# Non-native Annual Grasses as Focal Species BASI

Best available scientific information (BASI): the responsible official shall document in the decision document how BASI was used to inform the plan monitoring program. This document provides additional detail to support the decision document, including how information was determined to be BASI and was determined to be most relevant, accurate, and reliable.

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| **Desired condition in the Forest Plan for the ecological system to be monitored with focal species. Other desired conditions may be listed secondarily.** | Below is a list of threats and desired conditions for dominant vegetation types in southern California Forests:<br><br>**1) Shrublands (Coastal Sage Scrub & Chaparral)**<br>A) Threats:<br>i. too frequent fire<br>ii. "coastal sage scrub and low elevation chaparral are at high risk of further decline because they are currently degraded or susceptible to invasion" (EIS: Appendix, Pg. 120).<br><br>B) Desired condition:<br>i. Goal 1.2.2 - Reduce the number of acres of chaparral and coastal sage scrub at risk from excessively frequent fires (FP: Part 1, Pg, 25).<br>ii. Move chaparral and coastal sage scrub habitats toward a fire condition class that reflects historic fire return intervals to reduce the area at risk of type conversion (FP: Part 1, Pg. 26).<br><br>**2) Invasive Species**<br>A) Desired condition:<br>i. The structure, function and composition of plant communities and wildlife habitats are not impaired by the presence of invasive nonnative plants (FP: Part 1, Pg. 32)<br>ii. Goal 2.1 – Reverse the trend of increasing loss of natural resource values due to invasive species (FS: Part 1, Pg. 31) |
| **Name a focal species and describe how the selected focal species meets the definition and requirements of the planning rule and directives.** | *Definition: A small subset of species whose status permits inference to the integrity of the larger ecological system to which it belongs and provides meaningful information regarding the effectiveness of the plan in maintaining or restoring the ecological conditions to maintain the diversity of plant and animal communities in the plan area. Focal species would be commonly selected on the basis of their functional role in ecosystems.*<br><br>Non-native annual grasses (includes *Bromus* sp., *Avena* sp., *Hordeum* sp., *Lolium* sp. and *Festuca* sp.) meet the objectives of focal species in the following ways:<br>1) Inform the ecological integrity of the southern California Forests by indirectly measuring native species extent, condition and diversity.<br>2) Indicate unnatural anthropogenic disturbance regime or condition, including too frequent fire, N deposition and soil disturbance. |

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| | 3) Represent an altered functional state with the potential to effect fire regime and behavior. |
| **Monitoring Question** | Are chaparral and coastal sage scrub vegetation communities type converting to non-native annual grasslands? |
| **Monitoring Indicators** | Extent of non-native annual grasses |
| **Describe how monitoring question and indicators evaluate changes and management effectiveness of the plan.** | The Forest Plan promotes the conservation of native habitats through the reduction of non-native species and unnatural disturbance regimes. If our monitoring efforts indicate that non-native annual grasses are becoming dominant then new consideration may be needed to ensure the integrity of shrubland ecosystems. Considerations may include ecological restoration, strategic vegetation management, public outreach, etc. |
| **How can the effects of management activities on the indicator be differentiated from those due to climate change? (Optional)** | To parse the effects of management from climate change, we can spatially project the change in vegetation cover (i.e. shrubland converted to non-native grassland) and overlay activity databases generated by the Forests (i.e. FACTS) to look for patterns in type conversion. |
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## Best Available Scientific Information

1) *Altered fire regime impacts shrublands.*
   Summary: Fire frequency in wildlands has increased in many counties in southern California. Frequent fire results in the reduction of native shrub species and an increase of non-native annual species. Repeated fire and dominance by non-native annuals decrease native species diversity.
2) *Non-native annual grass persistence*
   Summary: The legacy of non-native annual grasses can remain on the landscape even following cessation of the disturbance and they often remain abundant despite removal efforts. Recolonization of native shrub species following invasion of non-native annual grasses is often unsuccessful and is likely constrained by competition for soil moisture and light at the soil surface. Therefore, preventative actions should be taken to reduce the likelihood of invasion.
3) *Positive feedback (fire-non-native annual grasses)*
   Summary: Non-native annual grasses, through their effect on fire regime, can create a positive feedback that further degrades ecological integrity and promotes their abundance on the landscape. Non-native annual grasses increase the frequency of fire (higher surface:volume makes them more combustible), which enhances the survival of non-native annual seedbanks through the reduction of fuel loads.

