Ontario
Ministry of Natural Resources

Forest Fire Management

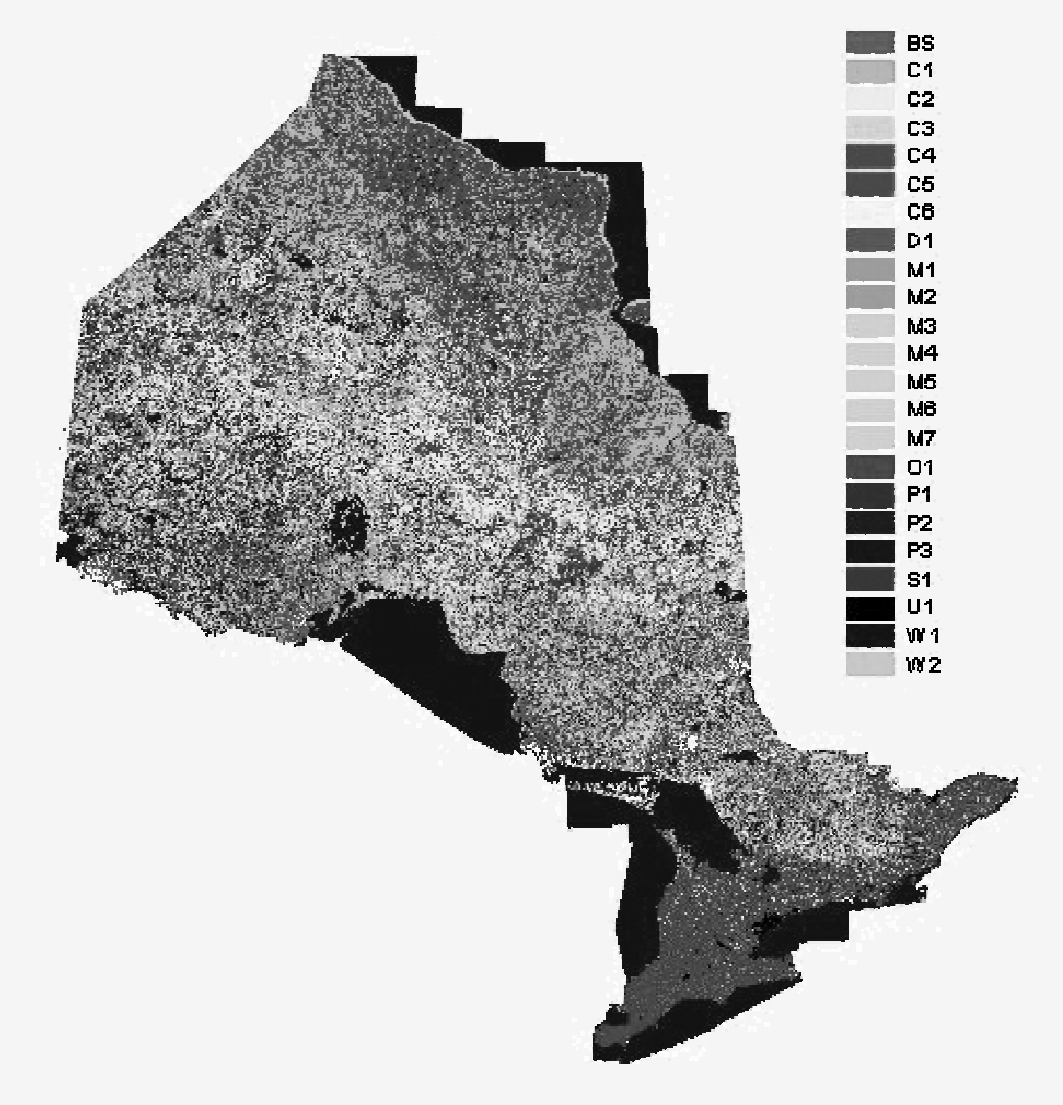
Overview - 4 Sections

- Fire Management in Ontario
- Information Systems
- Models and Decision Making
- Business Management

Fire Management In Ontario

- Ontario's fire environment
- Policy response
- Operation of fire protection
  - Resources
  - Organizational structure
  - Daily fire activities
    - Province, regions, fire management headquarters, attack bases
  - Other fire management activities
- 2003

Ontario's Fire Environment



Total Area:

- 1.1 million km^2

Forest Area:

- 0.8 million km^2

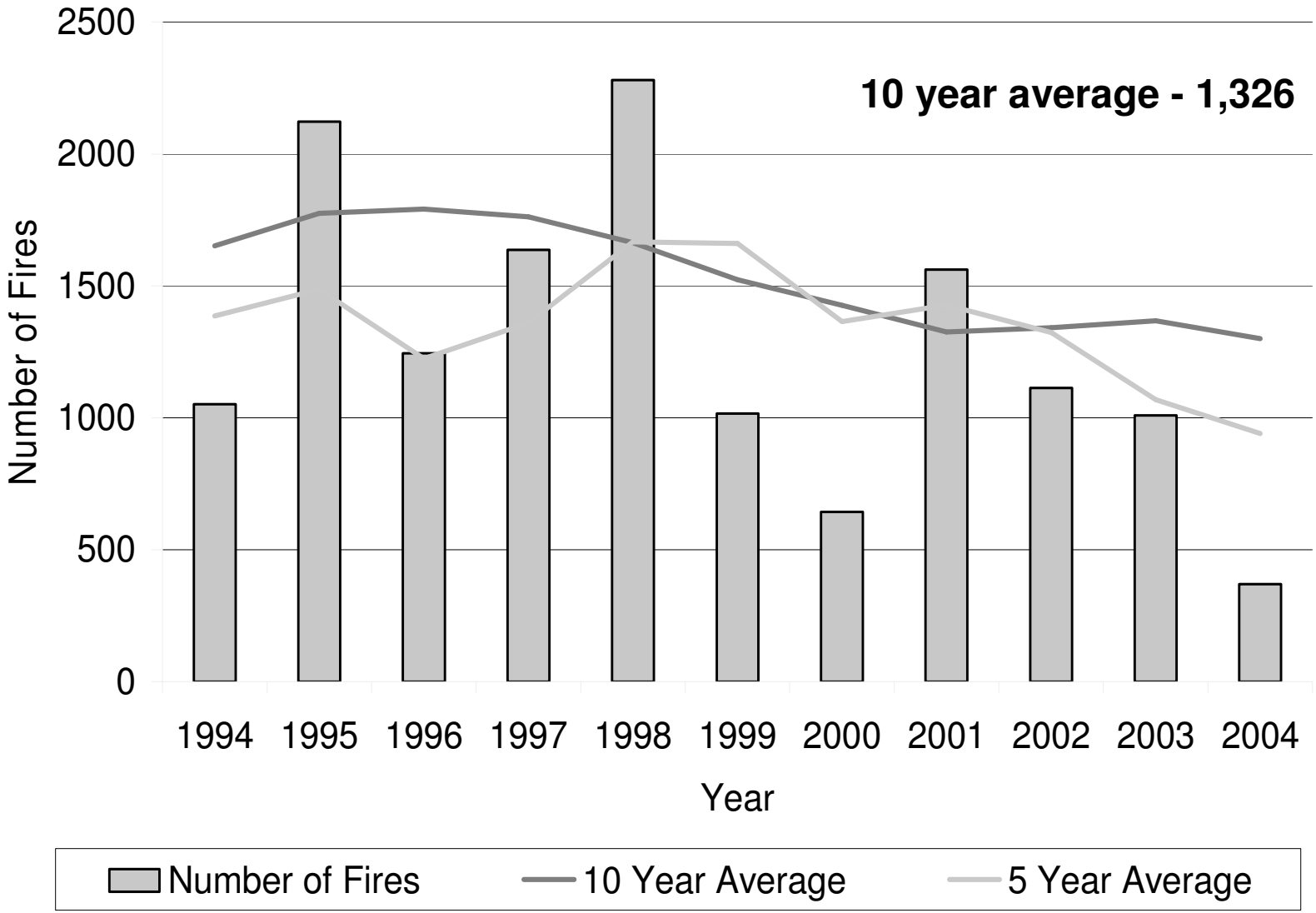
Forest Types:

- Boreal forest and mixedwood

Fire Activity:

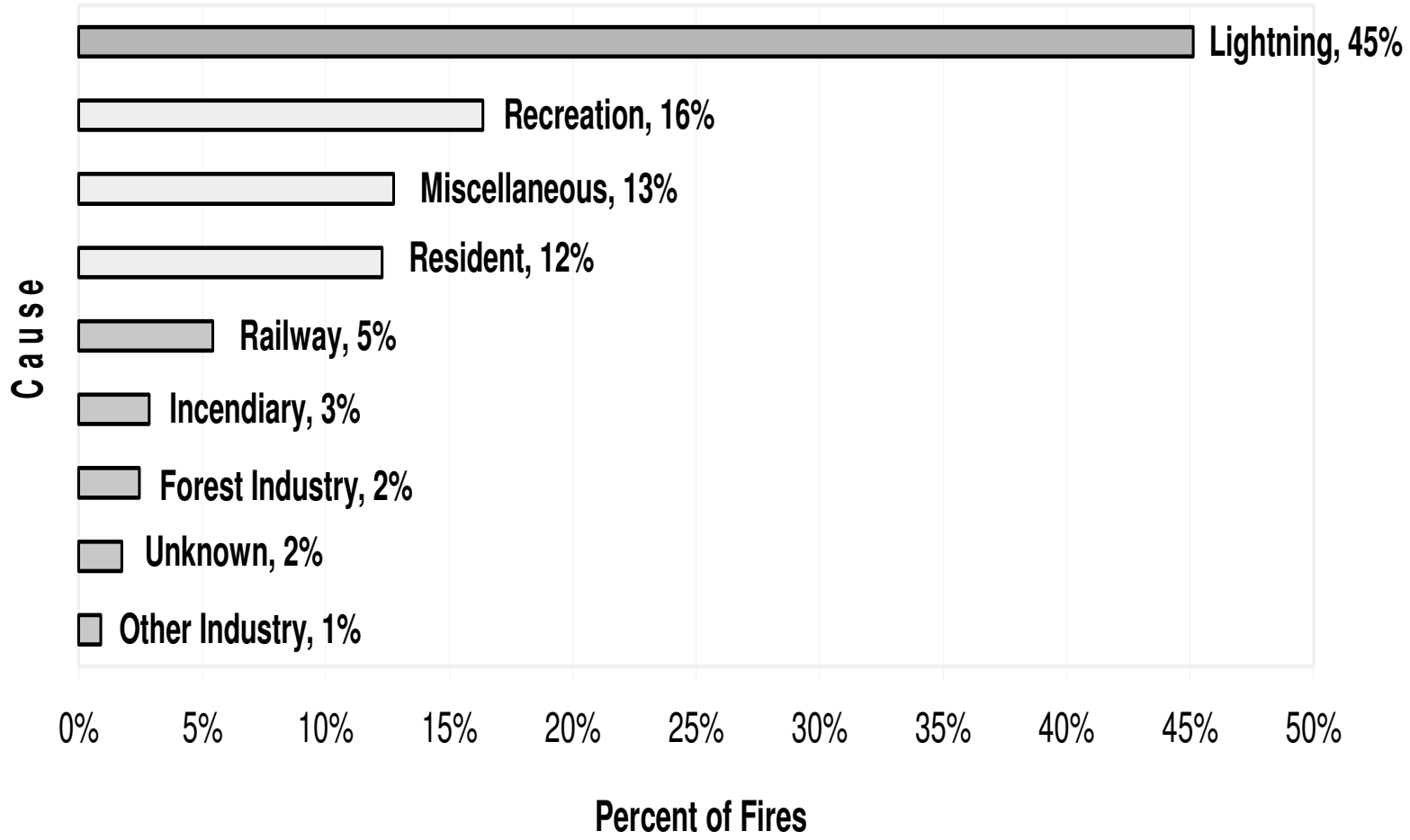
- Average 1,326 fires/yr

Annual Number of Fires

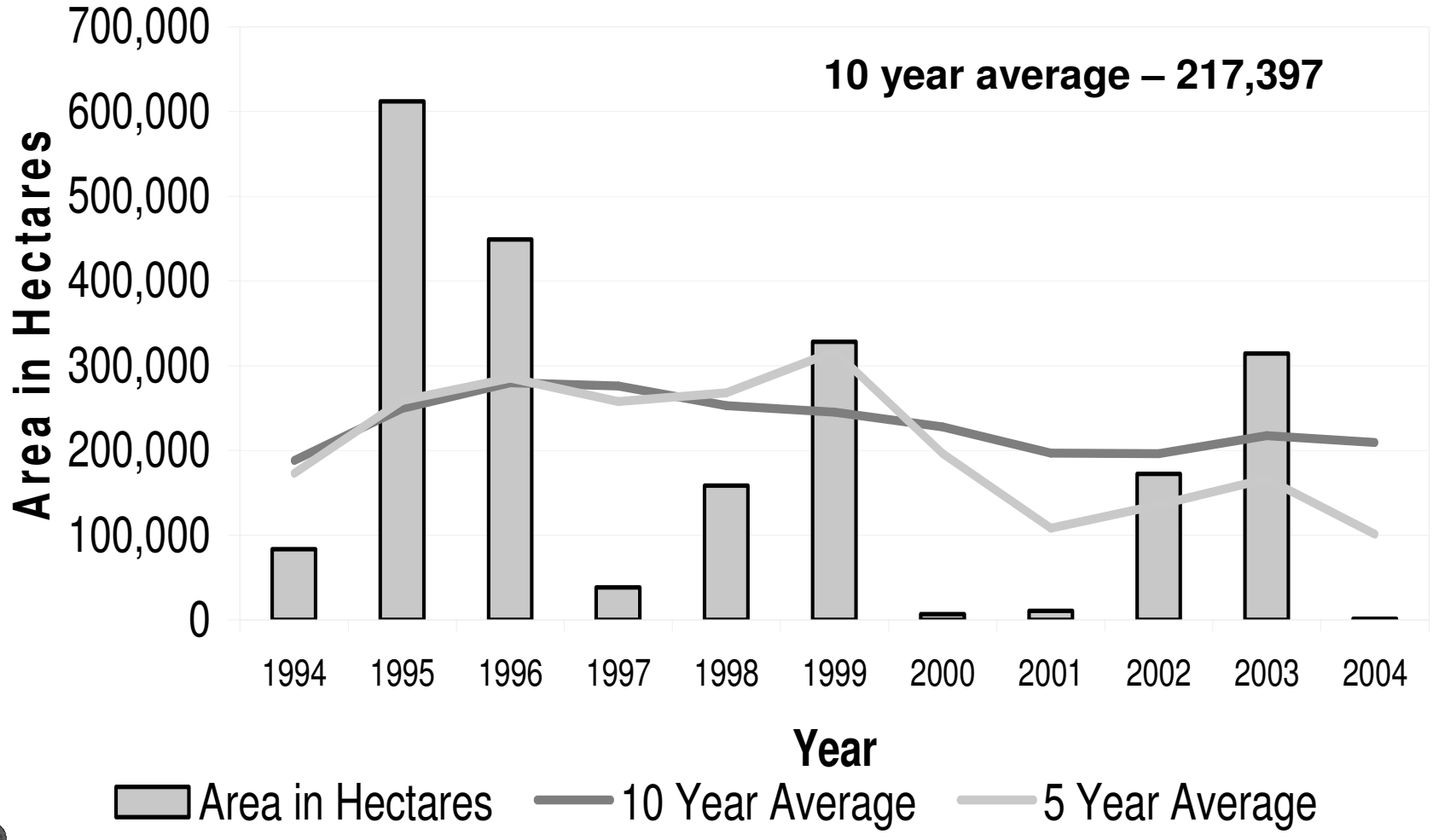


Fires by Cause

(Annual Average 1991 to 2000)



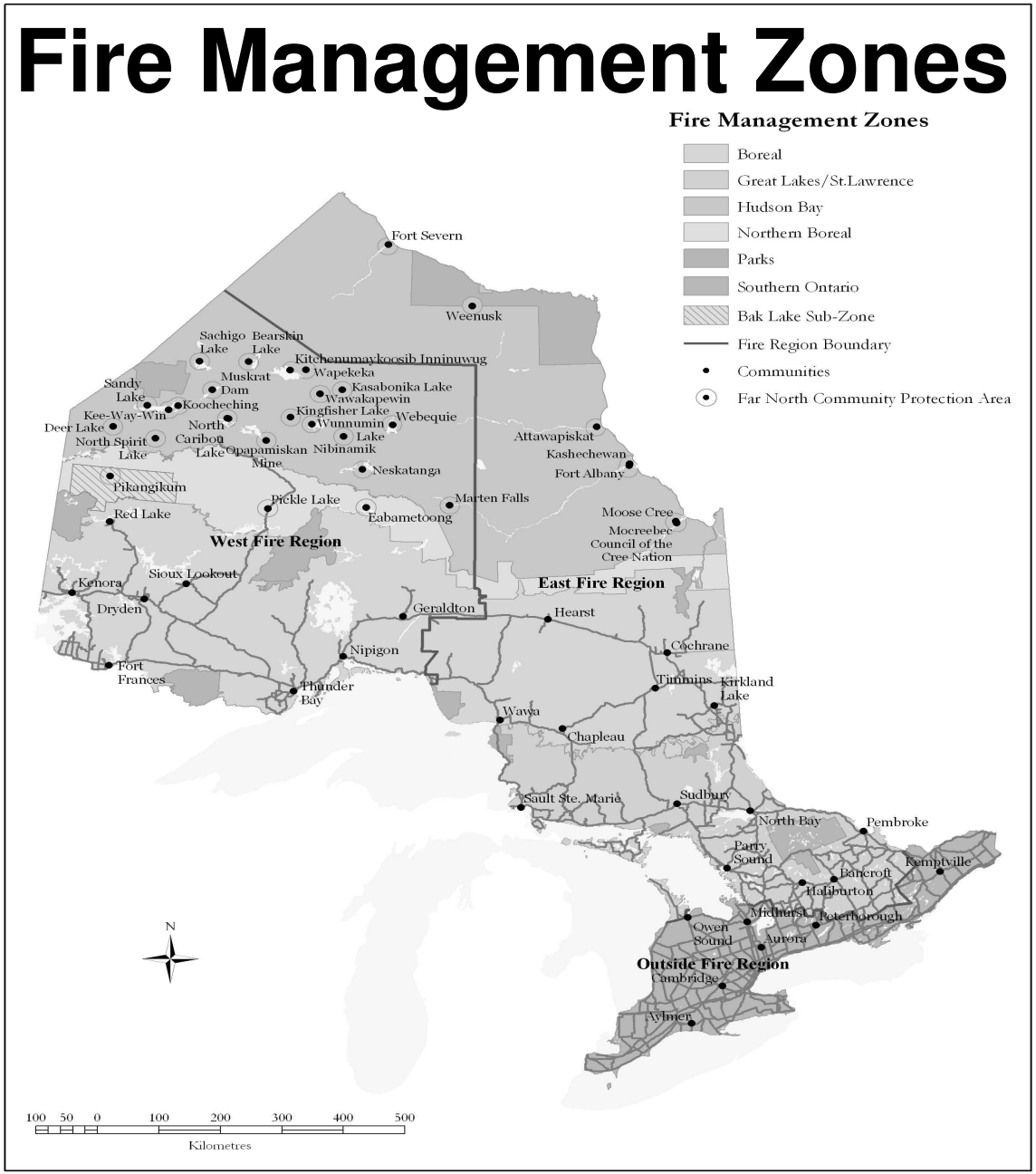
Annual Number of Hectares



Fire Protection Policy

- Public Safety and Well-Being
  - Communities
  - Private property
  - Infrastructure: communication, energy, transportation
  - Commercial / industrial property
  - Economic activity
- Wood Supply
  - Existing and future wood supply
  - Protection increases wood supply up to 35%

Fire Management Zones



Fire Fighting Resources

- $27 Million in suppression equipment
- 207 Initial attack crews (MNR)
- 150 Sustained attack crews (contract)
- 9 CL-415 Airtankers
- 5 Medium Airtankers
- 13 Medium / intermediate helicopters
- 11 Detection aircraft
- 7 “Birddog” aircraft (guide airtankers)
- Peak activity:
  - 4,000 people and 200 aircraft
  - National and international sharing agreements in place

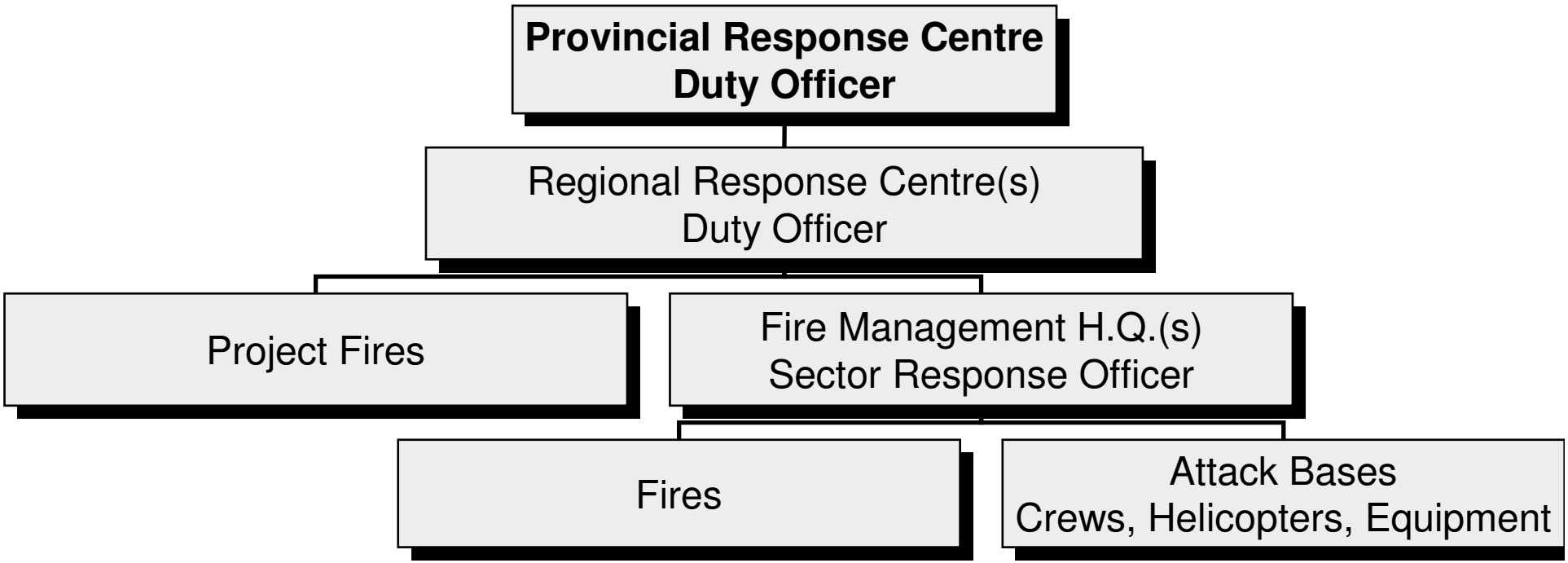
Organization for Fire Response

Provincial Response Centre
Sault Ste. Marie

West Region Fire Centre
Dryden

East Region Fire Centre
Sudbury

Command and Control




Regional Fire Centres

Fire Attack Bases

Daily Fire Activities

Level	Responsibilities
Province (1-10 d)	• Weather forecasting • Fire occurrence & behaviour prediction • Getting sufficient resources in province • Lending resources out of province • Balancing resources between regions
Regions (1-5 d)	• Fire occurrence & behaviour prediction • Putting sufficient resources on alert within region • Detection • Dispatching aircraft to fires • Project fire management
Fire Manage-ment H.Q.s and Attack Bases (1-2 d)	• Dispatching fire fighters to fires • Small fire management • Equipment retrieval

