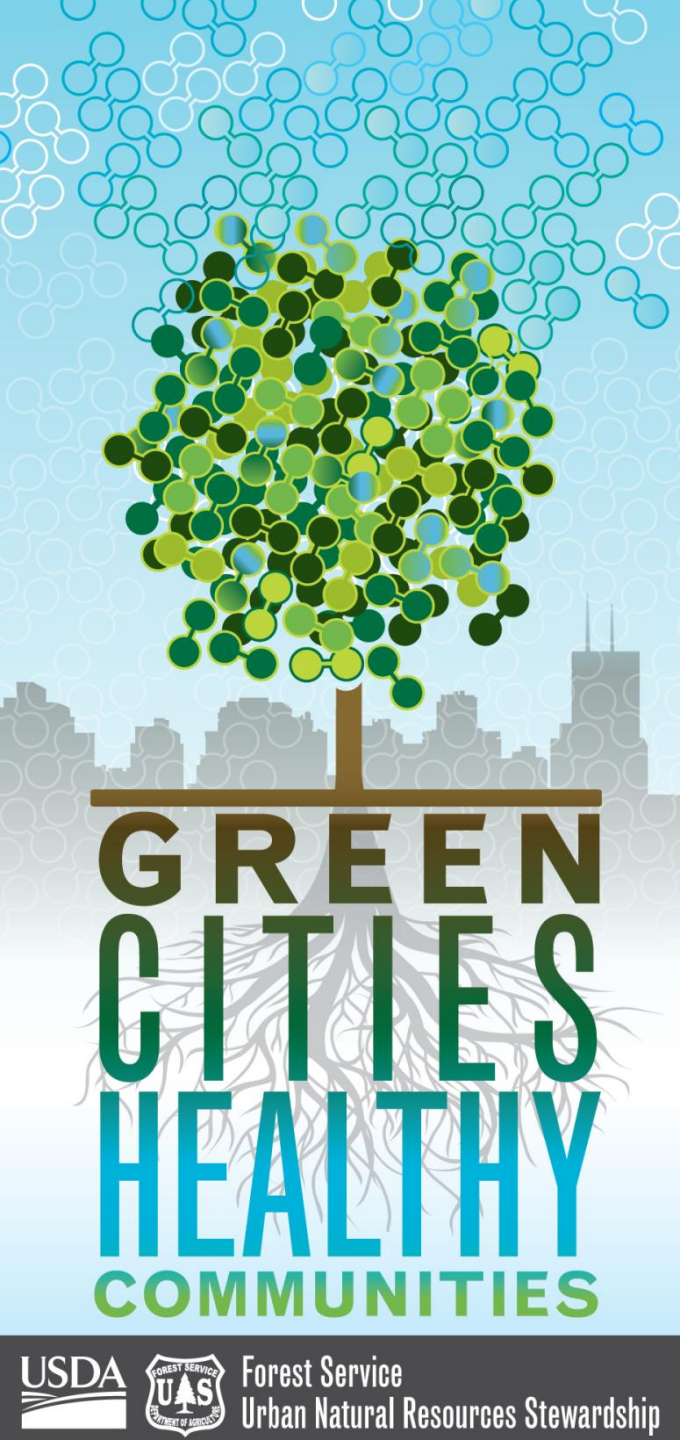


USDA Forest Service

URBAN FOREST CONNECTIONS

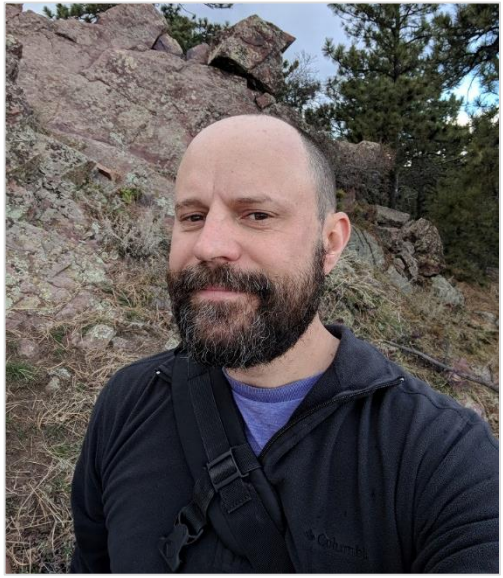
webinar series

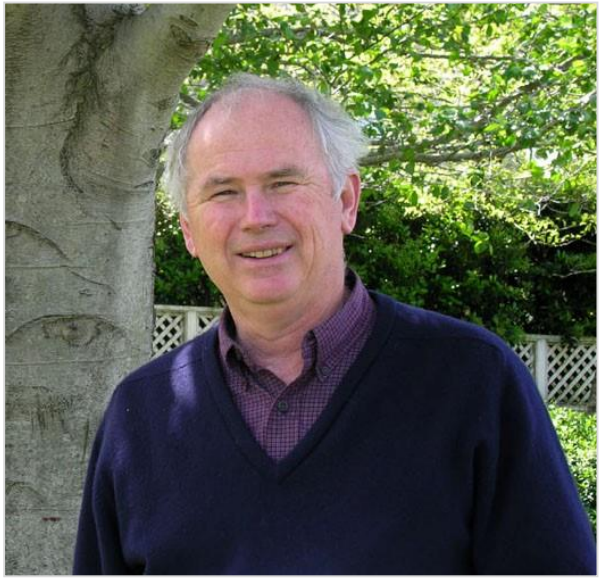
Second Wednesdays | 1:00 – 2:15 pm ET

www.fs.fed.us/research/urban-webinars

USDA is an equal opportunity provider and employer.

Construction Damage, Severe Storms, and Tree Failure Analysis





Eric North

Assistant Professor of Practice

University of Nebraska-Lincoln

eric.north@unl.edu

Larry Costello

President

Oracle Oak LLC & University of California Emeritus

larryoracleoak@me.com

Tree Failure Analysis: Western Tree Failure Database

L. R. Costello, University of California (Emeritus)

USDA Forest Service
Urban Forest Connections
Webinar Series 9/12/18

Interference with utilities and human activities

http://ucanr.edu/sites/treefail/

SKIP TO CONTENT SITE MAP Enter Search Terms

University of California

California Tree Failure Report Program

- Home
- News
- Become a Cooperator
- Contact Information
- CTFRP Statistics
- Failure Photos
- Species Profiles and Summaries
- Stories
- Annual Meetings
- Annual Meeting Speakers Presentations and Handouts
- Post a Question
- Downloads
- Quick Break newsletters
- Tree Links

SHARE | PRINT

Home

The California Tree Failure Report Program (CTFRP) was established in 1987 to collect quantitative information on the mechanical failure of urban trees (trunk breaks, branch breaks, and uprootings). This information is used to develop "failure profiles" for genera and species to more accurately assess failure probability in standing trees and thereby reduce failure potential in urban forests.

Over 200 tree care professionals in California are cooperating in this effort by systematically inspecting fallen trees and reporting failure details for entry into the CTRFP database. To date (April 18, 2018) 6099 failure reports have been filed.

California Tree Failure Report data has been (up to 2012) merged with the International Tree Failure Database.

August, 2015, The ITFD website is off line for the foreseeable future.

January 2018, There is an on going attempt to restore the ITFD...stay tuned.

Contact Katherine Jones at treefail@mac.com if you have questions.

An occasional e-newsletter, Quick Break, is circulated to CTFRP cooperators. Annual Regional Meetings addressing issues relevant to hazard assessments and failure analysis are presented in January for northern California and March in southern California.

incense cedar root failure

Photo: K. Jones

Monterey cypress trunk failure

Photo: K. Jones

Division of Agriculture and Natural Resources, University of California

© 2018 Regents of the University of California | Division of Agriculture and Natural Resources | Nondiscrimination Statement
Accessibility | Get PDF Reader | Get Flash Player | Site Information

Rationale

- Collect detailed information regarding trees after they fail.
- Learn key factors that contribute to failures.
- Use the information to manage trees to reduce their potential for failure .

Objectives

- Reduce the potential for personal injury (increase safety).
- Reduce the potential for property damage.
- Reduce interference with utilities and human activities.
- Reduce liabilities associated with failures.

Process

- Cooperator training
- Entering data on report form
- Submitting data

Form ID Number_____

TREE FAILURE DATABASE - REPORT FORM

*REQUIRED FIELD

1 General Tree Info
2 Failure Type
3 Failure Specifics
4 Structural Defects
5 Decay or Injury
6 Maintenance History
7 Tree Failure Details
8 Weather Conditions
9 Comments & Save

1 Tree Genus*_____ Species*_____
Cultivar_____ Country*_____
State/Province*_____ County_____
DBH*_____in/cm Height_____ft/m Age_____years
Tree/Site Ownership: ○ Private ○ Utility ○ Other or unknown
○ Fed./Nat.: (○ NFS ○ BIA ○ BLM ○ DOD ○ NPS)
○ State/Province ○ County ○ Municipal
Address/Site name_____
GPS: Latitude_____._____ Longitude_____._____ (NAD83)

2 FAILURE TYPE* (select one)

○ TRUNK FAILURE ○ BRANCH FAILURE ○ ROOT FAILURE

3 Trunk Failure Specifics
Height of failure above grade*_____ft/m
Dia. at break (inside bark)*_____in/cm

4 Defects Associated with Failure
☐ None
☐ Unknown
☐ Failed portion dead
☐ Decay ☐ Canker Species:_____
☐ Multiple trunks/codominant stems
☐ Dense Crown ☐ Flush cuts
☐ Topped ☐ One-Sided
☐ Low live crown ratio ☐ Included Bark
☐ Bow ☐ Crook ☐ Sweep/corrected lean
☐ Uncorrected lean
☐ Cracks in wood:
○ Vertical ○ Horizontal
☐ Lightning Injury ☐ Animal Injury
☐ Fire Injury ☐ Insect Injury
☐ Mechanical Injury ☐ Girdling

5 Location of Decay
☐ HEARTWOOD
Avg. sound wood thickness_____in/cm
Opening (cavity) at failure? ○ No
○ Yes, opening_____% of trunk circ.
☐ SAPWOOD
Avg. depth of rot_____in/cm
Circumference rotted_____%
Type of Decay
☐ Unknown ☐ Brown rot
☐ Canker rot ☐ White rot
Conks/mushrooms/other signs? ○ No
○ Yes Name:_____
Distance from conk to failure:_____ft/m

6 Hardware
☐ None
☐ Girdling hardware
☐ Other device
☐ Cable ○ Intact ○ Failed
☐ Guying ○ Intact ○ Failed
☐ Prop ○ Intact ○ Failed
☐ Brace/bolt ○ Intact ○ Failed

3 Branch Failure Specifics
Dia. at break (inside bark)*_____in/cm
Total length failed branch_____ft/m
Break at attachment: ○ Yes ○ No
If No, distance from the attachment to break:_____ft.

