TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE
NEW MEXICO July, 2011

BIOLOGY TECHNICAL NOTE NO. 59

Habitat Development for Beneficial Insects for Pest Management

Planning Criteria

Refer to New Mexico Water Quality Technical Note No. 20 for NM Guidance for Integrated Pest Management, found at: *http://www.nm.nrcs.usda.gov/technical/tech-notes/water.html*

Conservation Practices

Many existing conservation practices may be used to implement and/or manage habitat for beneficial insects. Table 1 lists some of the most appropriate practices.

Table 1: Conservation practices that may be used to provide beneficial insect habitat.

327 - Conservation Cover (ac)	422 - Hedgerow Planting (feet)
342 - Critical Area Planting (ac)	550 – Range Planting (ac)
380 - Windbreak/Shelterbelt Establishment (ft)	595- Integrated Pest Management (ac)
386 - Field Border (feet)	612 - Tree/Shrub Establishment (ac)
390 - Riparian Herbaceous Cover (ac)	643 – Restoration, Mgmt. of Rare or Declining Habitats (ac)
393 - Filter Strip (ac)	645 - Upland Wildlife Habitat Management (ac)

Ecology of Native Beneficial Insects and the Pests they Control

Appendix 1 provides a table to help determine what native beneficial insects should be targeted for habitat development; based on the ecology of the species, its habitat requirements and the pest it controls.

Plants Suitable for Beneficial Insect Habitat (Insectory)

Appendix 2 provide a list of plants suitable for beneficial insect habitat. Mixtures should be designed to provide blooming plants attractive to the beneficial insects that will feed on pest insects identified.

- Mixtures shall consist of at least two plant species for each blooming period (spring, summer, fall) within the cropping system of the target crop.
- Plantings should consist of a diversity of plants with at least six species in the mix.

Additional Criteria

- No disturbances that affect the plant blooming is allowed during the growing season.

Additional Resources

National Center for Appropriate Technology. 2000. Farmscaping to enhance biological control. Appropriate Technology for Rural Areas. http://attra.ncat.org

Ellington, et al. 2005. Guide to the Biological Control of Some Common Yard and Garden Pest Insects of New Mexico. Circular 607. New Mexico State University. Cooperate Extension Service.

