Garry Oak Ecosystems Recovery Team

Annotated Bibliography on the Ecology and Management of Invasive Species:

Cotoneasters (*Cotoneaster spp.*)

prepared by

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Cotoneasters (*Cotoneaster* spp.)

References outlining the horticultural uses, techniques and management of *Cotoneaster* (i.e., how to grow *Cotoneaster* species) are not included in this review.

Peer-reviewed Journal Articles

Abouhaidar, S. S., E. Fereres, and R. W. Harris. 1980. Drought adaptation of 2 species of Cotoneaster. Journal of Horticultural Science 55 (3): 219-227.

> Authors' abstract: The transpiration of *C. salicifolius* and *C. lacteus* plants previously subjected to mild, moderate or severe water stress was persistently reduced compared to the unstressed controls. For *C. salicifolius* this was due to partial stomatal closure and to a decrease in leaf area following water stress. For *C. lacteus* it was mostly due to a lengthy reduction in leaf conductance. In previously unstressed *C. salicifolius* and *C. lacteus* water stress had an after-effect on stomatal opening, whereby leaf conductance did not increase readily as plant water status recovered after irrigation. Leaf conductance of *C. lacteus* plants that underwent several stress cycles increased readily after irrigation, independent of leaf water potentials, which were slower to recover.

Chang, C-S., and J. Jeon. 2003. Leaf flavonoids in *Cotoneaster wilsonii* (Rosaceae) from the island Ulleung-do, Korea. Journal of Environmental Science and Health, Part A, 38 (11): 2549-2563. Also online: http://147.46.223.123/Database/ar2003/%EC%9E%84%EC%97%85%EA%B3%BC%ED%95%99%EC%97%B0%EA%B5%AC%EC%86%8C/changchinsung.pdf

> Authors' abstract: The leaf flavonoids of *Cotoneaster wilsonii*, an endemic shrub to the island Ulleung-do in East Sea of Korea, were characterized and compared with flavonoids in some eastern Asian *Cotoneaster* species. The highly specialized taxa belonging to sect. Cotoneaster (sensu Yu) including *C. wilsonii* produced a mixture of flavone O- and C-glycoside and flavonol O-glycosides, including isorhamnetin glycosides. The morphologically similar species, *C. multiflorus* and *C. hebephyllus* of central China and *C. wilsonii* of Korea had similar flavonoid profiles. In addition, *C. tenuipes*, *C. zabelii*, and *C. dielsianus* (sect . Cotoneaster, ser. Integerrimi) had similar flavonoid patterns to taxa in the *C. multiflorus* complex (sect. Cotoneaster, ser. Multiflori). This indicated that the chemical data cut across Y's serial treatment within section Cotoneaster. Earlier studies showed that there were few absolute differences between many of the other woody plants growing on this island and those on the Korean peninsula and mainland of China, or the Japanese archipelago. *C. wilsonii* appears to be another example in which no change in chemistry or morphology has occurred. Many of the woody plants on this island are very recently derived and their progenitors were historically more widely and continuously distributed in eastern Asia.

Corbet, S. A., and A. Westgarthsmith. 1992. Cotoneaster for bumble bees and honey-bees. Journal of Apiculture Research 31 (1): 9-14.

Authors' abstract: Regular monitoring between May and August 1988 of a collection of 22 taxa of cotoneaster in the UK showed that the bumble bees *Bombus pratorum and B. pascuorum* preferentially visited species in the section cotoneaster. The short-tongued bumble bees *B. terrestris/lucorum* and honey bees visited species in both sections of the genus, concentrating on the section Cotoneaster in the dearth period of early summer and on *Chaenopetalum* after mid-June. The section Cotoneaster is recommended as particularly valuable for bee forage. This phenological survey should make it possible to select groups of species for amenity plantings to give a seasonal spread of flowering, enhancing the availability of nectar plants.

Froude, V. A. 2002. Biological control options for invasive weeds of New Zealand protected areas. Science for Conservation 199. 68 pp. Also online: http://www.doc.govt.nz/Publications/004~Science-and-Research/Science-for-Conservation/PDF/sfc199.pdf

According to this document, there are no biological control options for *Cotoneaster* spp. in New Zealand.

Kraus, H. T., S. L. Warren, and C. E. Anderson. 2002. Nitrogen form affects growth, mineral nutrient content, and root anatomy of Cotoneaster and Rudbeckia. Hortscience (1): 126-129.

Authors' abstract: Five ratios of NH4+: NO3- (100:0, 75:25, 50:50, 25:75, and 0:100) were evaluated for impact on growth of *Cotoneaster dammeri* Schneid. 'Skogholm' (cotoneaster), a woody ornamental shrub, and *Rudbeckia fulgida* Ait. 'Goldsturm' (rudbeckia), an herbaceous perennial. Nitrate alone decreased dry weight and leaf area of cotoneaster and rudbeckia compared with mixtures of NH4+ and NO3- and NH4+ alone. Additionally, NO3- alone suppressed accumulation of cationic nutrients and N in cotoneaster, while mixes of NH4+ and NO3- enhanced accumulation of nutrients in roots and shoots of rudbeckia compared with solutions containing either NH4+ or NO3- alone. The steles of roots of cotoneaster and rudbeckia contained more secondary xylem with larger tracheary elements with a mix of 25 NH4+: 75 NO3- than with NO3- alone.

Lelliott, R. A. 1971. *Erwinia amylovora* affecting *Cotoneaster horizontalis* D. Plant Pathology (Oxford) 20 (4): 196.

No abstract available.

Marosz, A. 2004. Effect of soil salinity on nutrient uptake, growth, and decorative value of four ground cover shrubs. Journal of Plant Nutrition 27 (6): 977-989.