4 Defects Associated with Failure
☐ None ☐ Unknown
☐ Failed portion dead ☐ Decay
☐ Dense Crown
☐ Heavy lateral limbs/Heavy ends
☐ Included bark ☐ Crook
☐ Failed portion is an epicormic branch
☐ Cracks in wood
☐ Mistletoe or epiphyte
☐ Mechanical Injury ☐ Lightning Injury
☐ Insect Injury ☐ Animal Injury
☐ Canker/Gall

5 Location of Decay
☐ HEARTWOOD
Avg. sound wood thickness_____in/cm
Opening (cavity) at failure? ○ No
○ Yes, opening_____% of branch circ.
☐ SAPWOOD
Avg. depth of rot_____in/cm
Circumference rotted_____%
Type of Decay
☐ Unknown ☐ Brown rot
☐ Canker rot ☐ White rot
Conks/mushrooms/other signs? ○ No
○ Yes Name:_____
Distance from conk to failure:_____ft/m

6 Hardware
☐ None
☐ Girdling hardware
☐ Other device
☐ Cable ○ Intact ○ Failed
☐ Guying ○ Intact ○ Failed
☐ Prop ○ Intact ○ Failed
☐ Brace/bolt ○ Intact ○ Failed

3 Root Failure Specifics* (select one)
○ **Roots broken**
Dia. of largest broken root_____in/cm
Distance from break to trunk_____ft/m
Condition of broken roots:
☐ Dead, no decay ☐ Decayed
☐ Live, no decay ☐ Unknown
○ **Roots cut/severed**(not decayed or broken)
Dia. of largest broken root at cut____in/cm
Distance from trunk to cut_____ft/m
% of roots cut_____
○ **Root plate lifted out of ground**
Root plate radius_____ft/m
Root plate depth_____in/cm
○ **Root restricted due to:**
☐ Container ☐ Root barrier
☐ Sidewalk/curb ☐ Wall/foundation
☐ Natural Feature ☐ Other
Distance from trunk to restriction____ft/m
% of root zone restricted_____
Root collar girdled? ☐ Yes ☐ No
% circumference girdled_____

Site/Soils Conditions
Soil composition: ○ Sand ○ Silt ○ Loam
○ Clay ○ Rock/gravel ○ Unknown
Soil moisture at time of failure: ☐ Unknown
○ Dry ○ Saturated ○ Moist ○ Flooded
Restricted rooting depth due to:
☐ Poor drainage ☐ Shallow or layered soil
☐ High water table ☐ Compacted ☐ Other
Other Site Conditions:
☐ Soil eroded ☐ Compaction
☐ Grade change ☐ Well surrounds trunk
☐ Fill soil against trunk or planted too deep
Depth of excess soil_____in/cm

4 Defects associated with failure
☐ None ☐ Unknown
☐ Fire scar/injury ☐ Basal wound
☐ Low live crown ratio
☐ Corrected lean (sweep)
☐ Uncorrected lean ☐ Animal Injury
☐ Cracks in trunk prior to failure
☐ Surface roots or root collar wounded

5 Type of Decay
% of roots decayed_____
Conks/mushrooms/other signs?
☐ No ☐ Yes Name:_____
Avg. sound wood thickness_____in/cm
Type: ☐ Unknown ☐ Brown rot ☐ White rot

6 Surface Treatment
☐ Mulch ☐ Bare soil ☐ Turf
☐ Ground cover ☐ Natural forest litter
☐ Gravel/rock ☐ Pavement ☐ Other
Irrigation:
○ Infrequent ○ Frequent ○ Never

7 ADDITIONAL INFORMATION
Tree Condition and Pruning History

Were the defects associated with failure visible before the tree failed?
○ Yes ○ No ○ Unknown
At time of failure the tree was:
○ Dead ○ Declining ○ Alive
Was there construction around this tree?
○ Yes ○ No
If Yes, when_____years ago

PRUNING HISTORY
☐ No pruning ☐ Cleaned ☐ Thinning
☐ Lions-tailed:
○ Proper ○ Excessive
☐ Reduction/Directional pruning:
○ Proper ○ Excessive
☐ Crown raised_____% of height
☐ Topped Diameter of stub at cut_____in/cm

Habitat Information

Trees recently removed in the vicinity of the failed tree:
○ Yes ○ No
History of prior failures at site:
○ Yes ○ No

Setting
○ Forest ○ Campground
○ Picnic area ○ Trailhead
○ Other developed forest site
○ Commercial site / Institution
○ Street tree / Median-Urban
○ Road side - Rural
○ Utility right-of-way
○ Yard / Garden
○ Park - Urban ○ Golf course
○ Parking lot ○ Other

Aspect
○ N ○ NE
○ E ○ SE
○ S ○ SW
○ W ○ NW
○ Not applicable / Flat

Slope
○ No slope ○ <5
○ 5-15 ○ 15-30
○ 30-45 ○ >45

Date / Time of Failure

☐ Date / Season Unknown

Date of failure (Mo/Day/Yr):_____
Time of failure hour_____
○ A.M. ○ P.M. ○ Unknown

OR Season of failure:
○ Spring ○ Summer ○ Fall ○ Winter
Year_____

8 WEATHER AND OTHER FORCES AT TIME OF FAILURE

☐ Unknown
Wind speed (approx.)_____mph/kph
Temperature (approx.)_____ °F/°C
Precipitation: ○ None ○ Rain ○ Snow ○ Ice ○ Unknown

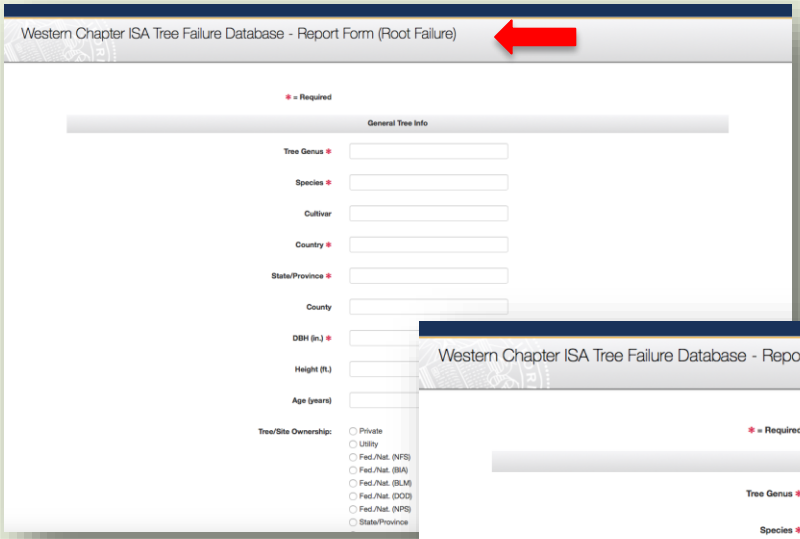
9 CAUSE / RESULT OF TREE FAILURE

Why did this failure occur?

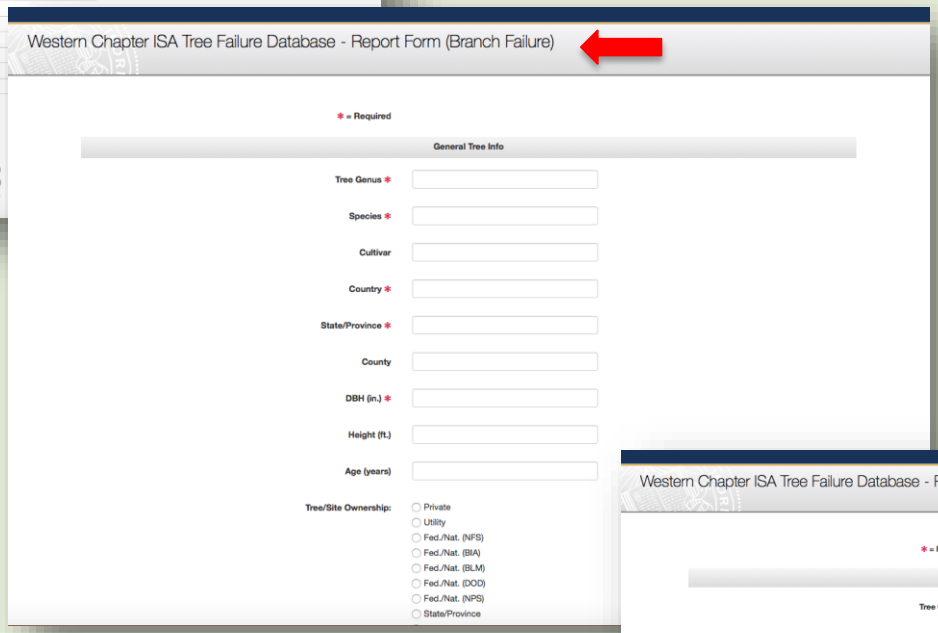
Result of tree failure:
☐ None (No damage other than the failure described) ☐ Property damage ☐ Personal injury
☐ Fire ☐ Power outage ☐ Removal of this tree ☐ Loss of other trees ☐ Other damage
Property damage estimate $_____(US) Cleanup costs $_____(US) If personal injury describe below.
Additional Comments (injury, target, damage, etc.):

Cooperator name_____Date_____
Please enter data at: **http://svinetfc2.fs.fed.us/natfdb/**

