# Rapid Assessment Reference Condition Model

*The Rapid Assessment is a component of the LANDFIRE project. Reference condition models for the Rapid Assessment were created through a series of expert workshops and a peer-review process in 2004-2005. For more information, please visit www.landfire.gov. Please direct questions to helpdesk@landfire.gov.*

## *Potential Natural Vegetation Group (PNVG):*

**R9MARF** **Maritime Forest**

## *General Information*

**Contributors** *(additional contributors may be listed under "Model Evolution and Comments")*


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**Vegetation Type**

Forested

**Dominant Species***

QUVI CHLA6
QULA3
PITA
PIEL

**General Model Sources**

- [x] Literature
- [x] Local Data
- [x] Expert Estimate

**LANDFIRE Mapping Zones**

| | | |
|---|---|---|
| 60 | 56 | 37 |
| 58 | 46 | 36 |
| 55 | 45 | |

**Rapid Assessment Model Zones**

- [ ] California
- [ ] Great Basin
- [ ] Great Lakes
- [ ] Northeast
- [ ] Northern Plains
- [ ] N-Cent.Rockies
- [ ] Pacific Northwest
- [ ] South Central
- [x] Southeast
- [ ] S. Appalachians
- [ ] Southwest

### Geographic Range

Maritime forest occurs from southeastern Virginia to Florida, and west along the Gulf Coast to east Texas (excluding the inland live oak savanna type of south central Texas).

This broad model includes locally associated but very different vegetation types associated with maritime forest such as dunes, swales, Atlantic and Gulf coast strand vegetation and palmetto communities in and on the fringe of maritime forests. The more narrowly defined model MARF focuses specifically on non-wetland Maritime forest dominated by live oak (Quercus virginiana) and pines.

### Biophysical Site Description

This PNVG occurs on coastal dunes and flats on barrier islands, on mainlands adjacent to salt water and along fresh and tidewater steams some distance above and especially below the region of fresh/salt water mixing. It also includes associated dunes, some marshes, swales, beaches and palmetto communities.

### Vegetation Description

Live oak (Quercus virginiana) is the most characteristic species in the maritime forest. Other common canopy dominants include laurel oak (Quercus laurifolia), loblolly pine (Pinus taeda) and slash pine (Pinus elliottii). Species of more sheltered stands may include cherrybark oak (Quercus pagoda), pignut hickory (Carya glabra), sand hickory (Carya pallida) and other oaks and hickories. Coastal fringe stands from central South Carolina south may have sabal palm (Sabal palmetto) in the understory beneath hardwoods and pine or as the canopy dominant on marsh fringes, flats and shallow sloughs. Some typical shrubs include yaupon (Ilex vomitoria), wax myrtle (Myrica cerifera), saw palmetto (Serenoa repens) and coral bean (Erythrina herbacea). Vines, especially greenbriers (Smilax rotundifolia, S. bona-nox, and S. glauca), are abundant. Herb layer diversity is low except where fire-maintained stands grade into mainland longleaf pine communities. The most typical herb layer species, especially where frequently burned, is slender wood-oats (Chasmanthium laxum). Rare species include bluff oak (Quercus austrina) in South Carolina

*Dominant and Indicator Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.

stands and a variety of tropical species in the Florida Keys.

In coastal environments, live oak maritime forest occurs in a fine-scale mosaic with marshes, dune grasslands, coastal strand (high beach) vegetation, cheniere and many other local vegetation types. On the side bordering saline environments, maritime forest grades into palmetto fringes and sloughs, oligohaline, brackish and salt marsh. On the wetland side bordering freshwater wetlands, maritime forest grades into wetland shrubs and saplings on the margins of cypress (Taxodium distichum) and black gum (Nyssa biflora) swamps and interdunal pools. On the dry side, it grades into a nearly pure live oak canopy on sand dunes exposed to salt spray.