Author's abstract: Nutrient uptake and growth of ground cover shrubs: *Cotoneaster horizontalis*, *Cotoneaster* 'Ursynow,' *Potentilla fruticosa* 'Longacre,' and *Spiraea* 'Grefsheim,' grown at different soil salinity levels, were determined. Plants were watered five times in seven day intervals with water or four different sodium chloride (NaCl) solutions, every year during 1997-1999. Tolerant species such as *P. fruticosa* and *C. horizontalis* were not affected by soil salinity of 12 mS cm(-1) (electrical conductivity), while *Cotoneaster* 'Ursynow'

exhibited moderate to severe injury symptoms which became more severe with each growing season. At the end of the experiment, growth of *Spiraea* was significantly decreased at high doses of NaCl. Increasing soil salinity also had a significant effect on nutrient uptake of tested plants.

Raffa, K. F., and G. L. Lintereur. 1988. New host records and developmental notes on the pear slug *Caliroa cerasi* Hymenoptera Tenthredinidae feeding on *Cotoneaster* and *Chaenomeles* species. Great Lakes Entomologist 21 (2): 75-80.

Authors' abstract: The pear slug, *Caliroa cerasi,* was collected and reared to adulthood on flowering quince and three species of *Cotoneaster*. This is the first record of *C. cerasi* attacking any member of the genus *Chaenomeles* and the first confirmation of feeding on *Cotoneaster* in North America. Adult emergence, oviposition, and larval development were evaluated under both laboratory and field conditions. Females lay an average of 48 eggs, with about two-thirds of the oviposition occurring during their first 24 hours. A method for monitoring adult emergence in the field was developed.

[The pear slug (*C. cerasi*) is actually the larva of a Tenthredinid wasp (sawfly), and feeds on pear, apple, and cotoneaster leaves by eating the leaf surface, leaving a skeleton of veins.]

Schultz, P. B., and M. A. Coffelt. 1987. Oviposition and nymphal survival of the hawthorn lace bug (Hemiptera: Tingidae) on selected species of *Cotoneaster* (Rosaceae). Environmental Entomology 16 (2): 365-367.

Authors' abstract: Oviposition and nymphal development of the hawthorn lace bug, *Corythucha cydoniae* (Fitch), were evaluated on 13 species or cultivars of *Cotoneaster. C. cydoniae* had high oviposition and nymphal survival on glabrous foliage of *C. dammeri* 'Royal Beauty' C. K. Schneid. Low oviposition and nymphal survival occurred on pubescent foliage of *C. lacteus* W. W. Sm. Leaf pubescence seemed to have an inhibitory effect on oviposition and nymphal survival. Oviposition was not affected by application of neem seed extract to the foliage.

Stepanek, L. J., and M. O. Harrell. 2002. Mortality of seedling windbreak trees caused by a common sunflower insect *Isophrictis similiella* (Chambers) (Lepidoptera: Gelechiidae). Journal of the Kansas Entomological Society 73 (2): 123-125.

Authors' abstract: A common pest of native sunflowers (*Helianthus* spp.) was found to cause mortality in seedling trees of newly planted windbreaks. *Isophrictis similiella* (Chambers) (Lepidoptera: Gelechiidae) tunnels into the main stem of recently planted trees, causing top dieback and often mortality. Rocky Mountain juniper (*Juniperus scopulorum* Sarg.) and eastern redcedar (*J. virginiana* L.) are commonly attacked. The insect has also been found in cotoneaster (*Cotoneaster* spp.) and potentially may attack a number of species of seedling trees and shrubs. *I. similiella* larvae normally inhabit the stems and heads of sunflower, but if disturbed, as from tree planting operations, the larvae may seek out alternative shelter. Newly planted seedlings are often the only vegetation available.

Sukopp, H., and A. Wurzel. 2003. The effects of climate change on the vegetation of central European cities. Urban Habitats 1 (1): 3-26. Online: http://www.urbanhabitats.org/v01n01/climatechange_pdf.pdf

Authors' abstract: Since the 1850s the effects of global warming have been anticipated by the rise of temperature in many big cities. In addition, vegetation changes in central European cities have been well documented. This paper explores the changing urban distribution of some ruderal herbaceous species and discusses changes in distribution and physiological changes in tree and shrub species in response to this rise in temperature. Examples of affected species covered here include *Acer negundo*, *Ailanthus altissima*, *Amelanchier spicata*, *Berberis julianae*, *Buddleia davidii*, *Colutea arborescens*, *Cornus alba*, *C. stolonifera*, *Cotoneaster bullatus*, *Cytisus multiflorus*, *C. striatus*, *Juglans regia*, *Laburnum anagyroides*, *Ligustrum vulgare*, *Mahonia aquifolium*, *Paulownia tomentosa*, *Philadelphus coronarius*, *Platanus x hispanica*, *Populus x canadensis*, *Prunus armeniaca*, *P. laurocerasus*, *P. mahaleb*, *P. persica*, *P. serotina*, *Pyrus communis*, *Quercus cerris*, *Q. rubra*, *Q. robur*, *Ribes aureum*, *Robinia pseudacacia*, *Sambucus* spp., *Sorbus intermedia* agg., *Symphoricarpos albus*, and *Syringa vulgaris*. The responses of some woody scramblers and creepers are also examined. For many of these species, there was a long lag time between introduction and invasion in the wild. We briefly review phenological investigations, including studies of *Aesculus hippocastanum* and *Tilia euchlora*. Finally, we consider the extent to which cities can act as simulators of global climate change. We conclude that although other ecological and socioeconomic factors are affecting the vegetation in urban areas, many of the nonnative invasive species found colonizing cities (or naturalizing within them) originate in warmer areas and are benefiting from the more favorable climate.

