



Flammability and Fire Behavior Comparisons of Sea Buckthorn in The Netherlands to East Texas and Southern California Shrub Species



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Introduction and Objective

Sea buckthorn (*Hippophae rhamnoides*) is a common coastal species in The Netherlands that potentially burns with extreme energy levels. Due to potential wildfire concerns, the objective of this study was to compare foliage flammability of sea buckthorn, yaupon (*Ilex vomitoria*), chamise (*Adenostoma fasciculatum*), and manzanita (*Arctostaphylos spp.*). Yaupon is a common East Texas shrub, and chamise and manzanita are common California chaparral species. Flammability parameters were evaluated using thermogravimetric analysis (TGA) and oxygen bomb calorimetry to estimate relative spontaneous ignition temperature (RSIT), gas-phase maximum mass loss rate (GP-MMLR), gas-phase combustion duration (GP-CD), volatile matter%, fixed carbon%, ash%, and net heat content (NHC). Anecdotal information from a recent prescribed burn along the coast of The Netherlands highlighted significant fire behavior, and this analysis shows similarities with these two North American ecosystems.



Prescribed burning of sea buckthorn



Prescribed burning of chamise

Prescribed Burn Conditions

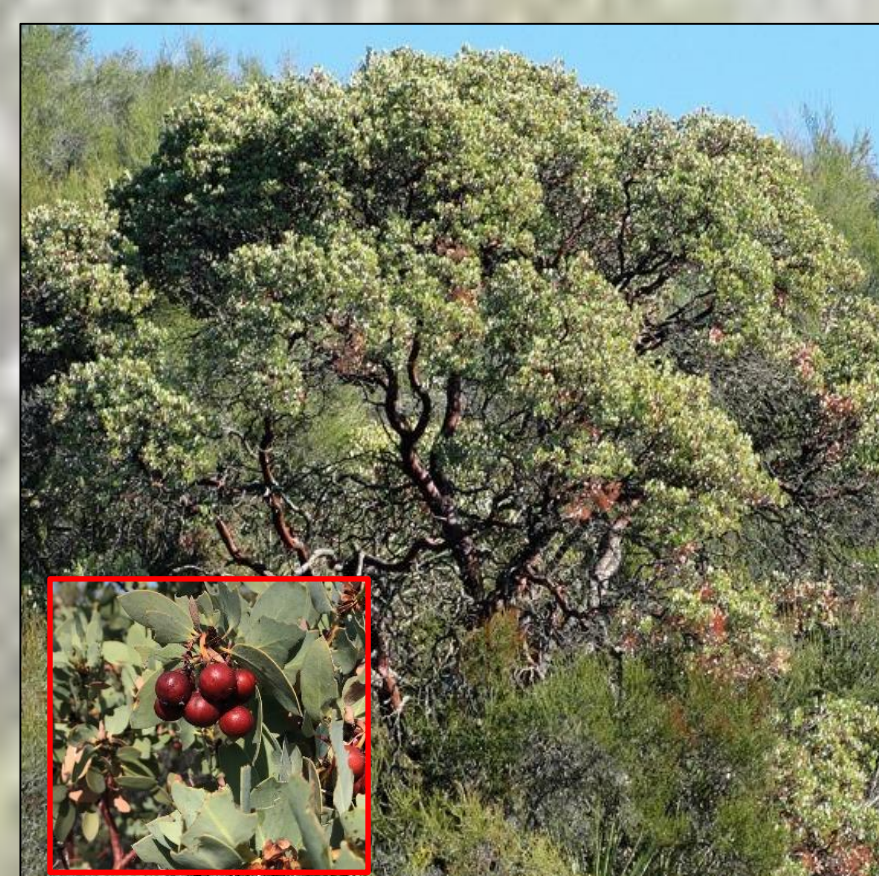
- The Netherlands was under drought conditions, with 33% of normal rainfall three months prior to the burn in February 2019. Last measurable precipitation was 0.8mm four days prior to burning
- Six-day fire weather: maximum temperatures 7.3–10.0 °C and minimum relative (RH) 53-89%
- Fire weather day of ignition (13:00-17:00): RH 82-90% and wind SW 1.9-4.5 m/s
- Ignition method: head fire secured by flanking fire and stripping downwind



Sea buckthorn (*Hippophae rhamnoides*)



Chamise (*Adenostoma fasciculatum*)



