WHEN THE BAER HITS IN THE WOODS

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Emergency treatment and rehabilitation of archaeological sites under BAER (Burned Area Emergency Response) after wildfire requires a much different approach than the rehabilitation techniques used for other public lands resources. The objective for archaeological sites is not to slow erosion over a large area, but to prevent damage from erosion, deposition, and human activities to a specific small area, the archaeological site. Treatments depend on both topography and the nature of the site. The 2002 Mustang Fire on Ashley National Forest in northeastern Utah required treatments of two main site types, rockshelters and lithic scatters with probable buried features, in the rugged terrain of the Uinta Mountains.

The Mustang Fire, ignited when a tire rim struck sparks from a cattle guard, burned 20,000 acres of Ashley National Forest (ANF) in July 2002. Fire severity (heat intensity and duration) ranged from high to low depending on terrain, ground cover and suppression efforts. Although entire areas were characterized as high, moderate, or low severity, the effects were patchy; small, pockets of unburned vegetation survived within high severity areas; isolated vegetation patches within low severity areas experienced intense, long-duration burns. The fire area experienced torrential rainstorms immediately after the fire. Except for occasional cloudbursts, the area has remained in drought condition since the fire.

The fire occurred on the north slope of the eastern Uinta Mountains in northeastern Utah. The area, ranging in elevation between 5600-8500 feet, is a marginal bench cut by the canyon of the Green River. Bedrock outcrops define an extensive series of descending terraces that support juniper and pinyon, occasional Ponderosa pine, sagebrush and sparse grasses. Ravines or draws with sagebrush, cacti and sparse grass cover incise rocky ridges with pinyon-juniper, Ponderosa pine or brush cover. A few seeps, springs and small streams tributary to the Green River support narrow riparian communities. The local bedrock is largely Uinta quartzite, relatively coarse-grained, and ranging from tool-quality to poorly metamorphosed. Bedrock is exposed as ground surfaces, ledges, outcrops, detached blocks, boulders and cobbles.

I was the Heritage representative on the BAER team. In May 2003 I also made a post-fire visit to the Hammond Fire on the Manti-LaSal National Forest, which occurred at the same time as the Mustang Fire. The Mustang and Hammond fires burned in the same month, after four years of West-wide drought, in mountainous terrain. However, the Hammond Fire area experienced post-fire continued drought and windstorms (Don C. Irwin, personal communication 2003), rather than the torrential rains that followed the Mustang Fire.

Wildfire immediately and directly threatens cultural resources through the fire itself and through ground disturbance during suppression efforts. Additional, indirect effects include increased erosion and deposition due to subsequent precipitation, and changed visibility and accessibility that that can increase susceptibility to recreational activity and vandalism. Any of these factors may destroy archaeological sites, or change the context in ways that impact scientific analysis and interpretation. The BAER mission was to: a) identify known Heritage resources impacted by the fire and b) prevent damage to Class I cultural resources from fire-related erosion events, debris flows, and rehabilitation efforts. Class I resources are **“**those historic or prehistoric resources determined eligible to the National Register of Historic Places (NRHP) per criteria 36 CFR 60.4. Also, Forest Service Manual (FSM) 2361 direction states that Class II sites, which are classified as heritage resource sites whose NRHP status is unknown or unevaluated, be afforded the same consideration and protection as Class I sites” (Heritage Resources: Application and Incorporation within the BAER Process 2003:11).

PERCEIVING THE BAER: SITE TREATMENTS AND MONITORING

Site and Treatment Selection

The Mustang Fire burned area encompassed 271 known archaeological sites. We were charged with implementing Burned Area Emergency Response (BAER) for Heritage (cultural) resources. We performed archaeological clearance of areas prior to ground disturbance for construction of log erosion barriers (LEBs) and mechanized earthmoving. We identified National Register-eligible sites at risk from increased post-fire erosion, then installed and subsequently are monitoring preventative treatments at those sites.

