DEER VEHICLE CRASHES IN MICHIGAN: AN EXAMINATION OF AVAILABLE OPTIONS AND NEW IDEAS

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February 23, 2001

Introduction:

This paper consists of three parts. The first part of the paper is a cost-benefit analysis of existing options to solve the Michigan deer-vehicle crash (DVC) problem. By the term existing options we mean that these options have already been put to use in different parts of the country. The second part of the paper looks at deer from a biological standpoint, and from their anatomy/physiology/behavior we generate new ideas to ameliorate the deer-vehicle crash problem. Unlike the cost-benefit analysis which examines options that have already been put to use the new ideas are yet to be tried out. Some of these new ideas might seem ludicrous but they are here to serve as guiding posts for further expansion of our thinking horizons on deer-vehicle crashes. The third part of the paper is a very brief examination of human behavior in deer-vehicle crashes and facts we need to be aware of. The paper concludes with a list of recommendations that would help decrease deer-vehicle crashes in the state of Michigan.

Problem:

Last year alone there were 67,669 car-deer crashes in Michigan, and in the last five years car-deer crashes have consistently numbered over 60,000. Car-deer crashes are expensive. Over $100 million dollars were paid out in collision repair claims in 1999 (OHSP release, September 2000) and this is only an estimate of the direct cost. Indirect costs likely run well into the millions as well.

Car-deer crashes are correlated to both deer population and VMT (Cutler, 1997). However a percentage change in VMT is expected to have an effect on the number of deer accidents 2.5 times greater than the same percentage change in the size of the deer herd (Cutler, 1997). Given that VMT has been increasing every year, and deer population numbers haven't decreased correspondingly, the number of car-deer crashes can be expected to increase each year. Without any intervention, car-deer crashes are predicted to increase at an estimated rate of 1.5% per year, or by 15,000 crashes over the next five years (OHSP release, September 2000).

Cause: Deer habitat in Michigan has been fragmented by 120,000 miles of roadways. Movement from one fragment to another requires that deer cross the road, resulting in car-deer crashes.

Goal:

Prevent car-deer crashes in the state of Michigan.

Primary Objective:

To reduce car-deer crashes by a rate of 5-10% each year over the next five years.

Secondary objectives include reducing habitat fragmentation, maintaining genetic flow between deer/other species and other ecological considerations.

Criteria:

The criteria used to evaluate our policy options are:

a) Effectiveness (Scale of 1 to 10, 1 being low and 10 being high).

b) Economics (reduction in car-deer crashes for every dollar spent).

c) Benefit to wildlife and aesthetics (Scale of 1 to 10, 1 being low and 10 being high).

While the scores assigned might seem entirely subjective it is our intention to substantiate the scores given with objective data.

Policy Options:

We will evaluate the following five policy options:

a) Construction of wildlife fences next to roads.

b) Construction of overpasses/underpasses (or corridor).

c) Combination of wildlife fences/underpasses.

d) Allow for more deer hunting.

e) Wildlife reflectors and wildlife whistles

Assumptions:

Before proceeding any further we need to make a few assumptions clear.

a) Given that the average insurance claim for car-deer crashes is $2,000 (OHSP release, September 2000), total direct costs averaged around $135 million dollars for 1999. $2,000 per crash is taken as the baseline for subsequent analysis.

b) Annual growth rate of the economy is assumed to be 3% and inflation is assumed to be 2%.

c) Now to place a value on the indirect costs associated with car-deer crashes. According to the 1990 census, median family income in Michigan was $36,652 per year. Assuming that after a deer crash, a family is thrown in turmoil and to get their life back in order requires at least a week of their time. Weekly median income is around $750, emotional distress and other causes are assumed to be around $250, giving us a figure of $1000 per crash as an approximate estimate of indirect costs. 1999 estimates of total indirect costs would therefore give us a value of $68 million. If we however assume that a family requires only 2-3 days to recover, then our indirect cost estimate would be $500 per crash. In this case total indirect costs for 1999 would be $34 million.

d) Given $135 million in direct costs (1999) and $34-68 million (1999) in indirect costs (lower/upper bound), total annual cost of car-deer crashes ranges between $170 million to $200 million.

e) $ 200 million every year for the next five years has a present value of :

PV= *(200/1.05) + (200/1.05^2) + (200/1.05^3) + (200/1.05^4) + (200/1.05^5) = 190.47 + 181.41 + 172.77 + 164.61 + 156.72 = 865.98 ~ 866.*