Fire Detection

- Daily planning
- Aerial - 11 aircraft with observers
- Public - Common reporting system
- Report directly to Fire Centres

Fire Dispatch

- Main dispatch centres are Regional Fire Centres
- Daily positioning of resources
- Set Alert Readiness
- Receive fire reports
- Rapid dispatch
- Multiple dispatch from attack bases depending on need of fire
- Set priorities if shortages

Fire Attack

Integrated attack:

- Fire Crews - Ground and Helitack
- Air Attack - CL-415 & Twin Otters
- Initial Attack fails ⟶ Sustained Attack

- Organization grows with need
- Incident Commander responsible for:
  - Assessment
  - Attack strategy
  - Supervision
  - Reporting results

Air Attack

- Airtankers improve initial attack success and support sustained attack

- "Birddog" aircraft assess, control, and lead air attack

Fire Logistics

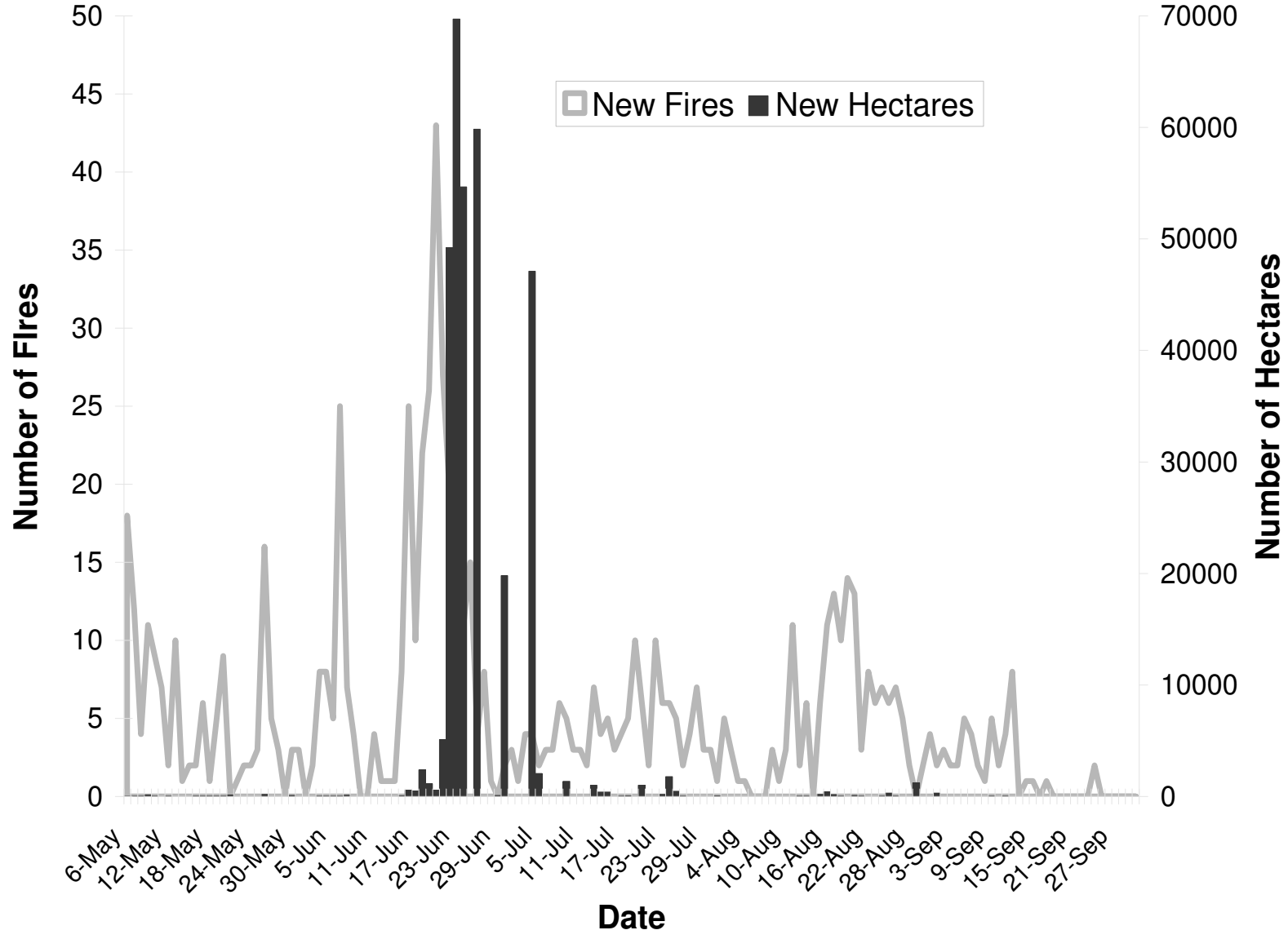
- Personnel
- Transportation
- Basecamps
- Health services

Forest Fire Equipment

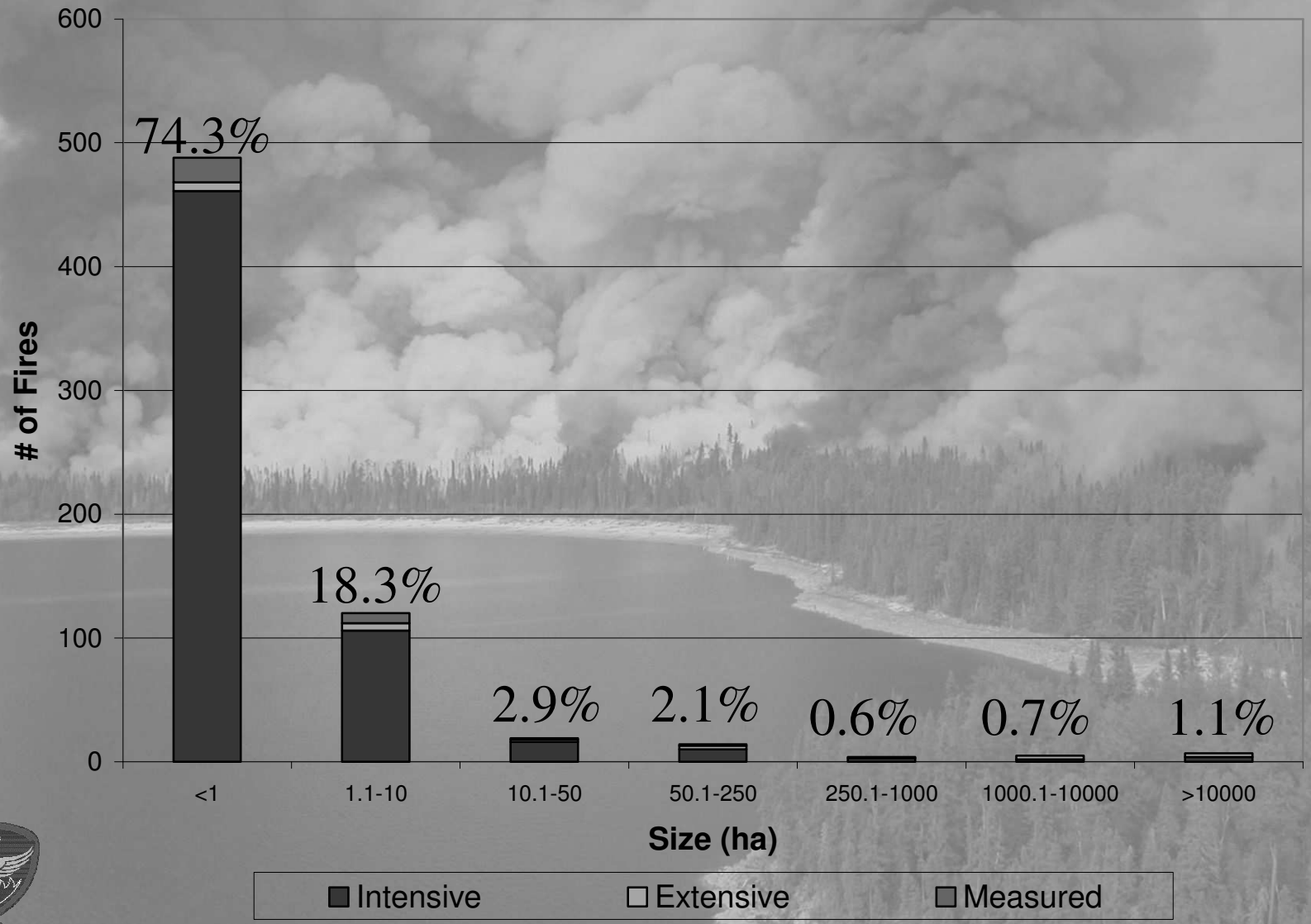
- Equipment standards (provincial / national) allow sharing
- Inventory and control system
- Mobilization, repair, recycle


2003

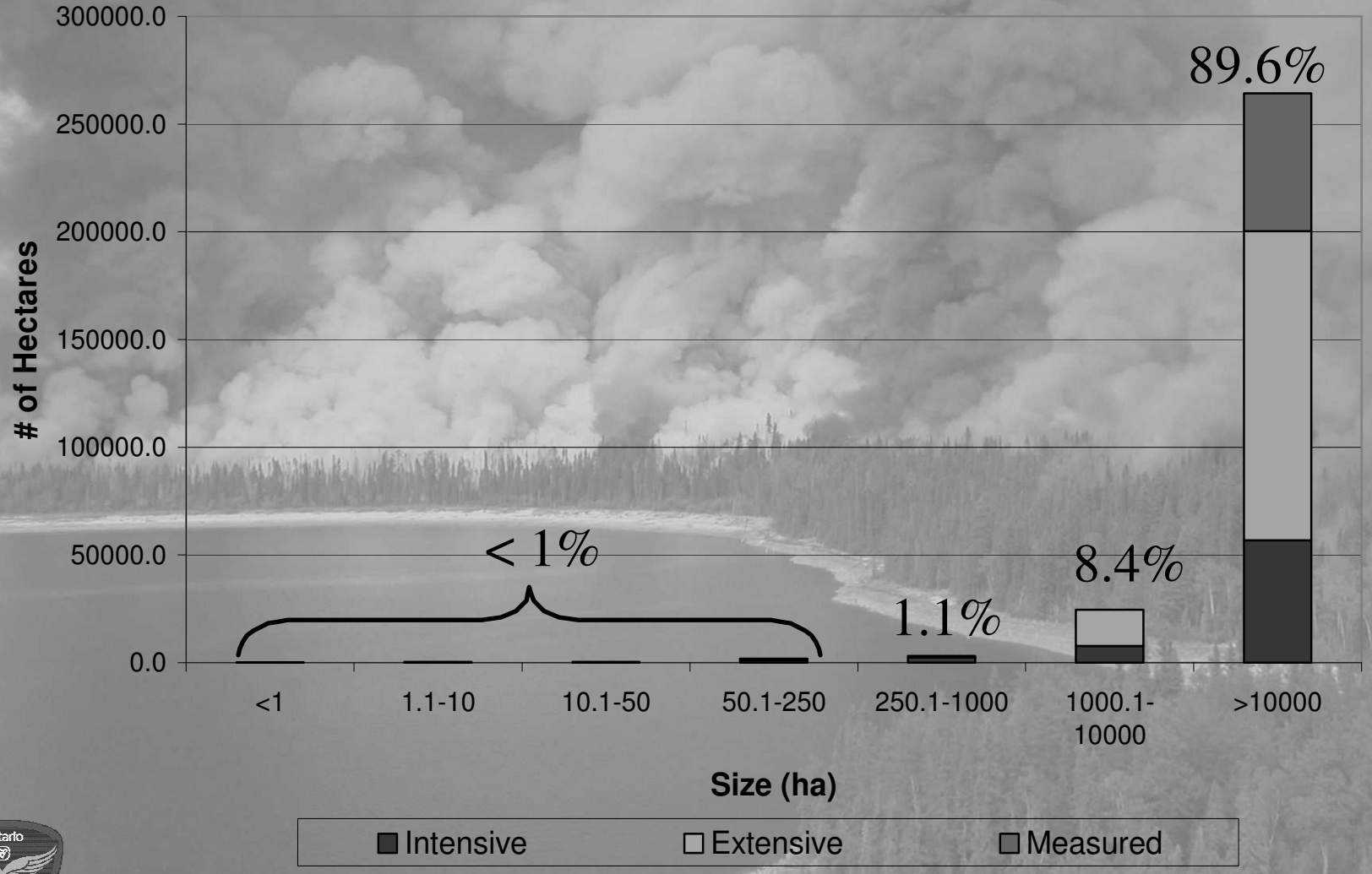
Fires 2003


New Fires
New Hectares
Number of Fires
Number of Hectares
Date
0
5
10
15
20
25
30
35
40
45
50
0
10000
20000
30000
40000
50000
60000
70000
6-May
12-May
18-May
24-May
30-May
5-Jun
11-Jun
17-Jun
23-Jun
29-Jun
5-Jul
11-Jul
17-Jul
23-Jul
29-Jul
4-Aug
10-Aug
16-Aug
22-Aug
28-Aug
3-Sep
9-Sep
15-Sep
21-Sep
27-Sep

