Wildlife and environmentally friendly erosion control materials

Highlights

- Many people are unaware of important risks to wildlife and the environment from plastics found in common erosion control materials
- We could save many individual animals, including reptiles that help control pest species, some of our most beloved bird species, and many others, by choosing carefully the materials used for erosion control
- Reducing plastics in our environment reduce the risks to people too

INTRODUCTION

Erosion prevention and control due to construction, agriculture, landscaping, or restoration work is an important element for repairing and protecting the soil after a disturbance or natural events (Benik et al. 2003; Kaufman 2000). The purpose of erosion control is to prevent the movement of topsoil and sediment and to assist vegetation establishment (Rivas 2006; RUSLE2). Unfortunately, some erosion control methods, while protecting the soil, can harm wildlife and the environment (Ward et al. 2020). Depending on the type of erosion control used, wildlife can become entangled suffering injuries and death (Black 2003; Ebert et al. 2019; Kapfer et al. 2011; Stuart et al. 2001; Ward et al. 2020). When using erosion control products with plastics it can lead to multiple wildlife and environmental problems in addition to entanglement, such as ingestion of plastics across many wildlife taxa and breaking down of harmful plastics into the environment as microplastics (Rich et al. 2020, USGS 2016). It is more common to hear about plastics causing harm in marine ecosystems (Thiel et al. 2016; USGS 2016), but these products also damage and injure terrestrial systems and wildlife (Ward et al. 2020).

Erosion control products (ECPs) come in many different shapes, sizes, and materials. Products range from spray on mulches, netting, blankets, mats, wattles (fiber rolls), and reinforced fencing (ECTC 2021). The variety of erosion control products can be linked to the various topography and soil types that need erosion control. The slope, potential water flow velocity, desired plant species, ecosystem, and soil type, along with the longevity of need over time all influence which products are used (Rivas 2006). A cluster analysis of ECPs approved in Texas found that 86% used mesh, with 71% of that mesh made from polypropylene (Jobe et al. 2020). But even across varying environmental conditions, it is still possible to choose ECPs that reduce harm to wildlife and the environment.

Osprey with plastic netting wrapped around talon. (Photo by Randy Loftus, USFWS)

WILDLIFE ENTANGLEMENT

Erosion control products that contain plastic mesh or netting pose the largest threat for wildlife and the environment (Barton & Kinkead 2005; Black 2003; Ebert et al. 2019; Kapfer et al. 2011; Stuart et al. 2001; Townsend & Barker 2014; Walley et al. 2005; Ward et al. 2020). Wildlife entanglement, causing injury and death, occurs when animals get caught in plastic netting found in erosion control mats and blankets. Negative impacts from plastic netting reach across all species groups, including snakes, frogs, lizards, turtles, fish, small mammals, and birds (Stuart et al. 2001).

Reptiles and amphibians may be most as-risk from plastic-containing erosion control products. Reptiles and amphibians use the environment to regulate their body temperature; when they become entangled in plastic netting it puts them in danger of becoming exposed to temperatures extremes that they would normally not choose to remain in, leading to stress and sometimes death (Herpetological Resources and Management 2019). Snakes become entangled in the plastic netting leading to injury and death (Mitchell et al. 2006). Reports of fatalities include the eastern massasauga rattlesnake (*Sistrurus catenatus*), a federally threatened species. Eastern massasaugas live in wet areas, such as marshlands, prairies, areas around lakes/rivers and other habitat-transition zones (MNFI n.d.; USFWS 2019).

Eastern massasauga rattlesnake found dead in plastic netting. USFWS photo.

Not all species are affected equally, with larger-sized snakes, including gravid females, more vulnerable to entanglement. For snakes between 50-199 mm circumference, every increase in mm of circumference lead to an increase of predicted entanglement (Ebert et al. 2019). Entanglement can cause lacerations in the skin, open wounds can lead to infection, decreased mobility, and eventually death even if they manage to break free from the netting (D. Mifsud, pers. comm., 2020). Reported species of snakes and lizards that have been observed tangled in plastic netting include: eastern fox snake (*Pantherophis gloydi*), gray rat snake (*Pantherophis spiloides*), Butler's garter snake (*Thamnophis butleri*), eastern massasauga rattlesnake (*Sistrurus catenatus*), northern watersnake (*Nerodia Sipedon*), black ratsnake (*Elphae obsoleta*), timber rattlesnake (*Crotalus horridus*), coachwhips (*Masticophis flagellum*), bullsnakes (*Pituophis catenifer*), western