Timmins, S. M., and P. A. Williams. 1991. Weed numbers in New Zealand's forest and scrub reserves. New Zealand Journal of Ecology 15 (2): 153-162.
Also online: http://www.nzes.org.nz/nzje/free_issues/NZJEcol15_2_153.pdf

Authors' abstract: New Zealand's protected natural areas are being increasingly threatened by weeds as the natural landscape is fragmented and surrounding land use intensifies. To assist in designing management to reduce the threat, we attempted to determine the most important reserve characteristics influencing the presence of problem weeds in forest and scrub reserves. Data on 15 reserve characteristics were derived from surveys of 234 reserves. From correlation analysis, analysis of variance and consideration of several multivariate models, it appears that the most important characteristics influencing the number of problem weeds in reserves are proximity to towns, distance from roads and railway lines, human use, reserve shape, and habitat diversity. These factors reflect principally increased proximity to source of propagules associated with intensifying land use, including urbanisation. Reserves with the most weeds are narrow remnants on fertile soils with clearings and a history of modification, and those close to towns or sites of high human activity. If these reserves are to continue to protect natural values, they will require regular attention to prevent the establishment of further weeds.

[*Cotoneaster* spp. were among those studied.]

Tommasi, D., A. Miro, H. A. Higo, and M. L. Winston. 2004. Bee diversity and abundance in an urban setting. Canadian Entomologist 136 (6): 851-869.

Authors' abstract: We assessed bee diversity and abundance in urban areas of Vancouver, British Columbia, Canada, to determine how urban environments can support bees. Habitats

examined were community and botanical gardens, urban wild areas, Naturescape flower beds and backyards, and traditional flower beds and backyards. A total of 56 bee species (Hymenoptera), including species of the genera *Andrena* Fabr. (Andrenidae), *Bombus* Latr. (Apidae), *Osmia* Panzer and *Megachile* Latr. (Megachilidae), and *Halictus* Latr. and *Dialictus* Pauly (Halictidae), were collected. Abundance exhibited strong seasonal variation. Wild bees were most abundant during late spring, whereas honey bees peaked at the end of the summer. The most abundant species seen was the managed honey bee *Apis mellifera* L. (Apidae), followed by wild *Bombus flavifrons* Cresson. Community and botanical gardens, and plants such as cotoneaster (*Cotoneaster* Medik. sp.) and blackberry (*Rubus discolor* Weihe & Nees) (Rosaceae), centaurea (*Centaurea* L. sp.; Asteraceae), buttercup (*Ranunculus* L. sp.; Ranunculaceae), and foxglove (*Digitalis* L. sp.; Scrophulariaceae), had the highest abundance of bees, while bee populations in wild areas were the most diverse. Weeds such as dandelions (*Taraxacum officinale* G.H. Weber ex Wiggers; Asteraceae) dominated these wild areas and had one of the highest diversities of bee visitors. Traditional flower beds with tulips (*Tulipa* L. sp.; Liliaceae) and petunias (*Petunia* Juss. sp.; Solanaceae) had relatively poor diversity and abundance of bees throughout the year. Our study suggests that urban areas have the potential to be important pollinator reservoirs, especially if both bloom and habitat heterogeneity are maintained and enhanced through sustainable urban planning.

Vincent, M. A., and A. W. Cusick. 1998. New records of alien species in the Ohio vascular flora. Ohio Journal of Science 98 (2): 10-17.

Authors' abstract: Examination of specimens of vascular plants from various herbaria, as well as field collections, have revealed 70 taxa not previously reported for Ohio, or previously reported without documentation. This paper documents these new taxa, 44% of which are escapes of woody landscape plants. The specimens cited represent 55 genera in 30 families. Of these, the following genera are first reports for the state: *Achyranthes, Albizia, Carthamus, Cercidiphyllum, Cotoneaster, Dactyloctenium, Fontanesia, Gaillardia, Guizotia, Gypsophila, Stenosiphon, Tripsacum*, and *Zinnia*. Cercidiphyllaceae is the only family reported as new for the state. Some taxa cited in this paper represent first reports as escapes for North America. These are *Cotoneaster divaricatus* (Rosaceae), *Fontanesia fortunei* (Oleaceae), *Magnolia* x *soulangeana* (Magnoliaceae), *Magnolia stellata* (Magnoliaceae), *Viburnum buddleifolium* (Caprifoliaceae), and *Viburnum* x *rhytidiphylloides* (Caprifoliaceae).

Weller, R., and A. Ormerod. 1996. Contact dermatitis from cotoneaster. Contact Dermatitis 34 (6): 433-444.

No abstract available. Document is a note, not a full article.

Other Published Sources

Brayshaw, T. C. 1996. Trees and Shrubs of British Columbia. UBC Press, Vancouver, BC, and Royal British Columbia Museum, Victoria, BC. 374 pp.

This reference book describes nearly 300 species of trees and shrubs, as well as many subspecies and varieties, including cotoneasters, found in British Columbia.

Crofts, A., and R. G. Jefferson. 1999. Lowland Grassland Management Handbook. The Wildlife Trusts, English Nature, and the Countryside Council for Wales and Scottish Natural Heritage, United Kingdom.

Excerpt: A particular problem in calcareous grasslands is the establishment and spread of a range of shrubs belonging to the genus *Cotoneaster*. More than 100 species, many of Chinese or Himalayan origin, are widely cultivated in British towns and gardens, and most have the potential to become established in the wild. The prostrate species *C. integrifolius* (often recorded as *C. microphyllus*) and *C. horizontalis* appear to be particularly problematic, erect species such as *C. simonsii* occurring more locally. Infestations have been reported from a variety of substrates in different parts of England and Wales, including chalk as well as harder Jurassic and Carboniferous limestone. *Cotoneaster* berries are highly attractive to blackbirds and other thrushes, which readily disperse them to defecation sites. Once established, expansion of local colonies may result in extensive smothering of native communities, greatly altering their structure and composition. Ledge, crevice and scree communities may be affected, as well as a range of calcicolous grassland communities. Among the latter, open *Festuca ovina – Carlina vulgaris* (CG1) swards on summer-parched slopes, as well as *F. ovina – Avenula pratensis* grassland (CG2) and other closed turf communities on deeper soils, are prone to infestation. Root systems are highly pervasive, often penetrating deeply into crevices in the bedrock. Five methods of control have been trialed (Nile Waller (British Trust for Conservation Volunteers), Frances Cattanach (North Wales Wildlife Trust) and Matthew Oates (National Trust, pers. comm.)).

