

VASCULAR PLANTS FROM THE ISLANDS OF LASKEEK BAY, 1990-2005

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SUMMARY

During 1990-2005, we studied the vascular flora of ten islands in Laskeek Bay, Haida Gwaii. We found 171 vascular plants, less than a quarter of those found on the entire archipelago. They comprised 5% trees, 14% shrubs, 56% wildflowers, 16% grasses and 9% ferns. The highest number of species was found on Reef Island (249 ha, 135 species) and the lowest on West Limestone Island (16 ha, 47 species). The larger islands supported more forest interior species than the small islands. Among the islands less than 20 ha in extent, the smallest and furthest offshore supported the greatest diversity of plants, presumably because of an absence of deer.

INTRODUCTION

During the period since the Laskeek Bay Conservation Society began field research on East Limestone Island there has been a continuing interest in the vascular plants of the area. Previous reports have dealt in detail with those found on East Limestone Island (Smith and Buttler 1998, Smith 2003) and on the status of the previously unnoticed Menzies' pipsissewa, *Chimaphila menziesii* (Smith and Buttler 1999). In this paper we detail all species found on the Laskeek Bay islands during the past 15 years and comment on their distributions.

STUDY AREA

Laskeek Bay includes 15 islands large enough to support vegetation other than purely shoreline plants. We studied ten of these, ranging in size from South Low Island (4.5 ha, maximum elevation 15 m) to Kunga Island (353 ha, maximum elevation 200 m). Lost Islands, a group of three small islets, barely separated at low tide, are here treated as a single island.

The ecology of the Laskeek Bay islands has been described by Stockton et al. (2005), Stockton (2006) and Gaston et al. (2006). The vegetation of the larger islands is temperate coniferous forest, dominated by Sitka spruce *Picea sitchensis* and western hemlock *Tsuga heterophylla*. Varying amounts of western

redcedar *Thuja plicata* and shore pine *Pinus contorta* also occur. None of the ten islands studied has been commercially logged and all maintain primary forest cover. Small areas of non-forest habitat occur along shorelines, especially where they are exposed to the southeast, the prevailing direction of storm winds. Those areas support either a diverse sward of forbs and low shrubs, or a rather uniform tussock grass meadow of Nootka reedgrass *Calamagrostis nootkaensis*.

Black-tailed deer *Odocoileus hemionus*, introduced into the Haida Gwaii archipelago in the past 120 years, occur on some islands in Laskeek Bay. The deer have had an important impact on the vegetation of all islands that they have reached (Pojar & Banner 1984, Pojar 1999, Stockton et al. 2005, Gaston et al. 2006). Estimates of the duration of deer presence on the different islands in Laskeek Bay have been made from comparative analyses of shrub stem age structures and the dating of fraying scars (Vila & Martin 2005). South Low, Low and Lost islands show no sign of deer, past or present. West and South Skedans islands showed evidence of deer for less than 20 years. Reef, Kunga, East and West Limestone and Haswell islands all showed evidence of deer presence for 50 or more years. West Limestone Island, West and South Skedans islands, and South Low and Low islands are part of a British Columbia Wildlife Management Area. Kunga Island and Lost Islands fall within the perimeter of Gwaii Haanas National Park Reserve and Haida Heritage Site.

METHODS

Plant records were kept on Reef and East Limestone islands on a casual basis during 1990-1996, when field parties were present to conduct other biological work. In 1997-2005, systematic vegetation surveys on the study islands were carried out as part of a project to monitor the impact of introduced deer and the vegetation recovery following culling of the deer population on Reef Island (Gaston et al. 2006). All islands were surveyed extensively for vascular plants by 2-5 people during June of 1997-2001. Repeat surveys were carried out in 2003 and 2005. Intensive surveys of 10 m (shoreline) and 25 m (interior) diameter circular plots, randomly spaced throughout the islands, were made on all islands during this period. The intensity of surveys was similar for all islands except for Kunga Island, where visits were of shorter duration (2-5 days annually) and involved only two people. East Limestone Island was the most intensively studied. The latter island was known from surveys during 1990-1996 to support several plant species otherwise rare in Haida Gwaii. Further surveys were undertaken each summer from 1997 onwards (Smith & Buttler 1999, Smith 2003). Identifications were made with the help of Hitchcock and Cronquist (1973) and Pojar and Mackinnon (1994). Voucher specimens of were preserved and identifications confirmed by staff at the Central Experimental Farm, Ottawa.