Eastern king snake killed in plastic erosion control netting. Photo by Meredith Semel

diamondback rattlesnakes (*Crotalous atrox*), racers (*Coluber constrictor*), ratsnakes (*Elaphe obsolete*), kingsnakes (*Lampropeltis getula*), spiny lizards (*Sceloporus magister*) (D. Mifsud, Herpetological Resources Management, pers. comm. 2020; Fauth & Welter 1994; Stuart et al. 2001).

Snakes are not the only wildlife that are harmed by erosion control products (Stuart et al. 2001). Research shows that birds will use discarded plastic netting as filler in their nests. Birds can have decreased nest success and plastic netting can lower fledgling success due to entanglement and indigestion of plastics (Montevecchi 1991; Townsend et al. 2014). Rich et al. (2020) gathered data from multiple sources showing that birds, turtles, snakes, and invertebrates have all been documented becoming entangled, ingested, or killed by plastic netting products in the environment. Bird species that were tangled or ingested plastic were mourning dove (*Zenaida macroura*), European coot (*Fulica atra*), mallard (*Anas platyrhynchos*), shelduck (*Tadorna tadorna*), osprey (*Pandion haliaetus*), American black duck (*Anas rubripes*), common eider (*Somateria mollissima*), American crow (*Corvus brachyrhynchos*), American robin (*Turdus migratorius*), Eastern bluebird (*Sialia sialis*), California condor (*Gymnogyps californianus*), and great tit (*Parus major*) (Rich et al. 2020).

Plastic netting found in bird nest. Photo by Peter McGowan, USFWS.

POLLUTION & MICROPLASTICS IN THE ENVIRONMENT

ECPs are just one of the many sources for plastic pollution, but the plastic contained in some erosion control products does contribute to the problem. Plastic netting in erosion control products can lead to long term pollution and contribute to microplastics and chemical contaminants in our soils and water. Fragments of plastic can break off from the netting and lead to microplastics in water and chemicals leached from the plastics into water and soil that remain in place following the restoration of the site (USGS 2016). Research has shown that polypropylene, commonly used in plastic erosion netting, can lead to long-term environmental problems (Kärrman et al. 2016). Chemical additives from plastics leach into the environment, including chemicals that stabilize plastics from UV exposure like those used in some ECPs; these chemicals may cause immediate and long-term harm to mammals, amphibians, fish, and invertebrates (Rich et al. 2020). Soil chemistry and physical properties can also be altered from plastics used in the environment (Rich et al. 2020). Fragments of plastic that end up in lakes, streams, and rivers can also end up ingested by fish and other wildlife. A recent study showed that polypropylene was the most prevalent microplastic in freshwater mussels, 71% of which had microplastics when tested (Wardlaw & Prosser 2020).

Even products that claim to be biodegradable may not degrade over time. Many of the so-called biodegradable plastics need the sunlight to assist in the degradation process but once vegetation grows up between the netting, it is shaded and will remain in the environment indefinitely unable to degrade as promised (USGS 2016).

WILDLIFE FRIENDLY PRODUCTS

The good news is that there are alternative erosion control products to choose from that are more wildlife and environmentally friendly. First, choose a product that does not contain plastic netting for ECPs such as blankets, mats, and logs. There are products made from natural fibers that can replace plastic netting (examples in Fig 2-5) in these products. To reduce entanglement, the joints in netting need to be moveable and un-welded to allow wildlife to escape. The size of the opening in the mesh can also make a difference. Instead of choosing square mesh, use elongated mesh with a rectangular shape (Ebert et al. 2019; Herpetological Resource and Management, 2019; Kapfer et al. 2011). This allows a snake or other animal to wiggle out more easily while avoiding injury in the process. Natural fibers also have varying shelf lives and will break down, not polluting or leaching chemicals and microplastics into the environment. When looking for erosion and sediment control methods, consider options when marketed as "degradable" versus "biodegradable" products. Most erosion and sediment control products are designed to degrade over time and are considered temporary, whether due to natural processes of degradation or by removal. One marketing strategy is to push for UV-degradable products, which often do not work as intended, due to vegetation cover of the mesh. Many of these products will end up being left in place for long periods of time. Plastic netting products have been found intact up to eight years after its initial installation (USDA and NRCS 2013). This is especially true when they are being used for vegetation reestablishment purposes or water retention, for there is fear of damaging growth upon its removal. The concern with degradable plastics is that many petroleum-based products eventually do degrade but because of the time to break down, they end up breaking into small pieces which result in microplastics in lakes, rivers and other waterways. Fragments of netting can result in entanglement of wildlife, ingestion hazards, or increases in the concentration of pollutants found in the environment.

