2013 ARCHAEOLOGICAL SURVEY IN WADI QUSAYBA AND THE MANDAH PLATEAU, IRBID REGION, JORDAN

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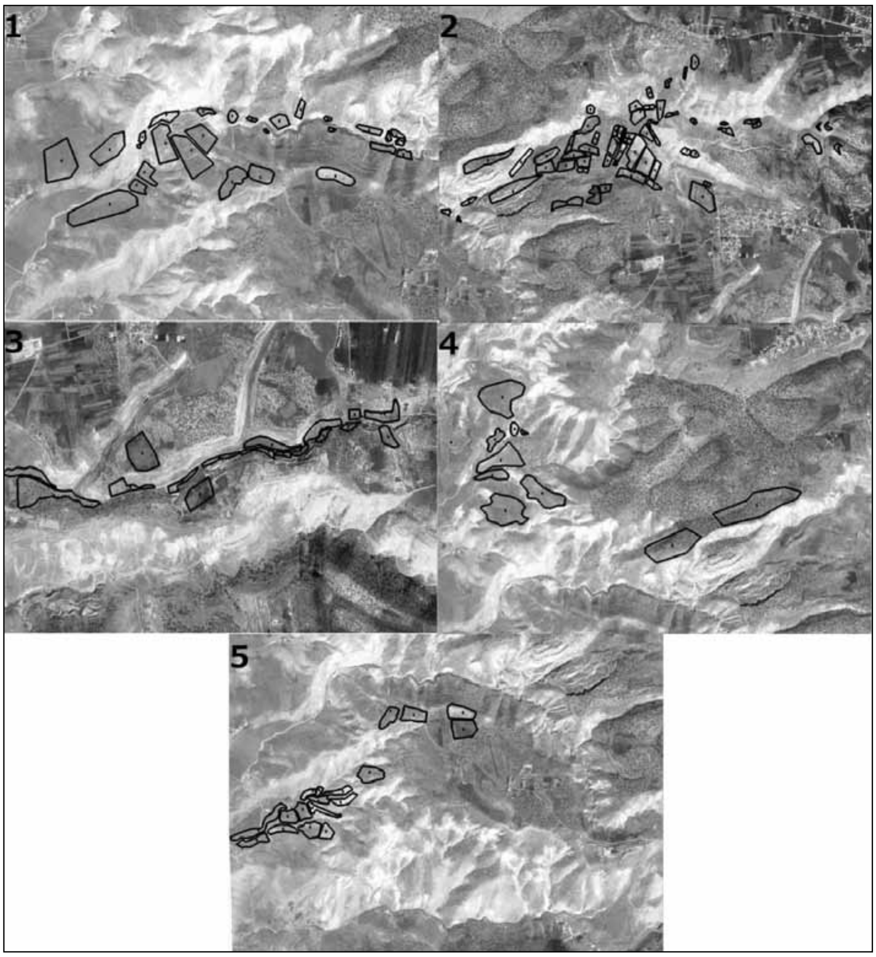
From 31 July to 5 September 2013, a team from University of Toronto continued the survey begun the previous year of the region west of the town of Taiyyiba, stretching down to the Jordan valley in the ravine of Wadi Qusayba, north of Wadi Taiyyiba, south of the village of Makhraba and east of Waqqas (**Fig. 1**). The survey area now includes the small Wadi Umm ad-Dabbar north of Wadi Qusayba and a small *wadi* between Wadi Taiyyiba and Wadi Qusayba, both on the edge of the Jordan valley. We have divided this survey area into five sub-regions: (1) the main channel of Wadi Qusayba; (2) its northern tributary, Wadi Darraba; (3) its southern tributary, Wadi Khadra and Wadi al-Bir; (4) the ridge north of Wadi Qusayba and Wadi Darraba, along with Wadi Umm ad-Dabbar; (5) the small *wadi* north of Wadi Taiyyiba and the slopes west of Subregion 3 that drain into it (**Fig. 2**).

1. *Wadi Qusayba Project Survey Area.*

A particular focus of our project, as an extension to previous work in Wadi Ziqlab and Wadi Taiyyiba (Banning 1996; Field and Banning 1998; Kadowaki *et al.* 2009; Maher 2005, 2011; Maher and Banning 2001) has been the Epipalaeolithic, Neolithic and Chalcolithic periods, which were not represented in Glueck's (1951) results from his brief survey in this region. We also document sites we encounter that belong to other periods and made monitoring visits to some known sites. One of the pimportant goals of the 2012 season, on which we have expanded in 2013, was to try out and elaborate methods to allocate survey effort to landforms that have the best potential for preserving evidence for the late prehistoric periods. We were unable to apply these new methods fully in the 2012 field season, owing to some computational difficulties, so 2013 allowed us to carry out a much more thorough test of our allocation algorithm. In addition, we continue to assess our survey effectiveness through measurement of surveyors' 'sweep widths'.

