Appendix E – Fire Hazard Model

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Appendix E – Fire Hazard Model

The GGNRA Fire Hazard Model defines fire hazard as areas where steep slopes, south-facing aspects, and high-danger fuels exist in close proximity to urban or developed areas. The analysis was conducted to help visualize and differentiate parklands in terms of wildland fire hazard. The model takes into consideration potential fire behavior should a fire start (fuels and topography) and values at risk (wildland urban interface). The model was conducted using a Geographic Information System (GIS) with input from fire management, natural resource, and cultural resource experts.

Methodology

Using a GIS, GGNRA lands affected by the Fire Management Plan (approximately 15,000 acres) were divided into a grid of 100 meter^2 cells. Five variables were analyzed for each cell (see below). Each variable was assigned a common rating scale of 1 (low), 2 (moderate), and 3 (high), representing the level of hazard. Zero was assigned where the hazard or factor did not exist. The factors were then weighted according to their influence on fire hazard and added together. The calculation resulted in a numeric scale representing the hazard value for each cell. The scale is unit-less and has no absolute meaning; rather, it is intended to show wildland fire hazard relative to other cells.

Model Inputs

Five variables were analyzed: fuels, slope, aspect, proximity to urban areas, and the presence of nonnative evergreen trees. Each variable is described below. Table E-1 summarizes the hazard rating system and input variable weighting. The level of analysis was based on the availability of staff resources, existing data, and time. Some factors such as response time to a fire and weather were omitted due to insufficient data; however, the NPS understands the importance of these factors and is working to fill in these data gaps. Fire hazard analysis for the park will continue to be refined as data and modeling techniques become available.

1. Fuels

Fuels are considered any organic material (live and dead vegetation, litter, and duff) that may combust during a fire. Fuel models are a numeric description of the quantity and arrangement of fuels and were developed to allow easy input of environmental parameters and fuel characteristics into fire behavior prediction models. A fuel model describes potential fire behavior for a given fuel loading (weight per area) and arrangement (surface versus crown fuels), which generally correspond to vegetation type (Rothermel 1972). GIS specialists, fire ecologists, botanists, and local fire experts from GGNRA, PRNS, and the NPS Fire Program Analysis team convened to assign local vegetation types a fuel model consistent with the Anderson framework (Anderson 1982). Park vegetation maps from 1994 aerial photography were assigned fuel models based on the alliance-association vegetation type and field plot information. Table E-2 gives a description of fuel models assigned to GGNRA.

Fuel models were rated in terms of fire hazard in accordance with the Marin County Fire Plan (2000*)*. Fuel models 1, 2, 4, 9 and 10 were identified as extreme hazards during severe fire-weather conditions

(dry and windy). Fuel types 3, 5, 7, and 8 were ranked moderate. Fuel types 98 and 99 (water and barren) were ranked low.

2. Slope

Slope affects fire behavior characteristics and the ability of firefighters to suppress a fire. Fire typically burns faster up steeper slopes due to the arrangement of fuels in relation to the flaming front and pre-heating of fuels by fire below. Steep slopes and difficult terrain affect the ability to safely combat a fire.

3. Aspect

Aspect refers to the geographic orientation of the slope. Slopes facing south and southwest receive more sun than slopes in other orientations. Consequently, vegetation on these slopes tends to dry out faster. In late summer and fall warm, easterly winds tend to dry fuels on east and northeast slopes as well.

4. Proximity to Urban Areas

The GGNRA boundary includes approximately 40 miles of border along residential areas. A wildland fire near this boundary could threaten homes and private property. Furthermore, urban areas that border the park could serve as ignition sources for a wildland fire. Parklands within 400 meters of an urban area including structures within the park were ranked highest in terms of hazard.

5. Nonnative Evergreen Forest

Fire that burns through the tree canopy is termed crown fire and is an indication of extreme fire behavior. Crown fire potential in GGNRA and surrounding lands is high in only a few fuel types. Therefore, areas where these trees exist and are represented in the vegetation map were given a 5-percent weighting in the hazard calculation in addition to the weighting assigned in the fuel model input.

Results

Several iterations of analysis were conducted with input variables weighted differently before park staff settled on the final process that resulted in distinguishable hazard differences. The final analysis relies heavily on the hazard created by fuel types and proximity to the wildland urban interface. It comes as no surprise that areas along the park boundary rank high in terms of fire hazard due to their close proximity to development and the fact that many of these areas contain heavy fuels, nonnative forest, and hilly terrain. Maps of the results of the analysis are represented in Figures E-1 and E-2.