- Hand excavation and extraction are possible in some situations but often cause undesirable disturbance to the substrate.
- Hand cutting at ground level reduces the vigour of invasive plants but is labour-intensive and does not result in eradication. Repeated cutting on a 3-4 year rotation is required.
- Herbicide treatment of cut shoot bases is excessively time-consuming because of the highly divided stems, and is ineffective at preventing regeneration.
- Herbicide treatment of growing shrubs using glyphosate (30 per cent solution in water), applied either by weed wiper or hand-held spray, is effective at killing plants and controlling regrowth.
- Burning is ineffective at controlling regeneration, risks damaging associated vegetation and causing nutrient-enrichment of soils, and is not recommended.

Douglas, G. W., D. Meidinger, and J. Pojar (eds.). 1999. Illustrated Flora of British Columbia, Volume 4: Dicotyledons (Orobanchaceae Through Rubiaceae). Ministry of Sustainable Resource Management and British Columbia Ministry of Forests, Victoria, BC. 427 pp.

This comprehensive reference has excellent identification keys and detailed technical descriptions of vegetative and sexual morphology. This flora is the taxonomic authority for the invasive species fact sheets (unless otherwise indicated). Douglas et al. describe the habitat for the following *Cotoneaster* species, all of which were introduced from Asia:

- *C. bullatus* Bois., puckered-leaf cotoneaster: found in moist edges of forests and disturbed places in the lowland zone; rare on the Lower Mainland;
- *C. horizontalis* Decaisne, rock cotoneaster: dry to mesic waste places or open forests in the lowland zone; rare garden escape on southern Vancouver Island, the Gulf Islands and the lower Fraser Valley;

- *C. simonsii* Bak., Himalayan cotoneaster, Simon's cotoneaster: moist edges of forests and disturbed places in the lowland zone; rare on the Lower Mainland.

Evans, I. R. 1996. Impact of fire blight on Rosaceous species in central Alberta. Pages 27-28 *in* Bonn, W. G. (ed.). VII International Workshop on Fire Blight. ISHS Acta Horticulturae 411.

Author's abstract: The relatively dry prairie climate of central Alberta does little to constrain destructive outbreaks of fire blight (*Erwinia amylovora* (Burr.) Winsl. *et al*.) on a range of Rosaceous species. The most severely affected species are European mountain ash (*Sorbus aucuparia* L.) and crabapple (*Malus coronaria* (L.) Mill.). Destructive outbreaks on mountain ash in urban and suburban locations seem to occur in roughly 5 year cycles. On crabapple, particularly the columnar (*Malus baccata* 'Columnaris') and royalty (*Malus* x adstingens 'Royalty') types, the disease is omnipresent and generally kills trees within 1–2 years of the onset of infection. Fire blight infections may also be destructive on apple (*Malus pumilla* Mill.), hawthorn (*Crataegus* spp.), cotoneaster (*Cotoneaster* spp.), saskatoon (*Amelanchier alnifolia* Nutt.) and raspberry (*Rubus* spp.), but it rarely occurs on pear (*Pyrus* spp.) and apricot (*Prunus mandschurica* L.). The disease has never been confirmed on cultivated cherry (*Prunus cerasus* L.) and plum (*Prunus* spp.) or their wild relatives in Alberta.

Groves, R. H., R. Boden, and W. M. Lonsdale. 2005. Jumping the Fence: Invasive Garden Plants in Australia and Their Environmental and Agricultural Impacts. CSIRO report prepared for World Wildlife Fund, Sydney, Australia. Also online: http://www.wwf.org.au/News_and_information/Publications/PDF/Report/jumping_the_garden_fence.pdf

The report lists *Cotoneaster* spp. in the ten most serious invasive garden plants for sale in the Australian Capital Territory.

Hill, H. 2001. Where on Earth Is Your Garden? *Menziesia* (Newsletter for the Native Plant Society of BC) 6 (2): 1, 10. Victoria, BC. http://www.npsbc.org/Newsletter/Menziesia01Spring.pdf

Hill suggests replacing creeping cotoneaster with kinnikinnick.

Linderman, R., J. Parke, and E. Hansen. 2002. Potential impact of *Phytophthora ramorum* on nursery crops in the Pacific Northwest. Sudden Oak Death Science Symposium, December 15-18, 2002, Monterey, CA.

Authors' abstract: The discovery of *Phytophthora ramorum* infecting plants such as *Rhododendron* and *Viburnum* that are grown extensively in nurseries, raised the question of what its potential impact would be if introduced into production areas of the nursery industry in the Pacific Northwest. We predict very high risk because of the wide range of tree and shrub plant species and cultivars grown; because the climatic conditions in Oregon's Willamette Valley would be optimum for the pathogen; because irrigation and fertilization practices might favor infections in the nursery; because plant material at all stages of growth is moved within and between nurseries; and because symptoms caused by *P. ramorum* and other *P*. species on any one host, such as rhododendrons, might be similar and therefore preclude its detection. Furthermore, symptoms caused by *P. ramorum* might not be the

same on different hosts. As a result, infected symptomatic or symptomless plants might be shipped to other nurseries.

Our studies sought to determine (1) if there would be any distinguishing symptoms caused by *P. ramorum* on a range of ornamental plants compared to those caused by other *P*. species known to occur in Oregon (*P. cactorum*, *P. syringae*, *P. citricola*, *P. hevea*, *P. parasitica*, *P. citrophthora*, and *P. cinnamomi*); (2) how many plants would be potential hosts for *P. ramorum* compared to other *P*. species, (3) if *P. ramorum* is more virulent than other *P*. species on any given host plant, and (4) if the biological traits for *P. ramorum*, especially sporulation capacity, would increase its potential to have a major disease impact on nursery production.