For analysis we divided the vascular plants into five types: trees, shrubs, wildflowers (non-woody plants with showy flowers), graminoids (grasses, sedges and rushes) and ferns and allies (including clubmosses), following the classification of Pojar and Mackinnon (1994). Island area was measured as the area above high tide. For some analyses, we compared the three largest islands (>40 ha) with the five small offshore islands (Low, South Low, Lost, West and South Skedans; all <10 ha and >1 km remote). Because of the known effect of deer browsing on species richness we distinguished among three types of islands: those where deer have never been reported (deer-free), those with deer, but where deer had been present for <20 yr (moderately deer-affected) and those where deer have been present for >50 yr (heavily deer-affected).

RESULTS

Species richness

We found 171 species of vascular plants on the study islands, of which 5% were trees, 14% shrubs, 56%

wildflowers, 16% graminoids and 9% ferns and allies (Table 1). Twelve species were not native to Haida Gwaii, nine wildflowers and three grasses. The potato *Solanum tuberosum*, found only on Reef Island, was almost certainly introduced for cultivation by the Haida. This species was omitted from further analyses. All of the species we identified had been previously recorded in the archipelago.

Reef Island, the second largest, supported the most species (135 spp., 79% of the Laskeek Bay total), while the lowest number was found on West Limestone Island, an inshore island, heavily deer-affected, with heavy forest canopy (47 spp., 27% of the total). The large islands (Reef, Kunga and East Limestone) among them aggregating 685 ha, supported 95% of the species recorded. The five small offshore islands, together aggregating 35 ha, supported 86 species (50% of the total).

Effect of island area

As would be expected, numbers of species recorded increased with island area (Fig. 1). Among species found only on the large islands, there were 3 trees (yellow cedar *Chamaecyparis nootkatensis*, bitter cherry *Prunus emarginata*, and western yew *Taxus brevifolia*; 33% of total), 4 shrubs (17%), 18 wildflowers (19%), 9 grasses (33%) and 6 ferns (40%). All of the introduced species were found on the large islands.

The species missing from the smaller islands were not a random sample of the flora, but included a high proportion of species associated with the forest interior. The small offshore islands supported only 5 species (31%) of ferns, compared with 15 species (62%) of shrubs, 48 species (51%) of wildflowers and 13 species (48%) of graminoids. Species missing from all the five small, offshore islands were the shrub, red osier dogwood *Cornus stolonifera*, the wildflowers, goat's beard *Aruncus dioicus*, bunchberry *Cornus canadensis*, queen's cup *Clintonia uniflora*, groundcone *Boschniakia hookeri*, coral root *Corallorhiza maculata*, pinesap *Hypopitys monotropa* and showy Jacob's ladder *Polemonium pulcherrimum*, four species of ferns and all three species of clubmosses. All these species are characteristic, in our study area, of forest interior situations. In addition, six out of the twelve non-native species were found only on the large islands. Early hairgrass *Aira praecox* was the only non-native species

found on any of the three deer-free islands, although both wood groundsel *Senecio sylvaticus* and bull thistle *Cirsium vulgare* were found on all other islands. Of the seven species found only on small offshore islands, one was the shrub, Sitka mountain ash *Sorbus sitchensis* and six were wildflowers: seabeach sandwort *Honkenya peploides*, beach lovage *Ligusticum scoticum*, tufted saxifrage *Saxifraga caespitosa*, entire-leaved gumweed *Grindelia integrifolia*, woolly hawkweed *Hieracium triste* and tufted vetch *Vicia cracca*, all characteristic of meadows or forest edges (Pojar & Mackinnon 1994).