** Relevant citations are found at the end of the document*

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| **Rationale for choice of question and indicators, informed by BASI.** | Non-native annual grasses are expected to increase in dominance into the future. Their abundance on the landscape indicates a degraded ecological condition driven by multiple anthropogenic factors, including short fire return interval, N deposition and climate change. Non-native annual grasses promote themselves at the expense of native vegetation through altered fire regimes (e.g. reduced fuel load and greater ignitability). Once established, non-native annual grasses constrain native regeneration and are challenging to remove from the landscape. Together these factors have garnered support of academic institutions and land managers interested in conserving the functionality of southern California ecosystems while reducing wildfire risk. This interest has led to the development of methods to track their distribution and abundance across the landscape. The southern California forests will partner with UC Riverside and the FS |

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| | regional office to evaluate the extent of non-native annual grass abundance across the province. |
| **Monitoring protocol, method, or data source; rationale informed by BASI.** | The R5 Remote Sensing Lab (RSL) has agreed to modify pre-existing algorithms that incorporate multiple facets of phenology to parse out the acres of herbaceous vs woody dominance across the four Southern California National Forests. Baseline data will be obtained using landsat imagery from the mid-1980's. RSL will quantify the acreage of shrub-dominated and non-native herbaceous-dominated lands across the southern California province through time to track type conversion. . |

## BASI Determination

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| **Relevant – BASI is relevant to the plan area, question and indicators, the desired condition, objective, and required monitoring item.** | Shrublands dominate nearly 2 million acres of the southern California forests and their dominance is being threatened by too frequent fire and other disturbances that give way to invasion by non-native annual species. Monitoring the extent of non-native annual grasses in shrublands is directly relevant to the southern California forest plan by evaluating the extent of type conversion from shrubland to non-native annual grassland, which informs objectives related to ecosystem structure, composition, and function. Many rare and endangered species depend on shrublands (e.g. CA gnatcatcher and coastal sage scrub) for habitat and foraging, therefore the relevance of this work reaches beyond the defined objectives for the plant communities themselves.<br><br>Using a landscape scale approach, like remote sensing is relevant to the goals of evaluating ecological integrity across vast landscapes.<br><br>See monitoring protocol for more details. |
| **Accurate – BASI describes the true condition. To support monitoring methods, the method has been shown to provide evidence that can answer the question and address the desired condition.** | This indicator is accurate in that it is a direct measure of ecosystem threat and estimates the condition of shrublands in southern California. |
| **Reliable – BASI uses appropriate scientific methods that are consistent with scientific principles (e.g., peer-reviewed articles). To support monitoring methods, BASI reliability also includes methods that produce reliable measurements with statistical rigor.** | The BASI is reliable and there are multiple peer-reviewed articles that support non-native annual grasses as a threat to native shrubland integrity. The R5 Remote Sensing Lab (RSL) has agreed to provide the appropriate data to the province. |

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| **Additional documentation of BASI for this monitoring question and indicators.** | |
| **Contact person** | Nicole Molinari, Province Ecologist<br>nmolinari@fs.fed.us<br>805-961-5732 |

## References Cited


1. *Altered fire regime impacts shrublands*

   **a)** Keeley J.E., Fotheringham C.J. & M. Morais (1999) Reexamining fire suppression impacts on brushland fire regimes. *Science*. 284: 1829-1832.

   **b)** Zedler P.H., Gautier C.R. & G.S. McMaster (1983) Vegetation change in response to extreme events: the effects of a short interval between fires in California chaparral and coastal scrub. *Ecology*. 64: 809-818.

   **c)** Haidinger T.L. & J.E. Keeley (1993) Role of high fire frequency in destruction of mixed chaparral. *Madrono*. 40: 141-147.

2. *Non-native annual grass persistence*

   **a)** Eliason S. & E.B. Allen (1997) Exotic grass competition in suppressing native shrubland re-establishment. *Restoration Ecology*. 5: 245-255.

   **b)** Cox R.D. & E.B. Allen (2008) Stability of exotic annual grasses following restoration efforts in southern California coastal sage scrub. *Journal of Applied Ecology*. 43: 495-504.

3. *Positive feedback (fire-non-native annual grasses)*

   **a)** D'Antonio C. & P. Vitousek (1992) Biological invasions by exotic grasses, the grass/fire cycle and global change. *Annual Review of Ecology and Systematics*. 23: 63-87.