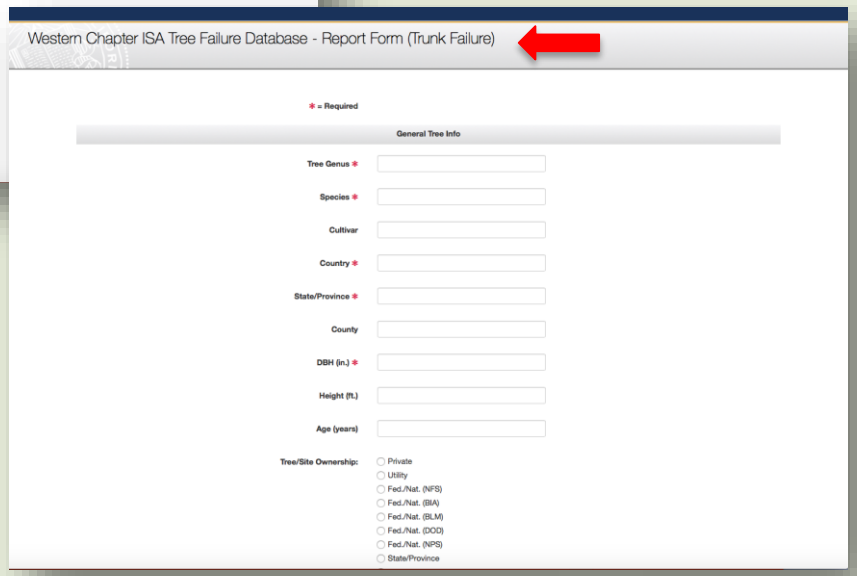
ITFD Field Form Revised 06/18/2007



https://ucanr.edu/survey/survey.cfm?surveynumber=21299



https://ucanr.edu/survey/survey.cfm?surveynumber=21298



https://ucanr.edu/survey/survey.cfm?surveynumber=20923

ROOT FAILURE

Aleppo pine
Pinus halepensis
DBH: 58.5”
Height: 100 feet
Location: Sherman Oaks, Los Angeles Co., CA

Levitt Ln
4200
BUMPS
15
MPH

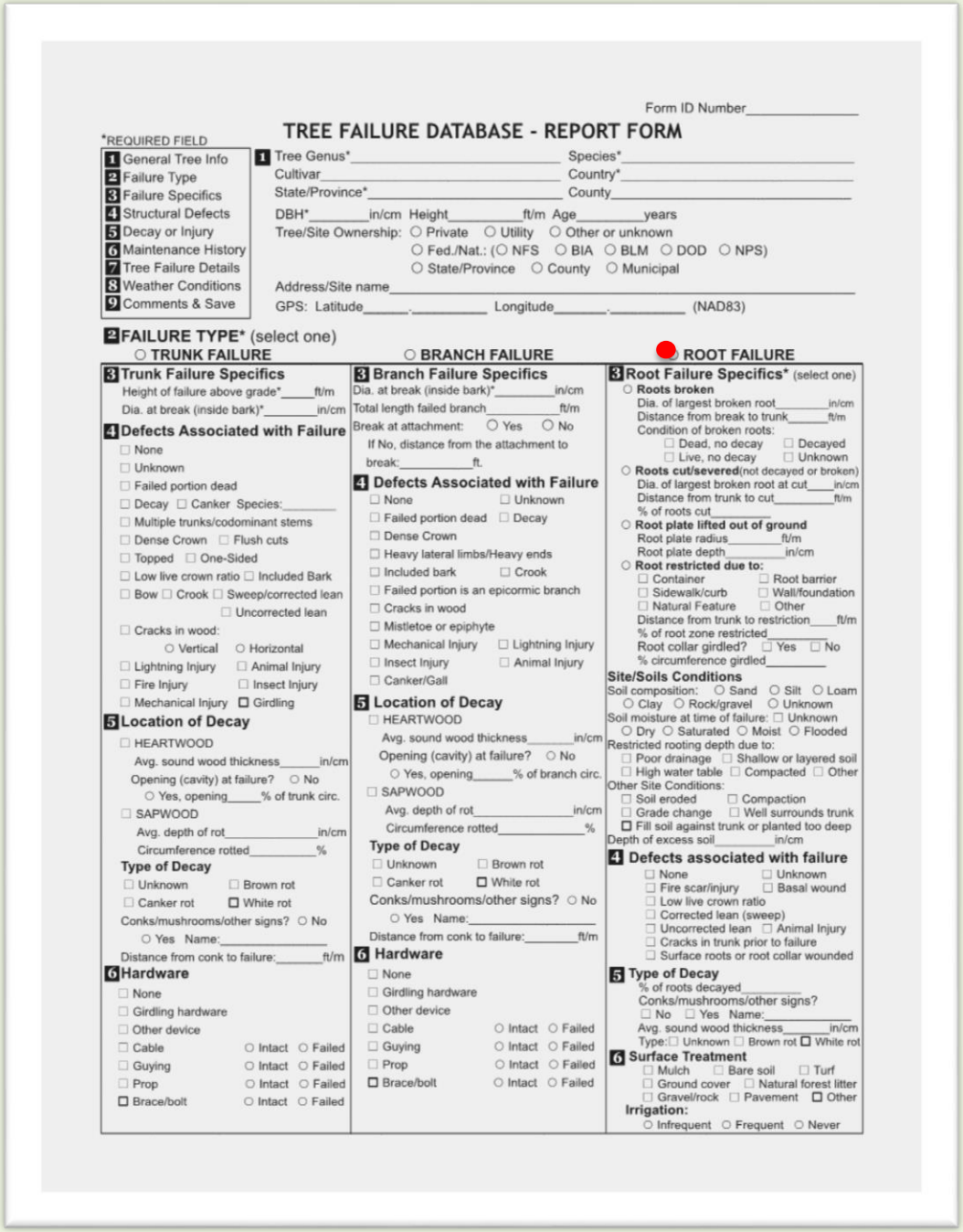
GMC

Aleppo pine
Pinus halepensis

DBH: 58.5”
Height: 100 feet
Spread: 70

Location: Sherman Oaks, Los Angeles Co., CA

Conditions: no rain or wind



Form ID Number_____

TREE FAILURE DATABASE - REPORT FORM

*REQUIRED FIELD

1 General Tree Info
2 Failure Type
3 Failure Specifics
4 Structural Defects
5 Decay or Injury
6 Maintenance History
7 Tree Failure Details
8 Weather Conditions
9 Comments & Save

1 Tree Genus*_____ Species*_____
Cultivar_____ Country*_____
State/Province*_____ County_____
DBH*_____in/cm Height_____ft/m Age_____years
Tree/Site Ownership: ○ Private ○ Utility ○ Other or unknown
○ Fed./Nat.: (○ NFS ○ BIA ○ BLM ○ DOD ○ NPS)
○ State/Province ○ County ○ Municipal
Address/Site name_____
GPS: Latitude_____._____ Longitude_____._____ (NAD83)

2 FAILURE TYPE* (select one)
○ TRUNK FAILURE ○ BRANCH FAILURE ● ROOT FAILURE

3 Trunk Failure Specifics
Height of failure above grade*_____ft/m
Dia. at break (inside bark)*_____in/cm

4 Defects Associated with Failure
☐ None
☐ Unknown
☐ Failed portion dead
☐ Decay ☐ Canker Species:_____
☐ Multiple trunks/codominant stems
☐ Dense Crown ☐ Flush cuts
☐ Topped ☐ One-Sided
☐ Low live crown ratio ☐ Included Bark
☐ Bow ☐ Crook ☐ Sweep/corrected lean
☐ Uncorrected lean
☐ Cracks in wood:
○ Vertical ○ Horizontal
☐ Lightning Injury ☐ Animal Injury
☐ Fire Injury ☐ Insect Injury
☐ Mechanical Injury ☐ Girdling

5 Location of Decay
☐ HEARTWOOD
Avg. sound wood thickness_____in/cm
Opening (cavity) at failure? ○ No
○ Yes, opening_____% of trunk circ.
☐ SAPWOOD
Avg. depth of rot_____in/cm
Circumference rotted_____%
Type of Decay
☐ Unknown ☐ Brown rot
☐ Canker rot ☐ White rot
Conks/mushrooms/other signs? ○ No
○ Yes Name:_____
Distance from conk to failure:_____ft/m

6 Hardware
☐ None
☐ Girdling hardware
☐ Other device
☐ Cable ○ Intact ○ Failed
☐ Guying ○ Intact ○ Failed
☐ Prop ○ Intact ○ Failed
☐ Brace/bolt ○ Intact ○ Failed

3 Branch Failure Specifics
Dia. at break (inside bark)*_____in/cm
Total length failed branch_____ft/m
Break at attachment: ○ Yes ○ No
If No, distance from the attachment to break:_____ft.

4 Defects Associated with Failure
☐ None ☐ Unknown
☐ Failed portion dead ☐ Decay
☐ Dense Crown
☐ Heavy lateral limbs/Heavy ends
☐ Included bark ☐ Crook
☐ Failed portion is an epicormic branch
☐ Cracks in wood
☐ Mistletoe or epiphyte
☐ Mechanical Injury ☐ Lightning Injury
☐ Insect Injury ☐ Animal Injury
☐ Canker/Gall

5 Location of Decay
☐ HEARTWOOD
Avg. sound wood thickness_____in/cm
Opening (cavity) at failure? ○ No
○ Yes, opening_____% of branch circ.
☐ SAPWOOD
Avg. depth of rot_____in/cm
Circumference rotted_____%
Type of Decay
☐ Unknown ☐ Brown rot
☐ Canker rot ☐ White rot
Conks/mushrooms/other signs? ○ No
○ Yes Name:_____
Distance from conk to failure:_____ft/m

6 Hardware
☐ None
☐ Girdling hardware
☐ Other device
☐ Cable ○ Intact ○ Failed
☐ Guying ○ Intact ○ Failed
☐ Prop ○ Intact ○ Failed
☐ Brace/bolt ○ Intact ○ Failed

3 Root Failure Specifics* (select one)
○ Roots broken
Dia. of largest broken root_____in/cm
Distance from break to trunk_____ft/m
Condition of broken roots:
☐ Dead, no decay ☐ Decayed
☐ Live, no decay ☐ Unknown
○ Roots cut/severed(not decayed or broken)
Dia. of largest broken root at cut____in/cm
Distance from trunk to cut_____ft/m
% of roots cut_____
○ Root plate lifted out of ground
Root plate radius_____ft/m
Root plate depth_____in/cm
○ Root restricted due to:
☐ Container ☐ Root barrier
☐ Sidewalk/curb ☐ Wall/foundation
☐ Natural Feature ☐ Other
Distance from trunk to restriction____ft/m
% of root zone restricted_____
Root collar girdled? ☐ Yes ☐ No
% circumference girdled_____

Site/Soils Conditions
Soil composition: ○ Sand ○ Silt ○ Loam
○ Clay ○ Rock/gravel ○ Unknown
Soil moisture at time of failure: ☐ Unknown
○ Dry ○ Saturated ○ Moist ○ Flooded
Restricted rooting depth due to:
☐ Poor drainage ☐ Shallow or layered soil
☐ High water table ☐ Compacted ☐ Other
Other Site Conditions:
☐ Soil eroded ☐ Compaction
☐ Grade change ☐ Well surrounds trunk
☐ Fill soil against trunk or planted too deep
Depth of excess soil_____in/cm