Effects of deer on small islands (<25 ha)

Highest numbers of shrub and wildflower species (15 and 36 species) were recorded on the smallest island, the deer-free South Low Island, while lowest numbers of wildflowers occurred on the two largest islands, Haswell and West Limestone (21 and 19 species, respectively), both heavily deer-affected. Species found on at least two deer-free islands, but on none of the smaller islands with deer, were the shrub, thimbleberry *Rubus parviflorus*, and the wildflowers, cow-parsnip *Heracleum lanatum*, American wintercress *Barbarea orthoceros*, Siberian miner's lettuce *Claytonia sibirica*, and fringe cup *Tellima grandiflora*. Species missing from the heavily deer-affected small islands (Haswell, West Limestone), but found on other small islands were all wildflowers: spreading stonecrop *Sedum divergens*, fireweed *Epilobium angustifolium*, western strawberry *Fragaria chiloensis* and monkey flower *Mimulus guttatus*. Although the moderately deer-affected islands were similar in species richness to deer-free islands, they showed substantial effects of deer browsing in the form of dead and dying shrubs, especially red huckleberry *Vaccinium parvifolia*, snowberry *Symphoricarpos albus*, and sword fern *Polystichum munitum*. This applied particularly to West Skedans Island, where the interior was, until recently, dominated by sword fern.

Effects of limestone on species richness

Although heavily deer-affected, East Limestone Island supported more species (103) than predicted by its 41 ha area (Fig. 1) and substantially more than the five small offshore islands (86 species), which had an aggregate area almost as large. Native plants not found on other islands of Laskeek Bay were: yellow cedar *Chamaecyparis nootkatensis*, eight species of wildflowers (cut-leaved anemone *Anemone multifida*, queen's cup *Clintonia uniflora*, broad-petalled gentian

Gentiana platypetala, Richardson's geranium *Geranium richardsonii*, slender sandwort *Minuartia tenella*, showy Jacob's ladder *Polemonium pulcherrimum*, self-heal *Prunella vulgaris*) and the fern *Asplenium trichomanes*. As its name suggests, East Limestone Island lies on a limestone outcrop that not only affects soil chemistry, but also affords numerous refuges for plants in the form of steep cliffs and limestone karst features that keep them out of reach of deer.

Other records from Laskeek Bay

A survey of several islands in Laskeek Bay by P. Krannitz (pers. comm.) and others in September 1995 yielded several additional plant species records. On Titul Island, off the north end of Kunga Island, they found roseroot *Sedum integrifolia*, not recorded by us, and silver hairgrass *Aira caryophyllea*, which we found only on East Limestone Island. In addition, they found two other species that we did not record, nodding trisetum *Trisetum cernuum*, on Kunga, Titul and South Skedans islands, and large-awned sedge *Carex macrochaeta* on South Low Island.

DISCUSSION

As expected, the flora of these small and relatively isolated islands proved to be very limited compared to the archipelago as a whole. However, as documented previously (Smith and Buttler 1998), East Limestone Island is an important station for several plants otherwise rare or absent from Haida Gwaii.

Our observations show that the effect of island size on species richness in Laskeek Bay operates mainly through an increase in forest interior species on the larger islands. Shrubs and wildflowers characteristic of shorelines and forest edges were well represented on the smallest islands. Among the small islands, more species were found on the most remote islands, which were deer-free (Low, South Low and Lost), than on the least remote, which were heavily deer-affected. The deer-affected islands were especially lacking in wildflowers and shrubs. The diverse shrub and wildflower communities of the deer-free islands indicate the strong effect that is being caused by deer browsing on plant diversity. Many of the plants missing or uncommon on deer-affected islands, but widespread and abundant on the deer-free islands are among the most attractive, in terms of flower size and colour (red

columbine *Aquilegia formosa*, many-flowered shooting star, monkey flower – note that these are commoner at east Limestone island, where they find refuge on cliffs, than on other deer-affected islands).

On the larger islands, especially Reef Island, we found most of the species in Laskeek Bay. However, species strongly affected by deer (i.e. those absent from small, heavily deer-affected islands), tended to be found on the larger islands only on cliff faces, where they were out of reach of the deer. At Reef Island, a small valley on the south coast was completely inaccessible to deer, being surrounded by steep cliffs on the landward side. This valley supported luxuriant stands of red elderberry *Sambucus racemosa*, thimbleberry, cow-parsley, Siberian miner's lettuce, red columbine and fringe cup. The list includes several species found on deer-free islands but not on other small islands. Without this valley and the deer-free refugia provided by cliff ledges, it is likely that we would have found substantially fewer species on Reef Island.