We were directed to identify treatment sites and estimate treatment materials based on modeling of burn severity and site vulnerability, rather than field examination. Our model examined Class I and II sites using GIS information, site forms and topographic maps in conjunction with a burn severity map. The burn encompassed 271 sites, of which 207 were not NRHP-eligible. The modeling process selected 18 Class I sites (11 open sites and 7 rockshelters) for treatment: 12 in high severity areas, 2 in moderate severity areas, 3 on boundaries between high and lower severity areas, and one site in an isolated, unburned area. We also selected three sites adjacent to treatment sites as control sites, so we could monitor differences between the effects of our treatments and more standard rehab efforts. During site treatment, we found that eight of the sites, including the supposedly unburned area site, were actually on boundaries between burn severity zones. One ANF site, a historic cabin and dugout (42DA167), was in a high severity burn area, but in a grassy clearing with damp soil areas from surrounding seeps. The structures burned entirely, although within two months after the fire the surrounding grassy area looked unburned. We performed case file documentation on 42DA167. Ashley Heritage personnel treated the selected sites between late August and mid-September of 2002. Unfortunately, after the fire was suppressed but before treatment materials could arrive parts of the burned area experienced torrential rainstorms. Thus, our fieldwork afforded some first-hand observations of post-fire erosion and deposition before sites could be treated.

After observing a hired crew engaging in standard (non-site) rehab efforts including tree felling, shovel work and construction of log erosion barriers (LEBs), we decided that non-destructive treatment of cultural sites would be best performed by Ashley Heritage personnel, who were familiar with local cultural sites, materials, and preservation concerns. Finding little in the way of practical guidance for actual treatment of our site types (rockshelters small, open lithic scatters with buried components), we based treatment design on intuition informed by observations of past erosion and minor flooding. To avoid adverse affects due to the treatments themselves, we planned to treat in ways that were: a) off-site to the extent possible, and b) non-ground disturbing to the extent possible. Our goal was not to retard runoff over a large area, but to divert runoff and sheetwash <u>before they reached site surfaces</u>. Since many of the sites were remote, we selected site treatment materials that could be transported on foot. The selected treatment materials were standard items: straw wattles, erosion blanket and hand-broadcast seed. However, to effectively protect our cultural sites, we had to use these materials (and some field expedients) in non-standard ways.

Treatment Materials and Application

Aerial Seeding and Pellet Mulching. We coordinated with other BAER team members to assure that large-scale (aerial seeding and pellet mulching) treatment coverage included our areas of concern. In some cases we were able to get specific low burn severity areas or drainages upslope or upwind from cultural resource sites added to the aerial seeding plan. An area selected for pellet mulching included two of our sites: a treatment site and a control site. A similar attempt to coordinate hydro-mulching on two sites failed due to equipment difficulties. Fortunately, we had treatment alternatives for one of the sites, and field inspection determined that the other site (selected through modeling) did not actually need treatment. We hand-broadcast the aerial seed mix, especially in site areas like rockshelters that were inaccessible to aerial seeding.

Straw Wattles. Wattles are biodegradable plastic mesh tubes about 9 inches in diameter (Figure 1) with a natural (coconut or straw) fiber fill, used as runoff barriers.

Figure 1. Derek Stertz and Sandy Duarte with treatment materials.

Unlike LEBs, straw wattles are flexible and conform to the ground surface; ground disturbance can be essentially confined to the footprints for three or four one by two inch wood anchor stakes. Standard rehabilitation efforts typically use straw wattles in 25' (foot) lengths installed in a concave shape (belly downslope) as check dams on slopes or in rills and small channels, to collect and slow sediment-bearing flows. The goal for cultural resource sites was specifically to prevent on-site erosion or deposition by sediment bearing flows, and to do it with materials that could be transported by a person on foot. We employed 12' long straw wattles, used as diverters rather than collectors. We installed these straw wattles in a convex shape (belly upslope) at points immediately upslope of sites to divert rill and small channel flows and sheetwash from the site itself. In rare cases were it was necessary to slow rill or channel flows originating within the boundaries of relatively large sites we installed the wattles on-site in the conventional manner (belly downslope, as collectors), in such a way that they avoided artifacts and features. Straw wattles were also used as diverters at rockshelters, which are discussed later.

