South of the Spotted Owl, Revisited

Recurrence, recharge, restoration and resilience

Balance Hydrologics, Inc.

Berkeley • Santa Cruz • Auburn • San Rafael • Truckee

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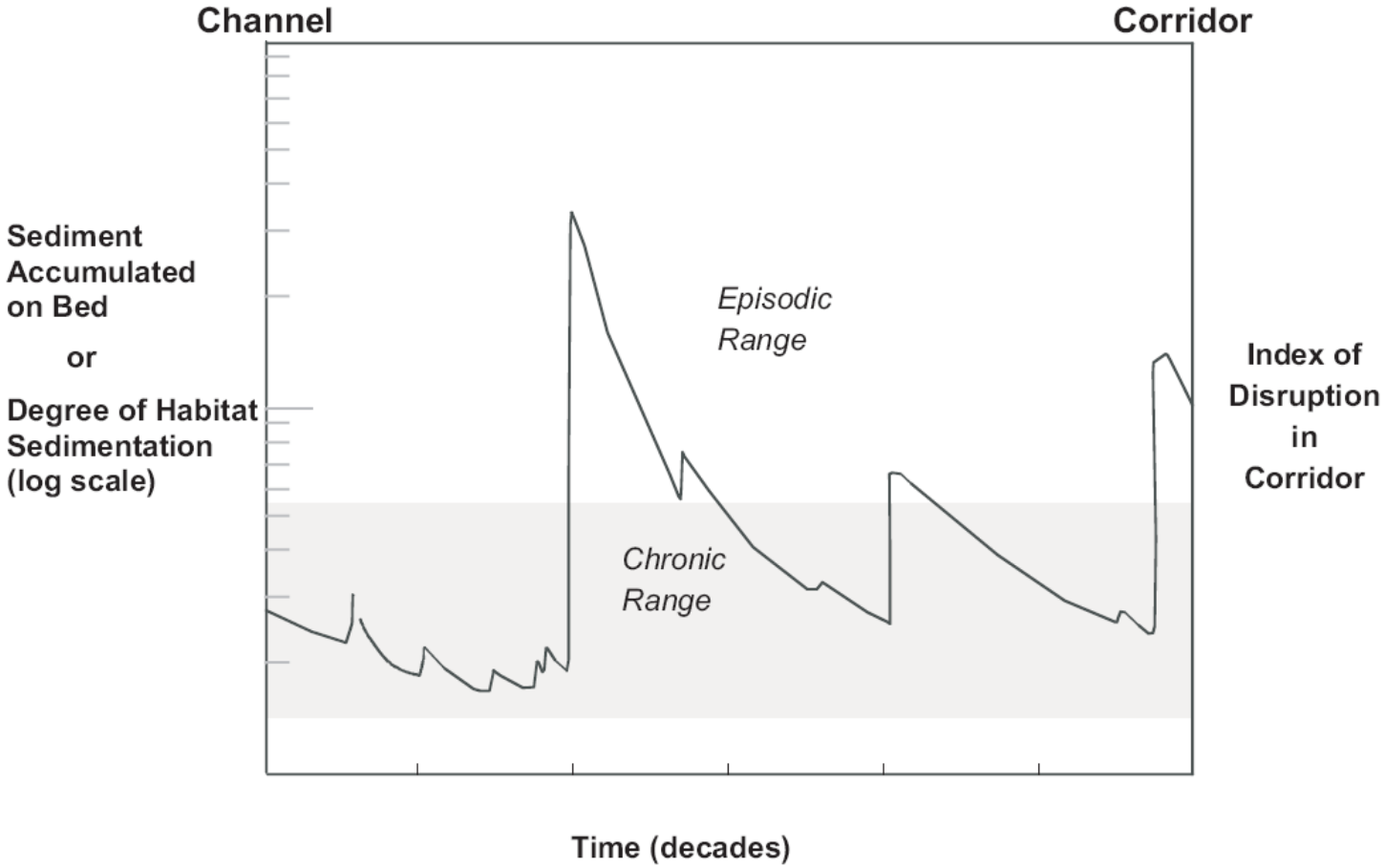
Roadmap

- South of spotted owl, summarized
- South of spotted owl, expanded
- Applying episodicity, in the real world
- Integrating episodicity. . .a few thoughts

South of spotted owl, summarized

Definition

- An episodic corridor is one where the substrate is renewed, rejuvenated or ‘reset’ abruptly, at intervals shorter than those typically needed for a mature woodland or streamside community to develop.



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Schematic representation of episodic variations in bed sedimentation and/or disturbance in riparian alluvial-scrub corridors of central or southern California streams.

Episodic.cdr

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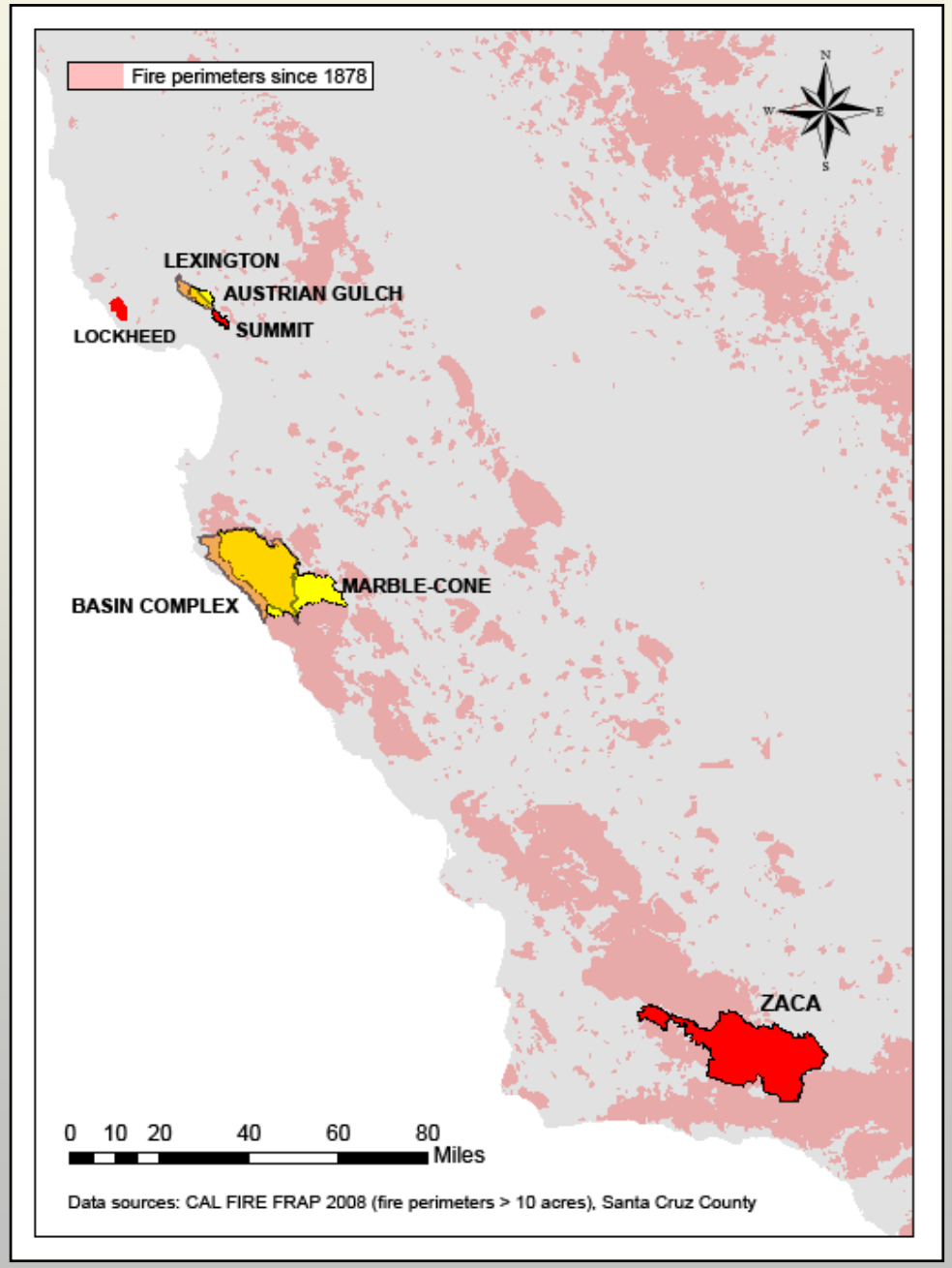
Central California fire region

Study sites



“Episodes can be up to half the load”

Table 2.—Sequential sediment accumulation in Los Padres Reservoir[1].

Survey date	Reservoir capacity[2] (acre feet)	Loss in capacity (acre ft.)	Annual rate of capacity loss (acre ft.)
Nov 1947[3]	3200	-	-
Nov 1977	2592.7	607.3	20.2
Sep 1978	2037.6	555	555
Oct 1980	1996.3	41.3	20.6

[1]Source: R. M. Bloyd[4]

[2]Below spillway elevation of 317.2 m. (1040.8 ft.) above mean sea level.