$170 million every year for the next five years has a present value of:

PV= *(170/1.05) + (170/1.05^2) + (170/1.05^3) + (170/1.05^4) + (170/1.05^5) = 161.90 + 154.20 + 146.86 + 139.80 + 133.23 = 735.99 ~ 736.*

Present cost of car-deer crashes in the next five years is therefore assumed to range between $736 million and $866 million.

f) 10% reduction in 1999 numbers means 6,767 fewer deer crashes in 2000. On average a reduction of 6750 car-deer crashes per year is assumed to be the target of our analysis.

g) All subsequent analysis is for a five year period.

Baseline data on the Top 10 Michigan Counties with the highest DVC:

County Name	1999 Deer Crashes	Miles of Road	Deer Crashes/Miles of Road
Kent	2,070	3,362	0.62
Jackson	2,033	1,920	1.06
Calhoun	1,852	1,952	0.95
Oakland	1,759	5,475	0.32
Montcalm	1,605	1,747	0.92
Mecosta	1,502	1,286	1.17
Menominee	1,480	1,376	1.08
Eaton	1,381	1,445	0.96
Ingham	1,363	1,928	0.71
Kalamazoo	1,326	1,832	0.72

Analysis:

Option1: Construction of Wildlife fences next to roads

This option involves construction of six-foot high wildlife fences on one side or on both sides of a road.

Effectiveness: Score=10

Installation of wildlife or game fences have been shown to be highly effective in reducing car-deer crashes. Installation of such fences in Banff National Park in Canada produced a 97% reduction in ungulate-vehicle crashes (mostly elk), and similar reduction rates (96%) have been reported in British Columbia along the Coquihalla Highway (Final report, Deer-Vehicle Crash Conference, 2000). Wildlife/game fences would thus be a very highly effective way of controlling car-deer crashes.

Economics:

One sided wildlife fence installed in British Columbia is said to have cost $8,540/kilometer or translated into miles this would $13,664/mile. Based on our baseline data we would want to install wildlife fences in the counties of Mecosta, Menominee, Jackson, Eaton, and Calhoun (Counties where deer crashes/road mile is the highest). Since our objective is to reduce annual car-deer crashes by 6,750 we would need to install approximately 6,466 miles (6750/1.044) of wildlife fence. Cost of installing 6,466 miles of wildlife fence is approximately $88 million. Economic benefits due to fewer car-deer crashes are the amount saved in direct and indirect costs (we will use the higher estimate of indirect cost) and totals $19.05 million. The costs of installing wildlife fences outweighs the benefits by a 4.5:1 margin for the 1st year. For the 2nd, 3rd, 4th and 5th years there are no costs except maintenance costs. Exact figures for maintenance costs are not available but for simplicity we will assume they are negligible and valued at $0.

Net Present Value= Total Benefits - Total Costs = *$86.6 million – $88 million= $ -1.40 million.*

In five years time the cost of constructing wildlife fences would be nearly balanced by the savings from fewer car-deer crashes. However, even an optimistic estimate results in a $1.4 million net loss.

Benefit to Wildlife and aesthetics: Score 1

Wildlife fences would provide no real benefit to wildlife. They would on the contrary do some unquantifiable damage by preventing the flow of genetic material between various populations of species (deer, elk, moose etc.) which would be unable to travel freely between fragments. People would also find fences on the side of roads unappealing to the eye.

Option 2: Construction of overpasses/underpasses (or corridor)

Underpasses are similar to tunnels or bridges built beneath the road. They would serve as links between habitat fragments for animals.

Effectiveness: Score 5

Data available from Banff National Park suggests that wildlife underpasses are readily used by ungulates (Final report, DVC Conference, 2000). However there is no data available on how close/far such underpasses should be constructed with regards to each other and how successful they are in reducing car-deer crashes.

Economics:

Data is unavailable for the cost of constructing an underpass. In Banff National Park, an overpass, 50 meters wide, covered with soil and landscaped cost $1.8 million Canadian dollars ($1.18 million US dollars), (Final report, DVC

Conference, 2000). Economics of building overpasses/underpasses and thereby reducing car-deer crashes cannot be assessed satisfactorily at the moment due to unavailable data.

