Assessing current fire protection capability of two different air base locations

It is well known that fixed wing and helicopter based aircraft are integral and often used components of the fire suppression system in Southern California and in Riverside County. For Riverside County, the best summary of the effectiveness of the overall fire suppression system is the "Riverside Unit Fire Management Plan 2005" (Anthony 2005). This is posted on the CDF web site at http://www.fire.ca.gov/FireEmergencyResponse/FirePlan/units_countyfireplan.asp and is also available at any CDF unit on the CDF's intranet at http://cdfweb/Its/FirePAS/UnitFireMgtPlans/RRU.pdf . In addition to describing the overall approach of the Fire Plan, the document provides detailed information on the specific assets at risk for each battalion within the County as well as a detailed Ignition Workload Assessment that summarizes where wildland fires start in the county, the type of ignition, and the whether the fire is contained within initial attack. The 2005 Fire Plan notes that Riverside Unit achieves very good initial attack success, for grass fuel types – 96%, brush fuel types – 91%, woodland – 94% and conifer forests – 95%. These high success rates are due in large part to the quick arrival of a range of fire suppression resources in initial attack – fire engines, hand crews, bulldozers, fixed wing aircraft, and helicopters.

Using the California Fire Economics Simulator to assess different location of fire suppression resources

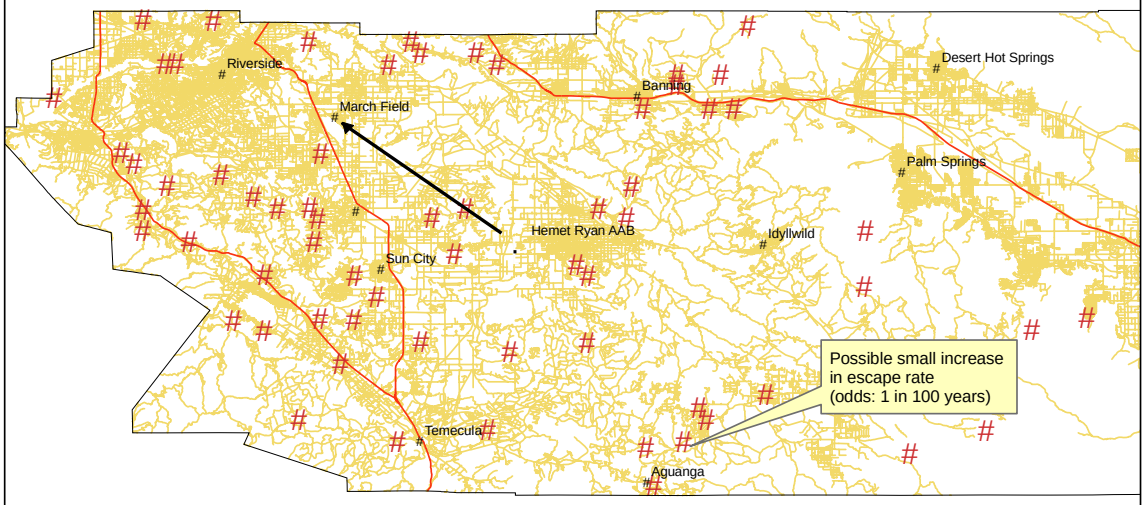
The increase, decrease or relocation of any fire suppression resource will change the timing and scale of suppression resources arriving at a fire. To assess the potential impact of moving or building a fire engine station, adding additional resources to existing stations, or locating or relocating, CDF worked with the University of California to develop a tool to accurately predict any potential changes in initial attack success due to changing the number and location of fire suppression resources. The details of the tool, known as the California Fire Economics Simulator (CFES2), are described in the two attached memorandum – "CFES2 – California Fire Economics Simulator" (Stewart 2002) and "CFES2 in Brief" (Spero 2002) that were prepared for briefings of legislative staff and the Department of Finance. Basically, an accurate comparison of the potential differences between the two proposed air tankers locations requires three primary components to ensure that the results match the real world conditions.

1. A database of the potential fire starts and weather conditions that replicates historic, and presumably future, conditions. This database should include best case and the worst case, and scenarios describing everything in between in the same proportions that they occur.

2. An accurate inventory of all available suppression resources (fire engines, bulldozers, hand crews, fixed wing aircraft, helicopters, etc.), the rules by which they are deployed, travel times to fire starts, and effectiveness rates once on site.
3. A simulation of how the resources match up against the full range of fire conditions (wind driven, non-wind driven, few fires in the region, multiple fires in the region, etc.) The model must be calibrated to match historic initial attack success rates to be useful for modeling any changes. As documented in the Riverside Unit Fire Management Plan (Anthony 2005), the initial attack success in Riverside rates vary from 91% to 96% for different fuel types.

CDF uses our California Fire Economics Simulator (CFES2) to estimate potential impacts in changes to any one of the three main sets of conditions described above. In conjunction with the Riverside Unit CFES Coordinator, CDF's Fire and Resource Assessment Program (FRAP) fire economist used Riverside Unit's updated CFES2 input data to model initial attack for representatives fire occurrence and fire suppression activity at 64 Representative Fire Locations throughout the Riverside Operational Unit. The location of the representative fires capture the fuels and locational diversity of Riverside County. To provide a statistically accurate outcome, the model is run 100 times with the air tankers based at Hemet-Ryan and at March. Given that there are around 700 wildland fires on SRA in Riverside County every year, this simulation compared the impact of the two different air bases over approximately 70,000 simulated fires. As noted in the following figure, if the air base was moved from Hemet-Ryan to March, the analysis predicted more fires to escape initial attack in only 1 out of 64 locations in 1 out of 100 years. Compared to 70,000 fires, this simulation suggests that the two locations are essentially equal in terms of the overall effectiveness in initial attack on wildland fires.