[3]From pre-construction capacity curves developed by California Water and Telephone Company.

Sedimentation at the head of Los Padres Reservoir, May 1980

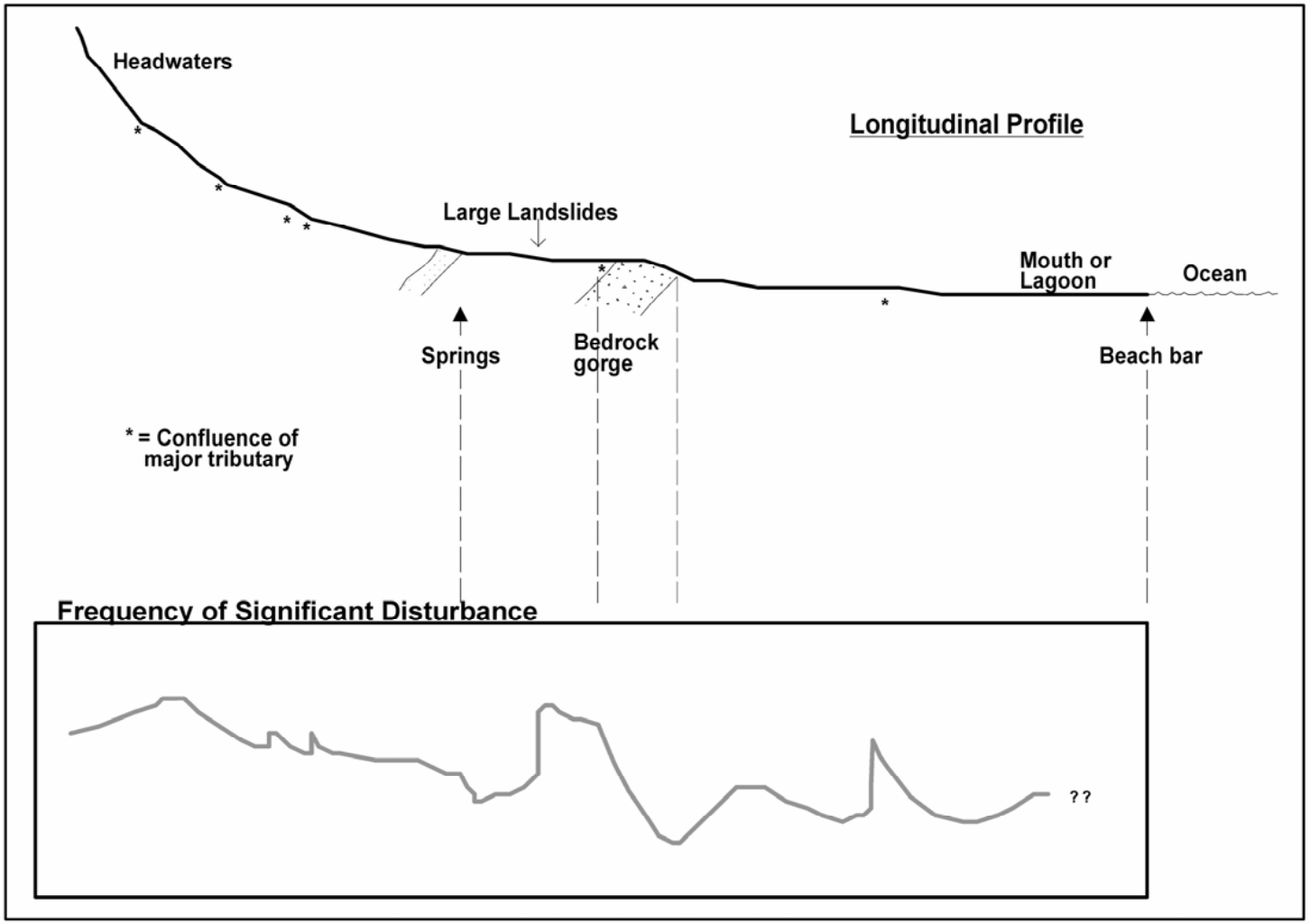


Figure 4. Schematic longitudinal variability in the frequency of episodic disturbance in a representative central California corridor. Reaches immediately downstream from channel confluences and other point sources of sediment are more susceptible to frequent disturbances; reaches with gorges or perennial springs tend to be more resilient to the same disturbances. Frequency diminishes from upstream to downstream, but relative severity or extent of disturbance does not.

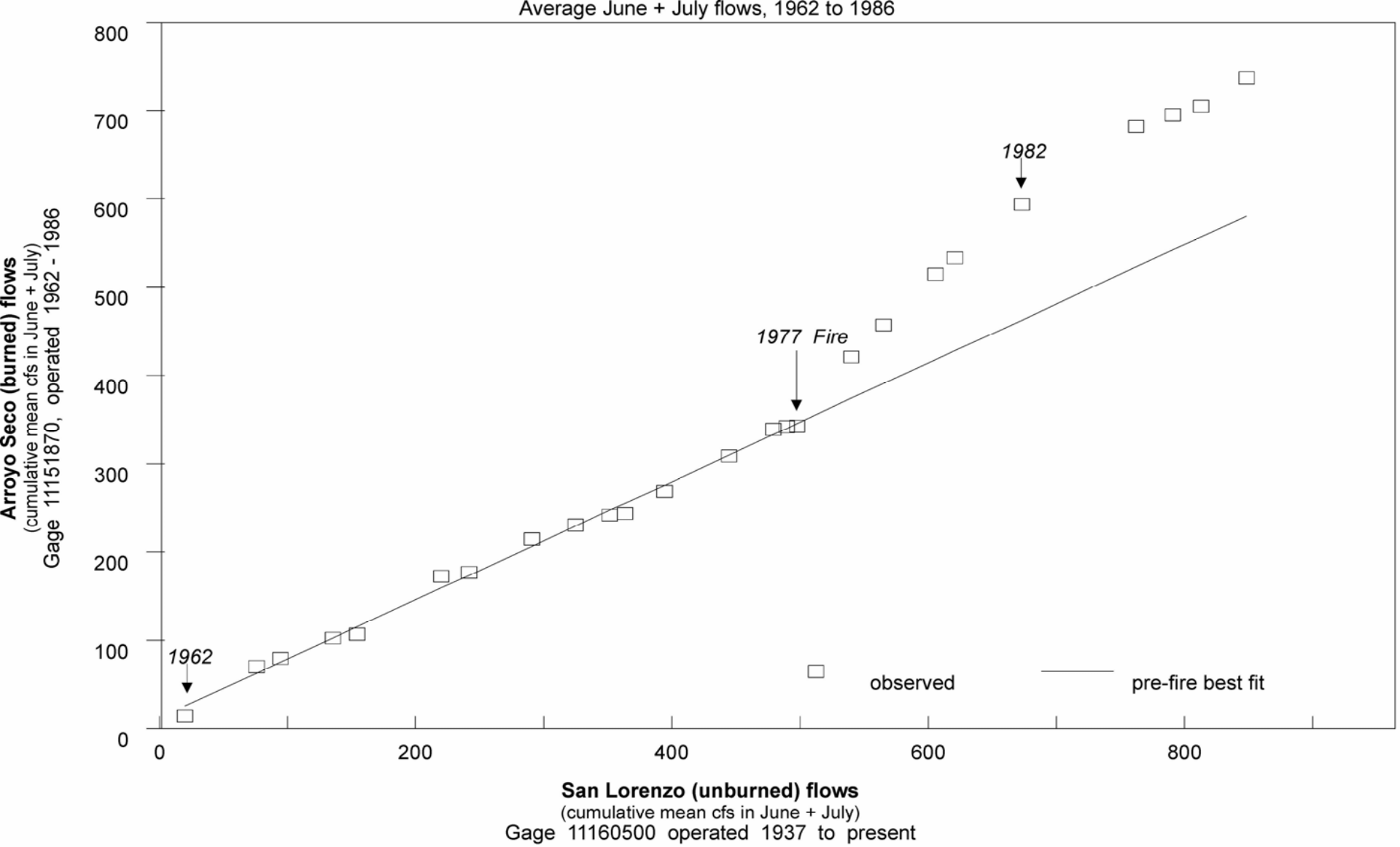


Figure 5. Increased summer streamflows following the Marble-Cone fire (1977) helped sustain aquatic and near-channel habitat in Arroyo Seco and adjoining streams, which were initially heavily sedimented by post-fire runoff. From 1978 through 1982 or 1983, summer flows in Arroyo Seco were nearly twice values expected based on long-term correlation with the San Lorenzo River (unburned watershed), offsetting some of sediment water-quality and temperature effects on aquatic biota. The double-mass curve shows that the pre-fire relation for June and July flows between Arroyo Seco and the San Lorenzo River resumed after 1982 or 1983.