Marshes: All salinity levels of marshes can be found in and around coastal maritime forest. Salinity ranges from hypersaline salt flats dominated by nonflammable species such as glasswort (Salicornia spp.), to marshes with full strength sea water( > 3% salinity ), to freshwater marsh. Neither the hypersaline or saline types is known to burn, except on margins where vegetation is mixed with more flammable species. On the other end of the salinity gradient, freshwater marshes (salinity <0.5 PPT) tend to be dominated by nonpyrophytic, emergent broadleaf species such as pickerelweed (Pontederia cordata), green arrow arum (Peltandra virginica), pennyworts (Hydrocotyle spp.) and smartweeds (Polygonum spp.), and floating-leaved aquatics such as fragrant water lily (Nymphaea odorata) (Cowardin et al. 1985). Most marshes bordering coastal maritime forests range in the saline to brackish or oligohaline ranges. Marsh species composition ranges from predominantly smooth cordgrass (Spartina alterniflora) and black rush (Juncus roemerianus) in saline marshes to as many as 60 species in oligohaline marshes (Frost 1995).

Dune Grasslands: In the unstable coastal environment, dunes can usually be found in all stages of primary succession. On the Atlantic coast this often occurs at the southern ends of barrier islands where alongshore movement of sand from north to south causes accretion at the southern end of each island. The islands are bounded by inlets and the process of island extension often results in closing these inlets. This may be followed by formation of a new inlet somewhere north of the sand stream, when storm surge back and forth across an island washes out a new channel to the ocean (Dolan et al., 1973). The new, low sands are typically colonized first by grasses and forbs such as salt meadow cordgrass (Spartina patens), sea oats (Uniola paniculata) and sea elder (Iva imbricaria). These species accumulate sand and small dunes begin to form. This provides habitat for species favoring dryer microsites such as sea oats. In this situation and through the mechanism described below on large dunes, vegetation succession results in maritime forests dominated by live oak. These communities are stable unless destroyed by further geomorphic changes such as island erosion by inlet migration.

A second mechanism of primary succession occurs in the geologically unstable dune and sand flat communities of the barrier islands and strands. When sand dunes moving across the flats, bury existing vegetation and come to rest at the edge of swamps or against older vegetated dunes (Latrobe 1799), they form a new substrate for colonization by vegetation. New dunes are first colonized by sea oats and a handful of xerophytic coastal forbs such as ground cherry (Physalis viscosa), and jumping cactus (Opuntia drummondii). Older dunes may have red cedar (Juniperus virginiana), shrubs and patches of dune grassland vegetation in gaps. These dunes have young live oak which in time becomes the canopy dominant. Scattered individuals and small stands of longleaf pine (Pinus palustris) may occasionally be found on larger dune fields. On the fire-exposed mainland, maritime live oak grades into longleaf pine communities.

There are changes associated with human disturbance of the sand flow. While natural primary succession characterized only a small percent of stands, perhaps only 5-10% of the coastal landscape under presettlement conditions, many new stands are developing today on what were open sands or maritime grasslands before the construction of man-made barrier dunes, beginning when the work of the Civilian Conservation Corps in the 1930's stopped ocean overwash and reduced salt spray (Wentworth et al. 1992). Formation of new dune habitats by this version of primary succession has been essentially eliminated by human activities along the coast.

Beach Strand Vegetation: The high beach, while geologically dynamic, is the first land stable enough to be colonized by pioneer vegetation such as salt meadow cordgrass (Spartina patens), sea oats (Uniola paniculata) and sea elder (Iva imbricaria) as described above under dune grasslands. In south Florida, tropical such species as railroad vine (Ipomoea pes-caprae) and sea grape (Coccoloba uvifera) are added to the mix.