California Fire Economics Simulator (CFES2) Initial Attack Simulation: Moving Air Resources from Hemet/Ryan to March Field Did Not Significantly Change Initial Attack Outcomes



CFES2 Initial Attack Simulation

\# Representative Fire Locations

0 3 6 12 Miles

Key Assumptions

- All cooperating ground and air resources included in simulation.
- Simulation period: 100 years
- Fire occurrence and behavior variables held constant.
- Fireline production rate variables held constant.
- Comparison to current organization differs only in response times.

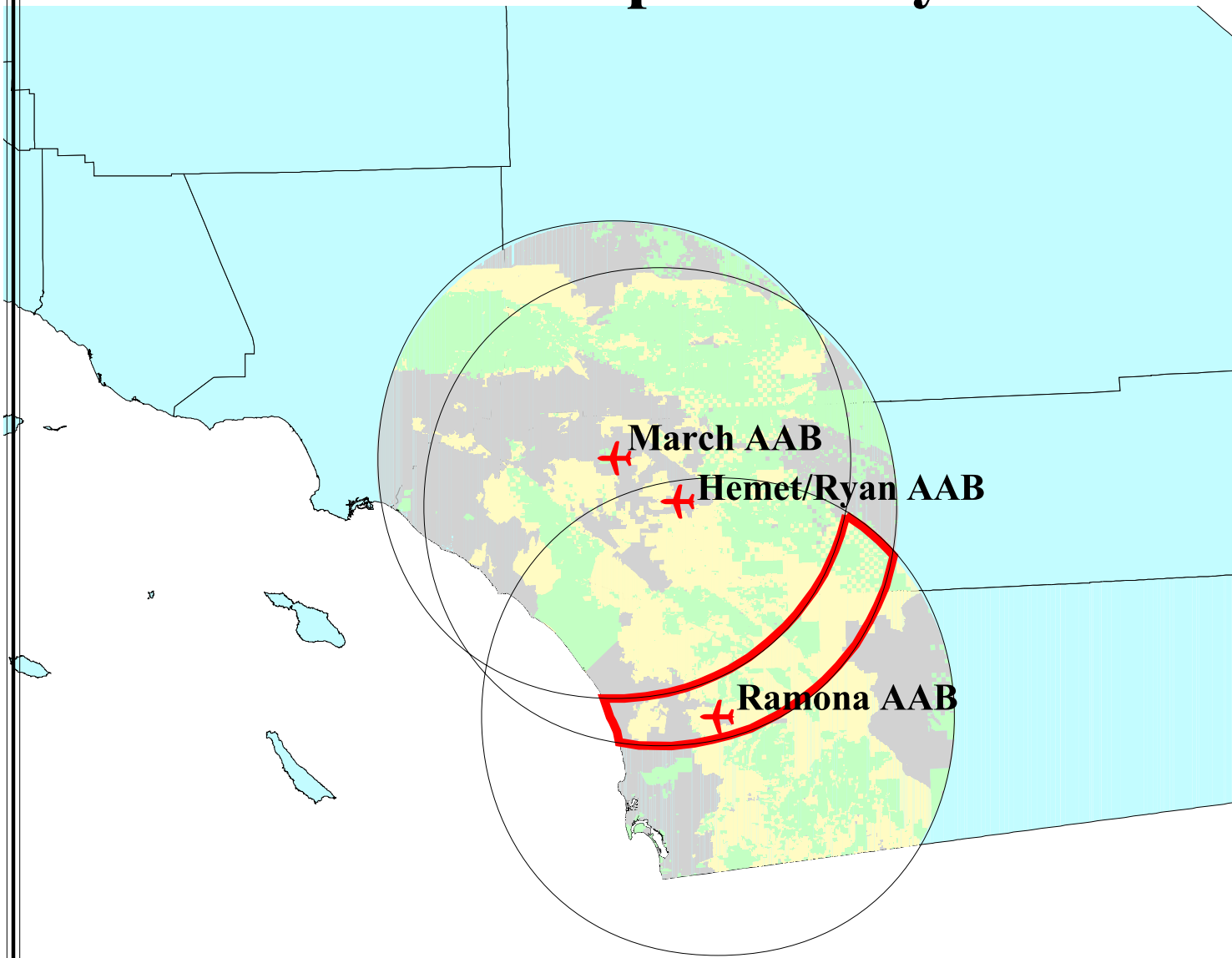
Changes in acreage within a 15 minute flight circle of the two airbases

It should not be surprising that the additional escape was in a location with a comparatively large difference in flight time to the fire. The movement of the air base northwest from Hemet-Ryan to March will logically place it closer to some acres and farther from others. To assess overall effectiveness of air suppression, it is necessary to look at the location of all air resource in Southern California as well as areas that historically have had aggressive fires that can escape initial containment. In addition to CDF's air base in Riverside County, CDF also has an airbase at Ramona in northern San Diego County. The US Forest Service also operates air bases at San Bernardino and Fox Field in Los Angeles County. The following figure labeled 'Responsibility Acres" shows the fire suppression responsibilities within the 15 minute flight circles of Ramona, Hemet-Ryan, and March air attack bases. A shift from Hemet-Ryan to March would create an 'arc' outside the 15 minute circle on the south side at the same time it would add other coverage to the northwest. The following table describes the potential changes in terms of acres within the 15 minute circle and acres within a 16-19 minute range.

