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## **Survey of OHWM Indicator Distribution Patterns across Arid West Landscapes**

Lindsey Lefebvre, Robert Lichvar, and Katherine Curtis

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## Abstract

Arid West fluvial systems are regulated as “Waters of the United States” (WoUS) under Section 404 of the Clean Water Act. The jurisdictional limits in Arid West channels are defined by using the “ordinary high water mark” (OHWM). Hydrology is the driving factor in the development and distribution of OHWM indicators, but incorporating landscape position may provide further insight into their distribution and reliability. The US Army Corps of Engineers OHW delineation manual indicates a large variability in the occurrence and position of OHWM indicators across channels but fails to evaluate the distribution of indicators at a larger scale. Evaluating OHWM indicators at a larger scale requires an understanding of what indicators are present, their sorting and distribution within a watershed, and their relationship to landscape features. For this study, the frequency and occurrence of OHWM indicators were evaluated to understand their distribution patterns across the Arid West region in 14 mountain, 18 foothill, and 17 basin ephemeral and intermittent channels within multiple watersheds. We found no significant OHWM indicator distribution patterns in any specific landscape position, but there were several OHWM indicators that occur more frequently than others across the entire landscape. The lack of a significant relationship between OHWM indicators and types of channels and their landscape positions supports previously reported results that showed that indicators are randomly distributed in all locations across a channel and may best be described as flow indicators rather than OHWM indicators.

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## Preface

This research was funded by the Wetland Regulatory Assistance Program (WRAP), US Army Corps of Engineers. The principal investigators were Lindsey Lefebvre, Robert W. Lichvar, and Katherine Curtis, all of the Remote Sensing/ Geographic Information Systems (RS/ GIS) and Water Resources Branch, Cold Regions Research and Engineering Laboratory (CRREL), US Army Engineer Research and Development Center (ERDC), Hanover, NH. Robert Lazor of the Environmental Laboratory, ERDC, Vicksburg, MS, and Dr. Mark Sudol, Institute of Water Resources, US Army Corps of Engineers, Washington, DC, are recognized for their early foresight and interest in pursuing OHW research in the western United States in support of the Corps Regulatory Program. Since then, both Meg Gaffney-Smith and Karen Mulligan of the Headquarters Regulatory Program have continued an interest in and funding support for pursuing this important effort to support western Corps Districts.

This study was conducted under the general supervision of Timothy Pangburn, Chief, RS/ GIS and Water Resources Branch, CRREL; Dr. Justin B. Berman, Chief, Research and Engineering Division, CRREL; Dr. Lance Hansen, Deputy Director, CRREL; and Dr. Robert E. Davis, Director, CRREL. Permission to publish was granted by the Director, Cold Regions Research and Engineering Laboratory.

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# 1 Introduction

Over 81% of stream channels in the Arid West landscape include intermittent and ephemeral channels that are regulated as “Waters of the United States” (WoUS) under Section 404 of the Clean Water Act (Levick et al. 2008), as determined by using the “ordinary high water mark” (OHWM). The OHWM is a defining element for identifying the lateral limits of non-wetland waters, and the boundary is determined by observing a characteristic geomorphic signature. OHWM is defined in 33 CFR Part 328.3 “as a line on the shore established by fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of the soil, destruction of terrestrial vegetation, or the presence of litter and debris.” Channel morphology and physical characteristics that develop within the Arid West channels are a result of short-term, high-intensity hydrometeorological events that produce extreme floods and that are characteristic of the climate in the Arid West (Graf 1988; Tooth 2000; Lichvar and Wakeley 2004). Physical features found along channels can vary for different stream types, along the length of any given channel, and through time at a single point (Field and Lichvar 2007).

The hydrologic regime of Arid West intermittent and ephemeral channels influences channel morphology by driving the quantity of sediment deposited and eroded in the channel, which subsequently shapes the signature of the channel and the surrounding floodplain. Common fluvial features of intermittent and ephemeral channels in the Arid West include three hydrogeomorphic surfaces: the low-flow channel, the active channel, and the floodplain (Fig. 1). An important geomorphic distinction between intermittent and ephemeral channels and perennial channels is that intermittent and ephemeral channels lack a traditional bankfull channel. In perennial systems, the bankfull channel is maintained by continuous flows and is established and maintained by a 1.4- to 1.6-year flood (Leopold et al. 1964; Rosgen 1996). The concept of a bankfull channel is inappropriate in Arid West intermittent and ephemeral channels because it suggests frequent flows that maintain a stable channel. Rather, the flows in intermittent and ephemeral channels are flashy and highly unstable, and they migrate within the boundaries of the active channel. This extremely dynamic portion of the floodplain is called the low-flow channel.