Manzanita (*Arctostaphylos spp.*)

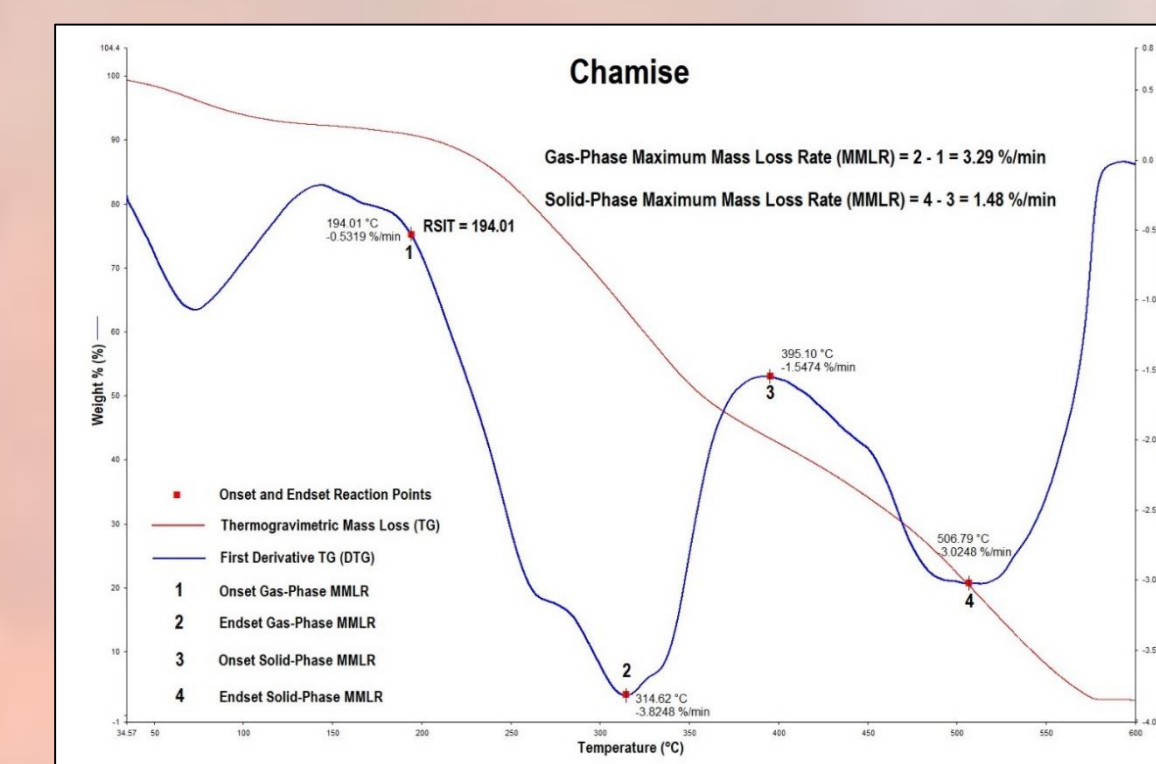
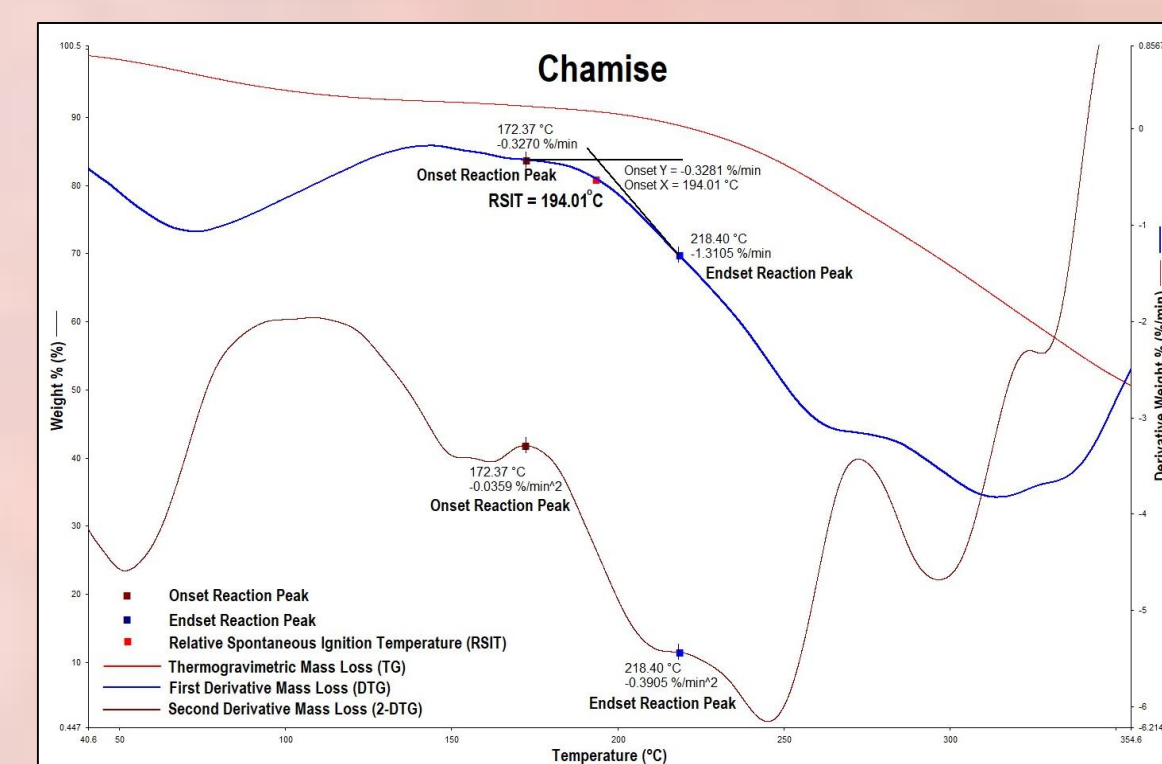