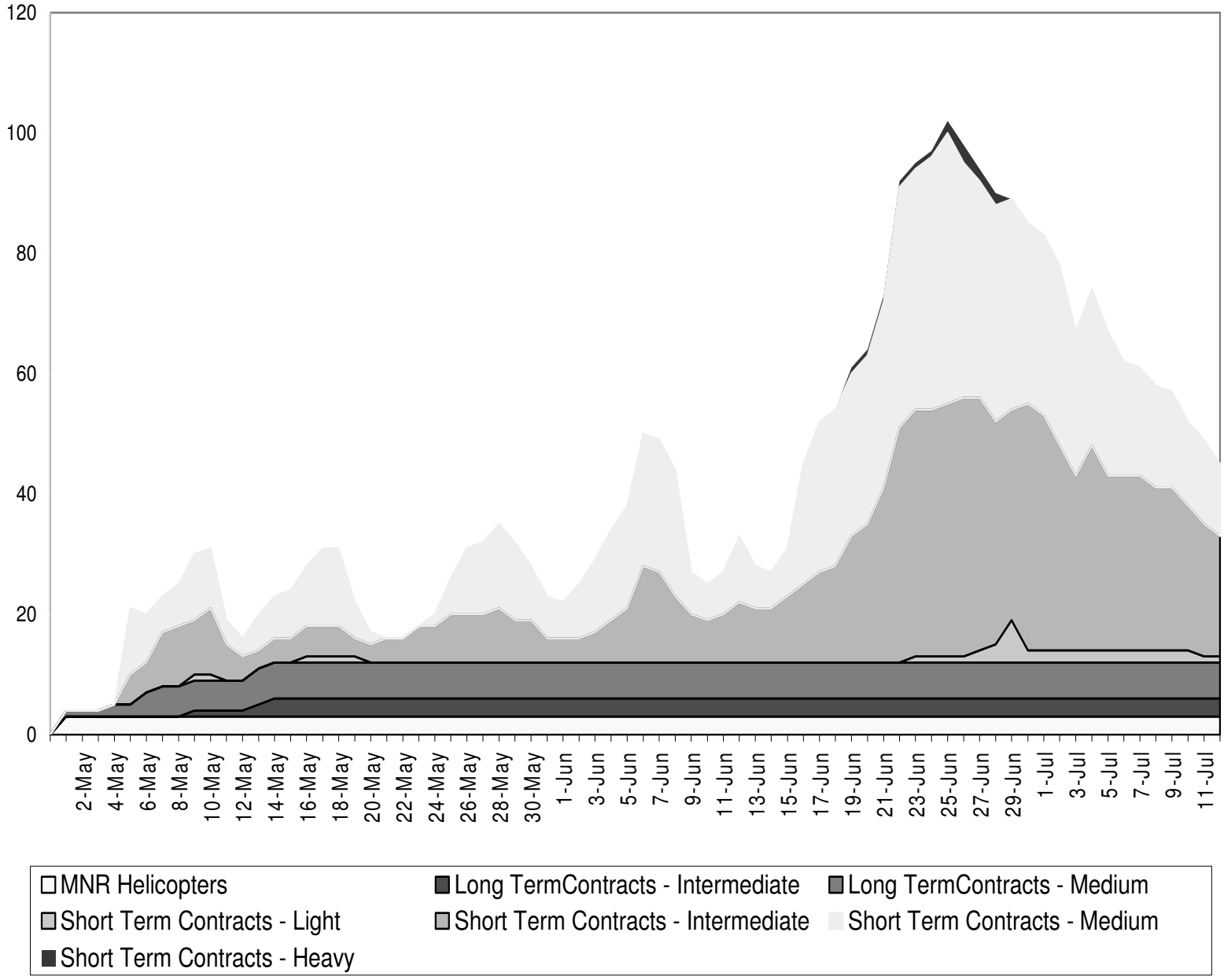
Number of Fires by Size Class



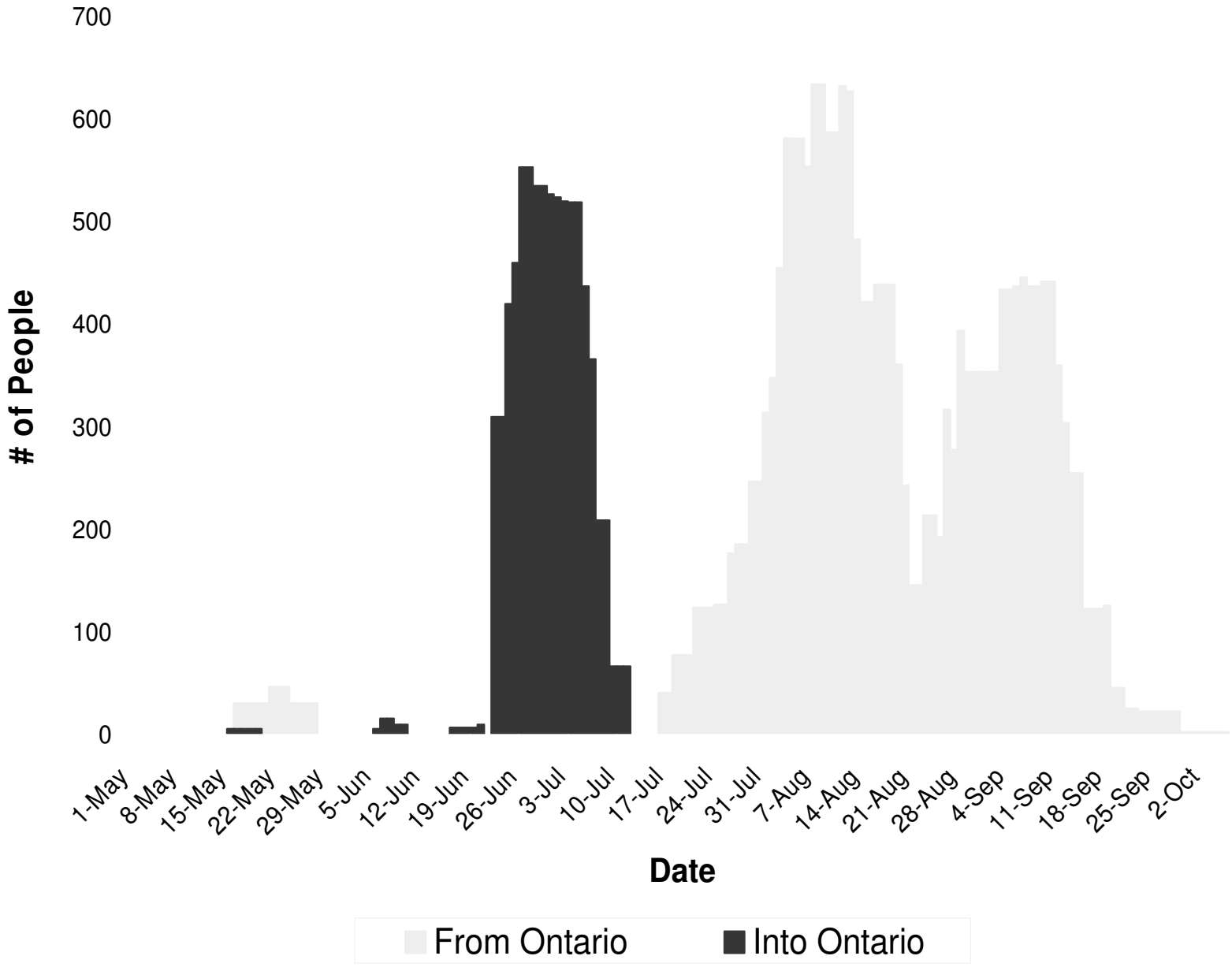
Hectares by Size Class



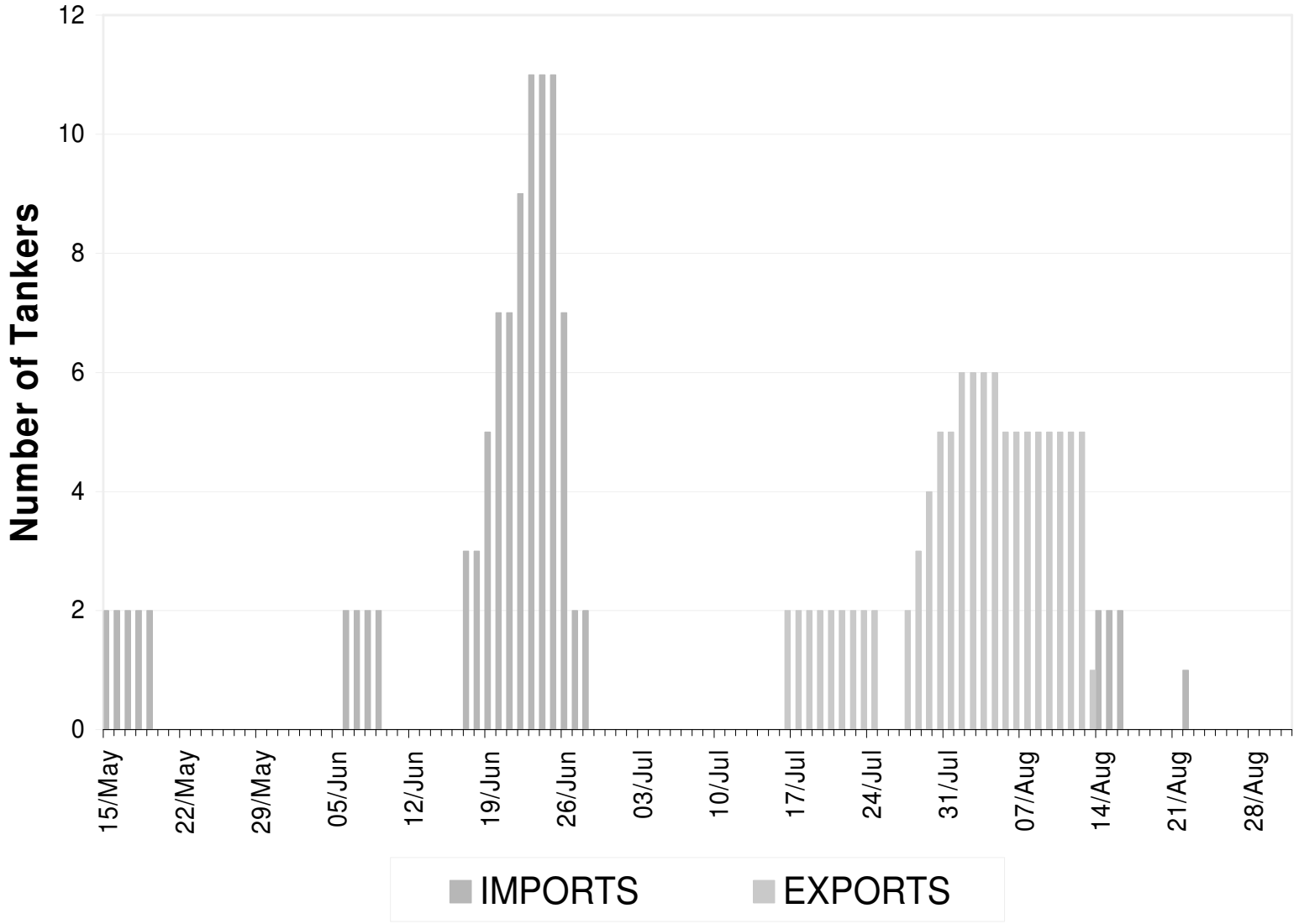
Helicopters Hired from May 1 - July 12 2003



Personnel Resource Sharing 2003



2003 Tanker Movements



Information Systems

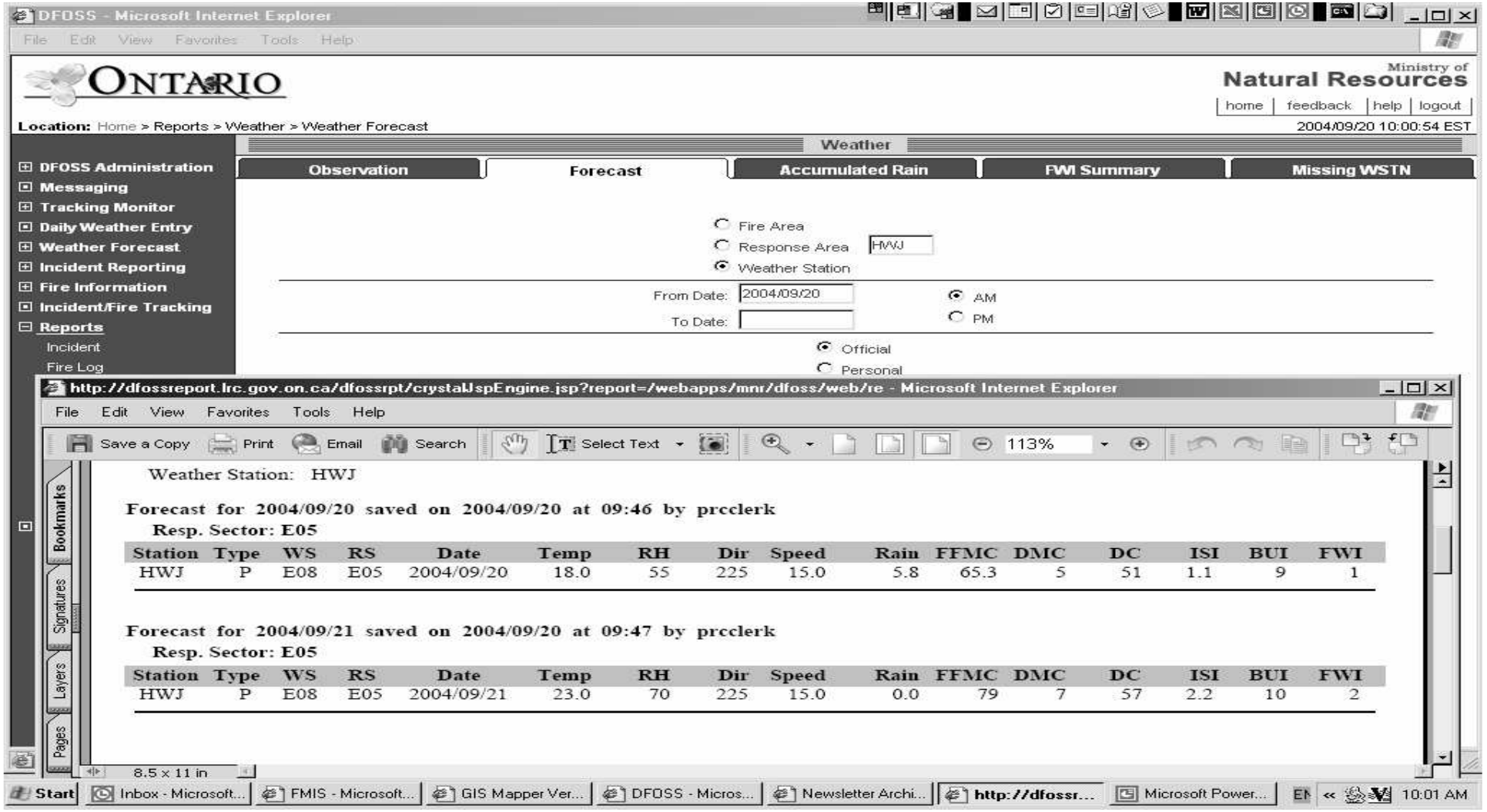
Information Systems

- Four Core Fire Management Information Systems
  - **DFOSS** – Daily Fire Operations Support System
  - **IMIS** – Inventory Management Information System
  - **A/CIMS** – Aircraft Information Management System
  - **PIMS** – Personnel Information Management System

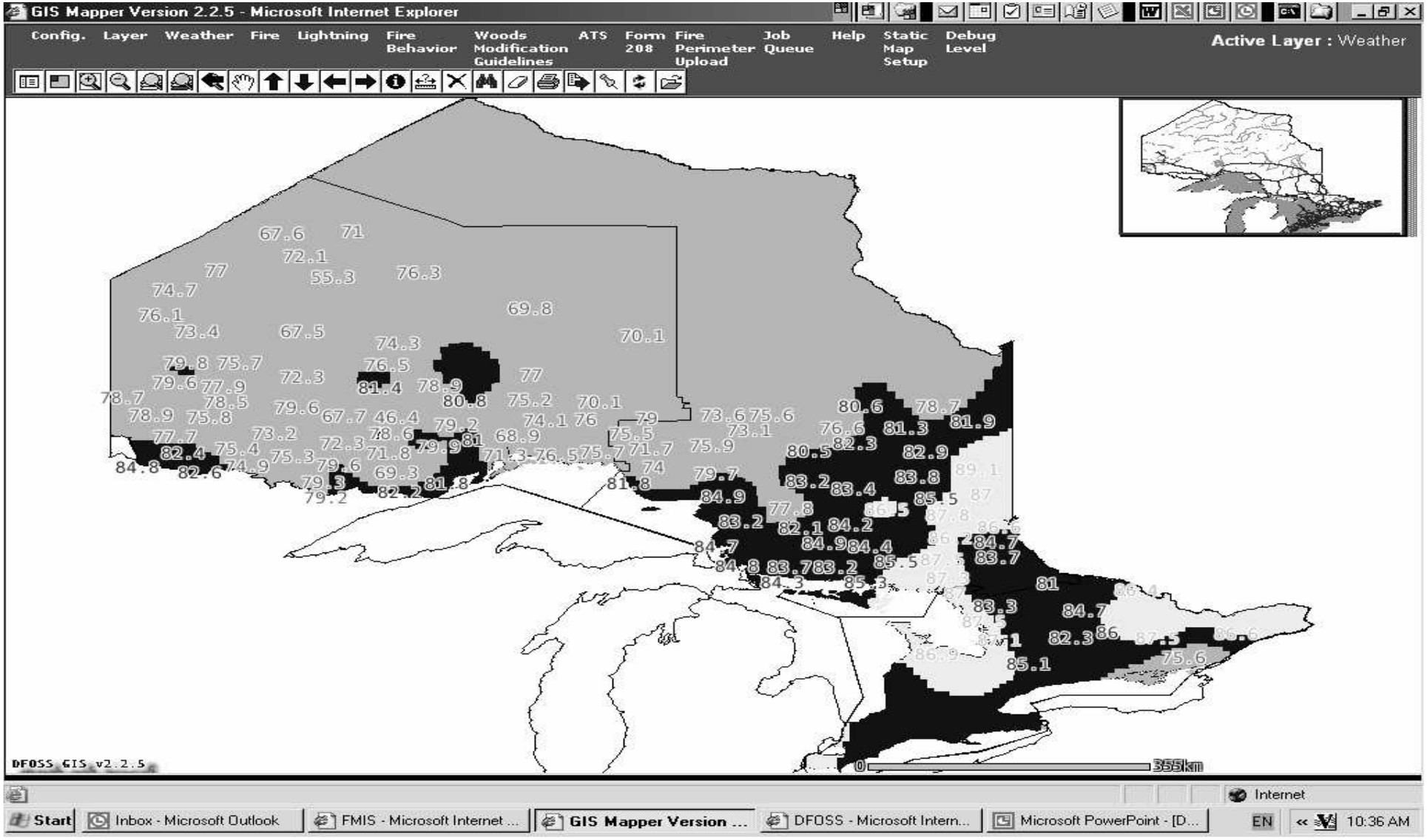
DFOSS – Daily Fire Operations Support System

- Record and store weather (observed and forecast), incident and fire information as it is reported
- Calculate Fire Weather Indices, fire occurrence predictions and fire behaviour predictions to support daily planning and decision making
- Produce reports listing and summarizing the above information
- Produce maps illustrating and overlaying the above information

Tabular Data



Spatial Data



IMIS – Inventory Management Information System

- Track fire suppression inventory items
  - Current location;
  - Movement;
  - Disposal.
  - Acquisition;

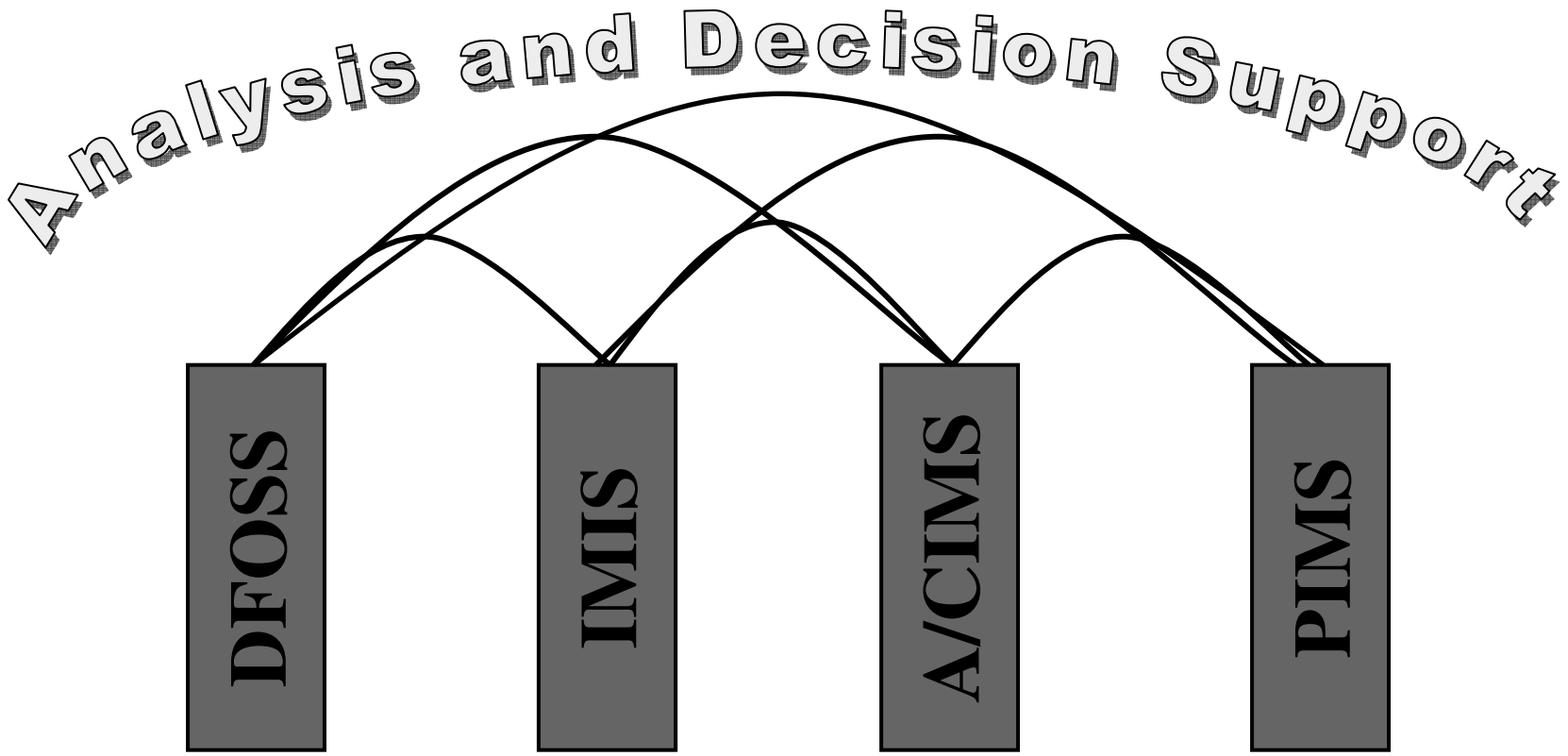
A/CIMS – Aircraft Information Management System

- Pre-Flight Planning
- Post-Flight
- Pilot Certification and Scheduling
- Maintenance
- Recoveries
- Management Information Reporting
- Real Time Aircraft Tracking

PIMS – Personnel Information Management System

- Staff personal information - an inventory of staff
  - fireline functions
  - training courses taken
  - fire qualifications and experience
- Tracks requests, mobilizations, status, assignments, locations, and demobilization of personnel
- Hours worked - calculate and summarize cost information
- Reports listing and summarizing

Building Beyond the Basics



Models and Decision Making

Models to support decision making

- Decision Making at all scales
  - On-Site - Fire Line
  - Local - Dispatching
  - Regional - Positioning
  - Provincial - Business Management

Fireline - Operations

- Fire Behaviour Models
  - Intensity
  - Spotting (distance/number)
- Fire Growth Models
  - Where / When
- Suppression Effectiveness

Dispatching

- Suppression Effectiveness
- Fire Behaviour Potential
- Occurrence prediction
- Other Factors
  - Values at Risk
  - Resource Availability

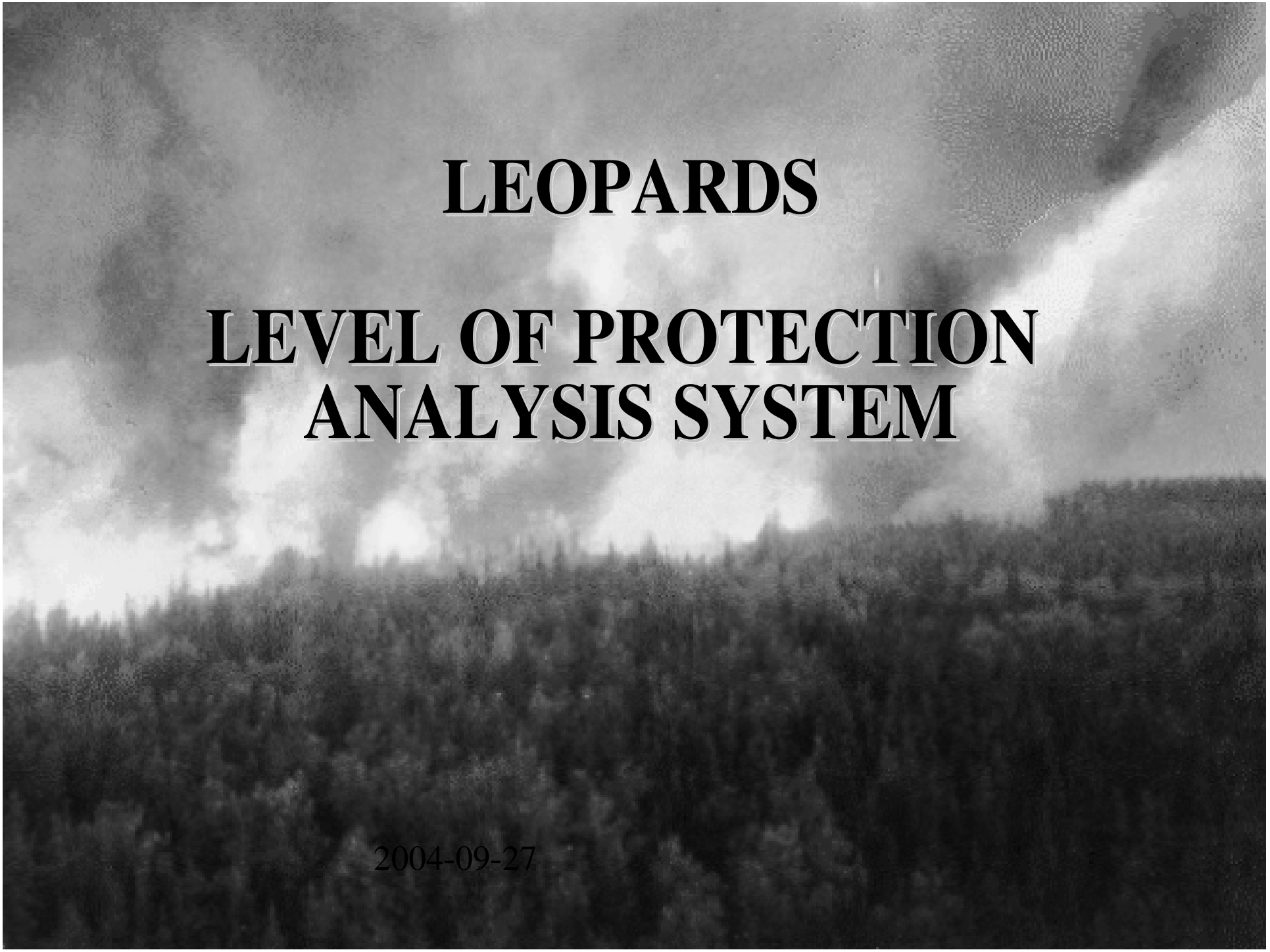
Regional Decisions

- Deployment
  - Fire Occurrence
  - Behaviour Potential
- Detection
- Resource Needs/Availability

Province

- Resource needs assessments
- Business management
  - How many resources?
  - What balance of resources do we need?
  - How do we measure our success/failure

Provincial Models



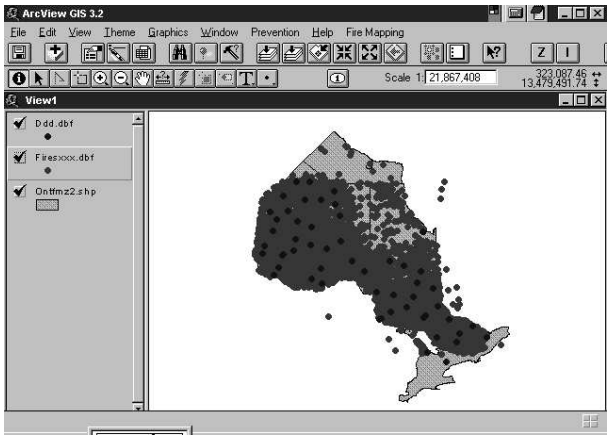
LEOPARDS

LEVEL OF PROTECTION ANALYSIS SYSTEM

2004-09-27

WHAT IS LEOPARDS ?