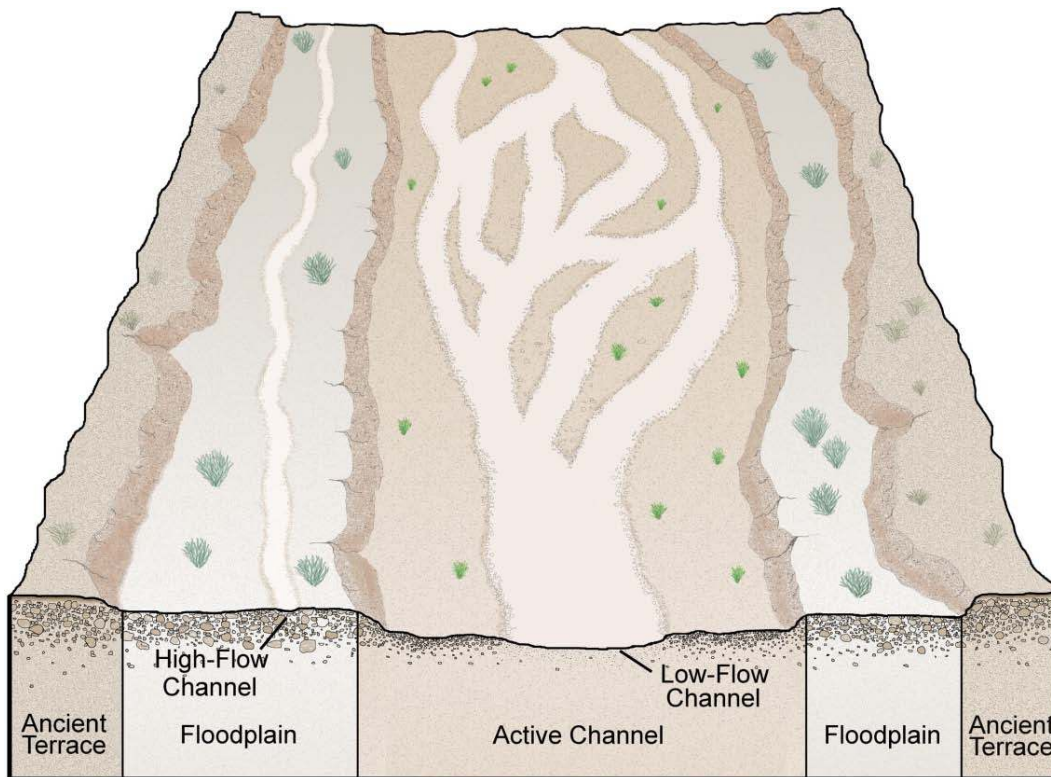


Figure 1. Hydrogeomorphic floodplain units for a typical Arid West channel.

The geomorphically stable features of intermittent and ephemeral channels in the Arid West are the active channel and the floodplain. The active channel is characterized by low-flow channels, generally unvegetated surfaces, and a break in slope (Lichvar et al. 2006), and it frequently receives over-bank flow from the low-flow channel (Williams 1978; Province of British Columbia 1995; Rosgen 1996). A previous study (Lichvar et al. 2009) found that the outer limits of the active channel remain more consistent over time, regardless of the size of the discharge event, and they represent the extent of the OHWM. Lichvar et al. (2009) also found that the floodplain maintains its vegetative and morphological composition after discharges as large as an 18.7-year flood event, the largest event studied. A study of gauged channels throughout the Arid West region determined that the flow recurrence interval responsible for creating active signatures is highly variable (<1–15.5 years) and that more-stable channels typically had lower recurrence intervals while less-stable channels with more erodible substrates had higher recurrence intervals (Curtis et al. 2011).

Historically, OHW delineations for intermittent and ephemeral channel forms that dominate the Arid West landscape have frequently been

problematic. Recently, a delineation manual for identifying the OHWM in the Arid West region (Lichvar and McColley 2008) listed potential OHWM indicators typically found below, at, and above the OHW boundary. Lichvar et al. (2006) explored the distribution of OHWM indicators at the local channel reach scale. They determined that all OHWM indicators had random distribution patterns across the channel and that the only repeatable feature within the channel reach was the physical geomorphic signature that is identified by the sparsely vegetated channel and the portion of the channel with active sediment processes. Evaluating OHWM indicators at a larger scale requires an understanding of what indicators are present, their sorting and distribution within a watershed, and their relationship to landscape features.

We have devised an artificial channel classification for Arid Western landscapes to support understanding of the distribution of OHWM indicators (Lefebvre et al. 2012). The classification was based on general characteristics of the watershed and channel, including geology, slope, watershed design, floodplain geomorphology, and channel morphology. To develop the classification, we visited 49 channels in the Arid West, and 18 channel types were classified: 4 in the mountains, 8 in the foothills, and 6 in the basins. The findings suggest that watershed and channel characteristics vary across the landscape in the Arid West.

While we were visiting the 49 channels, we also collected data on OHWM indicators to determine if they were associated with specific types of channels or specific channel positions within the watershed. We evaluated the distribution patterns of OHWM indicators at the landscape scale using the channel classification as the basis of comparison.

## 2 Site Locations

The area covered by this study includes the Arid West region as defined by the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region* (USACE 2008) (Fig. 1). The Arid West region includes a wide range of landscape forms and ecosystems that have many climatic, physiographic, and ecological sub-regions with varying precipitation source areas, watershed characteristics, and vegetation patterns (Field and Lichvar 2007). This region has a predominately dry climate with long, dry summers, and the annual evapotranspiration exceeds precipitation (Bailey 1995). In the Arid West, precipitation is driven by three distinct storm types (Lichvar and Wakeley 2004): winter North Pacific frontal storms, summer convective thunderstorms, and late-summer eastern North Pacific tropical storms (Ely 1997). Typically the winter storms have a long duration, whereas summer storms are short, intense, and flashy (Lichvar and McColley 2008). Because of the variation in storm events and topography in the Arid West, precipitation patterns across the region are spatially variable (Graf 1988; Reid and Frostick 1997).