The Xerces Society for Invertebrate Conservation. http://www.xerces.org

Appendix 1 –Ecology of Key Native Beneficial Insects

Pest to be Controlled	Ecology of the Native Beneficial Insect that controls the pest species	Plants Suitable for Habitat[1] - Insectory Plants -	Other Habitat Requirements
Aphids (primary) *Soft-bodied insects:* thrips, mealybugs, bean beetles, immature whiteflies, scale, moth eggs, very small caterpillars, spider mites	**Lacewing** (Chrysopidae and Hemerobiidae families) Description. Adults are light green or brown with long slender antennae, golden eyes and long delicately veined wings. Adults fly, larvae do not. Life Cycle. Complete metamorphosis. Females lay eggs in groups on slender stalks which keep young larvae from eating each other after they hatch. Larvae grow through three stages for 2 to 3 weeks before each spins a white silken cocoon. The adult emerges in about 5 days. Winter is spent in the cocoon or adult stage, depending on species. Adults disperse widely after emerging. Some species have several generations per year while others have one. Behavior. Predator. Wingless larvae have sickle-shaped jaws that contain tubes with which they can inject prey with paralyzing venom and then suck out the body fluids. The larvae are carnivorous and predaceous on many soft-bodied plant feeding insects and mites, including eggs. They can consume over 425 aphids or other prey per week. Some species are predaceous as adults to a limited extent.	**Carrot family:** angelica, fennel, caraway, wild carrot, coriander, dill **Daisy/Sunflower family:** yarrows, cosmos, golden marguerite, coreopsis, sunflowers, goldenrod **Legume family:** alfalfa, clover, vetch **Buckwheat family:** buckwheats **Goosefoot family:** four-wing saltbush **Mallow family:** purple poppymallow **Cabbage family:** alyssum	▪ Adults are mostly active from dusk to dawn when temperatures are milder and relative humidity higher; ▪ Adults are poor fliers, active at night (nocturnal); ▪ Attracted to lights and are among those burned up in electric bug-zappers; ▪ The adult feeds on nectar, pollen, and honeydew.
Aphids (primary) *Soft-bodied insects:* mealybug, spider mite, soft scales adelgids, chinch bugs, bean beetle, asparagus beetle larvae, alfalfa weevils, bean thrips, grape root worms, CO potato beetle larvae, whitefly, mites	**Ladybird Beetle / Lady Bugs** (Coccinellidae family and others) Description. The adult is a small, oval beetle 1/4" to 3/8" long with orange-red elytra (hardened wing-covers) with 6 black spots each. Adults fly, larvae do not. Life Cycle. Complete metamorphosis. The female lays up to 1,500 small eggs over several months during spring and early summer. The eggs are laid near the prey in upright batches of fifteen to thirty eggs. The larvae are dark and somewhat alligator-shaped. Once the larvae begin feeding, they grow quickly and moult four times over a period of up to a month. The pupal stage lasts about a week and mating takes place soon afterwards. If there is an abundant supply of aphids the female may start laying within about a week of mating, but if the supply is scanty, she may wait for up to nine months. Behavior. Predator. When the larvae encounter prey, they generally bite a hole in the body and suck out the contents. The non-flying larvae consume about 50 aphids or similar prey per day. Some species of adults also prefer to eat aphids, however most eat other soft bodied insects.	**Carrot family:** dill, fennel, coriander, wild carrot, angelica **Daisy/Sunflower family:** coreopsis, cosmos, golden marguerite, goldenrod, max. sunflower, Missouri ironweed, yarrows **Legume family:** alfalfa, crimson clover, vetch **Figwort family:** rocky mnt. penstemon **Buckwheat family:** buckwheats **Milkweed family:** butterfly weed **Goosefoot family:** four-wing saltbush	▪ In order to breed, they need an abundance of aphids; ▪ These insects have a diverse diet so they can survive when aphids are scarce, including honeydew, nectar, pollen or even petals and other soft parts of plants; ▪ Once aphids leave a crop, beetles will also. To retain active beetles, maintain cover crops.
Aphids (primary) *Soft-bodied insects:* Scales	**Hoverflies / Syrphid flies / Flower flies** (Syrphidae family, many species) Description. Adults are generally 5-20mm in size, often with a yellow stripe and black body resembling small honey bees or wasps, and have large compound eyes that nearly	**Carrot family:** caraway, coriander, dill, parsley, fennel, wild carrot **Daisy/Sunflower family:**	▪ Adults are often seen hovering at flowers and quickly darting away;