CONCLUSIONS

Because the most isolated islands have avoided colonisation by deer, they continue to support plants that have been extirpated on deer-affected islands of similar size. The same species persist on larger islands because those islands are large enough to support diverse terrain and a higher chance of refuges created by cliffs and gullies. Consequently, the small inshore islands, easily colonised by deer (West Limestone and Haswell islands) are those with the lowest complement of species. There is some indication from our results that colonisation by non-native species is more likely on deer-affected islands, although the absence of non-natives from the deer-free islands could also be because of their isolation.

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Table 1
Presence or absence data for all vascular plants recorded on the study islands during 1990-2005

	RE(1)	EL(2)	KU(3)	HA(4)	WL(5)	WS(6)	SS(7)	SL(8)	LO(9)	LT(10)
Trees										
Red alder <i>Alnus rubra</i>	1	1	1	1	1	1	1	1	1	1
Yellow cedar <i>Chamaecyparis nootkatensis</i>			1							
Pacific crab apple <i>Malus fusca</i>	1	1	1	1	1	1	1	1	1	
Sitka spruce <i>Picea sitchensis</i>	1	1	1	1	1	1	1	1	1	1
Shore pine <i>Pinus contorta</i> var. <i>contorta</i>		1			1					
Bitter cherry <i>Prunus emarginata</i>			1							
Western yew <i>Taxus brevifolia</i>			1							
Western redcedar <i>Thuja plicata</i>	1	1	1	1	1	1	1		1	1
Western hemlock <i>T. heterophylla</i>	1	1	1	1	1	1	1	1	1	1
Shrubs										
Sitka alder <i>Alnus crispa</i> ssp. <i>sinuata</i>		1	1	1	1	1	1	1	1	1
Saskatoon <i>Amelanchier alnifolia</i>	1	1	1	1	1	0	0	1	0	1
Kinnikinnick <i>A. uva-ursi</i>	1	1	1	1		1		1		1
Bunchberry <i>Cornus canadensis</i>	1									
Red osier dogwood <i>Cornus stolonifera</i>				1						
Salal <i>Gaultheria shallon</i>	1	1	1	1	1	1	1	1	1	1
Black twinberry <i>L. involucrata</i>	1	1	1	1		1	1	1	1	1
False azalea <i>Menziesia ferruginea</i>	1	1	1	1						
Devil's club <i>Oplopanax horridus</i>			1							
Stink currant <i>Ribes bracteosum</i>	1		1							
Black gooseberry <i>Ribes lacustre</i>	1	1	1		1			1		
Trailing black currant <i>R. laxiflorum</i>	1	1	1		1	1	1	1	1	1
Nootka rose <i>Rosa nutkana</i>	1	1	1		1	1		1	1	1
Thimbleberry <i>Rubus parviflorus</i>	1	1	1					1	1	1
Salmonberry <i>Rubus spectabilis</i>	1	1	1	1	1	1	1	1	1	1
Scouler's willow <i>Salix scouleriana</i>	1	1	1	1	1	1	1	1	1	1
Sitka willow <i>Salix sitchensis</i>	1	1								
Red elderberry <i>S. racemosa</i>	1	1	1		1	1	1	1	1	
Sitka mountain ash <i>Sorbus sitchensis</i>										1
Snowberry <i>Symphoricarpos albus</i>	1	1	1		1	1		1	1	1
Alaskan blueberry <i>Vaccinium alaskaense</i>	1	1	1	1						
Red huckleberry <i>V. parvifolium</i>	1	1	1	1	1	1	1	1	1	1
Wildflowers										
Yarrow <i>Achillea millefolium</i>	1	1	1	1	1	1	1	1	1	1
Silver burweed <i>Ambrosia chamissonis</i>		1						1		
Pearly everlasting <i>Anaphalis margaritacea</i>	1									
Cut-leaf anemone <i>Anemone multifida</i>			1							
Sea-watch <i>Angelica lucida</i>	1	1	1	1				1	1	1

