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The Anatomy, Physiology, Psychology and Economics of Desert Destruction and Restoration

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Desert degradation is usually caused by a set of interlocking factors involving the fragility of the desert environment, flawed economics, weak laws and regulations, and human "needs" for immediate gratification. The historic failure of most desert protection and restoration programs can be linked to an overly narrow focus on the technical issues surrounding the symptoms rather than the fundamental causes. A doctor can't cure many diseases without treating the causes, neither can we. The key to restoring damaged arid lands is understanding how and why they have been degraded, how they should look and function, and how best we can provide signals and incentives that more closely match true cost and value.

The primary cause of desert destruction is almost always economics. In the case of much of the Mojave Desert this historically came from ranchers and miners who mined asset value. Today it is primarily from the OHV community of manufacturers, retailers, and suppliers and their advertising agencies and dependents. Uncertain tenure, weak government policy (limited support for enforcement, research and restoration, subsidies, few rules), the psychology of consumption, and ignorance. While it is easy to say these are the causes, it is extremely difficult to do anything about them as an individual land manager, rancher, or environmentalist; but until we address these "drivers" we are "mopping up the floor without turning off the water" as the Dutch say. Until the true costs are recognized, there will be little progress in the attempt to halt and reverse the destruction of the Mojave Desert.

1. The anatomy *(the science of structure)*

The desert remains under unprecedented assault from development, infrastructure (new roads and utility corridors), air pollution and nitrogen deposition, invasive species, military operations, and OHV activity (Lovich and Bainbridge, 1999). The OHV activity is the least necessary, very extensive; and almost certainly plays an important role in the spread of invasive species and also contributes to air pollution and nitrogen deposition. The impacts of OHV activity were first assessed in a ground-breaking book assembled by Webb and Wilshire more than twenty years ago (1983); but progress in understanding, controlling, and repairing OHV damage is still very limited.

The full extent of OHV damage is unknown, but studies now underway as part of the U.S.G.S. Recoverability and Vulnerability of Desert Ecosystems project may help clarify the picture (D.M.G., 2004). The recent upswing of OHV activity has led to continued expansion of damage and destruction despite increasing efforts to better manage the desert resource areas.

The most apparent level of OHV damage is total destruction of all vegetation in high use areas. In many cases these sand bowls expand from 1 to 10 to 20 hectares or more fairly quickly.

Camp areas where use is concentrated and mobile homes and larger trucks are staged can be very severely affected. Even in areas of moderate use the damage is quite extensive, although to the untrained eye it may appear less severe if the larger shrubs are still standing. In low use areas the damage is often still significant, but with the exception of motorcycle trails and erosion gullies, not readily apparent. Here the damage is to the soil ecosystems, hydrologic flows, buried roots, and annuals. The damage becomes clear when a major annual flower event occurs and flowers are missing in the damaged area yet fully carpet adjacent undisturbed areas.

Extensive use of desert washes for OHVs has been a disaster for wash ecosystems. Use has been concentrated in washes because they are interesting and drivable, but also in the mistaken belief that they are somehow less affected by vehicles. In many cases the wash annual community is simply gone from repeated damage to plants, gradual destruction of the soil seed bank, elimination of important soil organisms and nutrients, and changes in water retention from light rains. These highly dynamic ecosystems still can be washed clean by flood events, but with few seeds in the soil seed bank there is little recovery after flows occur.

2. The physiology (the science of function)

Our site evaluation research across a number of sites has compared soil physical, chemical, and biological properties. The disturbance patterns are similar to those chronicled in other studies including on-going studies of the U.S.G.S. desert project (Bainbridge, 1994;1995; 1998; Bainbridge and Virginia, 1990; Bainbridge et al., 1993, 1995; Desert Managers Group, 2004; Virginia and Bainbridge, 1986; Webb and Wilshire, 1983). Plant communities are disrupted by direct impacts, crushing, and damage to roots. In moderate use areas many plants are gone, and those that remain are often compromised by changes in soil properties and damage to extensive root systems. This may prove fatal during an extended drought. New weeds are introduced and spread, just as past weed invasions occurred (Bainbridge, 1997). Weed invasions are thought to make desert ecosystems much more vulnerable to fire (Brooks, 1999).

Compaction is often severe in heavily used areas. Infiltration can be very limited in compacted soils and these changes in hydrologic function may exacerbate water limitations in these arid soils. Soils associated with disturbance are typically impoverished. Organic materials are often very diminished. Europium staining found reduced levels of hyphae and bacteria in more disturbed soils (Conners et al., 1994).