- "Level of Protection Analysis System"
- Simulation model:
  - Initial attack on forest fires
  - All forest fires in Ontario
  - Every day for the fire season
  - Spatially and temporally explicit
  - Records initial attack success and costs
- Developed in Ontario
  - Currently used in Ontario, British Columbia, and Quebec

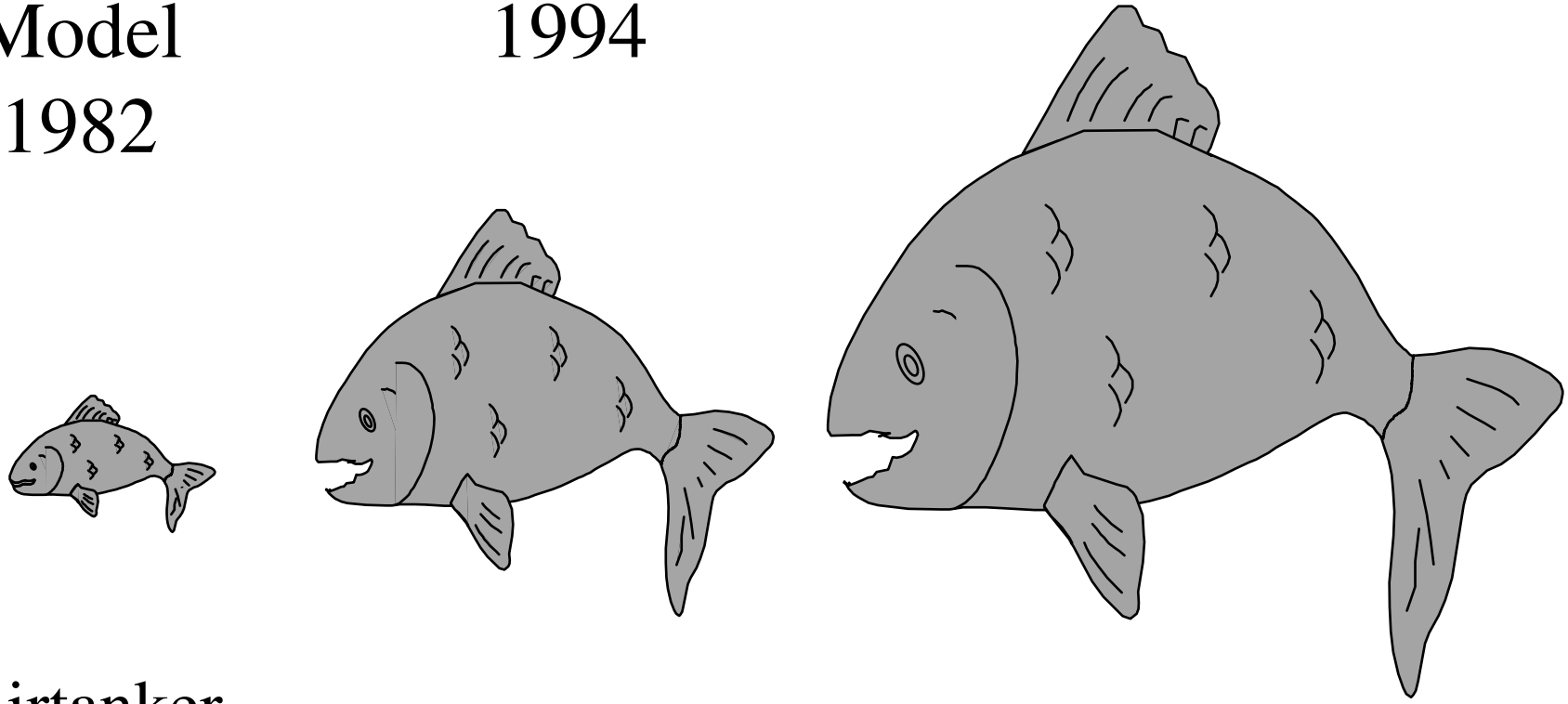


DEVELOPMENT OF LEOPARDS

Initial Attack Model 1982

"Lanik" 1994

Leopards - 1998



Airtanker Assessment (Temporal)

Level of Protection (Spatial and Temporal)

Historical Data

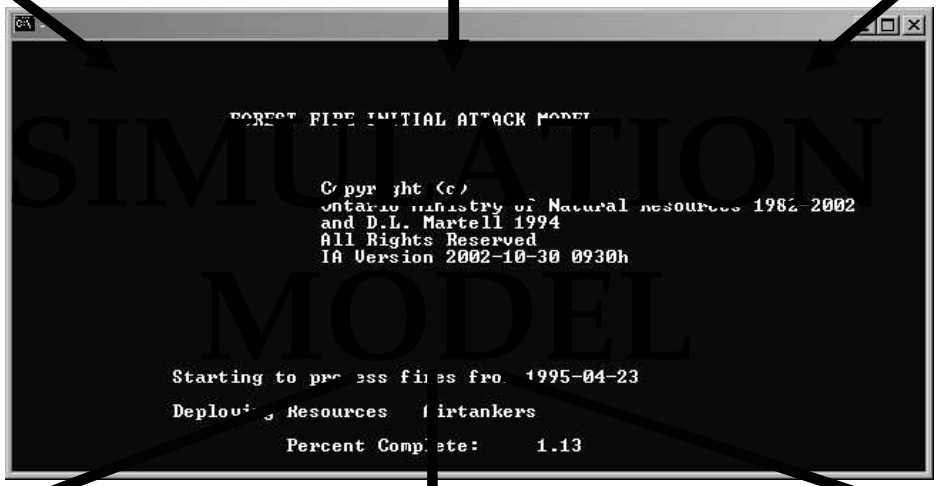
- Fires
- Weather

Dispatch Rules

- Location Specific

Resources

- Quantity
- Capabilities
- Location



Fire Results

- Status
- Size

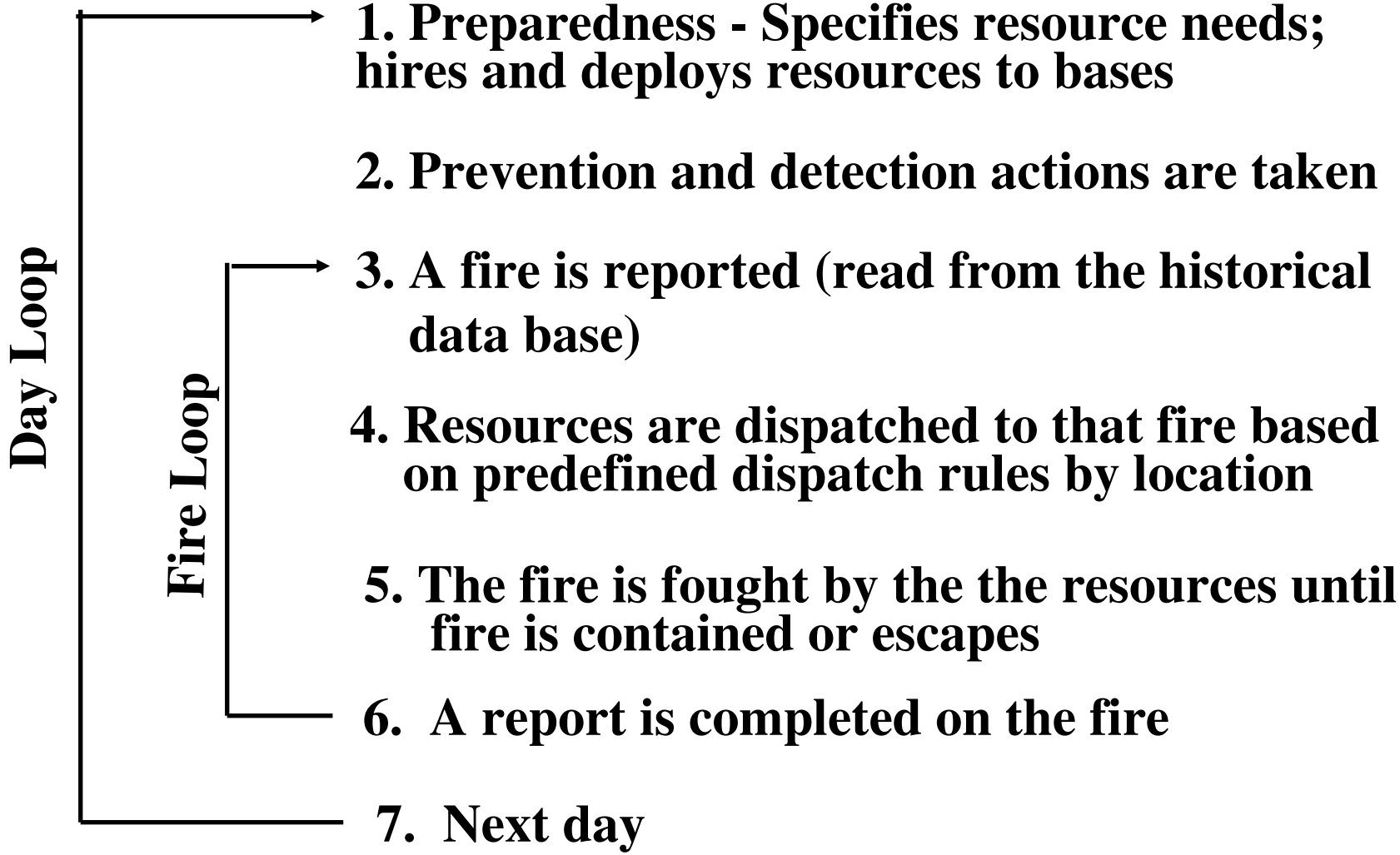
Resource Usage

- Deployment
- Dispatches
- Flight Hours

Costs

- Ground Crews
- Aircraft
- Attack Bases

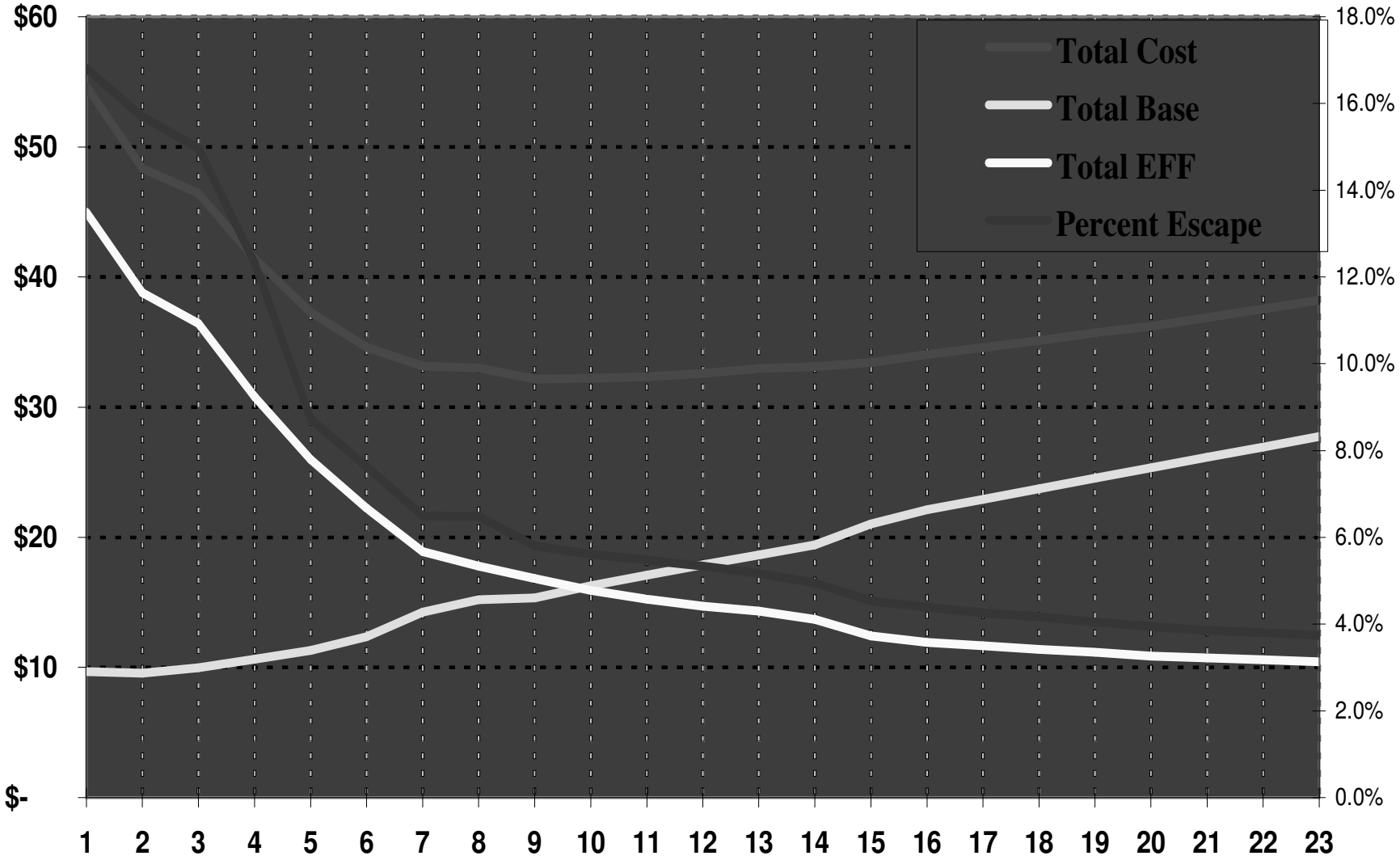
DAILY PROGRAM FLOW



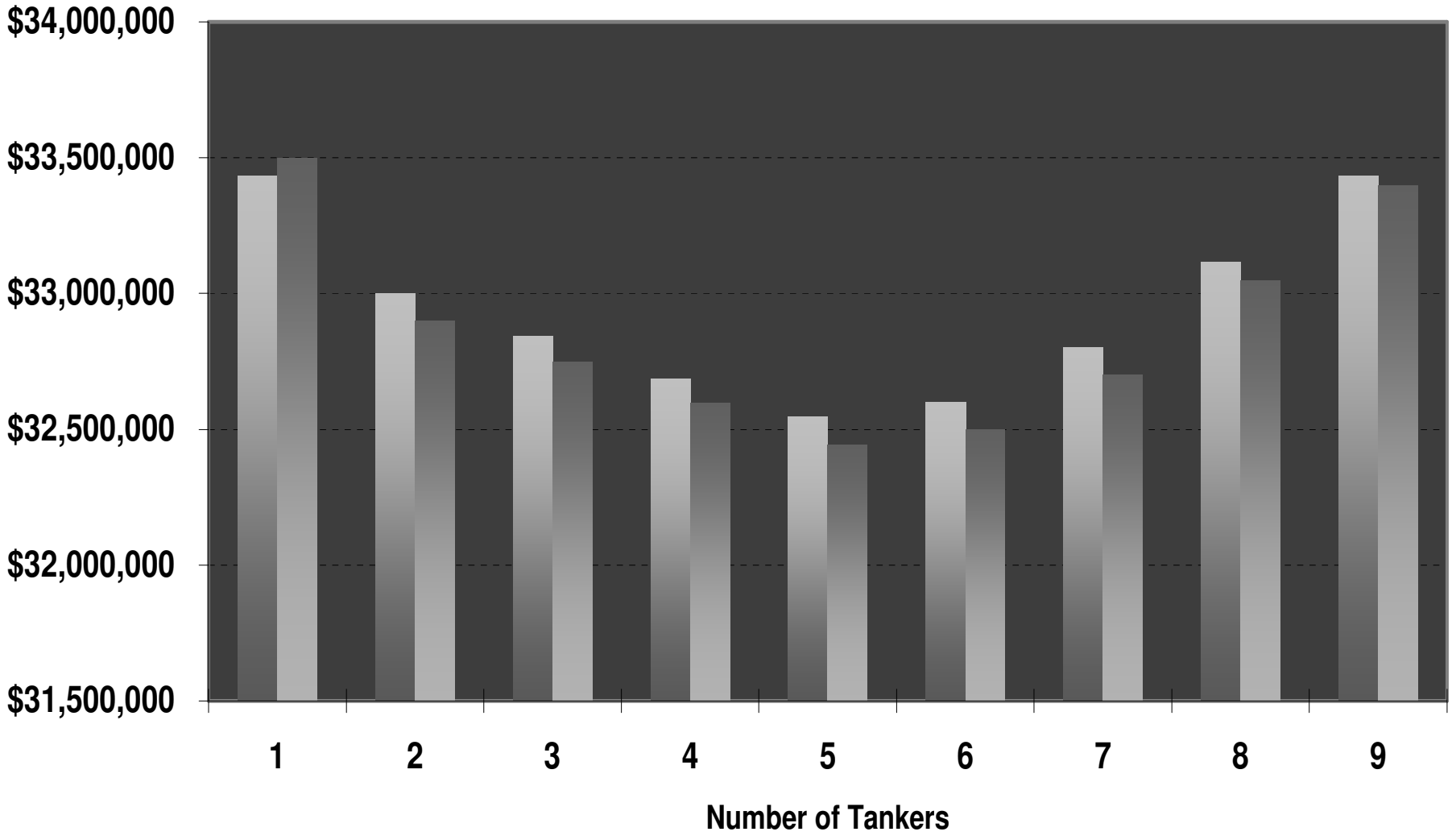
EXAMPLES OF ANALYSES

- Funding and Total Cost
- Equipment Comparison
- Change of “LOP” for an Area

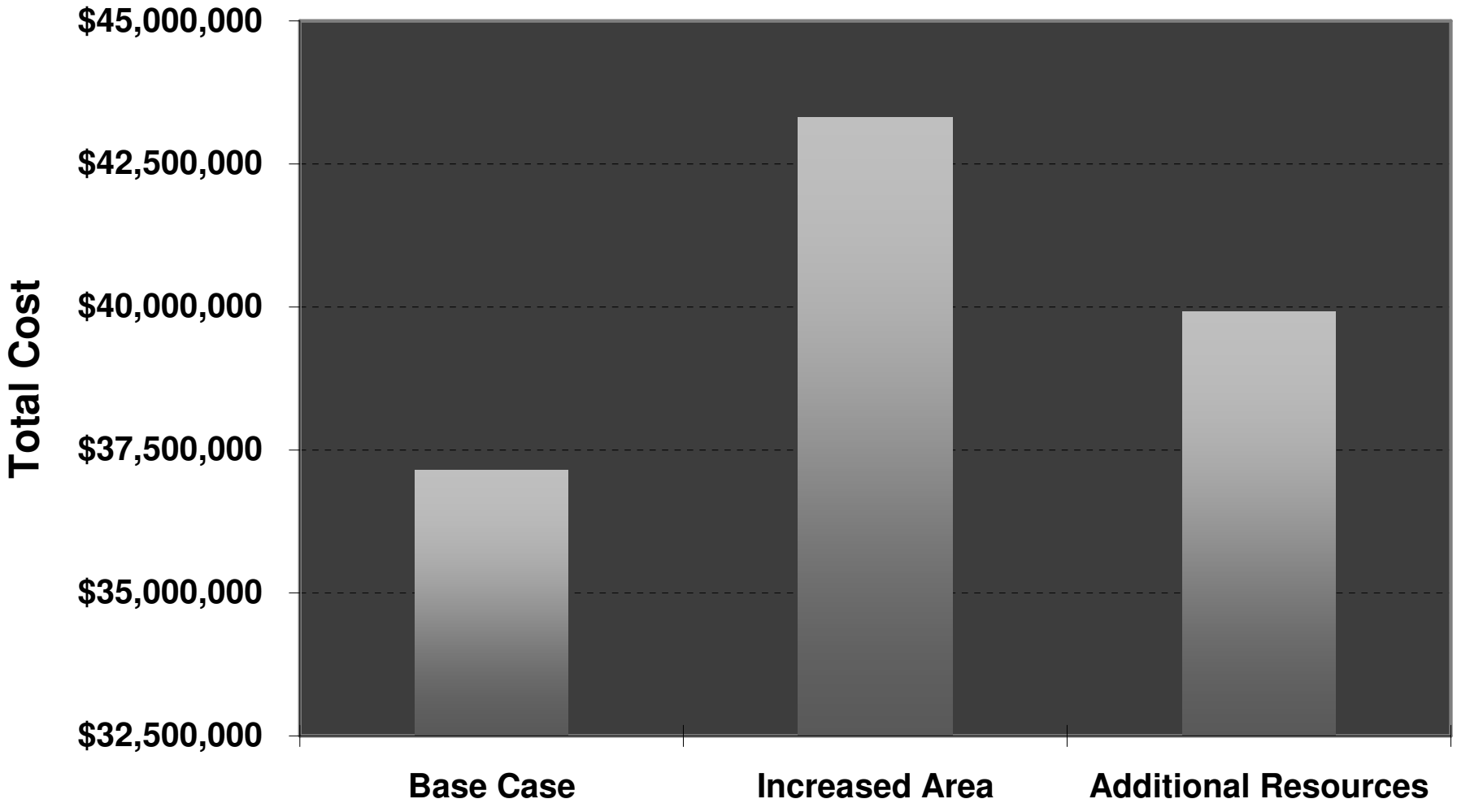
Funding and Total Cost



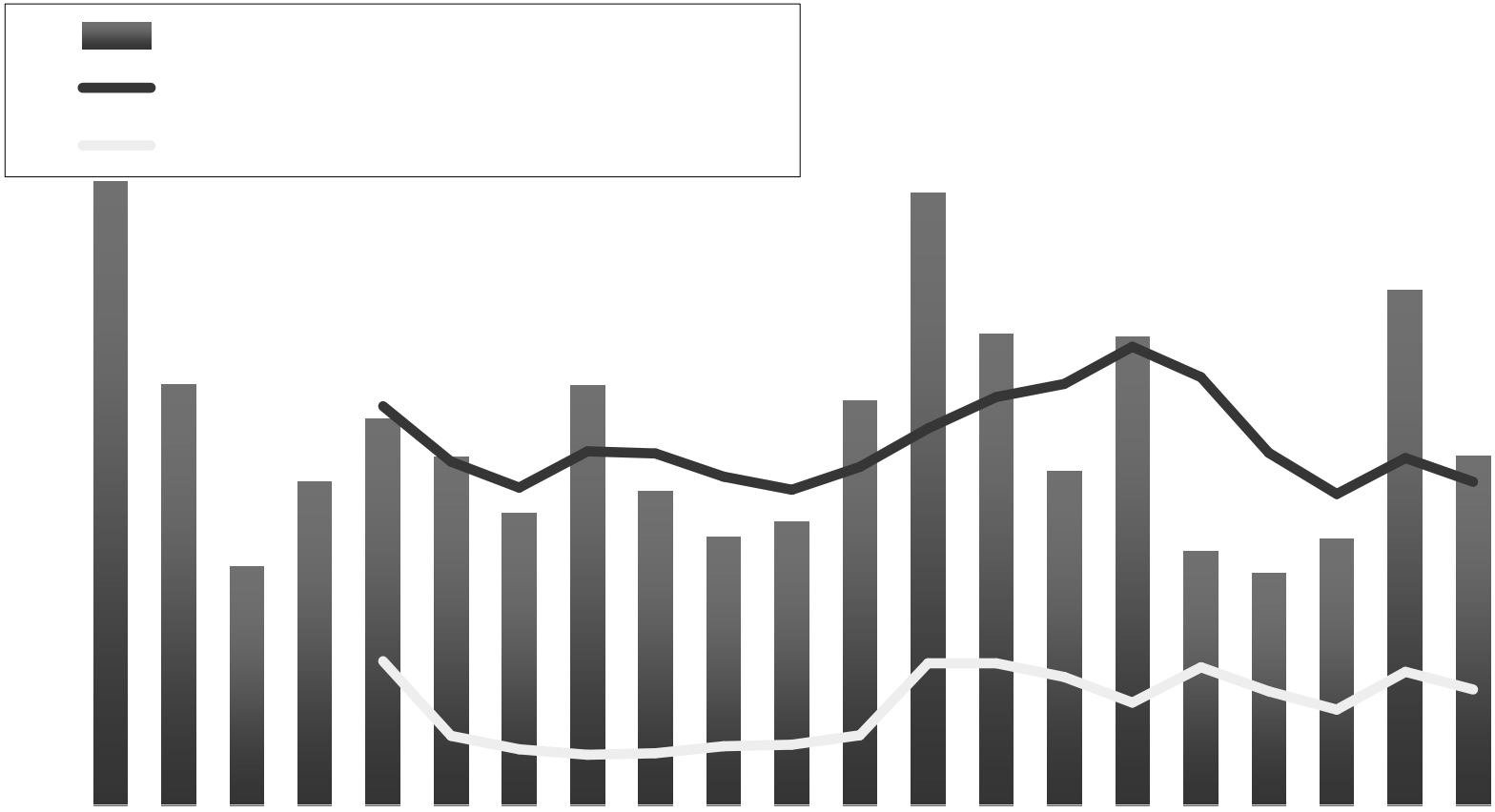
Equipment Comparison



Change in the LOP for an Area



Investigating Climate Effects



Ontario's Resource Forecasting Model

- Model to evaluate resource levels at the regional and provincial scale
- 10-day planning horizon
- Based on planning "scenario"