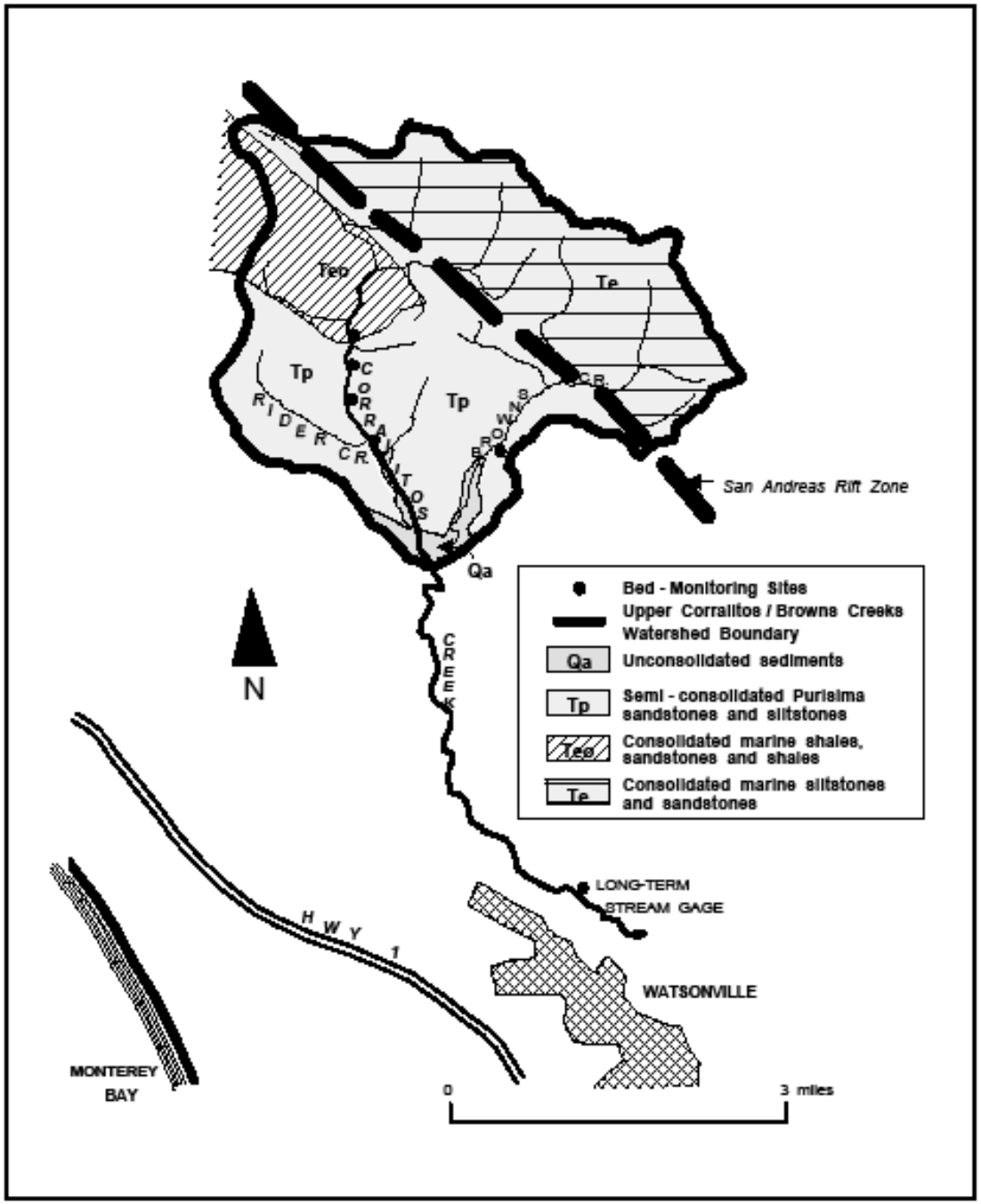


Figure 6. Location and geologic influences, Corralitos and Browns Creeks.

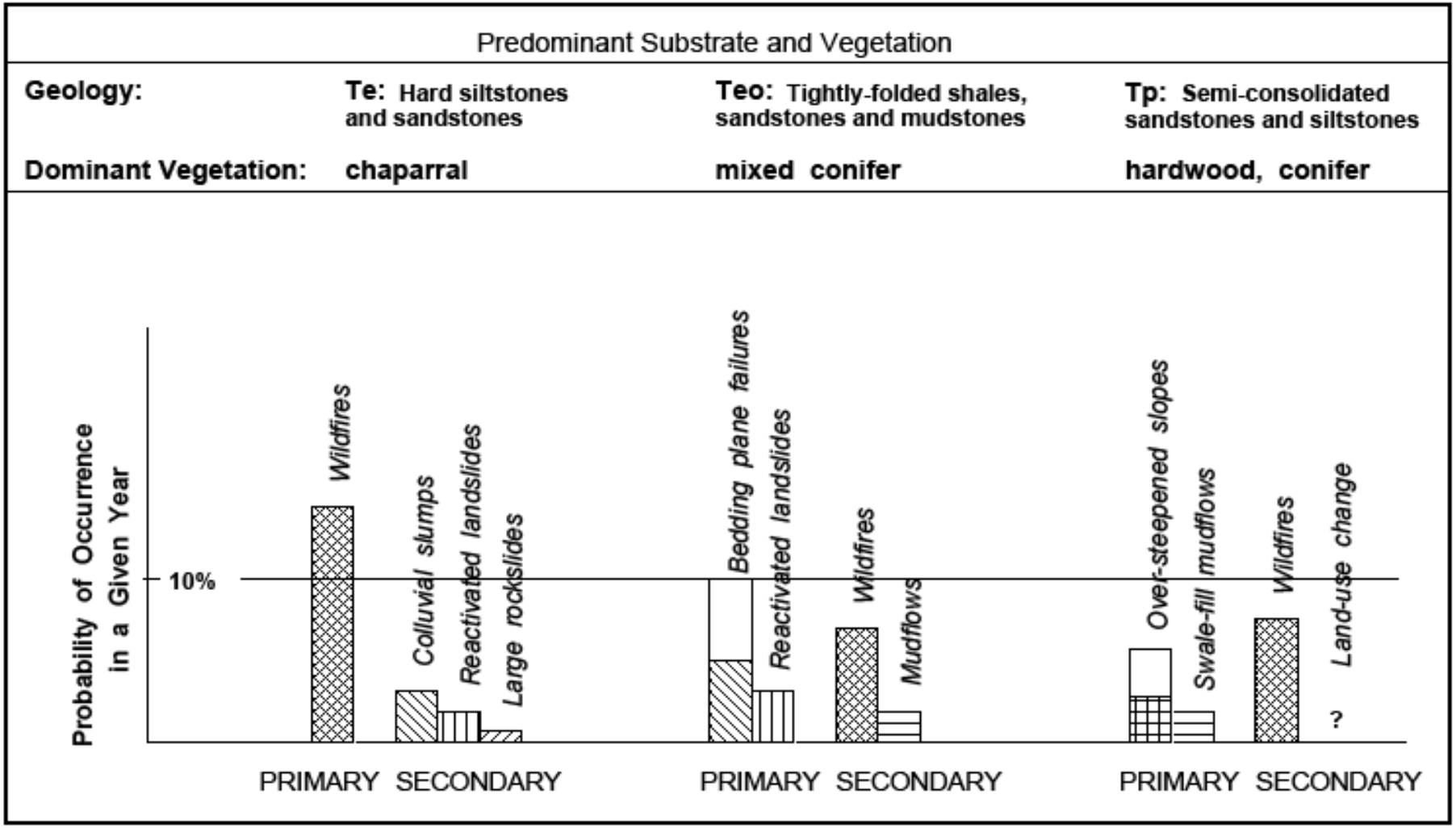
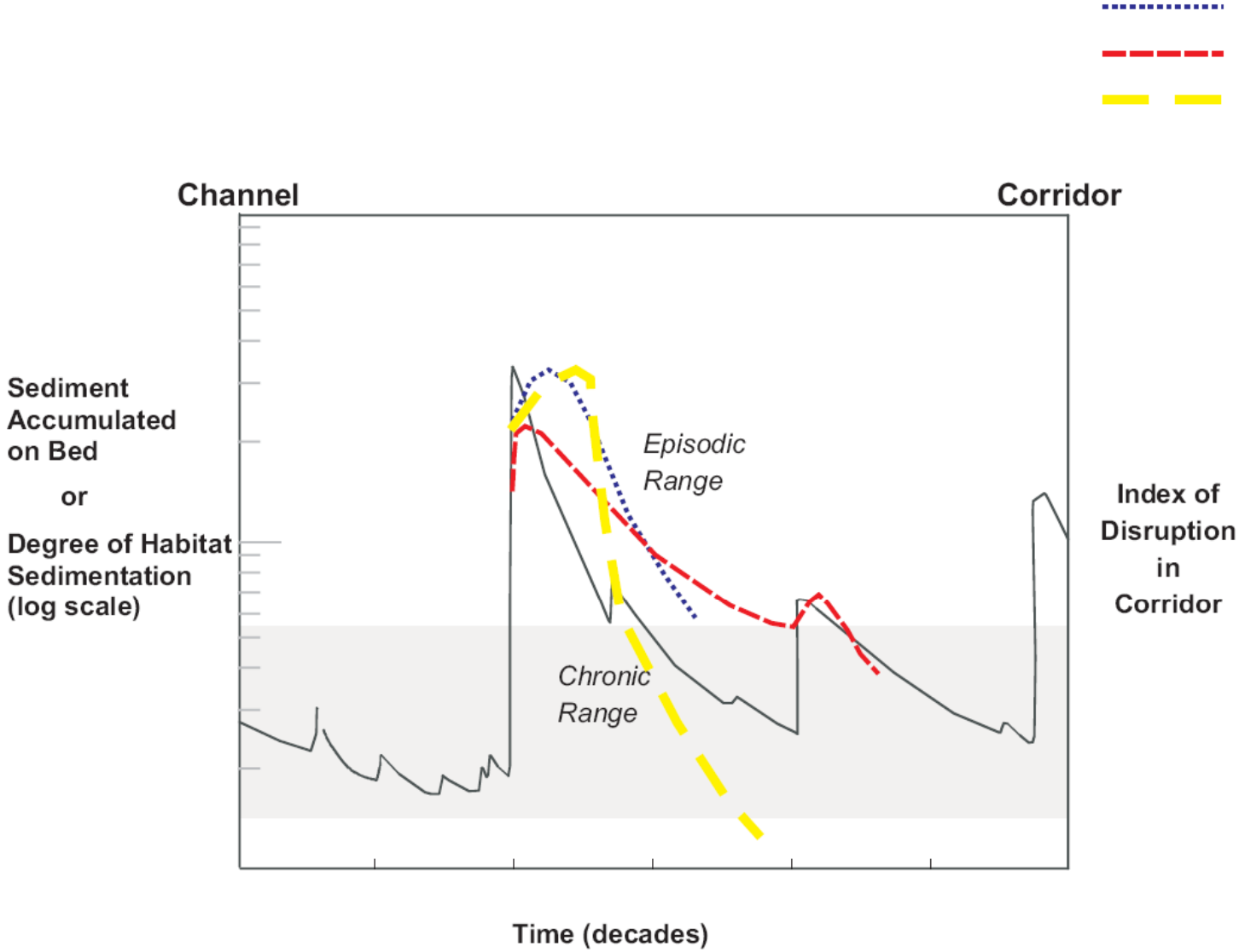