Silt fences are another temporary erosion control product that are often used. These prevent sediment from moving with storm water runoff. They are made of plastic filters and are may be reinforced with more plastic netting or metal mesh. Backing is used in the case of heavy sediment load. The mesh netting on some of these products has smaller apertures and have been documented to entrap and harm snakes, including the Eastern massasauga (Black 2003). Non-reinforced silt fences tend to be a more wildlife friendly choice, however, as the fence is left up, it begins to wear, fray, and develop holes, which may also contribute to wildlife entanglement. Alternatives exist that are made from heavy-duty polymer matrices from recycled materials that do not break down and can be reused on multiple projects. These products can be installed with one-way wildlife openings letting wildlife escape from construction zones, while keeping them out and controlling erosion and runoff (ERTEC).

Consult with an engineer as sometimes it is possible to design a site to reduce the slope so that a more environmentally erosion control method can be used. For example, terraces added to some slopes, can reduce the sediment yield because there is less overall erosion occurring on less steep terraced slopes. Engineers may also be able to design a mock terrace by using sediment logs (Fig. 9) interlaced to slow the flow combined with plastic free erosion control blankets. Where appropriate, ridges, channels, and impoundments should also be used where applicable to slow and control erosion (RUSLE2).

If you must use plastic due to the slope, water flow velocity, or other factors on your site, there are still options that are less risky to wildlife. Plastic netting that is larger and rectangular in shape (Fig. 4) reduces wildlife entanglement compared to products that contain square-shaped mesh (Fig. 6-7). Choosing moveable, unwelded joints (sometimes called “leno weave”) allows wildlife to get out of netting even if it is plastic based. Keeping ECPs secure and installing them correctly helps reduce the risk to wildlife. Ward et al. (2020) found that burying the edges of erosion control blankets reduced the number of snake entanglements in the erosion control netting. Another means to secure ECPs is using wooden or 'live' stakes; these can keep ECPs in place, reduce the ability for wildlife to crawl underneath, and help aid in vegetation growth when native live stakes are used (Rivas 2006). For more information the Forest Service has a detailed guide titled “Erosion Control Treatment Selection Guide” by Rivas (2006).

Many state agencies, municipalities, and manufacturers of erosion control products are aware of the dangers that some designs of ECPs pose to wildlife and the environment and are taking action to reduce its use in their geographic areas. California, Illinois, Minnesota, Vermont, and Wisconsin have created guidelines for the use of environmentally friendly ECPs (California Coastal Commission 2012; Illinois Department of Natural Resources 2020; MN Department of Natural Resources 2013; Slesar, C. 2009; Wisconsin Department of Natural Resources). The NRCS has a fact sheet the use of snake-friendly erosion control materials in Indiana, and they are updating their standards in Illinois to reflect the need to protect wildlife from plastics in ECPs (Brad Semel, Illinois Department of Natural Resources, pers. comm., 2021). To have a greater impact, collaboration is needed across all levels of government and non-government groups including but not limited to manufacturers, contractors, farmers, and the public.

In summary, based on our review of the scientific literature on the effects of ECPs on wildlife and the environment, we recommend choosing products with natural fiber netting, or no netting (such as spray on mulch); products with 100% biodegradable materials; carefully installing materials using natural stakes and burying edges; and removing ECPs when no longer needed.