4 Defects associated with failure
☐ None ☐ Unknown
☐ Fire scar/injury ☐ Basal wound
☐ Low live crown ratio
☐ Corrected lean (sweep)
☐ Uncorrected lean ☐ Animal Injury
☐ Cracks in trunk prior to failure
☐ Surface roots or root collar wounded

5 Type of Decay
% of roots decayed_____
Conks/mushrooms/other signs?
☐ No ☐ Yes Name:_____
Avg. sound wood thickness_____in/cm
Type:☐ Unknown ☐ Brown rot ☐ White rot

6 Surface Treatment
☐ Mulch ☐ Bare soil ☐ Turf
☐ Ground cover ☐ Natural forest litter
☐ Gravel/rock ☐ Pavement ☐ Other
Irrigation:
○ Infrequent ○ Frequent ○ Never

Aleppo pine
Pinus halepensis

DBH: 58.5”
Height: 100 feet
Spread: 70

Location: Sherman Oaks, Los Angeles Co., CA

Conditions: no rain or wind

7 ADDITIONAL INFORMATION
Tree Condition and Pruning History

Were the defects associated with failure visible before the tree failed?
○ Yes ○ No ○ Unknown
At time of failure the tree was:
○ Dead ○ Declining ○ Alive
Was there construction around this tree?
○ Yes ○ No
If Yes, when_____years ago

PRUNING HISTORY
☐ No pruning ☐ Cleaned ☐ Thinning
☐ Lions-tailed:
○ Proper ○ Excessive
☐ Reduction/Directional pruning:
○ Proper ○ Excessive
☐ Crown raised_____% of height
☐ Topped Diameter of stub at cut_____in/cm

Habitat Information

Trees recently removed in the vicinity of the failed tree:
○ Yes ○ No

History of prior failures at site:
○ Yes ○ No

Setting
○ Forest ○ Campground
○ Picnic area ○ Trailhead
○ Other developed forest site
○ Commercial site / Institution
○ Street tree / Median-Urban
○ Road side - Rural
○ Utility right-of-way
○ Yard / Garden
○ Park - Urban ○ Golf course
○ Parking lot ○ Other

Aspect
○ N ○ NE
○ E ○ SE
○ S ○ SW
○ W ○ NW
○ Not applicable / Flat

Slope
○ No slope ○ <5
○ 5-15 ○ 15-30
○ 30-45 ○ >45

Date / Time of Failure

☐ Date / Season Unknown

Date of failure (Mo/Day/Yr):_____
Time of failure hour_____
○ A.M. ○ P.M. ○ Unknown

OR

Season of failure:
○ Spring ○ Summer ○ Fall ○ Winter
Year_____

8 WEATHER AND OTHER FORCES AT TIME OF FAILURE

☐ Unknown
Wind speed (approx.)_____mph/kph

Temperature (approx.)_____ °F/°C
Precipitation: ○ None ○ Rain ○ Snow ○ Ice ○ Unknown

9 CAUSE / RESULT OF TREE FAILURE

Why did this failure occur?

Result of tree failure:
☐ None (No damage other than the failure described) ☐ Property damage ☐ Personal injury
☐ Fire ☐ Power outage ☐ Removal of this tree ☐ Loss of other trees ☐ Other damage
Property damage estimate $_____(US) Cleanup costs $_____(US) If personal injury describe below.
Additional Comments (injury, target, damage, etc.):

Cooperator name_____Date_____
Please enter data at: **http://svinetfc2.fs.fed.us/natfdb/**
ITFD Field Form Revised 06/18/2007

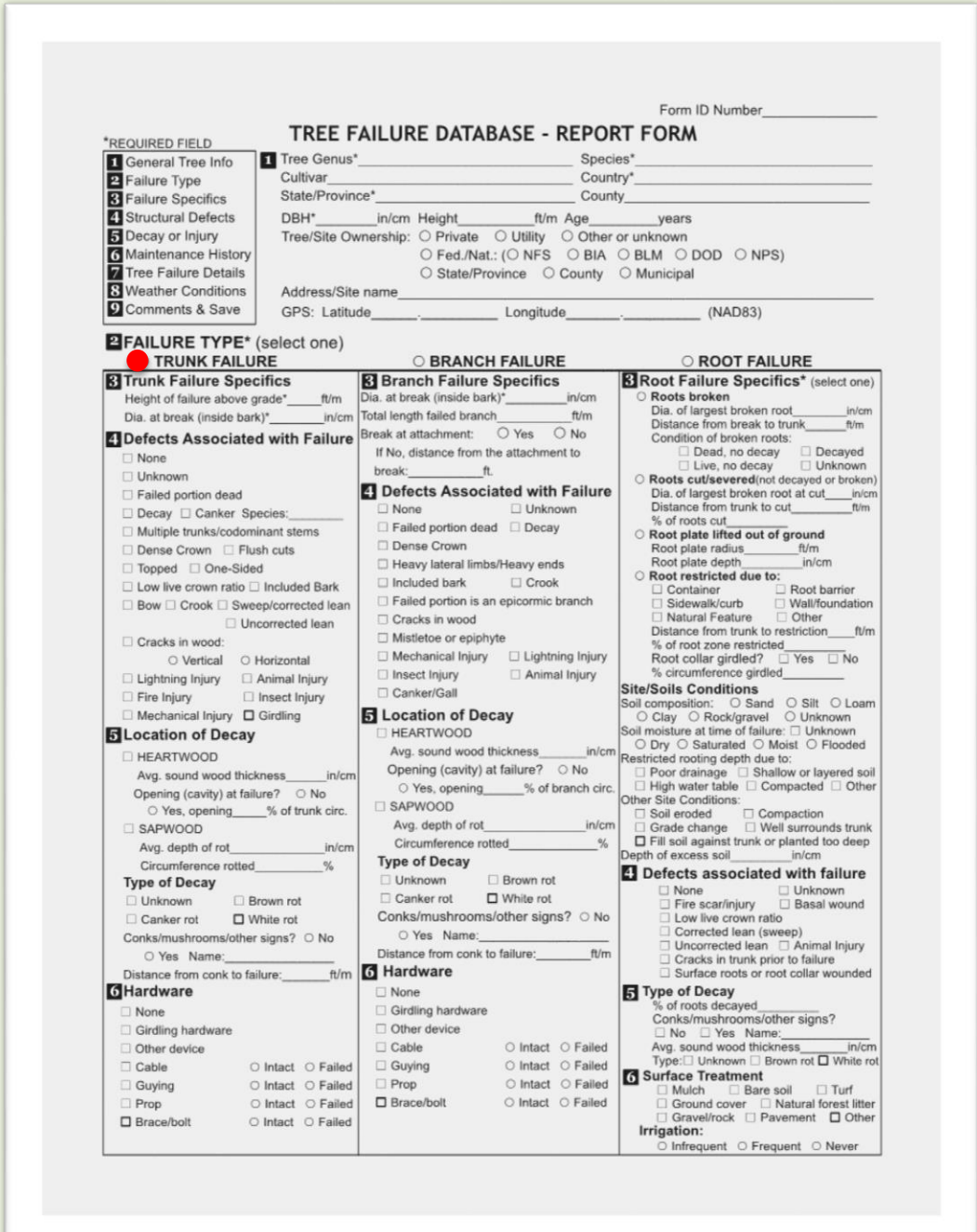
What are the key factors that contribute to failure?

TRUNK FAILURE

Purple-leaf plum
Prunus cerasifera
'Atropurpurea'

Purple-leaf plum
Prunus cerasifera ‘Atropurpurea’

Height: 25 ft
DBH: 10 inches
Age: 25 years
Location: Commonwealth Ave., SF, CA
Time of year: winter
Conditions: rain, wind (~15 mph)
Soil: sandy
Irrigation: frequent
Groundcover: turf



Form ID Number_____

TREE FAILURE DATABASE - REPORT FORM

*REQUIRED FIELD

1 General Tree Info
2 Failure Type
3 Failure Specifics
4 Structural Defects
5 Decay or Injury
6 Maintenance History
7 Tree Failure Details
8 Weather Conditions
9 Comments & Save

1 Tree Genus*_____ Species*_____
Cultivar_____ Country*_____
State/Province*_____ County_____
DBH*_____in/cm Height_____ft/m Age_____years
Tree/Site Ownership: ○ Private ○ Utility ○ Other or unknown
○ Fed./Nat.: (○ NFS ○ BIA ○ BLM ○ DOD ○ NPS)
○ State/Province ○ County ○ Municipal
Address/Site name_____
GPS: Latitude_____._____ Longitude_____._____ (NAD83)

2 FAILURE TYPE* (select one)
● TRUNK FAILURE ○ BRANCH FAILURE ○ ROOT FAILURE

3 Trunk Failure Specifics
Height of failure above grade*_____ft/m
Dia. at break (inside bark)*_____in/cm

4 Defects Associated with Failure
☐ None
☐ Unknown
☐ Failed portion dead
☐ Decay ☐ Canker Species:_____
☐ Multiple trunks/codominant stems
☐ Dense Crown ☐ Flush cuts
☐ Topped ☐ One-Sided
☐ Low live crown ratio ☐ Included Bark
☐ Bow ☐ Crook ☐ Sweep/corrected lean
☐ Uncorrected lean
☐ Cracks in wood:
○ Vertical ○ Horizontal
☐ Lightning Injury ☐ Animal Injury
☐ Fire Injury ☐ Insect Injury
☐ Mechanical Injury ☐ Girdling

5 Location of Decay
☐ HEARTWOOD
Avg. sound wood thickness_____in/cm
Opening (cavity) at failure? ○ No
○ Yes, opening_____% of trunk circ.
☐ SAPWOOD
Avg. depth of rot_____in/cm
Circumference rotted_____%
Type of Decay
☐ Unknown ☐ Brown rot
☐ Canker rot ☐ White rot
Conks/mushrooms/other signs? ○ No
○ Yes Name:_____
Distance from conk to failure:_____ft/m

6 Hardware
☐ None
☐ Girdling hardware
☐ Other device
☐ Cable ○ Intact ○ Failed
☐ Guying ○ Intact ○ Failed
☐ Prop ○ Intact ○ Failed
☐ Brace/bolt ○ Intact ○ Failed

3 Branch Failure Specifics
Dia. at break (inside bark)*_____in/cm
Total length failed branch_____ft/m
Break at attachment: ○ Yes ○ No
If No, distance from the attachment to break:_____ft.