Purpose of the Model

- The Provincial Response Centre plans ahead to meet the need for:
  - Fire fighters and other fire personnel
  - Airtankers
  - Helicopters
  - Equipment
- Delays
- Daily 10-day forecast of need
  - Days 6 to 10 preliminary

Model Inputs

- Based on:
  - The fires we have now (by size and stage)
  - The fires forecast over the next 10 days (by size)
  - Current and forecast burning conditions
  - Average resource needs (by size and stage)

Resources & Personnel Tracked

- Fire Fighters
  - Type 1
  - Type 2
- Helicopters
  - Light/ Intermediate
  - Medium
- Airtankers
  - CL-415s
  - Twin Otters / SEATS
- Hose Lengths
- Pumps

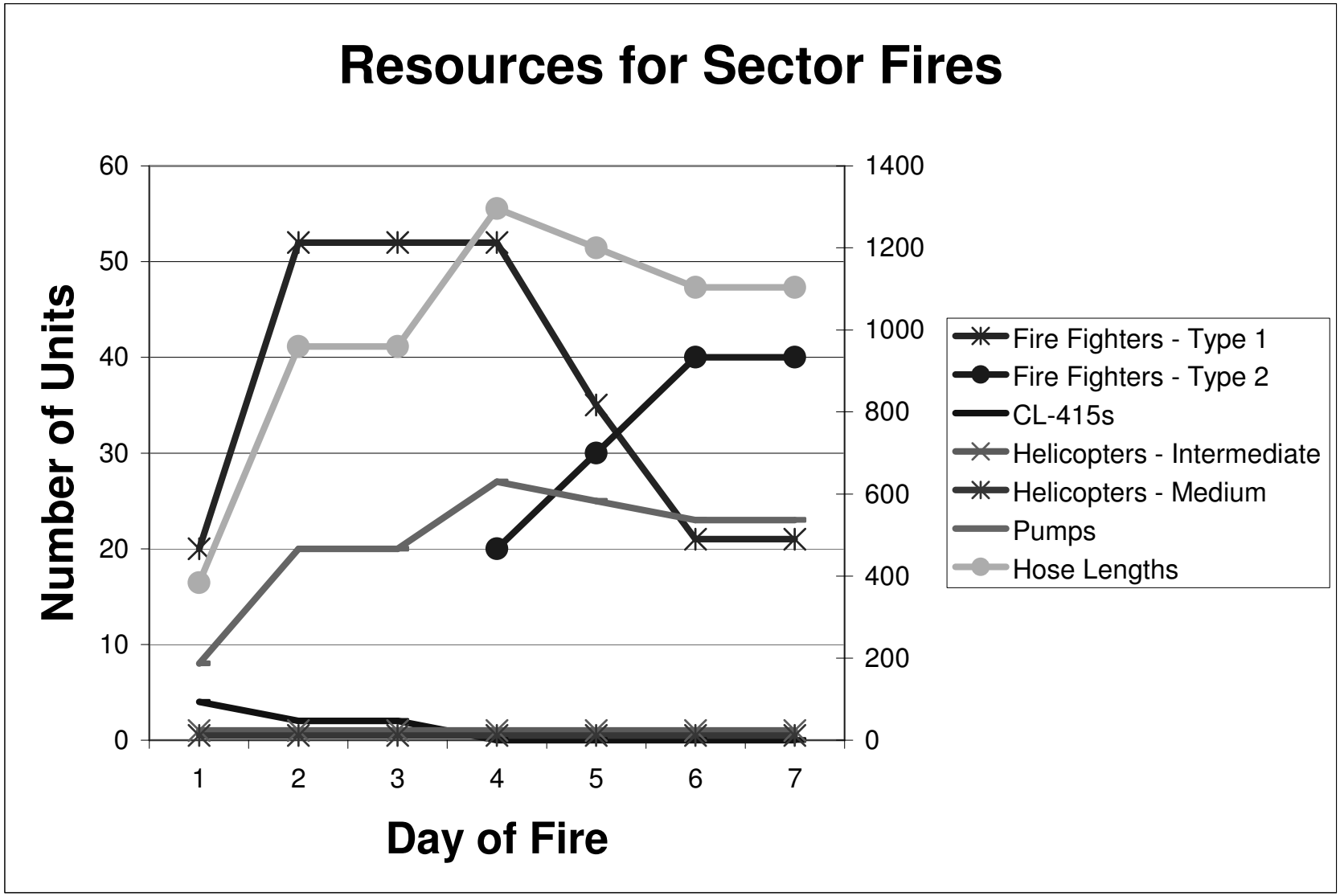
- Sector Leaders
- Division Supervisors
- Fire Behaviour Analysts
- Incident Management Teams – Long
- Incident Management Teams – Short

- Pack Pumps
- Sprinkler Kits
- Burnout Units
- Chain Saws
- Tents
- Base Camps
- Transport Aircraft

Categories of Fires

Category of Fire	Size (ha)	Duration (Days)
Non-Challenging	0.1 – 2	1 to 2
Challenging	2.1 - 4 (10)	2 to 4
Sector	4.1 (10.1) - 150	7
Project A	150 - 2,500	21
Project B	2,500+ - 7,500	21
Project C	7,500+ - 15,000	21
Project D	15,000+ - 30,000	21
Limited Action	Any Size	10

Average Resource Needs



Model in Excel Spreadsheets

	A	B	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN
2			Jul	Jul	Jul	Jul	Jul	Jul	Jul	Jul	Jul	Jul	Jul	Jul	Jul
4	**ALL FIRES**				Today										
5	**Category**	**Day**	**Sat 13**	**Sun 14**	**Mon 15**	**Tue 16**	**Wed 17**	**Thu 18**	**Fri 19**	**Sat 20**	**Sun 21**	**Mon 22**	**Tue 23**	**Wed 24**	**Thu 25**
6	***I/A 1***	**1**	22	40	20	15	15	15	15	20	15	15	15	15	0
7	*Sustained IA*	**2**	9	23	38	20	15	15	15	15	20	15	15	15	15
8	***Total IR 1-2 IA***		**31**	**63**	**58**	**35**	**30**	**30**	**30**	**35**	**35**	**30**	**30**	**30**	**15**
9	***I/A 2***	**1**	0	2	3	2	5	3	4	3	2	2	2	2	0
10	*Sustained IA*	**2**	3	1	2	3	2	5	3	4	3	2	2	2	2
11	*Sustained IA*	**3**	1	1	1	2	3	2	5	3	4	3	2	2	2
12	*Sustained IA*	**4**	0	1	2	1	2	3	2	5	3	4	3	2	2
13	***Total IR 3-4 IA***		**4**	**5**	**8**	**8**	**12**	**13**	**14**	**15**	**12**	**11**	**9**	**8**	**6**
14	***Sector Fire 3***	**1**	0	0	1	1	0	2	2	1	0	0	0	0	0
15		**2**	2	0	0	1	1	0	2	2	1	0	0	0	0
16		**3**	2	1	0	0	1	1	0	2	2	1	0	0	0
17		**4**	0	2	2	0	0	1	1	0	2	2	1	0	0
		5	2	1	2	2	0	0	1	1	0	2	2	1	0
		6	1	2	0	2	2	0	0	1	1	0	2	2	1
		7	0	1	3	0	2	2	0	0	1	1	0	2	2
	Total Sector Fires		**7**	**7**	**8**	**6**	**6**	**6**	**6**	**7**	**7**	**6**	**5**	**5**	**3**
	Project Fire 1	**1**	0	1	0	0	1	1	1	0	0	0	0	0	0
		2	0	0	1	0	0	1	1	1	0	0	0	0	0
		3	0	0	0	1	0	0	1	1	1	0	0	0	0
		4	0	0	0	0	1	0	0	1	1	1	0	0	0
		5	0	0	0	0	0	1	0	0	1	1	1	0	0
		6	0	0	0	0	0	0	1	0	0	1	1	1	0
		7	0	0	0	0	0	0	0	1	0	0	1	1	1
		8	0	0	0	0	0	0	0	0	1	0	0	1	1
		9	0	0	0	0	0	0	0	0	0	1	0	0	1
		10	0	0	0	0	0	0	0	0	0	0	1	0	0
		11	0	0	0	0	0	0	0	0	0	0	0	1	0
		12	0	0	0	0	0	0	0	0	0	0	0	0	1
		13	0	0	0	0	0	0	0	0	0	0	0	0	0
		14	0	0	0	0	0	0	0	0	0	0	0	0	0
		15	0	0	0	0	0	0	0	0	0	0	0	0	0
		16	0	0	0	0	0	0	0	0	0	0	0	0	0
		17	0	0	0	0	0	0	0	0	0	0	0	0	0
		18	0	0	0	0	0	0	0	0	0	0	0	0	0
		19	0	0	0	0	0	0	0	0	0	0	0	0	0
		20	0	0	0	0	0	0	0	0	0	0	0	0	0
		21	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total Project Fires1		**0**	**1**	**1**	**1**	**2**	**3**	**4**	**4**	**4**	**4**	**4**	**3**	**3**

Resources	**13-Jul**	**14-Jul**	**15-Jul**	**16-Jul**	**17-Jul**	**18-Jul**
Personnel						
Total Type 1	406	352	426	426	426	426
Type 1 Off	71	70	63	63	63	63
Type 1 Working (total-off)	335	282	363	363	363	363
Type 1 Available for I/A (on alert)	200	146	243	243	243	243
Type 1 Committed (on fire)	133	132	116	116	116	116
Type 2 Hired	111	127	224	224	224	224
Total All Available	517	479	650	650	650	650
Type 2 Avail for Hire	459	430	333	333	333	333
Total Type 2 Avail. For Hire	600	600	600	600	600	600
Number of crews	102	88	107	107	107	107
Airtankers						
215/415's Available	6	6	6	6	6	6
Twins Available	2	2	2	2	2	2
Helicopters						
Light Helicopters on Hire	14	18	19	19	19	19
Medium Helicopters on Hire	10	11	12	12	12	12
Equipment						
Pumps Available in region	584	684	685	685	685	685
Pumps Committed	200	206	175	175	175	175
Pumps in retrieval	6	14	103	103	103	103
Hose Available in region	14924	14924	17348	17348	17348	17348
Hose Committed	4041	3595	4075	4075	4075	4075
Hose in retrieval	100	447	1248	1248	1248	1248
Sprinklers Available in Region	335	335	335	335	335	335
Sprinklers Committed	64	46	46	46	46	46
Sprinklers in retrieval	39	5	5	5	5	5

Ten Day Fire and Fire Weather Input

To enable this button, click the button below

Forecast New Fires

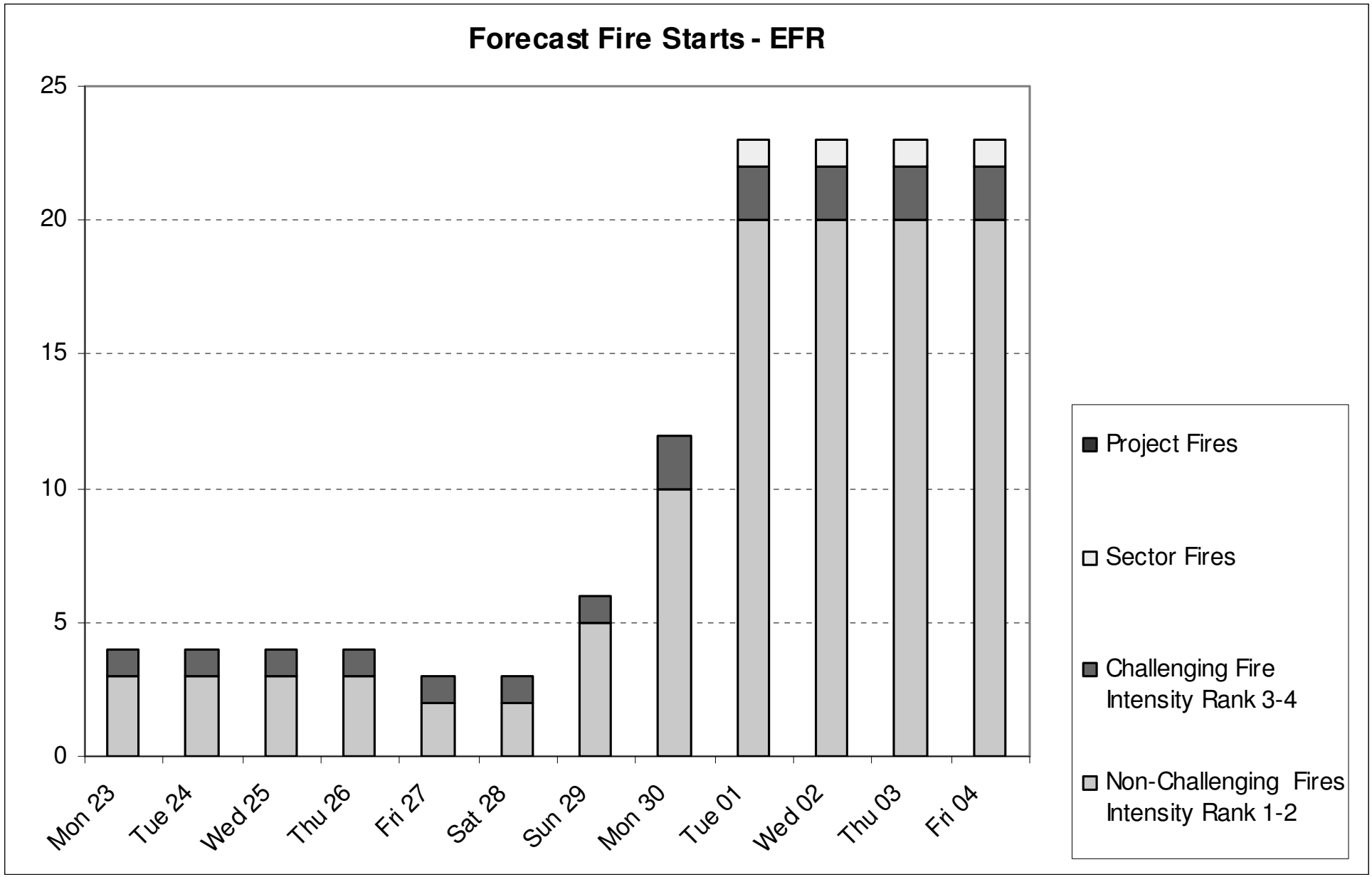
Fire Category for Planning

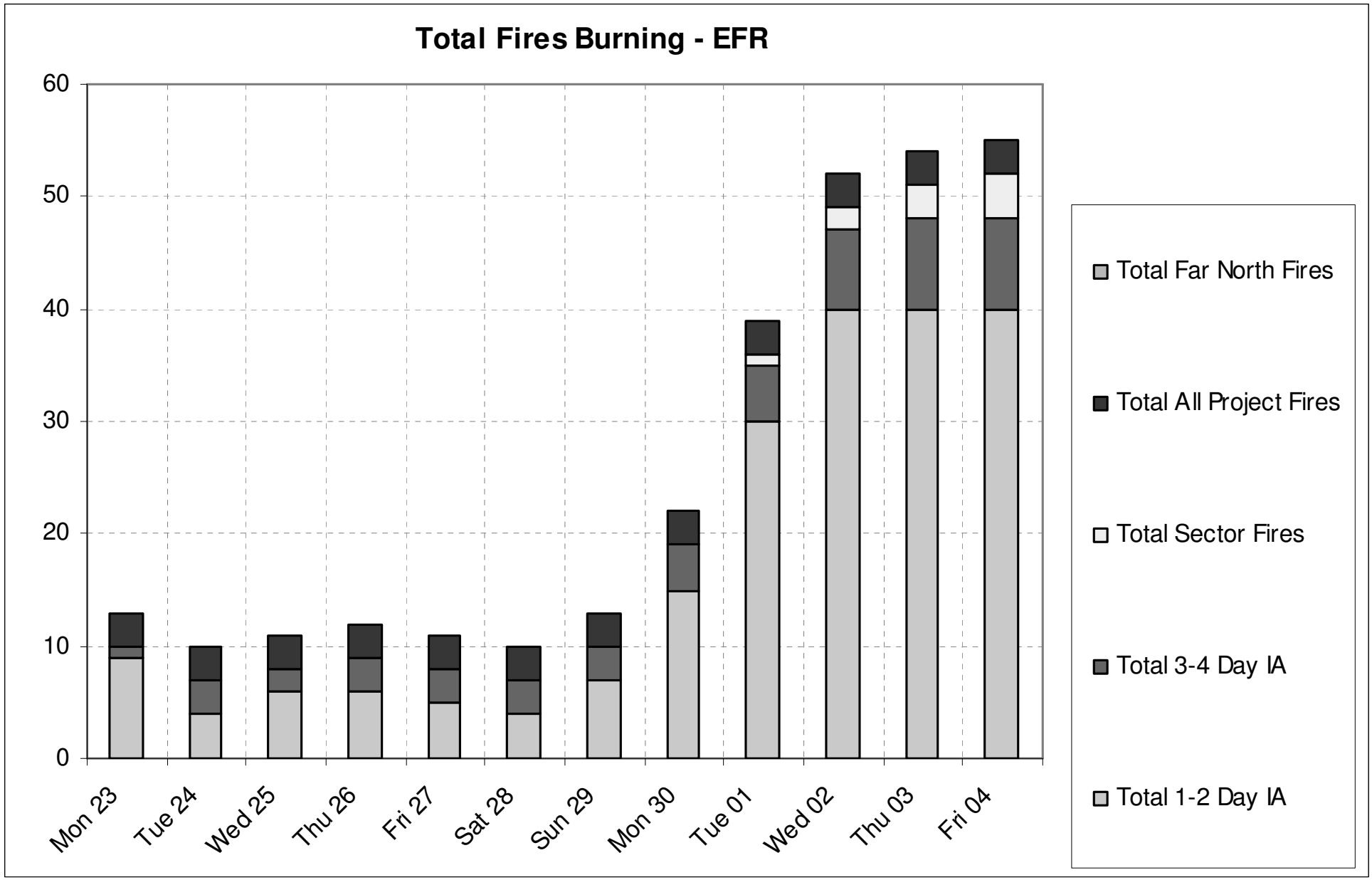
0	24-Jun	WFR				14	1			19	4	L	M	
	Tue	EFR				3	1				4	M	H	
1	25-Jun	WFR	1-2	1-2		2	1			7	1	L	M	
	Wed	EFR	1-3	0-2		3	1				4	M	H	
2	26-Jun	WFR				2	1			7	0	L	M	
	Thu	EFR				3	1				2	M	H	
3	27-Jun	WFR				2	1			6	0	L	L	
	Fri	EFR				2	1				1	L	H	
4	28-Jun	WFR				2	1			6	0	L	L	
	Sat	EFR				2	1				0	L	H	
5	29-Jun	WFR				5	1			12	0	L	L	
	Sun	EFR				5	1				1	L	H	
6	30-Jun	WFR	0.81	2.15		10	2	0	0	24	8	H	M	
	Mon	EFR	2.15	1.85		10	2	0	0		6	H	H	
7	1-Jul	WFR	0.85	2.1		20	2	1	0	46	8	H	M	
	Tue	EFR	2.1	1.63		20	2	1	0		6	H	H	
8	2-Jul	WFR	0.87	2.05		20	2	1	0	46	8	H	H	
	Wed	EFR	2.18	1.5		20	2	1	0		6	H	H	
9	3-Jul	WFR	0.89	2.33		20	2	1	0	46	8	H	H	
	Thu	EFR	2.39	1.58		20	2	1	0		6	H	H	
10	4-Jul	WFR	0.92	2.63		20	2	1	0	46	8	H	H	
	Fri	EFR	2.5	1.68		20	2	1	0		6	H	H	