Methods and Predictive Modelling

Our previous experience in both Wadi Ziqlab and Wadi Qusayba has shown us that portions of the landscape where sediments formed during the Epipalaeolithic and Neolithic are preserved in limited spaces, but are fairly predictable. Sites of these periods were often located on what was then the floor of the *wadi*, often close to the stream or to springs. Downcutting



2. *Five survey sub-regions showing "polygons" or landscape elements for the allocation of survey effort.*

of the stream channel over more than 6000 years has destroyed most of this old valley floor, leaving only small fragments stranded some way up the side of the modern valley. In addition, these remnants are often buried by more recent colluvium (Banning 1996; Beaumont 1985; Field and Banning 1998; Maher 2011; Maher and Banning 2001). Although both archaeologists and geologists have recorded this phenomenon in many parts of the world, including Jordan, for many decades (notably Butzer 1982: 136; Copeland and Vita-Finzi 1978; Vita-Finzi 1964, 1966), its effects have not explicitly guided most surveys or the practice of archaeological predictive modelling.

In our survey of Wadi Qusayba and its vicinity, we attempt to improve our probability of discovering 'target' sites by employing a predictive model that is not restricted to attempts at predicting where human settlement was likely to be in the past, since it is very clear that many of these places have already been destroyed or deeply buried in the case of the deeply-incised valleys on the margins of the Jordan rift valley. More specifically, our predictive model helps us to predict where such traces that have survived millennia of *wadi*-forming processes are most likely to have survived and to outcrop near the modern surface, so that they have some reasonable probability of being detectable by surface survey. As we have discussed in our previous report (Banning *et al*. 2014), this involves predicting the probabilities that various landforms or 'landscape elements' in the survey area meet the following criteria:

1. They contain sediments or old land surfaces preserved since the Epipalaeolithic, Neolithic or Chalcolithic,
2. The ancient land surfaces are not so sloped as to have discouraged permanent or seasonal settlement in those periods,
3. Visibility of those surfaces or associated arti-

facts is not too compromised by either overlying, more recent deposits (chiefly colluvium) or dense vegetation.

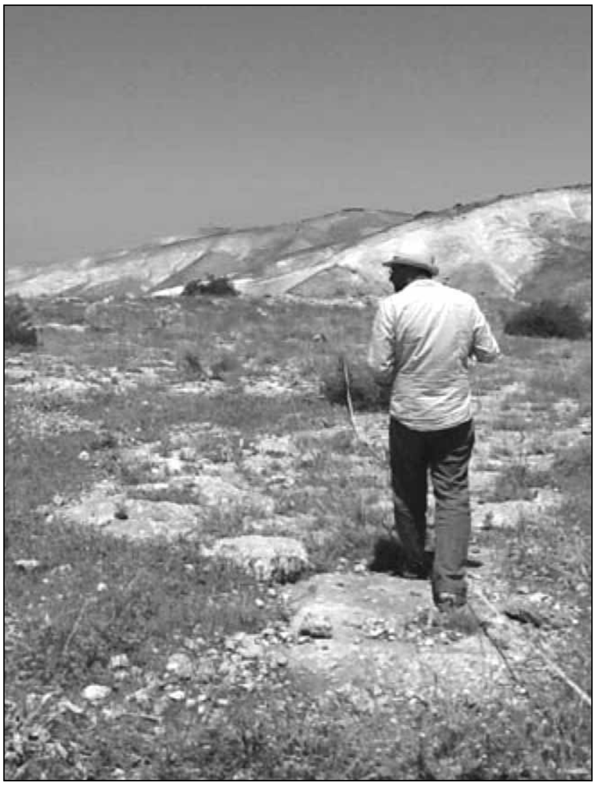
In addition to these overarching criteria, our model also takes into account some of the key elements of prehistoric decision-making, notably the presence of current or exhausted springs (cf. Shreideh 1992) and the confluences of *wadis* that probably had perennial water in the past.

Our initial predictive model, constructed in GRASS GIS, identified a large number of stream terraces and other landscape elements with slopes of less than 12 degrees as potential targets for survey on the basis of a DEM made with ASTER and SRTM imagery. The first step in an iterative process was to conduct reconnaissance to check on the accuracy of these 'polygons' (landscape elements) and to see if any other conditions made them poor candidates for survey. During the reconnaissance phase, we also conducted survey transects across enough of the polygons to assess whether, on the basis of artifacts found and geomorphological indications, some of the terraces were too young (i.e. too low) to have existed prior to about 6000 years ago, or too high above the *wadi* channel to have been close to the *wadi* floor during late prehistory. This process eliminated some polygons from the model or resulted in assigning them low prior probabilities (see below) and allowed us to adjust the boundaries of some and to add others. To a large extent, we completed this phase of the model testing during the 2012 season, but still had to carry out this phase in Subregions 4 and 5, which we only added to the survey area during 2013. Later iterations of the model took distance above the modern *wadi* channel into account and modelled the effects of deep colluviation on the likelihood of site burial.