Figure 7. Estimated probability of significant sedimentation of steelhead habitat caused by episodic events, in three geologic/vegetative regimes, Corralitos Creek watershed. Probabilities based on estimated or observed frequencies and projected durations of bed sedimentation. Primary disturbances warrant site assessments by knowledgeable specialists and may merit temporary management measures. Secondary influences are more localized or less severe than primary. Source: Hecht and Woyshner (1991).

- South of spotted owl, expanded



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Schematic representation of episodic variations in bed sedimentation and/or disturbance in riparian alluvial-scrub corridors of central or southern California streams.

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Expanded episodic characterization of a post-fire sediment pulse

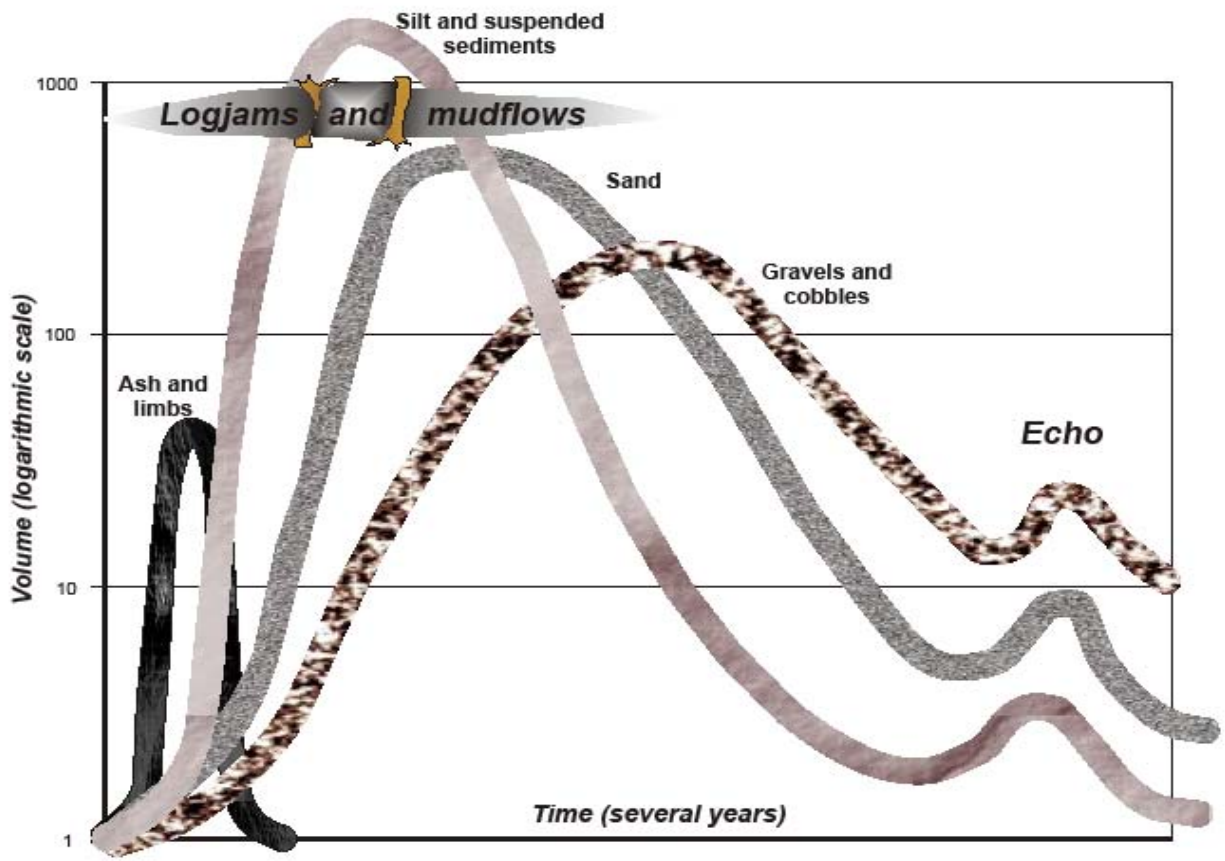

Figure 2. Schematic timeline of the fire-flood sediment cycle, Northern Santa Lucia Mountains.
Note that the volume scale is logarithmic. The sediment echo may occur several years later, probably when slopes and banks beneath dead or split trees collapse as their roots decay.