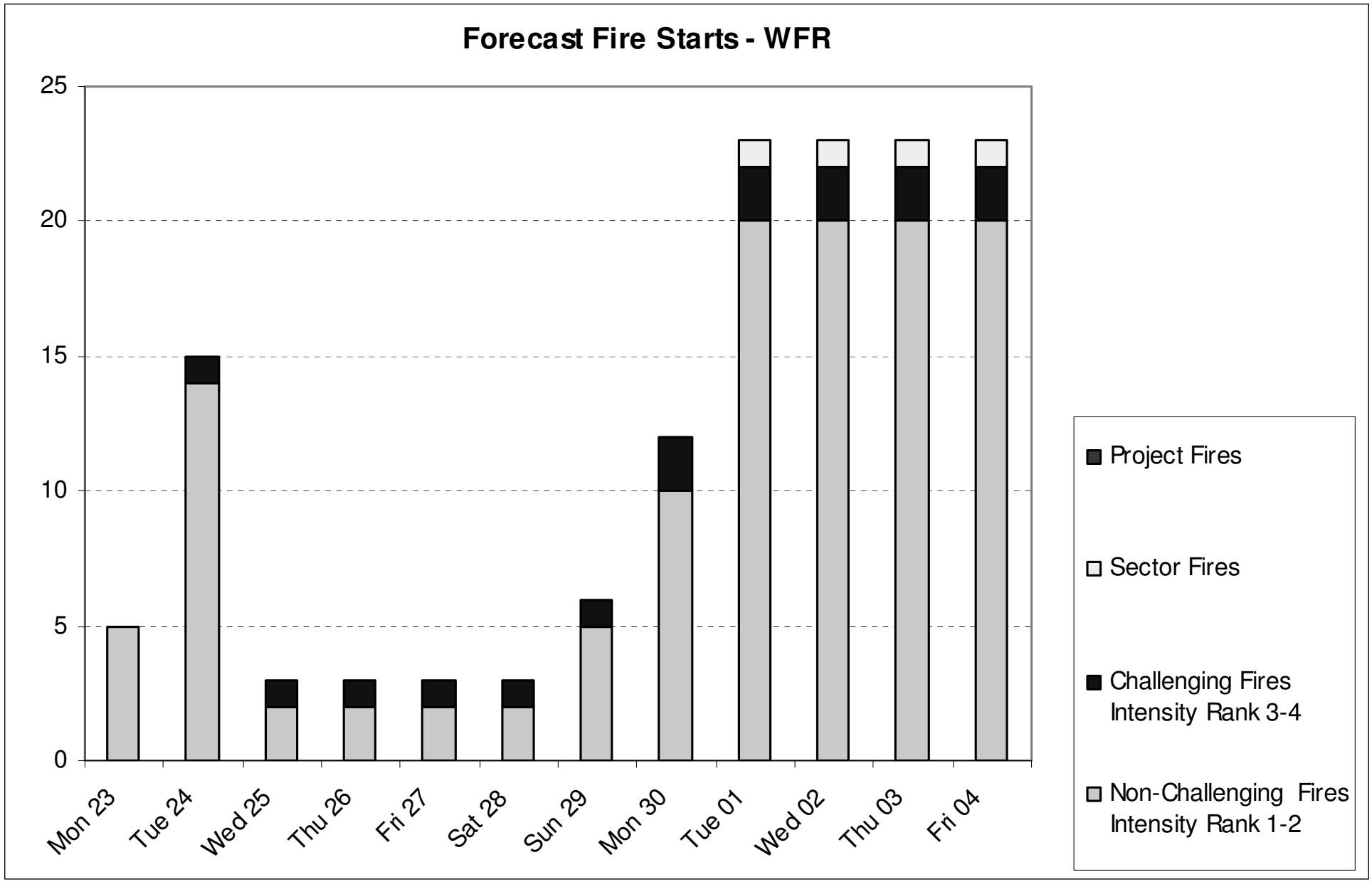
FIO: Janser

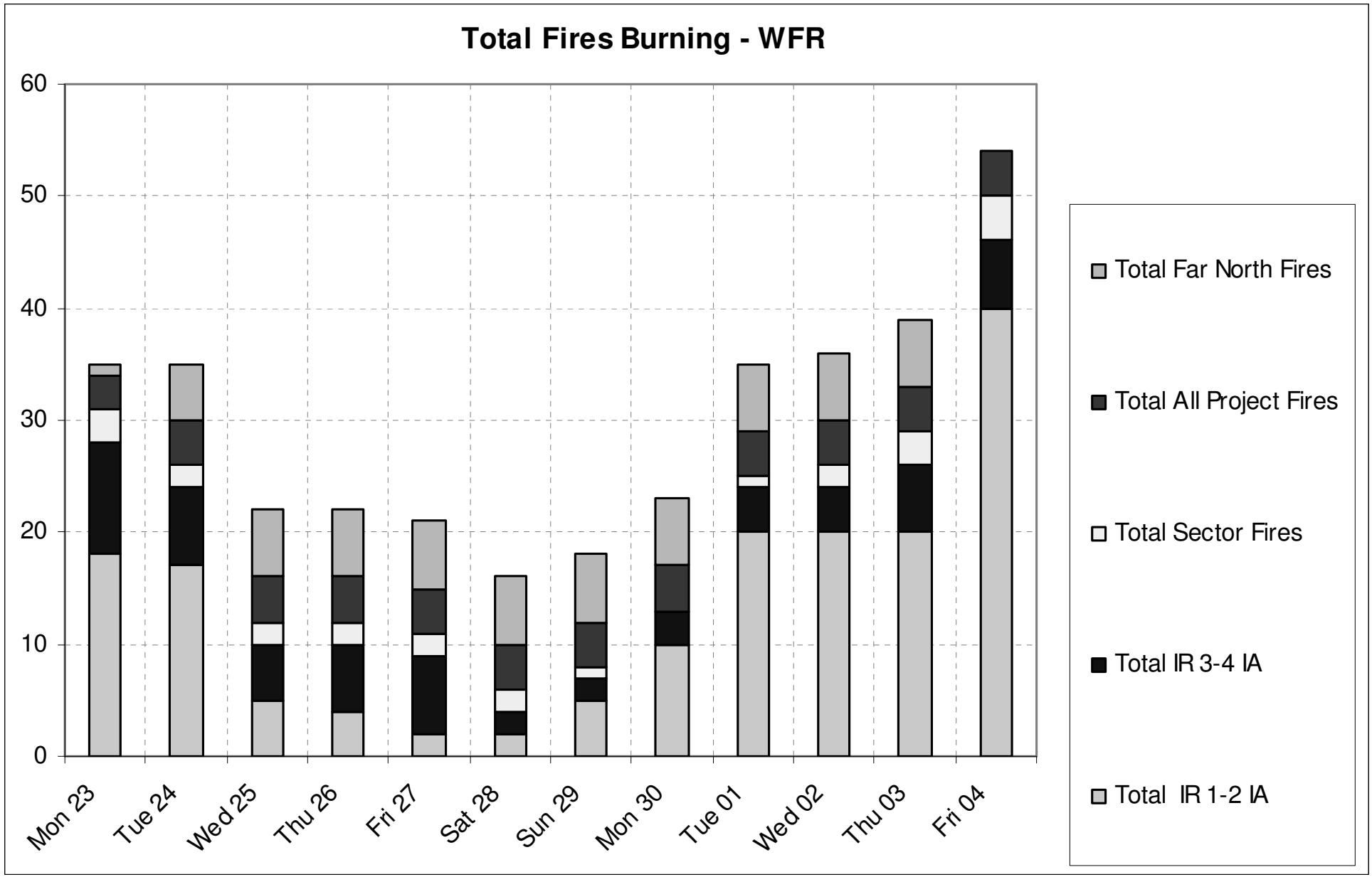
Date: **Wednesday, June 25**

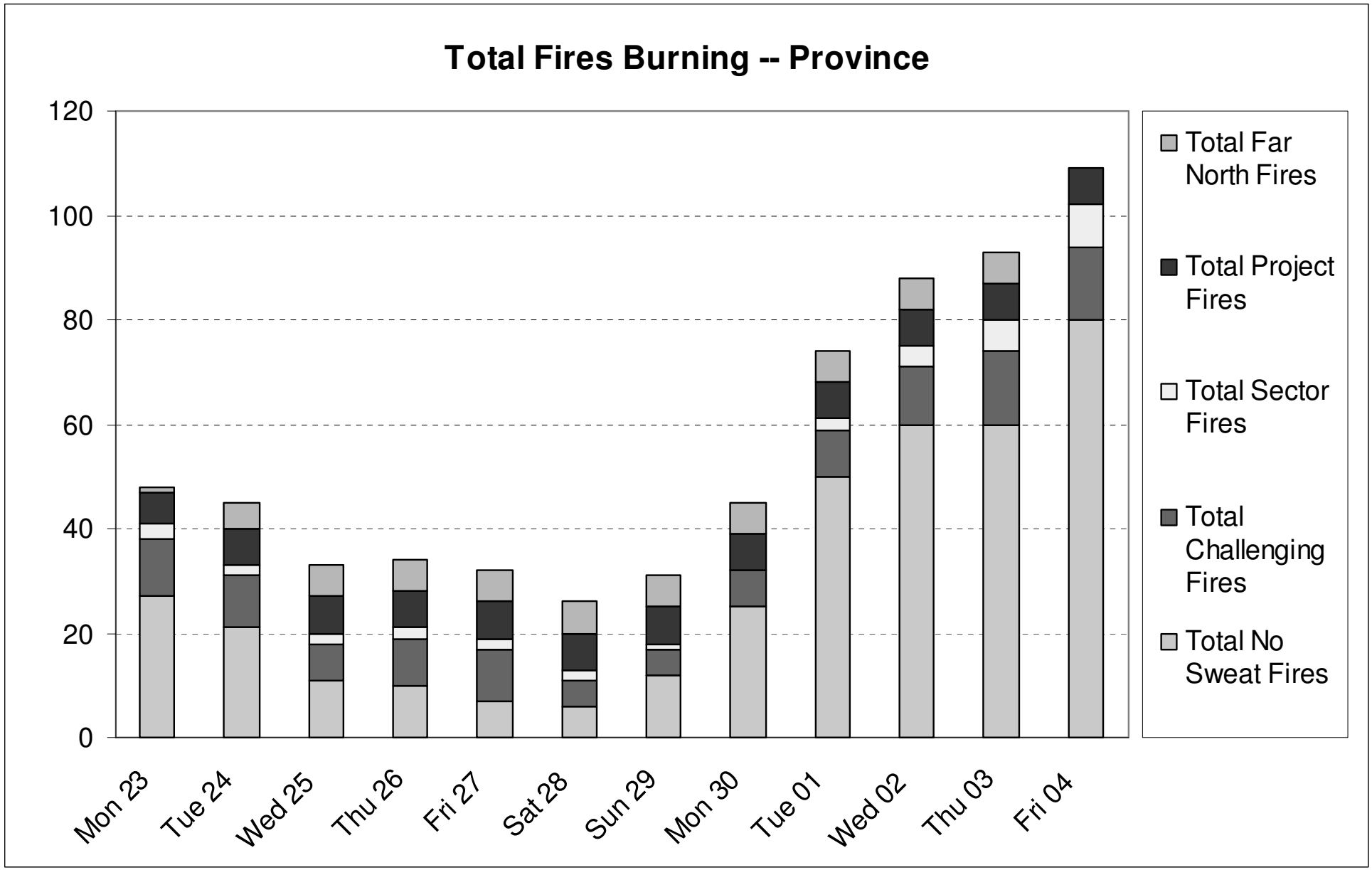
Day		Spread Potential (ISI)		Fuel Available (BUI)		No. Sectors High/Ext FWI		Total Number of Fires	
		WFR	EFR	WFR	EFR	WFR (8)	EFR (6)	WFR	EFR
0	24-Jun Tue	L	M	M	H	4	4	15	4
1	25-Jun Wed	L	M	M	H	1	4	3	4
2	26-Jun Thu	L	M	M	H	0	2	3	4
3	27-Jun Fri	L	L	L	H	0	1	3	3
4	28-Jun Sat	L	L	L	H	0	0	3	3
5	29-Jun Sun	L	L	L	H	0	1	6	6
6	30-Jun Mon	H	H	M	H	8	6	12	12
7	1-Jul Tue	H	H	M	H	8	6	23	23
8	2-Jul Wed	H	H	H	H	8	6	23	23
9	3-Jul Thu	H	H	H	H	8	6	23	23
10	4-Jul Fri	H	H	H	H	8	6	23	23

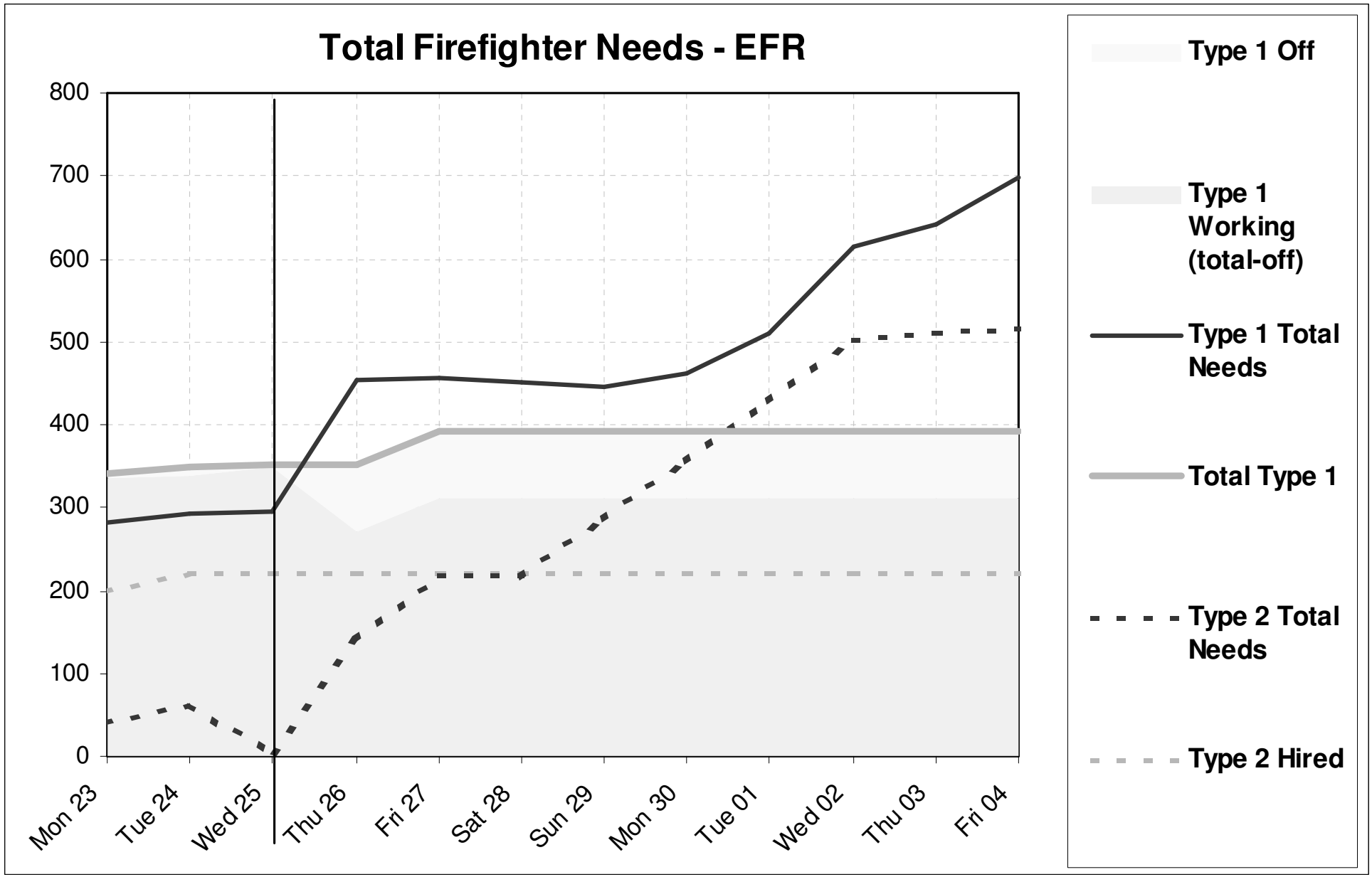

Forecast Fire Starts - EFR
25
20
15
10
5
0
Mon 23
Tue 24
Wed 25
Thu 26
Fri 27
Sat 28
Sun 29
Mon 30
Tue 01
Wed 02
Thu 03
Fri 04
Project Fires
Sector Fires
Challenging Fire Intensity Rank 3-4
Non-Challenging Fires Intensity Rank 1-2

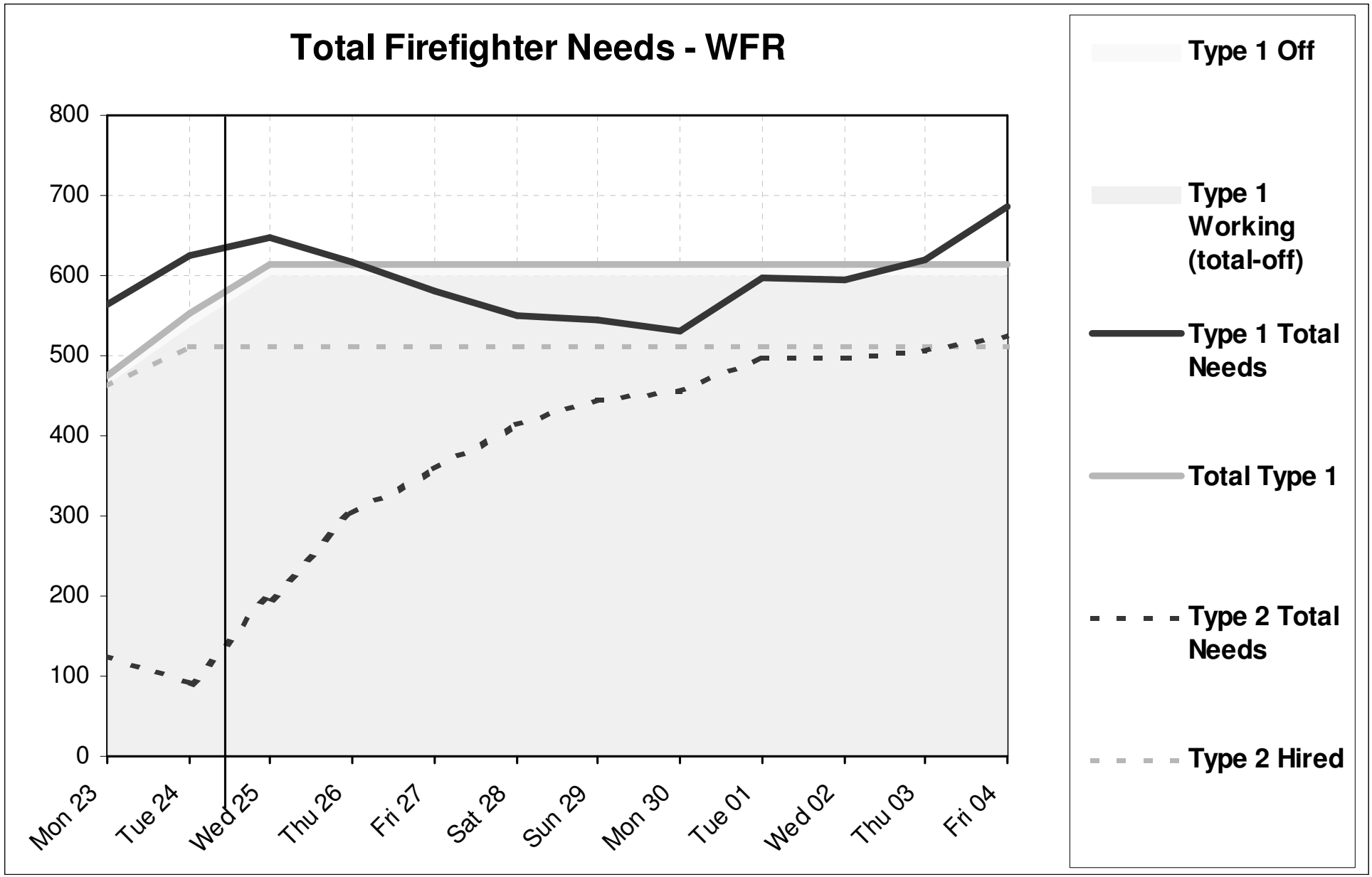

Total Fires Burning - EFR
60
50
40
30
20
10
0
Mon 23
Tue 24
Wed 25
Thu 26
Fri 27
Sat 28
Sun 29
Mon 30
Tue 01
Wed 02
Thu 03
Fri 04
Total Far North Fires
Total All Project Fires
Total Sector Fires
Total 3-4 Day IA
Total 1-2 Day IA