Tropical Hardwood Hammock: In South Florida and the Florida keys, temperate maritime forest grades into a subtropical variant with many species that have Caribbean affinities. These communities are thinly distributed along coastal uplands south of a line from about Vero Beach on the Atlantic coast to Sarasota on the Gulf coast. They occur on some tree islands in the Everglades and on uplands throughout the Florida Keys. This subtropical community has high plant species diversity, sometimes containing over 35 species of trees and up to 65 species of shrubs. Characteristic tropical plants include strangler fig (Ficus aurea), gumbo-limbo (Bursera semaruba), false mastic (Sideroxylon foetidissimum) , willow bustic (Sideroxylon salicifolium), lancewood (Ocotea coriacea), ironwood (Krugiodendron ferreum), (poisonwood (Metopium toxiferum), pigeon plum (Coccoloba diversifolia), Jamaica dogwood (Piscidia piscipula), and false tamarind (Lysiloma latisiliquum). Live oak and cabbage palm (Sabal palmetto) are also sometimes found within this community. Tropical hammocks in the Florida keys may also contain several rare plants, including lignumvitae (Guaiacum sanctum), West Indian mahogany (Swietenia mahagoni), silver thatch palm (Coccothrinax argentata), and manchineel (Hippomane mancinella) (Gilbert, 2005).

Cheniere: These linear sand ridges are similar to barrier islands but have a different geomorphic origin. Barrier islands form in areas with rising sea levels. They migrate upslope by a process of repeated ocean overwash that intermittently deposits new sand on the inland side of the island. This causes barrier islands to grow upslope. Chenieres also form as shoreline berms and dunes. But, since they occur in areas of deltaic accretion near the mouths of major rivers, they remain fixed in place and new land forms around them as new layers of sediments are periodically deposited during incidents of fluvial overwash. This produces isolated islands of sand four or five feet higher than the surrounding marsh and prairie flatlands. As these islands become less exposed to salt spray they develop a different suite of species. Live oak is still the most common dominant but hackberry (Celtis laevigata) is often codominant in the canopy. Other characteristic species are swamp red maple (Acer rubrum var. drummondii), sweet gum (Liquidambar styraciflua), water oak (Quercus nigra), green ash (Fraxinus pennsylvanica), and American elm (Ulmus americana). Dwarf palmetto (Sabal minor) and prickly pear cactus (Opuntia spp.) are common in the understory.

Interdunal Swales: Numerous plant community types can be defined in interdunal swales depending particularly upon their age and depth to water table. In early primary succession those with moist sand substrates may have species dominated by graminoids such as Hairawn Muhly (Muhlenbergia capillaries), bulrushes (Scirpus spp), and black needle rush (Juncus roemerianus). In intermediate succession these sites may become dominated by wetland shrubs such wax myrtle (Myrica cerifera). Later the shrubs may be replaced with wetland pines such as loblolly and slash pine. Over hundreds of years sea levels may rise high enough to fill the swales with water, forming interdunal freshwater ponds bordered with cypress-gum forest (Taxodium distichum-Nyssa biflora).

Sabal palm (Sabal palmetto) fringes, flats and swales can be found on the margins of live oak forests and in swales on moist sands or shallow organic soils over sand. Sabal palms can tolerate oligohaline conditions and short periods of inundation with salt water during hurricanes. Just upslope from stands where the canopy is dominated by sabal palms, it may occur as subcanopy and shrub layer stems beneath the maritime oak-pine canopy. Typical species in sabal palm stands may include small live oaks, loblolly pine (Pinus taeda), eastern red cedar (Juniperus virginiana), wax myrtle (Myrica cerifera), marsh elder (Iva frutescens), silverling (Baccharis angustifolia), yaupon (Ilex vomitoria), switchgrass (Panicum virgatum), giant foxtail (Setaria magna), black needle-rush (Juncus roemerianus), saltgrass (Distichlis spicata), sawgrass (Cladium jamaicense), and a variety of wetland forbs such as camphorweed (Pluchea purpurascens) and seaside goldenrod (Solidago sempervirens).

A. Johnson, in her review, indicated that in Florida, pines are uncommon in maritime forests and the understory is typically shrubby, with saw palmetto (Serenoa repens) and yaupon common. Red bay (Persea borbonia), southern magnolia (Magnolia grandiflora), and pignut hickory (Carya glabra) are associated co-dominants with live oak. These temperate canopy species are replaced by sub-tropical and tropical species in southern peninsular Florida, including those listed above. She also referenced an article published by Bratton and Miller, 1994, describing the impacts of past agricultural activities on understory composition and pine abundance in maritime forests on Cumberland Island, Georgia. In the article Bratton and Miller attribute reduced levels of saw palmetto and a more open, grassy understory in some maritime forest areas on the island to past agricultural clearing or grazing, rather than fire. In addition, pines were present, but less abundant in previously un-cultivated areas of maritime forest. They did caution about drawing conclusions about the absence of pines in maritime forests due to potential impacts from past logging activities.