Erosion Blanket. Erosion blanket is a biodegradable plastic mesh envelope with natural fiber fill (Figure 1 above) used to stabilized ground surfaces and channel walls. Direct precipitation or minor sheet flows onto erosion blanket tend to slow and soak in. Erosion blanket in channels tends to armor the channel walls. Ground disturbance can be limited to the footprints of 6" (inch) long, U-shaped, wire anchor staples pushed into the ground at intervals of up to one meter. Erosion blanket is available in a range of fill materials and sizes. We chose CFO72RR coconut fiber in 8' by 67.5' rolls. For field transport, we typically carried up no more than half a roll (8' by 30') at a time, based on estimates of the material required at a site. The blanket can be cut with tin snips (or a pocketknife, in a pinch), but serrated tools like pinking shears may do a better job. It is impractical to blanket ground surfaces the size of typical archaeological sites. Erosion blanket was used to stabilize midden surfaces at the Hammond Fire. We used erosion blanket primarily to stabilize rockshelter floors and apron. At one site where five metates lay on the surface adjacent to a small drainage channel, we blanketed the surrounding surface and a portion of a channel.

Expedient Treatments. Some of the treatment sites were reached only by several hours of walking. Since modeling rather than on-site inspection was used for site selection and treatment design, there were often unanticipated threats. At remote sites we employed several field expedients to deal with these threats. When our straw wattles came up short at one site, we extended the wattle diverter using a burned log buttressed with a section of erosion blanket. As discussed below with rockshelters, burnt limb or log diverters buttressed with rocky rubble were especially effective in narrow, rocky cracks along ledge tops. In a small, rocky, ephemeral drainage that meandered along a site boundary, we took loose rocks from the channel and from off-site and arranged them strategically as wing walls to divert the main thrust of high runoff flows away the site side of the channel.

Site Type and Treatment

Open Sites. More than half of our treated sites were open sites described as lithic scatters with potentially intact buried components. Site locations ranged from small terraces or benches along slopes to more extensive marginal benches, ridge top flats, and canyon bottom stream terraces. The sites were relatively small in physical extent, typically measuring less than one hundred meters across, and precipitation directly onto site surfaces was not the threat. Open sites typically faced three threats. Sheetwash sediments from a slope above might cover the site. Runoff over the terrace or bench lip might cut back into the site, washing deposits down the slope below. Increased flows through existing, on-site runoff rills and channels might erode deposits.

Typical open site treatments were: a) convex to straight straw wattle deflectors (and sometimes, added expedient deflectors) strategically placed at the base of the slope above a site to divert flows away from the site, b) concave to straight straw wattles strategically placed at terrace lips, and c) straw wattle deflectors and collectors placed across existing drainage channels and rills above sites to divert or to reduce the energy of channel flows. In rare cases, site extent and topography forced us to deal with channels or rills on-site. In these cases we deployed straw wattles and erosion blanket in the fashion recommended for standard rehabilitation efforts while attempting to avoid cultural materials and features.

Rockshelters. About half of our treatment sites included rockshelters judged to contain intact, buried deposits. Rockshelters were typically on slopes, in the base of intermediate ledges or outcrops, although some rockshelters were at the base of large boulders or blocks on a terrace or marginal bench. Intact deposits were typically described as confined to the rockshelter itself, although site boundaries often included some of the slope of flat immediately below the shelters. Accelerated post-fire runoff can cause severe erosion of rockshelters deposits that appear dry and safe under more normal conditions. Direct precipitation and increased flows at the dripline are minor threats. The major, and unanticipated threat is inflows along the ledge from the sides of a rockshelter, or less commonly, flows from above emerging from cracks in the back wall of a rockshelter. Virtually every rockshelter visited after the Mustang Fire experienced some degree of water inflow from the sides; the exit points were typically low points in the apron. At 42DA897 runoff inflows through a previously unnoted crack in the back wall combined with inflows along the ledge from the sides of the rockshelter to completely wash out the floor deposits to bedrock. Decreasing flows deposited a mound of fresh, fine, ash-stained sediments and debris on the rockshelter floor near the back wall. Examination of 42DA897 with precipitation and runoff in mind indicated that rainstorm or snowmelt runoff must have replaced the deposits in this rockshelter many times in the past. We did not treat 42DA897.

