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The Use of Replicative Studies in Understanding the Function of Expedient Tools: The Sandstone Saws of San Nicolas Island, California

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Malcolm J. Rogers (1930) described artifacts in his field notes that he referred to as stone saws. Recent excavations at CA-SNI-25 yielded numerous utilized sandstone artifacts that might very well be the saws noted by Rogers. In this paper, we describe the production, use, and function of these tools and their spatial distribution across the site. Experiments show that these tools were capable of working a variety of materials, including wood, sea mammal bone, and marine shell; however, our study suggests that they were probably used for the manufacture of circular shell fishhooks.

* * *

> Often, we can only speculate as to how a certain material was processed or a specific implement was used; for this reason, the need for research involving such things as the analysis of wear patterns, experimental archaeology, and replicative studies is repeatedly mentioned in this volume. Research such as this could be carried out without additional excavation or major expenditures of time and money, and would be enormously valuable in providing us with clues that might enable us to better understand and interpret the rich body of data that is now extant on the material life of the Chumash and their neighbors [Hudson and Blackburn 1987:20].

Flaked stone tools and lithic debitage represent the most prevalent artifact types excavated from archaeological sites throughout California. Due to the degradable nature of organic materials, artifacts produced from stone are often the only surviving objects at many sites (Andrefsky 2005:1; Whittaker 1994). Flaked stone artifacts come in a variety of complex forms, including bifacially worked knife blades and projectile points, triangular and trapezoidal drills, and a variety of quickly produced and used expedient flakes and other tools. Expedient tools differ from formal or "curated" tools in that their production involves minimal effort or time, and they are generally used and discarded without retooling or reaching a point of exhaustion (Andrefsky 2005:31; Bousman 2005; Gould 1980:72; Wenzel and Shelly 2001:115).

Expedient tools are generally produced from abundant and easily accessible local materials (Andrefsky 2005:119; Clevenger 1982:104; MacDonald 2008:224). The majority of flaked stone artifacts, including expedient tools, are manufactured from amorphous, cryptocrystalline, or microcrystalline stones such as obsidian, chert, and other fine-grained igneous, metamorphic, and sedimentary rocks (Clevenger 1982:27; Odell 2003:43; Whittaker 1994). Coarse-grained sedimentary rock, especially sandstone, is much less abundant in archaeological flaked stone tool assemblages (Crabtree 1967:8). When sandstone is found it is usually in the form of pestles, bowls, and grinding stones that are ground and sometimes pecked but not flaked. Sandstone on San Nicolas Island is highly indurated, extremely hard, and comes in a variety of grain sizes (Thomas-Barnett 2004). Among these is a particularly hard form of sandstone found on cobble and shingle beaches on the island. Extremely hard and highly indurated sandstone can be flaked and made into a variety of formal and expedient tools. The density and hardness of San Nicolas Island sandstone made it possible to manufacture a tool capable of cutting, sawing, and abrading, combining the attributes of both chipped and groundstone artifacts.

Replicative studies have been used to provide frames of reference for understanding patterns in the archaeological record (Adams 2002:62; Andrefsky 1994:21–34; Coles 1979:112; Tomenchuk and Stork 1997:513; Whittakker 1994:12). Many of these studies focus on the replication of formal or composite artifacts to analyze use-wear patterns (Martindale and Jurakic 2006:417), cut marks (Seetah 2008), and manufacturing techniques (Dibble 1987, 1997), yet relatively few studies have focused solely on expedient tools (Clevenger 1982:16). Because expedient tools are often used to produce formal artifacts, understanding how they fit into manufacturing sequences is critical. Replicating and using expedient tools modeled on the archaeological record is an ideal way to understand their functional

