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MUNITIONS RESPONSE (MR) ACTIONS

OBSERVED EFFECTS OF FIRE RETARDANT AND FIRE FOAM ON MARITIME CHAPARRAL IN RANGES 43-48

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Parsons

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Introduction

This report documents some of the observed effects of a fire retardant (Fire-Trol® LCA-F Liquid Concentrate), and two types of fire suppressant foams (Fire-Trol® 103 and 103B, and Phos-Chek® WD881) on maritime chaparral growth in an area that was prepared for a prescribed burn in preparation for an ordnance removal project on Fort Ord. This was not originally intended to be a formal study but rather an series of informal observations of visual effects that could contribute a basic understanding of how retardant and foam application in support of prescribed burning may affect maritime chaparral habitat. The focus of the effects of retardant and foam is invasion of non-native grasses, currently the primary weeds of concern along the established fuel breaks. For the most part, other weedy plants species were few compared with the grasses, so the focus remains on the latter.

Periodic observations were made and photo-documented over a period of 3 years, from May 2001 through June 2004, showing changes in vegetation cover in the treated areas from two years before the prescribed burn to one year after. The treatment areas consisted of fuel breaks established along existing dirt roads that were originally 10-12-ft wide. Fuelbreaks were established by mowing chaparral or grassland vegetation on either side of the dirt roads to create a total width of between 45-50ft and a one-time cut within the Ranges 43 – 48 perimeter of approximately 100ft. Retardant and foam were applied generally within the width of the fuel breaks on mowed chaparral or grass. Retardant and foam were applied to the fuelbreaks twice during this 3-year period, once in October 2002, and a second time in November 2003. The first time the prescribed burn was aborted due to unfavorable weather conditions. The second time the prescribed burn was completed within a few days.

Fire retardant is known to have significant effects on growth of plants due to the fertilizing influence of high nitrogen content. Although retardant is known to have significant effects on vegetation growth, it is important to note that the changes in vegetation documented here were associated with several different “treatments” throughout the 3 year period all of which could cause increases in weed establishment: the dirt roads at the center of the fuelbreaks were regularly disturbed by vehicle driving; the 45-ft wide fuel breaks were all maintained by mowing in the summers of 2001, 2002 and 2003; fire foam and retardant were applied two years in a row in the fall of 2002 and 2003; finally the area within the boundary of the fuel breaks burned completely in November 2003. The changes observed in vegetation during this time could have been affected by any or all of these factors depending on the location. The photos and discussion following describe where possible the effect of each of these factors.

Effects of vehicle use

Vehicles were driven along fuel break roads periodically during the 3-year period, causing soil disturbance. However, the disturbance was limited almost exclusively to the center of the fuel break roads, using within existing tracks (Photo 1). The effects of retardant and foam described here apply to the 15-ft swathes on either side of the road tracks where vegetation was not disturbed by driving, except for a once-a year pass over the whole width of the fuel break with a Bobcat used for mowing. Vehicle use, therefore contributes an insignificant amount to the changes in vegetation described in this report.

Effects of mowing alone

Mowing of chaparral shrubs to a 6-inch height was performed on all the fuel breaks around the Ranges 43-48 burn area. This may have contributed to some of the changes in vegetation, along with retardant and foam application, and burning. To separate the effects of mowing alone, observations have been made along other fuel breaks that have been regularly maintained by mowing in the same manner as the Range 43-48 fuel breaks, and have received no other treatments. Regular observations and photo-documentation of some of these areas shows that weedy non-native grasses may encroach into these areas over time, but the rate of infestation is highly variable. Some fuel breaks have been annually mowed 3 times in succession without a noticeable increase in density of non-native grasses or other weeds (Photo 2). Other fuel breaks show a significant increase in grass density, in a few cases approaching the same density as seen in the retardant drop areas (Photos 3-4). Increase in grass infestation appears to be closely associated with proximity to existing stable patches of grass or grasslands. Where stable populations of non-native grasses persist, encroachment into nearby disturbed areas (mowed or burned) is quite rapid. In areas where the primary cover are shrubs, without existing grass patches, grass infestation is slow or not even apparent, even after 3 years.

