TL Morelli *et al.* – Supporting Information

WebPanel 1. Refugia glossary

Climate-change refugia: Morelli *et al*. (2016) defined in situ climate-change refugia as areas relatively buffered from contemporary climate change over time that enable persistence of valued physical, ecological, and sociocultural resources. More broadly, climate refugia are habitats that components of biodiversity retreat to, persist in, and can potentially expand from under changing environmental conditions (Keppel *et al.* 2012).

Disturbance refugia: locations that are disturbed less severely or frequently than the surrounding landscape (Krawchuk *et al*. 2020); the overlap of multiple disturbances can degrade or amplify disturbance refugia function.

Ecosystem-protected refugia: areas in which ecosystem processes provide buffering against climate change, providing long-term refugia or holdout potential in the absence of major disturbance (Stralberg *et al.* 2020).

Ex situ refugia: refugia located outside a species' current distribution, ie areas that are [at present] geographically removed from a species' current range but where climate conditions are projected to be suitable in the future (Ashcroft 2010; Keppel *et al.* 2012; Stralberg *et al.* 2018).

Holdout: a population that persists in a microclimate for a limited time under deteriorating climate conditions (Hannah *et al.* 2014).

Hydrologic refugia: also referred to as mesic refugia, areas within otherwise water-limited regions that sustain relatively high water availability with hydrologic conditions that are loosely coupled to (buffered from) regional climate change (McLaughlin *et al.* 2017).

In situ refugia: refugia located within a species' current distribution, ie defined by overlap between current and future climate niches (Ashcroft 2010; Keppel *et al.* 2012; Stralberg *et al.* 2018).

Macrorefugia: large areas with sustained climate suitability at broad spatial and temporal scales (Ashcroft 2010; Michalak *et al*. 2018).

Microrefugia: geographically small areas with locally favorable environmental conditions that enable persistence of small populations in regions of unfavorable climate (Rull 2009; Dobrowski 2011). Microrefugia have been referred to as "cryptic refugia" because of the difficulty in locating them using coarse-grained models (Ashcroft *et al.* 2012).

Refuge: microhabitat providing contemporary protection from adverse conditions, eg disturbances, predation, competition, herbivory (Keppel *et al.* 2012; Davis *et al.* 2013).

Stepping-stones: populations occupying successive microclimates that have a role in mediating the range shift of a species in response to climate change (Hannah *et al.* 2014).

Terrain-mediated refugia: areas that are buffered against climate change by physical terrain features, resulting in a local decoupling from regional climates (Stralberg *et al.* 2020). Terrain-mediated refugia may occur at multiple spatial scales.

Vegetative refugia: locations where a vegetation assemblage is more likely to persist/not to transition to other vegetation types or remains within the most frequently occupied climates that it currently experiences across its entire range (Williams *et al.* 2018; Thorne *et al.* 2020).

WebReferences

Ashcroft MB. 2010. Identifying refugia from climate change. *J Biogeogr* **37**: 1407–13.

Ashcroft MB, Gollan JR, Warton DI, and Ramp D. 2012. A novel approach to quantify and locate potential microrefugia using topoclimate, climate stability, and isolation from the matrix. *Glob Change Biol* **18**: 1866–79.

Davis J, Pavlova A, Thompson R, and Sunnucks P. 2013. Evolutionary refugia and ecological refuges: key concepts for conserving Australian arid zone freshwater biodiversity under climate change. *Glob Change Biol* **19**: 1970–84.

Dobrowski SZ. 2011. A climatic basis for microrefugia: the influence of terrain on climate. *Glob Change Biol* **17**: 1022–35.

Hannah L, Flint L, Syphard AD, *et al.* 2014. Fine-grain modeling of species' response to climate change: holdouts, stepping-stones, and microrefugia. *Trends Ecol Evol* **29**: 390–97.

Keppel G, Van Niel KP, Wardell-Johnson GW, *et al.* 2012. Refugia: identifying and understanding safe havens for biodiversity under climate change. *Global Ecol Biogeogr* **21**: 393–404.

Krawchuk MA, Meigs GW, Cartwright JM, *et al.* 2020. Disturbance refugia within mosaics of forest fire, drought, and insect outbreaks. *Front Ecol Environ* **18**. [this issue]

McLaughlin BC, Ackerly DD, Klos PZ, *et al.* 2017. Hydrologic refugia, plants, and climate change. *Glob Change Biol* **23**: 2941–61.

Michalak JL, Lawler JJ, Roberts DR, *et al.* 2018. Distribution and protection of climatic refugia in North America. *Conserv Biol* **32**: 1414–25.

Morelli TL, Daly C, Dobrowski SZ, *et al.* 2016. Managing climate change refugia for climate adaptation. *PLoS ONE* **11**: e0159909.

Rull V. 2009. Microrefugia. *J Biogeogr* **36**: 481–84.

Stralberg D, Arseneault D, Baltzer JL, *et al.* 2020. Climate-change refugia in boreal North America: what, where, and for how long? *Front Ecol Environ* **18**. [this issue]

Stralberg D, Carroll C, Pedlar JH, *et al*. 2018. Macrorefugia for North American trees and songbirds: climatic limiting factors and multi-scale topographic influences. *Global Ecol Biogeogr* **27**: 690–703.

Thorne JH, Gogol-Prokurat M, Hill S, *et al.* 2020. Vegetation refugia can inform climate-adaptive land management under global warming. *Front Ecol Environ* **18**. [this issue]

Williams JN, Rivera R, Choe H, *et al.* 2018. Climate risk on two vegetation axes – tropical wet-to-dry and temperate arid-to-moist forests. *J Biogeogr* **45**: 2361–74.