## Disturbance Description

Maritime forest and associated communities are classified as Fire Regime Group I, with frequent, light surface fires in marshes and swales with thin grass, and pine needle and evergreen oak litter in maritime forest. The original Mean Fire Return Interval (MFI) ranged widely, from 2-26 years or more, depending on the topographic situation and ignition source. The fire regime was bimodal, with March-April lightning season fires and October-November fires ignited by Native Americans. Lightning was the dominant ignition source in the largest fire compartments of the coastal plain mainland, producing a 2-3 year fire interval (Frost 2000). On coastal islands and peninsulas, isolated from the frequent fire regime of the mainland, Native American burning became the dominant factor (Frost 2004). These fires, for hunting purposes, were mostly in the fall. An island of about 2 km2 in size with no Indian burning would have been expected to experience lightning ignition only about every 26 years. On most of these isolated stands a combination of lightning and Native American burning produced a fire frequency around 5-7 years (Frost 2004). On smaller islands and small vegetation stands isolated by barren sands on larger islands, longer intervals could be expected.

Most natural stands were influenced by fire. Those with frequent fire (2-5 years) were bilayered, having a nearly closed tree canopy over a moderately well-developed grassy layer usually dominated by woodoats (Chasmanthium laxum). With lower fire frequency, (5-7) years, a shrub layer often dominated by yaupon (Ilex vomitoria) was found.

There is some impact from hurricanes, mostly in the form of broken branches of laurel oak (Quercus laurifolia). Live oak (Q. virginiana) is extremely strong and wind-resistant and hurricane blowdown is rare. Occasionally tornadoes, particularly those spawned by hurricanes, created narrow streaks of downed or damaged trees over a small percent of the landscape. Such gaps are filled quickly by loblolly pine (Pinus taeda), slash pine (P. elliottii) or captured by undamaged subcanopy stems of live oak or laurel oak.

A. Johnson, in her review of this document indicated that fire may not play a critical role in maintenance of some maritime forests, specifically, those occurring on barrier islands along the Atlantic coast of Florida south of Cape Canaveral. The presence of tropical species that may not recover post fire and the prevalence of onshore easterly winds that would limit the spread of fire on the narrow, north-south oriented islands, is evidence that other factors such as salt spray and storm overwash may control successional dynamics. More research is needed on forest dynamics in these systems to clarify this question.

## Adjacency or Identification Concerns

This model covers eight major vegetation community types found in close association with each other: Live oak forest (often called live oak hammock in Florida), marshes, dune grassland, beach strand vegetation, tropical hardwood hammock (south Florida), cheniere (Louisiana), interdunal swales, and palmetto fringes, flats and swales.

In coastal environments, live oak maritime forest occurs in a fine-scale mosaic with marshes, dune grasslands, coastal strand (high beach) vegetation, cheniere and many other local vegetation types. On the side bordering saline environments, maritime forest grades into palmetto fringes and sloughs, oligohaline, brackish and salt marsh. On the wetland side bordering freshwater wetlands it grades into wetland shrubs and saplings on the margins of cypress (Taxodium distichum) and black gum (Nyssa biflora) swamps and interdunal pools. On the dry side, it grades into nearly pure live oak canopy on sand dunes exposed to salt spray.

## Scale Description

**Sources of Scale Data** ☑ Literature ☐ Local Data ☑ Expert Estimate

Most original stands of live oak were less than 1,000 acres. They occurred as one element in a much more extensive coastal complex consisting of the eight major types listed under the vegetation description above.

