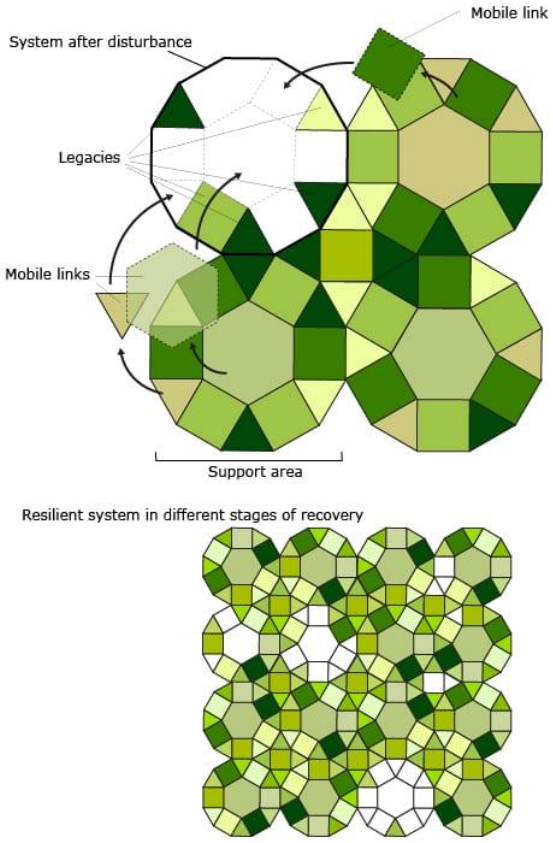
生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	生態系自擾動復原 Ecosystems Recover From Disturbance
生物系統 LIVING SYSTEM	森林生態系 Forest ecosystems
功能類別 FUNCTIONS	# 群落調節擾動 # Manage Disturbance in a Community
作用機制標題	森林和其他生態系統可以藉由生物傳承性、流動連結物種和支持區域復原至干擾前的組成和結構。 Forests and other ecosystems can return to their predisturbance composition and structure through the presence of biological legacies, mobile links, and support areas.
生物系統/作用機制示意圖 (確認版權、註明出處；畫質)	 出處： Ask Natue

作用機制摘要說明 (SUMMARY OF FUNCTIONING MECHANISMS)

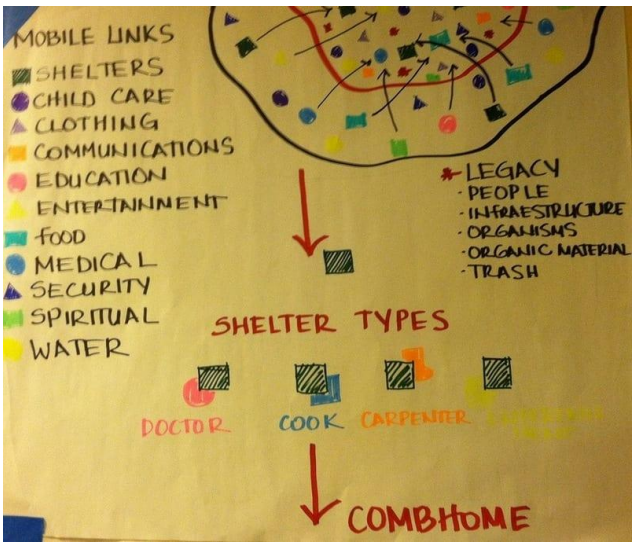
這張圖展示了一片經過火燒的森林，正在以地下部萌蘗或是種子庫萌發的形式更新。

This shows a burned forest with regrowth coming from legacy roots underground or seed bank.



這個生存策略帶來了啟發：當擾動發生後，如果有生物遺產、流動連結物種和鄰近支持區域的存在，會更加容易復原。

Design principle abstracted from this strategy: After disturbance of a system, recovery is aided when legacies, mobile links, and nearby support areas are present.



這張草稿展示了一套在天然災害後提供避難所的救援系統，由仿生學專業的學生在一場限時設計挑戰中使用了這個 AskNature 策略。

This sketch of a potential system for providing shelters after a natural disaster was

done by Biomimicry Specialist students during a quick design challenge, using this AskNature strategy.