Coverage within 20 minute response (5 minute takeoff, 15 minute in flight)	SRA - State Responsibility Area (acres)	LRA - Local Responsibility Area (acres)	FRA - Federal Responsibility Area (acres)
Same	1,337,723	1,518,981	1,376,315
1-4 minutes closer to March	114,023	284,274	480,915
1-4 minutes closer to Hemet Ryan	376,866	231,522	236,137
Net Difference at March	-262,843	52,752	244,778
Percent Difference	-14%	3%	12%

A shift to March would primarily impact acreage in northern San Diego County that is within 10 minutes of flight time from Ramona Air Attack Base. In addition a review of the potential of large fires in this part of San Diego is not that high compared to other areas within Southern California

Responsibility Acres



March AAB

SRA 1,449,646
FRA 1,800,512
LRA 1,857,616

Hemet AAB

SRA 1,747,331
FRA 1,718,108
LRA 1,613,629

Ramona AAB

SRA 1,678,766
FRA 1,195,695
LRA 969,959

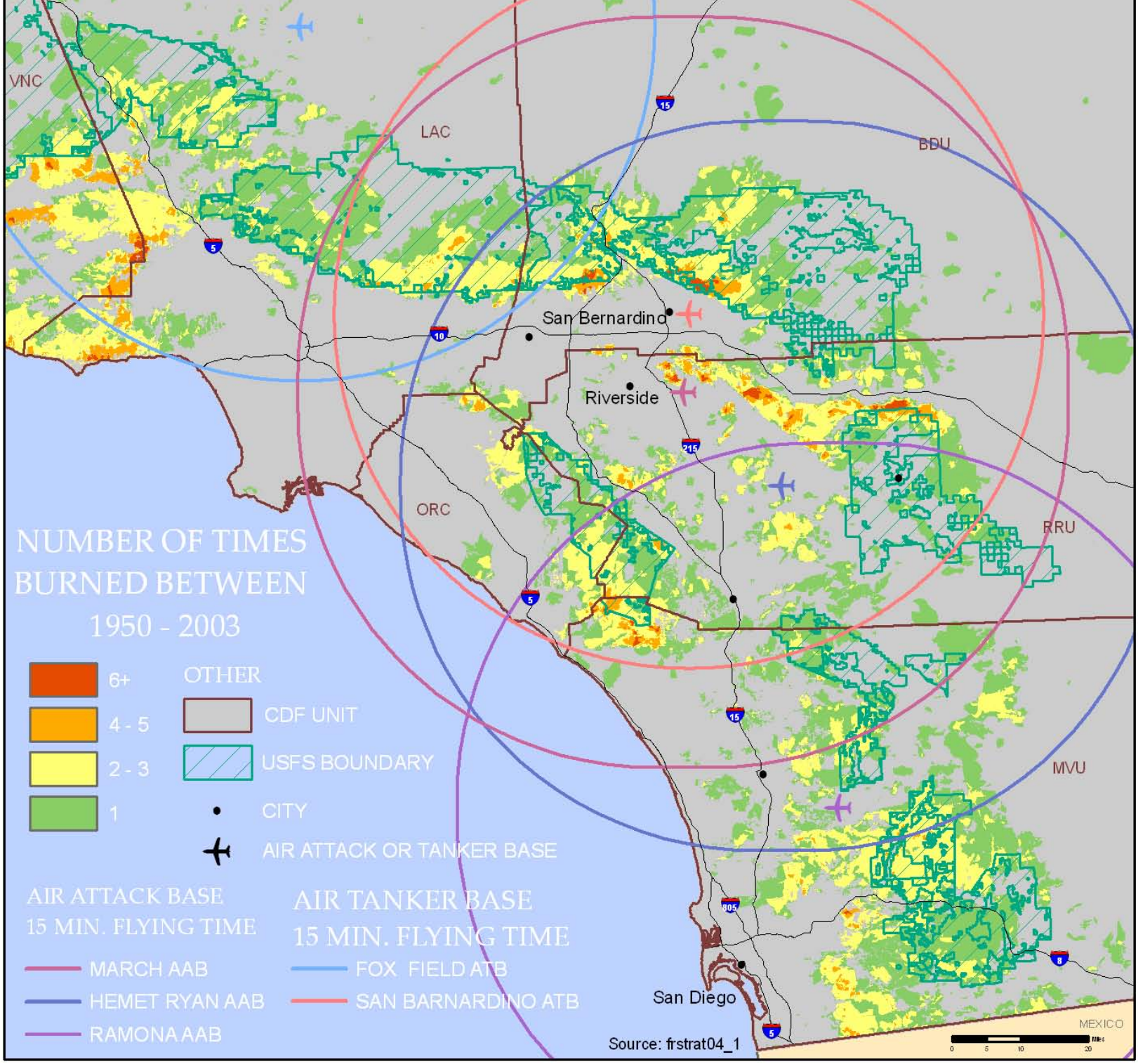
Highlighted Area

SRA 370,033
FRA 143,531
LRA 115,278

NOTE:
Circles are 52 miles in diameter approximately 15 minutes of flight

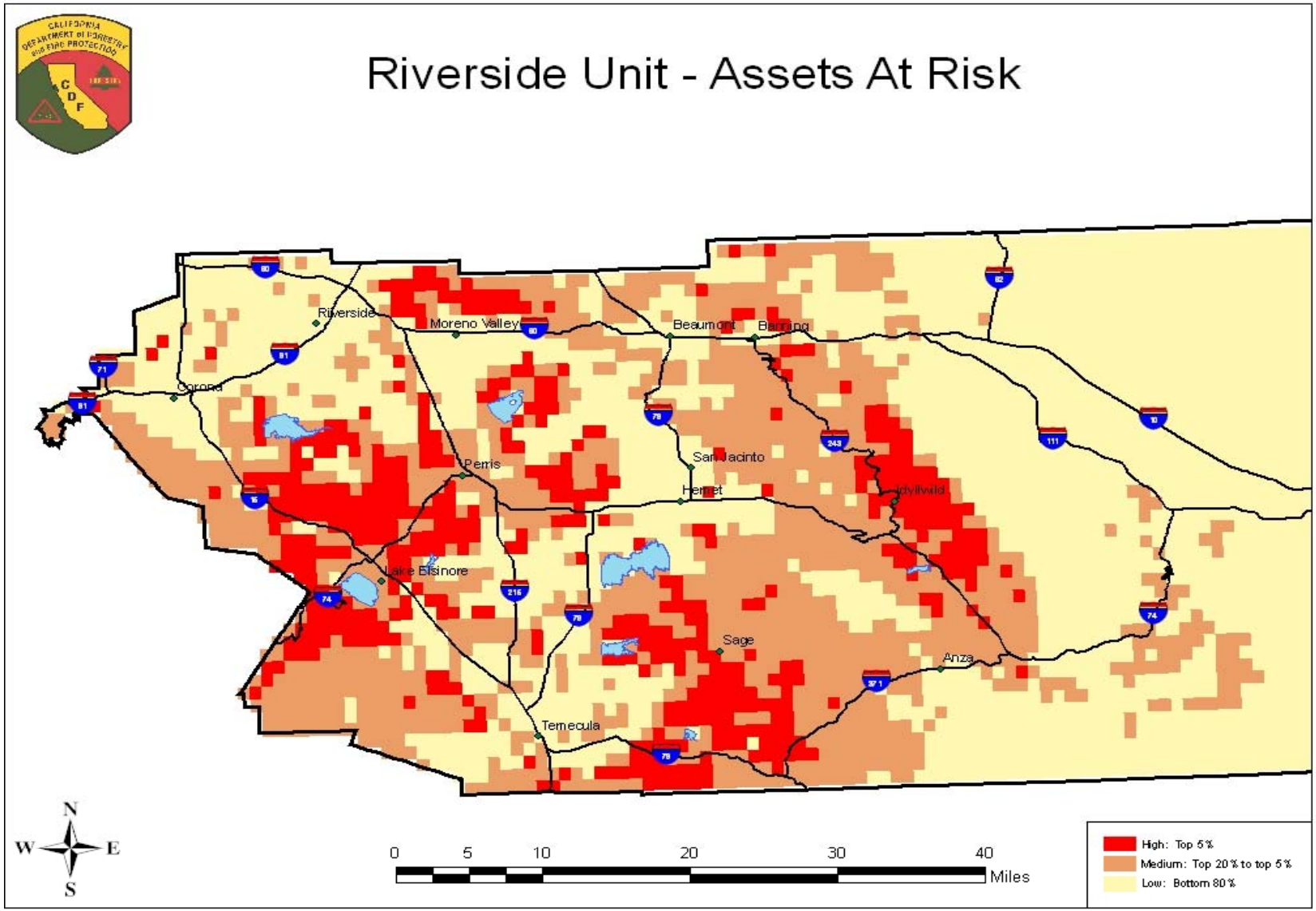
A comparison of 15 minute flight circles to historic fires

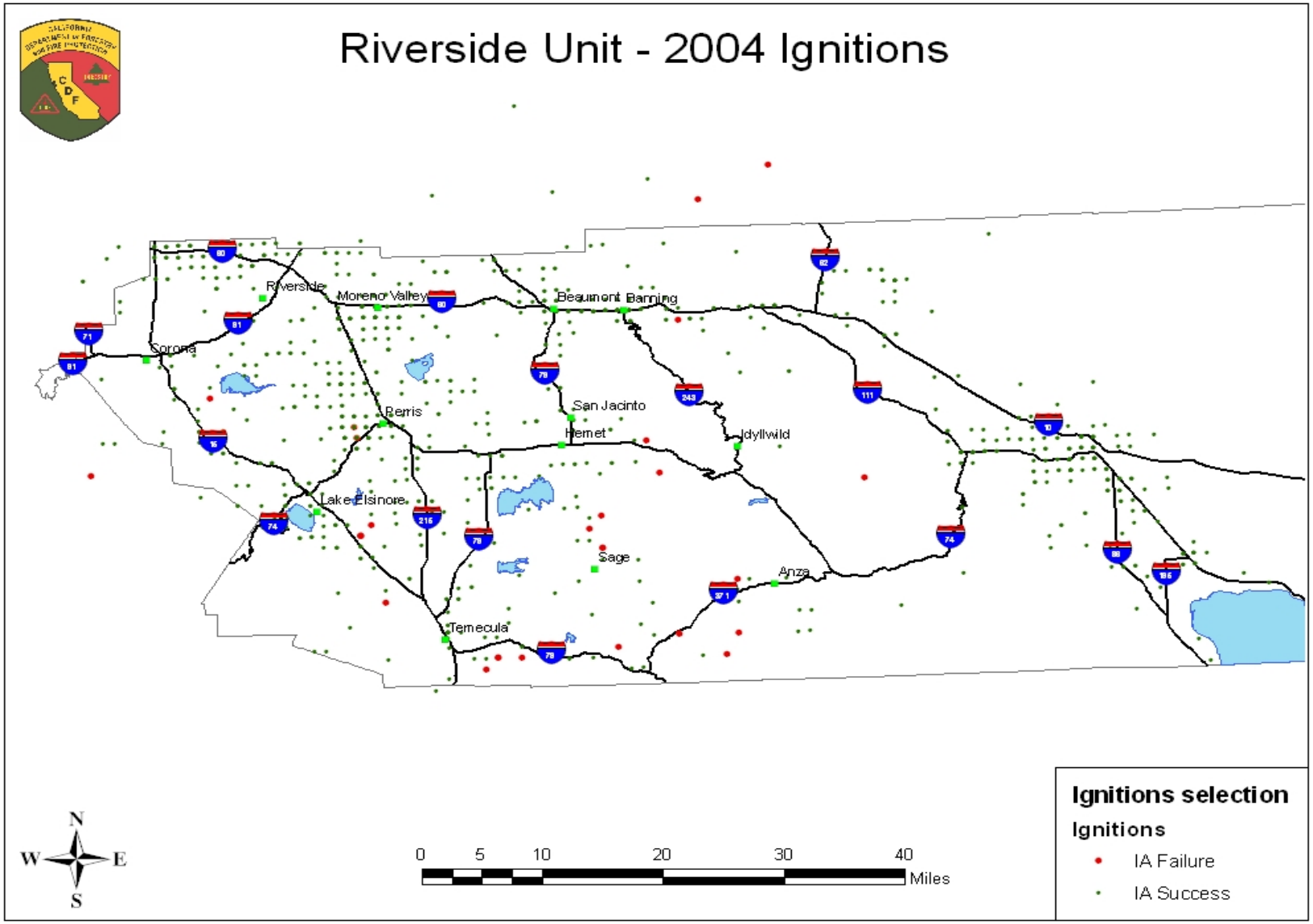
A shift to March would primarily impact acreage in northern San Diego County that is within 10 minutes of flight time from Ramona Air Attack Base. In addition a review of the potential of large fires in this part of San Diego is not that high compared to other areas within Southern California. The following figure overlay the 15 minute flight circles of CDF's potential sites as well as the combined circles of CDF and US Forest Service air attack bases. Four air tanker bases currently serve Southern California – two federal and two state. The 'flight circle' map overlays the 15 minute flying circles on top of a coverage of 'times burned between 1950-2003' and the location of the National Forests. This map clearly shows the areas where large fires have burned and will probably burn again in the future. The area outside the 15 minute flight circle from March but within the Hemet circle includes relatively limited area that has experienced more than 2 fires in the past 53 years. While the area outside the Hemet circle but within the March circle includes considerable areas that had from 2 to 5 fires over the past 53 years. Most of these fire prone areas are within the Angeles National Forest and directly upslope from very densely populated areas.