   **b)** Davies K. & A. Nafus. (2013) Exotic annual grass invasion alters fuel amounts, continuity and moisture content. *International Journal of Wildland Fire*. 22: 353-358.

   **c)** Keeley, J.E. 2001. Fire and invasive species in Mediterranean-climate ecosystems of California. Pages 81–94 *in* K.E.M. Galley and T.P. Wilson (eds.). Proceedings of the Invasive Species Workshop: the Role of Fire in the Control and Spread of Invasive Species. Fire Conference 2000: the First National Congress on Fire Ecology, Prevention, and Management. Miscellaneous Publication No. 11, Tall Timbers Research Station, Tallahassee, FL.


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# Plan Monitoring Program BASI Multiple Use Monitoring

Best available scientific information (BASI): the responsible official shall document in the decision document how BASI was used to inform the plan monitoring program. This document provides additional detail to support the decision document, including how information was determined to be BASI and was determined to be most relevant, accurate, and reliable.

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| **Desired condition in the Forest Plan** | From Goal 4.1a: The desired condition is that approved minerals and energy developments are managed to facilitate production of mineral and energy resources while minimizing adverse impacts to surface and groundwater resources and protecting or enhancing ecosystem health and scenic values.<br><br>From Goal 4.1b: The desired condition for solar, wind and hydro-electric energy resources is that national forests will support the use of these renewable resources to help meet the growing energy needs in southern California while protecting other resources. The desired condition for biomass is that as national forests generate timber and chipped woody material as a by-product of ecosystem management, healthy forest restoration, fuels management and community protection projects, that biomass will provide for energy co-generation when other higher value options are not available.<br><br>From Goal 7.1: Special-uses serve public needs, provide public benefits, and conform to resource management and protection objectives. |
| **Monitoring Question** | How many of each type of special use authorization, mining permit, and forest product permit are active on the forest? |
| **Monitoring Indicators** | Number of Special Use Authorizations and Permits by Type |
| **Describe how monitoring question and indicators evaluate changes and management effectiveness of the plan.** | This question and its indicators will provide a means for tracking the volume and diversity of multiple uses across the Southern California National Forests. This information will help gage progress towards achieving the desired conditions listed above. |
| **Describe how this monitoring relates to one or more of the eight required items for forest plans.** | This monitoring would reveal "(vii) progress toward meeting the desired conditions and objectives in the plan, including for providing multiple use opportunities." |

## Best Available Scientific Information

There is high demand for special uses of the Southern California National Forests, and as a multiple use land management agency, balancing these uses against one another and ecosystem management is an ongoing, important function of the Forest Service. Fedkiw (1998) provides an overview of the history of Forest Service multiple use management in the context of the evolving uses of the National Forests. The proposed monitoring question answers basic questions for tracking special uses through time, and it directly evaluates the desired conditions for 4.1a, 4.1b, and 7.1 in terms of the extent of use authorization.

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| **Rationale for choice of question and indicators, informed by BASI.** | Monitoring special uses volume and diversity will inform Southern California National Forest managers about the level of multiple use opportunities being offered and an indication of societal values. |
| **Monitoring protocol, method, or data source; rationale informed by BASI.** | The Forest Service Special Uses Data System (SUDS), Timber Information Management System (TIMS), and Minerals and Geology Database will be queried for each National Forest to inform the monitoring report, in terms of the type of each active use and number of permits by type. These data will be compared against the previous monitoring report to evaluate change. |

## BASI Determination

Fedkiw (1998) is the only suitable reference found for monitoring special uses of the Southern California National Forests. It is relevant, accurate, and reliable, and the monitoring approach is similar to other Land Management Plan monitoring questions that use readily available data to evaluate progress towards its Goals.

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| **Relevant – BASI is relevant to the plan area, question and indicators, the desired condition, objective, and required monitoring item.** | Fedkiw (1998) directly addresses National Forests, many types of special uses, the need to provide uses while protecting resources, and multiple use opportunities. |
| **Accurate – BASI describes the true condition. To support monitoring methods, the method has been shown to provide evidence that can answer the question and address the desired condition.** | The method in this case is very straightforward, in that it summarizes the database that tracks special uses of the National Forests. |
| **Reliable – BASI uses appropriate scientific methods that are consistent with scientific principles (e.g., peer-reviewed articles). To support monitoring methods, BASI reliability also includes methods that produce reliable measurements with statistical rigor.** | Fedkiw (1998) is a narrative analysis of the topic without statistical analysis. It is replete with data and references that support the claims being made, and it received review sufficient for agency publication and a foreword by the former Chief of the Forest Service. No peer-reviewed article was found that addressed this topic directly. |
| **Additional documentation of BASI for this monitoring question and indicators.** | This monitoring question and indicator is similar to other elements of ongoing Land Management Plan monitoring that use existing Forest Service databases to evaluate progress towards meeting its Goals. |
| **Contact person** | Jeff Heys, Forest Planner, Cleveland National Forest<br>(858) 674-2959<br>jaheys@fs.fed.us |