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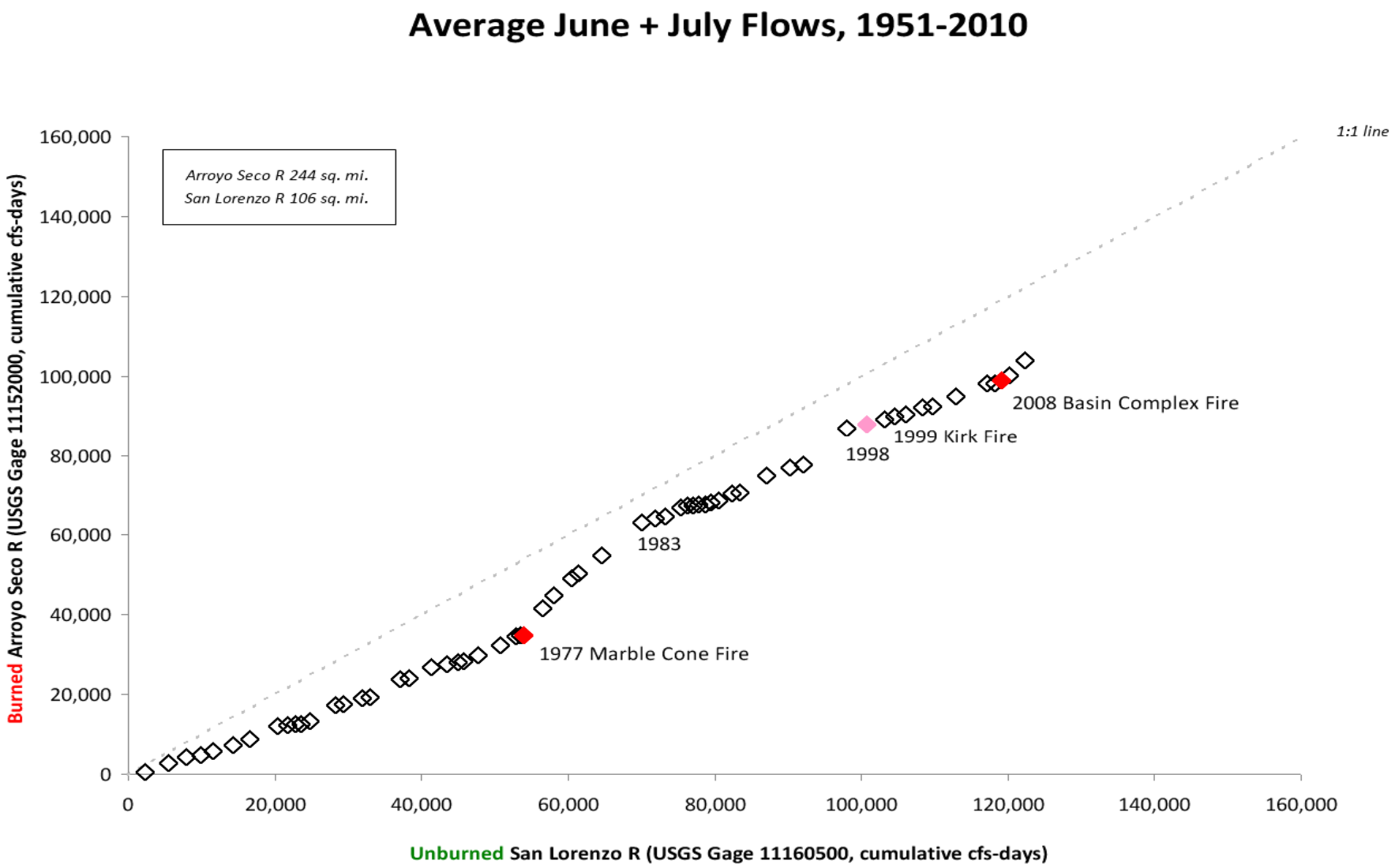
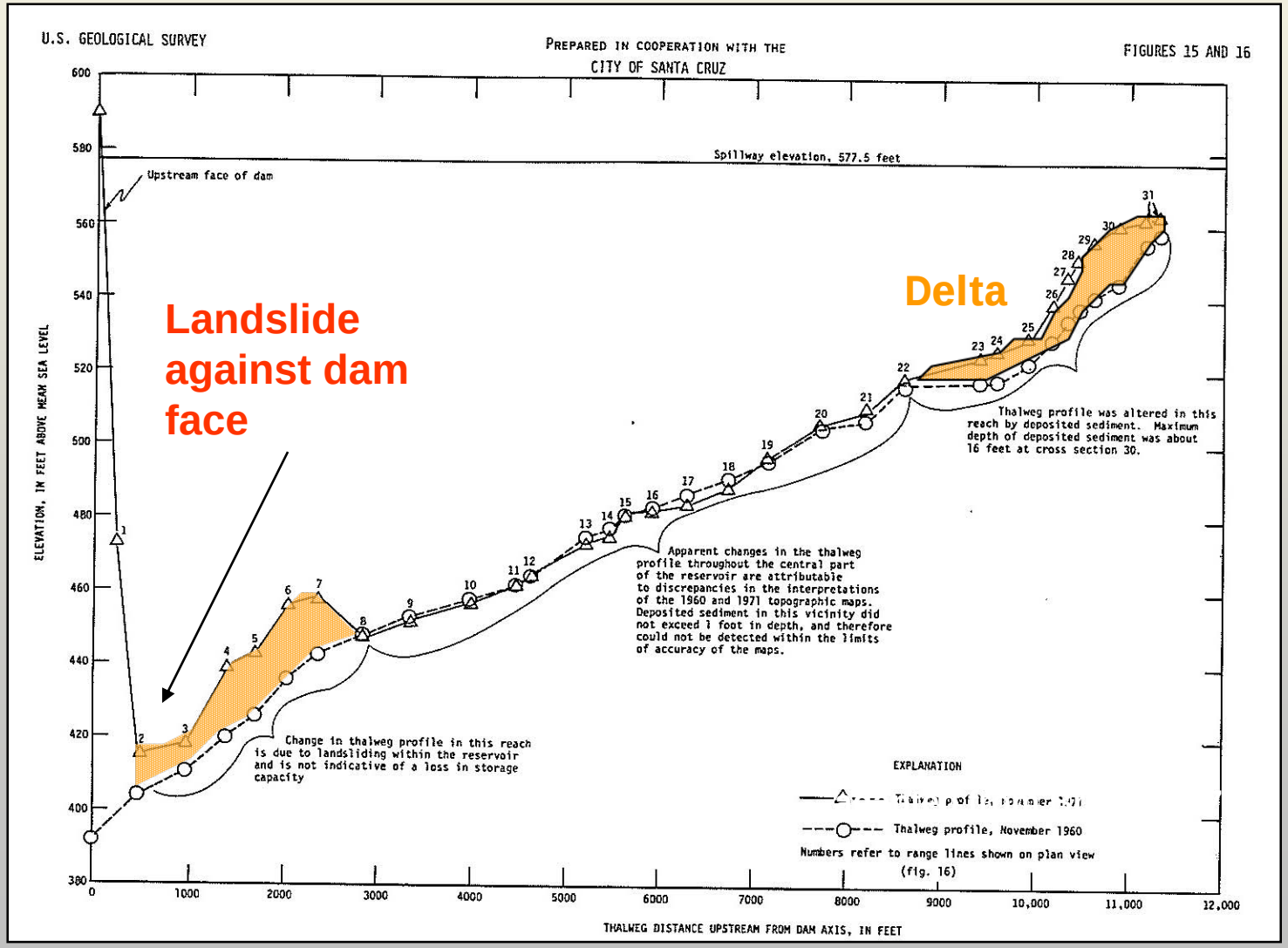
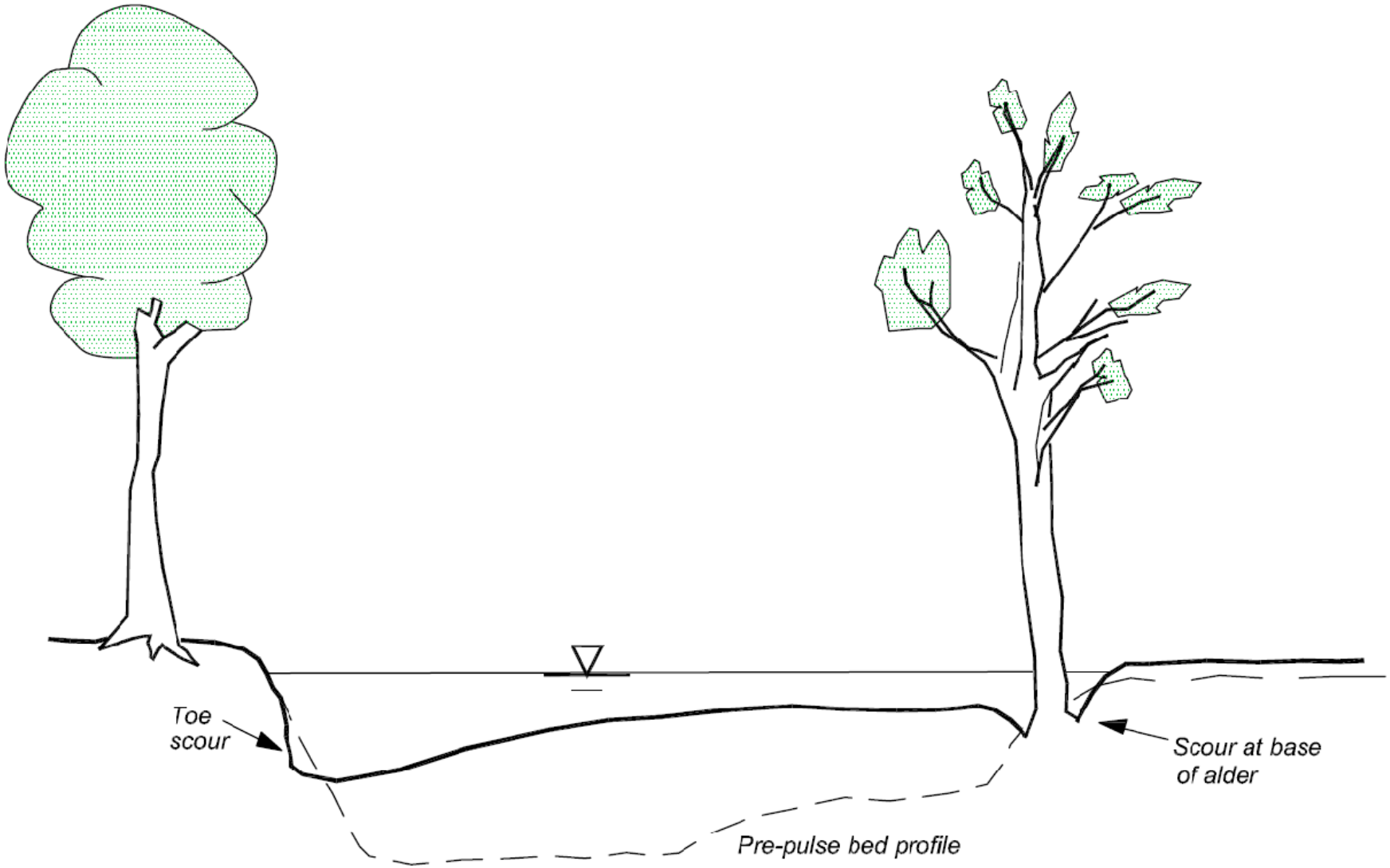
Subsequent and recurrent episodicity



“Moment-of-Terror” Subsequent Episodicity





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Downstream secondary effects of post-pulse sedimentation on mature alders.