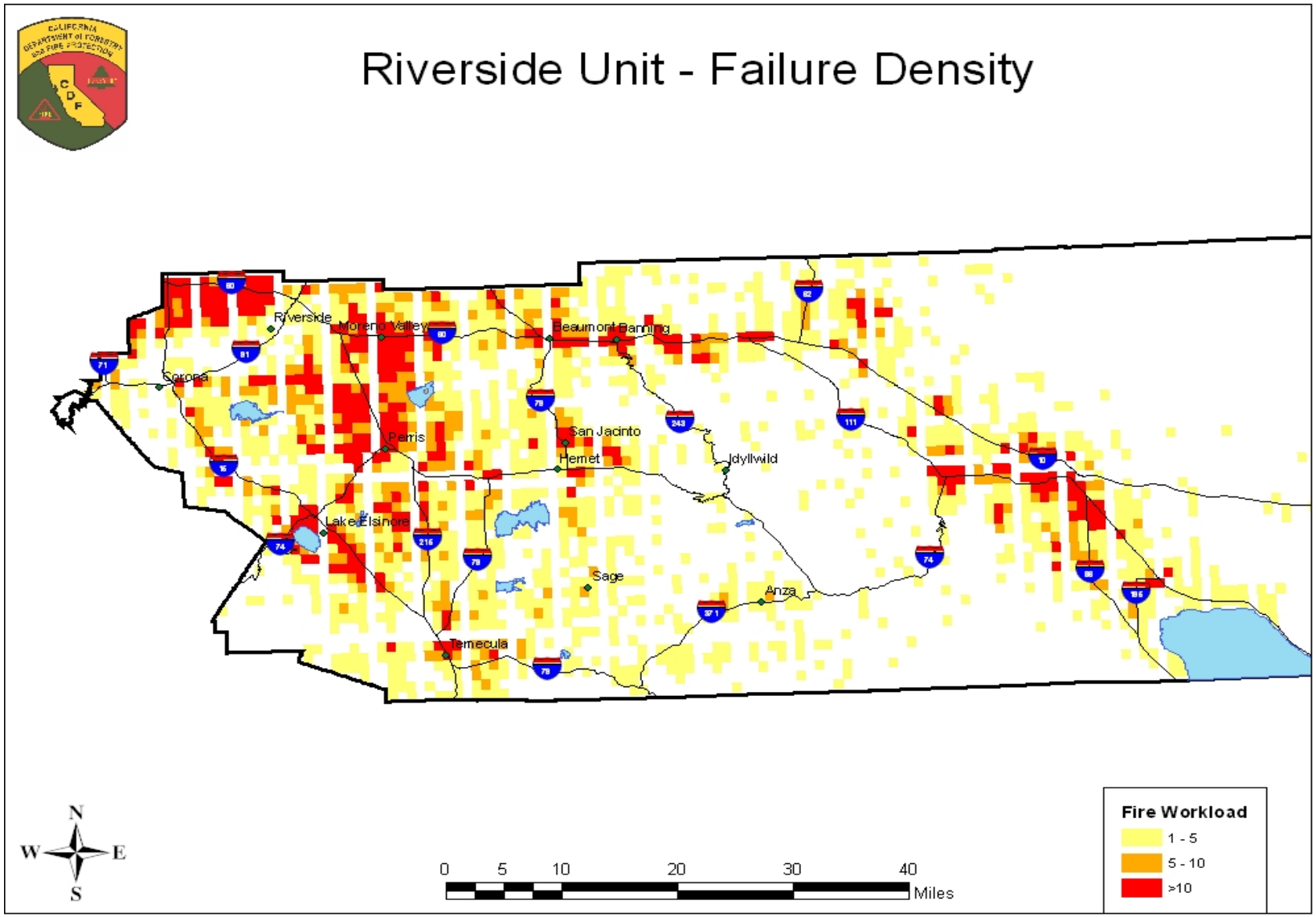

KRN
VNC
LAC
BDU
San Bernardino
Riverside
ORC
RRU
MVU
San Diego
MEXICO
NUMBER OF TIMES BURNED BETWEEN 1950 - 2003
6+
4 - 5
2 - 3
1
OTHER
CDF UNIT
USFS BOUNDARY
CITY
AIR ATTACK OR TANKER BASE
AIR ATTACK BASE 15 MIN. FLYING TIME
MARCH AAB
HEMET RYAN AAB
RAMONA AAB
AIR TANKER BASE 15 MIN. FLYING TIME
FOX FIELD ATB
SAN BARNARDINO ATB
Source: frstrat04_1

Fire Assets, Ignitions, Initial Attack Success, and Initial Attack Failure in Riverside County