Yaupon (*Ilex vomitoria*)

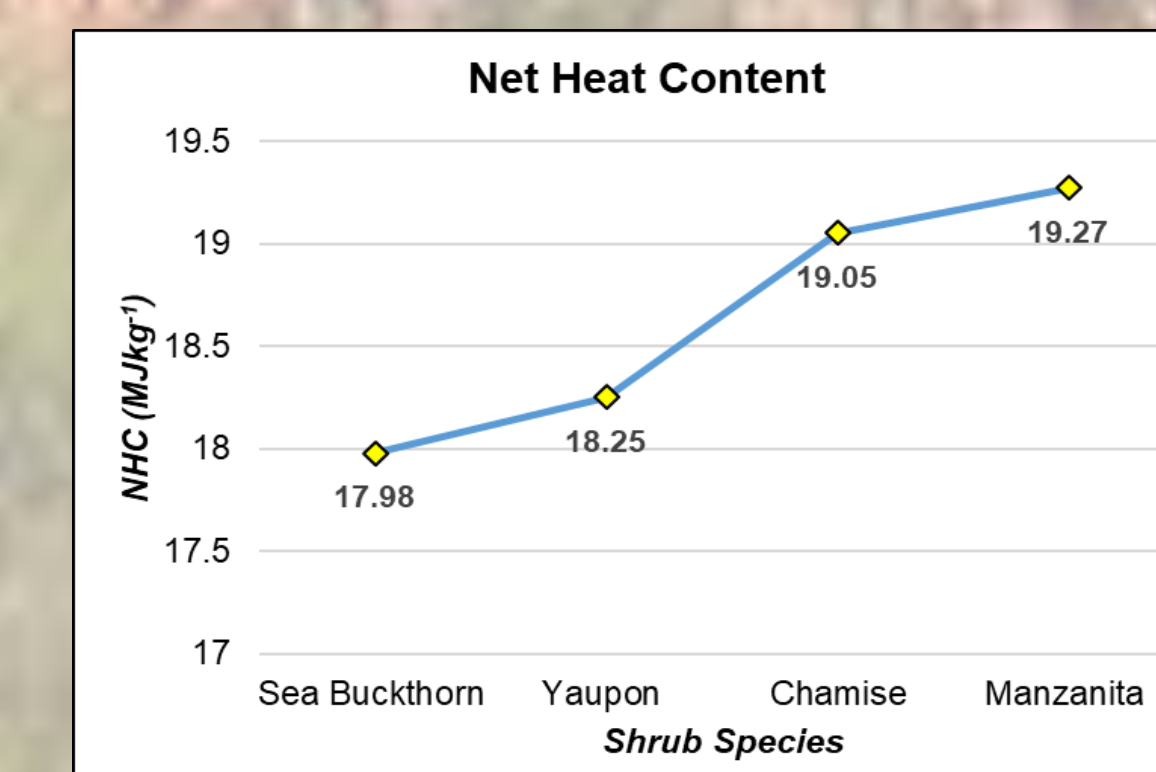