Inoculation of detached leaves of all hosts with mycelial plugs of each *P*. species resulted in varied susceptibility and severity of symptoms based on visual ratings of lesion size. On any given host, lesions were essentially identical in appearance, but on hosts like laurels, "shot-hole" lesions developed compared to general necrosis seen on most hosts. Species of *Rhododendron*, *Pieris*, *Vaccinium*, *Syringa*, *Prunus* (Laurel), *Cotoneaster*, and *Arctostaphylos* were the most susceptible to the most *P*. species. Some plants were susceptible to *P. ramorum* but not other *P*. species (*Viburnum plicatum* 'Tomentosum' and *V. davidii*), while others were susceptible to other *P*. species but not *P. ramorum*. *P. ramorum*, *P. citricola*, and *P. citrophthora* were the most aggressive/virulent pathogens, often spreading throughout the entire leaf. Of the many plant species and cultivars tested by inoculation with mycelial plugs or by dipping leaves in a zoospore suspension, some were essentially resistant, others varied from low to moderate to highly susceptible. Sporulation (sporangia/zoospores and chlamydospores) by *P. ramorum* also varied on different hosts when leaf discs were inoculated by floating them on a zoospore suspension, and it was more profuse on infected tissues and on agar media than any other *P.* species. These results indicate (1) that a wider range of nursery and landscape plants should be surveyed for early detection of *P. ramorum* and other aggressive species in the nurseries; (2) that *P. ramorum* is as virulent as *P. citricola* and *P. citrophthora* on some hosts, uniquely virulent on some hosts, and less virulent on others; and (3) that the sporulation potential of *P. ramorum* exceeds that of most *P*. species, leading to the conclusion that *P. ramorum* would have very significant disease-causing potential in nurseries in the Pacific Northwest.

Sigg, J. 1996. *Cotoneaster microphyllus, C. pannosus, C. lacteus* Cotoneaster. Pages 49-50 *in* Randall, J. M., and J. Marinelli (eds.). Invasive Plants: Weeds of the Global Garden. Brooklyn Botanic Garden Publications, Brooklyn, NY. 112 pp.

The common name of *C. microphyllus* is rockspray cotoneaster; no common names are given for the other 2 species.

"[*Cotoneaster* spp.] flower and fruit best in poor, dry soils. … Although cotoneasters are apomictic—that is, they can set seed without benefit of pollination and subsequent fertilization—they can also produce seed following pollination, and different species may hybridize. … Other species in addition to the three listed above may become pests."

"Cotoneasters are native to Eurasia, principally China. They were much collected by English plant hunters, and from England made their way to U.S. gardens. Rockspray cotoneaster was introduced to England in 1824 and to California in 1854. Collectors sent additional species throughout the next century, and by 1900 a wide selection was available. For a long time they were not reported as escaping cultivation, but during the past two or three decades increasing numbers have been seen in wildlands along the foggy central and northern

California coast, and they are now beginning to be taken seriously by those concerned with the health of native biological communities."

"Although they are still not seen in large numbers, the fact that cotoneasters are bird-distributed, can penetrate intact and seemingly healthy ecosystems and thrive in poor, thin and droughty soils that many native California species claim as their domain, makes them cause for concern. All cotoneasters have aggressive root systems, and the plants shade and smother sun-loving natives. Eventually, diverse native communities are displaced by cotoneaster. In California, cotoneasters may directly compete with the closely related native toyon (*Heteromeles arbutifolia*), its equal in beauty."

"Although they have a tough and deep root system, while young they can be uprooted with a weed wrench. Because cotoneasters branch profusely at ground level, this technique cannot be used on larger plants. Cutting branches to the stump and painting them with a 100 percent glyphosate herbicide is very effective. The myriad seedlings surrounding cut shrubs can be either smothered with mulch or black plastic, hand-pulled or sprayed."

Zheng, H., Y. Wu, J. Ding, D. Binion, W. Fu, and R. Reardon. 2004. Invasive Plants of Asian Origin Established in the US and Their Natural Enemies. Volume 1. USDA Forest Service, FHTET-2004-05.
http://www.invasive.org/weeds/asian/cotoneaster.pdf

This website includes information about *Cotoneaster* spp. in Asia (where they originate). The document lists eight fungi and three arthropods that are reported to attack members of the genus *Cotoneaster.*

Unpublished Sources and Websites

ARC – Plant Protection Research Institute. No date. Alien Invasive Plants and Weeds. South Africa.
http://www.arc.agric.za/institutes/ppri/main/divisions/weedsdiv/alienplants/legislation.htm

Cotoneaster franchetii and *C. pannosus* are declared weeds under Category 3 in South Africa.

Berney, P. 2002. Extending Weed Control Beyond the Boundaries of Reserves. TASWEEDS Edition 16, Tasmania, Australia.
http://www.angelfire.com/nb/tasweeds/tasweeds_august_2002.pdf

This article describes an exchange program in Tasmania in which residents were encouraged to replace invasive garden species with native species. "Cotoneaster was the target weed in a program that offered residents free native plants in exchange for cotoneaster plants that they removed from their gardens. Cotoneaster was planted extensively in the Mt Nelson area following the 1967 bushfires in Hobart. It is now a major problem weed in the Lambert Gully Reserve. The project began with a brochure being delivered to each house explaining the impact cotoneaster was having in the reserve and the connection between the problem and their gardens. The incentive offered to the households was in the form of a free native plant for each cotoneaster removed, up to a limit of ten plants per household. The information brochure explained how to remove a cotoneaster and poison the stump. … Altogether a total of 17 tonnes of cotoneaster was [sic] removed in the

project. … The approach adopted in these weed reduction programs has two advantages, firstly, it leads to an increased awareness for many members of the public about the issue of environmental weeds. Secondly, it provides them with an incentive and a deadline for them to act on the problem."