Effects of Fire foam

Two types of fire foam were applied along the fuel breaks in both October 2002 and November 2003. The foam brands used were Fire-Trol® 103 and 103B, and Phos-Chek® WD881. Since fire foam was often applied in the same areas as fire retardant, it was not always easy to tell what effects may have been caused by which chemical. In general, the effects of fire retardant were much more easily observed, while the effect of fire foam alone was not noticeable. This generalization was derived from observing areas of fuel breaks around the prescribed burn perimeter where no retardant was dropped (areas that were missed, or where it was dropped in very small quantities and did not visibly persist). Some of these areas had only foam applied. These areas did not show any visible change in vegetation growth that was not due to burning or mowing. More detailed studies of effects of foam might show subtle effects, but within the limits of this qualitative study, the foam effects were not noticeable compared with the more dramatic effects of the retardant.

Effects of Fire Retardant

While both fire foam and fire retardant were applied to most of the perimeter fuel breaks of the Ranges 43-48 burn area, fire foam was not applied to Broadway Road fuel break, so studies of this fuel break give a view of the effect of retardant application alone. The retardant used was Fire-Trol® LCA-F Liquid Concentrate.

The photo sequences in Photos 5-7, 8-11, and 12-14 show changes over time on several sections of the fuelbreaks around the Range 43-48 area where retardant was applied. They show distinctive changes in vegetation composition associated with the retardant, mainly in the establishment of non-native grasses. Photos show changes from baseline conditions (2001- after first mowing) to the third year (2004) following a sequence of annual vegetation mowing and two consecutive years of retardant application, and the final burn in November 2004.

Baseline conditions

Before fuel breaks were first established in spring 2001 by mowing, the vegetation along the dirt roads consisted of low-growing (approximately 1-3ft) maritime chaparral shrub cover with numerous openings. Openings were typically inhabited by a low-density of mostly native forbs. There were probably some non-native forbs and grasses present but these occurred at low density. Moister swales in the gently rolling landscape frequently had a mix of native and non-native grasslands with high percent of native forbs including extensive mats of Monterey spineflower and other rare and special-status species. The slopes and ridges had almost no grasses along the edges of the existing dirt roads. Photo 15 is an example of pre-mowing baseline conditions along Broadway fuel break.

Effects of retardant application on non-native grass establishment

The first spring (2003) following the first fire retardant drop on Broadway fuel break shows significant increase in non-native annual grasses, represented mainly by *Vulpia myurus* (rat-tail fescue), *Bromus diandrus* (ripgut brome), and *Bromus madritensis* (red brome) (Photos 10 and 11). As shown in the Photo 9, *Vulpia* individuals along very densely grassy sections were unusually large for this type of habitat, and probably had enhanced growth from nutrients in the retardant.

Photos from spring 2004 (Photos 7, 13, 14) capture the effects of both the retardant drop and a complete burn of the Range 43-48 site. The difference in grass establishment after the first retardant drop and the second is not clearly defined. In some areas grasses established quickly following the first retardant drop, and less change was seen the next year, except for an increase in the thatch layer. In other areas, grass establishment progressed steadily over the 2-3 year period. In addition to dense growth of non-native grasses in the fuel breaks where retardant was applied, we also see significant encroachment of grasses in low to medium density into the burn area where neither mowing or retardant drops occurred. (Photo 14). It is likely the seed source was the recently invaded adjacent grassy fuel breaks, as well as the pre-existing grassland swale described in Photo 5. These slopes had previously been completely shrub-covered as the view on the right side of Photo 5 shows.

The Broadway fuel break photo series show a consistent pattern of significant grass invasion into the fuel breaks starting in the spring following the first retardant application. Photos on a different section of fuel break (Orion Road – Photos 16-17) show a somewhat different view of effects of retardant. On this slope, the treatments were very similar to those on Broadway fuel break, except that foam suppressant was also applied in October 2003 before the burn. These photos show that while some grasses have established into this area, the density is much lower, in some spots low density. On other sections of the same fuel break, however, grasses approach a very high density similar the those seen in the photos of Broadway.

