Quantifying the Marine Reservoir Effect for Early Holocene Southeast Alaska

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Introduction

This project contributes new data for the approximation of the early Holocene marine reservoir effect in Southeast Alaska. Variability in ocean water composition across both time and space influence the apparent radiocarbon age of marine shell, requiring local calibrations to account for the marine reservoir effect. Previously available data for the region were limited: eight data points from the northern half of Southeast Alaska and five from Haida Gwaii in British Columbia are provided by McNeely et al., 2006 (accessed on the 14Chrono Marine Reservoir database at calib.org). These appear to be calculated based on known age pre-bomb museum samples. Other regional studies from British Columbia are also available (including Southon and Fedje's extensive work across British Columbia and the recent publication by Edinborough et al. for Prince Rupert harbor).

We present 38 shell-wood pairs from secure contexts in early Holocene raised marine terraces from Baranof, Gravina, Kupreanof, Kuiu, Heceta, Kosciusko and Prince of Wales Islands.

Samples

Our database was compiled through years of consistent sampling of raised marine terrace features across southern Southeast Alaska by U.S. Forest Service Geologist Jim Baichtal and colleagues. Care was taken to sample secure, undisturbed contexts, as indicated by ancient shellfish trapped in growth position . Shell-wood pairs in close proximity (contextually the same age) were radiocarbon dated to determine the offset between the apparent age of the marine samples and age of the contemporary terrestrial sample. Charred Sitka spruce (*Picea sitchensis*) and western hemlock (*Thuja heterophylla*) needles were preferentially sampled to avoid the old wood problem; the Sitka periwinkle (*Littorina sitkana*) was preferentially sampled for its narrow habitat range in the mid-intertidal.

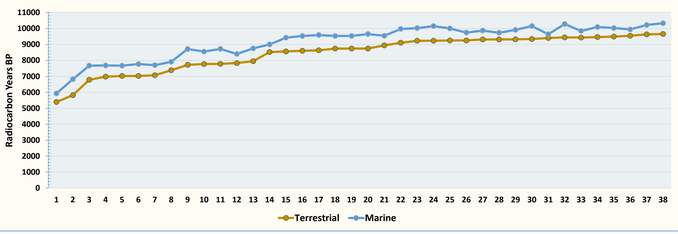
Results: Marine Reservoir Age

Our average reservoir age for southern Southeast Alaska in the early Holocene is 700 ± 70, with a range of 240 to 1000 years. A reservoir age higher than the global average of 400 years was expected for this high latitude region, so the two sampling locations with reservoir ages less than the global average are unusual (Stuiver et al., 1986).

Otherwise these data are in line with the range of reservoir ages reported for surrounding area.

Northern SE AK	860 ± 60	McNeely et al., 2006
Southern SE AK	700 ± 70	Present Study
Haida Gwaii	~ 600	Southon and Fedje, 2003
Haida Gwaii	590 ± 50	McNeely et al., 2006
Vancouver Island	720 ± 50	McNeely et al., 2006; Robinson 1981

Terrestrial/Marine Pairs Demonstrating Marine Reservoir Age for Southern Southeast Alaska