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Red columbine <i>Aquilegia formosa</i>	1	1	1		1			1	1	1
Hairy rockcress <i>Arabis hirsuta</i>	1	1	1					1		
Western dwarf mistletoe <i>Arceuthobium campylopodum</i>				1						
Arnica <i>Arnica spp.</i>		1								
Goatsbeard <i>Aruncus dioicus</i>	1		1							
Douglas' Aster <i>Aster subspicatus</i>	1	1	1			1	1	1		1
America wintercress <i>B. orthoceras</i>			1					1		1
Vancouver groundcone <i>Boschniakia hookeri</i>			1							
Fairyflipper <i>Calypso bulbosa</i>	1	1	1							
Common harebell <i>C. rotundifolia</i>	1	1	1		1	1	1	1	1	1
Western bittercress <i>Cardamine occidentalis</i>			1		1					
Few-seeded bittercress <i>Cardamine oligosperma</i>			1	1	1					
Unalaska paintbrush <i>C. unalascensis</i>		1	1				1		1	1
Field chickweed <i>Cerastium arvense</i>		1	1	1	1	1	1		1	
Menzies' pipsissewa <i>Chimaphila menziesii</i>	1		1		1					
Canada thistle <i>Cirsium arvense</i>	1	1	1							
Edible thistle <i>Cirsium edule</i>	1	1	1							
Bull thistle <i>Cirsium vulgare</i>	1	1	1	1	1	1	1			
Siberian miner's lettuce <i>C. sibirica</i>	1	1	1					1	1	1
Heart-leaved twayblade <i>Listera cordata</i>		1	1	1	1					
Alp lily <i>Lloydia serotina</i>										
Nootka lupine <i>L. nootkatensis</i>	1			1					1	1
Skunk cabbage <i>Lysichiton americanum</i>		1	1							
False lily-o-t-valley <i>M. dilatatum</i>	1	1	1	1	1	1	1	1	1	1
Field mint <i>Mentha arvensis</i>		1	1							
Yellow monkey-flower <i>M. guttatus</i>	1	1	1			1	1	1	1	1
Slender sandwort <i>Minuartia tenella</i>			1							
Single delight <i>Moneses uniflora</i>	1	1	1			1				
Small-leaved montia <i>Montia parvifolia</i>		1	1	1	1	1				
Pacific water-parsley <i>Oenanthe sarmentosa</i>	1		1							
Common Butterwort <i>Pinguicula vulgaris</i>										
Sea plantain <i>Plantago maritima</i>	1	1	1	1	1	1	1	1	1	1
Sea blush <i>Plectritis congesta</i>	1					1		1	1	1
Showy Jacob's ladder <i>Polemonium pulcherrimum</i>				1						
Villous cinquefoil <i>P. villosa</i>	1	1	1	1	1	1	1	1	1	1
W. rattlesnake-root <i>P. alata</i>	1	1	1	1	1	1	1	1	1	1
Self-heal <i>Prunella vulgaris</i>		1								
Western buttercup <i>R. occidentalis</i>	1	1	1				1	1	1	1
Creeping buttercup <i>Ranunculus repens</i>		1								
Little buttercup <i>Ranunculus uncinatus</i>		1								
Curled dock <i>Rumex crispus</i>	1	1				1	1		1	
Coastal pearlwort <i>Sagina maxima</i>	1	1	1	1	1	1	1	1	1	1
Tufted saxifrage <i>Saxifraga caespitosa</i>									1	
Alaska saxifrage <i>S. ferruginea</i>	1	1	1	1		1		1	1	1
Spreading stonecrop <i>S. divergens</i>	1	1	1			1	1	1	1	1
Wood groundsel <i>Senecio sylvaticus</i>		1	1	1	1	1	1	1		
Shore bue eyed grass <i>S. littorale</i>	1	1				1		1	1	1
Potato <i>Solanum tuberosum</i>	(1)									
Canada goldenrod <i>Solidago canadensis</i>		1								
Prickly sow-thistle <i>Sonchus asper</i>	1		1							
Cooley's hedge nettle <i>Stachys cooleyae</i>		1								
Crisp sandwort <i>Stellaria crispa</i>	1	1	1		1	1	1			1
Clasping twistedstalk <i>Streptopus amplexifolius</i>			1		1					
Common dandelion <i>Taraxacum officinale</i>		1				1	1	1		
Fringecup <i>Tellima grandiflora</i>	1	1	1					1		1
Foamflower <i>Tiarella trifoliata</i>	1	1	1							