Sweep Widths and the Probabilities of Archaeological Detection

Among the more innovative aspects of our survey project is an element that is also crucial to the effective use of our predictive model. This is our explicit attempt to estimate the probabilities that the amount of survey effort we have applied to different locations will actually result in the detection of prehistoric artifacts, should they be present on the modern surface. As described in our previous publication on this survey (Banning *et al.* 2014), this probability depends on both the amount of search effort (e.g. the total distance walked by all surveyors searching a particular area) and the distance of the 'target' (i.e. artifact) from the searcher's path (Banning 2002a, 2002b; Banning *et al.* 2006; Koopman 1980; Stone 1975; Washburn 1981). The most straightforward way to assess the latter factor is 'sweep width' (Banning *et al.* 2011) which, when multiplied by total transect length, yields the amount of area covered. To put it in simple terms, sweep width is the breadth of a searcher's path or transect within which the number of artifacts he or she fails to detect is equal to the number of artifacts he or she finds outside it. For example, if the sweep width is 1.6 m (0.8 m to left and right of the search path) and there were 100 artifacts potentially visible on the surface in the 1.6 m swath over which the searcher passed, the searcher might find 70 artifacts within the search width and 30 artifacts a little way outside it. Consequently, the number of artifacts actually found is the same as it would have been had he or she found all 100 artifacts inside the sweep width and none at all outside it. Sweep width is wider when surveyors search slowly and narrower when they search more quickly, so it summarizes the effects of both search effort, search speed and range. 'Coverage' is the total area covered or 'swept' (sweep width multiplied by total transect length) divided by the area of the surveyed space.

Our estimates of average sweep widths of surveyors on the Wadi Qusayba survey, in both 2012 and 2013, are based on 'calibration runs' that we conducted on several parts of the landscape that had characteristics of visibility and terrain similar to what we would expect during the survey, but which appeared to have no significant number of 'real' archaeological artifacts on them. We randomly 'seeded' these calibration locations with modern sherds and replicated flint flakes in known locations along a 150 m transect that we divided into three 50 m segments with stakes or stone cairns; we used 50 m tapes to mark the path (**Fig. 3**). Members of the survey team each walked the transect multiple times and on different days over the course of the survey, recording their start and finish times and their estimates of the distances to any artifacts they could see within each segment of the



3. Calibration runs used to measure sweep widths involved walking known and measured distances in search of seeded artifacts.

transect. Subsequently, we analyzed the data to determine what proportion of seeded artifacts were successfully detected at different ranges from the transect line and used this information to calculate the sweep width.

The results of these calibration surveys for the 2013 team (**Table 1**) allow us to calculate 'swept area' (total transect length times sweep width) for each polygon we survey, as well as its 'coverage', and to update these values in cases where a polygon was resurveyed, as long as our survey speed is similar to that in the calibration runs. Calibrations controlled only coarsely for artifact size and colour, and of course the actual survey requires team members to detect artifacts of a range of colours and sizes. Consequently, our estimates of sweep width are only approximate. Coverage is a direct estimate of the probability that we would find artifacts in a polygon, given that they are there: with coverage of 10%, for example, we could expect to find 10% of the artifacts (Banning *et al.* 2011; Frost 1999).

The ability to estimate the probability of detecting artifacts of course also entails its opposite: the probability that we could have missed something. It is this latter probability that is so critical to predictive modelling because it allows us to escape the unrealistic assumption that any space we surveyed without finding anything is devoid of archaeological material. As should be quite obvious, although it is typically ignored in practice, not finding sites in a region that has been surveyed at very low intensity does not at all mean there is nothing there. It is rather more likely that our coverage was simply too low for us to find it. As we also all know, some kinds of site or artifact are quite a bit easier to find than others, irrespective of visibility.

Table 1: Summary of calibration surveys of the 2013 field season and calculated estimates of sweep width based on integrating the detection functions for detection by range from the transect centre line. After data for individual dates are figures for cumulative ("Cum") results on the same ground cover (include data from both previous calibration runs). *Data are suspect due to the fact that the random distribution put almost none of them within 5m of the transect line. — Insufficient data for good estimate of W.

#	Date	Ground Cover	Mean Search Time (min)	Small Lithics W (m)	Large Lithics W (m)	L Red Sherds W (m)	S Red Sherds W (m)	L Yellow Sherds W (m)
1	3/8	Harvested field with chaff	13.6	1.8	1.3	—	3.1	0*
2	14/8	"	15.7	0.04*	0.81	2.1	2.1	0*
	Cum	"		.89	2.0	2.4	2.4	0*
3	15/8	Plowed Orchard	17.1	1.6	2.2	1.7	0.57**	0
4	21/8	"	13.2	1.4	3.8	2.7**	0.44	0.39
	Cum	"		1.2	3.3	2.4**	0.38	0.27

Estimates of sweep width are thus extremely important simply to evaluate whether or not we have surveyed a given space adequately to determine whether there are sites in it or not. However, these estimates are also critical to our use of the predictive model, since we employ it in an iterative way. What this means is that we regularly (ideally daily) update the predictive model with information gained since the survey began and allocate new survey effort accordingly. As our allocations of survey effort are tied to probability densities (the probability that a 'polygon' contains a detectable site of interest divided by the polygon's area, see below), it is important to note that our changing evaluations of the probabilities take into account the conditional probability that a 'polygon' contains a site, given the amount of survey effort that we have already applied to that polygon. When we survey a polygon without detecting 'target' materials, the probability that that polygon contains material of interest is lower than it was before the survey, but in some cases not by much. Consequently, the algorithm for allocating survey effort (see below) could direct us to resurvey it if its new probability density was still high; in practice we resurveyed some polygons many times.

Although the probability of finding artifacts is not exactly the same as that of finding a site (most of the sites we find are somewhat dense clusters of artifacts), the types of sites we are finding are generally not very recognizable unless we find at least one or two diagnostic tool types, such as sickle elements or bladelet cores. Consequently, the probability of finding individual artifacts is a reasonable proxy for the probability of finding a site of interest.