California Invasive Plant Council. No date. *Cotoneaster* spp. Berkeley, CA. http://ucce.ucdavis.edu/datastore/detailreport.cfm?usernumber=36&surveynumber=182

A fairly comprehensive overview of *Cotoneaster* species including identification, habitat, vectors of spread, impacts and management techniques. The website focuses on *Cotoneaster franchetii* and *C. pannosa*.

Catalog of Future Research Opportunities in Bay Area National Parks. No date. Containment of Cotoneaster (*Cotoneaster pannosa*). Point Reyes National Seashore, Point Reyes Station, CA. http://www.nps.gov/pore/science_catalog_invasive.htm#project6

This project involves the development of a parkwide cotoneaster (*Cotoneaster pannosa*) containment plan and its implementation. The project includes: creating GIS layers delineating population boundaries and noting possible directions of spread (through trail activities, wind transport, etc.); determining population expansion rates, by comparing data to 1987 mapping efforts; conducting literature searches; identifying patterns of spread; developing and enhancing containment and removal prescriptions; prioritizing populations for removal and implementing the containment/removal plan for the 5 most critical populations; implementing a parkwide education and awareness program for maintenance staff working in areas within or adjacent to infestations; expanding of volunteer and community involvement for long-term control.

Cooke, D. 2001. *Cotoneaster pannosus*. Pacific Island Ecosystems at Risk (PIER). http://www.hear.org/pier/wra/australia/copan-wra.htm

This website presents an assessment of the risk of *C. pannosus* for Australia. *C. pannosus* has a risk assessment of 5, which "requires further information" (but is getting close to 6, which is "reject this species for import").

Eugene Parks and Open Space. 2003. Invasive Species Discouraged-From-Use List. City of Eugene, OR. http://www.ci.eugene.or.us/parks/volunteer/invasive_list2.htm

Cotoneaster franchetii, C. horizontalis, C. parneyi and others occur in native prairies and woodland edges in Oregon. The website recommends that gardeners avoid all cotoneasters.

Hawaiian Ecosystems at Risk Project. A Global Compendium of Weeds. http://www.hear.org/gcw/html/index.html

Very basic information on various *Cotoneaster* species, and crosslinks to related references from around the world.

Karori Wildlife Sanctuary. 2004. Giving Our Forest Room to Regenerate. Karori Wildlife Sanctuary Trust, New Zealand.

http://www.sanctuary.org.nz/whatsnew/news/pdf/WeedControl.pdf

This site provides information on control of *Cotoneaster lacteus*. Control methods: “Dig out seedlings and smaller plants ensuring all roots are removed. Cut larger plants near ground level and treat cut surface *immediately* with 1 part Glyphosate (ask for this at any garden centre) to 4 parts water.”

Klinkenberg, B. 2004. E-Flora BC: Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. http://www.eflora.bc.ca/

This site provides information on the distribution of cotoneasters (*C. bullatus*, *C. horizontalis* and *C. simonsii*) in BC as well as information on identification, ecology, habitat and nomenclature. Links are given to other relevant websites. According to this website, *C. bullatus* is known from one record in the Lower Mainland of Vancouver, *C. horizontalis* is found on southern Vancouver Island and the Sunshine Coast, and *C. simonsii* is known from the Queen Charlotte Islands, Southern Vancouver Island, the Gulf Islands and the Lower Mainland (Vancouver).

Laime, B. No date. Invasive Plant Species. Latvian Environment Agency, Latvia. http://www.lva.gov.lv/daba/eng/biodiv/invazivas_sugas_e.htm

According to this site, *Cotoneaster lucida* is listed among the top 15 most invasive plant species in Latvia.

Murray, C., and R. K. Jones. 2002. Decision Support Tool for Invasive Species in Garry Oak Ecosystems. Prepared by ESSA Technologies Ltd. for the Garry Oak Ecosystems Recovery Team, Victoria, BC.
http://www.goert.ca/docs/goe_dst.pdf

“Rock cotoneaster” (several *Cotoneaster* species, not specified) is listed as an exotic known in Garry oak ecosystems as of February 2002.

Native Plant Society of Oregon. 2002. Invasive Gardening and Landscaping Plants of the Southern Willamette Valley. Native Plant Society of Oregon, Emerald Chapter, Eugene, OR. http://www.emeraldnpso.org/PDFs/Invas_Orn.pdf

This document describes *Cotoneaster* species as of moderate impact (i.e., moderately invasive but may not disperse widely). These species occur in native prairies and woodland edges. This organization discourages the use of all cotoneasters.

Natural Resources Conservation Service. No date. Plants Profile: *Cotoneaster* spp. United States Department of Agriculture Plants Database, Washington, DC.
http://plants.usda.gov/index.html

This database includes *Cotoneaster acutifolius*, *C. adpressus*, *C. apiculatus*, *C. franchetii*, *C. horizontalis*, *C. hupehensis*, *C. integerrimus*, *C. lacteus*, *C. lucidus*, *C. multiflora*, *C. pannosus*, *C. salicifolius* and *C. simonsii.* It provides information on physical characteristics, habitats and locations, edible and medicinal uses, cultivation and propagation. There are also links to numerous other sites.

NatureServe. 2005. Invasive Species Impact Ranks for the United States. Arlington, VA. http://www.natureserve.org/getData/plantData.jsp

NatureServe is assessing all of the estimated 3500 non-native plant species that have escaped from cultivation in the US using a new methodology called “Invasive Species Assessment Protocol.” This system, developed by NatureServe, the Nature Conservancy and the National Park Service, creates a prioritized list of non-native plants and their impact on biodiversity. The site also includes citations and references used in assessing the species. *Cotoneaster pannosus* is the only *Cotoneaster* species listed. It is considered a medium National I rank.

Parks and Recreation. No date. Integrated Pest Management (Chapter 4). San Francisco, CA. http://www.parks.sfgov.org/wcm_recpark/snra062002/Sections/4.%20Intergrated%20Pest%20Management.pdf

This document contains information on controlling *Cotoneaster* species. Cotoneasters “can be tolerated at moderate levels (moderate treatment threshold) because they are easier to control or are limited by on-site environmental factors. For these species, containment and reduction are the most frequently used strategies.” The document also provides a calendar for timing mechanical and chemical treatments.