3. The psychology *(the science of emotion)*

Understanding the allure of OHV operation is not difficult. Almost anyone with an open mind can appreciate the appeal, particularly to men, the predominant OHV users. OHV exploration (the more sedate part of the population) enables families to discover new areas and enjoy the beauty of the desert. This well behaved sector of the OHV community stays on roads, obeys signs, and does relatively little damage; but they prefer less damaged areas, and are reluctant to be confined to areas that are heavily used for OHV play.

OHV play is noisy, involves speed and power, is dangerous, and requires intense concentration. This provides an emotional rush that is legal and provides release from the tribulations of the work-a-day world. Opportunities for this type of play should be maintained. For a relatively small percentage of the OHV population, perhaps only 10% according to rangers, OHV "recreation" also includes the added "kick" of outlaw behavior. This may involve deliberating flouting route restrictions, deliberate damage of undisturbed areas, vandalizing

gates, signs, and displays, and smashing plants to bits. This outlaw crowd is often fueled by alcohol and drug consumption and may be well armed, adding damage from rifles, pistols, shotguns, machine guns, and explosives.

The OHV community, like most of America, is afflicted with a "me, now" psychosis that obscures the long term view. They are also victims of "affluenza", falling prey to relentless and sophisticated advertising, "If I just have more, I'll be happy". Poorly educated by a failed school system, they also have no concept of "nature's services", "natural capital", and "sustainability". Without proper education and awareness the psychological view of the users will remain, "what damage", "the desert is tough like me", and "sure, there may be some damage, but it will recover", and "who cares--live fast, die young".

4. The economics *(budgeting)*

Understanding the cause of desert destruction by OHVs is not hard, "it's the economy stupid". The OHV community of manufacturers, retailers, and suppliers and their advertising agencies and dependents is big business. The estimated economic impact of OHVs in California is in the range of $5- $10 billion dollars a year. Although a 1993-1994 report (Motor Vehicle Recreation, 1994), suggested it was only $3 billion a year for California, a more recent and detailed study showed it might be more than $3 billion for Arizona (Silberman, 2002), and use in California is much larger. The OHV industry itself suggests the impact in California is $10 billion and I think that is plausible, but perhaps high. Sadly, these reports ignored virtually all the external costs of OHV operation; providing a picture of OHV economics that is so misleading it would make Enron's accountants blush.

The desert resource is a classic open access resource like fish in the ocean (Costanza et al., 1997). Whoever gets their fastest and first gets the most benefit from the fleeting beauty of the desert. More than 40% of the money spent on OHVs is for vehicles (including tow vehicles, trailers, tires and custom parts) and almost 10% is for fuel. The value of the desert's scenic beauty, "natural capital", and "nature's services" are being mined and exported to Japan and Detroit. While the beneficiaries pay lip service to "tread lightly", advertising almost always shows the "tread heavily" mode.

To understand the flow of money from the desert we need a much better determination of the value of undisturbed desert ecosystems. Neoclassical economics (now called autistic economics by critics) says the value is determined by sales price or use value, which are extremely low, perhaps $500 to $700 per hectare. Ecological economics says a better way to judge value is replacement cost, and we now know that restoring the desert is very costly, perhaps $50,000 per hectare for a modest effort. Knowing this we can say that a full size 4x4 can do $40,000 dollars of damage in a day of ripping across the desert (emulating the advertisements they see on TV).

If we look across the full breadth of the Mojave Desert and start to total up the bill for damage we will find the total tab in the tens or hundreds of billions. Every mile of new kilometer of road represents a cost of $12,000+, every hectare of denuded land $50,000+. In the Dove Springs area alone, the cost for repair work would probably equal the annual revenue from all the green stickers sold in California in a year, about $30 million, table 1.

Table 1. Dove Springs

Condition	year	Area/length	Restoration cost/unit	Total damage
ha denuded or dense tracks	1965	66	50,000	3300000

ha with OHV impact	1965	272	20,000	5440000
km route	1965	49	12,000	588000
km wash routes	1965	5	25,000	125000
				9453000
ha denuded or dense tracks	2001	194	50,000	9700000
ha with OHV impact	2001	740	20,000	14800000
km route	2001	576	12,000	6912000
km wash routes	2001	77	25,000	1925000
				33337000

Damage assessment from Matchett et al., 2004. Repair estimates from experience, including work in this area. Costs are rough estimates. Hill climbs represent a good percentage of denuded areas and are notoriously difficult to repair. Disturbance categories outside heavy impacts were not well characterized so a relatively low estimate of repair costs was used.