Compounded Episodicity

Multiple fires affecting 70% of watershed

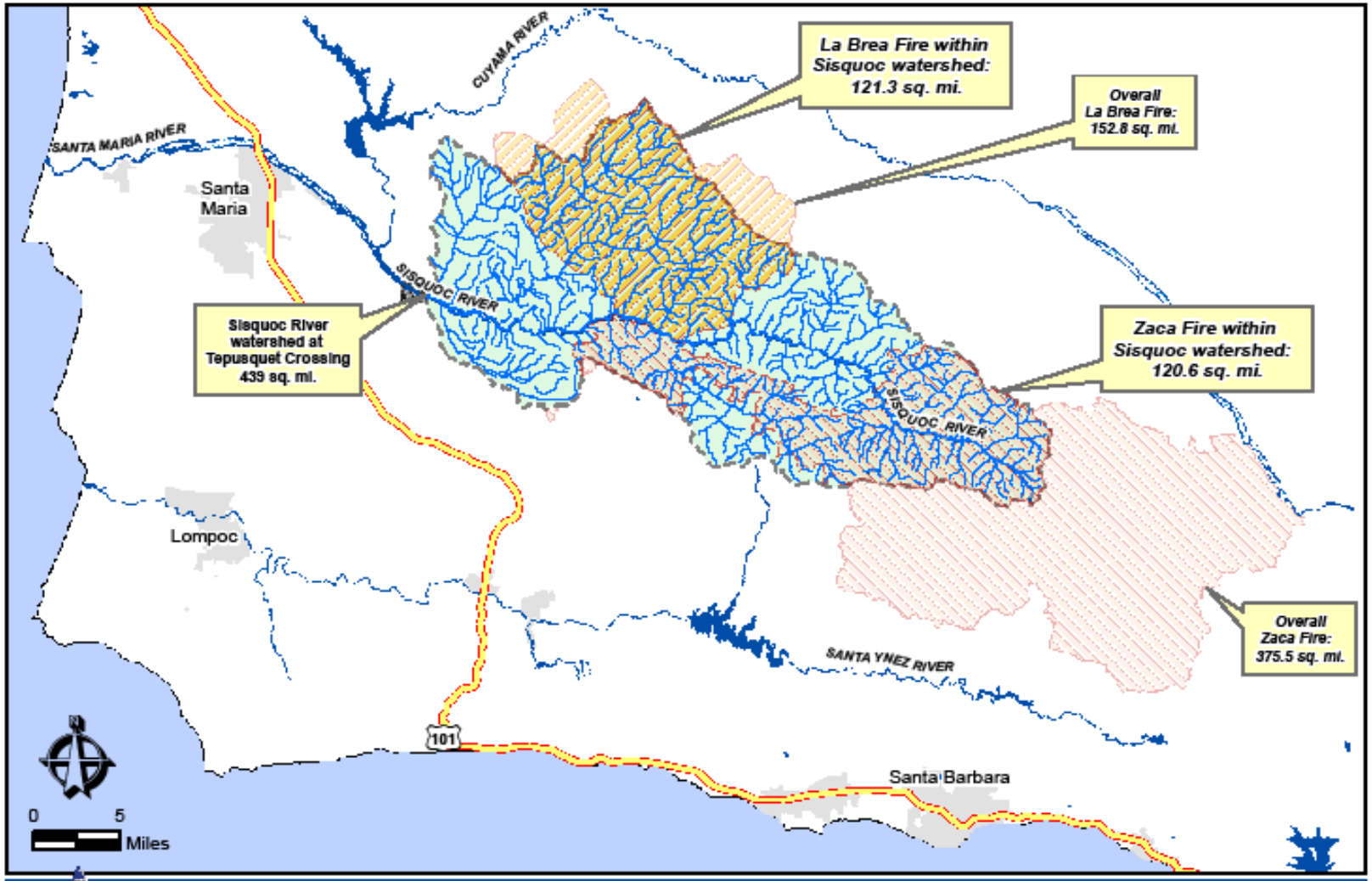

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Figure 1. Large fires within the Sisquoc River watershed, 2007 and 2009.

Sources: Santa Barbara County, California Spatial Information Library

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Sisquoc River

Northern Santa Barbara County

Sedimentation after the Zaca fire:

What comes next?

- Post-fire fill with ash at base

Ash and gunk phase, La Brea fire

La Brea Creek, Santa Barbara County Oct. 1, 2010

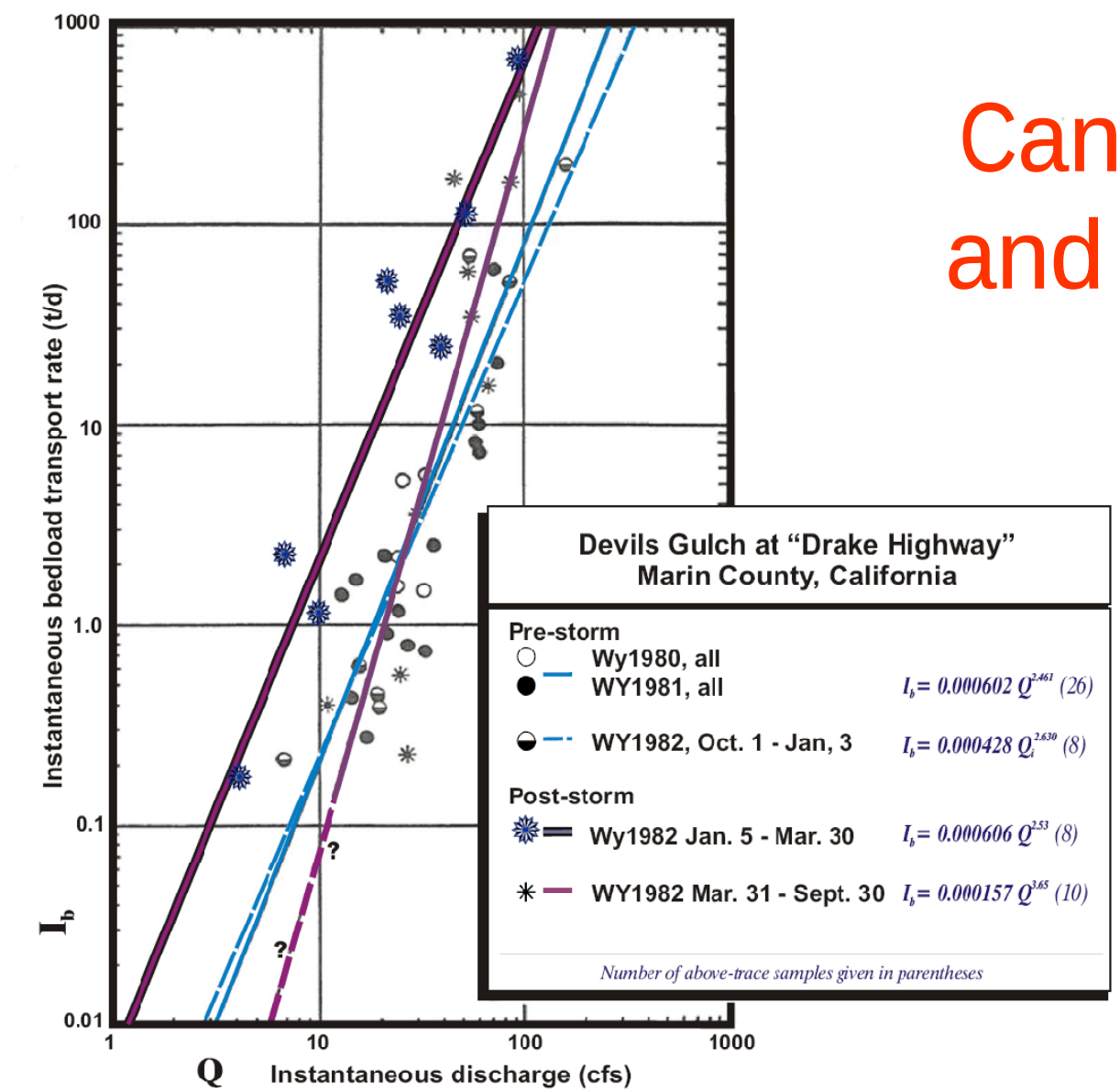
- Applied episodic analysis. . .in the real world

  - How to use the paradigm
  - How to quantify and predict
  - Anticipating
  - Applying in a regulatory setting

Parallel paradigms

- Dynamic equilibrium or metastability
  - Central tendency measures, with variability analysis
  - Recurrence as an organizing concept
- Episodic analysis
  - Pulse-response concept
  - Ecosystem or transdisciplinary emphasis

Can we predict and measure it, #1?