Plants for a Future Database. No date. *Cotoneaster* spp. Plants for a Future, Chapel Hill, NC. http://www.ibiblio.org/pfaf/D_search.html.

This database provides information on physical characteristics, habitats and locations, edible and medicinal uses, cultivation and propagation for *Cotoneaster acuminatus, C. bacillaris, C. divaricatus, C. franchetii, C. frigidus, C. glaucophyllus, C. lacteus, C. microphyllus, C. racemiflorus, C. serotinus, C. simonsii, C. wardii* and *C*. x *watereri* (all non-native). There are also links to numerous other sites.

Randall, J. M., and S. Reichard. No date. Roadside Use of Native Plants: Choosing Non-invasive Plant Species—When Is It Safe to Use Non-native Plants? US Department of Transportation, Federal Highway Administration, Washington, DC. http://www.fhwa.dot.gov/environment/rdsduse/rd_use19.htm

According to this website, *Cotoneaster adpressus* is a non-invasive ground cover that can be used on transportation corridors.

Science Now. No date. Invasive Species: Cotoneaster (C*otoneaster franchetti* [*sic*],*Cotoneaster pannosa*). California Academy of Sciences, San Francisco, CA. http://www.calacademy.org/science_now/invasive_species/

Extract: These shrubs, which evolved in Eurasia, were introduced to California in 1854 as decorative garden plants, but with the help of local birds, they quickly escaped the walls of cultivation. Unlike most native California plants, which produce berries in the summer and fall, cotoneasters fruit in the winter, making their bright red berries especially attractive to wintering birds. The birds then spread cotoneaster seeds in their droppings all along the California coast. Once they take root, cotoneasters compete aggressively for light and physical space, pushing out native plants like huckleberries. For the sake of these wild delicacies, gardeners should consider replacing invasive cotoneasters with native California plants.

Starr, F., K. Starr, and L. Loope. 2003. *Cotoneaster pannosus*. United States Geological Survey—Biological Resources Division, Haleakala Field Station, Maui, Hawai'i. http://www.hear.org/starr/hiplants/reports/html/cotoneaster_pannosus.htm

Author's overview: *Cotoneaster pannosus* is a popular ornamental plant that escapes from cultivation and has become a pest in at least Hawai'i, California, and Australia. Plants are dispersed by fruit eating birds and can form thickets along roads and pastures, in woodlands and shrublands, and in both disturbed and natural plant communities. This plant prefers cooler climates and poses the greatest risk to native mid-elevation shrubland and mesic forests where plants can readily germinate and form large stands. The plant is not currently on the Hawai'i state noxious weed list and it is somewhat widely planted on East Maui. Early detection of naturalized plants in natural environments will help prevent large infestations. Public education is needed to discourage plantings of this and other potentially harmful ornamentals, especially in or near natural areas.

StopWaste.org. 2005. Invasive Plants of the San Francisco Bay Area. Alameda County Waste Management Authority and Alameda County Source Reduction and Recycling Board, San Francisco, CA. http://www.stopwaste.org/home/index.asp?page=416

Alternative garden species recommended to replace *Cotoneaster lacteus* and *C. pannosus* include toyon (*Heteromeles arbutifolia* and cultivars), pineapple guava (*Feijoa sellowiana*), strawberry tree (*Arbutus unedo*), sandankwa viburnum (*Viburnum suspensum*) and calamondin orange (*Citrus mitis* or x *Citrofortunella microcarpa*).

Tucker, P. 1997. *Cotoneaster* Species – Cotoneaster. Trees for Life, Pasadena, South Australia. http://www.treesforlife.org.au/rogues/weeds/cotoneaster.html

This website provides information regarding the revegetation and protection of threatened and valuable bushland in Australia. It recognizes *Cotoneaster* species as invasive. For removal, cutting the plant close to ground and swabbing it with concentrated glyphosate is recommended. It may also be beneficial to rough up any exposed bark and paint it with glyphosate. Seedlings can be removed by hand, but soil disturbance should be minimized, which is easier when the soil is moist.

UK Biodiversity Action Plan. No date. Species Action Plan – Wild Cotoneaster (*Cotoneaster integerrimus*). UK Biodiversity Partnership and UK Government, United Kingdom. http://www.ukbap.org.uk/UKPlans.aspx?ID=242

This website discusses the conservation of endangered wild cotoneaster in Britain. One of the threats to this wild species is the introduction and spread of invasive non-native cotoneasters.

Weed Risk Assessment for Hawaii and Pacific Islands. No date. Hawaii. http://www.botany.hawaii.edu/faculty/daehler/wra/wra_table.asp

This website predicts that *Cotoneaster pannosus* is "likely to be invasive in Hawaii and on other Pacific Islands." Predictions are based on field observations and information from the USDA Forest Service and from the Hawaii Division of Forestry and Wildlife Urban and Community Forestry program.

General summaries of basic information, or fact sheets:

- http://www.orc.govt.nz/html/details.html?details=6&articleID=226
- http://www.nps.gov/redw/cotoneaster.htm
- http://www.state.hi.us/dlnr/dofaw/hortweeds/species/cotpan.htm
- http://www.ecoaction.net.au/ccserac/docs/weeds/cotoneaster.htm
- http://northcoastcnps.org/iwhc/iwhcb1.htm
- http://www.weeds.org.au/cgi-bin/weedident.cgi?tpl=plant.tpl&state=&ibra=all&card=S01
- http://www.weedsbluemountains.org.au/cotoneaster.asp
- http://www.weeds.asn.au/weeds/txts/cotoneaster.html
- http://www.es.govt.nz/Departments/biosecurity/WOM/documents/January%202004%20-%20Franchet%20Cotoneaster.htm
- http://www.ccc.govt.nz/Parks/TheEnvironment/WeedGuide/PDF/Jun2004.pdf
- http://www.sydneyweeds.org.au/Cotoneaster.htm

Personal Communications

Beckwith, Brenda. 2005. *Personal communication*. Ethnoecologist, University of Victoria, Victoria, BC. March 18, 2005.