Initially, and especially in 2012, our estimates of sweep width were very rough and, at the beginning of the 2013 season, guided by our calibrations of the previous year under rather different vegetation conditions. As we added new calibration runs during 2013, we were able to update our sweep-width estimates with new information that was better able to account for the current crew composition and vegetation characteristics.

Our estimated sweep widths from the repeated calibration runs were used to guide us in the selection of rough estimates of sweep widths in the actual survey, generally settling on something close to the sweep widths for reasonably large (lengths *ca* 5 to 10 cm) lithics. It is very clear that our actual sweep widths for some artifact classes, especially small Epipalaeolithic bladelets, are much narrower than these estimates. We subjectively adjusted our daily estimated sweep widths by reference to the calibration runs and how the visibility conditions at each transect or transect segment compared with those where the calibrations were conducted. While in the field, for relatively good visibility on ploughed fields or olive groves, we typically used sweep widths in the range of 1.5 to 2.0 m per crew member. For poorer visibility, with combinations of bare rock and patches of weeds and shrubs, we used sweep widths of 0.75 to 1.0 m; for cases of still worse visibility we estimated quite low sweep widths (e.g. 0.5 m). Although we used a generalized sweep width to estimate our daily coverages for the purposes of allocating effort to polygons, our data allow us to evaluate coverage for small and large lithics and pottery separately during later evaluation of the survey's results. In addition, our final estimates of coverage that we will use to evaluate our overall survey effectiveness will take into account all of our calibration runs, including the last ones that were too late in the season to have had an effect on our survey practice.

Optimal Allocation of Survey Effort

Probably the most novel aspect of our survey was our attempt to adapt methods designed to allocate limited survey resources in a way that optimizes the probability of finding artifacts and sites of interest in a very short field season and with a relatively small crew. In any survey, especially in one with limited resources, it is necessary to make tough decisions about how to distribute survey effort, as it is simply not possible to survey everything. However, it is also clear that some spaces are highly unlikely to reward even a great deal of survey effort with tangible results, either because geomorphological formation processes have destroyed or deeply buried things or simply because visibility or other factors make survey slow and difficult. Search theory also shows us that the survey effort applied to a finite space has diminishing returns; at some point it becomes more sensible to move on to the next space rather than expend further effort in the space we've already surveyed. Bayesian probability theory provides the tools to assist us with these tough decisions. We were only able to use a suboptimal version of this approach in 2012, but were able to employ a much better allocation algorithm in 2013.

Our intitial GIS model, which selected spaces based on slope and relationship to *wadi* bottoms on the basis of satellite imagery, identified sets of 'polygons' that would be the initial focus for survey. Early in the survey of each subregion, we attempted to ground-truth these polygons, some of which turned out to be more steeply sloped or more heavily colluviated than the predictive model had led us to expect. It also allowed us to discover some springs and former springs that were previously unknown to us, and which we could now incorporate into our model, and to examine the geomorphology of some of the terraces and alluvial fans, thus allowing us to improve the predictive model.

Then, taking the polygons in a particular subregion of our larger survey area, we assigned prior probabilities of having detectable late prehistoric material, taking into account how well they fit the various factors listed above, as well as the lead project members' subjective assessments. These initial probabilities, divided by the polygon areas, resulted in 'probability densities'. We then used a Bayesian optimal-allocation algorithm (Koopman 1980: 146-152; Banning 2002a) that determined the total length of transect we should devote to each of the polygons that met the conditions (these were always the several polygons with the highest probability densities), given the total amount of effort that we could afford to expend on a particular field day. After we surveyed a polygon, our coverage for that polygon (sweep width times total transect length) allowed us to estimate a posterior probability (or revised probability), which becomes a new prior probability in the next iteration of the allocation. In a case, for example, where we allocated a considerable density of search effort and still did not find clear evidence for a cluster of late prehistoric artifacts, this probability would be considerably lower than our original estimate.

Our experiments with this allocation method took considerable fine-tuning, particularly as our initial probability estimates were not sufficiently differentiated. This led the algorithm to allocate most of our effort to the smallest polygons, even when large ones had significantly higher probability. As the season progressed, we were able to achieve more reasonable allocations of effort, but we also reserved some effort for purposive or judgmental survey, especially to take advantage of travel time between target polygons.

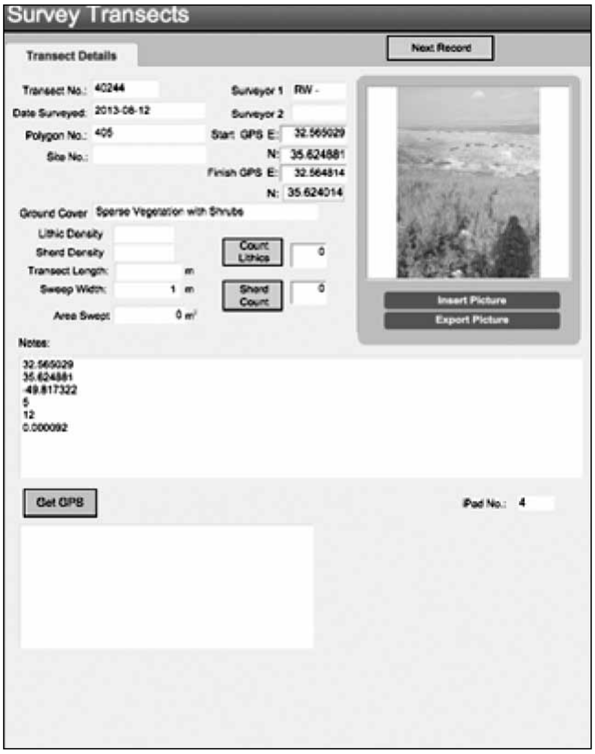
Other Aspects of Survey Method

As in the 2012 survey, we used a paperless recording system on iPads, with database fields compatible with the Jordanian Department of Antiquities' Mega-Jordan database.