Benefit to Wildlife and aesthetics: Score 8

The benefits to wildlife of constructing artificial corridors between habitat fragments are immense. Increasing species fitness and viability are the most important/apparent benefits. All types of species including ungulates have been known to use such corridors and so from an ecological standpoint underpasses/overpasses score very high.

Option 3: Combination of wildlife fences/underpasses:

Effectiveness: Score 10

As mentioned before a combination of wildlife fences and underpasses would be extremely effective in reducing car-deer crashes.

Economics:

This option would probably be the most expensive. Further analysis has been limited due to unavailability of data.

Benefit to Wildlife and aesthetics: Score 9

This option would be the most helpful to wildlife. Not only would animals have access to different fragments via corridors, they would also be saved from lethal

crashes with automobiles. Again, the presence of fences would be not very aesthetic.

Option 4: Allow for more deer hunting

Effectiveness: Score 5

There are two reasons why this policy would not be very effective. The first reason is that car-deer crashes are related more strongly to VMT than to deer population. If VMT continues to increase while deer population decreases at a slower rate we may find that car-deer crashes remain the same or keep increasing but at slower rates. Only if very large numbers of deer are harvested would we see an impact. The second reason is that there are many small scale economies in Michigan that rely on hunting. By making hunting unsustainable (i.e. removing a large proportion of the deer population, thereby decreasing the maximum sustained yield of deer/year) we might be causing a whole new set of problems. During 1999, an estimated 550,000 deer were taken during the deer-hunting seasons. In itself this number is extremely large and furthermore, DNR has recently expanded deer-hunting season and issued more permits (OHSP release, September 2000). The impacts of this are yet to be assessed.

Economics:

The cost of implementing a program to increase deer hunting is a sunk cost now that DNR has already taken such measures. Therefore any decrease in car-deer

crashes as a result of DNR's actions may be construed as a benefit. However given that VMT continues to increase it is extremely difficult to filter out the effects of population size alone. A further economic benefit to society is the reduction in crop and ornamental vegetation damage.

Benefit to Wildlife and aesthetics: Score 5

The benefits of removing a lot of deer are that other species that compete with deer will be benefited. Furthermore, due to the increased availability of foods, deer as well as other species may improve in fitness.

Option 5: Wildlife Reflectors and Wildlife Whistles

Effectiveness Score: 2

Wildlife reflectors as the name suggests, work by reflecting light from headlights of vehicles. Its effectiveness is based on the assumption that deer will avoid crossing the road when they see the reflected light and will only do so when everything is clear. Deer whistles again attempt to take advantage of deer behavior by emitting a ultrasonic sound which deer are presumed to hear, dislike and avoid. Two separate installations of reflectors in British Columbia reduced wildlife vehicle crashes by 23% and 40% respectively (Final report, DVC Conference, 2000). Other areas where reflectors have been shown to be effective are in Iowa, Minnesota, Oregon, Washington State and Wisconsin (Road Management and Engineering Journal, 1997). A recent local study in Michigan on the other hand found reduction in deer-vehicle crashes as a result of installing reflectors to be statistically non-significant (Final report, DVC

Conference, 2000). A study in California on the effectiveness of Swareflex wildlife reflectors has shown no statistical difference in the number of deer crashes (Road Management and Engineering Journal, 1997). Similar studies on Van de Ree wildlife reflectors conducted in Indiana, Colorado, Ontario, Washington State, Michigan and Maine have reached the same conclusion. Dr.James R.Gilbert from the University of Maine, on a 1982 report titled 'Evaluation of Deer Mirrors for reducing Deer-Vehicle collisions' concludes thus "There is no statistically valid evidence that either the Van de Ree stainless steel mirrors or the Swareflex Reflectors reduce vehicle-deer collisions." Another point to note is that snowfall was found to adversely affect the effectiveness of reflectors (e.g. in Wisconsin).

On the subject of deer whistles, no scientific evidence exists to suggest they work. A study conducted by the University of Georgia revealed that deer don't hear ultrasonic noise. The Georgia Game and Fish Department found that the force of air through the whistles was too weak to produce a noise at typical driving speeds of 25mph to 55 mph. Furthermore, when the researchers blew the whistles near captive deer, the deer didn't respond (Live Wire, March 27, 1998). A University of Wisconsin researcher who tested the devices near seven species of the deer family got a response from only one. Instead of fleeing, a bull elk charged. When the state police in Ohio installed the whistles on patrol cars, deer accidents were said to have actually increased (Live Wire, March 27, 1998). The reason for this was unclear, but it is hypothesized that drivers drove too fast

through the countryside because of a false sense of security (Live Wire, March 27, 1998).