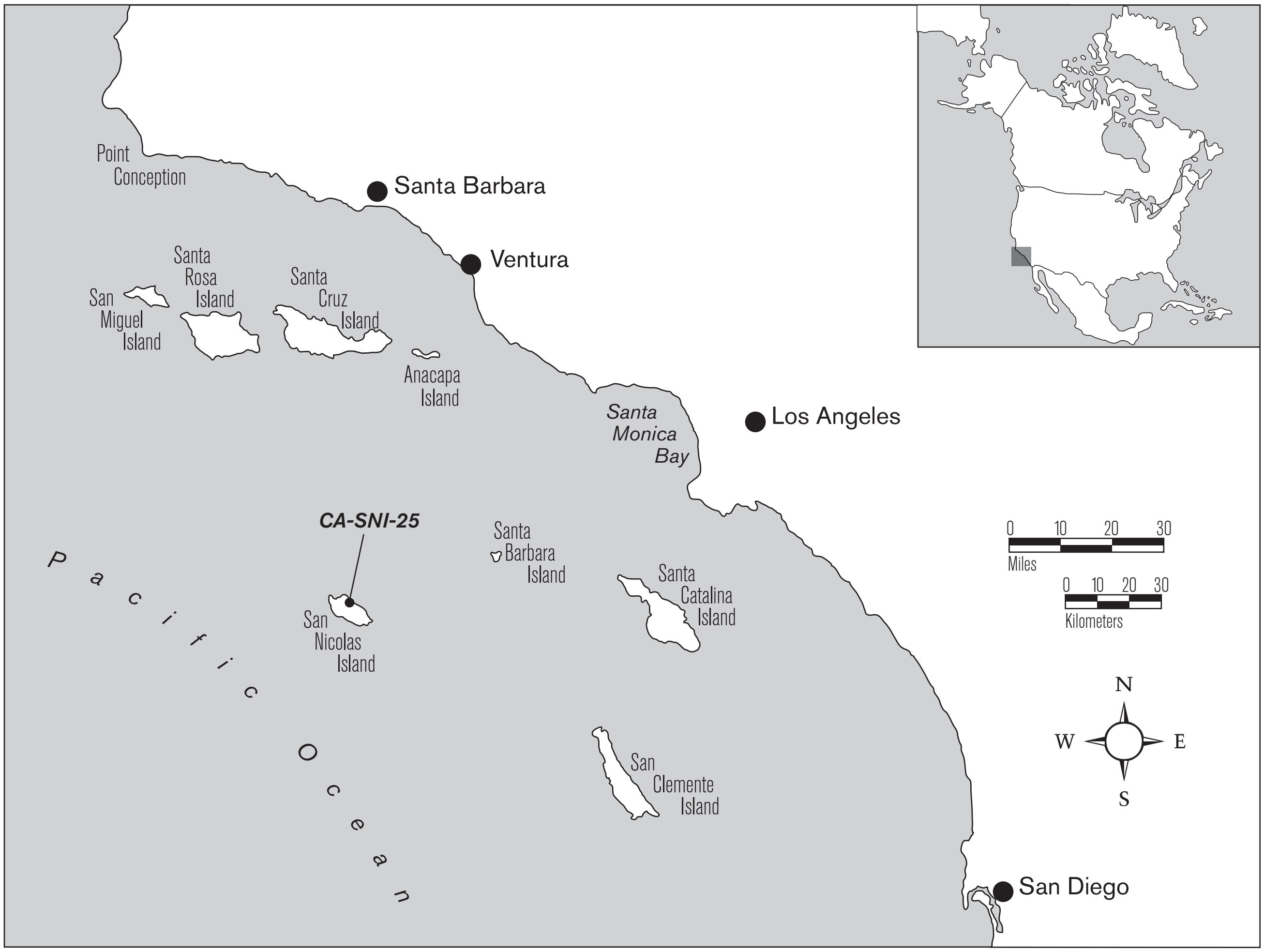

Figure 1. Southern California bight showing the location of CA-SNI-25.

linkages to other artifacts and features (Martindale and Jurakic 2006; Whittaker 1994).