4 Defects Associated with Failure
☐ None ☐ Unknown
☐ Failed portion dead ☐ Decay
☐ Dense Crown
☐ Heavy lateral limbs/Heavy ends
☐ Included bark ☐ Crook
☐ Failed portion is an epicormic branch
☐ Cracks in wood
☐ Mistletoe or epiphyte
☐ Mechanical Injury ☐ Lightning Injury
☐ Insect Injury ☐ Animal Injury
☐ Canker/Gall

5 Location of Decay
☐ HEARTWOOD
Avg. sound wood thickness_____in/cm
Opening (cavity) at failure? ○ No
○ Yes, opening_____% of branch circ.
☐ SAPWOOD
Avg. depth of rot_____in/cm
Circumference rotted_____%
Type of Decay
☐ Unknown ☐ Brown rot
☐ Canker rot ☐ White rot
Conks/mushrooms/other signs? ○ No
○ Yes Name:_____
Distance from conk to failure:_____ft/m

6 Hardware
☐ None
☐ Girdling hardware
☐ Other device
☐ Cable ○ Intact ○ Failed
☐ Guying ○ Intact ○ Failed
☐ Prop ○ Intact ○ Failed
☐ Brace/bolt ○ Intact ○ Failed

3 Root Failure Specifics* (select one)
○ Roots broken
Dia. of largest broken root_____in/cm
Distance from break to trunk_____ft/m
Condition of broken roots:
☐ Dead, no decay ☐ Decayed
☐ Live, no decay ☐ Unknown
○ Roots cut/severed(not decayed or broken)
Dia. of largest broken root at cut____in/cm
Distance from trunk to cut_____ft/m
% of roots cut_____
○ Root plate lifted out of ground
Root plate radius_____ft/m
Root plate depth_____in/cm
○ Root restricted due to:
☐ Container ☐ Root barrier
☐ Sidewalk/curb ☐ Wall/foundation
☐ Natural Feature ☐ Other
Distance from trunk to restriction____ft/m
% of root zone restricted_____
Root collar girdled? ☐ Yes ☐ No
% circumference girdled_____

Site/Soils Conditions
Soil composition: ○ Sand ○ Silt ○ Loam
○ Clay ○ Rock/gravel ○ Unknown
Soil moisture at time of failure: ☐ Unknown
○ Dry ○ Saturated ○ Moist ○ Flooded
Restricted rooting depth due to:
☐ Poor drainage ☐ Shallow or layered soil
☐ High water table ☐ Compacted ☐ Other
Other Site Conditions:
☐ Soil eroded ☐ Compaction
☐ Grade change ☐ Well surrounds trunk
☐ Fill soil against trunk or planted too deep
Depth of excess soil_____in/cm

4 Defects associated with failure
☐ None ☐ Unknown
☐ Fire scar/injury ☐ Basal wound
☐ Low live crown ratio
☐ Corrected lean (sweep)
☐ Uncorrected lean ☐ Animal Injury
☐ Cracks in trunk prior to failure
☐ Surface roots or root collar wounded

5 Type of Decay
% of roots decayed_____
Conks/mushrooms/other signs?
☐ No ☐ Yes Name:_____
Avg. sound wood thickness_____in/cm
Type: ☐ Unknown ☐ Brown rot ☐ White rot

6 Surface Treatment
☐ Mulch ☐ Bare soil ☐ Turf
☐ Ground cover ☐ Natural forest litter
☐ Gravel/rock ☐ Pavement ☐ Other
Irrigation:
○ Infrequent ○ Frequent ○ Never

Purple-leaf plum
Prunus cerasifera ‘Atropurpurea’

Height: 25 ft
DBH: 10 inches
Age: 25 years
Location: Commonwealth Ave., SF, CA
Time of year: winter
Conditions: rain, wind (~15 mph)
Soil: sandy
Irrigation: frequent
Groundcover: turf

7 ADDITIONAL INFORMATION
Tree Condition and Pruning History

Were the defects associated with failure visible before the tree failed?
○ Yes ○ No ○ Unknown
At time of failure the tree was:
○ Dead ○ Declining ○ Alive
Was there construction around this tree?
○ Yes ○ No
If Yes, when_____years ago

PRUNING HISTORY
☐ No pruning ☐ Cleaned ☐ Thinning
☐ Lions-tailed:
○ Proper ○ Excessive
☐ Reduction/Directional pruning:
○ Proper ○ Excessive
☐ Crown raised_____% of height
☐ Topped Diameter of stub at cut_____in/cm

Habitat Information

Trees recently removed in the vicinity of the failed tree:
○ Yes ○ No

History of prior failures at site:
○ Yes ○ No

Setting
○ Forest ○ Campground
○ Picnic area ○ Trailhead
○ Other developed forest site
○ Commercial site / Institution
○ Street tree / Median-Urban
○ Road side - Rural
○ Utility right-of-way
○ Yard / Garden
○ Park - Urban ○ Golf course
○ Parking lot ○ Other

Aspect
○ N ○ NE
○ E ○ SE
○ S ○ SW
○ W ○ NW
○ Not applicable / Flat

Slope
○ No slope ○ <5
○ 5-15 ○ 15-30
○ 30-45 ○ >45

Date / Time of Failure

☐ Date / Season Unknown

Date of failure (Mo/Day/Yr):_____
Time of failure hour_____
○ A.M. ○ P.M. ○ Unknown

OR

Season of failure:
○ Spring ○ Summer ○ Fall ○ Winter
Year_____

8 WEATHER AND OTHER FORCES AT TIME OF FAILURE

☐ Unknown
Wind speed (approx.)_____mph/kph
Temperature (approx.)_____ °F/°C
Precipitation: ○ None ○ Rain ○ Snow ○ Ice ○ Unknown

9 CAUSE / RESULT OF TREE FAILURE

Why did this failure occur?

Result of tree failure:
☐ None (No damage other than the failure described) ☐ Property damage ☐ Personal injury
☐ Fire ☐ Power outage ☐ Removal of this tree ☐ Loss of other trees ☐ Other damage
Property damage estimate $_____(US) Cleanup costs $_____(US) If personal injury describe below.
Additional Comments (injury, target, damage, etc.):

Cooperator name_____Date_____
Please enter data at: **http://svinetfc2.fs.fed.us/natfdb/**
ITFD Field Form Revised 06/18/2007

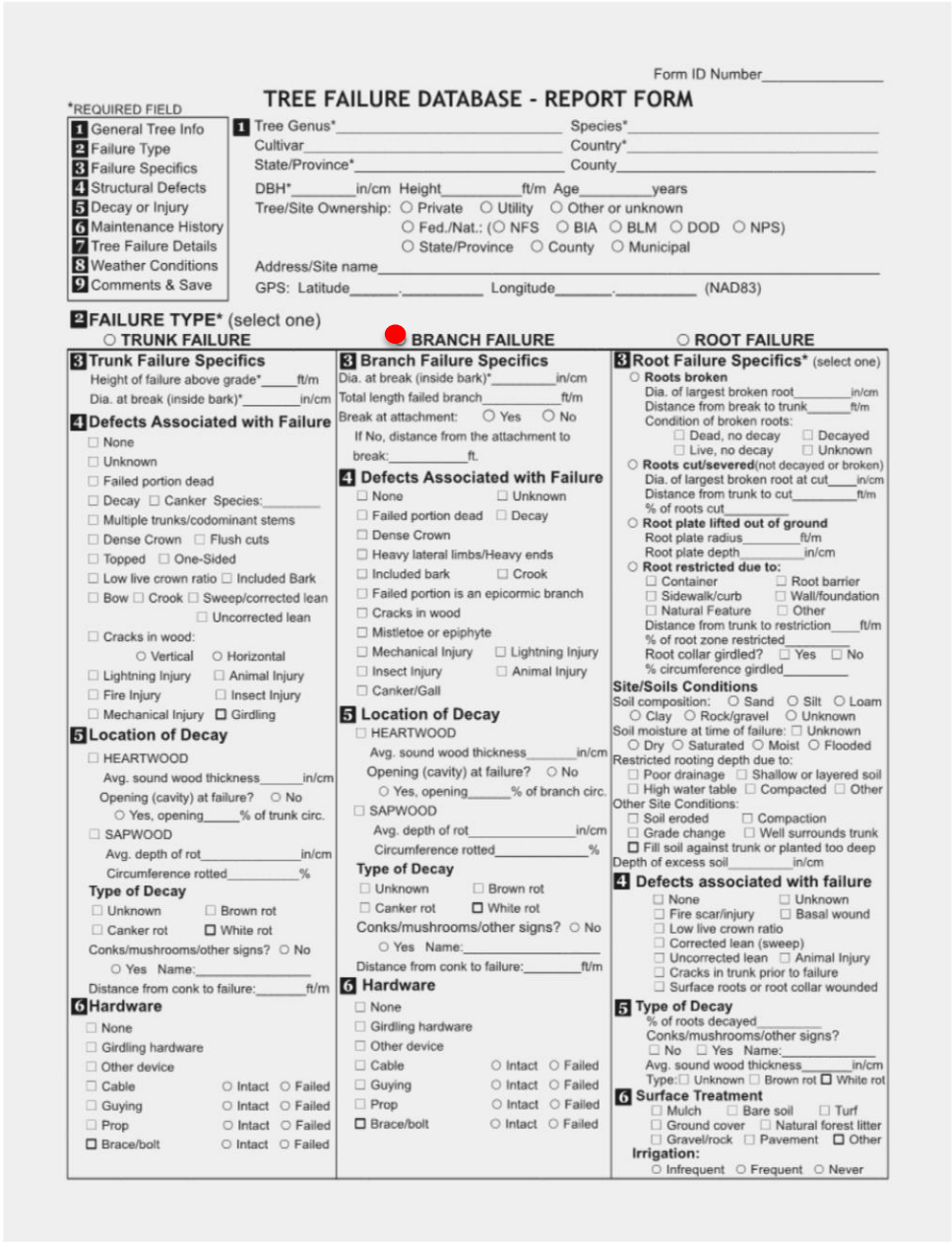
BRANCH FAILURE

Eucalyptus globulus
Tasmanian blue gum

BRANCH FAILURE

Blue gum
Eucalyptus globulus

Height: 60 ft
DBH: 45 inches
Spread: 40 ft
Age: 35 years
Location: Golden Gate Park, SF
Conditions: no rain, no wind
Time of year: spring
Location of failure: at attachment
Diameter at break: 20 inches
Length of branch: 25 ft.