Evaluating the information we presently have, we can expect wildlife reflectors and wildlife whistles to be ineffective or minimally effective.

Economics:

Swareflex reflectors on a one-mile section of Highway 26 in Wisconsin cost $7,000-$9000 per mile for a two-way, two-lane roadway, which county workers installed and maintained (Michigan Transportation Technology Transfer Center Newsletter, July/September 1995). Let us assume the reflectors to be 20% effective. Given this in regions were DVC rates are equal to 1 per mile, 5 miles of reflectors would lead to a reduction in DVC by one crash. Thus 6750*5 miles (33,750 miles) of reflectors would need to be installed in Michigan to meet our objective. The cost of installation would be $270 million (33,750 miles * $8000/mile). Benefits would be $86.6 million for a five year period (as calculated earlier).

Net Present Value = Total Benefits – Total Costs = *$ 86.6 million – $ 270 million = $ -183.4 million.*

By installing Swareflex reflectors needed to meet our objectives, in five years we would incur a loss of $183.4 million.

Benefit to Wildlife and aesthetics: Score 1

Reflectors would provide no benefits to wildlife except as maybe perching posts for birds. Reflectors would also be an eyesore to the driving public.

Summary of Policy Options:

Our Options are:

a) Construction of wildlife fences next to roads. (Option 1).

b) Construction of overpasses/underpasses (or corridor). (Option 2).

c) Combination of wildlife fences/underpasses. (Option 3).

d) Allow for more deer hunting. (Option 4).

e) Wildlife reflectors and wildlife whistles (Option 5).

	Effectiveness Score	Economics	Benefit to Wildlife/Aesthetics
Option 1:	10	$ -1.40 million	1
Option 2:	5	Unavailable (probably -)	8
Option 3:	10	Unavailable (probably -)	9
Option 4:	5	Positive (+)	5
Option 5:	2	$ -183.4 million	1

Now to the question of which policy option is best? This ties in directly with the goals of OHSP with regards to deer crashes. If the goal is to prevent deer crashes in Michigan then, fences alone are the best option (most effective at the cheapest cost among our options). If the goal includes wildlife considerations as a high priority (more in tune with DNR's goals) then fences along with corridors would be the best option. If the goal includes economics as a high priority the best option is to do nothing and hope that DNR's increased deer licenses will

have a positive effect. Clarity on the goals of OHSP with regards to deer vehicle crashes will be the ultimate guiding tool in reaching a policy decision.

Now to address the question of transfer costs. Currently the insurance industry bears the direct costs with regards to deer crashes while the indirect costs are borne by the individual traveler/family. Building fences or corridors involves spending money on the part of the state, county or local road commissions, benefits of which will accrue as savings to the insurance industry and to individuals. Policy makers are left with the problem of how to address this disparity. It is too obvious a solution to suggest that the insurance companies pay the equivalent to direct costs and the rest be paid by the government. This type of solution may be politically infeasible, and at best would require significant effort to achieve. Given the nature of this problem, innovative solutions need to be sought, starting with communication/information exchange between all relevant/interested parties.

Quick Facts:

a) Fences are expensive but over a period of approximately 5 years they would break even.
b) Overpasses/underpasses are ecologically most sound, but they are expensive to build. Data on the rates of reduction in car-deer crashes as a result of these structures alone is limited.

c) Combination of fences and overpasses/underpasses would meet wildlife as well as transportation safety objectives most closely, but at a high cost.
d) Increased deer hunting may not have the desired impact on car-deer crashes as long as VMT continues to increase.
e) There is no conclusive evidence to show that wildlife reflectors or wildlife whistles are effective in modifying deer behavior.

This concludes the cost-benefit analysis of existing options. We will now move to the section that deals with deer biology and the new ideas that arise from these considerations.