Rockshelter treatments involved erosion blankets and straw wattle and expedient diverters. Erosion blanket was placed to cover rockshelter floors, driplines, and a portion of the aprons. This absorbed direct precipitation and cliff face runoff, and protected the deposits in the case of inflows. Straw wattle and expedient diverters were strategically placed above rockshelters and along slopes or ledge bases near both sides of rockshelters. Strategic placement of very small diversions at runoff access points along the ledge or outcrop immediately upslope of a rockshelter is especially effective because rocky rims above rockshelters tend to be relatively horizontal, or to generally incline from the horizontal in one direction or the other along the ledge. In some cases straw wattles were strategically placed on the ledge rim above rockshelters to divert runoff. However, runoff paths through the ledges above rockshelters are often limited to a few narrow cracks. Small expedient diversions constructed using a burnt branch or log segment and rocky rubble from the immediate vicinity can effectively divert flows to cracks beyond the site boundaries. Similarly, small diverters at the base of a cracks can divert runoff away from rockshelters into alternate channels down the slope.

Monitoring

As of April of 2003, monitoring indicated that the treatments were functioning as intended, and effective to the extent feasible given continuing drought. Since precipitation did not cooperate, insects (and probably birds and rodents) made serious inroads on broadcast seed. At one control site visited a week after broadcast seeding, the only visible seed remaining at the site was a dense collection around an anthill. Treatment materials at two sites were disturbed by wind or by large herbivores between October of 2002 and April of 2003.

RIDING THE BAER: DISCUSSION AND RECOMMENDATIONS

Fire Effects

Direct Effects. The direct effects of fire on ground surfaces and archaeological sites include burning of surface features and heat alteration of sediments and archaeological materials. The effects tend to be greatest where fire is both intense and long-duration (high severity areas). Dense stands of trees or tall brush, or more open tree stands with ample dead wood and ladder materials, support intense, long-duration burns. Fire severity and related changes are less frequent or less severe in grasslands and in riparian or other areas with damp soils, although isolated hotspots occur even in these areas. Where fire intensity or duration is low, some grasses recover within weeks; trees, brush and succulents may only be singed. Non-arboreal vegetation in riparian areas may not burn at all, or recovers quickly. In areas of moderate to high fire severity, Clumps of cacti turn yellow; some clumps die and others recover. The first native plants to reappear the spring after the Mustang Fire were small-flowered mustards, *Chenopodium*, Thickstem wheatgrass and various bunchgrasses, and various “tuber” plants such as wild onions, Death camas, and Arrowleaf balsamroot. Surface features may be damaged by falling trees or during fire suppression, and organic elements of the features are destroyed. Some surface archaeological materials (bone, wood, obsidian, lithics, and possibly ceramics) are destroyed or are altered, with a resulting loss in the potential for analysis and interpretation. Rock art or inscriptions in moderate to high severity burn areas will be damaged by blackening and spalling during the fire, and probably entirely lost through exfoliation within a year or two.

Indirect Effects. The major indirect effect is post-fire wind and water erosion and deposition. Post-fire erosion can indirectly affect ground surfaces and sites down slope, including unburned areas. Post-fire runoff and sediments originating in burned areas result in channel cutting and filling and sheetwash deposition on distant, distant, unburnt ground surfaces and archaeological sites. While the magnitude and extent of these indirect effects depend on upslope fire intensity and topography, the most severely affected areas are ephemeral drainages and areas where slope and drainage channel gradients become less steep. Deflation, erosion and deposition of much greater magnitude than under "normal" conditions occur within a year or two after a fire, but accelerated erosion sometimes spans a decade or more (Robichaud et al. 2001). The effects on sites vary depending on local burn severity, soils, slope, and the topography of the surrounding terrain. Even flat surfaces can lose several centimeters of surface sediments within the year after the fire. Where even gentle slopes punctuate benches or terraces, sediments are stripped from ridge tops and slopes leaving only rocky rubble. These sediments are deposited on the terraces immediately below each slope. Erosion on terraces can begin at the downslope terrace lip and work back across a terrace. Where ephemeral drainages lose gradient and open onto flats, outwash can cover large areas with ash, charcoal-stained sediments and other materials transported from upslope. Apparently secure rockshelters can experience unanticipated inflows from the sides, or from cracks in shelter roofs or walls.

Specialized Treatment Needs. Research indicates that standard rehabilitation treatments aimed at reducing erosion over burned areas in general (contour tree felling, aerial seeding, LEBs and straw bale check dams) are relatively inefficient (Robichaud et al. 2001). With the exception of aerial seeding these are ground disturbing in practice. Standard treatments are aimed at reducing erosion in an area rather than preventing site-specific erosion damage. They do not work where the intent is to prevent site-specific damage to a complex, hidden resource using off-site and non-invasive treatments.