The analysis of the various air base locations suggests that most of the changes would occur in San Diego and Los Angeles counties. Since most Riverside County falls within the 15 minute flight circles of both Hemet-Ryan and March, analyzing the coverage impacts requires a more detailed analysis of fire risk and fire occurrence within the county. The preceding "Number of times Burned between 1950 and 2003" clearly show that the areas with the most fires are on the relatively unpopulated mountain areas running NW-SE behind both air bases. From the point of view of citizens and private property owners in Riverside County, it is also worth looking at the spatial location of assets at risk from wildfire, fire ignitions, ignitions that escape initial attack and require more fire suppression resources, and the overall fire workload for the Riverside Operational Unit. The best source of relevant information is the Riverside Unit Fire Management Plan - 2005 (Anthony 2005). The following three maps illustrate a consistent pattern: while the areas of historic burned acres are in the mountainous areas in the north central part of the county, the assets at risk, ignitions, and overall fire workload are primarily in the western end of the county. The 'Riverside Unit – Assets at Risk' coverage shows a weighted coverage of private and watershed assets could be at risk if a wildfire escaped initial attack. The 'Riverside Unit – 2004 Ignitions' shows where ignitions actually occurred and whether initial attack was successful. While the assets at risk coverage shows high value areas widely scattered across the western half of the county, the actual pattern of ignitions is mainly in the northwestern portion of the county. This is more clearly shown in the 'Riverside Unit – Failure Density' map where the heaviest fire workload areas are shown in red.


Riverside Unit - Assets At Risk
Riverside
Moreno Valley
Beaumont
Banning
Corona
Perris
San Jacinto
Hemet
Idyllwild
Lake Elsinore
Sage
Anza
Temecula
N
W
E
S
0
5
10
20
30
40
Miles
High: Top 5%
Medium: Top 20% to top 5%
Low: Bottom 80%


Riverside Unit - 2004 Ignitions
Riverside
Moreno Valley
Beaumont
Banning
Corona
Perris
San Jacinto
Hemet
Idyllwild
Lake Elsinore
Sage
Anza
Temecula
N
W
E
S
0
5
10
20
30
40
Miles
Ignitions selection
Ignitions
IA Failure
IA Success

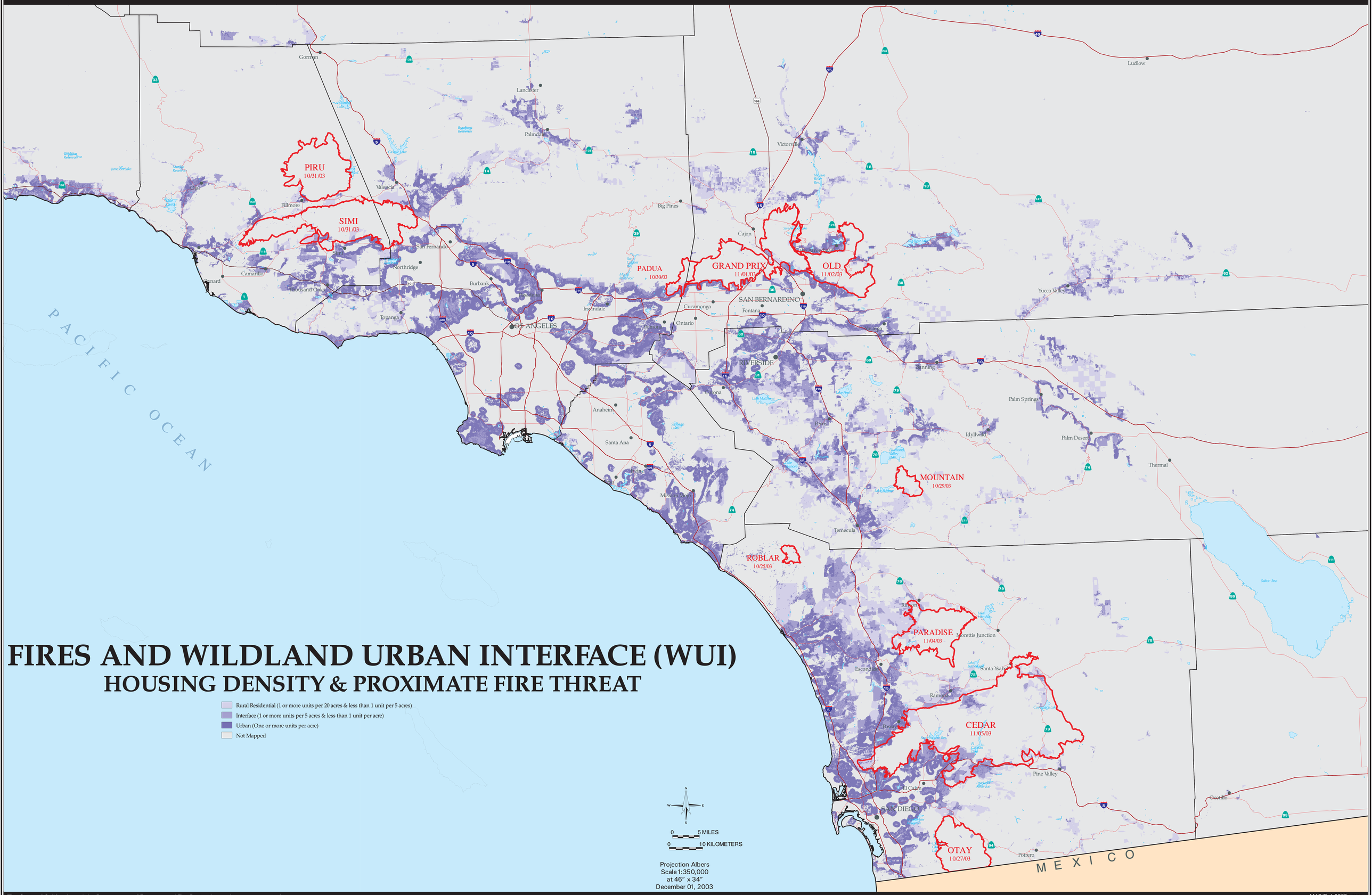

Riverside Unit - Failure Density
Riverside
Moreno Valley
Beaumont-Banning
Corona
Perris
San Jacinto
Hemet
Idyllwild
Lake Elsinore
Sage
Anza
Temecula
N
W
E
S
0 5 10 20 30 40
Miles
Fire Workload
1 - 5
5 - 10
>10

Southern California Subdivisions adjacent to Wildland Fuels and Potential Fires

Another approach for assessing the potential work load for air tankers is to analyze where large numbers of homes are adjacent to wildlands that could carry large wildland fires. In additional to initial attack on fires on State Responsibility Area (SRA), a substantial part of the overall number of flights comes from extended attack when fires threaten public safety in more developed areas whether they are in SRA or LRA. The 'Fires and Wildland Urban Interface (WUI)' map maps out residential areas that have a nearby wildland fire threat. For Riverside County, most of these areas are to the west of either Hemet or March and most of the acreage is in the northwestern corner of the county.