Given approximately equal treatment, there is small scale variation on the order of hundreds of feet in the patterns of non-native grass establishment into the fuel breaks. Some areas of the fuel breaks quickly became densely invaded, while other sections were not invaded, or only slowly invaded. However, overall, the pattern along all of the fuel breaks that received retardant treatment suggests strongly that retardant use promotes vigorous growth of the existing weedy grasses that would not have thrived as well without it, and may have been normally out competed by native plant growth.

Effect of retardant on growth of maritime chaparral shrubs

Observation of shrub growth in the early summer following the November 2003 retardant application showed there was consistent rejuvenation of shrub foliage. The observed shrubs were immediately adjacent to the 45-ft fuel break. They had not been mowed, but had retardant applied once. In the months immediately following the retardant drops, foliage was colored red-brown by the dye, and over the winter months some of the foliage died off in patches, appearing as dried and dropping leaves. In early summer toward the end of the growing season in 2004, most shrubs had vigorous new growth, which was very apparent as patches of bright green on the still-red colored shrubs (Photos 18-20). A small percentage (probably no more than 3-4%) appeared to have been killed by the retardant (a few *Ceanothus rigidus rigidus* did not have new growth by the following summer.) While observations so far are limited, it is likely that normal re-growth of shrubs would continue in the absence of further stresses and that there would be no significant effect on long-term shrub vigor.

Effect of retardant on growth of rare, threatened and endangered annual plants

There are two ways fire retardant or foam application could affect rare annuals plants, such as Monterey spineflower and sand gilia, in maritime chaparral. One is by inhibiting germination of the seedbank by damage to the seeds or changes in soil chemistry. The other is by the promoting growth of competing plant species, particularly the non-native annual grasses. Two types of situations were documented in the following photographs. In the first situation, rare annual plants appeared unaffected by the retardant drop, and may have actually benefited from increased nutrient availability. This is illustrated in Photo 21-22, which shows very dense mats of the federally threatened

Monterey spineflower within a retardant drop zone. Fire foam was applied to this area, suggesting that the fire foam did not have significant adverse impacts to the growth of native plants in this area. Other populations of rare plants were noted within the fuel breaks, but there were few other examples of where there was a large flourishing patch of a rare annual plant within a area without grasses or other plants competing. Most other occurrences of these rare species in the fuel breaks perimeter of this site have historically been fairly sparse, and it was not possible to tell qualitatively whether there was a difference in abundance or density from the previous year.

In the second situation, retardant application in the mowed fuel breaks was associated with the proliferation of dense non-native grasses, as seen on Broadway fuel break. Simple observation clearly indicated that where grass growth was tall and dense, growth of rare species such as sand gilia, Monterey spineflower, and Seaside bird's beak was severely inhibited. (Photos 23-25).

The observations suggest that the retardant itself did not appear to directly damage the seedbank, or otherwise prevent germination and growth of rare annual plants, when applied during the dry season. It may have enhanced growth in some cases by increasing nutrients available to germinating plants. It is important to note that retardant in these cases was applied during the dry season. If retardant was applied after germination had begun, it seems likely the plants would suffer the same type of foliage "burn" as seen in the shrubs, and likely kill the plants entirely.

However, there may be very detrimental indirect effects due to the enhanced growth of weedy species, particularly non-native grasses, which thrive in high nutrient conditions. These effects are particularly noticeable in densely grassy zones. In less grassy zones (such as the area shown in Photos 16-17, there may be much less or perhaps even no significant effect of competition). Further monitoring studies would be needed to determine whether grass density increases over time, or remains stable, permitting the rare plants to co-exist.

Summary points:

- To evaluate effects of fire retardant and fire foam on maritime chaparral within fuel breaks of Ranges 43-48, several other disturbance factors had to be considered as well.