Form ID Number_____

TREE FAILURE DATABASE - REPORT FORM

*REQUIRED FIELD

1 General Tree Info
2 Failure Type
3 Failure Specifics
4 Structural Defects
5 Decay or Injury
6 Maintenance History
7 Tree Failure Details
8 Weather Conditions
9 Comments & Save

1 Tree Genus*_____ Species*_____
Cultivar_____ Country*_____
State/Province*_____ County_____
DBH*_____in/cm Height_____ft/m Age_____years
Tree/Site Ownership: ○ Private ○ Utility ○ Other or unknown
○ Fed./Nat.: (○ NFS ○ BIA ○ BLM ○ DOD ○ NPS)
○ State/Province ○ County ○ Municipal
Address/Site name_____
GPS: Latitude_____._____ Longitude_____._____ (NAD83)

2 FAILURE TYPE* (select one)
○ TRUNK FAILURE ● BRANCH FAILURE ○ ROOT FAILURE

3 Trunk Failure Specifics
Height of failure above grade*_____ft/m
Dia. at break (inside bark)*_____in/cm

4 Defects Associated with Failure
☐ None
☐ Unknown
☐ Failed portion dead
☐ Decay ☐ Canker Species:_____
☐ Multiple trunks/codominant stems
☐ Dense Crown ☐ Flush cuts
☐ Topped ☐ One-Sided
☐ Low live crown ratio ☐ Included Bark
☐ Bow ☐ Crook ☐ Sweep/corrected lean
☐ Uncorrected lean
☐ Cracks in wood:
○ Vertical ○ Horizontal
☐ Lightning Injury ☐ Animal Injury
☐ Fire Injury ☐ Insect Injury
☐ Mechanical Injury ☐ Girdling

5 Location of Decay
☐ HEARTWOOD
Avg. sound wood thickness_____in/cm
Opening (cavity) at failure? ○ No
○ Yes, opening_____% of trunk circ.
☐ SAPWOOD
Avg. depth of rot_____in/cm
Circumference rotted_____%
Type of Decay
☐ Unknown ☐ Brown rot
☐ Canker rot ☐ White rot
Conks/mushrooms/other signs? ○ No
○ Yes Name:_____
Distance from conk to failure:_____ft/m

6 Hardware
☐ None
☐ Girdling hardware
☐ Other device
☐ Cable ○ Intact ○ Failed
☐ Guying ○ Intact ○ Failed
☐ Prop ○ Intact ○ Failed
☐ Brace/bolt ○ Intact ○ Failed

3 Branch Failure Specifics
Dia. at break (inside bark)*_____in/cm
Total length failed branch_____ft/m
Break at attachment: ○ Yes ○ No
If No, distance from the attachment to break:_____ft.

4 Defects Associated with Failure
☐ None ☐ Unknown
☐ Failed portion dead ☐ Decay
☐ Dense Crown
☐ Heavy lateral limbs/Heavy ends
☐ Included bark ☐ Crook
☐ Failed portion is an epicormic branch
☐ Cracks in wood
☐ Mistletoe or epiphyte
☐ Mechanical Injury ☐ Lightning Injury
☐ Insect Injury ☐ Animal Injury
☐ Canker/Gall

5 Location of Decay
☐ HEARTWOOD
Avg. sound wood thickness_____in/cm
Opening (cavity) at failure? ○ No
○ Yes, opening_____% of branch circ.
☐ SAPWOOD
Avg. depth of rot_____in/cm
Circumference rotted_____%
Type of Decay
☐ Unknown ☐ Brown rot
☐ Canker rot ☐ White rot
Conks/mushrooms/other signs? ○ No
○ Yes Name:_____
Distance from conk to failure:_____ft/m

6 Hardware
☐ None
☐ Girdling hardware
☐ Other device
☐ Cable ○ Intact ○ Failed
☐ Guying ○ Intact ○ Failed
☐ Prop ○ Intact ○ Failed
☐ Brace/bolt ○ Intact ○ Failed

3 Root Failure Specifics* (select one)
○ **Roots broken**
Dia. of largest broken root_____in/cm
Distance from break to trunk_____ft/m
Condition of broken roots:
☐ Dead, no decay ☐ Decayed
☐ Live, no decay ☐ Unknown
○ **Roots cut/severed**(not decayed or broken)
Dia. of largest broken root at cut____in/cm
Distance from trunk to cut_____ft/m
% of roots cut_____
○ **Root plate lifted out of ground**
Root plate radius_____ft/m
Root plate depth_____in/cm
○ **Root restricted due to:**
☐ Container ☐ Root barrier
☐ Sidewalk/curb ☐ Wall/foundation
☐ Natural Feature ☐ Other
Distance from trunk to restriction____ft/m
% of root zone restricted_____
Root collar girdled? ☐ Yes ☐ No
% circumference girdled_____

Site/Soils Conditions
Soil composition: ○ Sand ○ Silt ○ Loam
○ Clay ○ Rock/gravel ○ Unknown
Soil moisture at time of failure: ☐ Unknown
○ Dry ○ Saturated ○ Moist ○ Flooded
Restricted rooting depth due to:
☐ Poor drainage ☐ Shallow or layered soil
☐ High water table ☐ Compacted ☐ Other
Other Site Conditions:
☐ Soil eroded ☐ Compaction
☐ Grade change ☐ Well surrounds trunk
☐ Fill soil against trunk or planted too deep
Depth of excess soil_____in/cm

4 Defects associated with failure
☐ None ☐ Unknown
☐ Fire scar/injury ☐ Basal wound
☐ Low live crown ratio
☐ Corrected lean (sweep)
☐ Uncorrected lean ☐ Animal Injury
☐ Cracks in trunk prior to failure
☐ Surface roots or root collar wounded

5 Type of Decay
% of roots decayed_____
Conks/mushrooms/other signs?
☐ No ☐ Yes Name:_____
Avg. sound wood thickness_____in/cm
Type: ☐ Unknown ☐ Brown rot ☐ White rot

6 Surface Treatment
☐ Mulch ☐ Bare soil ☐ Turf
☐ Ground cover ☐ Natural forest litter
☐ Gravel/rock ☐ Pavement ☐ Other
Irrigation:
○ Infrequent ○ Frequent ○ Never

Blue gum
Eucalyptus globulus

Conditions: no rain, no wind

7 ADDITIONAL INFORMATION
Tree Condition and Pruning History

Were the defects associated with failure visible before the tree failed?
○ Yes ○ No ○ Unknown
At time of failure the tree was:
○ Dead ○ Declining ○ Alive
Was there construction around this tree?
○ Yes ○ No
If Yes, when_____years ago

PRUNING HISTORY
☐ No pruning ☐ Cleaned ☐ Thinning
☐ Lions-tailed:
○ Proper ○ Excessive
☐ Reduction/Directional pruning:
○ Proper ○ Excessive
☐ Crown raised_____% of height
☐ Topped Diameter of stub at cut_____in/cm

Habitat Information

Trees recently removed in the vicinity of the failed tree:
○ Yes ○ No

History of prior failures at site:
○ Yes ○ No

Setting
○ Forest ○ Campground
○ Picnic area ○ Trailhead
○ Other developed forest site
○ Commercial site / Institution
○ Street tree / Median-Urban
○ Road side - Rural
○ Utility right-of-way
○ Yard / Garden
○ Park - Urban ○ Golf course
○ Parking lot ○ Other

Aspect
○ N ○ NE
○ E ○ SE
○ S ○ SW
○ W ○ NW
○ Not applicable / Flat

Slope
○ No slope ○ <5
○ 5-15 ○ 15-30
○ 30-45 ○ >45

Date / Time of Failure

☐ Date / Season Unknown

Date of failure (Mo/Day/Yr):_____
Time of failure hour_____
○ A.M. ○ P.M. ○ Unknown

OR Season of failure:
○ Spring ○ Summer ○ Fall ○ Winter
Year_____

8 WEATHER AND OTHER FORCES AT TIME OF FAILURE

☐ Unknown
Wind speed (approx.)_____mph/kph
Temperature (approx.)_____ °F/°C
Precipitation: ○ None ○ Rain ○ Snow ○ Ice ○ Unknown

9 CAUSE / RESULT OF TREE FAILURE

Why did this failure occur?

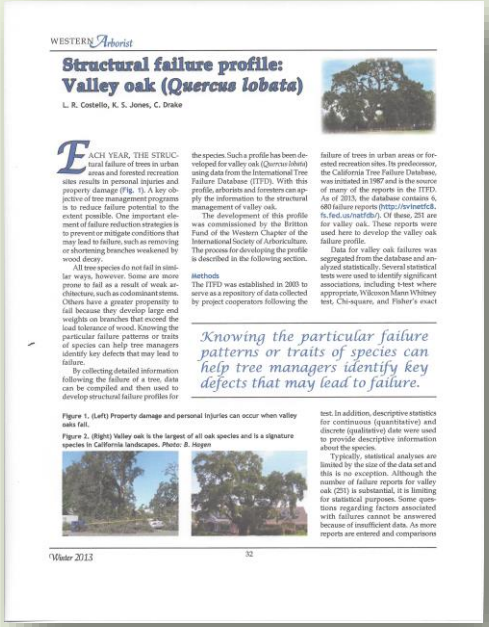
Result of tree failure:
☐ None (No damage other than the failure described) ☐ Property damage ☐ Personal injury
☐ Fire ☐ Power outage ☐ Removal of this tree ☐ Loss of other trees ☐ Other damage
Property damage estimate $_____(US) Cleanup costs $_____(US) If personal injury describe below.
Additional Comments (injury, target, damage, etc.):

Cooperator name_____Date_____
Please enter data at: **http://svinetfc2.fs.fed.us/natfdb/**
ITFD Field Form Revised 06/18/2007

BENEFITS of the TREE FAILURE DATABASE?

1. SPECIES PROFILES

Western Arborist 2013-15



WESTERN Arborist

Structural failure profile: Valley oak (*Quercus lobata*)

L. R. Costello, K. S. Jones, C. Drake

EACH YEAR, THE STRUCTURAL failure of trees in urban areas and forested recreation sites results in personal injuries and property damage (Fig. 1). A key objective of tree management programs is to reduce failure potential to the extent possible. One important element of failure reduction strategies is to prevent or mitigate conditions that may lead to failure, such as removing or shortening branches weakened by wood decay.

All tree species do not fail in similar ways, however. Some are more prone to fail as a result of weak architecture, such as codominant stems. Others have a greater propensity to fail because they develop large end weights on branches that exceed the load tolerance of wood. Knowing the particular failure patterns or traits of species can help tree managers identify key defects that may lead to failure.