## References Cited

Fedkiw, J. Managing Multiple Uses on National Forests, 1905-1995: A 90-year Learning Experience and It Isn't Finished Yet. 1998. USDA Forest Service. FS-628.

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# Plan Monitoring Program BASI
# Tree Mortality

Best available scientific information (BASI): the responsible official shall document in the decision document how BASI was used to inform the plan monitoring program. This document provides additional detail to support the decision document, including how information was determined to be BASI and was determined to be most relevant, accurate, and reliable.

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| **Desired condition in the Forest Plan** | From Goal 1.2, Montane Conifer Forests: In the long-term, the desired condition for the remaining unburned national forest land will be to: (1) create forests more resistant to the effects of drought, insect and disease outbreaks and stand-killing crown fires; (2) encourage tree recruitment that contain a species mix more like pre-settlement composition, (i.e., with a higher representation of shade-intolerant species like ponderosa pine that have declined during the period of fire suppression) - Figure 2; (3) recreate stand densities more like those of the presuppression era; and (4) encourage a stand structure that emphasizes large-diameter trees.<br><br>From Goal 1.2, Oak Woodlands and Savannas: The desired condition is to retain existing oak woodlands and savannas. |
| **Monitoring Question** | Is tree mortality increasing across the landscape, and is it distributed evenly across elevations? |
| **Monitoring Indicators** | Mortality Risk Assessment and Forest Health Protection Mortality Surveys |
| **Describe how monitoring question and indicators evaluate changes and management effectiveness of the plan.** | This question and its indicators will provide a means for tracking tree mortality across the Southern California National Forests, including cross-referencing this information with elevation data to evaluate potential effects of climate change. This information will help gage progress towards achieving the desired conditions listed above. |
| **Describe how this monitoring relates to one or more of the eight required items for forest plans.** | This monitoring would reveal "(ii) the status of select ecological conditions including key characteristics of terrestrial and aquatic ecosystems, …(iv) the status of a select set of the ecological conditions required under §219.9 to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern," and "(vi) measurable changes on the plan area related to climate change and other stressors that may be affecting the plan area." |

## Best Available Scientific Information

There is solid evidence that climate change along with other stressors can lead to tree mortality at lower elevations in mountainous regions (Allen and Breshears 1998, Allen et al. 2010, and Jump et al. 2009). The proposed monitoring question expands upon the existing monitoring question that evaluates tree mortality by adding an elevational component to investigate whether this trend is occurring across the Southern California National Forests.

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| **Rationale for choice of question and indicators, informed by BASI.** | National Forest management in Southern California needs to be informed by the tree mortality trends occurring on the landscape. Project initiation and design should take into account the potential for changes in suitable habitat for trees due to climate change and other stressors. |

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| **Monitoring protocol, method, or data source; rationale informed by BASI.** | Compare the annual National Insect and Disease Risk Map (NIDRM) data with Forest Health Protection tree mortality surveys, and cross-reference these with elevation data by species. |

## BASI Determination

Allen and Breshears 1998, Allen et al. 2010, and Jump et al. 2009 are the most relevant scientific articles found through literature research, and all three directly address the changing situation for forests due to climate change and other stressors. Increasing tree mortality is likely to occur in Southern California, and it may be concentrated at lower elevations.