## Issues/Problems

Fire suppression and logging has led to conversion of two-layered forest/grass stands with open understories to dense, multistoried woody vegetation. In some places these form nearly impenetrable thickets. Such stands may have abundant greenbriers (Smilax bona-nox, Smilax glauca, Smilax rotundifolia ), with essentially no herbs. The interface between maritime forest and marsh can be defended by a wall of poison ivy. Essentially all live oak stands have been logged at least twice for ship timbers beginning in the early 1700's (Wood 1981).

Uncharacteristic vegetation: With exception of Virginia and North Carolina, maritime forests are often affected by tallow tree (Sapium sebiferum), an invasive species in coastal areas.

## Model Evolution and Comments

Model Assumptions and special definitions: For the wooded communities, a special definition was used for closed versus open classes in the succession model: "Open" here refers to stands with open understories maintained by fire (as opposed to stands with canopy openings). With exception of areas undergoing primary succession, most wooded stands had 85-95% canopy cover. Replacement in the long-lived, hurricane- and fire-resistant trees of maritime forest is essentially a tree-by tree replacement model. Most stands were highly stable communities, even those maintained with frequent fire. As is the case with most southeastern vegetation, these were not seral stands except for primary succession on unstable barrier islands. Hurricanes have little effect on live oak, the strength and iron hardness of the wood of which caused them to be sought out for over two hundred years for ships timbers. The trees were especially valued for keels and right-angled keel knee braces which were cut and shaped on site from the natural forks of massive side branches with the main trunk (Wood 1981).

Model Notes: In the barrier island type of maritime forest habitat, fire-maintained stands can be cut off from fire flow by formation of a new inlet which may break the connection to a source of fire. In this situation an old-growth stand in class D would develop a dense understory with cessation of fire, moving it to class E. This is such a rare event and affects such a small part of the landscape that it is not shown in the model.

This model will be too broad for LANDFIRE. I (Frost) have separate models for just live oak maritime forest and for marshes. Depending upon scale it might work to combine marshes, dune grasses and swales into one coastal model.

## Succession Classes

*Succession classes are the equivalent of "Vegetation Fuel Classes" as defined in the Interagency FRCC Guidebook (www.frcc.gov).*

### Class A 15%

Early1 Closed

**Description**

Class A is characterized by early post-fire replacement dune and marsh grasses. It experiences fairly complete replacement with new grass appearing within 2 weeks, and most of the cover regrows by the end of the first year. Thickening cover and the accumulation of dead grass-sedge fuel characterizes subsequent years. Common dominant species are sea oats (Uniola paniculata, salt marsh cordgrass (Spartina patens) and bitter panicum (Panicum amarum). "Closed" here refers to a nearly closed grass layer. Sea elder (Iva imbricata) may be the most common forb.

**Indicator Species* and Canopy Position**

| | |
|---|---|
| UNPA | Upper |
| SPPA | Upper |
| PAAM2 | Upper |
| IVIM | Middle |

**Upper Layer Lifeform**

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

**Fuel Model** 1

**Structure Data (for upper layer lifeform)**

| | Min | Max |
|---|---|---|
| Cover | 10 % | 95 % |
| Height | Herb Short <0.5m | Herb Tall > 1m |
| Tree Size Class | no data | |

☐ Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

### Class B 5%

Early2 Closed

**Description**

Class B is characterized by an early post-fire stand almost entirely composed of woody species, a one-layered community. It includes live oak, laurel oak and loblolly pine reproduction to 15' tall. Openings tend to be single tree gaps or narrow streaks in tornado paths. Up to 90% are sprouts and small tree canopy cover, unless in a small gap the opening may be

**Indicator Species* and Canopy Position**

| | |
|---|---|
| QUVI | Upper |
| QULA3 | Mid-Upper |
| PITA | Upper |
| PIEL | Upper |

**Upper Layer Lifeform**

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

**Fuel Model** 5

**Structure Data (for upper layer lifeform)**

| | Min | Max |
|---|---|---|
| Cover | 10 % | 100 % |
| Height | Shrub Medium 1.0-2.9m | Tree Short 5-9m |
| Tree Size Class | Pole 5-9" DBH | |

☐ Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

*Dominant and Indicator Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.

captured by one or two subcanopy stems. Pines may appear from seed. Hackberry is important in chenieres. Closed here refers to the nearly closed layer of shrubby tree sprouts and new growth.