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Stinging nettle <i>Urtica dioica</i>	1	1	1							
American brooklime <i>Veronica beccabunga ssp. americana</i>				1	1					
Tufted vetch <i>Vicia cracca</i>							1			
Giant vetch <i>Vicia gigantea</i>	1		1	1	1	1		1	1	1
Violet <i>Viola spp.</i>	1		1							
Grasses, sedges and rushes										
Dewey's sedge <i>Carex deweyana</i>	1	1	1		1		1			
Gmelin's sedge <i>Carex gmelinii</i>	1		1							
Lynghby's sedge <i>Carex lynghbyei</i>	1									
Merten's sedge <i>Carex mertensia</i>	1			1						
Sitka sedge <i>Carex sitchensis</i>	1			1			1	1		1
Early hairgrass <i>Aira praecox</i>	1	1	1	1		1	1	1	1	1
Silver hairgrass <i>Aira caryophylla</i>			1							
Alaska brome <i>Bromus sitchensis</i>	1					1		1	1	1
Nootka reedgrass <i>C. nutkaensis</i>	1		1	1	1	1	1	1	1	1
Wood reedgrass <i>Cinna latifolia</i>	1									
Tufted hairgrass <i>Deschampsia elongata</i>		1	1							
Blue wildrye <i>Elymus glaucus</i>	1		1							
Dunegrass <i>Elymus mollis</i>	1	1	1		1	1	1	1	1	1
Western fescue <i>Festuca occidentalis</i>		1		1						
Red fescue <i>Festuca rubra</i>	1	1	1	1	1	1	1	1	1	1
Bearded fescue <i>Festuca subulata</i>	1	1	1		1		1			
Meadow barley <i>H. brachyantherum</i>	1		1		1	1	1	1	1	1
Common velvet-grass <i>Holcus lanatus</i>				1						
Alaska oniongrass <i>Melica subulata</i>				1						
Bluegrass <i>Poa sp.</i>		1								
Alaska alkali grass <i>P. nutkaensis</i>				1	1	1	1	1	1	1
Arctic rush <i>Juncus arcticus</i>	1	1	1	1			1	1	1	1
Common rush <i>Juncus effusus</i>	1		1							
Sickle-leaved rush <i>Juncus falcatus</i>	1									
Many-fl. wood-rush <i>L. multiflora</i>	1	1	1	1	1	1	1	1	1	1
Small-fl. wood-rush <i>L. parviflora</i>	1	1	1	1	1		1			
Piper's wood-rush <i>Luzula piperi</i>	1		1							
Ferns and allies										
Maidenhair fern <i>Adiantum pedatum</i>		1	1	1						
Maidenhair spleenwort <i>Asplenium trichomanes</i>				1						
Deer fern <i>Blechnum spicant</i>	1	1	1							
Spiny wood fern <i>D. expansa</i>	1	1	1	1	1	1	1			1
Oak fern <i>Gymnocarpium dryopteris</i>		1								
Lady fern <i>Athyrium filix-femina</i>	1	1	1	1				1	1	1
Parsley fern <i>Cryptogramma crispera</i>	1									
Licorice fern <i>P. glycyrrhiza</i>	1	1	1	1	1	1	1	1	1	1
Sword fern <i>Polystichum munitum</i>	1	1	1	1	1	1	1	1	1	1
Bracken <i>Pteridium aquilinum</i>	1						1	1	1	1
Wallace's selaginella <i>S. wallacei</i>	1		1							
Narrow beech fern <i>T. phegopteris</i>	1									
Horsetail <i>Equisetum spp.</i>	1		1							
Running clubmoss <i>Lycopodium clavatum</i>				1						
Fir clubmoss <i>Lycopodium selago</i>	1		1							
Stiff clubmoss <i>Lycopodium annotinum</i>				1						