As mentioned in our report on the 2012 season (Banning *et al.* 2014), we use the FileMaker Go App as our documentation system. In 2013, we were able to run this on nine Apple iPads and a corresponding FileMaker database running on two MacBook Pro laptops. The database includes fields for details of transects, GPS waypoints, sites, polygons, photographs and other observations in the field (e.g. **Fig. 4**). At the end of each field day, we uploaded the data from all nine iPads to a single database on one of the laptops. We also used the iPads and FileMaker to document the calibration surveys and make individual sherd records.

Each day, our survey team consisted of eight to eleven people, each of whom walked one or more transects across a polygon, recording on an iPad. Usually the team consisted of nine, each with his or her own iPad; when there were more people, or we were short one iPad, two would share one and walk adjacent transects, and the sweep width would be double that of others in the same polygon. We also had three Garmin GPS devices with which to check the GPS coordinates of the iPads' on-board GPS occasionally, but principally to track the length of transects to ensure that we allocated approximately correct amounts of search effort to each polygon (see 'Optimal Allocation' above). Team members used 'counter' buttons on the transect form of the iPad to count every sherd and lithic seen, whether collected or not.

Surveyors walked fairly straight or somewhat curved paths, mostly maintaining a distance between transects of approximately 5 m. Since our sweep widths for most artifact types are consid-



Transect No.: 40244
Date Surveyed: 2013-08-12
Polygon No.: 405
Site No.:
Surveyor 1 RW -
Surveyor 2
Start GPS E: 32.565029
N: 35.624881
Finish GPS E: 32.564814
N: 35.624014
Ground Cover Sparse Vegetation with Shrubs
Lithic Density
Shard Density
Transect Length: m
Sweep Width: 1 m
Area Swept 0 m²
Count Lithics 0
Shard Count 0
Notes:
32.565029
35.624881
-49.817322
5
12
0.000092
iPad No.: 4

4. *Example of electronic database record for collecting information in the field using iPad tablets*

erably less than this spacing, we would not expect overlap in coverage except where we did multiple surveys of the same polygon; the exact transect spacing is not as important as our estimate of area swept. Longer transects were subdivided into 'segments'; we changed segment whenever there was a change in terrain, visibility, artifact density or direction of path.

Samples of mainly diagnostic artifacts were collected and bagged by transect segment, but all observed artifacts were counted by tapping the lithic and sherd counters on the iPad. While this approach emphasizes diagnostic artifacts, such as rim sherds, where densities were quite low we collected all artifacts we could see, even though most of these were not very diagnostic flakes and body sherds.

Survey Results

Changes in the Predictive Model

As you would expect, given our methods, one result of the survey was a gradual refinement of the predictive model that we use to guide the survey, including changes to the shape and size of some polygons and changes to the probability densities and estimated coverage of almost all the polygons. Several polygons were added in the five subregions on the basis of field observations; our discovery of more springs (now typically weak or dried up entirely) that did not appear on any maps strongly increased the prior probability of Epipalaeolithic and Neolithic sites (as well as sites of later periods) in polygons close to these springs, as proximity to permanent water is a strong predictor for such sites.

Identification and Dating of Prehistoric Landscape Elements

One thing that the Digital Elevation Model (DEM) of the GIS cannot do on its own is to identify for us which landforms were available for use or occupation during the target periods of Epipalaeolithic, Neolithic and Chalcolithic. Only ground-truthing through initial reconnaissance survey could help us accomplish this, which often resulted in substantial revision of our preliminary assessments of the probability that polygons could contain relevant archaeological material. Notably, we could quickly establish that some valley terraces were much too young (generally too low in the *wadi*) for our purposes, with the result that their probabilities of containing late prehistoric sites fell to values near zero. Once we found artifacts of the target ages on even a few of the terraces, the approximate elevations of these terraces provided evidence to increase the probabilities of containment for nearby terraces of similar elevation.

Identification of Sites

As in the previous field season, we detected archaeological material both inside and outside the polygons or landscape elements that the predictive model identified. We considered some polygons to be candidates for late prehistoric site locations when they contained low-density scatters of artifacts, although some of these are likely palimpsests that accumulated over a considerable period or are concentrations that were deposited with colluvium. However, we did not generally define these as sites or site elements as defined in the Department of Antiquities' Mega-Jordan database. Some of these 'non-site' scatters can still be informative about the distribution of late prehistoric activities in the region, including probable agricultural land use, while others are potential sites that can only be confirmed through test excavation because of overlying colluvium (Banning 1996; Field and Banning 1998). For some of the periods of greatest interest to us, especially the Neolithic, we have candidate sites for which the material evidence is slim at best without such further work. For example, some places yielded typical Neolithic sickle elements but otherwise had only very low lithic densities. We discuss the most promising of these in the appropriate section but have not typically assigned a site element number unless there is also more certain evidence of use during another period, such as Iron Age. Most of the site elements outside target polygons belonged to periods either earlier (Palaeolithic) or later (Iron Age to Ottoman) than the target periods, and we surveyed them either to monitor their condition or as we encountered them while travelling to and from target polygons. In what follows, we only summarize the new site elements added during this year's survey, but provide a table including last year's as well.