Figure 2 is a map of the site locations. Appendix A lists each site location shown in Figure 2, along with the number of landscape positions associated with each point, the location of the landscape position (mountain, foothill, or basin) (Fig. 3), and the channel morphology. Because we sampled the OHWM indicators at the same time that we did the channel classification study, all of the 18 channel types were represented (Lefebvre et al. 2012). We sampled 49 sites; 14 were in the mountains, 18 in the foothills, and 17 in the basins. We chose channels that had minimal anthropogenic influences to ensure that channel responses and physical characteristics were the result of natural processes.

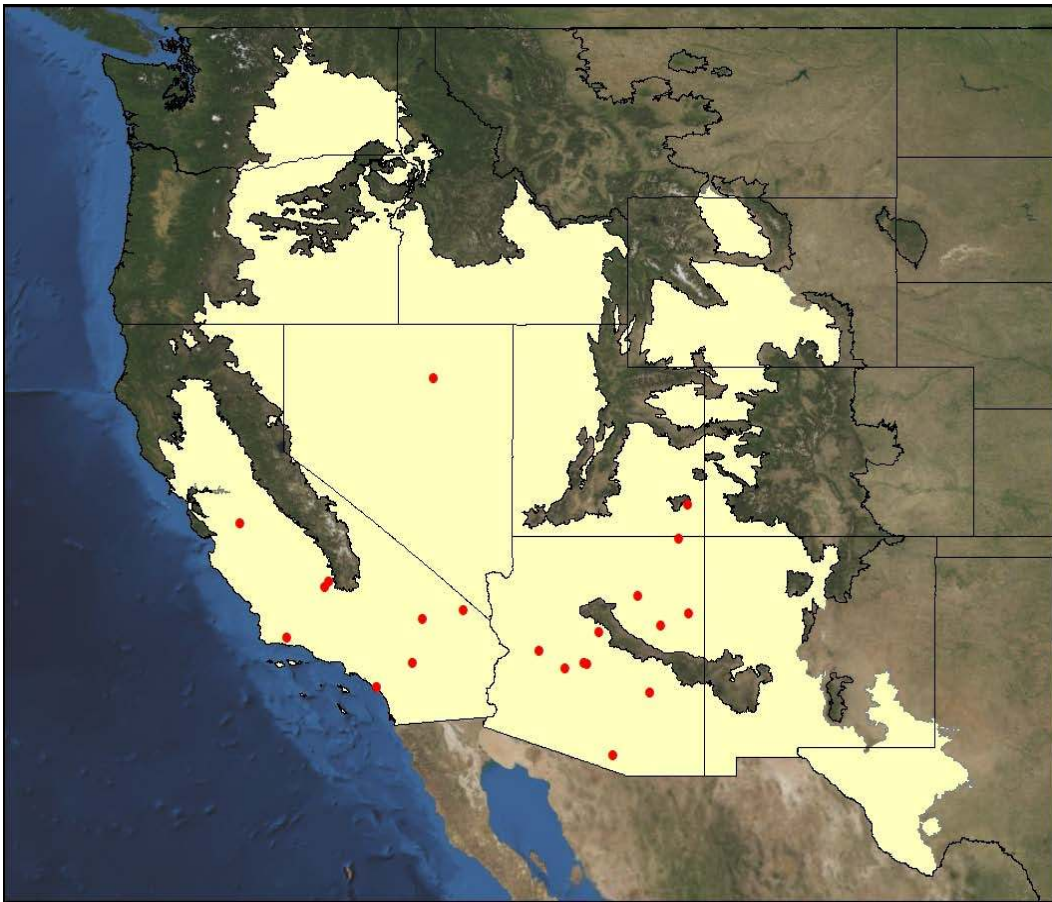


Figure 2. Site locations in the Arid West region. The red dots represent the general locations of channels sampled.