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	cover the head. Adults fly, larvae do not. Life cycle. Females lay eggs near aphid colonies. The slug-like, pale green to yellow maggots feed on aphids, scales, and other insects, growing to 10-15mm in length. Some pupate on the foliage near the feeding site, other pupate in the soil. The life cycle for most species lasts 2-4 weeks. Behavior. Predator. The larvae of many species of syphids are insectivores. Larvae can consume as many as 400 aphids during their development. However, in the absence of aphids, larvae of some species can subsist and develop entirely on diets of pollen.	cosmos, coreopsis, rudbeckia spp., marigolds, sunflower, goldenrod, zinnia, yarrows **Waterleaf family:** phacelia **Buckwheat family:** buckwheats **Mint family:** lemonbalm, spearmint, wild bergamot **Goosefoot Family:** four-wing saltbush **Figwort family:**penstemon **Mallow Family:**poppymallow **Cabbage family:** alyssum	▪ They resemble bees or wasps, but they do not sting; ▪ Larvae of hoverflies are often found in stagnant water; ▪ the adults of many species feed mainly on nectar and pollen; ▪ maintain cover crops (buckwheat).
Parasitic Mini-Wasps			
Flee beetle, Armyworm, cabbageworm, codling moth, gypsy moth, European corn borer, beetle larvae, flies, caterpillars, sphinx moths, cabbage (see description)	**Braconid & Chalcid parasitoid wasp** (Braconidae/Chalcididae families among others) Description. Adults are typically under a half-inch; may be slender or stout, with long antennae; frequently, a dark spot on the forewing; color varies. Life Cycle. Complete metamorphosis. The life cycle length will vary by species. Behavior. Parasites. Braconids usually parasitize the immature stagesof their hosts. The adult females have long ovipositor and lays eggs inside of an insect host. The larva feeds on the inside of the host until it is ready to pupate. The wasp can either pupate inside the host, or on the outside of the host. The wasps will then emerge and look for more hosts. Also controls: butterflies, almond moth, Indian meal moth, grain weevil, leaf miners	**Carrot family:** anise, caraway, coriander, dill, fennel, parsley, wild carrot **Daisy/Sunflower family:** golden marguerite, coreopsis, goldenrod, cosmos, marigolds, sunflowers, blazing stars, zinnia, yarrows, other yellow flowers **Cabbage family:** any mustards **Legume family:** alfalfa, vetch **Buckwheat family:** buckwheats **Mallow family:** purple poppymallow **Mint family:** lemonbalm **Legume family:** clovers **Cabbage family:** alyssum **Mint family:** spearmint	▪ Adult wasps are attracted to the color yellow, so any yellow sticky cards used to monitor pests should be removed; ▪ They are generally not strong fliers and are generally moved through the air by the prevailing winds; ▪ Important in preventing crop damage because they kill their hosts before the insect causes damage to the plant; ▪ Maintain cover crops (alfalfa). ▪ Harmless to people, animals, and plants (they do not sting).
Aphids (primary) green peach aphid, melon aphid, pea aphid, cotton aphid, green peach aphid, potato aphid, foxglove aphid and many other aphid species	**Aphid parasitoid wasp** (Aphidiinae subfamily) Description. A subfamily of parasitoid wasps that use aphids as their host. Life Cycle. Complete metamorphosis. A complete life cycle takes 10-14 days. Females lay eggs singly in aphid nymphs. As the larvae mature and the aphids are killed, the aphids turn into mummies. Behavior. Parasites. In addition to killing aphids directly, mechanical disturbance of aphid colonies by the searching behavior of the adult wasps causes many aphids to fall off the plants and die. Each female lays about 100 eggs in aphids but may attack 200 to 300 aphids in the process.		
Moths and butterflies. Spruce budworm, cotton bollworm, tomato hornworm,	**Parasitoid wasp of eggs** (Trichogrammatidae family) Description. Tiny wasps that include some of the smallest of all insects, with most species having adults less than 1 mm in length. Life Cycle. Complete metamorphosis. The female lays an egg into a recently laid host egg. As the wasp develops, the host egg is killed. The wasp's short life cycle of 8-10		