- Non-native grasses were by far the primary weeds of concern along all fuel breaks surrounding Range 43-48, at the end of the study period.

- Vehicle use along fuel break roads contributed an insignificant amount to establishment of non-native grasses.

- Mowing resulted in a large increase in grass density in areas of fuel breaks adjacent to existing grass patches or grasslands dominated by non-native species.

Mowing in chaparral far from grass sources resulted in little change in grass establishment after 3 annual mowings.

- Effects of fire foam could not be adequately assessed because of overlap of fire foam and retardant application on most of the fuel breaks. In a few locations where foam alone was used, there were no observable changes in non-native grass establishment.

- Retardant use resulted in large, easily observable increases in non-native grass establishment on more than half the areas of all mowed fuel breaks. The effect was noticeable in many areas after the first application. The 2004 observations after the second application (plus an additional mowing and burn) showed further increases in many areas. Retardant use in combination with mowing treatments appeared to support the greatest increases in non-native grass density.

- Burning created open areas where non-native grasses could invade from nearby established grasslands. It was observed that some significant grass encroachment originated from the recently invaded fuel breaks that had only become invaded by grasses the prior year as a result of the first retardant application.

- Retardant did not kill chaparral shrubs in the year following application. Almost all shrubs showed healthy re-growth. This suggests that retardant use does not have long-term effects on growth of most established chaparral shrubs.

- In the limited locations were observations could be made, retardant application during the dry season did not appear to inhibit germination or growth of Monterey spineflower in the following spring. Observations were limited because there were few areas where there are dense patches of rare annual plants along these fuel breaks.

Discussion and Recommendations:

Establishment of weedy plant species, especially non-native grasses on the fuel breaks of this study site has several causes. Regular mowing, burning, and retardant application during burns were the most likely sources of disturbance. Of these factors, application of retardant was observed to be a strong contributor. The effect of applying retardant in combination with either mowing or burning caused rapidly increased establishment of grasses, on average much more than either burning or mowing alone.

There are habitat concerns with the development of dense stands of grasses. These tend to be persistent. Thatch buildup from year to year decreases germination ability of native annual plants quickly. The bare sandy soils of rarely used roads in the past have provided quality habitat for the rare plant species. If fuel breaks are maintained by regular mowing, it is likely the new grass patches will become stable components of the ecosystem, providing many new sources of weedy seeds that can invade newly disturbed areas, including future prescribed burn areas. In the process, the native annual component of the fuel break community is decreased and its seedbank prevented from replenishing itself.

Until shrubs are allowed to re-establish, grasses will probably continue to pre-dominate in the most densely occupied areas. Future monitoring of the fuel breaks would be extremely useful to follow the change in grass density over the next few years following the burn, especially if regular maintenance by mowing continues.

Establishment of new grassy areas creates more seed sources which can spread into future burns or disturbed areas. Invasive weed removal or control by mowing is probably logistically infeasible in the long-term. Establishment may be slowed temporarily, but probably will not be prevented in the long term. The reasons are: The seeding time period is very short, and the total length of fuel breaks to be mowed can't be completed during the limited time window. Mechanical mowing is not very precise – it cuts some of the grass seed heads, but others are just flattened temporarily. Grasses can also resprout to a limited degree. The disturbance of mechanical mowing probably also assists with establishment of more grasses to some extent.

Because of the logistical difficulty of removal or control of non-native grasses in areas that undergo regular disturbance, prevention measures are highly desirable, probably more importantly than with other weedy species that can be more easily controlled. The following recommendations are presented.