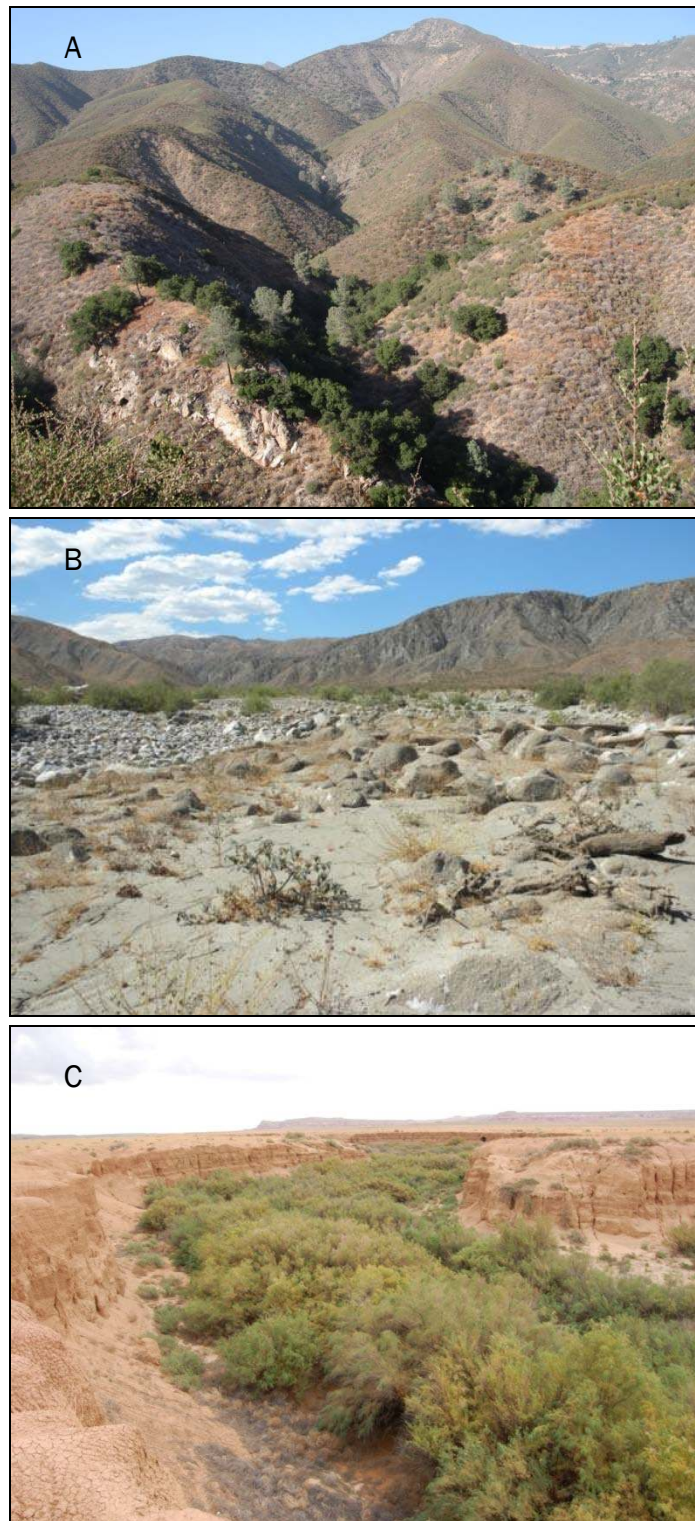


Figure 3. Examples of landscape positions sampled.  
A: Mountain, B: Foothill, and C: Basin.

## **3 Methods**

### **3.1 Field Efforts**

To analyze the frequency and occurrence of OHWM indicators associated with various channel forms at the watershed scale in the Arid West region, we observed OHWM indicators at the boundary of the active channel and floodplain of 49 intermittent and ephemeral channels. Data were collected simultaneously with the channel classification effort (August 2006, July 2009, and September 2009) (Lefebvre et al. 2012). At each channel, we recorded the presence and absence of OHWM indicators at the boundary for both the active channel and the floodplain. The OHWM indicators observed included bed and bank, benching, change in vegetation cover, change in vegetation species, change in texture, desert pavement, drift, exposed root hairs, gravel bars, mud cracks, phreatophytic mounds, ripples, silt deposits, slope, and swept-over vegetation.

### **3.2 Analysis of Field Data**

To understand the distribution patterns of OHWM indicators, we observed which indicators were present at each site ( $n = 223$ ) and determined their consistency across the different channel types. OHWM indicators that we observed at the active channel boundary over 50% of the time within a specific channel type we categorized as frequently occurring OHWM. For the three landscape positions—mountains, foothills, and basins—we calculated the frequency (the number of times an OHWM indicator occurred within a specific landscape position) and the percentage of occurrence (the frequency of an OHWM indicator in a specific landscape position divided by the total number of OHWM indicator occurrences in a specific landscape position). We also calculated frequency and percentage of occurrence for geology type (hard rock and soft rock) and channel morphology (single thread channels, compound channels, and discontinuous ephemeral channels). Using MINITAB 14, we performed three chi-square tests to analyze associations between OHWM indicators and landscape position, geology, and channel morphology. We hypothesized that there are no distinct distribution patterns of OHWM indicators strongly associated with landscape position, geology, or channel morphology.

## 4 Results

Tables 1–3 list the occurrences of all OWHM indicators observed in all landscape positions, rock types, and channel morphologies. To correlate these observations to the channel classification (Lefebvre et al. 2012), Table 4 lists the frequently occurring indicators that we found within each channel type listed in the classification for the Arid West region.