Recent excavations at the Tule Creek site (CA-SNI-25) yielded 126 flat, rectangular, ovate, and utilized sandstone tools that we concluded were the stone saws referred to by Rogers (1930). Although the smooth edge of these artifacts and the abrasive nature of sandstone would lead them to be categorized as files (see Adams 2002:187–188), we continue to use the term saw due to its early use by Rogers (Rogers 1930). Similar sandstone cutting tools were described by Judd (1954:124) as "stone saws" in reference to the material culture of Pueblo Bonito in the American Southwest. Miles (1963) also applied the term to thin sandstone tools having extensive edge-wear damage. In this paper, we provide a general classification of the sandstone saws excavated from Tule Creek Village and use replicative experiments to understand use-wear and residue patterning. Our experiments suggest these tools were capable of working a variety of materials, including wood, bone, and shell, and were especially useful for manufacturing circular shell fishhooks.

BACKGROUND

San Nicolas Island is the most isolated and remote of the eight California Channel Islands (Fig. 1). Situated roughly midway between the northern and southern Channel Islands, it lies approximately 120 km. (75 mi.) southwest of Los Angeles and 98 km. (60 mi.) from the nearest point on the mainland. Its nearest neighbors are Santa Barbara Island, which lies 46 km. (29 mi.) to the northeast (Schoenherr et al. 1999; Seapy and Littler 1993:274), and Santa Cruz Island, 67.6 km. (42 mi.) to the north (Hudson et al. 1978:150). San Nicolas Island is relatively small, being 15.6 km. (9.7 mi.) long by 5.9 km. (3.7 mi.) wide with an overall land mass of 83.4 sq. km. (32.2 sq. mi.). Composed primarily of uplifted and alternating Eocene sandstones, siltstones, and conglomerates (Burnham et al. 1963; Schoenherr et al. 1999; Vedder and Norris 1963), the island contains exposed cobbles and pebbles useful for manufacturing stone tools (Taskiran 2001:20). The island's primary feature is an uplifted central plateau with a maximum elevation of 277 m. (907 ft.), consisting of sand dunes and exposed bedrock (Vedder and Norris 1963). The plateau is surrounded by uplifted marine terraces and a narrow low-lying coastal plain.

San Nicolas has a windswept and arid landscape with relatively low terrestrial plant and animal diversity (Meighan and Eberhart 1953:113; Schoenherr et al. 1999:339–345). Coastal sage scrub, chaparral, and grasslands make up the majority of the island's plants, but overall vegetation is relatively sparse, with no native trees and few edible endemics (Schoenherr et al. 1999:340). Although the importance of terrestrial resources is poorly understood, a diversity of marine habitats provided the Nicoleño with food and the raw materials for making tools, decorative ornaments, and other artifacts (Meighan 1954; Meighan and Eberhart 1953:113; Vellanoweth et al. 2002). Fish and sea mammals were obtained using a variety of techniques, involving single and composite bone gorges and hooks, circular shell fishhooks, harpoons, and nets (Bleitz 1993; Mariani 2001; Meighan 1954). The island's terrestrial and marine resources supported a fluctuating population that varied over time (Meighan and Eberhart 1953:119; Vellanoweth et al. 2002:85).

San Nicolas Island remained unknown to Spanish explorers until 1565 (Swanson 1993:21). Direct contact between the Nicoleño and Europeans likely took place in the early nineteenth century when the island's abundant kelp beds attracted sea otter hunters (Maxwell and Benaron 2006:24; Swanson 1993:21–22). Only a few of the island inhabitants survived the disease epidemics, starvation, and violence of the post-contact period (Bean and Smith 1978:538; Erlandson and Bartoy 1995; Kroeber 1925:633–634; McCawley 1996:203, 211). By 1835, all surviving Nicoleño, except Juana María, the "Lone Woman of San Nicolas Island," were removed (Hardacre 1880; Heizer and Elsasser 1961; Nidever 1937:37–38). The Nicoleño spoke one of the four distinct dialects of Gabrielino recognized by Harrington. Gabrielino is a Cupan language in the Takic language family, which is part of the larger Uto-Aztecan linguistic group (Bean and Smith 1978:538; Kroeber 1925:633).