Recommendations:

- Limit fuel break establishment and fuel break widths as much as possible. Allow shrub canopy to re-grow in areas where fuel breaks are no longer necessary to maintain. Re-growth of the shrub canopy would likely eliminate habitat for grasses by shading and competition over time.
- Use temporary fuel breaks for perimeters of prescribed burns as much as possible limiting applications of retardant where possible. Mowing temporary new fuel breaks prior to a burn may be preferable to using old fuel breaks that have already been invaded by non-native grasses.
- Experiment with control of grasses by spraying with a monocot-specific herbicide. It may be feasible for smaller sections or the fuel breaks in the short-term, but may be undesirable/unfeasible for long-term control, over large areas of fuel breaks.
- Experiment with mowing grasses for control. This is very logistically difficult over large areas using mechanical equipment on rough terrain, but may be effective over smaller areas of the fuel breaks that must be maintained long-term.
- Continue monitoring the changes in non-native grass establishment on mowed fuel breaks to dertermine long term effects of maintaining permanent fuel breaks.

PHOTOGRAPHS

Photo 1(l): Disturbance due to driving occurs primarily in established tracks in the center of the fuel break roads.

Photo 2 (l): Mowed fuel break without non-native grass encroachment. This fuel break has been mowed twice, in 2001, and 2003.

Photos 3 and 4(above): Photo on left shows original condition of Steep fuel break road in 2001, with shrub cover and almost no weedy grasses even in areas of bare soil. Photo on right shows a section of the same fuel break in May 2003 after two mowings, and shows a large increase in non-native bromes. This section of the fuel break is adjacent to an area frequently disturbed in the past by soil erosion, and which is probably the source of the brome seed.

Photos 5-7: The sequence on this page shows a view of Broadway fuel break after mowing alone, and after retardant drops.

Photo 5 (l): July 2001, after first mowing in spring of 2001. This photo on left shows close to baseline conditions on this section of Broadway fuel break. Vegetation has been mowed to a 6 to 8-inch height for a total width of 45-ft centered on an old dirt road. At this stage, no grasses are evident on the slopes above the grass lowland.

Photo 6 (l): November 2002. This is the same section photographed right after the first retardant drop. By this time, vegetation within the fuel break has been mowed twice, (2001 and 2002). Reddish color is retardant.

Photo 7 (l): June 2004 – Broadway Road after second retardant drop of November 2003. Non-native grasses have fully encroached into the fuel break, on both sides, and grasses are quite high density. The seed source is probably the grasslands at the bottom of the swale in the top photo.

Photos 8-11: This sequence shows another view of Broadway fuel break after mowing alone, and after retardant drops.

Photo 8 (l): July 2001. After first mowing of spring 2001. This photo represents a baseline of typical conditions following mowing alone on Broadway fuel break. There is some shrub re-sprouting, but no growth of annual grasses, besides the natural grasslands in the bottom of the swale. Retardant was dropped in October 2002 along this mowed fuel break.

Photo 9 (r): A typical individual of *Vulpia* (rat-tail fescue) in the retardant zone, unusually large and bushy compared to grasses normally found in this habitat. (*Vulpia* individuals in this habitat usually have just one or a few stems).

Photo 10 (l): April, 2003. This was taken after the first retardant drop in November, 2002. Compared with above photo showing conditions after only mowing, there is significantly higher density of non-native grasses at the top of a hill where there had normally been only shrubs re-sprouting.

Photo 11 (l): Same view in July, 2003. The slope in the distance shows the yellow-brown color indicating high-density presence of grasses as well.

Photos 12-14: This sequence shows a third view of Broadway fuel break after mowing alone, and after retardant drops.

Photo 12 (l): October, 2002. Taken directly after first retardant drop. Fuel break has been previously mowed 2 times. There is probably some non-native grass within the fuelbreak zone but at low density, not enough to be visible in the photo.

Photo 13 (l): June 2004. This is taken after 2 years of retardant drops and the November 2003 burn. Fuel break has been mowed at least 2 times. In this photo non-native grasses can be seen encroaching to the left several hundred feet into the burned area. It is likely the source of the encroaching grass into the burn area was the new population of dense grasses within the fuel break that was established after the first retardant drop the previous year.

Photo 14 (r): June 2004. This photo shows a view north into the burn area from the Broadway fuel break. Non-native grasses have encroached into the burn area, probably from the densely grassy fuel break. The area in the photo has been burned, but has had no retardant or mowing treatments. Previously this area had been occupied with dense shrub cover, as can be seen on the right side of the fuel break in Photo 5.