**Table 1. Percentage of occurrences for OWHM indicators within the mountains, foothills, and basin.**

OWHM Indicator	Mountains	Foothills	Basin
Bed and bank	57	72	71
Benches	14	17	18
Change in vegetation cover	79	72	76
Change in vegetation species	36	61	47
Change in texture	79	78	53
Desert pavement	0	11	12
Drift	57	72	76
Exposed root hairs	7	0	6
Gravel bars	0	6	6
Mud cracks	7	11	18
Phreatophytic mounds	0	0	6
Ripples	0	6	6
Silt deposits	0	0	6
Slope	21	72	76
Swept-over vegetation	7	0	24



**Table 2. Percentage of occurrences for OWHM indicators within hard rock and soft rock channels.**

OWHM indicator	Hard rock	Soft rock
Bed and bank	68	67
Benches	16	17
Change in vegetation cover	74	63
Change in vegetation species	26	63
Change in texture	74	77
Desert pavement	11	7
Drift	79	63
Exposed root hairs	5	3
Gravel bars	0	7
Mud cracks	0	20
Phreatophytic mounds	0	3
Ripples	0	7
Silt deposits	0	3
Slope	53	17
Swept-over vegetation	0	67

**Table 3. Percentage of occurrences for OWHM indicators within single-thread channels, compound channels, and discontinuous channels.**

OWHM indicator	Single thread	Compound	Discontinuous ephemeral
Bed and bank	65	64	100
Benches	30	5	0
Change in vegetation cover	78	82	25
Change in vegetation species	48	45	75
Change in texture	74	73	25
Desert pavement	9	9	0
Drift	65	73	75
Exposed root hairs	4	5	0
Gravel bars	4	5	0
Mud cracks	17	9	0
Phreatophytic mounds	0	0	25
Ripples	0	0	0
Silt deposits	4	0	0
Slope	43	68	100
Swept-over vegetation	13	9	0

**Table 4. Channel types (Lefebvre et al. 2012) and frequently occurring OHWM indicators in the Arid West region.**

Channel classification type	Landscape position	Geology	Channel morphology	Channel type	Frequently occurring OHWM indicators
Type 1.1	Mountain	Hard Rock	Single Thread	Boulder/Cobble	Drift
Type 1.2	Mountain	Hard Rock	Single Thread	Sand/Silt	Change in vegetation cover, texture change, bed and bank
Type 2.1	Mountain	Soft Rock	Single Thread	Boulder/Cobble	Texture change
Type 2.2	Mountain	Soft Rock	Single Thread	Sand/Silt	Change in vegetation cover, bed and bank
Type 3.1	Foothill	Hard Rock	Single Thread	Cobble	Drift, texture change, change in vegetation cover, slope, bed and bank
Type 3.2	Foothill	Hard Rock	Compound Channel	Cobble; Elevation Difference > 200 m	Drift, texture change, slope, bed and bank
Type 3.3	Foothill	Hard Rock	Compound Channel	Cobble; Elevation Difference < 200 m	Texture change
Type 4.1	Foothill	Soft Rock	Single Thread	Cobble	Drift, texture change, change in vegetation cover, slope
Type 4.2	Foothill	Soft Rock	Single Thread	Sand/Silt	Change in vegetation species, bed and bank
Type 4.3	Foothill	Soft Rock	Compound Channel	Boulder/Cobble	Change in vegetation cover
Type 4.4	Foothill	Soft Rock	Compound Channel	Sand/Silt	Texture change, change in vegetation cover, slope
Type 4.5	Foothill	Soft Rock	Discontinuous Ephemeral	Sand/Silt	Drift, change in vegetation species, slope, bed and bank
Type 5.1	Basin	Hard Rock	Compound Channel	Cobble	Change in vegetation cover
Type 5.2	Basin	Hard Rock	Compound Channel	Sand/Silt	Drift, change in vegetation cover
Type 6.1	Basin	Soft Rock	Single Thread	Cobble	Bed and bank, change in vegetation cover, change in texture
Type 6.2	Basin	Soft Rock	Single Thread	Sand/Silt	Slope, mud cracks, benching
Type 6.3	Basin	Soft Rock	Compound Channel	Sand/Silt	Change in vegetation cover
Type 6.4	Basin	Soft Rock	Discontinuous Ephemeral	Sand/Silt	Slope and bed and bank

## 5 Distribution Patterns of OHWM Indicators across the Landscape

Our analysis of the distribution of OHWM indicators across channel types using the Arid West channel classification showed that the indicators we observed are not associated with any specific channel characteristic or watershed characteristic. Results from three chi-square tests support the null hypothesis that there are no distinct distribution patterns of OHWM indicators strongly associated with any specific channel form (Table 5). These results indicate that OHWM indicators have no pattern across the landscape; Lichvar and McColley (2006) found a similar lack of pattern at the reach scale. Also, a chi-square test comparing OHWM indicators and landscape position within a watershed did not find any strong association or relationship. Similarly, chi-square tests comparing OHWM indicators to geology and channel morphology showed no associations or relationships.

Table 5. Chi-square results of OHWM indicator association.

Variable	Chi-square	df	p-value	Association
Landscape position	6.055	12	0.913	None
Geology (hard and soft)	7.828	7	0.348	None
Channel morphology	8.505	8	0.386	None

Although there were no strong associations between specific landscape positions or channel forms, the percentages of occurrences (Tables 1–3) demonstrate that 6 of 15 OHWM indicators are more frequent in the active channel across the entire landscape in the Arid West. The six most frequent indicators include bed and bank, change in vegetation cover, change in vegetation species, change in texture, drift, and slope (Fig. 4). All six of these OHWM indicators were consistently observed in the mountains, foothills, and basin landscape positions, but these indicators vary in occurrence and frequency across the mountains, foothills, and basins. These six indicators were also consistently observed in the different geology types and channel morphologies. Basin watersheds had the greatest number of indicators present (15), and mountains had the least (10) (Appendix A). On average, at all three landscape positions, there are approximately four OHWM indicators at each site, including at least one of the indicators listed above.