Palaeolithic

Many of the highest terraces and the tops of ridges separating the *wadis* have Palaeolithic flakes on their deflated surfaces, but the distribution of these artifacts probably does not retain very much spatial or stratigraphic information. Many of these show evidence of Levallois technique; several points, blades and flakes removed from Levallois cores were found in quite a number of polygons, signaling a likely Middle Palaeolithic age, especially in polygons 401 and 402. Palaeolithic material also occurs on somewhat lower terraces along the edge of the Jordan valley, notably a broken Levallois core in polygon 509 and many flakes removed from Levallois cores there and in polygon 507.

Epipalaeolithic

Bladelets and what appear to be fragments of bladelet cores suggest a likely Epipalaeolithic age for artifacts in a number of polygons, such as polygon 404 and in site 121. Unfortunately, we found no bladelets that had been retouched into microlithic tools, apart from a single possible trapeze / rectangle in one polygon and a single backed bladelet as an isolated find south of the site of Tell Abu ul-Hussayn. We are therefore currently unable to date this material very closely, or even to confirm with certainty that it belongs to the Epipalaeolithic, since narrow bladelets were sometimes the products of Neolithic, Chalcolithic and even much later flint-knapping.

Site element 212, high above the western portion of Wadi Darraba's valley, yielded several blades, bladelets and fragments of what appear to be bladelet cores that might be of Epipalaeolithic age. However, none of these were highly diagnostic pieces, such as retouched tools or typical cores, making it difficult to date these closely; the majority of artifacts at this site date to the Iron Age.

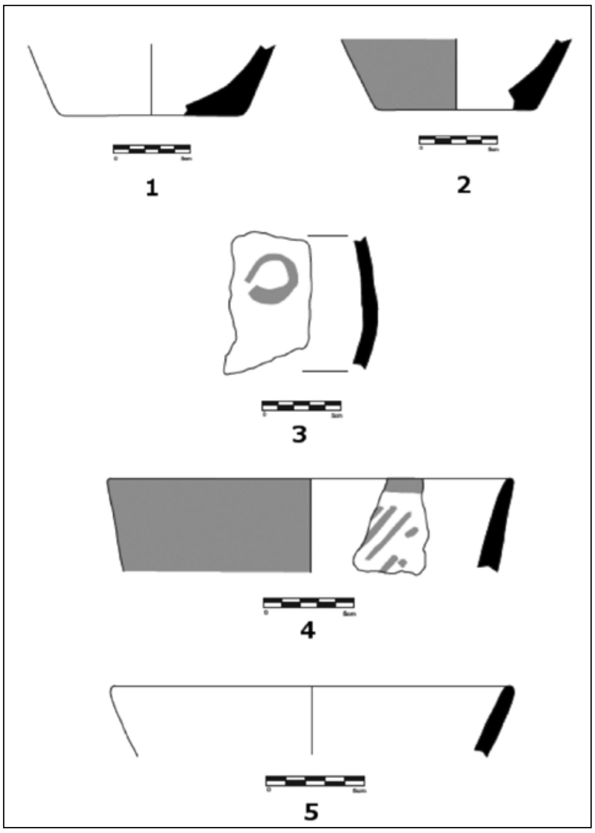
Overall, well-preserved Epipalaeolithic deposits appear to be less common in Wadi Qusayba and its near neighbours than in Wadi Taiyyiba or Wadi Ziqlab (Maher 2003, 2007, 2011; Maher and Banning 2001, 2002). Nor were we able to find evidence of the red paleosol that appears to date to Epipalaeolithic times in Wadi Ziqlab, except in a deeply buried and currently inaccessible location under a huge landslide at the boundary between Subregions 1 and 2.

Neolithic

The survey detected some clear Neolithic artifacts, usually sickle elements, in many locations. However, the 2013 survey was not able to confirm the presence of any Neolithic settlement sites that had not already been discovered in 2012. It did identify some candidate sites in some of the polygons, but these are heavily colluviated terraces, making it unlikely that significant numbers of diagnostic artifacts would appear on the surface or in shallow gullies.

A local farmer reported finding several groundstone artifacts of likely Neolithic or Chalcolithic age in one of these high-probability polygons, 335. Included in the finds from this site are a few pieces of likely Late Neolithic pottery (**Fig. 5**). To date, however, our best candidates for Neolithic settlements are both in Wadi Qusayba's main channel, WQ 117 and WQ 121, the former being a clearly Yarmoukian site found in 2012 that has suffered greatly from erosion and the bulldozing of a crude road.