> Beckwith has not observed this species in natural areas. At an old homestead at Christmas Hill, it is an established woody species. She recommends cutting the plants to eradicate them, or digging out the roots on sites where there is not high ecological value.

Boyer, Lynda. 2005. *Personal communication*. Restoration Biologist and Native Materials Manager, Heritage Seedlings Inc., Salem, OR. March 21, 2005.

> Boyer has seen cotoneasters only in wet prairies around Eugene and has not observed them in any oak or prairie habitats in Salem.

Ceska, Adolf. 2005. *Personal communication*. Botanist, Victoria, BC. March 16, 2005.

> Ceska has observed that cotoneasters are quite common in urban areas (like Victoria), but there is little evidence of them outside urban areas that have been impacted by people. He has seen them in Garry oak ecosystems, but not commonly.

Erickson, Wayne. 2005. *Personal communication*. Wildlife Conservation Ecologist, Ministry of Forests, Victoria, BC.

> Erickson notes that cotoneasters seem to spread under cover from landscaping material dumps (which unfortunately are common in Garry oak habitat).

Fairbarns, Matt. 2005. *Personal communication*. Plant Ecologist, Aruncus Consulting, Victoria, BC. February 22, 2005.

> Fairbarns has observed cotoneasters growing primarily on the coast at low elevations (100 m or lower), usually near cities or towns or gardening areas. A common variety is *C.*

horizontalis, which grows well across rocky or dirt areas. He notes that cotoneasters can really spread in some areas, particularly in Garry oak woodlands, although they don't usually form a dense canopy. Currently, he is seeing them as scattered plants, but he states that these species could become more abundant later, and they have the potential to become increasing pests in natural and semi-natural Garry oak woodlands and meadows. Since the species are bird dispersed, once a plant establishes there is a nucleus around which a whole population can develop. Fairbarns notes that cotoneasters tend to be quite tolerant of an extended summer drought, but they will die on particularly droughty habitat. He has observed them in soil types ranging from subhygric (rarely) through mesic (often) to dry mesic (fairly frequently) and subxeric (often), but has noted that they are most problematic on truly xeric sites where there are fissures in rocks. These species will shade out Garry oak meadow species, and probably compete with them quite successfully for moisture. Cotoneasters are also extremely popular with bees, so Fairbarns hypothesizes that these plants may reduce pollination rates of native species. Since cotoneasters are non-rhizomatous, he suggests cutting below the root crown. For prevention, Fairbarns suggests eliminating seed sources near natural communities.

Fitzpatrick, Greg. 2005. *Personal communication*. Stewardship Coordinator for the Willamette Valley, The Nature Conservancy, Corvallis, OR.

Fitzpatrick has observed cotoneasters in the Garry oak habitat of Oregon, but not to the stage where they look invasive or have taken over habitat. Since birds disperse the seeds, he predicts that cotoneasters would have already spread throughout the area if they were highly invasive. When he sees cotoneasters, he cuts them and uses a 50% dilution of Roundup on the stumps if they resprout.

Hebda, Richard. 2005. *Personal communication*. Curator of Botany and Earth History, Royal BC Museum, Victoria, BC. March 16, 2005.

Hebda has not observed cotoneasters to be an issue in Garry oak ecosystems. He has seen them primarily in gardens, or in sites that were previously gardens. One potential problem with these species is that they could invade cracks in rocky sites, and then would be difficult to remove. Hebda suggests that cotoneasters should be more widely monitored to ensure that they are not becoming a problem.

Lomer, Frank. 2005. *Personal communication*. Naturalist, New Westminster, BC. March 8, 2005.

Lomer has observed *Cotoneaster paladus*, *C. horizontalis*, *C. simonsii* and *C. franchetii* in natural areas, although they have been sparse. He has seen cotoneasters in the Queen Charlotte Islands, and has noted *C. simonsii* on one of the Gulf Islands. However, cotoneasters usually can't survive droughts and he has not seen much of them in the very dry ecosystems. He feels that none of these species would be much of a problem in BC generally, and in Garry oak ecosystems in particular. Cotoneasters are spread by birds and often occur on rocky slopes. He has observed that they usually occur as just one or two plants and are not very "weedy." He predicts that *C. horizontalis* would be the worst of the species, but that cotoneasters should not generally be species of concern.

Polster, Dave. 2005. *Personal communication*. Plant Ecologist, Polster Environmental Services Ltd., Victoria, BC. February 21, 2005.

Polster considers cotoneasters to be a problem since they are spread by birds and can appear in odd locations. He has seen them tolerate both shade (like holly in a forest) and sun (open rocky areas). In Garry oak ecosystems, cotoneasters are very scattered, and tend to grow in harsh places like rock outcrops and spread from there. He suggests controlling cotoneasters by cutting them with pruners low on the stem. He suggests removing these plants from gardens to prevent further spread.

Roemer, Hans. 2005. *Personal communication*. Botanist, Victoria, BC. March 17, 2005.

Roemer notes that there are several species of *Cotoneaster* in the Vancouver Island area that have come as garden escapees. Most of these are originally from countries with a different precipitation regime, so they are not very well adapted to the dry Garry oak ecosystems. However, because of the number of cultivated species, there may be some that come originally from dry habitats. Roemer has observed cotoneasters occasionally in Garry oak communities. He feels that there is a possibility that populations could expand, but because there is a tremendous number of species, it is challenging to properly identify those that most frequently escape. He has observed *C. franchetii* scattered in local Garry oak habitats. Roemer notes that cotoneasters will not survive on the driest aspects since they need more moisture, and he has seen them on north-facing slopes and sometimes in partial shade. He notes that there is always a possibility that a very drought-resistant species will find a niche and increase from there.