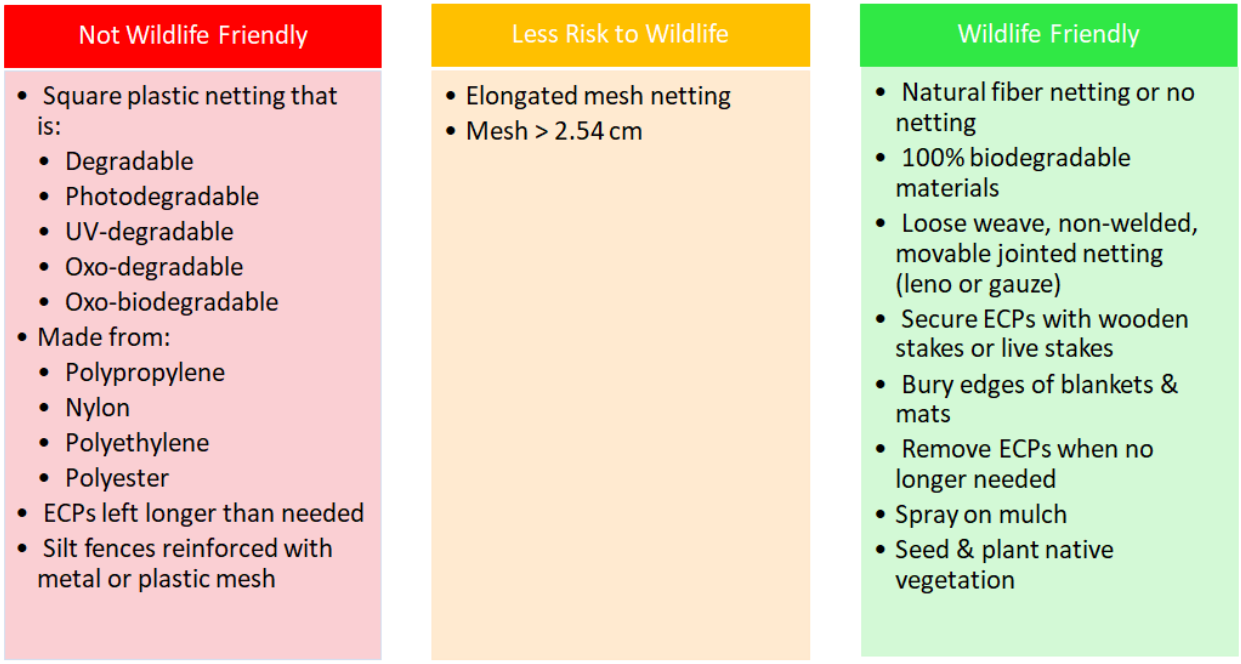

Figure 1. Attributes of erosion control products that make them not friendly to wildlife, somewhat more friendly, and friendly to wildlife. Use the specifications in the wildlife friendly box as much as possible.

Conclusion

Depending on the erosion control product that you use, the negative byproduct of your erosion control can be minimized by using wildlife-friendly products that will reduce entanglement of wildlife and reduce environmental pollution associated with plastic netting. By using certain products over others and reducing the risks to wildlife you are taking a proactive approach and contributing towards the stewardship and conservation of all species. For more information, please see https://fws.gov/midwest/eastlansing/ecp.html for more information the products we reviewed and whether they meet the definition of wildlife friendly according to the criteria found in published literature. We hope that this will assist you to find the best product for your project that suite your erosion control needs and reduces risk to wildlife.