Table E-1: Fire Hazard Ratings
(1 = Low, 2 = Moderate, 3 = High)

Input Variable	Data Value	Hazard Rating	Weight
Fuels	Models 1-10, 98, 99	Fuel Model 1, 2, 4, 9, 10 = **3** Fuel Model 3, 5, 6, 7, 8 = **2** Fuel Model 98, 99 = **1**	40%
Slope	Degrees	>40° = **3** 21° - 40° = **2** 0° - 20° = **1**	15%
Aspect	Degrees	135° - 270° = **3** 46° - 135°, 271° - 315° = **2** 0° - 45°, 316° - 360° = **1**	5%
Proximity to Urban Areas	Meters	0 – 400m = **3** 401-1200m = **2** >1200m = **1**	35%
Nonnative Evergreen Forest	Presence vs. Non-presence	Present = **3** Not Present = **0**	5%

Source: NPS, GGNRA Fire Management Office, 2004.

Table E-2: GGNRA Fuel Models

Fuel Model	Description
1	Short grasses (1 foot)
2	Timber with grass understory
3	Tall grasses (2.5 feet)
4	Chaparral (6 feet)
5	Brush (2 feet)
8	Closed timber litter
9	Hardwood litter
10	Timber (litter and understory)
98	Water
99	Unburnable / Barren / Developed

Source: NPS, GGNRA Fire Management Office, 2004.

Note:

For a detailed description of fuel models, see Anderson 1982.

References

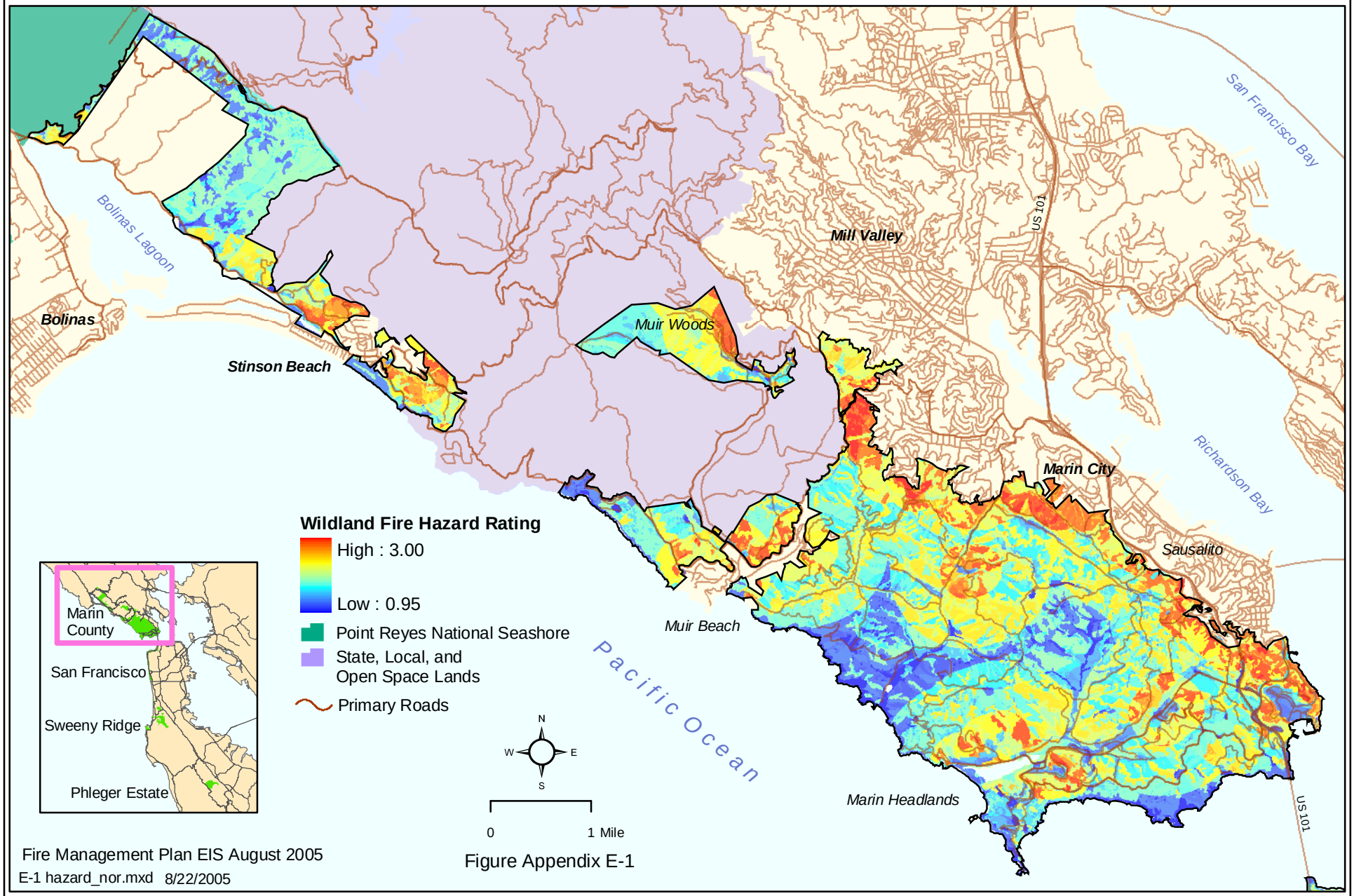
Anderson, H. E. 1982. Aids to Determining Fuel Models for Estimating Fire Behavior. Ogden, UT: United States Department of Agriculture, Forest Service, Intermountain Research Station.