White-tailed Deer
Odocoileus virginianus

Class: Mammalia
Order: Artiodactyla
Family: Cervidae
Sub Family: Capreolinae
Genus: Odocoileus
Species: virginianus

Vital Statistics

Weight: 125-300 lbs
Length with tail: 60-90”
Shoulder Height: 3.5”
Sexual Maturity: 2 years
Mating Season: October to December
Gestation Period: 200 days
Number of Young: 1-4, 2 average
Birth Interval: 1 year
Lifespan: 10 years in the wild
Typical diet: Various types of vegetation

White-tail Deer Anatomy: Eyesight

With eyes set in the sides of their heads, white-tail deer have a wide range of sight. A doe or a buck looking straight can in-fact see some 310 degrees around. Such an impressive field of vision allows the white-tail deer to be acutely aware of its surroundings.

Deer see best during the night, which is one of the reasons they forage mostly after dark. Deer have more rods (light-detecting cells) in their eyes than humans do. When exposed to headlights or other bright lights, white-tail eyes shine, this is due to a reflection off a special membrane in the eye called the tapetum.

Deer see at a lower resolution than humans, they are also believed to be colorblind (that’s why hunters can get away with wearing Blaze Orange). Since

deer have eyes on the sides of their head, they also have very poor depth perception. Even with the disadvantages listed above white-tail deer detect danger very quickly (through a combination of vision and other senses).

White-tail Deer Anatomy: Ears

White-tail deer have a keen sense of hearing that is crucial in detecting danger. They can easily pick up faint sounds and in a split second determine the approximate distance to the noise. In controlled experiments conducted at Texas A&M University, white-tail deer were found to have the greatest sensitivity between 1 and 8 Khz, with a marked peak centered at 4 Khz. This is in tune with literature that reports the range to be between 1 and 9 Khz. Deer whistles have been found to produce sound at a frequency range of 18-20 Khz, a range which is outside the hearing level of white-tail deer (a strong reason why they are unlikely to prevent car-deer crashes).

White-tail deer ears contain many complex muscles, which allows them to move their ears freely. A deer can rotate its ears in all directions to hone in on sounds. Upon hearing a strange noise, a deer stops all movement and focuses its ears in that direction. If other deer are present, an alert deer's ear can become the focal point for raising an alarm.

White-tail Deer Anatomy: Smell

Smell is one of the most important senses available to deer. Human sense of smell is extremely feeble when compared to deer. Humans use about 5 million

scent receptors in our nose, mouth and upper throat to smell odors as compared to the estimated 125 million receptors that deer use. Studies have found that deer sense of smell is 4,000 to 10,000 times more sensitive to odors than humans are, and that they can differentiate up to 6 smells at one time. As with other animals deer smell best on cool, damp days (high humidity).

Deer rely on their sense of smell to warn them of predators, to sniff out the best foods, to mark out territory (by use of scent glands) and to signal their sexual readiness (via hormones).

White-tail Anatomy: Glands

White-tail deer have a network of glands all over their body. The forehead with its pre-orbital gland is used for signposting during the breeding season. The nasal gland helps to keep a deer's nose moist. Interdigital glands are located on a deer's feet. Wherever a deer treads, it leaves a small amount of scent, over time these scents may actually form a trail. A buck or doe may follow such a scent trail having figured out that deer walked there without harm. The metatarsal glands, located on the outside of a deer's legs give off an odor that warns other deer of danger. White-tail deer stamp their feet when they sense danger in order to mark the area with secretions from the metatarsal gland. Other deer flee an area instantly when they whiff this scent. Another gland is the tarsal gland used in mating.

White-tail Deer Anatomy: Legs/Hooves

Deer legs are well suited for running, whether chasing during the rut or evading danger. Deer also possess a great deal of leaping ability, often jumping 8 feet into the air while running. The front legs are ideal for pivoting, allowing a deer to make sharp turns. White-tail deer have a top speed of around 35 mph. They are also good swimmers.

A deer's feet is actually two elongated toes. Their hooves are like big, thick toenails. A deer's hoof is made of three parts: the compact horn, the sole horn and the cuneus. The compact horn is the hardest and widest part, responsible for dissipating the shock from running. Hooves grow fastest in the summer and slowest in the winter, reflecting the deer's slower metabolism late in the year. Since deer hooves are extremely hard, deer walking on roads is comparable to humans walking on ice.

White-tail Deer Anatomy: Coat

The two main purposes of a deer's coat are camouflage and thermoregulation. In order to regulate body temperature, a deer grows a different coat in summer and winter. This process called molting is triggered by hormonal changes brought about by the changing seasons. Summer coats are thin, and by September the deer coats begin to change. The new winter coat has hairs that are hollow, stiff and about 2 inches longer than the summer hairs. Soft inner hairs, which keep deer warm in the cold weather, curl against the skin.