Allocation of additional survey at the confluence of Wadi Darraba and Wadi an-Nuhayr, in polygon 228, helps to confirm the impression of the 2012 survey that this may represent a small PPNB site (WQ 207). Once again, none of the



5. Late Neolithic Pottery from Polygons 335 (1-3) and 355 (4-5)
- *1- 32821.1: Inclusions: Limestone, medium and very frequent; Chaff, large and rare. Color: 10YR6/4 light yellowish brown. Incomplete oxidation firing.*
- *2- 32821.2: Inclusions: black, bubbly particles that could be disintegrating limestone, small to large, frequent; limestone, medium and rare; iron oxide, fine and rare. Color: 5YR7/4 pink. Medium firing.*
- *3- 32821.3: Inclusions: Limestone, fine to medium, common; iron oxide, fine and occasional; black, bubbly particles that could be disintegrating limestone, medium size and occasional. Color: 5YR7/4 pink. Medium firing.*
- *4- 32762.1: Inclusions: Clay nodules, large and frequent; limestone, medium and occasional; chert, large and rare; calcite, small and rare. Color: 10YR8/4 very pale brown. Medium firing. Paint color: 10R4/6 red.*
- *5- 32752.1: Inclusions: Limestone, fine to large, common; clay nodules, large and occasional; calcite, medium and rare; chert, medium and rare. Color: 10YR7/4 very pale brown. Medium fired.*

lithics found are highly diagnostic, such as naviform cores or projectile points, but many of them are long, narrow blades made from high-quality flint, a number of which appear to have been struck from bidirectional cores. In addition, there are some lithics of likely Middle or Upper Palaeolithic age. This location would have benefitted from perennial water supply from ‘Ayn an-Nuhar and ‘Ain Milih in Wadi an-Nuhayr. Today, an abandoned well and pump station lies about 50 m west of the site.

We also returned briefly to the Yarmoukian site (WQ117) that was discovered in polygon 118 in Wadi Qusayba in order to monitor its condition and better assess its preservation. It seems likely that the road that has been bulldozed through the site, in combination with erosion by the *wadi* channel, has destroyed the greater part of this site, but some portions appear to survive that could warrant excavation.

As in 2012, sickle elements that most likely date to the Late Neolithic occurred on some relatively high terraces and ridges. To date, we have found these up high in polygons 126, 127 and 401. We also found sickle elements on lower terraces in polygons 103 and 118. Although the find locations of most of these pieces probably do not correspond with settlements, the fact that some of them, on the tops of ridges, are not colluvial suggests the possibility that they mark portions of the landscape that Neolithic farmers exploited for agricultural production. The challenge remains to find their associated settlements which, where they survive at all, are probably buried under colluvial deposits on terraces below them.

Chalcolithic

The 2013 survey found no clearly Chalcolithic sites (but see Early Bronze). We collected a further small sample of artifacts from WQ 302 in Wadi Khadra, but the sherds and lithics are not very diagnostic. We also collected a few more from the largely destroyed site of WQ 122.

Early Bronze Age

Polygon 233 in the vicinity of Mendah, on a terrace below the Early Bronze Age site of Ras Abu Lofah (Glueck 1951: 185-186; WQ 210), unsurprisingly exhibited considerable Early Bronze pottery and groundstone. Again, the more diagnostic artifacts appear to date to EB I and II.

We also returned to monitor a dolmen field (WQ304, Kerem Dahleh), which probably dates to the Early Bronze Age (Prag 1995; Yassine 1985). Mega-Jordan has this site listed as ‘Mendah Jamla’ (no. 3185). We took further waypoints to define its boundary more accurately and to document damage to the site that has occurred since last year. Someone has bulldozed two roads through the site, knocking down some of the dolmens and piling the stone slabs, apparently indicating plans to develop the site for residential construction. This makes it all the more urgent to document this site in detail before most or all of the dolmens are lost. Very few dolmens at this site are now standing.

Iron Age

Polygon 403, whose position at a stream confluence near two or three springs made it a high-probability candidate for Neolithic occupation, yielded finds that more strongly point to Iron Age use of the site (WQ 403). There has been at least some bulldozing on this site that has damaged some of the Iron Age remains there. The survey identified numerous Iron Age sherds and many basalt fragments and nearly complete grinding stones, as well as a limestone bowl or mortar, at the site. This was not documented in the East Jordan Valley Survey (Ibrahim *et al.* 1976: 49). Although some of the groundstone artifacts have forms that would not be out of place on a Neolithic site, these forms are not very chronologically diagnostic and, given the large number of Iron Age sherds and lack of distinctively PPNB or Late Neolithic stone tools or cores, it seems likely that they are of Iron Age date.

Site WQ 212, on a hill and accompanying slope and saddle that overlooks the eastern end of Wadi Qusayba's ravine and the western valley of Wadi Darraba, shows some slight evidence for prehistoric use (see above) but more abundant evidence for Iron Age occupation. It is not clear what kind of site this is without further investigation, including some excavation, but it may be a small village site.

We also made a brief revisit to Tell Mudawwar (WQ 406), previously documented by the Jordan Valley Survey (Ibrahim *et al.* 1976) and more recently by Hussein al-Jarrah. The site shows evidence for significant Iron Age occupation as well as some sherds of Early Bronze II and classical periods.

Hellenistic, Roman and Byzantine

Artifacts of the classical periods are nearly ubiquitous in the region, but usually at very low densities that are more likely to reflect agricultural activities than Roman, Byzantine or early Islamic settlement.