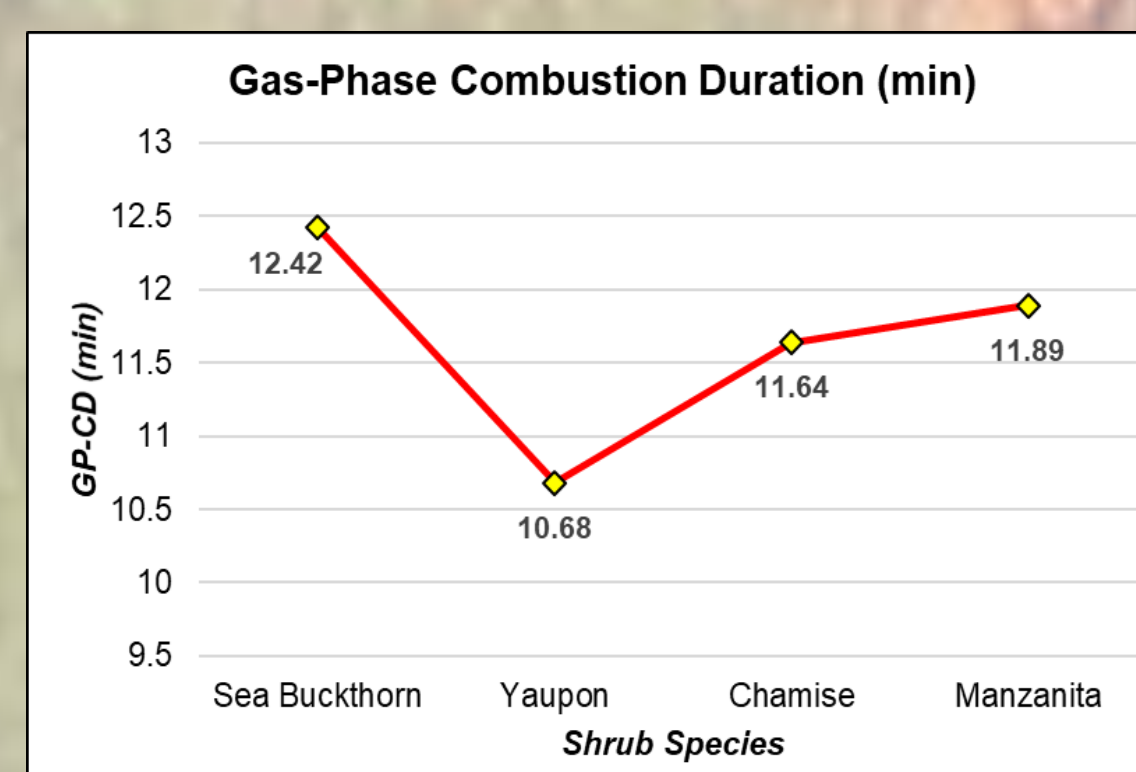
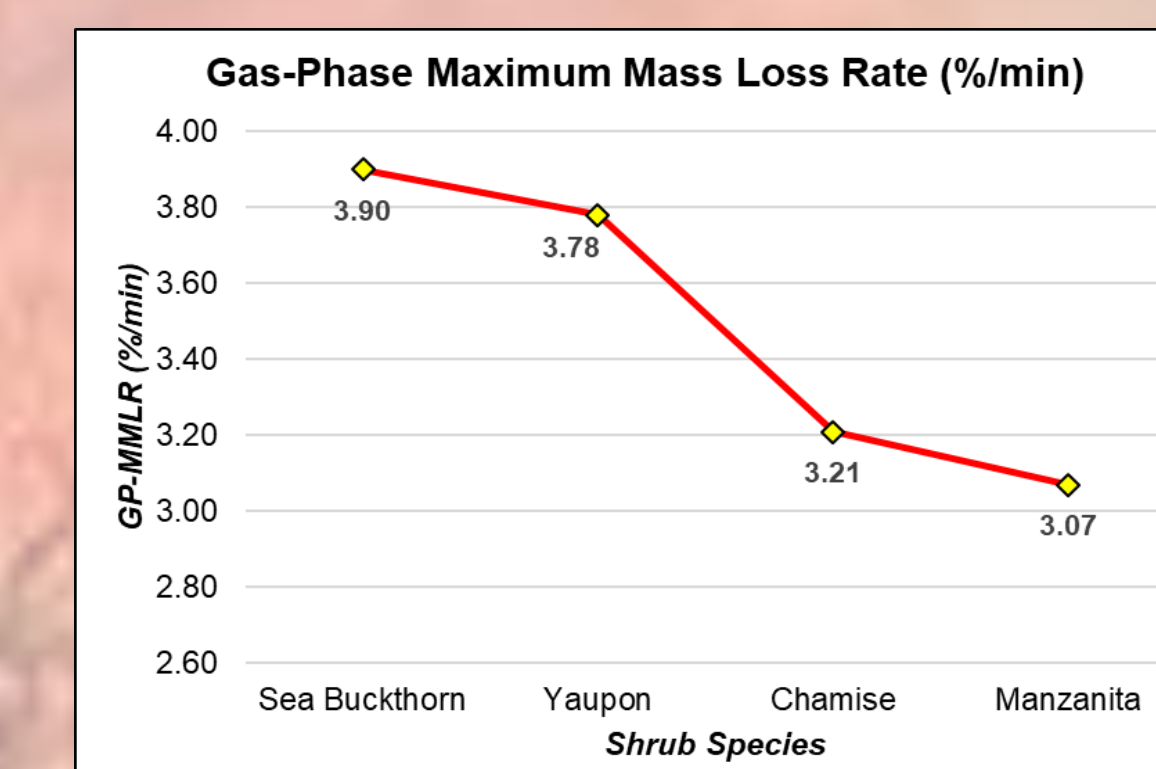