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| **Relevant – BASI is relevant to the plan area, question and indicators, the desired condition, objective, and required monitoring item.** | Two of the papers (Allen et al. 2010 and Jump et al. 2009) are globally focused, while the third (Allen and Breshears 1998) is from a neighboring region. All three papers are directly relevant to forest health and tree mortality as well as climate change and ecological conditions. |
| **Accurate – BASI describes the true condition. To support monitoring methods, the method has been shown to provide evidence that can answer the question and address the desired condition.** | The method in this case relies on aerial overflights to visually document areas of tree mortality. These data are annually collected by trained field observers and directly relate to the monitoring question and the desired conditions. The elevation data can be analyzed in GIS to determine the evenness of tree mortality distribution. |
| **Reliable – BASI uses appropriate scientific methods that are consistent with scientific principles (e.g., peer-reviewed articles). To support monitoring methods, BASI reliability also includes methods that produce reliable measurements with statistical rigor.** | All three references come from peer-reviewed journals, and two are syntheses of multiple studies. |
| **Additional documentation of BASI for this monitoring question and indicators.** | This monitoring question and indicator is similar to other elements of ongoing Land Management Plan monitoring that use existing Forest Service databases to evaluate progress towards meeting its Goals. |
| **Contact person** | Jeff Heys, Forest Planner, Cleveland National Forest<br>(858) 674-2959<br>jaheys@fs.fed.us |

## References Cited


Allen, C.D., Breshears, D.D., 1998. Drought-induced shift of a forest-woodland ecotone: rapid landscape response to climate variation. Proceedings of the National Academy of Sciences of the United States of America 95: 14839–14842.

Allen, C.D., A.K. Macalady, H. Chenchouni, D. Bachelet, N. McDowell, M. Vennetier, T. Kitzberger, A. Rigling, D.D. Breshears, E.H. Hogg, P. Gonzalez, R. Fensham, Z. Zhang, J. Castro, N. Demidova, J. Lim, G. Allard, S.W. Running, A. Semerci, and N. Cobb. 2010. A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests. Forest Ecology and Management 259: 660-684.


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Jump, A.S., C. Mátyás, and J. Peñuelas. 2009. The altitude-for-latitude disparity in the range retractions of woody species. Trends in Ecology and Evolution, doi:10:1016/j.tree.2009.06.007.

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# Plan Monitoring Program BASI Streamflow

Best available scientific information (BASI): the responsible official shall document in the decision document how BASI was used to inform the plan monitoring program. This document provides additional detail to support the decision document, including how information was determined to be BASI and was determined to be most relevant, accurate, and reliable.

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| **Desired condition in the Forest Plan** | From Goal 5.1: Watersheds, streams, groundwater recharge areas, springs, wetlands and aquifers are managed to assure the sustainability of high quantity and quality water. Where new or re-authorized water extraction or diversion is allowed, those facilities should be located to avoid long-term adverse impacts to national forest water and riparian resources.<br><br>From Goal 5.2: The desired condition is that watercourses are functioning properly and support healthy populations of native and desired nonnative riparian dependent species.<br><br>From Goal 6.2: Flow regimes in streams that provide habitat for threatened, endangered, proposed, candidate, and/or sensitive aquatic and riparian-dependent species are sufficient to allow the species to persist and complete all phases of their life cycles.<br><br>Habitat conditions sustain healthy populations of native and desired nonnative fish and game species. Wildlife habitat functions are maintained or improved, including primary feeding areas, winter ranges, breeding areas, birthing areas, rearing areas, migration corridors, and landscape linkages. Fish habitat functions are maintained or improved, including spawning areas, rearing areas, and upstream and downstream migration, where possible. |
| **Monitoring Question** | How do streamflows compare with historical records? |
| **Monitoring Indicators** | Monthly Streamflows, Timing and Magnitude of Peak Flows, Degree of Variation |
| **Describe how monitoring question and indicators evaluate changes and management effectiveness of the plan.** | This question and its indicators will detect changes in streamflows over time, which is particularly needed to address uncertainty about the potential influence of climate change on streamflows in Southern California. The monitoring results would enable evaluation of the effectiveness of the plan in achieving the desired conditions specified above. In particular, this monitoring will help determine how to balance water needs of the National Forests against requests for water use in a changing climate and may inform habitat protection and restoration efforts. |
| **How can the effects of management activities on the indicator be differentiated from those due to climate change? (Optional)** | Large-scale water use on the National Forest is monitored, whereas effects of land management on water supply are less well known. The analysis that would be needed to discriminate between climate change and ordinary streamflow variation falls beyond the scope of this monitoring question. Instead, trends could be identified over time to inform water and land management. |

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| **Describe how this monitoring relates to one or more of the eight required items for forest plans.** | This monitoring would reveal "(i) the status of [a] select watershed condition" as well as "(ii) the status of [a] select ecological condition including key characteristics of terrestrial and aquatic ecosystems." Changing streamflows also clearly constitute "(vi) measurable changes on the plan area related to climate change and other stressors that may be affecting the plan area." |