Fire and Resource Assessment Program
California Department of Forestry and Fire Protection

SOUTHERN CALIFORNIA



FIRES AND WILDLAND URBAN INTERFACE (WUI)

HOUSING DENSITY & PROXIMATE FIRE THREAT

- Rural Residential (1 or more units per 20 acres & less than 1 unit per 5 acres)
- Interface (1 or more units per 5 acres & less than 1 unit per acre)
- Urban (One or more units per acre)
- Not Mapped

N
W E
S

0 5 MILES
0 10 KILOMETERS

Projection Albers
Scale 1:350,000
at 46" x 34"
December 01, 2003

Obtain FRAP maps, data, metadata and publications on the Internet at http://frap.cdf.ca.gov
or from CDF-FRAP, 1920 20th Street, Sacramento, CA 95814, (916) 227-2651.

Arnold Schwarzenegger, Governor,
State of California
Michael Chrisman, Secretary for Resources,
The Resources Agency
Andrea E. Tuttle, Director,
Department of Forestry and Fire Protection

MAP ID: fs2003a_map

DATA SOURCES
WILDLAND FIRE THREAT & HOUSSING DENSITY, v03_1

1:100,000 USGS DLGs
TIGER 2000 Roads

March Air base would provide roughly equal fire suppression success that has been historically achieved in the region

The overall conclusion from these various sources of data is that the two air base locations have slight differences in terms of how close they are to assets, fire ignitions, and fire escapes but that they would be equally effective within the overall fire suppression systems of CDF and its partners in Southern California.

This conclusion is different than those reached in the draft document of July 9, 2005 that was based on 5 non-representative fires and suppression only with air attack for a number of reasons.

1. It assumed suppression by air tankers only with no use of nearest available assets such as fire engines and hand crews during initial attack
2. The 5 selected fires are a small and non-representative sample of SRA fires in Riverside County and Orange County
3. The 60% initial attack rate for the current situation (Hemet best and worst cases) is too different from the actual 91%-96% success rate for this scenario to be considered an accurate simulation of actual fire and fire suppression in the region
4. The worst case scenario for March assumed delays from both an arriving and a departing plane at the same time as the CDF plane is trying to depart. The probability of both types of delays occurring in quick succession is extremely small, possibly one percent of the time, rather than the 50% of the time that is implied by using the worst case scenario for 5 out of the 10 fire simulations.

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CFES2 – California Fire Economics Simulator

The California fire economics simulator is essentially a competition between how fast fires expand with how fast fire agencies can deploy resources to build fireline around the fire to contain it. If the 'fire' wins, we have an escaped fire that requires additional resources and time to put it out. If the 'fire agency' wins, the fire is suppressed with a specific estimate of resources required.

How fast the fire expands is mainly a function of

1) the type of fuel (ex. shrubs burns a lot hotter and with greater intensity than grass) and
2) the fire weather (ex. hot and windy days drive fires faster).

How many resources the fire agencies can deploy to make fireline is mainly a function of

1) how many resources are available (engines with crews, dozers, hand crews)
2) how long it takes it to be deployed on the fireline (travel time from various fire stations, set up time)
3) how many structures are near the fire (this is the primary responsibility of local fire engines but in practice local fire engines, and CDF engines will be assigned in the order they arrive at the fire, not by statutory responsibility. The number and location of local fire engines is a key component of CFES2)
4) how fast different resources (engines, dozers, hand crews) can put in fireline in different vegetation types (forest and shrub require more work per linear foot of fireline than grass) and terrain (steep terrain preclude the use of many vehicles)

A simulation model based on thousands of runs accounting for different fuel, weather, and number of simultaneous fires is more accurate than historic averages because of the very high year to year variability in the type of fire events that make up California's fire seasons. The accuracy of the model is tested by calibrating the model results with historic resources and historic fire starts. The simulation model then allows CDF to do 'what if' scenarios of more resources, less resources, moving stations to new locations, changes in fire weather, broad changes in fuel conditions, etc. The current statewide CFES2 runs are currently based on an extrapolation from CDF units where all data has been recently updated and verified. The financially relevant estimate of the cost of the fires that exceed initial attack resources is the sum of the number of escapes from CFES2 multiplied by the costs per escaped fire that is taken from empirical cost data.

The Full online manual is available at
http://webmain02/Library/cfes2/CFES2_Procedures.htm
A simple animation of the process is available at

http://frap.cdf.ca.gov/tools/CFES/cfes.html
A bibliography of peer reviewed research articles about CFES2 and its specific components

Gilless, J.K. and J.S. Fried. 2000. Generating beta random variables from probabilistic PERT/CPM-type estimates of production times: an application in planning for wildland fire control <http://jeremy.msu.edu/pubs/annalsor.pdf>. ***Annals of Operations Research*** [in press].

Fried, J.S. and J.K. Gilless. 1999. CFES2: The California Fire Economics Simulator Version 2 User's Guide <http://jeremy.msu.edu/pubs/cfes2_manual.pdf>. University of California, Division of Agriculture and Natural Resources Publication 21580. 92 p. Fried,

Gilless, J.K. and J.S. Fried. 1999. Stochastic representation of fire behavior in a wildland fire protection planning model for California. <http://jeremy.msu.edu/pubs/fs_behavior_98.pdf> ***Forest Science*** 45(4):492-499.