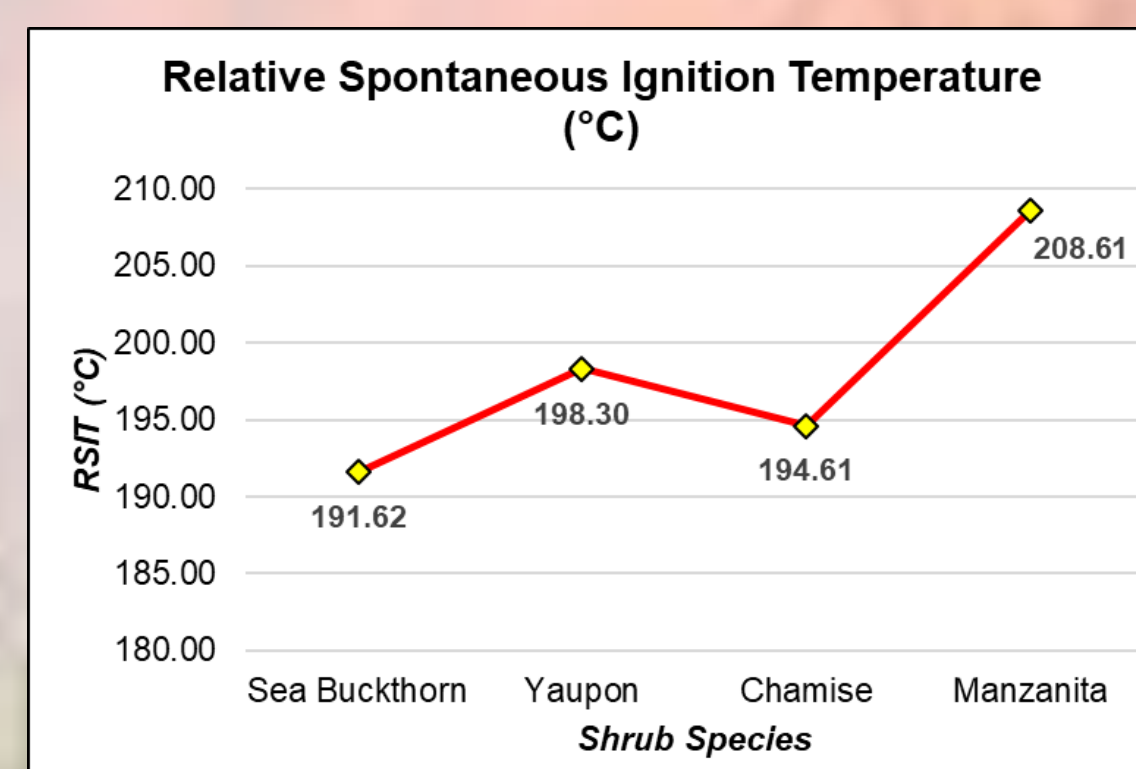
Methodology