The intensity and quality of archaeological research have varied greatly since the removal of the native population from San Nicolas Island. Early explorations (1870–1950) of the island were conducted by antiquarians and archaeologists interested in collecting specimens from the surface of the island's numerous exposed sites (Meighan and Eberhart 1953:112). A more thorough archaeological analysis began after 1959, and between 1983 and 1984 a complete survey of the island was undertaken (Martz 2005; Reinman and Lauter 1984). Distributed across the island are at least 550 archaeological sites representing villages, camps, and specialized production areas such as shell artifact processing and flake stone reduction sites. Radiocarbon samples taken from several sites suggest an overall increase in human habitation from the early to late Holocene, with a peak just prior to contact (Martz 2005:65).

TULE CREEK SITE

The Tule Creek site (CA-SNI-25) is a relatively intact village with little subsurface disturbance. It is located approximately 3.2 km. (2 mi.) southeast of Thousand Springs, the northernmost point on the island, and lies directly above and to the south of Corral Harbor, which is one of the only places on the island suitable for landing or launching watercraft. The site's abundant artifacts and exposed features caught the attention of antiquarians and relic hunters early in the post-contact history of the island. However, Rogers (1930) began one of the first detailed archaeological investigations in the early twentieth century (Hanna 1982). Rogers described the site as containing numerous house pits, eleven communal houses (nine of which had been used as cemeteries), several sandstone saws and fishhooks, and a vast quantity of flaked stone (Rogers 1930:27).

Recent excavations beginning in 2001 have concentrated primarily on two loci, designated as East Locus and Mound B, but have also included several other loci that have undergone testing and excavation to a lesser extent (Fig. 2). Detailed stratigraphic excavation and

Figure 2. Excavated Loci at CA-SNI-25.

analysis, including radiocarbon dating of materials from living surfaces, several pits, and midden deposits, place the earliest occupation of the site at about 2,000 B.C. The most intensive use of the site dates from A.D. 1200 to European contact and suggests extensive exploitation of marine resources to meet both the nutritional and material needs of the village's inhabitants (Cannon 2006). The vast majority of artifacts identified were produced from locally available materials. However, some items were produced from non-native materials such as Coso obsidian, Santa Catalina Island steatite, Monterey banded chert, and Cico chert, a dark gray to white translucent stone from San Miguel Island (Erlandson et al. 1997; Rick et al. 2001:30). Excavated materials also contain a variety of ornamental and utilitarian shell artifacts, which include hundreds of circular and J-shaped fishhooks in various stages of production (Cannon 2006:134). The flaked stone assemblage consists of arrow points, drills, knife blades, spear points, and other formal artifacts, in addition to numerous slightly modified and unmodified expedient stone tools.

METHODS

Post-excavation analysis of the sandstone saws included visual inspection and description with a 10x hand lens and a stereoscopic binocular microscope. Approximately 40 percent of the saws were cleaned with water and a soft brush to remove soil residue, allowing for better examination of use-wear and residue accumulation patterns. From these data, descriptions of the general morphology, wear patterns, and residue placement were compiled. Data recorded from each specimen included its archaeological provenience and its maximum length, width, and thickness using a sliding digital caliper. Saws were weighed with a precision digital balance and edge-wear length was recorded with a flexible nylon measuring tape. Residue was recorded as present or absent; if present, its placement and patterns were documented. If the artifact was incomplete, notes were taken as to which sections were missing and whether the broken edges had signs of use-wear (Table 1).

Replicative experiments used raw materials from the island, including sandstone shingles and cobbles collected