Rothermel, R. C. 1972. A Mathatical Model for Prediction Fire Spread in Wildland Fuels. Ogden, UT: United States Department of Agriculture, Forest Service, Intermountain Research Station.

Wildland Fire Risk Hazard Assessment

Marin County

National Park Service
U.S. Department of the Interior
Golden Gate National Recreation Area



Fire Management Plan EIS August 2005
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Figure Appendix E-1

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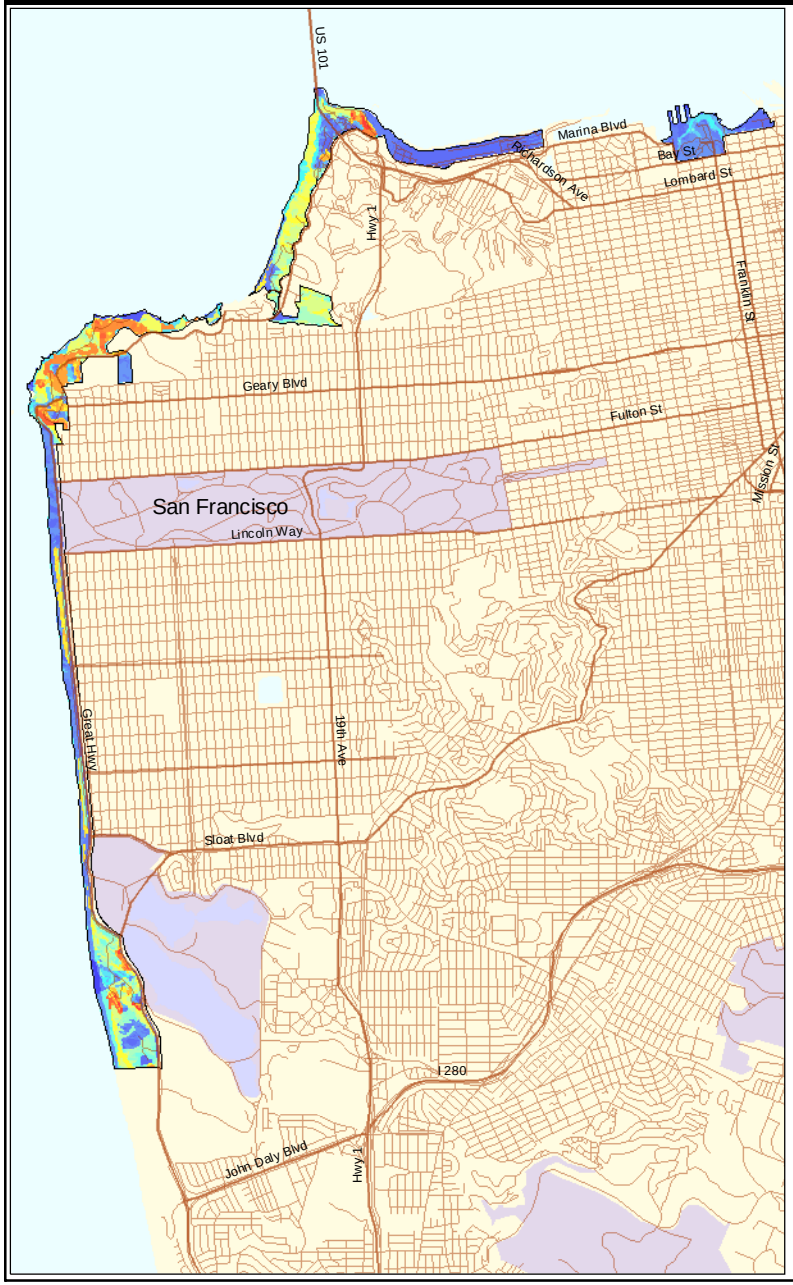
