

# Do Marine Protected Areas Alter Rockfish Niche Widths?

Angeleen M. Olson<sup>1</sup>, Rowan Trebilco<sup>1,2</sup>, Anne K. Salomon<sup>1</sup>  
<sup>1</sup>School of Resource and Environmental Management, Simon Fraser University  
<sup>2</sup>Department of Biology, Simon Fraser University



## Background

Marine protected areas (MPAs) are implemented to conserve community dynamics and biodiversity from threats of over-fishing and habitat destruction. Effects of MPAs on food webs are most commonly measured directly from biological responses such as abundance, biomass, densities and diversity. However, our understanding of how niche widths are affected by MPAs is limited.

Ecological niche is a hypervolume in n-dimensional space determined by axes of a species resource and habitat use<sup>1</sup>. Stable isotopes of  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  can be used in the quantification of isotopic niche space<sup>2,3</sup>. Convex hulls and Bayesian ellipses are stable isotope metrics used to calculate species niche width<sup>4,5</sup>.

*We investigated how the isotopic niche widths of rockfish change in MPAs vs. non-protected areas.*

## Research Questions

1. Do rockfish species have distinct isotopic trophic niches in a given study area?
2. Do rockfish species isotopic niches vary across areas of protection and no protection?
3. Are the rockfish community niche widths different between areas of protection and no protection?



Anne Salomon



Rowan Trebilco

## Study Area

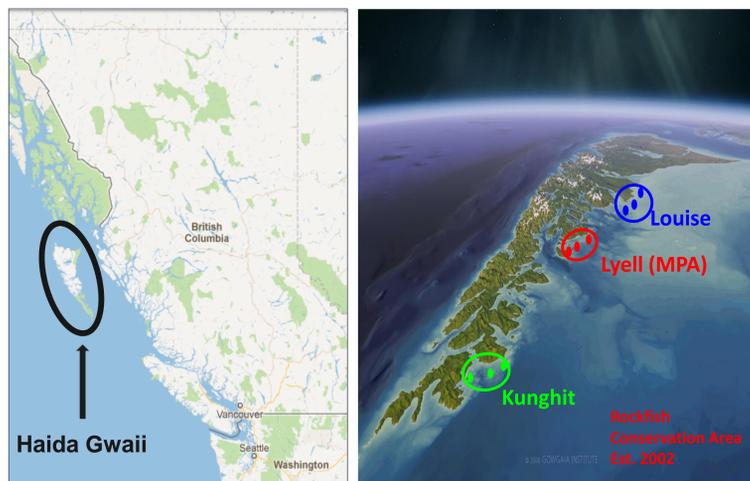


Figure 1. (a) Haida Gwaii, BC, Canada (b) Study areas: Louise, Lyell (MPA), and Kunghit. At each area, 3 sites were sampled for rockfish in 2009. Lyell has been an MPA since 2002; Louise and Kunghit are non-protected areas.

## Methods

$\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  analysis were conducted on rockfish muscle tissue collected from areas in Haida Gwaii (Fig. 1). For each area, we estimated the niche width for all species by calculating Standard Ellipse Areas (SEAs) using Bayesian inference (Fig.2). Credible intervals of posterior distributions of SEAs were used to estimate uncertainty in niche widths (Fig.3).

We compared the overall rockfish community niche widths between study areas. Bayesian inference was used to draw the population mean  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values for each species within an area to construct a convex hull for each rockfish community. Niche widths were estimated using the total area (TA) of the convex hulls (Fig.4).

## Results

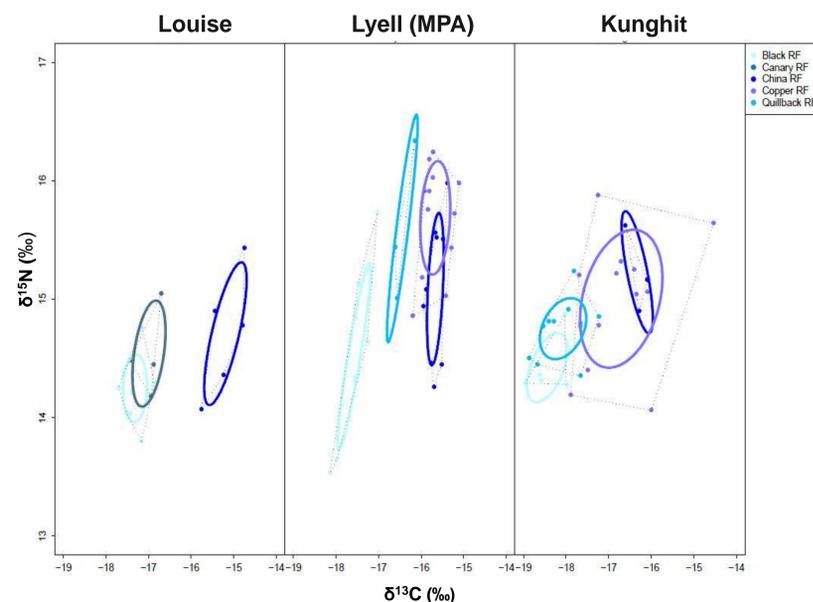


Figure 2. Standard ellipse areas (SEAs) of rockfish species for each study area. Points represent individual rockfish and SEAs are depicted with solid lines; convex hulls are dashed lines.

