if they are not incidents requiring an emergency response.
Fire scars are captured from satellite imagery by the agencies Northern Australia Fire Information (NAFI) and Landgate. This data capture is not near real-time and the data is mainly used for the collation of fire history. NAFI captures remote area fire boundaries. Landgate also capture hot spots in addition to burnt areas, however this data capture is dependent on the return schedule of the satellites. Landgate collates a year-to-date fire scars dataset on their website. Local government carry out prescribed burns in the more remote parts of WA, larger burns are mapped but the burn scars are not supplied centrally to the fire agencies. Landgate capture a majority of the non-operational fire boundaries outside the built up areas using VIIRS data.

Data Sharing:

DFES and DCBA share mapped fire extents. The current incident feed is included with emergency warnings in the Emergency WA website.

Landgate share the WMS to DFES and DBCA of the fire history. The raw data is also provided via download, this is usually a monthly process.

Recommendation:

- Work is required to separate the emergency warning areas from current incident areas in the feed provided by Emergency WA to their website. This website is coordinated by DFES with information sourced from DFES, DBCA and Federal agencies. It shows all emergency information and includes extent for some bushfires and prescribed burns. This work could be done in association with Work package 4 in the provision of the MVP for the current incident (polygon) feed.
- DBCA 's fire mapping system has reached end of life and they are exploring what opportunities there are in building a new system.
- Investigate building a single system to capture fire history for all three agencies.
- To make data available for national programs, Landgate could review its provisions under its licencing and pricing policies.
- Funding for Landgate to continue and expand on the data provision services.

Overarching recommendations:

All states provide fire history data in a projection that allows the area and perimeter to be calculated, so it matches published state figures.

All states add a field to their data where they add in the State name to the feed provided nationally.

All states check their data against privacy legislation and remove any data that breaches the legislation.

All states improve data and system Interoperability to allow improved data sharing, ensuring the data feed for the commonwealth is built.

Create a data dictionary for Fire History points which aligns with the Fire history data dictionary for mapped fires. Fire history points are using location of first response or the 000 call for most states.

Look at how fire origin data is captured, especially around the complexity of fire investigations for major fires and what are the timelines in releasing this data into an internal or external dataset (post investigations). Investigate whether this dataset be created for different states.

Appendix 1: Operational Bushfire Boundary Gap Analysis

Table 12 - Current Incident Information

Jurisdiction /Agency	ACT	NSW RFS	NSW NPWS	Bushfire NT	PFES	QFES	QPWS&P	SA CFS	SA DEW	TAS NRE	TFS	DELWP	DFES
Current Incident point feed	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	N/A	Yes	Yes	Yes
Current burnt area as a feed	Yes	Yes	Yes	Yes	No	Yes	Yes	P	P	N/A	Yes	Yes	No
Public warning system with fire shapes (eg Fires Near Me app)	Yes	Yes	Yes	No	No	P	No	P	P	N/A	P	Yes	No
Near real-time linescan availability	Yes	Yes	Yes	No	No	P	Yes	No	No	Yes	P	Yes	Yes
Field data integration into Systems	P	P	P	No	No	P	No	P	P	P	P	P	Yes
Need for Software/ data processing improvements for mapping systems	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Need for Hardware/ network updates to improve performance	P	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	P	Yes
Need for additional staff to maintain these layers	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Create /show planned burns areas	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	P
Operational/ unvalidated Fire history available season to date	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	P	P	Yes	P
Validated Yearly fire history - fire scar	Yes	Yes	Yes	Yes	No	P	Yes	Yes*	P	Yes	Yes	Yes	P
Validated Yearly fire history - severity	P	Yes	Yes	No	No	No	No	P	No	No	Yes	Yes	No
Validated Single State - combined agency - fire history	Yes	No	No	No	No	P	No	No	Yes*	Yes	Yes	Yes	No
Is satellite imagery available to create burnt area	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes	P	P	Yes	P
Automated Fire Severity available	No	P	P	No	No	No	No	No	No	No	No	P	No

P = Partial, * = Limitations

Definitions **Current Incident point feed:** Agency/State has an incident point feed for all current bushfires - across their jurisdiction in near real-time.

Current burnt area as a feed: Agency/State has an incident polygon for all current bushfires - across their jurisdiction in near real-time.

Public warning systems with fire shapes: Agencies/State which have a publicly available app or website which shows current fire shapes and warnings in near real-time.

Appendix 2: Agency Names

Table 13 - Agency Acronyms and Names

Acronym	Agency Full Name
ACT ESA	Australian Capital Territory Emergency Service Agency
ACT PCS	ACT Parks and Conservation Service
ARDC	Australian Research Data Commons
EMSINA	Emergency Management Spatial Information Network Australia
NAFI	Northern Australia Fire Information
NSW RFS	New South Wales Rural Fire Service
NSW NPWS	New South Wales National Parks and Wildlife Service
NT DIPL	Northern Territory Department of Infrastructure, Planning and Logistics
NT PFES	Northern Territory Police Fire & Emergency Services
NT FRS	Northern Territory Fire Rescue Service
BFNT	Bushfires Northern Territory
QLD DES	Queensland Department of Environment and Science
QLD FES	Queensland Fire and Emergency Services
QLD PWS&P	Queensland Parks and Wildlife Service and Partnerships
SA CFS	South Australian Country Fire Service
SA DEW	Department for Environment and Water SA
TAS NRE	Department of Natural Resources and Environment Tasmania
TAS TFS	Tasmania Fire Service
VIC CFA	Victorian Country Fire Authority
VIC DEECA	Department of Energy, Environment and Climate Action
WA DFES	Department of Fire and Emergency Services WA
WA DBCA	Department of Biodiversity, Conversation and Attractions WA
WA Landgate	Western Australian Land Information Authority

Appendix 3: Consultation Dates

Table 14 - Jurisdictional Consultation Dates

Date	State	Agency
03/08/2021	NSW	NSW NPWS, NSW RFS
10/08/2021	NSW	DPIE, NSW NPWS
18/08/2021	VIC	DELWP, VIC CFA
16/09/2021	TAS	DPIPWE, TFS
22/09/2021	ACT	ACT PCS
22/09/2021	WA	Landgate, DFES, DBCA
23/09/2021	NT	PFES, Charles Darwin University – NAFI, Bushfire NT
22/09/2021	SA	DEW, CFS
01/10/2021	QLD	QFES
11/10/2021	QLD	QFES
10/11/21	NT	Charles Darwin University - NAFI
24/01/22	SA	DEW
27/01/2022	QLD	QFES, DES, QPWS&P
04/02/22	NT	DIPL, PFES
9/06/23	WA	Landgate

All agencies had a second consultation between February and June 2023 to update the original information provided.