In addition to the simple damage to ecosystems we also have many uncompensated costs related to OHV operation. Some could be determined, but haven't been studied; while others are quite challenging to cost. One of the largest uncompensated costs is medical treatment in emergency rooms and hospitals for OHV accidents. In Arizona the out-of-pocket cost for OHV operators for medical treatment was $9 million a year, and it may be reasonable to assume that the taxpayers pay more than that for the uninsured or underinsured. One of my students racked up a bill of $160,000 from the taxpayers for a motorcycle accident, and if long term disability is involved the costs quickly reach the millions. In California the costs might be on the order of $20-30 million a year; again comparable to the total Green Sticker program.

The Highway Patrol and local police get some funding from the Green Sticker programs, but costs probably outrun fees by a significant margin. Adding a single deputy can cost more than $100,000 a year including salary and equipment. In addition to the deputies and police activities there are also costs for cleanup and repair of facilities. Vandalism of fences and gates is extensive and may represent a million dollars or more a year. This is often paid for by agencies, universities, volunteers, and private landowners with no mechanism for compensation from the OHV program.

The more challenging costs are those related to natural capital and nature's services (Dailey, 1997; Hawken et al., 1999). What is the value of biodiversity? Of beauty? Of endangered species? Of natural hydrologic function? What are the costs of exotic species suppression? What is the cost of fire suppression made necessary by the spread of highly flammable exotic grass species? The economic impact of nitrogen deposition? What is the cost of global warming? Almost certainly in the tens of billions, but we don't know.

Balancing the budget is unlikely. Users have been heavily subsidized and are unwilling to have any "free" goodies taken away. Analysis of automobile operation in the U.S. suggests we who drive cars get a 90% subsidy (Batt, 1998). I would suggest that OHV operators are currently getting a subsidy closer to 99%. Yet few users are willing to pay more than a few dollars a day for the OHV privilege. Today OHV users usually pay only $12.50 a year (for a green sticker), $50 a year for an OHV park pass, or $90 a year for an Imperial Dunes pass. In contrast you have to pay $120 a year for a state park pass that involves walking, beach going, or biking and very little environmental impact.

OHV manufacturers and retailers are making money at the expense of the desert owners (the American public) and future generations. They are mining the desert as clearly as the gold companies, but causing damage over a much larger area. Billions of dollars of damage have already been done, but little effort has been made to curb use or even to extract use fees. Until the true costs are recognized, there will be little progress in the attempt to halt and reverse the destruction of the Mojave Desert.

5. The future

Desert destruction and restoration is not primarily a technical problem, although many technical questions remain to be solved. The root cause of desert destruction is ultimately poor accounting. It is compounded by uncertain tenure, weak government policy (limited support for enforcement, research and restoration, subsidies, few rules), the psychology of consumption, ignorance, and very limited understanding of the structure and function of desert ecosystems. While it is easy to say these are the causes, it is extremely difficult to do anything about them as an individual land manager, responsible OHV operator, or environmentalist; but until we address these "drivers" we are, as the Dutch say, "mopping up the floor without turning off the water".

One of the first and important steps is increasing awareness of the problem and it's economic implications. A careful study of uncompensated costs related to medical care, police, and vandalism, would be a good start. The ongoing assessments of the current condition of the desert will also provide some better insight into the flow of value out of the desert. Research is also needed to explore the value of changes in behavior, such as better signing and training, improved enforcement, and wash-down stations to clear weed seeds off OHVs before operation in less weed invested areas.

Manufacturers should be encouraged to play a much bigger role in "tread lightly", and should probably pay a tax for selling OHVs. At the very least they should be charged a fee of $50-100,000 for each advertisement exhibiting "tread heavily" behavior. As A.C. Pigou first noted in the 1920s, if the market is not complete, including all costs, it won't work (Costanza et al., 1997). A fee or tax provides a way to bring these external costs to the market. Increased fees for OHV operation should also be encouraged despite the resistance it will entail. If a park pass costs $120 a year, then an OHV pass should probably cost $1,000 a year. If a ski pass costs $36 a day, then an OHV pass should be probably be $100 a day. Developing and implementing these fees would be politically unfeasible, but perhaps a fee of $250 a year would eventually be plausible.

The added money from these taxes and fees would provide some funding to pay for current uncompensated costs to the medical system, added funding for better management, and perhaps some critically needed funding for research and restoration. It might also provide the money needed to develop new, high quality OHV play areas on lands removed from agriculture due to water transfers. It might also help fund much needed OHV play areas closer to urban areas. This would help move some of the most destructive play activities out of less disturbed areas. It could also provided a needed economic boost to these areas.

To solve problems like desert destruction by OHVs we must address the root causes, not just the symptoms. One of the underlying causes of OHV damage is poor accounting for costs and until this is remedied there will be only modest reductions in the rate of desert destruction.

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