Figure 5 shows the frequency and percentage of occurrence for the six common OHWM indicators within each landscape position. Mountain watersheds had the greatest variability in frequency and percentage of occurrence; foothills had the least variability. In mountain watersheds, slope had the lowest percentage of occurrence (21.4%) of the six OHWM indicators, whereas change in vegetation cover and texture change had the highest percentage (78.6 %). In the foothills, all six OHWM indicators occurred between 61.1–77.8% of the time. In the basins, change in species was the least common (44.4%), whereas change in vegetation cover, drift, and slope were most commonly observed (72.2%).



a. Change in vegetation cover.



b. Bed and bank.



c. Change in vegetation species.



d. Drift.



e. Slope.



f. Change in texture.

Figure 4. Most common OHWM indicators across mountain, foothill, and basin landscape positions in the Arid West region.

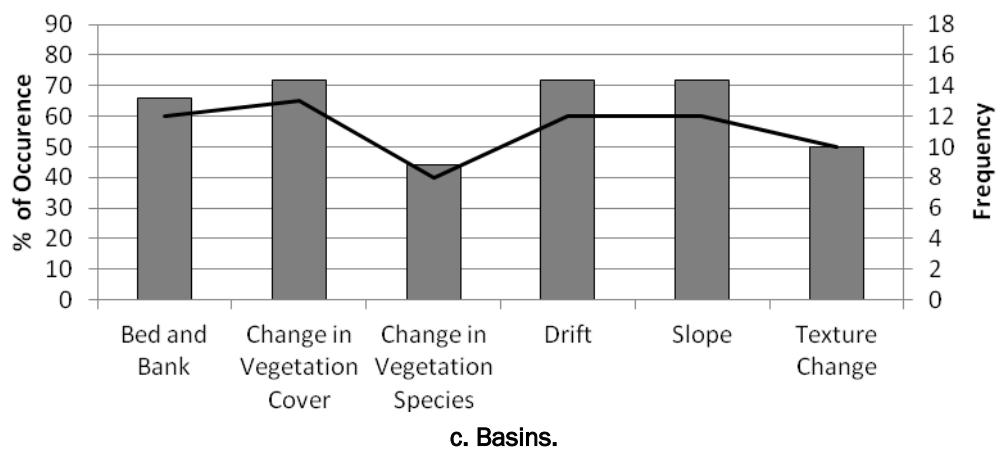
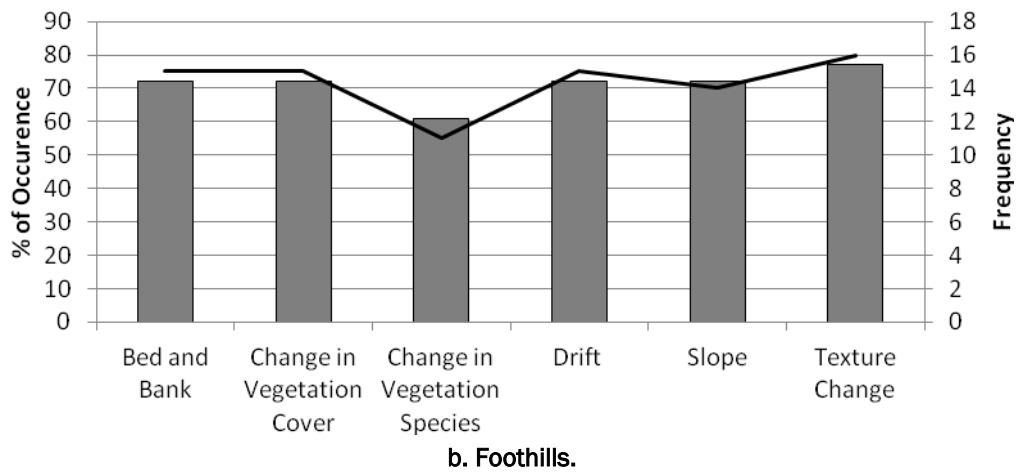
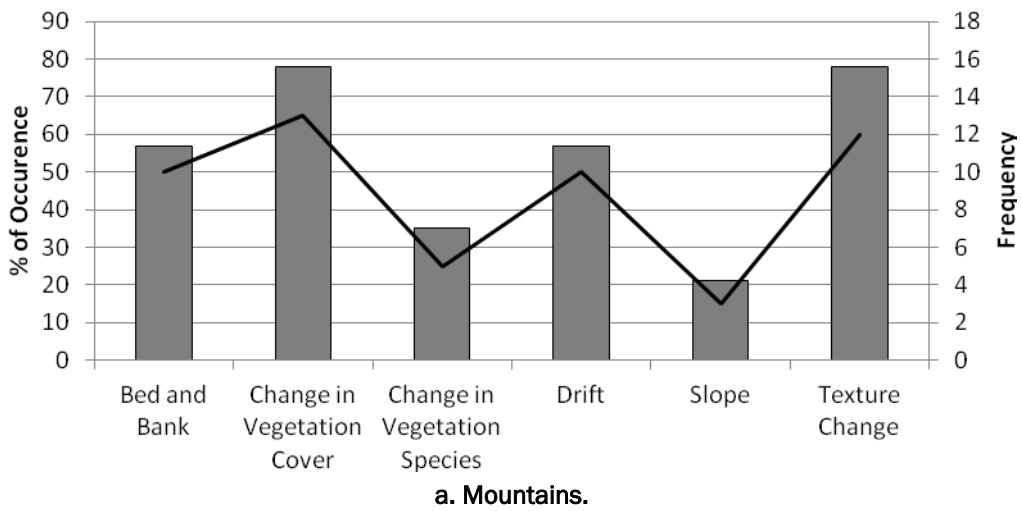