Citations

1. Barton, C., & Kinkead, K. (2005). Do erosion control and snakes mesh? Journal of Soil and Water Conservation, 60(2), 33A.
2. Benik, S.R., B.N. Wilson, D.D. Biesboer, B. Hansen, and D. Stenlund. 2003. Evaluation of erosion control products using natural rainfall events. Journal of Soil and Water Conservation 58(2):98-105.
3. Black, R. (2003). Conservation Advisory: Heavy duty silt fence may cause high mortality in large-bodied snake species. Ministry Natural Resources. Ontario, Canada. http://www.massasauga.ca/pub_docs/Advisory_silt_fence.pdf
4. California Coastal Commission. (2012). Water Quality Fact Sheet: Wildlife-Friendly Plastic-Free Netting in Erosion and Sediment Control Products. http://www.coastal.ca.gov/nps/WildlifeFriendly_Products.pdf.
5. Ebert, S. E., Jobe, K. L., Schalk, C. M., Saenz, D., Adams, C. K., & Comer, C. E. (2019). Correlates of snake entanglement in erosion control blankets. Wildlife Society Bulletin, 43(2), 231-237. https://doi.org/10.1002/wsb.963
6. Environmental Conservation Online System, USFWS. https://ecos.fws.gov/ecp/species/8193 Date Accessed: 7/21/21.
7. ECTC: Erosion Control Technology Council. https://www.ectc.org/ Date Accessed: 6/10/2021.
8. ERETC: Environmental Systems. https://ertecsystems.com/wp-content/uploads/2021/01/ERTEC-E-Fence-Brochure.pdf Date Accessed: 7/26/2021.
9. Fauth, J. E., & Welter, S. M. (1994). *Nerodia sipedon* (Northern Water Snake): Fatality. Herpetological Review, 25, 29.
10. Herpetological Resource and Management, LLC. 2019. Evaluation of Soil Erosion Control Netting and Impacts on Herpetofauna.
11. Illinois Department of Natural Resources. 2020. Plastic Erosion Control Blankets and Wildlife Don't Mesh.
12. Kapfer, J. M., & Paloski, R. A. (2011). On the threat to snakes of mesh deployed for erosion control and wildlife exclusion. Herpetological Conservation and Biology, 6(1), 1-9.
13. Kaufman, M.M. 2000. Erosion control at construction sites: The science–policy gap. Environmental Management 26:89-97.
14. Kärrman, A., Schönlau, C., & Engwall, M. (2016). Exposure and effects of microplastics on wildlife: A review of existing data.
15. Jobe, K., Schiwitz, N. C, Ward, K., Saenz, D., & Schalk, C. M. (2020). On the Diversity of Erosion Control Products: Implications for Snake Entanglement. https://scholarworks.sfasu.edu/urc/2020/Posters/11/ Date Accessed: 6/15/2021.
16. Michigan natural features inventory. (n.d.). Michigan Natural Features Inventory. https://mnfi.anr.msu.edu/species/description/11519/Sistrurus-catenatus
17. Mitchell, J. C., Gibson, J. D., Yeatts, D, & Yeatts, C. R. 2006. Observations on Snake Entanglement and Mortality in Plastic and Horticultural Netting. Bulletin of the Virginia Herpetological Society, 26(2): 64-69.

18. MN Department of Natural Resources. (2013). Wildlife Friendly Erosion Control. https://files.dnr.state.mn.us/eco/nongame/wildlife-friendly-erosion-control.pdf
19. Montevecchi, W. A. (1991). Incidence and types of plastic in gannets' nests in the northwest Atlantic. Canadian Journal of Zoology, 69(2), 295-297.
20. Rich, L. N., Mantor, M., Ferguson, E., Baker, A. D., & Chappell, E. (2020). Potential impacts of plastic from cannabis cultivation on fish and wildlife resources. CALIFORNIA FISH AND GAME, 106, 121-132.
21. Rivas, Todd. 2006. Erosion Control Treatment Selection Guide. USDA Forest Service. https://www.fs.fed.us/t-d/pubs/pdf/hi_res/06771203hi.pdf Date accessed: 6/15/2021
22. RUSLE2 - https://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm. Date Accessed: 6/15/2021
23. Slesar, C. 2009. Wildlife-Friendly Erosion Control Matting: The Standard for Vermont. Vermont Agency of Transportation.
24. Stuart, J. N., Watson, M. L., Brown, T. L., & Eustice, C. (2001). Plastic netting: An entanglement hazard to snakes and other wildlife. Herpetological Review, 32(3), 162-164.
25. Thiel, M., Luna-Jorquera, G., Álvarez-Varas, R., Gallardo, C., Hinojosa, I. A., Luna, N., Miranda-Urbina, D., Morales, N., Ory, N., Pacheco, A.S. and Portflitt-Toro, M., & Zavalaga, C. (2018). Impacts of marine plastic pollution from continental coasts to subtropical gyres—fish, seabirds, and other vertebrates in the SE Pacific. Frontiers in Marine Science, 5, 238.
26. Townsend, A. K., & Barker, C. M. (2014). Plastic and the nest entanglement of urban and agricultural crows. PLoS One, 9(1), e88006.
27. U.S. Fish and Wildlife Service. (2019, May 29). USFWS: Eastern massasauga fact sheet. https://www.fws.gov/midwest/endangered/reptiles/eama/eama-fct-sht.html
28. Walley, H. D., King, R. B., Ray, J. M., & Robinson, J. (2005). Erosion mesh netting a major threat hazard to snakes. Bulletin of the Maryland Herpetological Society, 41(1), 36-38.
29. Ward, K. J., Jobe, K. L., Schiwitz, N. C., Saenz, D., & Schalk, C. M. (2020). Risk of snake entanglement is affected by installation method of erosion control blankets. Journal of Fish and Wildlife Management, 11(1), 273-278.
30. Ward, K. J., Jobe, K. L., Schiwitz, N. C., Saenz, D., & Schalk, C. M. (2020). The diversity of erosion control products and implications for wildlife entanglement. Journal of Soil and Water Conservation, 75(4), 82A-87A.
31. Wardlaw, C., & Prosser, R. S. (2020). Investigation of Microplastics in Freshwater Mussels (Lasmigona costata) From the Grand River Watershed in Ontario, Canada. Water, Air, & Soil Pollution, 231(8), 1-14.
32. Wisconsin Department of Natural Resources. Technical Standard:Channel Erosion Mat (1053). https://dnr.wi.gov/topic/stormwater/documents/1053ChannelErosionMat.pdf Date Accessed: 6/20/2021
33. USDA and NRCS. (2013). Biology Fact Sheet: Guidelines for Use of Snake-Friendly Erosion Control Blankets.