The Heritage BAER Process

The BAER Heritage guidance papers (2003) are sketchy, and are under review; studies of fire effects, strategies and research needs are ongoing (Gleeson et al. 2000). The Mustang Fire experience suggests that conceptual, perceptual and methodological changes are needed to effectively identify and protect cultural resource sites from fire.

Proactive Procedures. BAER funding does not cover proactive actions before a fire occurs. However, some relatively inexpensive changes in day-to-day priorities and procedures before the inevitable fire occurs may reduce or mitigate resource damage, saving time and money. When fires occur, the probability of loss or irretrievable damage to some archaeological materials and feature types is very high. Especially at risk of direct loss are surface features, exposed organic materials, obsidian artifacts (Loyd 2002, editor), glass, and rock art. Some toolstone materials and possibly ceramics may lose scientific and interpretive value when burned. Trees and brush can be cleared from the vicinity of surface features and rock exposures that bear rock art. Research designs can assign higher priorities to the collection of surface obsidian and ceramics, and to thorough documentation of glass, groundstone, debitage, core and tool condition during site recording. Thorough documentation and study of surface structures and rock art should have a high priority. The severe rock surface exfoliation observed after the Mustang Fire indicates that unless fuels can be kept clear of rock art sites, thoughtful and thorough documentation of rock art should be a very high priority. This is especially important if observation or anecdotal evidence suggests that the rock art may be of interactive design (Johnson 1993:71-88).

Site Recording. High quality and detailed GIS data greatly improve the chance of avoiding sites during suppression and other rehab, of relocating sites and site features after a fire. Detailed GIS data offers a useful context for collected obsidian and ceramics samples. Crews recording cultural sites seldom include hydrologists and soil scientists. Unfortunately, site sketches and descriptions typically cover the site rather than the surrounding (especially upslope topography), and do not contain the kind of informative detail that allows prediction of post-fire erosion effects. Nor are 20 to 40-foot contour interval topographic maps very useful in this regard. However, personal experience with the aftermath of fire would allow an archaeologist to record at least an intuitive judgment regarding the likely level and nature of threats if a fire occurred.

Modeling and Site Selection. The Mustang Fire experience leaves me deeply distrustful of modeling as a tool for selecting treatment sites. The map is not the territory. The fire severity map, topographic maps and site forms did not have sufficient detail to accurately depict on-site terrain and threats, and in no way addressed the essential randomness of nature that can result in a blocked, insignificant drainage channel changing course to cross an important site the year before a fire. Ten percent of the modeled sites turned out not to require treatment for various reasons. Several of the sites turned out to be more extensive than had been recorded. Nearly every site treated faced some threat unanticipated by the model. As mentioned above, awareness of fire effects and a judgment call by site recorders would help. However, I recommend visiting the Class I sites immediately after a fire regardless of fire severity classification, ideally accompanied by experience in hydrology and soils. Cultural resources are irreplaceable; models leave too much to chance.

Site Treatments. Treatment requires awareness both of local cultural resources, and of how wind and water erosion operate. The goal is no on-site ground disturbance (apply treatments off-site wherever possible). If on-site treatments are necessary, they should avoid known features, and ground disturbance should be limited to a minimal number of stakes or pins plus loose, non-cultural surface materials. Treatments must be tailored to specific sites or features, and address specific threats. Treatment designers should work with nature where possible, subtly guiding or redirecting natural forces rather than attempting to stop them. Standard treatment materials are used for individual site treatments, but their application differs from standard practice since the goal is to prevent site-specific damage.

The first step is to work with the BAER team to insure that areal treatments (aerial seeding and pellet mulching) cover the areas of cultural concern. This means upslope and upwind of sites, as well as on-site. The overall aerial seeding plan will probably be initially based on fire severity maps. However, such maps lack the detail to identify variable fire severity in small drainages or on minor slopes that may threaten specific cultural resource sites below. Heritage personnel should work with other BAER team members to extend aerial seeding plans where necessary.