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### *Class C* 25 %

Mid1 All Structures

**Description**

Class C is characterized by early to mid succession dune and marsh grasses and forbs, with up to 50% cover by shrubs and shrubby trees of species such as red cedar and live oak on dunes, and wax myrtle, marsh elder (Iva frutescens), young red cedar and loblolly pine in marsh fringes and sloughs.

**Indicator Species* and Canopy Position**

| | |
|---|---|
| JUVI | Upper |
| QUVI | Upper |
| IVFR | Upper |
| MYCE | Upper |

**Upper Layer Lifeform**

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

**Fuel Model** 3

**Structure Data (for upper layer lifeform)**

| | Min | Max |
|---|---|---|
| Cover | 0 % | 100 % |
| Height | Shrub Medium 1.0-2.9m | Tree Regen <5m |
| Tree Size Class | Sapling >4.5ft; <5"DBH | |

☑ Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Although woody succession is in progress the dominant species are still the dune and marsh grasses in the large openings between woody patches.

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### *Class D* 50 %

Late1 Open

**Description**

Class D is a mature to old growth maritime forest dominated by live oak. "Open" here refers to an open, grassy understory maintained by fire at frequencies ranging from 2 to 26 years, depending upon location in the landscape and proximity to Native American villages. Under these conditions, the canopy may be closed and still have an open understory.

**Indicator Species* and Canopy Position**

| | |
|---|---|
| QUVI | Upper |
| QULA3 | Mid-Upper |
| PITA | Upper |
| CHLA | |

**Upper Layer Lifeform**

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

**Fuel Model** 2

**Structure Data (for upper layer lifeform)**

| | Min | Max |
|---|---|---|
| Cover | 0 % | 10 % |
| Height | Tree Medium 10-24m | Tree Tall 25-49m |
| Tree Size Class | Very Large >33"DBH | |

☐ Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

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**Class E** 5 %

Late1 Closed

**Description**

Class E is an early to old growth Maritime forest with some bald cypress, swamp black gum and red maple in associated freshwater interdunal sloughs and pools. The live oak understory may have dense wax myrtle, yaupon and other shrubs.

**Indicator Species* and Canopy Position**

| | |
|---|---|
| QUVI | Upper |
| QULA3 | Mid-Upper |
| SMRO | Lower |
| MYCE | Lower |

**Upper Layer Lifeform**

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

**Fuel Model** 7

**Structure Data (for upper layer lifeform)**

| | Min | Max |
|---|---|---|
| Cover | 80 % | 100 % |
| Height | Tree Medium 10-24m | Tree Tall 25-49m |
| Tree Size Class | Very Large >33"DBH | |

☐ Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

## Disturbances

**Non-Fire Disturbances Modeled**

- ☐ Insects/Disease
- ☑ Wind/Weather/Stress
- ☐ Native Grazing
- ☐ Competition
- ☐ Other:
- ☐ Other:

**Historical Fire Size (acres)**

Avg: 30
Min: 5
Max: 2000

**Sources of Fire Regime Data**

- ☑ Literature
- ☑ Local Data
- ☑ Expert Estimate

**Fire Regime Group:** 1

I: 0-35 year frequency, low and mixed severity
II: 0-35 year frequency, replacement severity
III: 35-200 year frequency, low and mixed severity
IV: 35-200 year frequency, replacement severity
V: 200+ year frequency, replacement severity

***Fire Intervals (FI):***
Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inverse of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class. All values are estimates and not precise.

| | *Avg FI* | *Min FI* | *Max FI* | *Probability* | *Percent of All Fires* |
|---|---|---|---|---|---|
| *Replacement* | 40 | | | 0.025 | 18 |
| *Mixed* | 310 | 100 | 500 | 0.00323 | 2 |
| *Surface* | 9 | 3 | 50 | 0.11111 | 80 |
| *All Fires* | 7 | | | 0.13934 | |

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