Figure 5. Percentage of occurrence (bar graph) and frequency (line graph) of OHWM indicators across basin, foothill, and mountain watersheds in the Arid West region

## 6 Discussion

Lichvar et al. (2006) reported that the OHWM indicators had no direct correlation with any recurrence interval of flood events at Mission Creek, CA, nor were they associated with any physical geomorphic channel feature at the reach scale. Six OHWM indicators (drift, knick points, litter, mud cracks, sand deposits, and silt deposits) were present at Mission Creek in 2006, with a total of 156 occurrences at this site. Of these 156 occurrences, 74% were located within the low-flow channel and active channel, and the remaining occurrences were within the floodplain.

In this study, we describe similar results showing a lack of strong association between OHWM indicators, channel types, and the OHWM boundary. These random occurrences can be partly explained by a model developed by Lichvar et al. (2006). The model demonstrates how OHWM indicators are deposited within the active channel after water recedes from low to moderate events and are subsequently removed after another geomorphically effective event takes place (Lichvar and Wakeley 2004). Figure 6 depicts the re-working of a channel after various flow events shown in the hydrograph. After an ordinary high water event (1), any existing OHWM indicators are removed, and new indicators are deposited as the water recedes. Subsequent to an ordinary high water event, multiple low flows (2, 3) deposit more indicators in the channel until another OHW event removes the indicators and starts the cycle over.

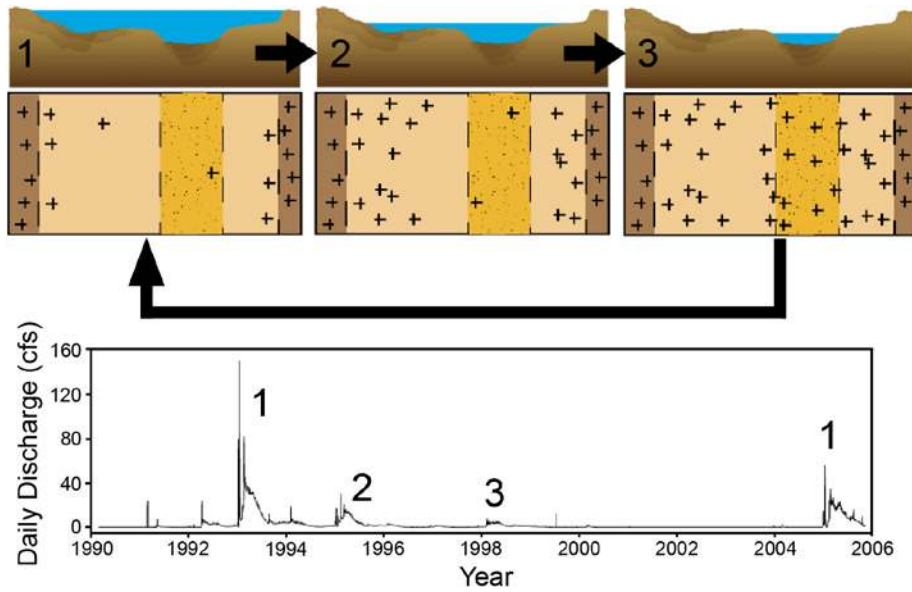


Figure 6. Working OHW concept model for understanding the distribution of OHWM indicators. Top: Channel cross section and plan view, showing the distribution of OHWM indicators. Blue represents the maximum level of inundation at each numbered event, dark yellow represents the low-flow channel, tan represents the active channel, brown represents the floodplain, and the plus signs indicate OHWM indicators. Bottom: Observed flood hydrograph for Mission Creek corresponding to the numbered events. (Adapted from Lichvar et al. 2006.)



## 7 Conclusion

In this study we found no direct association between OHWM indicators and channel type or landscape position. These findings suggest that OHWM indicators are distributed randomly throughout the landscape and are not related to specific channel characteristics. Even though there were no associations of OHWM indicators with a specific landscape position, there are six indicators that are more frequent than others across the entire landscape: change in vegetation cover, bed and bank, change in vegetation species, drift, slope, and change in texture.

The lack of an association between OHWM indicators and types of channels and their landscape positions supports previously reported results that showed that the indicators are randomly located in all locations across a channel and may best be described as flow indicators rather than OHWM indicators. Flow indicators are features associated with flow events and include geomorphic features (such as mud cracks, ripples, and gravel bars) and indicators deposited by the flowing water (such as drift, silt deposits, or swept-over vegetation). Individually, flow indicators cannot be used to delineate the lateral extent of the OHWM. However, the indicators are useful for identifying portions of the channel that have been inundated from the most recent flow event. Delineating the lateral extent of the OHW requires a geomorphic approach that includes identifying the hydrogeomorphic floodplain units of the channel (low-flow channel, active channel, and floodplain), linking vegetation and sediment texture patterns to changes in channel morphology, and identifying the break in slope associated with the geomorphically effective event.