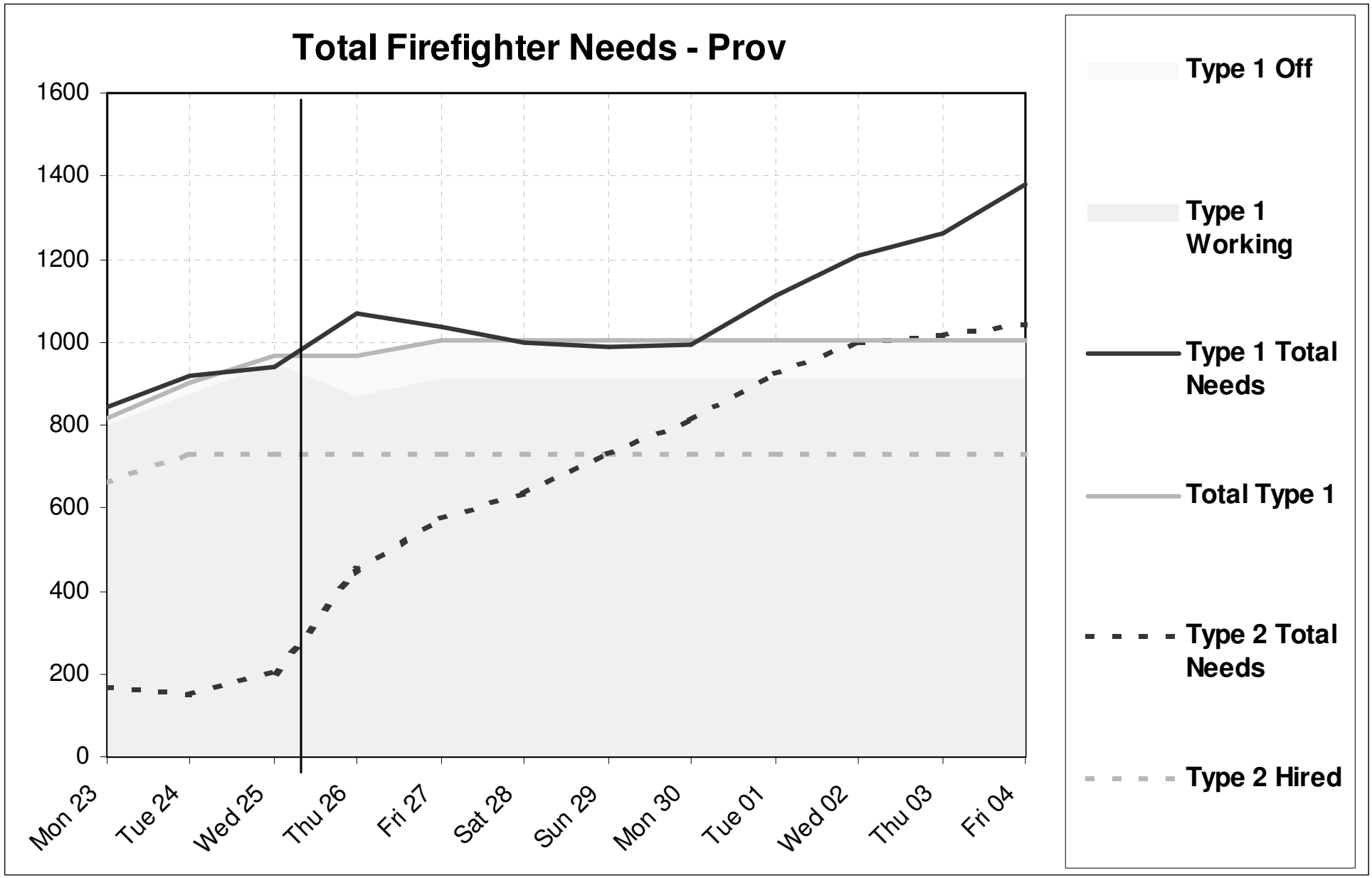

Forecast Fire Starts - WFR
25
20
15
10
5
0
Mon 23
Tue 24
Wed 25
Thu 26
Fri 27
Sat 28
Sun 29
Mon 30
Tue 01
Wed 02
Thu 03
Fri 04
Project Fires
Sector Fires
Challenging Fires Intensity Rank 3-4
Non-Challenging Fires Intensity Rank 1-2

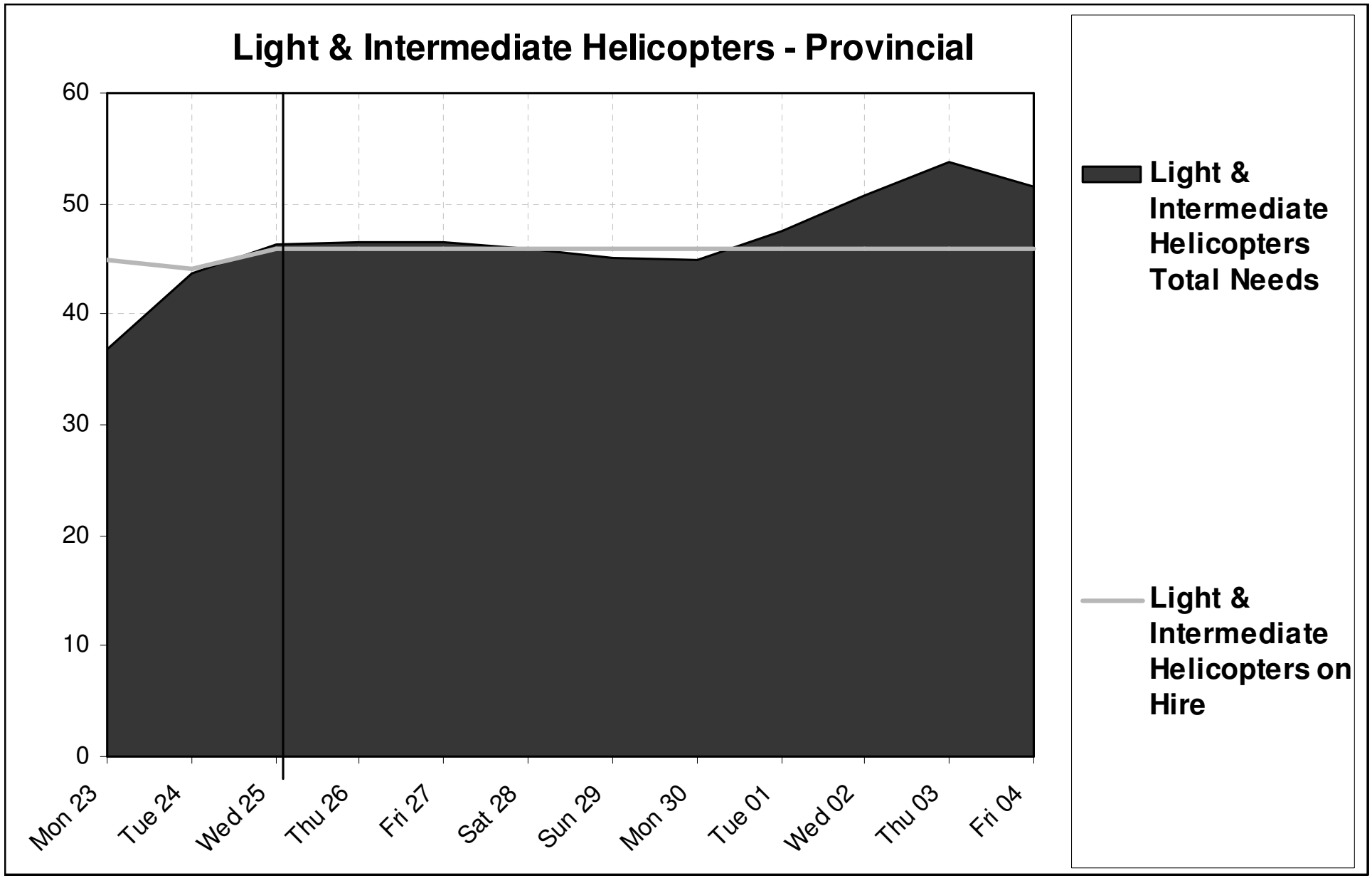

Total Fires Burning - WFR
60
50
40
30
20
10
0
Mon 23
Tue 24
Wed 25
Thu 26
Fri 27
Sat 28
Sun 29
Mon 30
Tue 01
Wed 02
Thu 03
Fri 04
Total Far North Fires
Total All Project Fires
Total Sector Fires
Total IR 3-4 IA
Total IR 1-2 IA

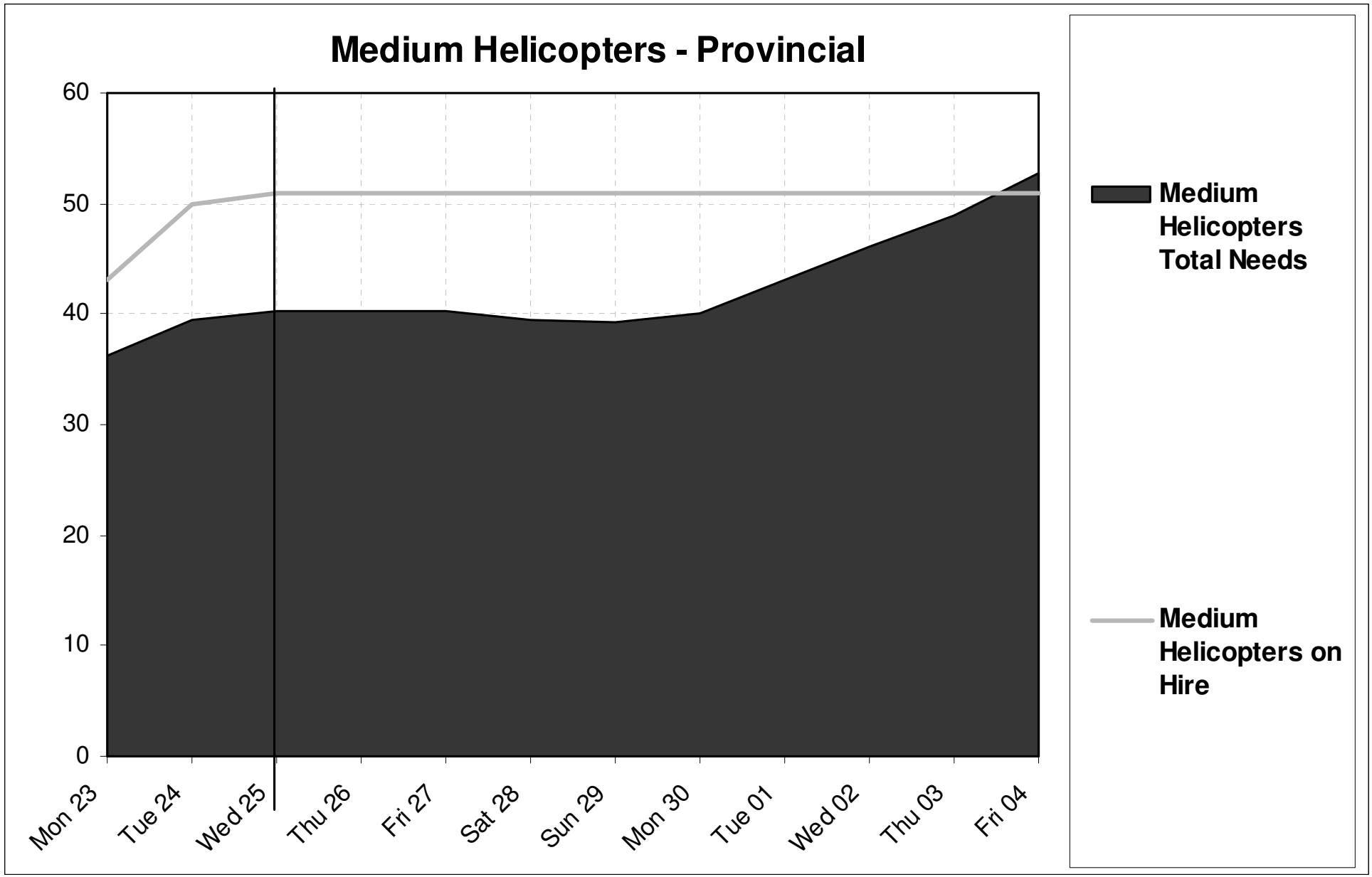

Total Fires Burning -- Province
120
100
80
60
40
20
0
Mon 23
Tue 24
Wed 25
Thu 26
Fri 27
Sat 28
Sun 29
Mon 30
Tue 01
Wed 02
Thu 03
Fri 04
Total Far North Fires
Total Project Fires
Total Sector Fires
Total Challenging Fires
Total No Sweat Fires

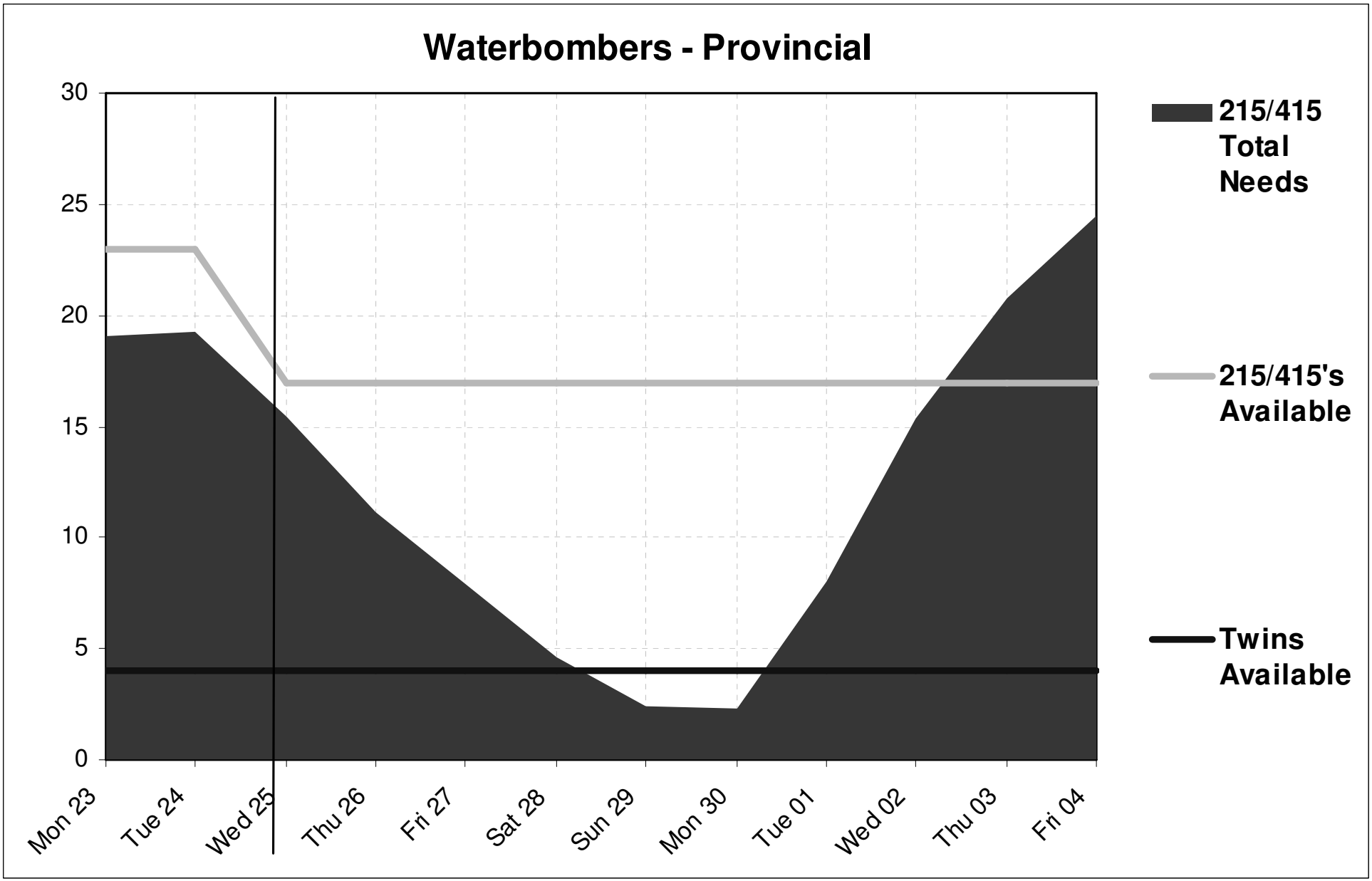

Total Firefighter Needs - EFR
800
700
600
500
400
300
200
100
0
Mon 23
Tue 24
Wed 25
Thu 26
Fri 27
Sat 28
Sun 29
Mon 30
Tue 01
Wed 02
Thu 03
Fri 04
Type 1 Off
Type 1 Working (total-off)
Type 1 Total Needs
Total Type 1
Type 2 Total Needs
Type 2 Hired

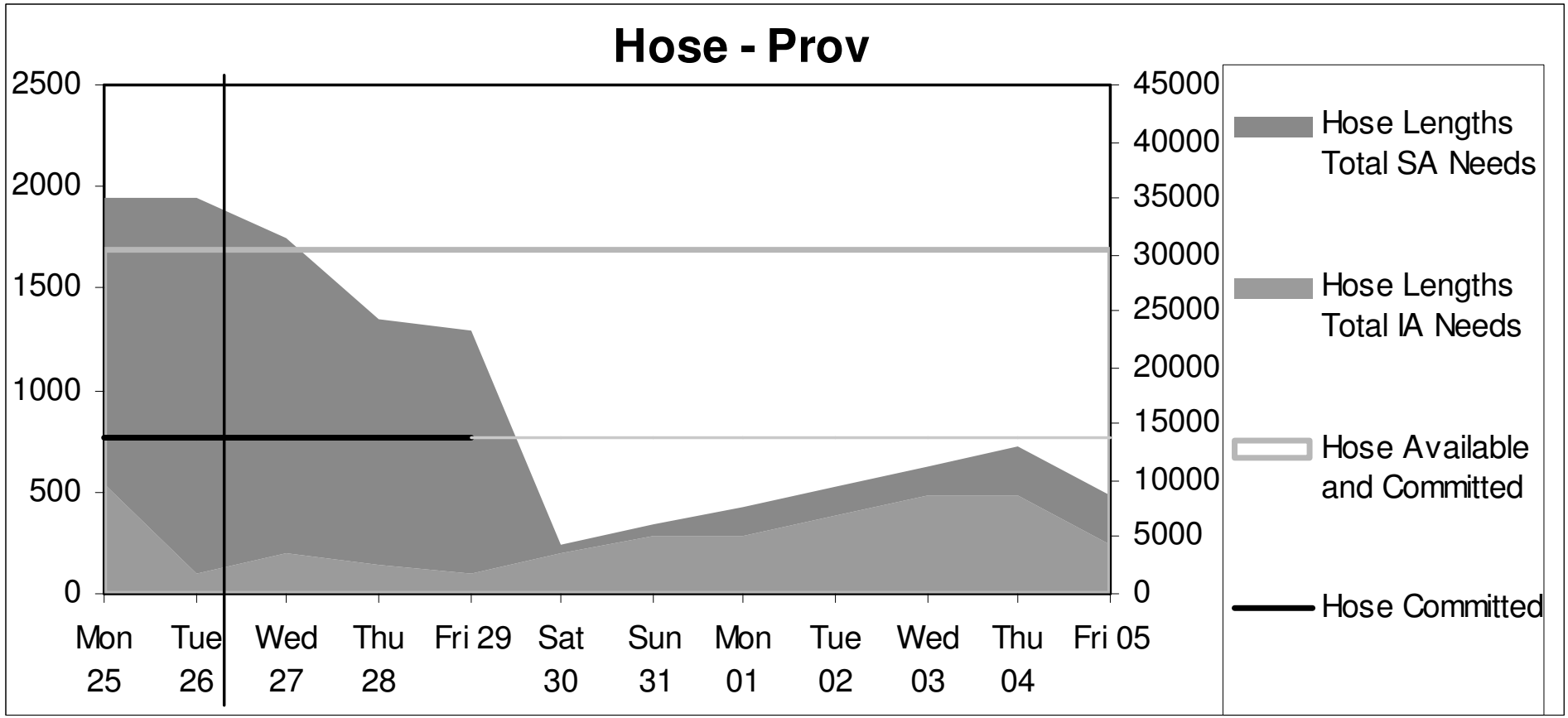

Total Firefighter Needs - WFR
800
700
600
500
400
300
200
100
0
Mon 23
Tue 24
Wed 25
Thu 26
Fri 27
Sat 28
Sun 29
Mon 30
Tue 01
Wed 02
Thu 03
Fri 04
Type 1 Off
Type 1 Working (total-off)
Type 1 Total Needs
Total Type 1
Type 2 Total Needs
Type 2 Hired


Total Firefighter Needs - Prov
1600
1400
1200
1000
800
600
400
200
0
Mon 23
Tue 24
Wed 25
Thu 26
Fri 27
Sat 28
Sun 29
Mon 30
Tue 01
Wed 02
Thu 03
Fri 04
Type 1 Off
Type 1 Working
Type 1 Total Needs
Total Type 1
Type 2 Total Needs
Type 2 Hired


Light & Intermediate Helicopters - Provincial
60
50
40
30
20
10
0
Mon 23
Tue 24
Wed 25
Thu 26
Fri 27
Sat 28
Sun 29
Mon 30
Tue 01
Wed 02
Thu 03
Fri 04
Light & Intermediate Helicopters Total Needs
Light & Intermediate Helicopters on Hire