By collecting detailed information following the failure of a tree, data can be compiled and then used to develop structural failure profiles for the species. Such a profile has been developed for valley oak (*Quercus lobata*) using data from the International Tree Failure Database (ITFD). With this profile, arborists and foresters can apply the information to the structural management of valley oak.

The development of this profile was commissioned by the Britton Fund of the Western Chapter of the International Society of Arboriculture. The process for developing the profile is described in the following section.

Methods

The ITFD was established in 2003 to serve as a repository of data collected by project cooperators following the failure of trees in urban areas or forested recreation sites. Its predecessor, the California Tree Failure Database, was initiated in 1987 and is the source of many of the reports in the ITFD. As of 2013, the database contains 6,680 failure reports (http://srinetfc6.fs.fed.us/natfdb/). Of these, 251 are for valley oak. These reports were used here to develop the valley oak failure profile.

Data for valley oak failures was segregated from the database and analyzed statistically. Several statistical tests were used to identify significant associations, including t-test where appropriate, Wilcoxon Mann Whitney test, Chi-square, and Fisher's exact test. In addition, descriptive statistics for continuous (quantitative) and discrete (qualitative) date were used to provide descriptive information about the species.

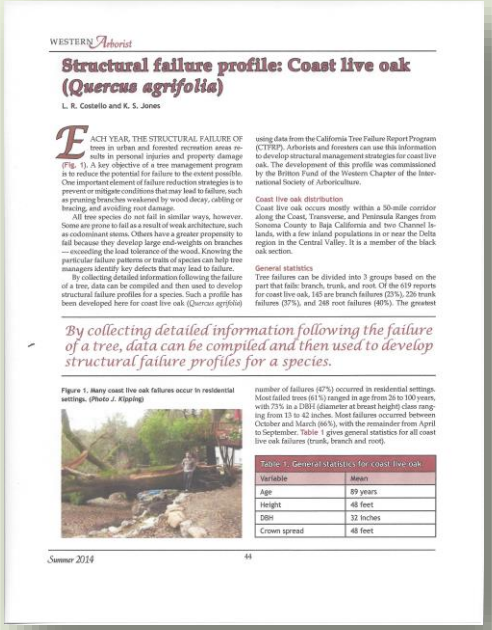
Typically, statistical analyses are limited by the size of the data set and this is no exception. Although the number of failure reports for valley oak (251) is substantial, it is limiting for statistical purposes. Some questions regarding factors associated with failures cannot be answered because of insufficient data. As more reports are entered and comparisons

Knowing the particular failure patterns or traits of species can help tree managers identify key defects that may lead to failure.

Figure 1. (Left) Property damage and personal injuries can occur when valley oaks fail.

Figure 2. (Right) Valley oak is the largest of all oak species and is a signature species in California landscapes. *Photo: B. Hogan*

Winter 2013 32



WESTERN Arborist

Structural failure profile: Coast live oak (*Quercus agrifolia*)

L. R. Costello and K. S. Jones

EACH YEAR, THE STRUCTURAL FAILURE OF trees in urban and forested recreation areas results in personal injuries and property damage (Fig. 1). A key objective of a tree management program is to reduce the potential for failure to the extent possible. One important element of failure reduction strategies is to prevent or mitigate conditions that may lead to failure, such as pruning branches weakened by wood decay, cabling or bracing, and avoiding root damage.

All tree species do not fail in similar ways, however. Some are prone to fail as a result of weak architecture, such as codominant stems. Others have a greater propensity to fail because they develop large end-weights on branches — exceeding the load tolerance of the wood. Knowing the particular failure patterns or traits of species can help tree managers identify key defects that may lead to failure.

By collecting detailed information following the failure of a tree, data can be compiled and then used to develop structural failure profiles for a species. Such a profile has been developed here for coast live oak (*Quercus agrifolia*) using data from the California Tree Failure Report Program (CTFRP). Arborists and foresters can use this information to develop structural management strategies for coast live oak. The development of this profile was commissioned by the Britton Fund of the Western Chapter of the International Society of Arboriculture.

Coast live oak distribution

Coast live oak occurs mostly within a 50-mile corridor along the Coast, Transverse, and Peninsula Ranges from Sonoma County to Baja California and two Channel Islands, with a few inland populations in or near the Delta region in the Central Valley. It is a member of the black oak section.

General statistics

Tree failures can be divided into 3 groups based on the part that failed: branch, trunk, and root. Of the 619 reports for coast live oak, 145 are branch failures (23%), 226 trunk failures (37%), and 248 root failures (40%). The greatest number of failures (47%) occurred in residential settings. Most failed trees (61%) ranged in age from 26 to 100 years, with 75% in a DBH (diameter at breast height) class ranging from 13 to 42 inches. Most failures occurred between October and March (86%), with the remainder from April to September. Table 1 gives general statistics for all coast live oak failures (trunk, branch and root).

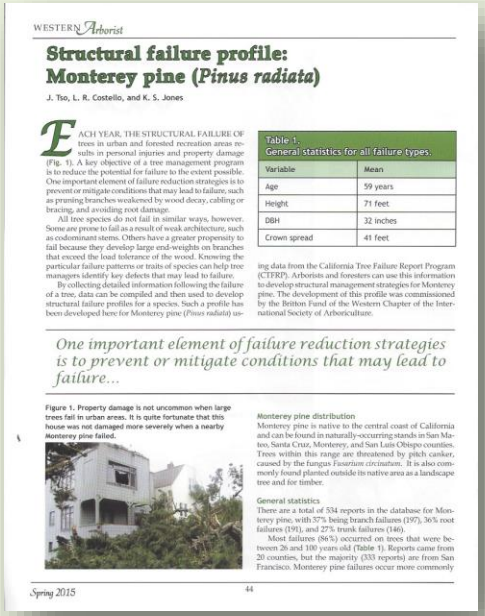
By collecting detailed information following the failure of a tree, data can be compiled and then used to develop structural failure profiles for a species.

Figure 1. Many coast live oak failures occur in residential settings. (*Photo J. Kipping*)

Table 1. General statistics for coast live oak

Variable	Mean
Age	89 years
Height	48 feet
DBH	32 inches
Crown spread	48 feet

Summer 2014 44



WESTERN Arborist

Structural failure profile: Monterey pine (*Pinus radiata*)

J. Tso, L. R. Costello, and K. S. Jones

EACH YEAR, THE STRUCTURAL FAILURE OF trees in urban and forested recreation areas results in personal injuries and property damage (Fig. 1). A key objective of a tree management program is to reduce the potential for failure to the extent possible. One important element of failure reduction strategies is to prevent or mitigate conditions that may lead to failure, such as pruning branches weakened by wood decay, cabling or bracing, and avoiding root damage.

All tree species do not fail in similar ways, however. Some are prone to fail as a result of weak architecture, such as codominant stems. Others have a greater propensity to fail because they develop large end-weights on branches that exceed the load tolerance of the wood. Knowing the particular failure patterns or traits of species can help tree managers identify key defects that may lead to failure.

By collecting detailed information following the failure of a tree, data can be compiled and then used to develop structural failure profiles for a species. Such a profile has been developed here for Monterey pine (*Pinus radiata*) using data from the California Tree Failure Report Program (CTFRP). Arborists and foresters can use this information to develop structural management strategies for Monterey pine. The development of this profile was commissioned by the Britton Fund of the Western Chapter of the International Society of Arboriculture.

One important element of failure reduction strategies is to prevent or mitigate conditions that may lead to failure...

Table 1. General statistics for all failure types.

Variable	Mean
Age	59 years
Height	71 feet
DBH	32 inches
Crown spread	41 feet

Figure 1. Property damage is not uncommon when large trees fail in urban areas. It is quite fortunate that this house was not damaged more severely when a nearby Monterey pine failed.

Monterey pine distribution

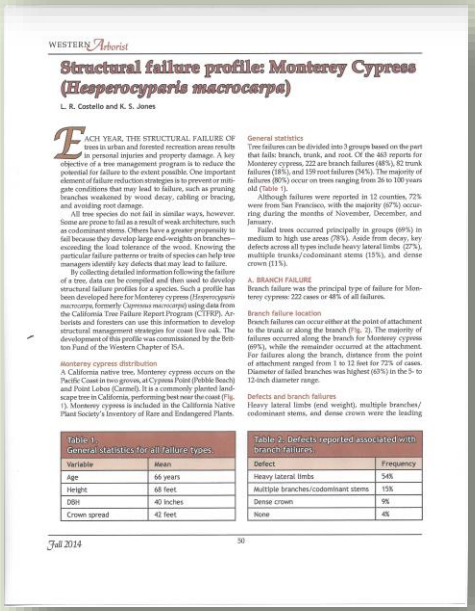
Monterey pine is native to the central coast of California and can be found in naturally-occurring stands in San Mateo, Santa Cruz, Monterey, and San Luis Obispo counties. Trees within this range are threatened by pitch canker, caused by the fungus *Fusarium circinatum*. It is also commonly found planted outside its native area as a landscape tree and for timber.

General statistics

There are a total of 534 reports in the database for Monterey pine, with 37% being branch failures (197), 36% root failures (191), and 27% trunk failures (146).

Most failures (86%) occurred on trees that were between 26 and 100 years old (Table 1). Reports came from 20 counties, but the majority (333 reports) are from San Francisco. Monterey pine failures occur more commonly

Spring 2015 44



WESTERN Arborist

Structural failure profile: Monterey Cypress (*Hesperocyparis macrocarpa*)

L. R. Costello and K. S. Jones

EACH YEAR, THE STRUCTURAL FAILURE OF trees in urban and forested recreation areas results in personal injuries and property damage. A key objective of a tree management program is to reduce the potential for failure to the extent possible. One important element of failure reduction strategies is to prevent or mitigate conditions that may lead to failure, such as pruning branches weakened by wood decay, cabling or bracing, and avoiding root damage.

All tree species do not fail in similar ways, however. Some are prone to fail as a result of weak architecture, such as codominant stems. Others have a greater propensity to fail because they develop large end-weights on branches—exceeding the load tolerance of the wood. Knowing the particular failure patterns or traits of species can help tree managers identify key defects that may lead to failure.

By collecting detailed information following the failure of a tree, data can be compiled and then used to develop structural failure profiles for a species. Such a profile has been developed here for Monterey cypress (*Hesperocyparis macrocarpa*, formerly *Cupressus macrocarpa*) using data from the California Tree Failure Report Program (CTFRP). Arborists and foresters can use this information to develop structural management strategies for coast live oak. The development of this profile was commissioned by the Britton Fund of the Western Chapter of ISA.