## Best Available Scientific Information

Lettenmeier, Wood, and Wallis (1994) used monthly streamflows among other variables to evaluate trends in hydro-climatological observations across the U.S. and found that detectable trends were due to both climatic and water management effects. Lins and Michaels (1994) used monthly streamflows to document increasing streamflows across the U.S. due to "greenhouse forcing." Lins and Slack (1999) also found a trend of increasing streamflow across the U.S. using stream gage data. All three studies support the use of streamflow data to evaluate the effects of climate change, but no study was found that focused on changes in Southern California. The use of similar methods is therefore needed to provide local analysis of streamflow change.

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| **Rationale for choice of question and indicators, informed by BASI.** | The potential for climate change to affect streamflow for the Southern California National Forests, where any changes could substantially affect riparian ecosystems and water users, warrants monitoring. |
| **Monitoring protocol, method, or data source; rationale informed by BASI.** | Compare monthly streamflows, timing and magnitude of peak flows, and degree of variation for the period being monitored with streamflow baseline data prior to 1990. While the referenced studies suggest that streamflows were already being affected by climate change by 1990, data reliability would be reduced with the use of an earlier baseline and the pace of change is likely to have increased since then. |

### BASI Determination

Lettenmeier, Wood, and Wallis (1994), Lins and Michaels (1994), and Lins and Slack (1999) all evaluated streamflow trends across the U.S. in relation to climate change, and similar methods would be suitable for analysis of streamflow trends on the Southern California National Forests.

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| **Relevant – BASI is relevant to the plan area, question and indicators, the desired condition, objective, and required monitoring item.** | The three references provided are studies conducted across the U.S., pertain directly to evaluating streamflow trends due to climate change using gage data, evaluate flow conditions that support water supply, riparian function, and wildlife, and investigate watershed and ecological conditions with measureable changes related to climate change and other stressors. |
| **Accurate – BASI describes the true condition. To support monitoring methods, the method has been shown to provide evidence that can answer the question and address the desired condition.** | The use of streamflows from gage data in all three studies enabled analysis of nationwide trends in streamflows over time. Trends at the level of the Southern California National Forests can be analyzed with similar methods. |

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| **Reliable – BASI uses appropriate scientific methods that are consistent with scientific principles (e.g., peer-reviewed articles). To support monitoring methods, BASI reliability also includes methods that produce reliable measurements with statistical rigor.** | All three articles were published in peer-reviewed journals and have been cited by numerous additional studies. Because the monitoring question and indicators do not include correlation of streamflow with climatic data, less sophisticated statistical methods will be needed. |
| **Contact person** | Jeff Heys, Forest Planner, Cleveland National Forest<br>(858) 674-2959<br>jaheys@fs.fed.us |

## References Cited


Lettenmaier, D.P., E.F. Wood, and J.R. Wallis. 1994. Hydro-climatological trends in the continental United States, 1948-88. Journal of Climatology 7: 586-607.

Lins, H.F. and P.J. Michaels. 1994. Increasing U.S. streamflow linked to greenhouse forcing. Eos, Transactions, American Geophysical Union 75(25): 281, 284, 285.

Lins, H.F. and J.R. Slack. 1999. Streamflow trends in the United States. Geophysical Research Letters 26(2): 227-230.


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# Plan Monitoring Program BASI Fire Frequency

Best available scientific information (BASI): the responsible official shall document in the decision document how BASI was used to inform the plan monitoring program. This document provides additional detail to support the decision document, including how information was determined to be BASI and was determined to be most relevant, accurate, and reliable.

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| **Desired condition in the Forest Plan** | **Goal 1.2**: Restore forest health where alteration of natural fire regimes have put human and natural resource values at risk.<br>**Goal 3.2**: Retain a natural evolving character within wilderness.<br>**Goal 6.2**: Provide ecological conditions to sustain viable populations of native and desired nonnative species. |
| **Monitoring Question** | Is fire frequency becoming more departed from the natural range of variation? |
| **Monitoring Indicators** | Proportion of the landscape with departed fire frequency |
| **Describe how monitoring question and indicators evaluate changes and management effectiveness of the plan.** | The proposed question and indicators aim to detect changes in fire frequency through time. Deviations from historical fire frequency can be used to evaluate plan effectiveness as it relates to the specific desired conditions described above. In particular, this monitoring effort will inform deviations from the natural range of variation in southern California habitats and provide direction on valuable resources at risk and help prioritize resources in need of protection or restoration due to altered fire frequency. |
| **How can the effects of management activities on the indicator be differentiated from those due to climate change? (Optional)** | |
| **Describe how this monitoring relates to one or more of the eight required items for forest plans.** | This monitoring questions informs '(vi) measureable changes on the plan areas related to climate change and other stressors that may be affecting the plan area'. |
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## Best Available Scientific Information