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Data

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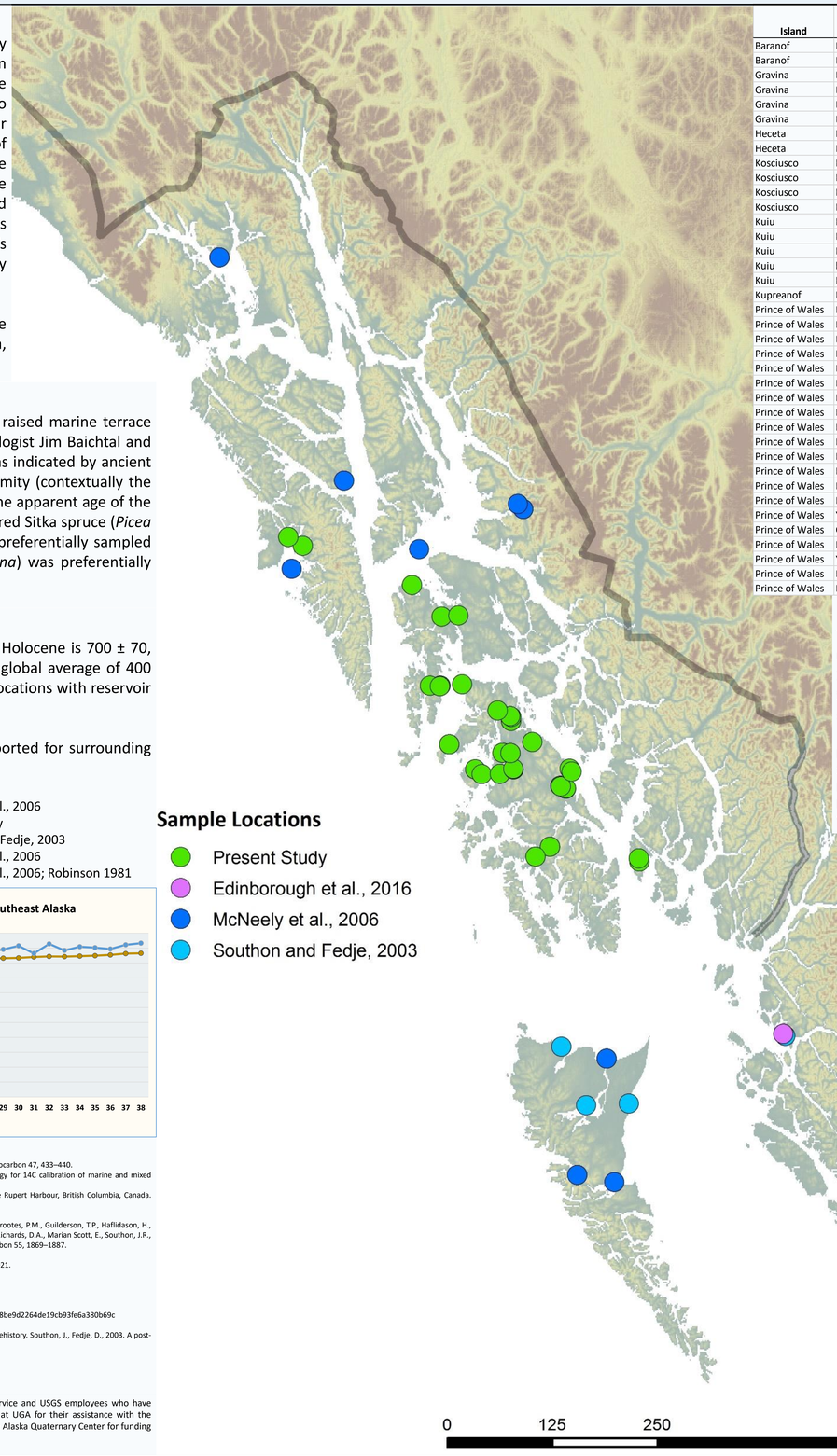