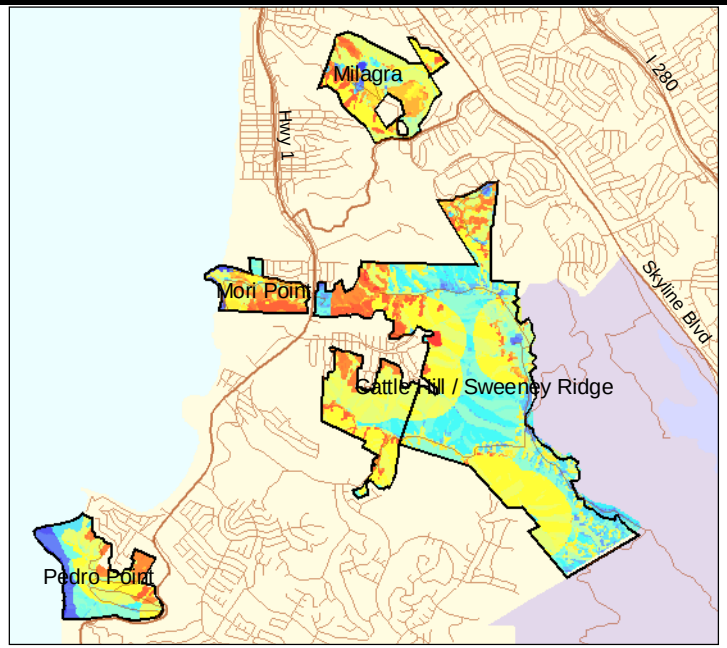
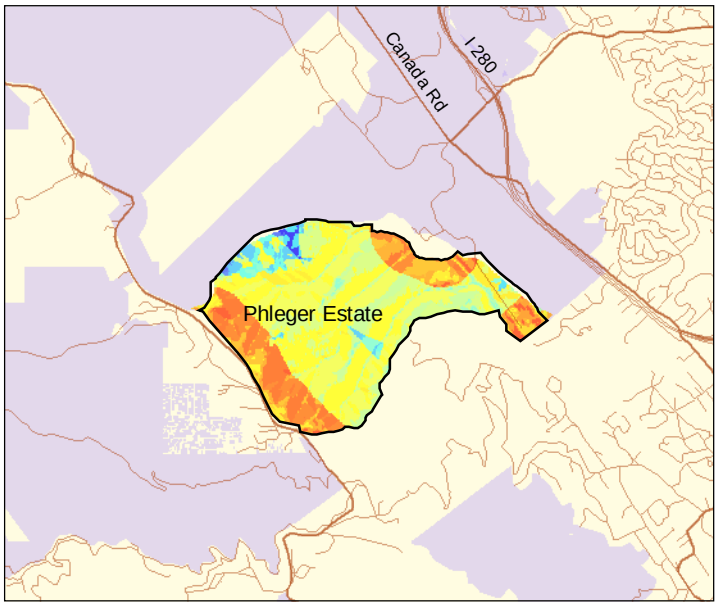
Wildland Fire Risk Hazard Assessment

San Francisco and San Mateo County

National Park Service
U.S. Department of the Interior
Golden Gate National Recreation Area







Hazard Rating

High : 3.00

Low : 0.95

GGNRA Boundary

State, Local, and Open Space Lands

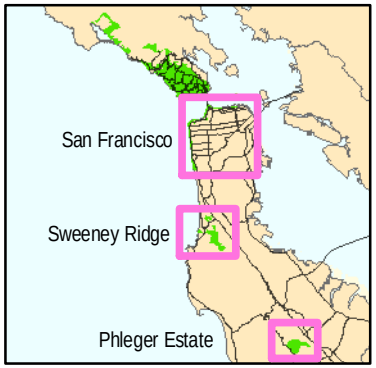


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Figure Appendix E-2

Fire Management Plan EIS August 2005

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