Photo 15: May 2001. Broadway fuel break. This photo shows baseline conditions typical of Broadway fuel break prior to any mowing.

Photos 16-17 (below): June 2004. Views of Orion fuel break (west burn area boundary) after two retardant drops and two mowings.

Photo 16 (l): This area received similar treatment to Broadway fuel break shown in the sequences above. There are non-native grasses present, but this slope has much less dense establishment of non-native grasses, even though there is a grassland swale below as a seed source. This illustrates that there is geographic variation in vegetation response with the same treatments.

Photo 17 (l): Close-up view of Photo 15. There is rather low establishment of non-native grasses on this slope. Reddish color of retardant and foliage die off can be seen at the adjacent shrub boundary.

Photos 18-20: Shrub recovery after retardant application. This retardant drop was made in October 2003. Photos were taken in June 2004. Reddish color on stems and leaves is retardant, which persists for many months after application, even through the rainy season. While the retardant coats and often (though not always) kills foliage (seen as greyish or brown patches in the photos), the stems survived and produced healthy new growth the following spring.

Photo 18 (l) : Chamise *(Adenostoma fasciculata)*

Photo 19 (r): Sandmat manzanita (*Arctostaphylos pumila*)

Photo 20(l): Monterey Ceanothus (*Ceanothus rigidus rigidus*)

Photos 21-22: June 2003. The above photos show two views of an extensive mat of Monterey spineflower within the retardant drop zone (shrubs still retain the reddish color, and some foliage “burn”). Non-native grasses are inhabiting the central strip of the road-fuel break, but grasses have not encroached into the spineflower area. Future monitoring of the area will determine whether grasses will encroach and out compete the spineflower, or whether the spineflower population will remain stable. In this case, the fertilizing effects of the retardant may have benefited the spineflower, or at least have caused no ill effects to its germination and growth.

Photos 23-25: This series of 3 photos illustrates probable loss of rare plant habitat through competition by non-native grasses in an area where grasses encroached quickly into a retardant drop zone (Broadway fuel break similar to areas shown in Photos 10, 11, 13). This is an area that had been mowed twice and had retardant applied twice. Historically there had been low-medium density (1-10's) patches of these plants along this section of fuel break. In this case it is clear that the native plants are indirectly affected by the retardant. Photos were not taken in 2004, but in some areas of dense grasses, there was a significant increase in thatch layer, which is likely to further inhibit rare plant germination in future years.

Photo 23 (l): April 2003. Sand gilia (*Gilia tenuiflora arenaria*) with *Vulpia* in retardant zone on Broadway fuel break.

Photo 24 (r): June 2003. Seaside birdsbeak (*Cordylanthus rigidus littoralis*) with *Vulpia* in retardant zone on Broadway fuel break.

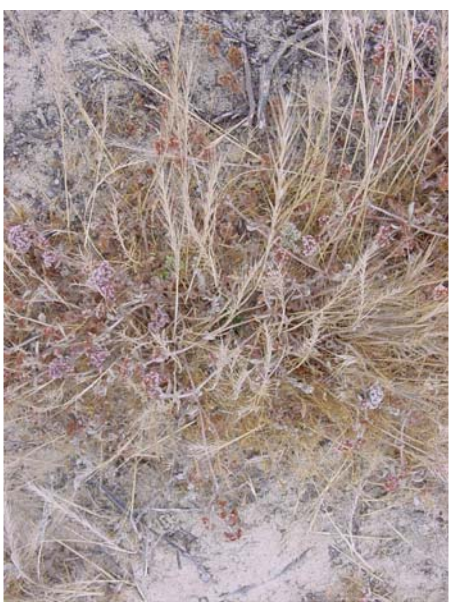

Photo 25 (l): June 2003. Monterey spineflower (*Chorizanthe pungens pungens*) with *Vulpia* in retardant zone on Broadway fuel break.