https://efotg.sc.egov.usda.gov/references/public/IN/Fact_Sheet_Biology_Snake-Friendly_Netting.pdf. Date Accessed: 6/15/2021
34. U.S. Geological Survey. Microplastics in our Nation's Waterways. 2016. https://labs.waterdata.usgs.gov/visualizations/microplastics/index.html. Date Accessed: 6/15/2021

Appendix 1. Photos and measurements of different types of erosion control mats.

Figure 2 Curlex NetFree. Aspen excelsior contains no netting. Slopes ≤ 3H:1V, Channels 1.0 lb/ft2 (48 Pa) shear stress, 3.0 ft/s (0.9 m/s) velocity. True biodegradable, seed free. Wildlife friendly.

*Figure 3 Curlex I. Aspen excelsior contains FibreNet netting on one side (1in * 0.5 in) jute with moveable joints. Slopes ≤ 2H:1V, Channels 1.75 lb/ft2 (84 Pa) shear stress, 7.0 ft/s (2.1 m/s) velocity. True biodegradable, seed free. Mowable 90 days. Wildlife friendly.*

*Figure 4 Curlex II. Aspen excelsior contains FibreNet netting on two sides (1in * 0.5 in) jute with moveable joints. Slopes ≤ 1.5H:1V, Channels 2.25 lb/ft² (108 Pa) shear stress, 9.0 ft/s (2.7 m/s) velocity. True biodegradable, seed free. Mowable in 90 days. Wildlife friendly.*

*Figure 5 Curlex III. Aspen excelsior contains FibreNet netting on two sides (1in * 0.5 in) jute with moveable joints. Slopes ≤ 1H:1V, Channels 2.5 lb/ft2 (120 Pa) shear stress, 10.0 ft/s (3.1 m/s) velocity. True biodegradable, seed free. Mowable in 90 days. Wildlife friendly.*

*Figure 6 Curlex I. Aspen excelsior contains standard polypropylene netting on one side (2 in * 1 in) welded joints, oxo-biodegrader, and UV additives. Slopes ≤ 2H:1V, Channels 1.75 lb/ft2 (84 Pa) shear stress, 7.0 ft/s (2.1 m/s) velocity. Seed free. Larger mesh size makes this less risky to snakes, but does not meet criteria for fully wildlife friendly.*