Table 1

SANDSTONE SAWS OF CA-SNI-25

Cat. #	Locus	Unit	Stratum / level	Weight (g.)	Length (mm.)	Width (mm.)	Thickness (mm.)	Use Wear (mm.)	Attributes
51	East	8	—	123.58	94.90	69.68	14.14	203	A, W, F
427	East	—	—	25.90	63.24	41.53	8.73	94	W, F
479	East	7S	I / 1	21.93	63.74	39.46	9.39	101	A, F
3561	East	7E	I / 1	37.63	86.92	53.27	8.02	136	C, W
3562	East	20	II / 1	61.24	99.06	63.01	8.24	208	C,W
3563	East	7T	II / 2	41.36	50.58	56.99	12.27	134	F, W
3564	East	7Y	II / 3	58.77	80.99	50.33	12.43	193	C
3567	East	7B1	II / 1	57.96	66.38	54.65	11.84	162	F
3569	East	Surface	I / 1	107.19	102.29	64.25	15.99	214	C
3570	East	7H	II / 1	163.94	120.99	73.20	15.96	313	C, W
3571	East	7Y	II / 3	189.22	137.71	69.56	19.91	298	A, C, W
3572	East	7E	II / 1	111.02	1256.86	63.16	11.55	254	A, C, W
3574	East	8W	II / 4	33.00	62.39	42.86	9.75	187	C
3575	East	7U	I / 1	39.39	58.07	55.61	10.58	6	F
3576	East	7Y	II / 3	51.92	86.69	52.45	11.07	126	C
3577	East	8E2	II / 2	89.55	86.62	54.87	20.71	182	C,W
3579	East	7	II / 1	34.21	79.24	41.77	9.70	183	C, W
3581	East	7M	II / 1	54.78	83.51	47.32	11.80	213	A, C, W
3582	East	8A1	IA / 1	74.70	79.11	78.49	9.79	111	F, W
3583	East	8	III / 1	70.75	55.42	71.55	15.80	98	F
3584	East	8A1	II / 2	115.35	106.32	59.32	16.90	273	C,W
3585	East	7A	II / 1	196.99	126.99	77.63	16.69	206	A, F, W
3586	East	8T North	I / 1	230.46	112.92	73.71	23.85	239	C
3587	East	NE Quad	—	115.62	116.75	57.05	13.77	137	C, W
3588	East	7V	I / 1	61.29	61.32	69.95	13.21	154	F
3590	East	7T	I / 1	38.10	63.71	50.32	11.95	177	C
3591	East	8R	I / 2	46.93	91.35	46.62	11.47	222	C
3592	East	8	— / 1	104.33	98.31	57.68	15.80	276	C, W
3593	East	8Y	I / 1	140.02	86.25	71.52	19.25	204	A, F
3594	East	7C	II / 1	77.61	74.12	71.18	13.68	99	F, O, W
3596	East	7X	II / 4	67.19	84.48	61.71	12.45	237	C
3599	East	8	III / 2	166.84	108.44	76.43	18.04	295	C, W
3601	East	8R	I / 2	124.60	66.76	74.27	18.05	172	F
3603	East	7A	II / 1	170.18	94.99	78.15	19.52	285	A, C
3604	East	7E	II / 1	31.15	68.50	48.74	10.05	183	A, C
3605	East	7W	II / 3	23.24	63.76	47.31	7.27	144	A, F
3606	East	7X	II / 3	88.04	137.36	50.91	10.17	201	A, C
3607	East	7Z	II / 4	88.93	106.48	46.80	15.85	231	C, W
3608	East	—	—	461.35	189.50	84.80	23.94	275	C
3650	East	7Q	II / 1	10.90	45.59	25.24	7.42	48	F
3651	East	7Z	II / 4	21.52	42.11	50.42	9.41	116	C
3652	East	7X Pit A	—	246.16	226.88	63.57	17.61	423	A, C
3688	East	7E1/07	II / 1	219.04	128.79	72.79	20.05	206	C

Table 1 (Continued)