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## Appendix A: Site Locations in the Arid West Region

Site locations	Number of landscape positions sampled	Location of landscape position	Channel morphology at each landscape position	Channel classification type
Agua Fria River, AZ	3	Mountain	Single-thread channel	Type 1.2
		Foothill	Compound channel	Type 3.3
		Basin	Single-thread channel	Type 6.1
Altar Wash, AZ	2	Foothill	Compound channel	Type 4.4
		Basin	Compound channel	Type 6.3
Caruthers Creek, CA	3	Mountain	Single-thread channel	Type 1.1
		Basin	Compound channel	Type 5.1
		Basin	Compound channel	Type 5.2
Chinle Creek, AZ	3	Mountain	Single-thread channel	Type 2.1
		Basin	Compound	Type 6.3
		Basin	Compound	Type 6.3
Dry Beaver Wash, AZ	2	Mountain	Single-thread channel	Type 2.1
		Foothill	Compound channel	Type 4.3
Hassayampa River, AZ	1	Foothill	Compound channel	Type 4.4
McDermitt Creek, NV	3	Mountain	Single-thread channel	Type 1.2
		Foothills	Single-thread channel	Type 4.1
		Basin	Single-thread channel	Type 6.1
Mission Creek, CA	2	Foothill	Compound channel	Type 3.2
		Basin	Compound channel	Type 5.1
Moenkopi Wash, AZ	3	Mountain	Single-thread channel	Type 2.2
		Foothill	Single-thread channel	Type 4.2
		Basin	Single-thread channel	Type 6.2
Mojave River, CA	1	Basin	Compound channel	Type 5.2
New River, AZ	3	Mountain	Single-thread channel	Type 1.1
		Foothill	Compound channel	Type 3.2
		Foothill	Compound channel	Type 3.2
Oraibi Wash, AZ	3	Mountain	Single-thread channel	Type 2.2
		Foothills	Discontinuous ephemeral channel	Type 4.5
		Basin	Discontinuous ephemeral channel	Type 6.4
Palm Springs Canyon, CA	3	Mountain	Single-thread channel	Type 2.2
		Foothills	Single-thread channel	Type 3.1
		Basin	Compound channel	Type 5.2

Site locations	Number of landscape positions sampled	Location of landscape position	Channel morphology at each landscape position	Channel classification type
Recapture Creek, UT	2	Mountain	Single-thread channel	Type 2.1
		Foothills	Compound channel	Type 4.3
Rio Puerco, NM	3	Mountain	Single-thread channel	Type 2.1
		Foothills	Single-thread channel	Type 4.2
		Basin	Single-thread channel	Type 6.2
Rock Creek, AZ	1	Foothills	Compound channel	Type 3.3
San Mateo Creek, CA	3	Mountain	Single-thread channel	Type 1.1
		Foothills	Single-thread channel	Type 4.1
		Basin	Compound channel	Type 6.3
Santa Cruz Creek, CA	3	Mountain	Single-thread channel	Type 2.1
		Foothills	Compound channel	Type 4.3
		Foothills	Compound channel	Type 4.3
Santa Maria River, AZ	3	Mountain	Single-thread channel	Type 1.2
		Foothills	Compound channel	Type 3.3
		Basin	Compound channel	Type 5.2
Susie Creek, NV	2	Basin	Discontinuous ephemeral channel	Type 6.4
		Basin	Discontinuous ephemeral channel	Type 6.4
Total	49	14 Mountain 18 Foothills 17 Basin	23 Single-thread channels 22 Compound channels 4 Discontinuous ephemeral channels	

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<b>14. ABSTRACT</b> Arid West fluvial systems are regulated as "Waters of the United States" (WoUS) under Section 404 of the Clean Water Act. The jurisdictional limits in Arid West channels are defined by using the "ordinary high water mark" (OHWM). Hydrology is the driving factor in the development and distribution of OHWM indicators, but incorporating landscape position may provide further insight into their distribution and reliability. The US Army Corps of Engineers OHW delineation manual indicates a large variability in the occurrence and position of OHWM indicators across channels but fails to evaluate the distribution of indicators at a larger scale. Evaluating OHWM indicators at a larger scale requires an understanding of what indicators are present, their sorting and distribution within a watershed, and their relationship to landscape features. For this study the frequency and occurrence of OHWM indicators were evaluated to understand their distribution patterns across the Arid West region in 14 mountain, 18 foothill, and 17 basin ephemeral and intermittent channels within multiple watersheds. We found that there were no significant OHWM indicator distribution patterns in any specific landscape position, but there were several OHWM indicators that occur more frequently than others across the entire landscape. The lack of a significant relationship between OHWM indicators and types of channels and their landscape positions supports previously reported results that showed that indicators are randomly distributed in all locations across a channel and may best be described as flow indicators rather than OHWM indicators.								
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