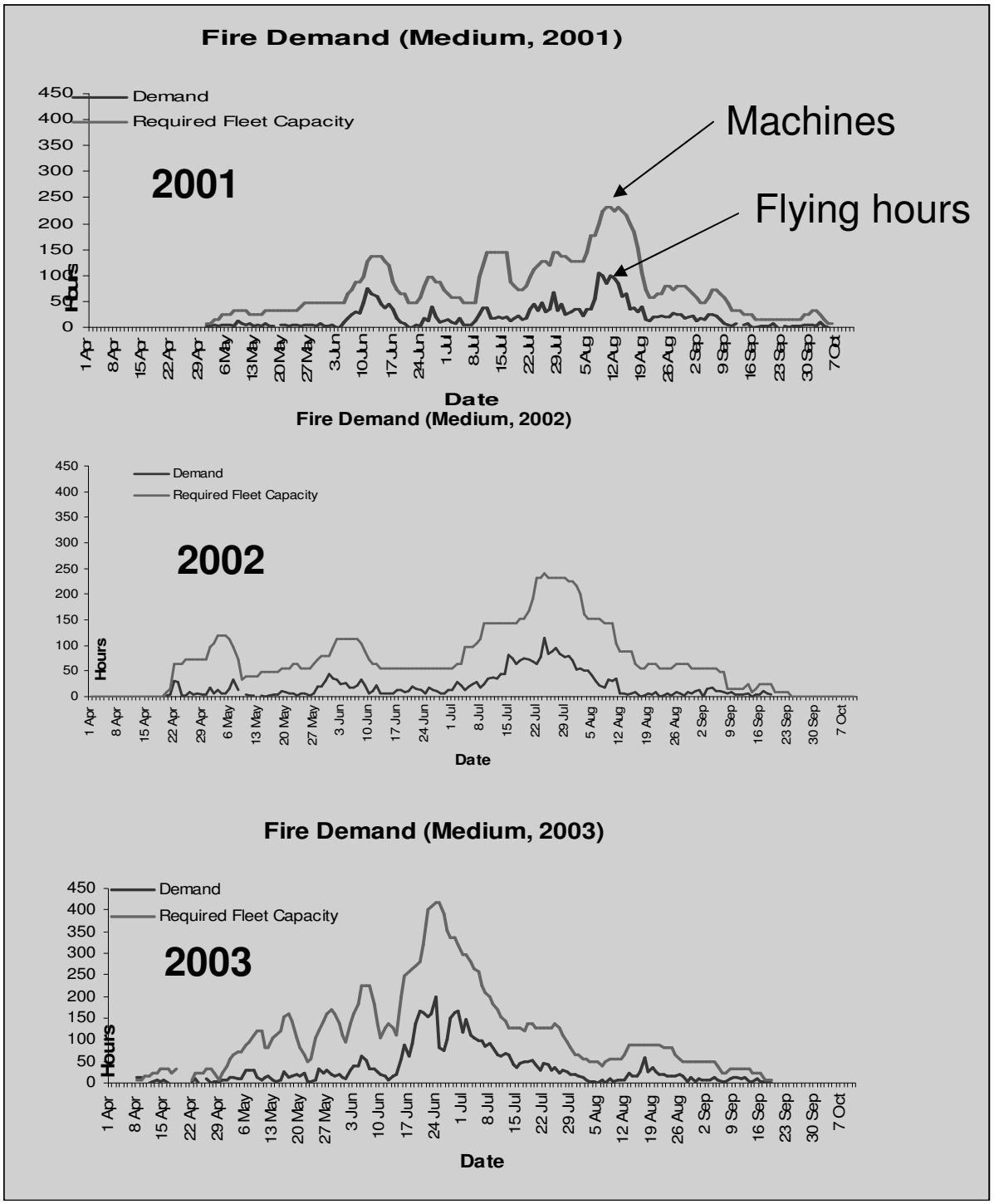

Medium Helicopters - Provincial
60
50
40
30
20
10
0
Mon 23
Tue 24
Wed 25
Thu 26
Fri 27
Sat 28
Sun 29
Mon 30
Tue 01
Wed 02
Thu 03
Fri 04
Medium Helicopters Total Needs
Medium Helicopters on Hire


Waterbombers - Provincial
30
25
20
15
10
5
0
Mon 23
Tue 24
Wed 25
Thu 26
Fri 27
Sat 28
Sun 29
Mon 30
Tue 01
Wed 02
Thu 03
Fri 04
215/415 Total Needs
215/415's Available
Twins Available


Hose - Prov
2500
2000
1500
1000
500
0
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Mon 25
Tue 26
Wed 27
Thu 28
Fri 29
Sat 30
Sun 31
Mon 01
Tue 02
Wed 03
Thu 04
Fri 05
Hose Lengths Total SA Needs
Hose Lengths Total IA Needs
Hose Available and Committed
Hose Committed

Helicopter Contract Optimization

- Economic decision problem: hiring helicopters efficiently
  - How many? Starting when? Contract type?
- Two main contract types:
  - Expensive Short Term (3 to 10 days; $2000/h)
  - Less expensive Long Term (80 days; $700/h)
- What is the optimal mix?

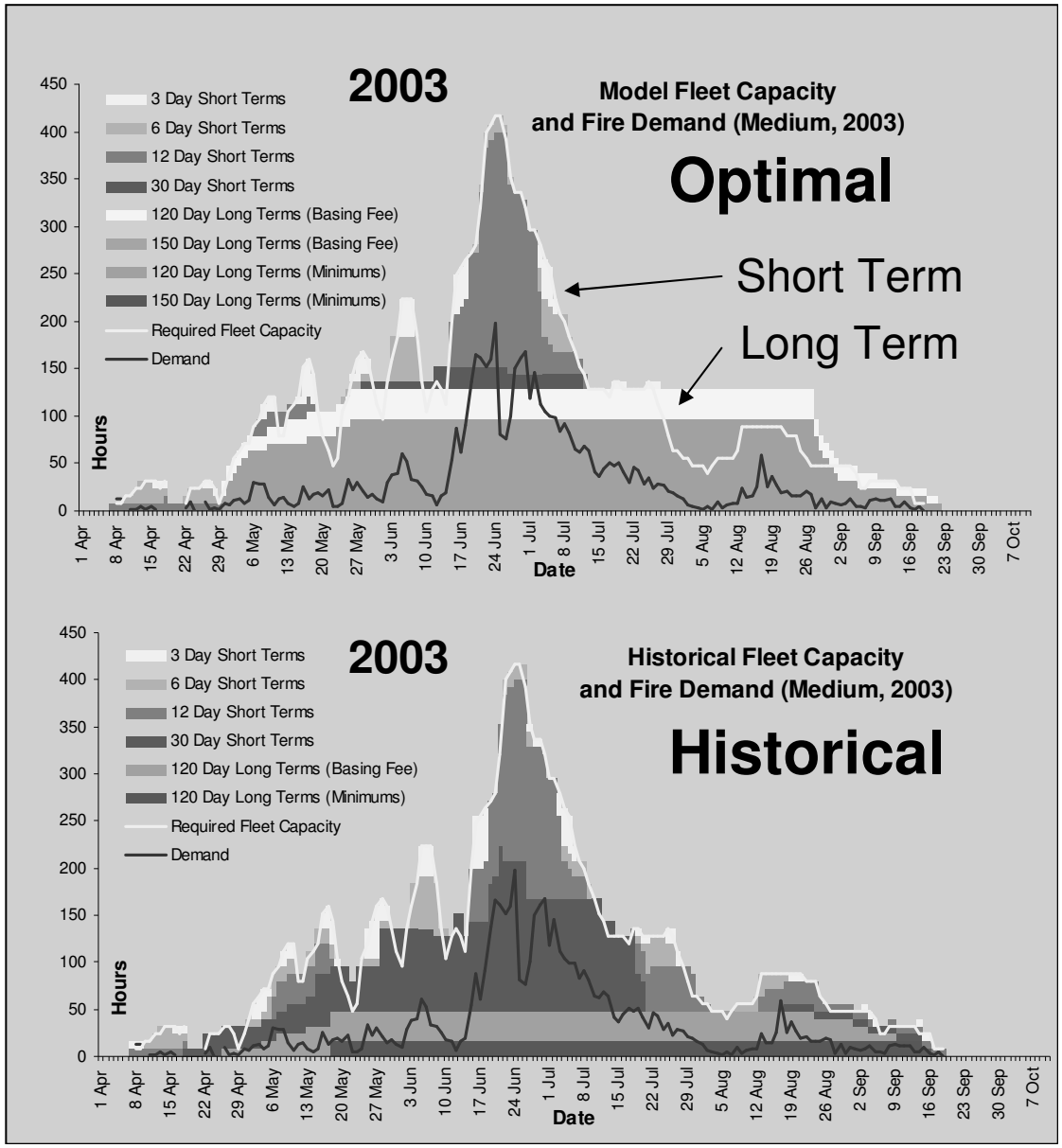


Problems:

- Demand is highly variable over space and time
- Contracts are complex (averaging, extensions, …)

Solution Approach

- Linear programming optimization model
- Savings >$1 million/y
- Further work:
  - More years' data
  - Helicopter size substitution



Business Management

The Business of Forest Fire Management

- $100M+ total annual budget
- Budget split
  - Infrastructure ($17M)
  - Preparedness ($36M)
  - Suppression (variable)

Business Management Performance Measures

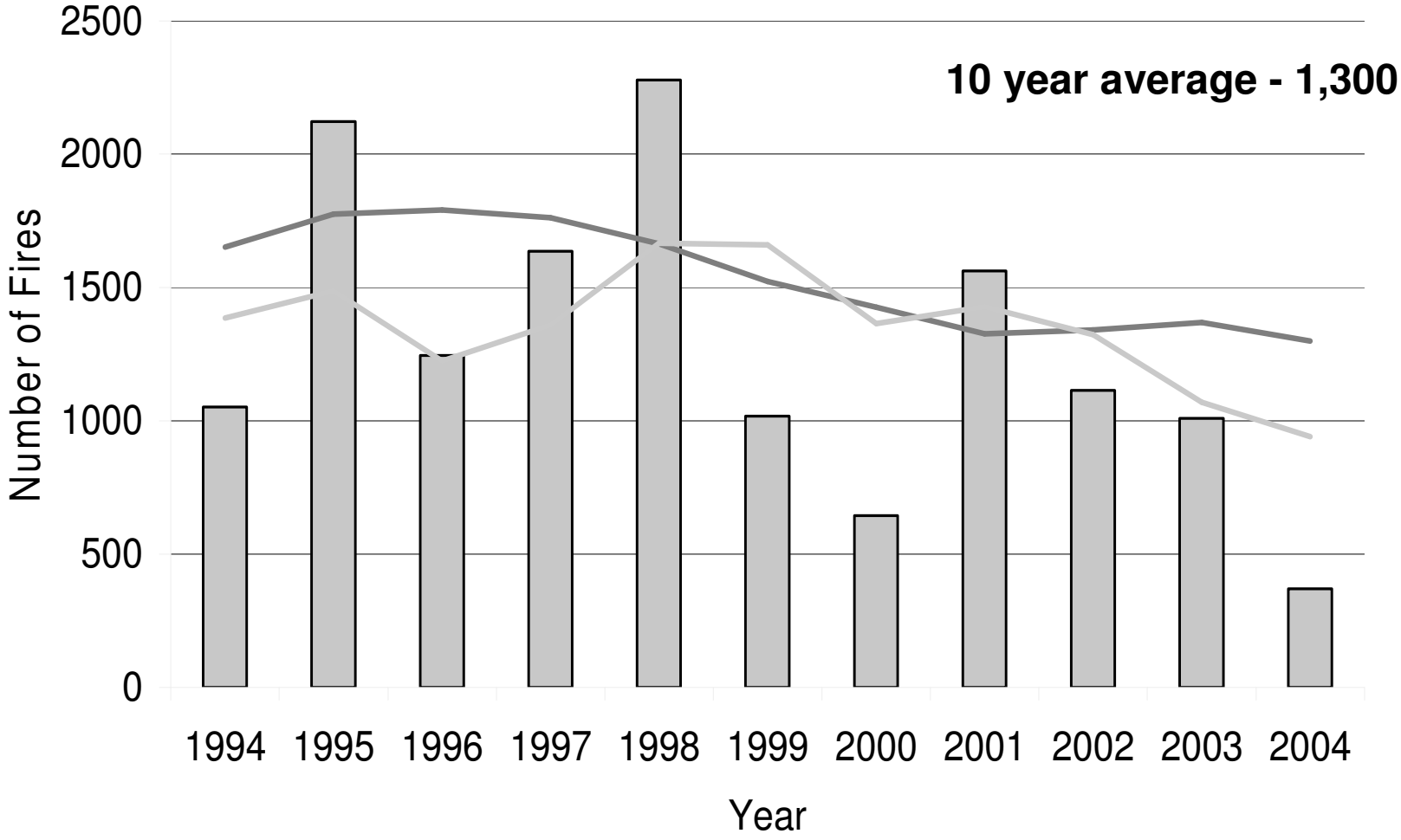
- How do we ensure and demonstrate “value” for money spent?
- How do we measure efficiency?

- In times of fiscal restraint, programs are subject to increased scrutiny

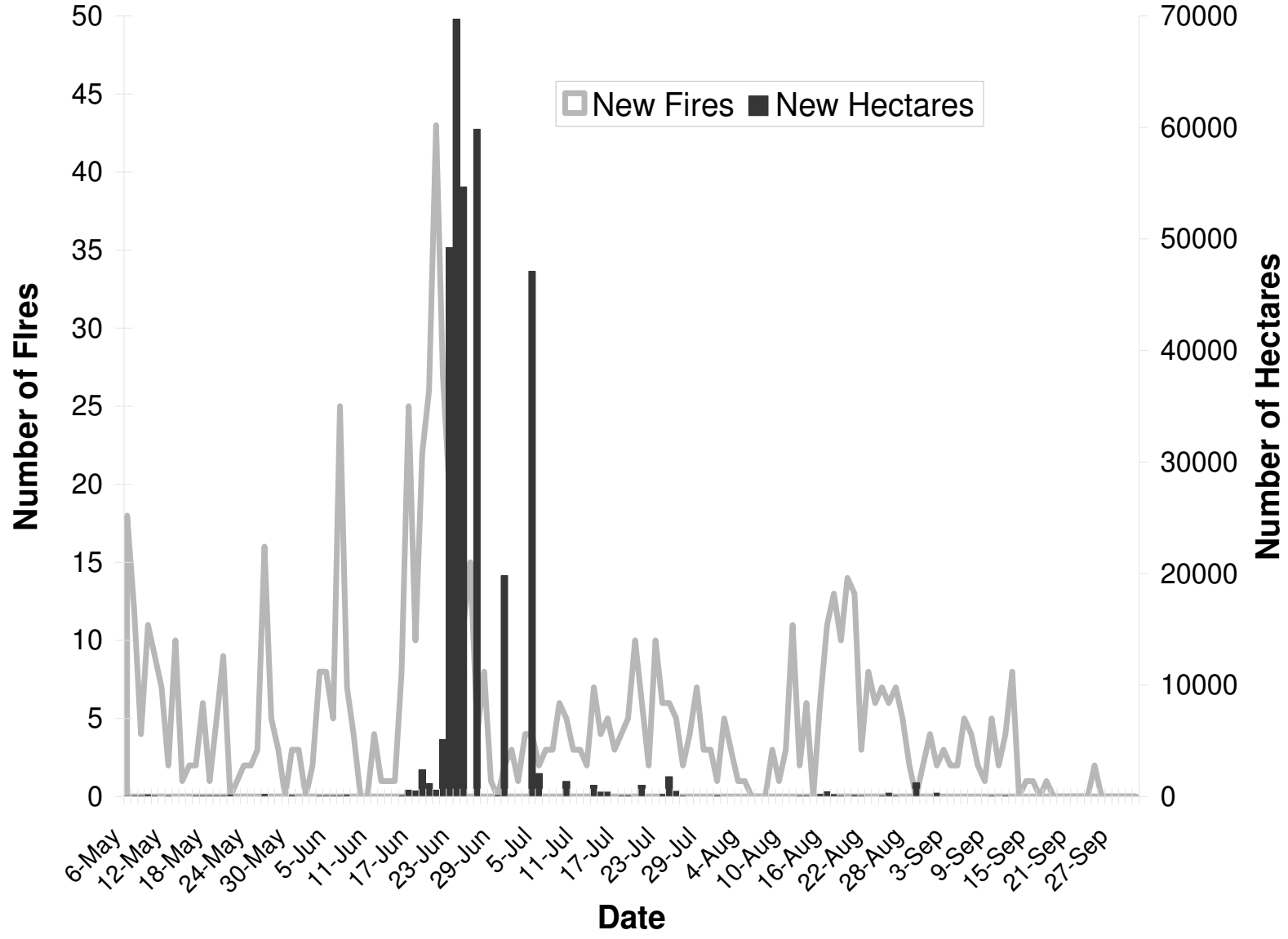
Performance Measures

- Program Level
  - Initial Attack Success
  - 10 yr avg. area burned
- Within Program
  - Prevention effectiveness/efficiency
  - Detection effectiveness/efficiency
  - Suppression effectiveness/efficiency
    - Transport
    - Ground crews
    - Air tankers

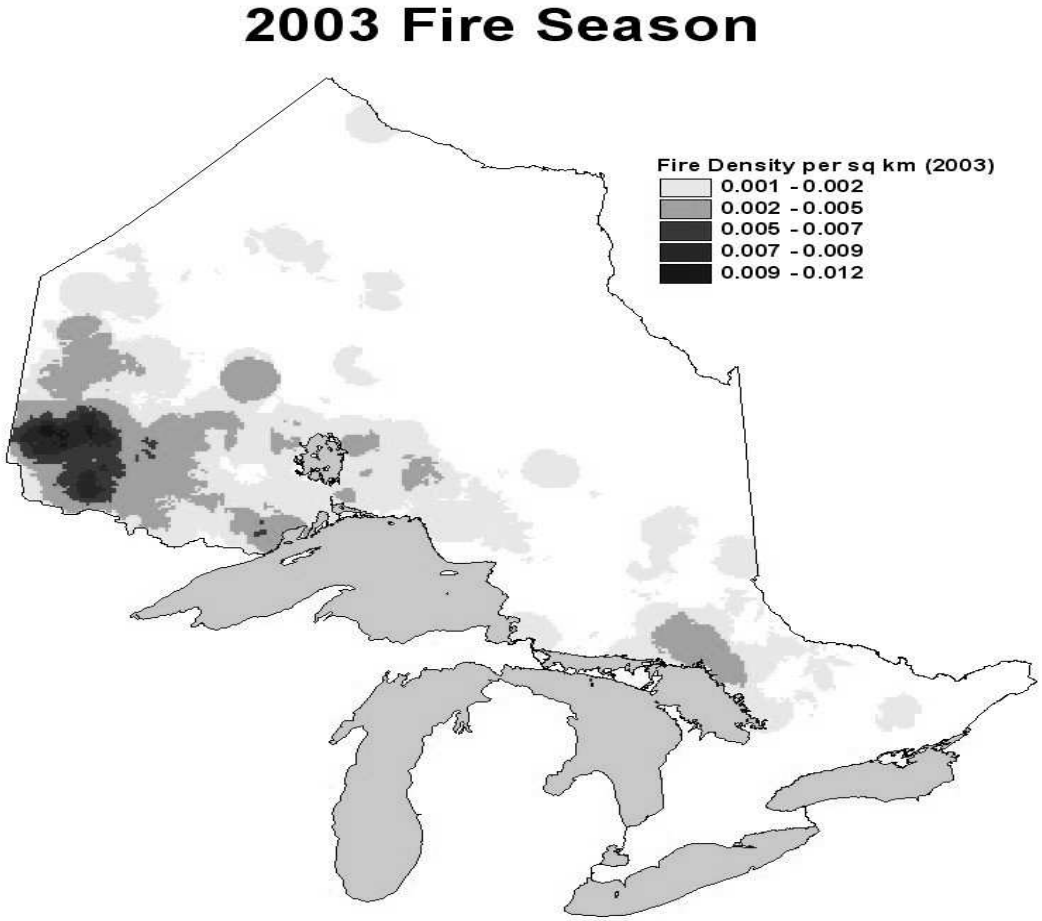
Annual Number of Fires



Fires 2003


New Fires
New Hectares
Number of Fires
Number of Hectares
Date
0
5
10
15
20
25
30
35
40
45
50
0
10000
20000
30000
40000
50000
60000
70000
6-May
12-May
18-May
24-May
30-May
5-Jun
11-Jun
17-Jun
23-Jun
29-Jun
5-Jul
11-Jul
17-Jul
23-Jul
29-Jul
4-Aug
10-Aug
16-Aug
22-Aug
28-Aug
3-Sep
9-Sep
15-Sep
21-Sep
27-Sep

Spatial Variability



Variability influenced by confluence of:

1. Weather
2. Fuel type and condition
3. Ignition source
4. Congestion – (area burned)

Performance Measures

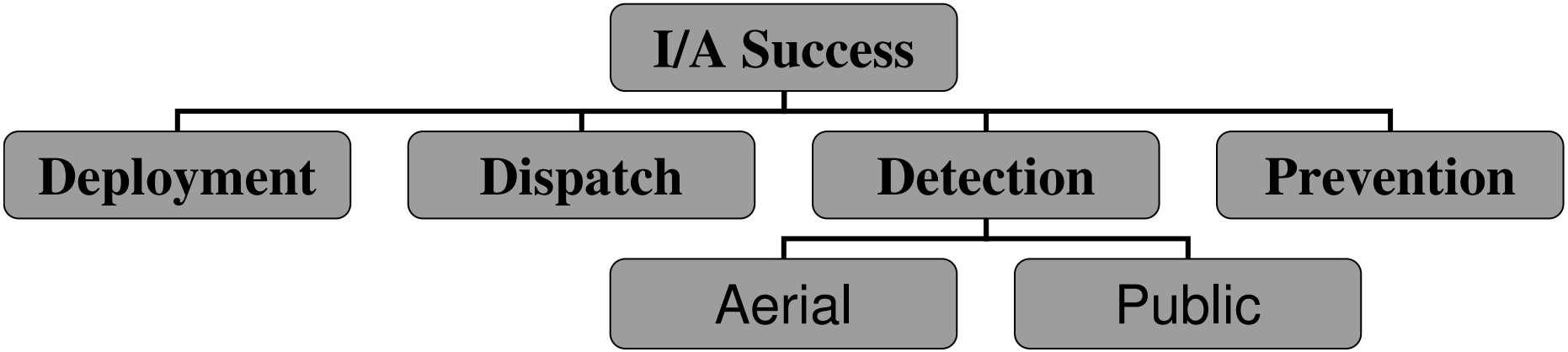
- High level – good overall
  - (most of the time)
  - Lacks detail to target problem areas
  - Always explanations…..

Performance Measures

- “Within” program measures – do not exist
- Difficult to design
- Eg Prevention:
  - How do you measure prevention effectiveness?
    - Fires that did not happen?
    - Behavioural patterns changed?

Performance Measures

- In a perfect world:



Summary

- Fire Management in Ontario
  - Overview
- Information Systems
  - – Flavour of the data sources
- Models and Decision Making
  - Picture of some of our tools
- Business Management
  - Challenges

Ontario

MINISTRY OF NATURAL RESOURCES

Ontario

AFFM