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Detecting most effective coastal plastic clean-up hubs using network theory: a case study in the Galapagos Marine Reserve

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Over 8 tonnes of plastic are removed from the coastlines of the Galapagos Islands each year. Although the Galapagos Marine Reserve is expanding to ensure an even larger protection of its unique biodiversity, the island authorities face the challenge to effectively remove plastic from its shorelines due to limited resources. We are developing a clean-up efficacy model that will optimize for most cost-effective and least-invasive clean-up locations. Network (connectivity) theory is widely applied in ecology to study the interaction of species between spatially separated habitats. Here, we use a similar approach to discern the most effective removal hubs on the Galapagos Islands. A connectivity matrix is constructed from a Lagrangian simulation describing the flow of macroplastic between the various islands within the Galapagos Marine Reserve, where the nodes represent locations along the coastline and the edges the likelihood that plastic travels from one location and beaches at another. To measure the impact of removal, various centralities are determined, such as degree centrality, betweenness centrality (using the most likely path) and eigenvector centrality. Combining the results with other metrics such as the distance to the nearest port or tourist attractions, recommendations are made for

- most effective *intervention* removal hubs that would prevent further spread of plastic throughout the marine reserve
- most effective *accumulation* removal hubs that would negate the impact of plastic on wildlife
- most suited regions for protection resulting from the existence of clusters (e.g. regions of limited connectivity)

Though we focus on the Galapagos Islands, the methods we present are directly applicable to archipelagos worldwide that face marine plastic pollution issues.