Site WQ 405, next to a modern pump-house at the hot spring, ‘Ain ad-Dabbar, has a sherd scatter of Late Roman, Byzantine and / or early Islamic pottery associated with various stone walls, including those of a large building some 18 m x 28 m in size.

Site WQ 404 consists of a classical-period cemetery that has mostly been robbed out in recent years. The tombs are dug into the relatively soft, chalky limestone of a hillside on the edge of the Jordan valley, immediately east of Tell Muddawar, and it is likely that it was the cemetery for Tell Muddawar's Roman - Byzantine population.

Tell Muddawar (WQ 406) is a large *tell* that had already been identified in the Jordan Valley Survey (Ibrahim *et al.* 1976) and was re-surveyed by Hussayn al-Jarrah of the Department of Antiquities. We made a brief revisit to this *tell* to monitor its condition (see above, under Iron Age).

Early Islamic or Mediaeval

Many of the ‘Byzantine’ sherds found in low densities during the survey could easily date to the Umayyad period. However, we found relatively little evidence for later Islamic artifacts. There were small numbers of Ayyubid / Mamluk body sherds in polygons 104, 221, 226, 242, 334, 349, 507, 509 and 513, and an Ottoman pipe fragment in 226.

Summary of Sites

Table 2 summarizes the sites recorded in 2012 - 2013 and the periods most likely represented at each, where discernable. Site numbers beginning with 1 are in the lower ravine of Wadi Quseiba, those beginning with 2 are in Wadi Darraba, those beginning with 3 are in Wadi Khadra or Wadi al-Bir, those beginning with 4 are in Wadi Umm ad-Dabbar and those beginning with 5 are in the small *wadi* between Wadi Taiyyiba and Wadi Qusayba. Periods summarized are Middle / Upper Palaeolithic (MLP), Epipalaeolithic (EPL), Neolithic (NL), Chalcolithic, Early Bronze (EB), Middle / Late Bronze (MLB), Iron Age, Classical and Islamic (ISL, including Umayyad, Abbasid and Ayyubid / Mamluk).

Table 2: Summary of the sites or site elements surveyed during the 2012 and 2013 field seasons with their most likely periods of use or occupation. Those with no period marked are of unknown date, and those with question marks indicate probable but uncertain date. * indicates sites that were previously known, but some of them were not correctly located by Glueck (1951) or MEGA-J.

Site No.	Character	MLP	EPL	NL	Chal.	EB	MLB	Iron	Clas.	Isl.
101	Lithic scatter	☐								
102	Isolated structure							?		
103	Lithic scatter	☐								
104	Cemetery								☐	
105	Cemetery								☐	
106	Cemetery								☐	
107	Cemetery							?	?	
108	Settlement								☐	
109	Lithic scatter	☐								
110	Lithic scatter			☐						
111*	Tell					☐	?	☐		
112	Lithic scatter		?							
113	Lithic scatter	☐								
114	Lithic scatter	☐								
115	Destroyed tell			?				☐		
116	Lithic scatter			?						
117	Settlement			☐						
118	Settlement			☐						
119	Lithic scatter									
120	Stone walls							☐		
121	Settlement?		?	?				☐		
122	Sherd scatter				?	?		?		
201	Walled hilltop									
202	Long wall									
203	Sherd scatter					☐		☐		
204	Rock-cut tomb								?	
205	Rock-cut tomb								?	
206*	Settlement					☐		☐	☐	☐
207	Lithic scatter	☐		?						
209	Sherd scatter									
210*	Settlement					☐				
211	Sherd scatter									☐
212	Settlement		?					☐		
301	Terrace wall									
302	Settlement?				?					
303	Sherd/Lithic scatter				?					
304*	Dolmen field					☐			☐	
403	Settlement							☐		
404	Cemetery								☐	
405	ʻAin ad-Dabbar								☐	?
406*	Tell					☐		☐	☐	
501	Settlement							☐		
502	Lithic scatter	☐	?	?						

Conclusions

Considering the short field seasons (less than four weeks each), small crew size and geomorphological obstacles to prehistoric preservation and visibility, the Wadi Quseiba project was quite successful at detecting late prehistoric sites and candidate sites. This was, we believe, made possible by the strategy put into use here, where locations in the modern physical landscape predicted to be ideal for the preservation of prehistoric material were allocated varying degrees of survey effort based on iterative probability assignments. This allowed for the survey (and often re-survey) of these areas in such a way that those most likely to reveal promising material remained the focus of the survey crew's attention, while those least likely - or deemed so via projections of past landscape evolution in a GIS and groundtruthing in the field - saw less time allocated to them. In essence, much smaller amounts of time were wasted on areas where prehistoric material was unlikely to have survived because of geomorphological processes or was unlikely to be visible on the surface. With this in mind, gradually refining the probabilities also allowed us to exploit the often overlooked possibility that, even though no archaeological material was detected in previous survey, it may indeed exist and be discoverable by allocating survey effort to high-probability areas repeatedly. In at least one case (polygon 335, where Late Neolithic material was finally discovered) it was only on the crew's third inspection of the survey area that material was successfully located, demonstrating the effectiveness of this survey method.

Acknowledgments

The authors would like to extend their gratitude for the support of the Department of Antiquities of Jordan, the Director of Antiquities Dr Munther Dahash Jamhawi, the University of Toronto and the Social Sciences and Humanities Research Council of Canada (SSHRC) without whom this research would not have been possible.

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