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corn earworm, corn borer, codling moth, other moths	days allows for their population to increase rapidly. Behavior. Parasite. See life cycle. Each female parasitizes about 100 host eggs.	*Other nectar-rich plants with small flowers. Attracted to yellow.*	
Cutworm, armyworm, tent caterpillar, corn earworm, cabbage looper/worm, gypsy moth; some attack sawfly larvae, Japanese beetle, May beetle, squash bug, green stink bug, sowbug, grasshoppers	**Tachinid fly** (Tachinidae family) Description. Adult flies may be brilliantly colored and then resemble blow-flies (family Calliphoridae), or rather drab, and then resemble house flies but tachinid flies are more bristly and more robust. Adults fly, larvae do not. Life Cycle. Reproductive strategies vary greatly between species. The female may lay white oval eggs on the skin of the host insect, or insert eggs into the host's body, or leave them in the host's environment, as for example on leaves, where the host will ingest them. Some tachinids that are parasitoids of stem-boring caterpillars deposit eggs outside the host's burrow, letting the larvae do the work of finding the host itself. In other species, the maggots use an ambush technique, waiting for the host to pass and then attacking it and burrowing into its body. The larvae feed on the host tissues. Behavior. Internal parasitic of caterpillars. See life cycle.	**Carrot family:** caraway, wild carrot, coriander, dill, fennel, parsley **Daisy/Sunflower family:** goldenrod, golden marguerite. **Cabbage family:** alyssum **Legume family:** clovers **Buckwheat family:** buckwheats **Mint family:** Lemonbalm **Waterleaf family:** phacelia	▪ Adult flies feed on flowers and nectar from aphids and scale insects; ▪ As many species typically feed on pollen, they can be important pollinators of some plants, especially at higher elevations in mountains where bees are relatively few.
Predatory Bugs			
Flea beetles, spider mites, pink bollworm, cabbage loopers, whiteflies, aphids, insect eggs and small caterpillars	**Big-eyed Bugs** (Lygaeidae Family, *Geocoris* spp.) Description. Big-eyed bugs are small black, gray, or tan with proportionately large eyes. Life Cycle. Simple metamorphosis. Eggs are deposited singly or in clusters on leaves near potential prey. They take approximately 30 days to develop from egg to adult depending on temperature. Behavior. Predator. Both nymphs and adults are predatory. Big-eyed bugs have piercing-sucking mouthparts and feed by stabbing their prey and sucking or lapping the juices. Nymphs can eat as many as 1600 spider mites before reaching adulthood, while adults have been reported consuming as many as 80 mites per day.	**Carrot family:** coriander, caraway, fennel, wild carrot **Daisy/Sunflower family:** cosmos, goldenrod, sunflower, daisies, marigolds, yarrow, blazing stars, any others **Cabbage family:** mustards **Legume family:** alfalfa, crimson clover, vetch **Waterleaf family:** phacelia **Buckwheat family:** Buckwheats (native preferred) **Mint family:** spearmint	▪ Will also feed on various seeds and suck plant juices but are not considered to be injurious to plants; ▪ Build up cool season cover crops; ▪ can survive on nectar and honeydew when prey are scarce.
Anything smaller than itself: Aphid, thrips, leafhopper, treehopper, small caterpillars.	**Damsel bug** (Nabidae family) Description. They are soft-bodied, elongate, winged terrestrial predators. Adults are tan or grey, with piercing-sucking mouthparts and enlarged front legs. They have slender bodies, and about 10 to 12 mm long. Nymphs resemble adults. Life Cycle. Simple metamorphosis. Eggs are deposited in soft plant tissues. Nymphs resemble adults and develop through 5 nymphal stages in about 50 days. Behavior. Predator. They are generalist predators, catching almost any insect smaller than themselves, and cannibalizing each other when no other food is available.		▪ Numerous in fields of legumes such as alfalfa, buckwheat; ▪ Adult damsel bugs spend the winter in groundcover and winter crops such as winter grain and alfalfa.

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Wide variety of small insects: Aphids, thrips, bean beetles, spider mite, leafhopper, corn earworm, small caterpillars, insect eggs	**Minute Pirate Bug** (Anthocoridae Family, *Orius* spp.) Description. Adult minute pirate bugs are small, 2-5 mm long, oval, black to purplish with white markings, and have a triangular head. Life Cycle. Simple metamorphosis. Eggs are inserted into plant tissues. These hatch into nymphs. Developmental time for minute pirate bugs is very short, only 3 weeks from egg to adult. Several generations may occur during a growing season. Behavior. Predator. Generalist predators are often the first predaceous insects to appear in the spring. Nymphs and adults feed on a variety of small prey, including insect eggs. Both feed by sucking juices from their prey through a sharp needle-like beak.		▪ Maintain permanent plantings for refugia; ▪ they feed on pollen and plant juices when prey are not available.
Soft-bodied insects: Small to medium sized armyworms, earthworms, rootworm and cucumber beetle adults	**Assassin bug** (Reduviidae family) Description. Commonly have an elongated head with a distinct narrowed neck, long legs, and a prominent, segmented tube for feeding (rostrum). Most species are dark in color. Life Cycle. Simple metamorphosis. Females lay eggs which are stuck in clusters to leaves and stems. After hatching, the wingless nymphs grow and molt 4-7 times before becoming full-sized, winged adults. Adults are usually the overwintering stage. Behavior. These predaceous bugs suck body fluids from prey using their long rostrum to inject a lethal saliva that liquefies the insides of the prey.		▪ Generally poor fliers; ▪ Maintain permanent plantings for refugia; ▪ capable of biting humans.
Aphids *(over 60 species)*	**Aphid midge** (Cecidomyiidae family, *Aphiodoletes aphidimyza*) Description. Adults are small delicate black flies (< 2mm long). Life Cycle. Females deposit 100-250 tiny (0.3 mm) shiny orange eggs singly or in small groups among aphid colonies that hatch in 2-3 days. After 3-7 days the larvae drop to the ground and burrow 3/4 to 1 and 1/2 inches into the soil to pupate. Lifespan is 10 days. Behavior. Predator. The small, bright orange, slug-like larvae inject a toxin into aphids' leg joints to paralyze them and then suck out the aphid body contents through a hole bitten in the thorax. Larvae can consume aphids much larger than themselves and may kill many more aphids than they eat when aphid populations are high. A single larva kills 4-65 aphids per day.	**Carrot family:** dill, thyme **Cabbage family:** mustards **Legume family:** clovers	▪ Adults feed primarily on pollen and honeydew; ▪ Shelter the site from strong winds (i.e. hedgerows); ▪ prefers to reside in dark, humid areas near the lower plant canopy; ▪ They hide beneath the leaves during the day, and are active at night.