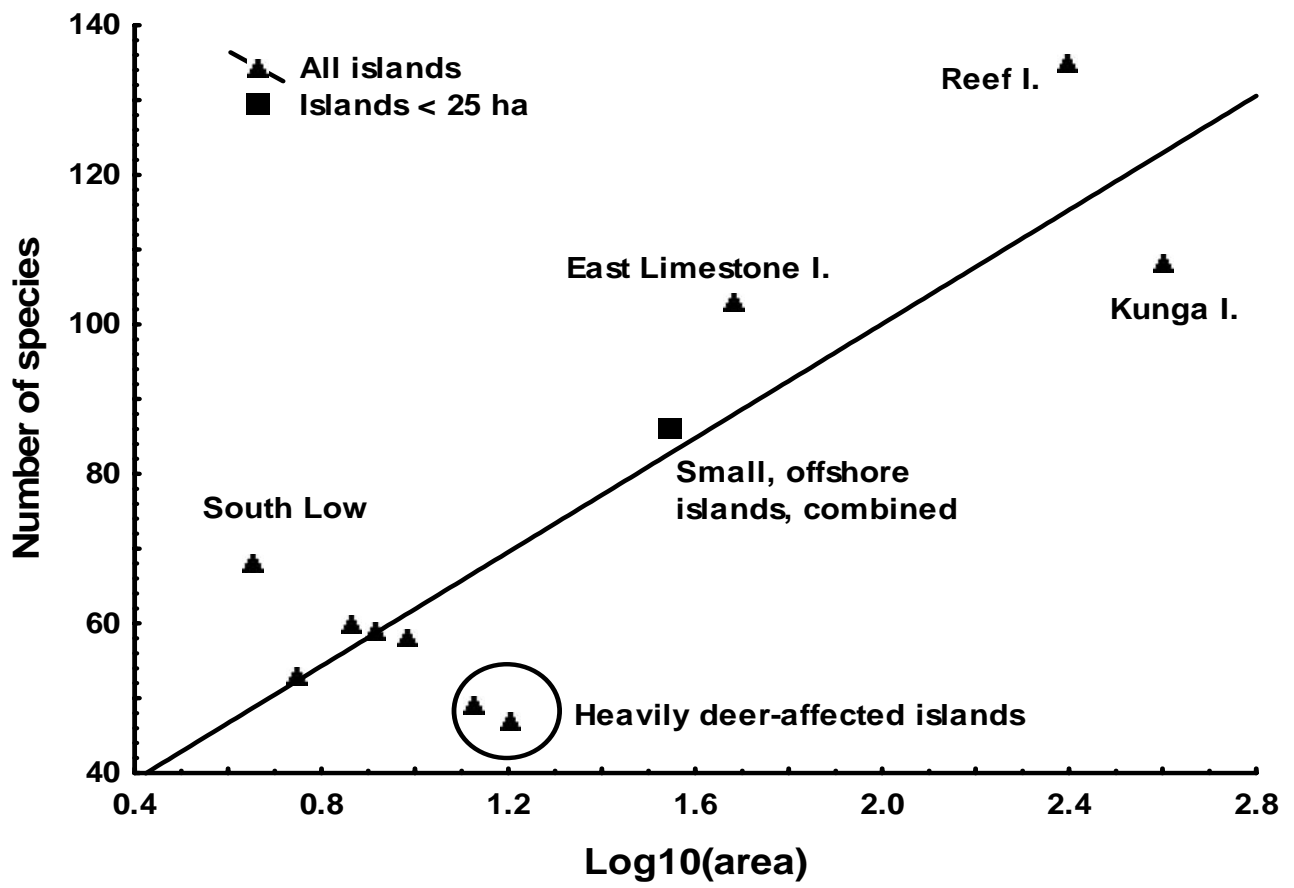


Figure 1
Numbers of species identified in relation to island area