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Bedload-transport rating curves during an episodic cycle, distinguishing transport during pre-event, high-yield and initial recovery phases

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Quantifying Episodic Response
Devils Gulch, Marin County, CA

Watershed condition	Sediment-transport relations	Remarks
Normal, or 'chronic'	$\mathbf{I_b} = 0.0061\mathbf{Q}^{2.5}$	Minimal year-to-year variance, despite 3- and 5-year events (1978, 1980) preceding monitoring
	Storm	
Initial recovery	$\mathbf{I_b} = 0.0060\mathbf{Q}^{2.6}$	Interpreted as removal of sediment stored on bed and sub-0.5 bankfull channel, based on field observations
Late-stage recovery	$\mathbf{I_b} = 0.000015\mathbf{Q}^{3.6}$	Depletion of high-bank storage
Normal, or 'chronic'	Resumed pre-event relations	Followed by very wet year, so other late-stage relations obscured.

Can we measure and track it, #2?

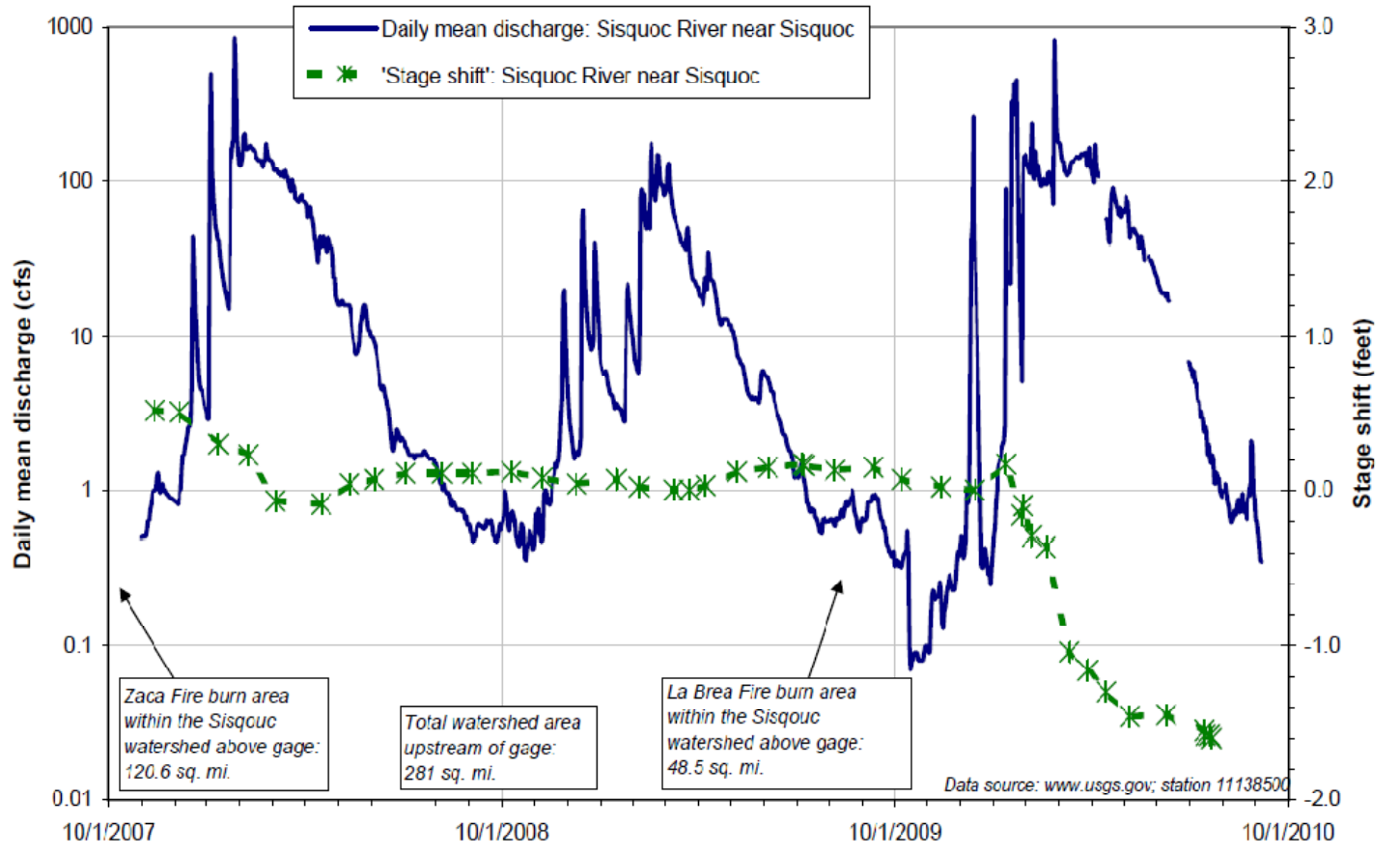

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Figure 3. Daily mean streamflow and stage shift at Sisquoc River near Sisquoc, Santa Barbara County, CA, water years 2008-2010. Note the significant decrease in 'stage shift' during water years 2008 and 2010. A decrease in the 'stage shift' generally indicates aggradation of the channel. The aggradation recorded in WYs 2008 and 2010 are likely responses to the July 2007 'Zaca' and August 2009 'La Brea' fires which each burned large portions of the upper Siquoc watershed. (See Figure 2 for distribution of burned areas.)

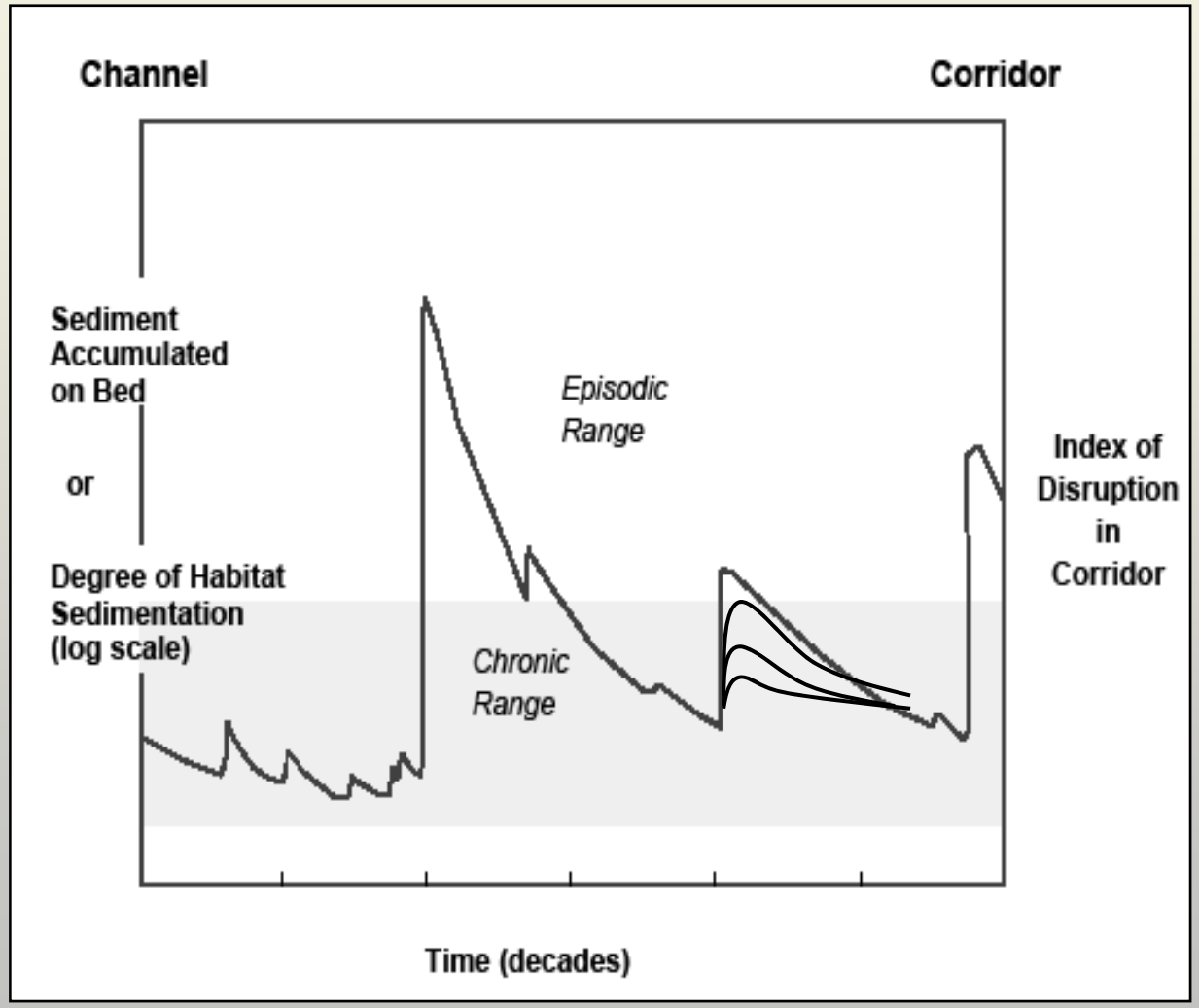
Linkages between episodic and climate-change analyses

Example:

"Climate change projections also include fluctuations in temperature, the potential for more frequent periods of drought, and the likelihood of intense storm events happening more often. These changes are likely to have an impact on riparian vegetation composition and density, as well as the frequency and erosive power of high flow events."