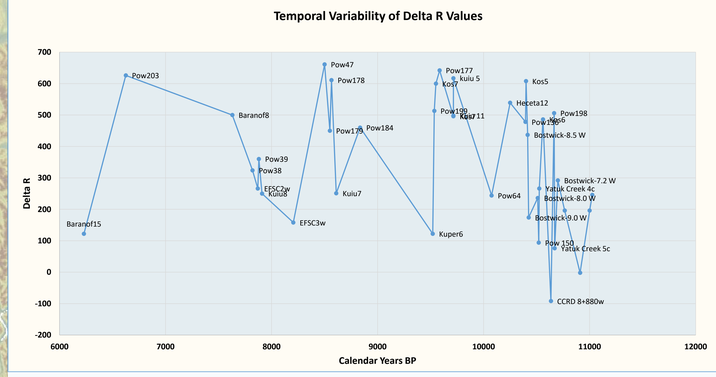
Island	Sample ID	Lab ID	Material	δ13C ‰	Conventional 14c age	±	Sample ID	Material	Conventional 14c age	±	δ13C ‰	Lab ID	Reservoir Age	±	DeltaR	±
Baranof	Baranof15	UGAMS - 26200	wood	-29.2	5390	30	Starrigavin1	shell	5930	30	2.6	Beta - 436194	540	40	122	50
Baranof	Baranof8	UGAMS - 26201	wood	-28.7	6780	30	Degroff1	shell	7670	30	0.1	Beta - 418058	890	40	500	40
Gravina	Bostwick-8.5 W	Beta - 472309	wood	-28.3	9250	40	Bostwick-8.5 S	shell	10000	30	1.1	Beta - 472309	750	50	437	60
Gravina	Bostwick-9.0 W	Beta - 472308	wood	-27.4	9250	30	Bostwick-9.0 S	shell	9740	30	0.7	Beta - 472307	490	40	174	50
Gravina	Bostwick-8.0 W	Beta - 472312	wood	-24.5	9310	40	Bostwick-8.0 S	shell	9870	40	1.1	Beta - 472311	560	60	236	60
Gravina	Bostwick-7.2 W	Beta - 472315	wood	-27.5	9460	30	Bostwick-7.2 S	shell	10090	30	-0.2	Beta - 472314	630	40	292	50
Heceta	Heceta12	UGAMS - 26203	wood	-27.3	9100	30	09RiceUp	shell	9970	90	-1.1	Beta - 264100	870	95	539	90
Heceta	Hecata13	UGAMS - 26202	wood	-25.7	9490	30	09RiceLW	shell	10030	80	-0.7	Beta - 264099	540	85	196	105
Kosciusco	Kos7	UGAMS - 26206	wood	-24.6	8600	30	CapePole 53	shell	9530	50	0.7	Beta - 276611	930	60	600	50
Kosciusco	Kos7	UGAMS - 26337	wood	-30.2	8740	30	CapePole 53	shell	9530	50	0.7	Beta - 276611	790	60	496	70
Kosciusco	Kos5	UGAMS - 26204	wood	-29.1	9230	30	CapePole 45	shell	10150	60	-1.4	Beta - 276609	920	70	608	70
Kosciusco	Kos6	UGAMS - 26205	wood	-29.2	9340	30	CapePole 52	shell	10150	60	-2.2	Beta - 276610	810	70	486	70
Kuiu	Kuiu8	UGAMS - 26210	wood	-27.3	7070	30	EBeauclerc1	shell	7700	30	0.7	Beta - 418065	630	40	250	50
Kuiu	Kuiu7	UGAMS - 26209	wood	-28.1	7830	30	BeauclercW	shell	8400	30	1.4	Beta - 418064	570	40	251	40
Kuiu	Kuiu 11	UGAMS - 26207	wood	-27.4	8740	30	EBeauclerc4	shell	9530	30	0.9	Beta - 418068	790	40	498	50
Kuiu	kuiu 5	UGAMS - 26337	wood	-30.2	8740	30	Saginaw2	shell	9650	40	-0.2	Beta - 395235	910	50	617	60
Kuiu	Kuiu 2	UGAMS - 26208	wood	-28.3	9630	30	Slippery3.3	shell	10220	40	-0.6	Beta - 276610	590	50	196	125
Kupreanof	Kuper6	UGAMS - 26211	wood	-26.9	8520	30	IrishCks	shell	9000	40	0.7	Beta - 283658	480	50	122	50
Prince of Wales	Pow203	UGAMS - 26223	wood	-30.2	5820	30	Satack	shell	6820	40	0.0	Beta - 283663	1000	50	626	60
Prince of Wales	Pow38	UGAMS - 26224	wood	-28.9	6980	30	TRS-499	shell	7680	40	-0.7	Beta - 283841	700	50	324	60
Prince of Wales	EFSC2w	Beta - 154991	wood	-31.0	7020	40	EFSC2s	shell	7670	80	-5.0	Beta - 154990	650	90	266	95
Prince of Wales	Pow39	UGAMS - 26225	wood	-28.3	7020	30	TRS-568	shell	7770	40	-0.4	Beta - 283842	750	50	360	60
Prince of Wales	EFSC3w	Beta - 154993	wood	-25.0	7380	60	EFSC3s	shell	7910	70	-5.0	Beta - 154992	530	90	158	100
Prince of Wales	Pow47	UGAMS - 26226	wood	-28.4	7720	30	TRS-723	shell	8710	40	-1.3	Beta - 283844	990	50	661	50
Prince of Wales	Pow179	UGAMS - 26218	wood	-29.1	7770	30	Twelve 14	shell	8550	50	-1.9	Beta - 276619	780	60	450	60
Prince of Wales	Pow178	UGAMS - 26217	wood	-30.1	7780	30	Twelve 13	shell	8720	50	-0.4	Beta - 276618	940	60	611	60
Prince of Wales	Pow184	UGAMS - 26219	wood	-29.4	7950	30	SalCreek-16.5	shell	8750	50	0.3	Beta - 276616	800	60	460	80
Prince of Wales	Pow199	UGAMS - 26222	wood	-25.4	8560	30	Little1082	shell	9420	40	0.3	Beta - 436192	860	50	513	50
Prince of Wales	Pow177	UGAMS - 26216	wood	-28.4	8630	30	NeckLake	shell	9590	30	0.7	Beta – 418061	960	40	642	40
Prince of Wales	Pow64	UGAMS - 26228	wood	-28.7	8940	30	Narrowpoint1	shell	9540	80	1.3	Beta - 145933	600	85	244	100
Prince of Wales	Pow136	UGAMS - 26215	wood	-30.1	9230	30	UnnamedLK-85cm	shell	10020	80	-1.1	Beta - 269004	790	85	478	90
Prince of Wales	Pow 150	UGAMS - 26212	wood	-29.2	9310	30	05JB06	shell	9730	60	-1.9	Beta - 214402	420	70	94	70
Prince of Wales	Yatuk Creek 4c	Beta - 214421	wood	-26.3	9320	60	Yatuk Creek 4s	shell	9910	70	-0.8	Beta - 214448	590	90	266	100
Prince of Wales	CCRD 8+880w	Beta - 214404	wood	-25.1	9400	60	CCRD 8+880s	shell	9640	70	-2.2	Beta - 214403	240	90	-92	100
Prince of Wales	Pow198	UGAMS - 26221	wood	-29.4	9440	30	Little081	shell	10280	40	1.7	Beta - 436191	840	50	506	60
Prince of Wales	Yatuk Creek 5c	Beta - 214422	wood	-26.2	9430	60	Yatuk Creek 5s	shell	9840	130	-0.6	Beta - 214423	410	145	76	150
Prince of Wales	Pow135	UGAMS - 26214	wood	-25.7	9540	30	UnnamedLK-170.5cm	shell	9940	50	-1.5	Beta - 269005	400	60	-2	95
Prince of Wales	Pow 54	UGAMS - 26213	wood	-27.4	9650	35	09Thorne-GR	shell	10330	80	-0.9	Beta- 264103	680	90	246	120