Fire regime in southern California has been altered from pre-European conditions and is likely to become more departed with global change factors, including climate change, non-native species and human population growth. Fire frequency is one component of fire regime where deviations from pre-European settlement to current conditions are better understood (Van de Water & Safford, 2011; Safford & Van de Water, 2013). Many shrubland habitats, especially those in ignition-prone areas in close proximity to the urban-interface, are burning more today than in the

past (Stephenson & Calcarone, 1999; Keeley & Fotheringham, 2001; Safford & Van de Water, 2014), which can affect native species composition and lead to an increase in the abundance of non-native annual species (Zedler et al., 1983; Haidinger & Keeley, 1993). In contrast, mixed conifer forests at higher elevations are experiencing far fewer fires today than before European settlement (Skinner et al., 2006; Safford & Van de Water, 2013) and fire suppression has resulted in changes in stand structure and increased fuel loads in southern California forests (Skinner et al., 2006). Altered fire frequency can lead to changes in fire severity, which can slow post-fire vegetation recovery and lead to type conversion.

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| **Rationale for choice of question and indicators, informed by BASI.** | Fire frequency across Southern California National Forests is likely to become more departed from historic conditions in the future, therefore monitoring is needed to identify areas on the landscape that are most departed and in need of management actions. |
| **Monitoring protocol, method, or data source; rationale informed by BASI.** | Spatial data from the Fire Return Interval Departure (FRID) assessment generated by the USDA Forest Service, Pacific Southwest Region will be used to inform current departure from pre-European fire return interval. This polygon layer consists of information compiled about fire return intervals for major vegetation types on the National Forests in California and adjacent land jurisdictions. Comparisons are made between pre-Euroamerican settlement and contemporary fire return intervals (FRIs). Current departures from the pre-Euroamerican settlement FRIs are calculated based on mean, median, minimum, and maximum FRI values. |

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| **Relevant – BASI is relevant to the plan area, question and indicators, the desired condition, objective, and required monitoring item.** | The National Forest lands in southern California are dominated by shrubland and mixed conifer vegetation types and therefore the fire frequency deviations described in the cited references directly apply across the southern California province. The Fire Return Interval Departure (FRID) developed by USFS, Pacific Southwest Region provides valuable spatial information needed to prioritize management actions to meet the desired conditions described above. |
| **Accurate – BASI describes the true condition. To support monitoring methods, the method has been shown to provide evidence that can answer the question and address the desired condition.** | Multiple techniques have been used to estimate pre-European fire return intervals in different vegetation types and the selected references include the best available techniques and information concerning estimates of historic fire return intervals. |
| **Reliable – BASI uses appropriate scientific methods that are consistent with scientific principles (e.g., peer-reviewed articles). To support monitoring methods, BASI reliability also includes methods that produce reliable measurements with statistical rigor.** | The FRID uses the best available data from published, peer-reviewed manuscripts to define fire return intervals prior to European settlement across California (see Van de Water & Safford, 2011 for literature review). Articles referenced in this BASI are either peer-reviewed journal articles or USFS General Technical Reports. They represent the current, most widely cited and accepted data describing departures from historic fire return intervals. |

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| **Additional documentation of BASI for this monitoring question and indicators.** | |
| **Contact person** | Nicole Molinari, Province Ecologist<br>805-961-5732<br>nmolinari@fs.fed.us |

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# Plan Monitoring Program BASI
# Fire Regime

Best available scientific information (BASI): the responsible official shall document in the decision document how BASI was used to inform the plan monitoring program. This document provides additional detail to support the decision document, including how information was determined to be BASI and was determined to be most relevant, accurate, and reliable.