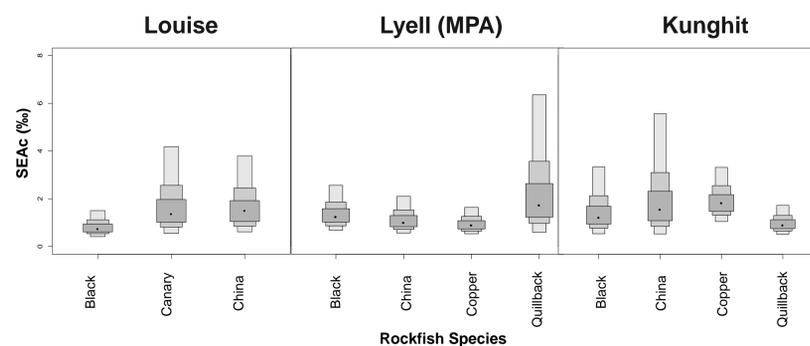


Figure 3. Density plots of 95% credible intervals for SEAs for each study area. The black points depict the mode SEA for each species of rockfish after simulations and the boxes represent the 95%, 75%, and 50% credible intervals of the posterior distributions.

## Community Niche Widths of Rockfish

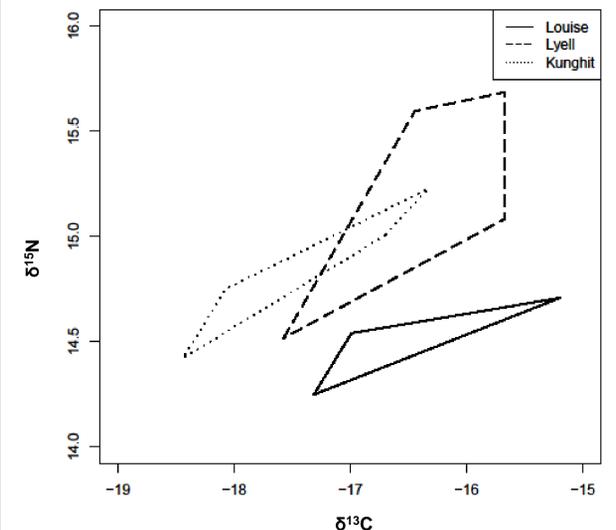


Figure 4. Estimated niche widths of the total rockfish community for each study area.

## Summary

### 1. How distinct are niche widths within study areas?

At Louise, the SEA of black rockfish is smaller than in canary and china rockfish (Table 1). Quillbacks have the largest SEA of all rockfish sampled in Lyell, but the smallest SEA in Kunghit.

Study Area	Rockfish a	Rockfish b	Probability (%) SEA a < SEA b
Louise	Black	Canary	91.6
	Black	China	91.7
Lyell	Black	Quillback	80.6
	China	Quillback	88.6
	Copper	Quillback	94.8
Kunghit	Quillback	China	89.8
	Quillback	Copper	94.6

Table 1. Bayesian probabilities of differences in rockfish SEAs within study areas.

### 2. Niche width comparisons between study areas

Black rockfish SEA is smallest in Louise (Table 2). Copper rockfish SEA is smaller in Lyell than in Kunghit. Quillback rockfish SEA is smaller at Kunghit than in Lyell.

Rockfish	Study Area a	Study Area b	Probability (%) SEA a < SEA b
Black	Louise	Lyell	87.4
	Louise	Kunghit	87.6
China	Lyell	Louise	77.6
	Lyell	Kunghit	83.2
Copper	Lyell	Kunghit	95.6
	Quillback	Kunghit	93.5

Table 2. Bayesian probabilities of differences in rockfish SEAs compared across study sites.

### 3. Rockfish community niche width comparisons

The community of rockfish at Lyell (MPA) has a larger niche width than that of the rockfish at Louise and Kunghit, the non-protected areas (Fig. 4). The TAs of Lyell and Kunghit are distinct of one another, while Lyell and Louise TAs overlap.

## Works Cited

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