--*County of Marin, Miller Creek Existing Conditions Report, 2008*

Indeterminate episodic variations in central California streams



Anticipating Episodes

Pine Borer Die-off, Gearhart Mountain, Headwaters of the Sprague River, Oregon

Sample of an episodic analysis

- Known event history
- Current conditions and their episodic status
- Evaluation of primary episodes, and their likely recurrences
- Description of expected secondary derivative and subsequent episodes and process
- Their likely effects
- What may not be known
- Implications for climatic change

Regulatory Applications

- Watershed plans of various types
- Biological Assessments and Biological Opinions
- Major EIRs, EISs,
  - Functional Equivalents, FERC and Water-rights permits
- HCPs and RWQCB Basin Plans
- Fiscal plans (capital improvement; and bonding),

plus

Regulatory Applications, cont'd

- General Planning process
  - General plans
  - Specific plans
  - Plan elements, e.g.:
    - Natural hazards or fire management
    - Conservation and open space
    - Aggregate-resource, and
    - Beach-sand supply plans

Integrating episodicity. . .a few thoughts

Episodic analysis as an integrator of Geomorphology

"Geomorphology . . . has evolved into an essentially bipartite discipline focusing either on 'process' or broader 'historical' (Quaternary) landscape interpretation. . . Indeed, some say we are not seeing the landscape for the processes."

-Ian Walker: The Canadian Geographer / Le Geographe canadien 54, no 3 (2010) 261–276

Analysis of episodes, their effects on the landscape and sustainability, and societal response to them offers a genuine linkage in time, space, and understanding of both process and thresholds.

Can we grow this opportunity?

Episodicity as a social paradigm in arid lands

From the biblical ancient near east:

Jubilee – a societal 'reset'

- Freeing of slaves
- Ending of feuds
- Cancelling of debts

The word for 'flood' and for 'jubilee' are based on the same root.

They are the only common words sharing that root

Summary

- Episodes are an integral and often non-segregable part of the California landscape
- Planning with episodic analysis has a quantitative scientific basis
- It has an important role in environmental management and planning, perhaps best incorporated as a parallel paradigm
- Primary episodes and a range of derivative or delayed results can be identified and anticipated.
- Episodic planning for arid, alpine, arctic, or dune landscapes can draw upon what is known from the semi-arid environments.
- There a lot more to do and a short time to get there.

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- Ellen Bauder
- . . . and others

"It takes a village to understand an event"

“Hoooo” has questions?

Episodic analysis, applied

- Working Definition:

Analysis of events which fundamentally change the functions and morphology of a channel in response to a watershed event, with attenuation/recovery over a finite period of years (relative to salmonid generations, riparian succession, or other management goal), including derivative or subsequent processes

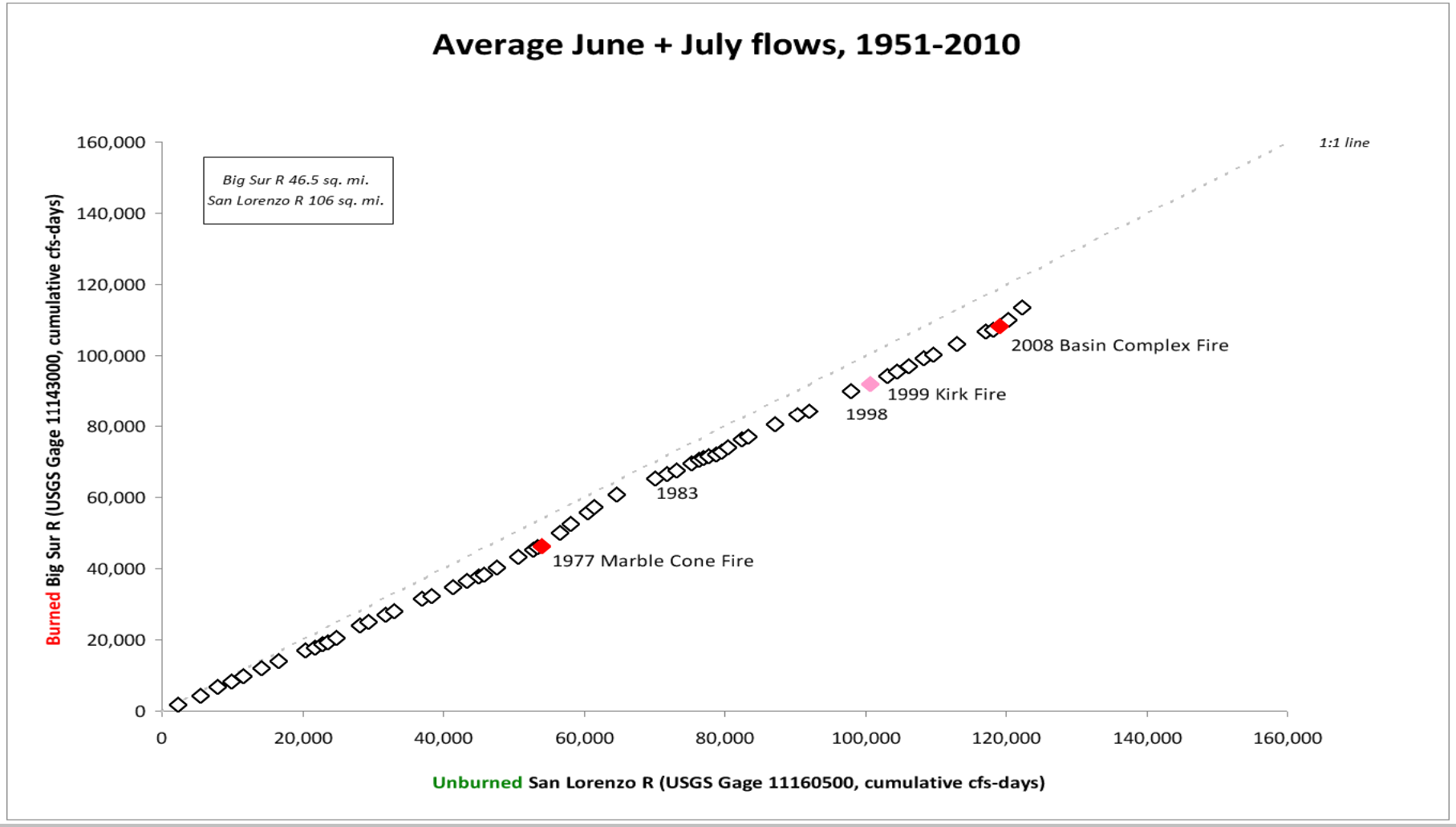
- Examples of primary events:

Major storms, fires, landslides; drought; earthquakes; cutoffs and avulsions; windstorms

- *Lagunitas Chronology, 1960 to present*
- *Drought: 1976, 1977*
- *Storm: January 4, 1982*
- *Big Bend events of 1995-1997 -- Channel avulsions (2) and Debris flow (2)*
- *Storm: December 31, 2005*

- Looking at examples of derivative effects:

Summer flows, Big Sur River



Disturbance	Assumptions		Probability of Occurrence in Any Given Year
Wildfire	No systematic suppression 40-year cycles in chaparral areas (.025)		
	Burning ½ of chaparral areas may be sufficient to cause disturbed conditions	(x2) .05	
	100-year cycle of major fires in woodland	.01	
	TOTAL		.06
Construction or Land Development	Generally 30 acres of bore ground surface; less in erodible or unstable areas	.03	
	Major road/pipeline construction; disturbance of 10 acres or more	.02	
	TOTAL		.05
Major Floods	Assumed cumulative recurrence of 25 years		.04
Major Slope Failures	Little is known about the nature and recurrence of slope movement in these basins		unknown; probably very small
Agricultural Conversion	Beyond present management perspective See text		N.A.
	Approximate cumulative incidence		.15
	Assumed effective incidence for management purposes (see text)		.05 - .075