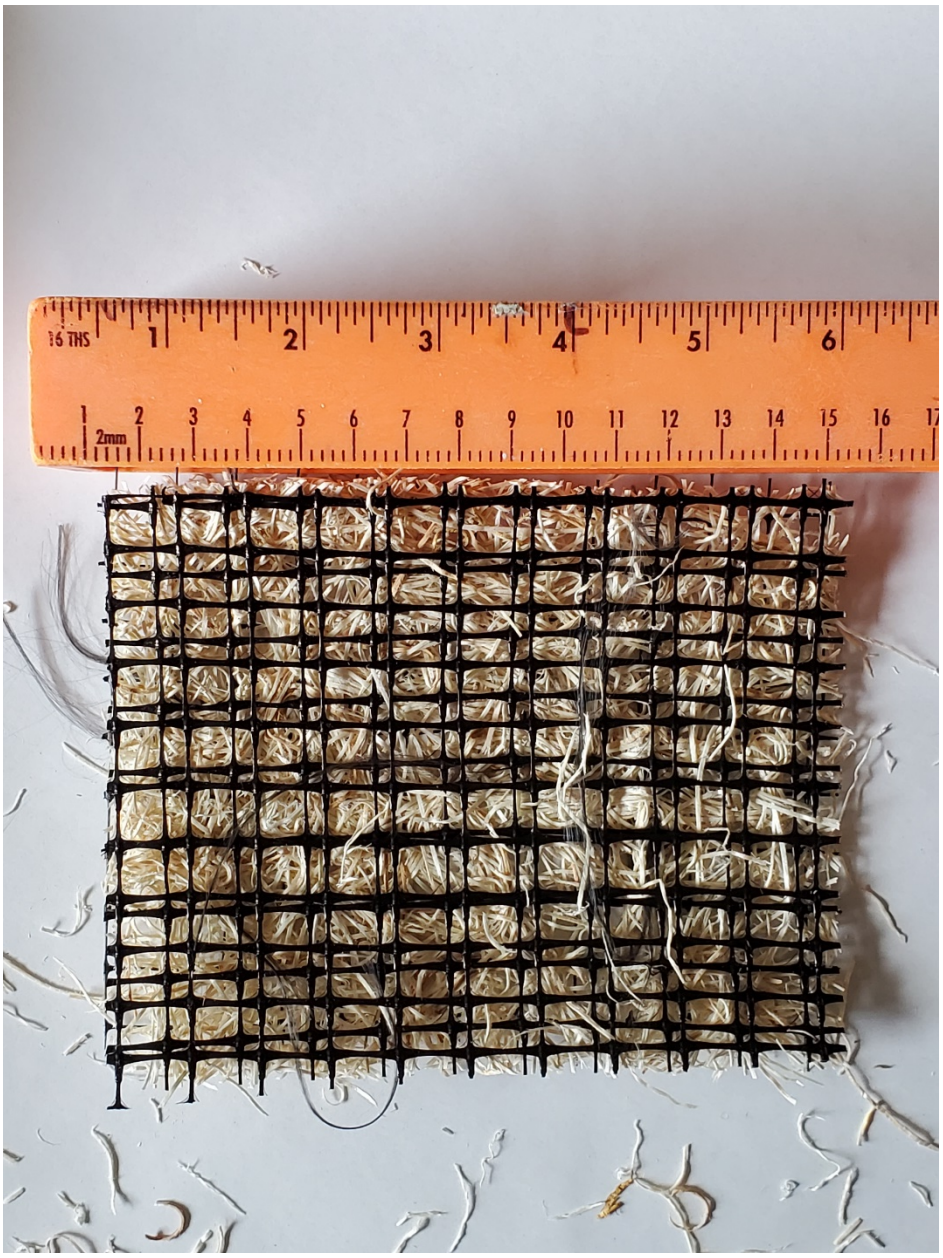

*Figure 7 Trinet Curlex side 1. Aspen excelsior contains standard polypropylene netting on both sides (0.5 in * 0.5 in) welded joints, heavy duty, and UV stabilized. Slopes ≤ 5H:1V, Channels 13 lb/ft2 (622 Pa) shear stress, 20.0 ft/s (6.1 m/s) velocity. Seed free Permanent reinforcement, also available in natural straw/coconut, natural coconut, Recyclex synthetic fibers with the same netting. Not wildlife friendly.*