Fried, J.S. and B.D. Fried. 1996. Simulating Wildfire Containment with Realistic Tactics (PDF) <http://jeremy.msu.edu/research/fs_96.pdf>. ***Forest Science*** 42(3):267-281.

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Fried, J.S. and M.S. Torn. 1990. Analyzing localized climate impacts with the Changed Climate Fire Modeling System. ***Natural Resource Modeling*** 4(2):229-253.

Fried, J. S., and J. K. Gilless. 1989. Expert opinion estimation of fireline production rates. ***Forest Science*** 35: 870877.

Fried, J. S., and J. K. Gilless. 1988. Stochastic representation of fire occurrence in a wildland fire protection planning model for California. ***Forest Science*** 34(4): 948-955.

Bill Stewart

September 13, 2002

CFES2 in Brief

CFES2 is an MS-DOS computer program that simulates, for a CDF Unit or other administrative area, initial attack on wildland fires over a range of real-world firefighting conditions. CFES2 is a strategic planning tool, the culmination of efforts by CDF and UC Berkeley researchers to improve initial attack modeling technology for CDF managers. The conceptual framework grew out of experience with CFES-IAM Version 1, a deterministic simulator patterned after the Initial Action Assessment model used by the USDA Forest Service and Bureau of Land Management.

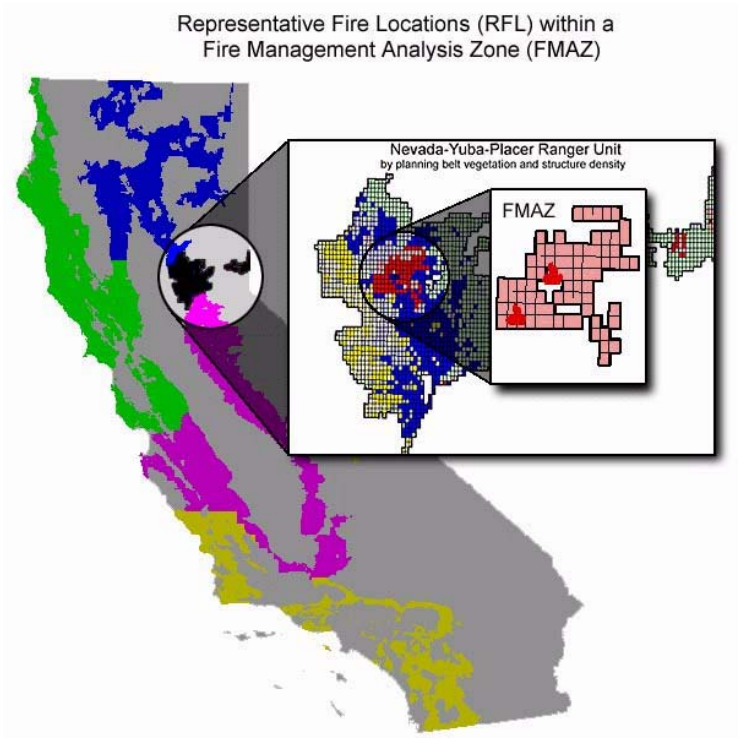
CFES2 is very different from both CFES-IAM and IAA, because it gets many of its critical operating parameters from statistical probability distributions rather than from averages. Data sources include historical fire and weather data; fuel, topography, weather, and population maps; and expert-opinion derived production rates. Simulation is a clock-driven, "next event" process that generates thousands of initial attack outcomes reflecting the complexity and variability of the initial attack system (e.g., drawdown, extreme rates of spread). CFES2 incorporates various institutional constraints on resource availability, such as staffing patterns, diversions of suppression resources for structure protection, turnaround time, and maintenance/other downtime. An innovative containment algorithm accounts for the timing of arrival of fire fighting resources and consequent effect on final containment size. CFES2 simulates initial attack in areas of similar vegetation, structure density, and weather, called Fire Management Analysis Zones (FMAZ).

CFES2 outputs include the expected annual number of fires that exceed initial attack simulation limits (and potentially become large and costly "escaped" fires), the percent of fires successfully contained within policy guidelines. The probability of escaped fires is also quantifiable.

CFES2 is part of the Fire Plan Assessment System and measures the Level of Service for purposes of focusing pre-fire management efforts. The Level of Service analysis is also an avenue for informing the state Board of Forestry in their efforts to ascertain to what extent CDF is providing "equal protection to lands of similar type, as required under PRC 4130. Ranger unit, regional, and state-level maps will depict the total level of service and the level of service by funding source. CFES2 can simulate just the "Schedule B" response, providing a measure of service that a fire history records cannot reveal directly. The California Board of Forestry will compare the levels of service provided by state-funded initial attack resources in "similar" Fire Management Analysis Zones. In addition, CFES2 facilitates a wide range of "what if" analyses, allowing managers the flexibility to test alternatives for stationing and using suppression resources, thus evaluating and improving the organization of resources for wildland fire protection.

A "historical" or "validation" simulation run is a check on the inputs, and can help identify problems with the data or assumptions. Only after the data used in the validation run is deemed satisfactory can the model's resources be updated to their current status and a "baseline run".

When model inputs are "in balance" for the historical (validation) simulation, the results (e.g., LOS, number of escapes per year) should be a reasonable reflection of the long run average fire history in each FMAZ. When any of these inputs are changed (e.g., number of engines dispatched), the scales may tip, resulting in a lower or higher Level of Service.



This graphic depicts the overall geographical context of a CFES2 simulation. As a hypothetical example, this FMAZ is the ranger unit's Brush planning belt.

The Brush Planning Belt has a Medium level of structure protection intensity. The two representative fire locations shown represent differences in travel times and dispatch policies (i.e., type, and number of suppression resources). The FMAZ is relatively homogeneous with respect to weather. Each Quad 81st in the FMAZ is associated with one or the other of the two RFLs (but not both).

James Spero ,CDF Fire and Resource Assessment Program , 2002