Ideas to prevent DVC using preceding biological information:

Idea 1:

Let us assume that we have identified stretches of highways with the most DVC in Michigan. Along these stretches, and at the tree-line we install motion detectors at periodic intervals. The sole purpose of these motion detectors is to pick up any movement in the patches alongside the road. The motion detectors are to be connected to water sprinklers along the tree-line and light posts adjacent to the road. Upon detecting motion the sprinklers are set into action, releasing chemicals that mimic secretions of the metatarsal glands mixed with water. Deer smell odors best in humid conditions and hence the water based sprinkler system. Predator odors should be rotated with metatarsal gland secretions in the sprinklers. There is a certain danger associated with the use of only one type of odor. Animals, not unlike human beings, can distinguish between a real threat and a fake one when presented over a temporal scale. If deer are subjected to only predator odors constantly (a threat) but never followed by an execution of the threat they might learn that the threat is not real. A common example of this is scare devices (such as fake owls that rotate in the wind) installed to prevent pigeons from sitting on rooftops. Once the pigeons have figured out that the owl is fake they peck the device down. Arguably the olfactory system is more hardwired and hence learning is more difficult, yet it might be possible over time. To prevent or make such learning impossible we need to mix our odors, that is make changes based partly on data and partly on intuition.

The motion detectors may also be connected to light posts that would serve as warning to drivers that there are deer nearby. This represents a two-pronged approach to lower DVC.

Idea 2:

A deer crossing a road is like a human walking on ice. The question is are there ways in which we can design roads to provide more traction for deer? The reason for such an endeavor is that deer might be able to cross roads quicker, and people driving on such a surface may also realize that they are in high deer concentration areas. Road design engineers need to be contacted to figure out a possible way in which this could be done. To further alert drivers, we could again install motion detectors at deer crossing areas.

From one side of the road (tree line to tree line; and maybe a little into the woods as well, including deer crossings) could be sprayed with chemicals from the interdigital glands to give deer the notion of a trail. Maybe over time deer may start using specific sites to cross the roads.

Idea 3:

As mentioned earlier deer are most likely colorblind. Having few or no natural predators (e.g. wolves) in Michigan means that the use of the camouflage element of deer coats is minimal. When it is dark deer are almost invisible to human beings (except for their eyes which reflects light). How can we make deer

more visible to the average driver? Based on this question and the fact that deer shed their coats every spring, have no natural predators in Michigan, we came up with the following idea. The idea is to distribute pellets to hunters that would release a fluorescent chemical on to deer coats. Drivers on roads would now be able to see deer more clearly and quickly. The color of the chemical may be made to match the brown of deer coats (so we don't have orange or purple deer) with the added element of fluorescence (e.g. phosphorus) to make it visible at night. Since DVC occur mostly during late fall we could also make the fluorescent pellets have a life expectancy/effectiveness of 4 months. The life expectancy of the chemicals combined with deer shedding their coats during spring should help remove the material every year and minimize side-effects.

The negative impacts of such an idea are numerous. Since they would be unable to make out which deer have been marked already, deer hunters would be constantly shooting deer. Deer behavior might change as a result of being shot at but not killed (e.g. become more wary of humans). The chemicals may have an impact on deer physiology. It is also possible that illegal night time hunting of deer may increase. Before an idea such as the above is carried out we need to be aware of it's possible negative impacts.

Idea 4:

One of the most effective solutions in preventing DVC is landscaping. A simple example is to plant less-preferred species in areas accessible by deer and establishing susceptible plants only in protected areas. Whether deer target a

particular plant species or variety depends on their previous habits and nutritional needs, plant palatability, seasonal factors, weather conditions, geographic area, and availability of alternative foods. One type of plant species may be rarely damaged in one region of the country, but highly preferred in another due to differences in deer pressure and other factors. Examples of species with noted regional differences include holly, white pine, and deciduous magnolias (Maryland Cooperative Extension Fact Sheet).