Monterey cypress distribution

A California native tree, Monterey cypress occurs on the Pacific Coast in two groves, at Cypress Point (Pebble Beach) and Point Lobos (Carmel). It is a commonly planted landscape tree in California, performing best near the coast (Fig. 1). Monterey cypress is included in the California Native Plant Society's Inventory of Rare and Endangered Plants.

General statistics

Tree failures can be divided into 3 groups based on the part that fails: branch, trunk, and root. Of the 463 reports for Monterey cypress, 222 are branch failures (48%), 82 trunk failures (18%), and 159 root failures (34%). The majority of failures (80%) occur on trees ranging from 26 to 100 years old (Table 1).

Although failures were reported in 12 counties, 72% were from San Francisco, with the majority (67%) occurring during the months of November, December, and January.

Failed trees occurred principally in groups (69%) in medium to high use areas (78%). Aside from decay, key defects across all types include heavy lateral limbs (27%), multiple trunks/codominant stems (15%), and dense crown (11%).

A. BRANCH FAILURE

Branch failure was the principal type of failure for Monterey cypress: 222 cases or 48% of all failures.

Branch failure location

Branch failures can occur either at the point of attachment to the trunk or along the branch (Fig. 2). The majority of failures occurred along the branch for Monterey cypress (69%), while the remainder occurred at the attachment. For failures along the branch, distance from the point of attachment ranged from 1 to 12 feet for 72% of cases. Diameter of failed branches was highest (63%) in the 5- to 12-inch diameter range.

Defects and branch failures

Heavy lateral limbs (end weight), multiple branches/codominant stems, and dense crown were the leading

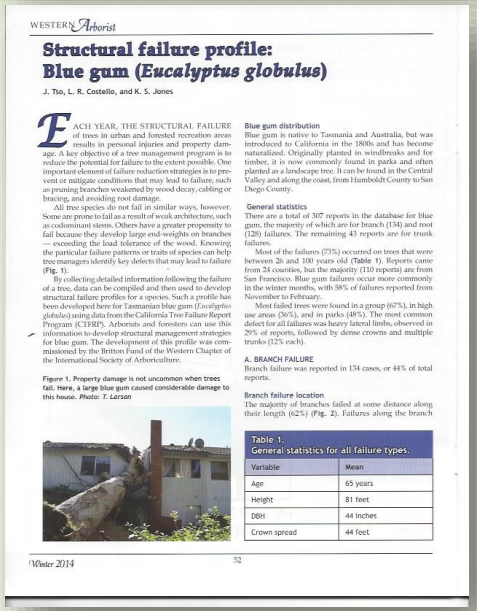
Table 1. General statistics for all failure types.

Variable	Mean
Age	66 years
Height	68 feet
DBH	40 inches
Crown spread	42 feet

Table 2. Defects reported associated with branch failures.

Defect	Frequency
Heavy lateral limbs	54%
Multiple branches/codominant stems	15%
Dense crown	9%
None	4%

Fall 2014 50



WESTERN Arborist

Structural failure profile: Blue gum (*Eucalyptus globulus*)

J. Tso, L. R. Costello, and K. S. Jones

EACH YEAR, THE STRUCTURAL FAILURE of trees in urban and forested recreation areas results in personal injuries and property damage. A key objective of a tree management program is to reduce the potential for failure to the extent possible. One important element of failure reduction strategies is to prevent or mitigate conditions that may lead to failure, such as pruning branches weakened by wood decay, cabling or bracing, and avoiding root damage.

All tree species do not fail in similar ways, however. Some are prone to fail as a result of weak architecture, such as codominant stems. Others have a greater propensity to fail because they develop large end-weights on branches — exceeding the load tolerance of the wood. Knowing the particular failure patterns or traits of species can help tree managers identify key defects that may lead to failure (Fig. 1).

By collecting detailed information following the failure of a tree, data can be compiled and then used to develop structural failure profiles for a species. Such a profile has been developed here for Tasmanian blue gum (*Eucalyptus globulus*) using data from the California Tree Failure Report Program (CTFRP). Arborists and foresters can use this information to develop structural management strategies for blue gum. The development of this profile was commissioned by the Britton Fund of the Western Chapter of the International Society of Arboriculture.

Blue gum distribution

Blue gum is native to Tasmania and Australia, but was introduced to California in the 1800s and has become naturalized. Originally planted in windbreaks and for timber, it is now commonly found in parks and often planted as a landscape tree. It can be found in the Central Valley and along the coast, from Humboldt County to San Diego County.

General statistics

There are a total of 307 reports in the database for blue gum, the majority of which are for branch (134) and root (128) failures. The remaining 43 reports are for trunk failures.

Most of the failures (73%) occurred on trees that were between 26 and 100 years old (Table 1). Reports came from 24 counties, but the majority (110 reports) are from San Francisco. Blue gum failures occur more commonly in the winter months, with 58% of failures reported from November to February.

Most failed trees were found in a group (67%), in high use areas (36%), and in parks (48%). The most common defect for all failures was heavy lateral limbs, observed in 29% of reports, followed by dense crowns and multiple trunks (12% each).

A. BRANCH FAILURE

Branch failure was reported in 134 cases, or 44% of total reports.

Branch failure location

The majority of branches failed at some distance along their length (62%) (Fig. 2). Failures along the branch

Figure 1. Property damage is not uncommon when trees fail. Here, a large blue gum caused considerable damage to this house. *Photo: T. Larson*

Table 1. General statistics for all failure types.

Variable	Mean
Age	65 years
Height	81 feet
DBH	44 inches
Crown spread	44 feet

Winter 2014 52

WESTERN Arborist

Structural failure profile: Italian stone pine (*Pinus pinea*)

L. R. Costello, J. Tso, and K. S. Jones

EACH YEAR, THE STRUCTURAL FAILURE OF trees in urban and forested recreation areas results in personal injuries and property damage. A key objective of a tree management program is to reduce the potential for failure to the extent possible. One important element of failure reduction strategies is to prevent or mitigate conditions that may lead to failure, such as pruning branches weakened by wood decay, cabling or bracing, and avoiding root damage.

All tree species do not fail in similar ways, however. Some are prone to fail as a result of weak architecture, such as codominant stems. Others have a greater propensity to fail because they develop large end-weights on branches — exceeding the load tolerance of the wood. Knowing the particular failure patterns of species can help tree managers identify key defects that may lead to failure.

By collecting detailed information following the failure of a tree, data can be compiled and then used to develop structural failure profiles for species. Such a profile has been developed here for Italian stone pine (*Pinus pinea*) using data from the California Tree Failure Database (CTFD). Arborists and foresters can use this information to develop structural management strategies for Italian stone pine. The development of this profile was commissioned by the Britton Fund of the Western Chapter of the International Society of Arboriculture.

Italian stone pine distribution

Italian stone pine is native to southern Europe and Turkey, but has become naturalized in many regions with a Mediterranean climate. It is a relatively common landscape tree in California, being found in both public and private landscapes (Fig. 1).

General statistics

There are a total of 170 reports in the CTFD for Italian stone pine, the majority of which are for root failures (41%). Trunk failures comprise 30% of reports, and branch failures make up the remaining 29%.

Reports came from 22 counties, but the majority (75 reports) are from Contra Costa, San Francisco, and Santa Clara Counties. Italian stone pine failures are slightly more common in winter than summer, with 52% of failures reported from December to February. General statistics for all failure types can be found in Table 1.

By collecting detailed information following the failure of a tree, data can be compiled and then used to develop structural failure profiles for species.

Figure 1. Italian stone pine is a relatively common landscape tree in California. Typically, it has a rounded crown and multi-stem structure. *Photo: K. Jones.*

Table 1. General statistics for all failure types.

Variable	Mean
Age	43 years
Height	47 feet
DBH	32 inches
Crown spread	44 feet

Fall 2015 44

Coast Live Oak

(*Quercus agrifolia*)

California native oak occurring within a 50-mile corridor along the Coast, Transverse, and Peninsula Ranges from Sonoma County to Baja

CLO Key Findings

619 reports

Root failures: 40%
Trunk failures: 37%
Branch failures: 23%

Most failures occurred between October and March (66%).

Failures occur during calm and dry conditions as well.

Most failures occurred in residential settings (47%).

CLO Key Findings

Root failure was the most common type of failure for coast live oak (40%).

Many root failures are associated with decay (73%), with 55% having less than 50% of the cross-sectional area decayed.

Saturated soil and wind (moderate and high - 67%) are key factors contributing to root failures.

CLO Key Findings

Decay was associated with 80% of trunk failures. Over 40% of these failures occurred when less than half of the cross-sectional area was decayed.

Sporophores are not found in the majority (80%) of failures associated with decay.

CLO Key Findings

Multiple trunks and codominant stems are key defects associated with trunk failure (35%).

CLO Key Findings

Branch failures occur along the branch almost as frequently as they occur at the attachment.

Heavy lateral limbs and embedded bark are key defects associated with branch failures.

Decay contributed to 74% of branch failures.

Photo credit: Blair Glen

2. RESOURCE FOR INQUIRIES REGARDING TREE FAILURES

- How many reports have been submitted for "summer branch drop" in valley oaks?
- What information is there on elm tree failures in the Sacramento Valley in the past five years?
- Which decay fungi have been reported most frequently?
- Is there any data on costs associated with failures?
- Are there any reports of tree failures during earthquakes?
- Information on failures of coast redwoods with codominant stems?
- Have failures of fire damaged redwoods been reported?

3. PROFESSIONAL DEVELOPMENT

Western Tree Failure Database
ANNUAL MEETING

Descanso Gardens, Los Angeles County

Filoli Center, San Francisco
San Francisco Bay Area

Topics focused on
tree failure
analysis and
risk assessment

Case Studies

Course Code: **M-0580-12**

WCISA Units: 6.5

Course Code: **WE-12-196**

Certified Arborist: 6.5

Certified Tree Worker: 6.5

Municipal Specialist: 6.5

Utility Specialist: 6.5

BCMA - M 2.25

BCMA - P 2.25

BCMA - S 2.0

United States Department of Agriculture

A Guide to Identifying, Assessing, and Managing Hazard Trees in Developed Recreational Sites of the Northern Rocky Mountains and the Intermountain West

Forest Service	Forest Health Protection Northern & Intermountain Regions	Publication R1-17-31	October 2017

Questions?