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| **Desired condition in the Forest Plan** | **Goal 1.1**: Improve the ability of southern California communities to limit loss of life and property and recover from the high intensity wildland fires that are a natural part of this state's ecosystems.<br>**Goal 1.2**: Restore forest health where alteration of natural fire regimes have put human and natural resource values at risk.<br>**Goal 3.2**: Retain a natural evolving character within wilderness.<br>**Goal 6.2**: Provide ecological conditions to sustain viable populations of native and desired nonnative species. |
| **Monitoring Question** | Are wildfires becoming larger, more frequent, or more severe, and is there a seasonal shift in fire activity? |
| **Monitoring Indicators** | Total and mean fire size, ignition density, fire severity and monthly area burned |
| **Describe how monitoring question and indicators evaluate changes and management effectiveness of the plan.** | The evaluation of these fire-related indicators will inform the direction and magnitude of changes in fire regime, which can be used to evaluate plan effectiveness as it relates to the specific desired conditions described above. In particular, this monitoring effort will track changes in fire related metrics through time to inform deviations in fire activity across southern California habitats. This monitoring will be used to identify valuable resources at risk, and direct the development of strategies for resource protection and restoration. |
| **How can the effects of management activities on the indicator be differentiated from those due to climate change? (Optional)** | Fire-related management activities, especially those employed in conifer dominated vegetation types, aim to ameliorate catastrophic wildfire events, while climate change may enhance the scale and intensity of wildfire events. Therefore, fire severity and mean fire size may be reduced in areas where fuels management activities have been conducted. |
| **Describe how this monitoring relates to one or more of the eight required items for forest plans.** | This monitoring questions informs '(vi) measureable changes on the plan areas related to climate change and other stressors that may be affecting the plan area'. |
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## Best Available Scientific Information

Climate interacts with fire through its effects on vegetation. Temperature and precipitation are important factors determining the moisture available for plant growth and the flammability of vegetation is dictated by climate

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patterns over shorter time scales (e.g. variability in interannual precipitation and temperature). There is uncertainty in the magnitude of warming and the direction and magnitude of precipitation change in California, and this is reflected in the range of projections for future fire trends (e.g. fire size, number, severity, seasonality). Westerling et al. (2011) project an increase in area burned (12-74%) in California through the next century (2085), with the potential increase of 56% for the medium-high emission scenario under the warmer drier climate scenario. Similarly, Lenihan et al. (2008) predict an increase in total area burned across the state at the end of the 21st century. In an analysis of climate change effects on fire in Mediterranean ecosystems, Batllori et al. (2013) found an increase in fire probability for California and Baja, Mexico over the next century. Jin et al. (2015) project shifts in fire size, fire number and area burned over the next 50 years (2041-2060) with a substantial increase in the area burned during non Santa Ana driven fires (77% ± 44%) and Santa Ana wind driven fires (64% ± 76%).

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| **Rationale for choice of question and indicators, informed by BASI.** | Given the likelihood of increased fire activity across California, it is important to identify the direction and magnitude of these changes through monitoring. |
| **Monitoring protocol, method, or data source; rationale informed by BASI.** | Compute mean fire size, total area burned, ignition density, fire severity and monthly area burned for the current monitoring period and compare to baseline statistics from the 2006 Southern California Land Management Plan analysis. |

## BASI Determination

Lenihan et al. (2008), Westerling et al. (2011), Batllori et al. (2013) and Jin et al. (2015) all evaluated elements of fire activity into the future using downscaled data from multiple global circulation models and emission scenarios. Despite the climate predictions from these various models, all the references are in agreement that California will experience an increase in total area burned or an increase in fire probability over the next century.

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| **Relevant – BASI is relevant to the plan area, question and indicators, the desired condition, objective, and required monitoring item.** | Given that the four references provided are specific to California, the findings from these studies are directly relevant to the lands managed by the US Forest Service in southern California. |
| **Accurate – BASI describes the true condition. To support monitoring methods, the method has been shown to provide evidence that can answer the question and address the desired condition.** | There is uncertainty associated with modeling climate change fire activity. Yet, the overwhelming conclusion from the BASI, regardless of modeling technique and climate scenario (warmer wetter and warmer drier), point towards increases in total area burned and fire probability in the future. |
| **Reliable – BASI uses appropriate scientific methods that are consistent with scientific principles (e.g., peer-reviewed articles). To support monitoring methods, BASI reliability also includes methods that produce reliable measurements with statistical rigor.** | All four articles were published in peer-reviewed journals and are well cited by other peer reviewed manuscripts. The indicators used in monitoring fire activity across southern California will be summarized and compared to baseline fire data and used to track trends through time. |

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## References Cited


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