- Foliage samples were collected at the following locations:
 - Sea Buckthorn*: Island of Terschelling in the province of Friesland, Netherlands; June 2018
 - Chamise* and *manzanita*: El Moro Elfin Forest Natural Area, Los Osos, California; August 2018
 - Yaupon*: Post Oak Savannah Ecoregion, College Station, Texas; August 2017
- Foliage samples were ground and dried at 40°C for 24 hours to avoid loss of volatiles
- Samples were passed through standard mesh sieves to obtain 35 mesh fractions
- TGA analysis using air was conducted to estimate flammability parameters of ignitability (RSIT), combustibility (GP-MMLR), and sustainability (GP-CD); and proximate analysis estimates of volatile matter%, fixed carbon%, and ash%
- Oxygen bomb calorimetry was used to estimate NHC
- NHC data was used to estimate fireline intensity (FI) and flame length (FL) following Byram (1959), as well as Scott and Burgan (2005)
 - Heat per unit area (HPA) (kJ/m²) = Fuel Load (kg/m) * NHC (kJ/kg)
 - FI (kW/m) = HPA * Rate-of-spread (m/s)
 - FL (m) = 0.078 * FI^{0.46}

Data Interpretation



Results



Acknowledgements: SFASU Department of Chemistry; Dr. Chris Dicus, Megan Knippers, and Landon Emmert

Results

Mean NHC of species with estimated fireline intensity and flame length based on similar Scott and Burgan (2005) fuel models. Rate-of-spread was set at high-moderate 0.20 m/s. (Standard deviation in parenthesis)

| <i>Fuel characteristic</i> | NHC (MJkg ⁻¹) | FI (kW/m) | FL (m) |
|----------------------------|---------------------------|-----------|--------|
| <i>Species</i> | | | |
| Sea Buckthorn * | 17.98 (0.24) | 2167.72 | 2.67 |
| Yaupon * | 18.25 (0.46) | 2200.11 | 2.69 |
| Chamise ** | 19.05 (0.22) | 2297.08 | 2.74 |
| Manzanita ** | 19.27 (0.20) | 2323.76 | 2.76 |

* FM SH8: High Load, Humid Climate ** FM SH5: High Load, Dry Climate

Mean proximate analysis composition of study species. (Standard deviation)

| <i>Species</i> | Volatile Matter % | Fixed Carbon % | Ash % |
|----------------|-------------------|----------------|-------------|
| Sea Buckthorn | 77.55 (0.10) | 20.48 (0.10) | 1.98 (0.19) |
| Yaupon | 77.66 (0.55) | 16.93 (0.54) | 5.41 (0.90) |
| Chamise | 77.04 (0.25) | 21.34 (0.25) | 1.63 (0.01) |
| Manzanita | 78.65 (0.18) | 17.13 (0.06) | 4.22 (0.13) |

Discussion

- Sea buckthorn exhibited the greatest ignitability and combustibility among all shrubs
- Species volatile matter% were similar, but fixed carbon% and ash% were quite variable
- Species with lower ash% exhibited greater ignitable as compared to species with higher ash%
- Sea buckthorn and yaupon exhibit similar NHC and subsequent FI and FL
- Overall, sea buckthorn exhibits high ignitability and combustibility comparable to chamise and yaupon respectively, both of which are well-known highly flammable shrubs in humid and dry climates of the United States
- Total species mean FI (2247.27 kW/m) and mean FL (2.72 m) suggests significant control problems under selected rate-of-spread conditions
- Based on sea buckthorn's flammability and fire behavior estimates, caution should be exercised in areas of moderate to high shrub densities in and around human development and recreation areas
- Extreme caution should also be exercised when Atlantic low pressure systems bring strong onshore winds capable of producing wind-driven fires. Likewise, drier offshore winds can produce significant fire behavior



Flank fire ignition in sea buckthorn



Head fire ignition in sea buckthorn