Summer deer food in Michigan includes leaves of select trees and shrubs such as aspen, red maple, white ash, blackberries, dogwoods and sassafras. Important grasses include orchard grass, timothy, blue grass, redtop, wheat, and oats. Deer also eat agricultural crops such as corn, soybeans, buckwheat, clovers, and alfalfa. Common ragweed, lamb's quarter, jewelweed, orchids, garden vegetables, and ornamentals are also heavily grazed. Autumn foods include acorns, beech nuts, crabapples, maple and dogwood leaves, willow, and brambles. Important winter food sources include white pine, white cedar, red maple, yellow birch, viburnam, sumac, dogwood, and aspen (Private Land Partnerships; White-tail Deer).

In our policy options we discussed building overpasses and underpasses (corridors). Landscaping would work well with such an option. From one tree line to the underpass and from the underpass to the other tree line we could plant foods preferred by deer as well as scent mark this trail. Over time we can expect deer to begin using such a pathway extensively.

So far we have tried to put forward some new ideas in solving the problem of deer vehicle crashes in Michigan and we have looked at it from the point of modifying deer behavior. Another aspect we can try to change is human behavior and this will be reviewed now.

Human Behavior in Deer Vehicle Crashes:

A lot of effort has been put into educating the general public on car-deer crashes. OHSP has the following recommendations to reduce an individual's chances of a car-deer crash.

1) Look for deer, especially in the evening – and slow down if you see them;
2) Watch for deer-crossing signs, a reminder to drive cautiously;
3) Drive at lower speeds through a posted area any time of the day or night;
4) Use common sense – wear safety belts, stay awake, alert and sober;
5) If you can't stop, don't swerve out of your lane. It's generally safer to hit the deer than run off the road or risk injuring another motorist; and
6) If you hit a deer, report the crash to local law enforcement.

Education on car-deer crashes and information on how to react when a deer is in front of your vehicle may form the backbone of OHSP's efforts but in addition to this we add a few observations and recommendations.

These observations and recommendations are as follows:

1) We need to be aware of certain human practices and in most cases need to change our practices. An example is mowing the grass next to highways in order to keep visibility high. While visibility is improved, mowing rejuvenates grass which in turn will attract deer. Again the importance of landscaping becomes obvious here, planting grasses/plants that are lower on the edibility chain for deer would help in lowering DVC.
2) White-tail deer are an edge loving species. Edges are places where two cover types come together, such as a wetland next to field or a stand of pines next to the road. Deer like edges because they provide both food and cover. For example, the grass by the side of the road provide a highly nutritious diet and the tree line provides quick cover. Where we can, we must try to reduce the amount of edge and when edges are created try to reduce their attractiveness to deer.
3) Research/data in order to build a geographic information system (GIS) for Michigan that incorporates deer-vehicle crashes is extremely important. Where are the stretches of highway where most DVC occur? What sort of landscape is adjacent to such areas? What soils are present and what type of vegetation do these areas support? Without geography being incorporated in our current analysis, we are consistently missing an important piece of the puzzle.

Solutions to DVC problems need to be addressed on two separate but interconnected fronts, deer behavior and human behavior with a common thread of better information/knowledge

Conclusion:

To reduce DVC, the specific policy option that is chosen depends entirely on the goals of OHSP. If the goal of OHSP is to prevent deer crashes in Michigan then, fences alone are the best option (most effective at the cheapest cost among our options). If the goal includes wildlife considerations as a high priority (more in tune with DNR's goals) then fences along with corridors would be the best option. If the goal includes economics as a high priority the best option is to do nothing and hope that DNR's increased deer licenses will have a positive effect. The options from our cost-benefit analysis have all been tried out in different parts of the United States and Canada with varying levels of success. We can only hope that the option chosen will fit well with the needs of Michigan and be a success.

In trying to reduce DVC, there are several new ideas that OHSP can be the first to experiment with. These include:

a) Use of motion detectors connected to an odor sprinkling system and to light posts by the side of roads. The odor would repel the deer and the lights would alert drivers to animals nearby.
b) Designing a road surface that provides more traction to deer. Deer would be able to cross the roads more quickly, and people driving on the

differently textured surface would be able to recognize it as a deer crossing zone.

c) Allow for hunters to tag deer with fluorescent chemical pellets that make deer more visible at night.

d) Begin a campaign for large scale landscaping changes. These include such things as planting foods less preferred by deer on roadsides, spraying deer crossings with secretions of the interdigital gland, and modifying certain human land-use patterns.

Serious effort also needs to be focused in the creation of a statewide GIS. The GIS would provide detailed information on specific patterns of DVC which is currently unavailable.