When treating individual cultural sites, straw wattles are most effective when strategically placed above a site to divert runoff, rather than using them to slow or collect runoff. The major threat to sites after the Mustang fire was not on-site precipitation, but aggregate flows originating upslope. A relatively small diverter or two strategically placed above a site boundary can divert flows into existing runoff channels that go around the site. Two exceptions are sites large enough that damaging flows originate from the site surface itself, and sites perched at the outer edge of a terrace or bench. In these two cases straw wattles can be used in the standard fashion, as collectors to slow or stop runoff. If a large site surface is generating flows, it may be necessary to slow and dissipate that runoff. In this case straw wattles can be installed on the surface in a concave fashion, avoiding known features, and with ground disturbance confined to the footprints of the retaining stakes. If carefully installed, the flexible wattles should only need to be slightly bermed on the uphill side using loose surface material from the immediate vicinity. In the case of terrace edge sites, concave or linear arrangements of wattles placed at the lip of the terrace can prevent erosion from beginning at the lip and working back across the site. One ANF straw wattle installation was scattered and partially eaten by large herbivores late in the winter following the fire. This problem might be serious where large herbivores are concentrated in an area and food-stressed.

Erosion blanket can be used to armor channel walls or slopes, but works best to stabilize specific areas of site surface. Ground disturbance is limited to the footprints of wire staples about one-eight inch in diameter and six inches long, which are installed at intervals to secure the blanket. Erosion blanket diffuses the force of direct precipitation or minor on-flows, allowing the water to soak in, and prevents wind erosion of the blanketed deposits. Erosion blanket provides a moist, protective environment for seed, which can be hand-broadcast prior to applying the blanket. Disadvantages include possible damage from that moist environment, and the fact that the blanket can be displaced if large, vigorous plants attempt to grow up through it. Both straw and neutral (coconut) fiber blanket are available, with straw being the least expensive to purchase. However, straw erosion blanket used at the Hammond Fire degraded much more quickly that the coconut fiber blanket that ANF used. I also heard of one instance of cows eating straw erosion blanket (Marian Jacklin, personal communication 2003).

Expedient off-site diversions can be very effective in cases where a threat to a site originates in or passes through a restriction before reaching the site. Examples are small notches or chutes above rockshelters, and existing minor erosion channels in rocky terrain. In these cases, minor dikes or wing diverters informally constructed from the materials at hand can direct flows away from sensitive areas. Care should be taken that these constructions are not so substantial as to be mistaken for cultural features in the future.

SUMMARY

Identification and protection of certain Heritage resources are part of the BAER process. However, the emergency nature of the problem and the process stress all involved. It appears axiomatic that nature will not cooperate. To be effective the response must be swift, but also must be carefully planned and executed. Cultural resources must be represented on the BAER team from the beginning of the process so that other team members are aware where their activities require clearances, and so that cultural resource sites benefit from, or at least are not sabotaged by, other reclamation efforts.

Proactive, pre-fire planning can prevent site damage, and save time and money in the event of a fire. Selective fuels thinning can protect rock art sites and some structures. Some features (like rock art or wooden structures) and some surface artifacts (like obsidian and possibly ceramics) are at such risk that it is wisest to document and study them thoroughly before a fire can destroy them. Sites should be evaluated when they are recorded; a site that is difficult or expensive to evaluate before a fire will be more difficult and expensive to evaluate after a fire. Good GIS data and site feature maps will assume unanticipated value after a fire. Consideration of topography, geology, hydrology and vegetative cover during site recording can better prepare archaeologists to manage sites in the aftermath of the next fire.

Using present technology, site selection through modeling of fire severity and topography is not good enough. At a minimum, Heritage personnel should evaluate Class I and II sites on the ground, accompanied by some hydrologic expertise. Indirect threats to cultural resources after fire can originate far off-site, upslope, and in low severity burnt areas. Threats unanticipated by any model (and conversely, anticipated threats that do not develop) will only be apparent through on-site examination.

Treatment design emphasis must be on protecting the cultural resource that is present, where possible by diverting runoff and sheetwash before they reach site surfaces. Treatments should avoid damaging or "creating" sites and features. Treatments should be off-site to the extent possible, and non-ground disturbing when possible. This requires avoiding some standard treatments (like LEBs), and using some standard treatment materials (straw wattles and erosion blanket) in new and creative ways. Assessment, treatment design and treatment installation all require grounding in local cultural resources as well as some understanding of natural processes.

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