[1] See Appendix 2 – New Mexico Insectory Plants for Beneficial Insects, for more details.

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Appendix 2 –New Mexico Insectory Plants for Beneficial Insects

Please note that this is not intended to be a comprehensive list, but to serve as a guide.

Plant Name	Scientific Name	Native Status[1]	Duration	Flower Color	Trap Crop	Bloom Period		
						April - June 15	June 15 - July	July - Oct
Carrot Family (Apiaceae)								
Dill, Bouquet	*Anethum graveolens*	I	annual	yellow-green				
Angelica	*Angelica spp.*	I	biennial	whitish green				
Caraway	*Carum caryi*	I	biennial	white				
Coriander / Cilantro	*Coriandrum sativum*	I	annual	pinkish				
Wild Carrot	*Daucus carota*	I	biennial	white				
Fennel, sweet	*Foeniculum vulgare*	I	biennial	yellow				
Parsley, garden	*Petroselinum crispum*	I	biennial	whitish green				
Anise / Saxifrage	*Pimpinella anisum*	I	annual	white				
Figwort Family (Scrophulariaceae)								
Penstemon, rocky mnt.	*Penstemon strictus*	N	perennial	blue-purple				
Mint Family (Lamiaceae)								
Balm, lemmon	*Melissa officinalis*	I	perennial	yellow/white				
Spearmint	*Mentha spicata*	I	perennial	pink/white				
Bergamot, wild	*Monarda fistulosa*	N	perennial	lavender/pink				
Milkweed Family (Asclepiadaceae)								
Butterfly weed	*Asclepias tuberosa*	N	perennial	orange				
Legume Family (Fabaceae)								
Prairie Clover, white	*Dalea candida*	N	perennial	white				
Prairie Clover, James	*Dalea jamesii*	N	perennial	yellow to orange		opportunistically		
Prairie Clover, purple	*Dalea purpurea*	N	perennial	purple				
Bundleflower, Illinois	*Desmanthus illinoensis*	N	perennial	white				
Alfalfa *	*Medicago sativa*	I	perennial	purple	Y			
Goldenbanner, mnt.	*Thermopsis montana*	N	perennial	yellow				
Clover, strawberry*	*Trifolium fragiferum*	I	perennial	purple				
Clover, alsike*	*Trifolium hybridum*	I	perennial	white				
Clover, crimson*	*Trifolium incarnatum*	I	annual	red				
Clover, red*	*Trifolium pratense*	I	biennial	pink/red				
Clover, white dutch*	*Trifolium repens*	I	perennial	white				
Clover, natives	*Trifolium spp. (many)*	N	--	--				
Vetch, American*	*Vicia Americana*	N	perennial	purple				
Vetch, sweetclover*	*Vicia pulchella*	N	perennial	whitish pink				
Vetch, Hairy or Winter	*Vicia villosa*	I	annual	purple				
Field pea / Cowpea*	*Vigna unguiculata*	I	annual	purple	Y			
Daisy/Sunflower Family (Asteraceae)								
Yarrow, fernleaf	*Achillea filipendulina*	I	perennial	yellow				
Yarrow, western	*Achillea millefolium*	I	perennial	white				
Golden Marguerite	*Anthemis tinctoria*	I	perennial	yellow				
Marigold, desert	*Baileya multiradiata*	N	biennial	bright yellow				
Coreopsis, lanceleaf	*Coreopsis lanceolata*	N	perennial	yellow				
Coreopsis, golden	*Coreopsis tinctoria*	N	annual	yellow/red band				
Cosmos, garden,	*Cosmos bipinnatus*	I	annual	white (is best)				
Cosmos, southwestern	*Cosmos parviflorus*	N	annual	pink				
Brittlebush/ Incienso	*Encelia farinosa*	N	perennial	yellow				
Firewheel	*Gaillardia aristata*	N	perennial	red, yellow tips				
Blanketflower	*Gaillardia pulchella*	N	annual	red, yellow tips				