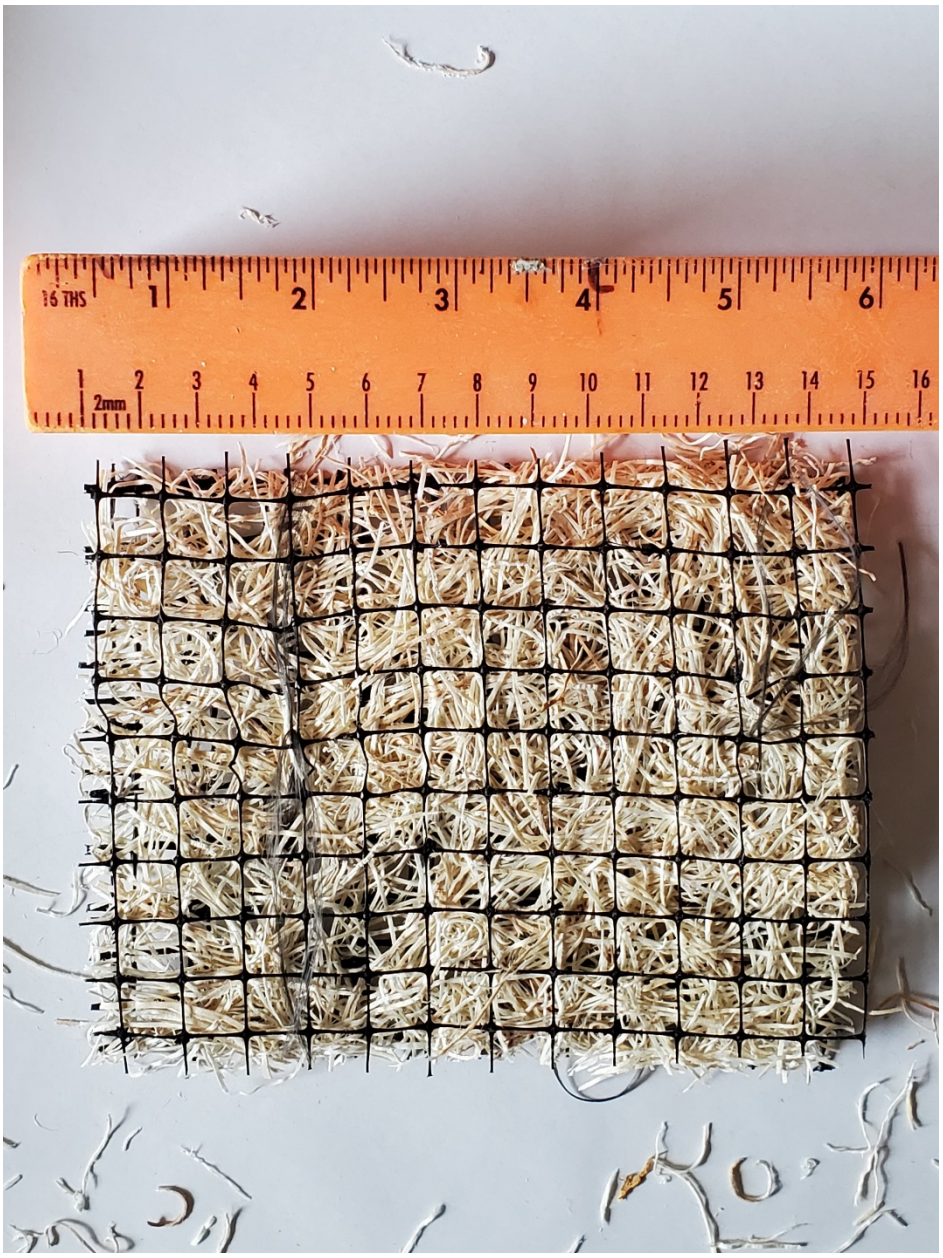

*Figure 8 Trinet Curlex side 2. Aspen excelsior contains standard polypropylene netting on both sides (0.5 in * 0.5 in) welded joints, heavy duty, and UV stabilized. Slopes ≤ 5H:1V, Channels 13 lb/ft2 (622 Pa) shear stress, 20.0 ft/s (6.1 m/s) velocity. Seed free Permanent reinforcement, also available in natural straw/coconut, natural coconut, Recyclex synthetic fibers with the same netting. Not wildlife friendly.*

Figure 9 Curlex sediment log. Aspen excelsior covered in open weave containment fabric on both sides (0.5 in hexagon) open weave joints. Filters and reduces hydraulic energy and sediment runoff. Available in 20, 12, 9, 6 inch or customizable lengths. Seed free, ≤ 24 months lifespan. Open weave mesh makes this less risky to wildlife.