Results: Delta R

To calibrate dates to calendar years, a Delta R factor provides more accuracy than simply applying the reservoir age to uncalibrated radiocarbon dates. We calculated our Delta R values using the online deltar software (Reimer and Reimer 2016) with IntCal13 and Marine13 calibrations (Reimer et al. 2013). Our weighted average of delta R values for southern Southeast Alaska in the early Holocene is 365 ± 80, ranging from -90 to 625. This falls neatly into place with calculated delta R values from neighboring portions of the Northwest Coast of North America.

Northern SE AK	520 ± 80	McNeely et al., 2006
Southern SE AK	365 ± 80	Present Study
Haida Gwaii	265 ± 80	McNeely et al., 2006
Prince Rupert, BC	273 ± 38	Edinborough et al., 2016
Vancouver Island	385 ± 75	McNeely et al., 2006; Robinson 1981

Temporal Variability of Delta R Values



Conclusions

These data reflect relationships with previously published results from localities both to the north and south of our sampling region, and provide confidence for future radiocarbon dating of marine shell for use in paleoshoreline modelling and dating archaeological contexts.

While the data presented here largely conform to our expectations based on neighboring studies, the potential impact of karst in this study area provides an obvious future avenue for future work (Engstrom et al., 1990; Ascough et al., 2005).

While a few contexts here were sampled with multiple pairs, another step to strengthen our study would be to include more multiple paired samples as suggested by Cook et al., 2015, to ease the identification of outliers.