Sunflower, common	*Helianthus annuus*	I	annual	yellow				
Sunflower, maximilian	*Helianthus maximiliana*	N	perennial	yellow				
Goldeneye, showy	*Heliomeris multiflora*	N	perennial	yellow				
Sunflower, ox eye	*Heliopsis helianthoides*	N	perennial	yellow				
Daisy, orange mnt.	*Hymenoxys hoopesii*	N	perennial	orange				
Blazing star, dotted	*Liatris punctata*	N	perennial	purple				
Blazing star, dense	*Liatris spicata*	N	perennial	purple				
Palafox, desert	*Palafoxia sphacelata*	N	annual	pink				
Paperflower, woolly	*Psilostrophe tagetina*	N	perennial	yellow				
Coneflower	*Ratibida columnifera*	N	perennial	varies: red/yellow				
Blackeyed susan	*Rudbeckia hirta*	N	biennial	yellow				
Coneflower, cutleaf	*Rudbeckia laciniata*	N	perennial	yellow				
Badlands mule-ears	*Scabrethia scabra*	N	perennial	yellow				
Groundsel, threadleaf	*Senecio flaccidus*	N	perennial	yellow				
Goldenrod, short hair	*Solidago canadensis*	N	perennial	yellow				
Perkysue	*Tetraneuris argentea*	N	perennial	yellow				
Crownbeard, golden	*Verbesina encelioides*	N	annual	yellow				
Missouri ironweed	*Vernonia missurica*	N	perennial	purple				
Zinnias, rocky mnt.	*Zinnia grandiflora*	N	perennial	yellow				
Buckwheat Family (Polygonaceae)								
Buckwheat, annual	*Eriogonum annuum*	N	annual	white turns pink				
Buckwheat, crispleaf	*Eriogonum corymbosum*	N	perennial	white				
Buckwheat, natives	*Eriogonum spp. (many)*	N	--	--				
Buckwheat, sulfur	*Eriogonum umbellatum*	N	perennial	bright yellow				
Buckwheat, common*	*Fagopyrum esculentum*	I	annual	white	Y	approx. 21 days after planting		
Waterleaf Family (Hydrophyllaceae)								
Desertbells	*Phacelia campanularia*	N	annual	blue				
Phacelia, gypsum	*Phacelia integrifolia*	N	annual	purple				
Phacelia, lacy	*Phacelia tanacetifolia*	N	annual	blue				
Cabbage Family (Brassicaceae) & Casper Family (Capparaceae)								
Beeplant, rocky mnt.	*Cleome serrulata*	N	annual	pink to purple				
Spectacle pod	*Dimorphocarpa wislizeni*	N	annual	white to pale pink				
Wallflower, western	*Erysimum asperum*	N	biennial	orange to yellow				
Peppergrass	*Lepidium virginicum*	N	annual	white, inconspicuous				
Alyssum	*Lobularia maritima*	I	annual	white/purple				
Princesplume, desert	*Stanleya pinnata*	N	perennial	yellow				
Mallow Family (Malvaceae)								
Poppymallow, purple	*Callirhoe involucrata*	N	perennial	redish pink				
Goosefoot Family (Chenopodiaceae)								
Four-wing saltbush	*Atriplex canescens*	N	perennial	yellow				

[1] Native Status: I = Introduced, N = Native. The planting should emphasis as many native species as practical.
*Potential cover crops that are good for insectory habitat.

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