文獻引用 (REFERENCES)

「森林藉由最少三個交互作用來『記住』受干擾前的組成和結構 (Nystrom 和 Folke 2001；Lundberg 和 Moberg 2003；Folke 等人 2004)：生物遺產 (biological legacies，或可譯為傳承性)、流動連結物種和支持區域。生物遺產是指在受干擾區域中持續存在，並作為恢復來源的物種、模式或結構，例如大型的活樹、死樹或叢生林木為次生林分提供種子、具活性地下部以及養分 (Franklin and MacMahon 2000)。在擾動發生時，比較容易倖存下來的結構或斑塊成為復原的重要基礎，例如森林火災期間的潮濕或低窪地區。流動連結物種是指那些在受干擾的生態系統和棲地之間移動的「關鍵」生物，透過個體的活動連接在空間或時間上相距甚遠的區域，提供原本缺乏的重要生態系統功能，如授粉、種子傳播或營養物質運輸 (Lundberg 和 Moberg 2003)。支持區域是指讓流動連結物種維持可存活族群的地景斑塊或棲地 (Lundberg 和 Moberg 2003)。這些交互作用共同在受干擾系統的更新和重組中扮演著至關重要的角色。 (Drever 等人 2006：2289-2290)

「我們將這個物種網絡、它們彼此之間以及與環境的動態互動，再加上使干擾後重組成為可能的各種結構組合，稱為系統的『生態記憶 (ecological memory)』(21、22)…這種生態記憶是生態韌性的關鍵組成，也就是系統吸收干擾、重新組織並適應的能力 (25)…生態系統更新循環使森林形成處於週期中不同階段的粗鑲嵌區塊 (67)，這個循環常始於某種干擾，並經歷一系列的發展，通常可識別的階段有： (i) 間隙期 (或稱為重組期)，(ii) 建立期 (利用期)，(iii) 成熟期 (保護期)，以及最終的 (iv) 退化期 (釋放期) 階段 (68，69)。生態記憶的累積，無論是以生物遺產或物種的形式在地景中留存，通常需要經過幾個世代的時間，在此期間土壤形成、營養物質和分解者逐漸累積。雖然我們常常根據特定的干擾機制來區分森林類型，但大多數的時候，森林受不同時空間尺度的各種干擾影響 (圖 3；70-73)。隨著演化，森林生態系中的生物已經適應了這些森林特有的干擾狀況。北方針葉林和地中海森林 (74) 經常受到大規模火災的侵襲，而溫帶落葉林，例如中歐的山毛櫸，主要受小規模風倒的影響。」(Bengtsson 等人 2003：389、392、393)

“A forest ‘remembers’ its predisturbance composition and structure by the presence of at least three interacting parts (Nystrom and Folke 2001; Lundberg and Moberg 2003; Folke et al. 2004): biological legacies, mobile links, and support areas. Biological legacies are species, patterns, or structures that persist within a disturbed area and act as sources of ecosystem recovery, such as large living and dead trees or tree clusters that provide seeds, buried rhizomes or roots, and nutrients to the regenerating stand (Franklin and MacMahon 2000). In some cases these legacies may

be biased towards structures or patches that are more likely to survive the disturbance, such as wet or low-lying sites during forest fires. Mobile links are 'keystone' organisms that move between habitats and ecosystems after a disturbance to provide essential ecosystem processes that are lacking, such as pollination, seed dispersal, or nutrient translocation, by connecting areas that may be widely separated spatially or temporally (Lundberg and Moberg 2003). Support areas refer to landscape patches or habitats that maintain viable populations of mobile links (Lundberg and Moberg 2003). Together these interacting parts play a pivotal role in renewal and reorganization of a disturbed system." (Drever et al. 2006:2289-2290)

"We term this network of species, their dynamic interactions between each other and the environment, and the combination of structures that make reorganization after disturbance possible; the 'ecological memory' of the system (21, 22)…The ecological memory is a key component of ecological resilience, i.e. the capacity of the system to absorb disturbances, reorganize, and maintain adaptive capacity (25)…The ecosystem renewal cycle in forests gives rise to a coarse mosaic of patches in different stages of a forest cycle (67), initiated by disturbance and comprising a series of structural phases; commonly recognized are the i) gap (in our terms reorganization), ii) building (exploitation), iii) mature (conservation), and eventually iv) degenerative (release) phases (68, 69). The build-up of ecological memory in the form of biological legacies and species in the mosaic landscape usually takes several forest generations during which the soil is formed and nutrient pools and decomposer organisms are accumulated. Although it is common to characterize forest types by particular disturbance regimes, most forests are affected by various disturbances acting at different temporal and spatial scales (Fig. 3; 70-73). Organisms in natural forests have adapted, over evolutionary time, to the characteristic disturbance regimes of these forests. Boreal taiga forests and Mediterranean forests (74) are often disturbed by large-scale fires, while temperate deciduous forests, e.g. beech in Central Europe, mainly are affected by small-scale windthrows." (Bengtsson et al. 2003:389, 392, 393)

參考文獻清單與連結 (REFERENCE LIST) Harvard 或 APA 格式

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Bengtsson, J., Angelstam, P., Elmqvist, T., Emanuelsson, U., Folke, C., Ihse, M., Moberg, F., & Nyström, M. (2003). Reserves, Resilience and Dynamic Landscapes. *AMBIO: A Journal of the Human Environment*, 32(6), 389–396.

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