SANDSTONE SAWS OF CA-SNI-25

Cat. #	Locus	Unit	Stratum / level	Weight (g.)	Length (mm.)	Width (mm.)	Thickness (mm.)	Use Wear (mm.)	Attributes
3689	East	7E1/07	I / 1	70.04	80.96	65.24	14.17	106	A, C
3926	East	7X	II / 1	207.38	100.26	73.67	26.65	158	F
3940	East	7Y	I / 1	23.70	61.47	40.15	8.63	114	F
4445	East	21	I / 1	125.22	118.60	64.95	14.60	302	C
4446	East	21	II / 1	67.10	78.05	45.84	16.41	260	C
4448	East	8Z	II / 1	140.94	94.74	72.62	17.48	141	F
4449	East	8Q	I / 1	42.20	48.68	62.36	13.78	117	F, W
4450	East	7E	I / 1	58.43	51.08	66.43	14.3	130	F
4451	East	8U	II / 3	33.32	53.55	55.57	11.82	110	F
4452	East	8X	I / 1	52.40	53.37	65.21	13.74	85	F
4453	East	7A1	I / 1	59.40	85.40	62.68	11.63	227	C
4455	East	8W	I / 1	25.96	61.53	42.21	9.66	175	C
4456	East	7D	II / 1	34.60	58.22	50.89	9.70	69	A, F, W
4457	East	8U	II / 2	35.79	46.43	54.78	13.91	107	F
4459	East	—	—	59.60	48.85	69.61	15.97	128	F
4460	East	7J1	II / 2	21.47	52.48	50.29	7.75	133	C
4461	East	7	II / 3	36.40	74.71	51.02	9.20	210	C
4462	East	8X	—	86.00	87.31	54.87	14.36	120	C
4464	East	7A1	II / 1	20.52	38.38	43.03	11.16	97	F
4465	East	8Q	II / 2	76.66	85.33	54.16	13.73	225	C, O
4466	East	8D2	II / 4	35.71	79.43	48.60	8.04	114	C
4467	East	21	II / 3	55.27	52.14	79.73	12.32	70	F
4468	East	7B	I / 1	46.07	83.32	53.88	11.11	120	C
4470	East	7I	II / 1	10.32	40.67	37.48	6.85	122	C, W
4471	East	7G	I / 1	28.51	46.88	50.74	9.81	156	C
4472	East	8Z	II / 1	22.66	50.39	39.38	12.00	131	C
4476	East	7Z	II / 1	10.79	39.78	41.76	7.22	95	F
4478	East	20	I / 1	13.80	55.02	27.33	7.92	90	C
4479	East	—	—	26.68	61.58	51.58	7.14	90	C
4485	East	7Z	II / 1	20.70	54.53	38.98	8.26	108	F
4486	East	7J	II / 1	72.78	73.80	61.78	13.78	149	F, W
4487	East	8S	I / 1	22.31	58.45	33.46	10.66	93	F
4489	East	21	I / 1	15.55	46.96	30.77	10.90	73	F
4490	East	8S	II / 2	17.03	43.22	54.90	5.08	34	F
4491	East	8P	II / 1	5.13	35.76	27.06	4.27	42	F
4493	East	8D2	II / 3	12.35	38.34	35.01	8.23	54	F
4494	East	8Q	I / 2	16.38	45.97	36.64	8.91	45	F
4495	East	8P	II / 1	6.78	36.31	35.66	4.76	49	F
4496	East	8Y	II / 1	2.77	29.83	18.48	5.68	36	F
4508	East	7Q	II / 8	8.49	22.00	65.82	6.92	73	F, W
3565	Mound B	21	I / 1	253.18	116.18	83.73	24.41	146	C
3566	Mound B	63	I / 2	139.19	134.14	59.40	15.46	154	C
3573	Mound B	44	II / 1	128.34	112.80	50.29	20.55	163	C, W

Table 1 (Continued)

SANDSTONE SAWS OF CA-SNI-25

Cat. #	Locus	Unit	Stratum / level	Weight (g.)	Length (mm.)	Width (mm.)	Thickness (mm.)	Use Wear (mm.)	Attributes
3578	Mound B	22	I / 1	92.02	82.67	56.35	18.48	228	C
3580	Mound B	24	I / 1	57.65	79.23	52.63	11.13	249	A, C, W
3595	Mound B	13	I / 3	112.68	106.70	64.19	14.66	178	C, O, W
3597	Mound B	30	I / 1	57.79	86.02	50.09	14.18	116	C
3598	Mound B	46	II / 2	76.92	76.05	53.38	14.14	101	F, W
4497	Mound B	61	II / 1	99.34	94.00	53.92	17.54	98	C
4498	Mound B	55	II / 2	28.75	69.16	40.60	9.22	141	C
4499	Mound B	33	I / 1	41.89	47.94	48.34	19.07	110	F
4500	Mound B	64	II / 1	48.08	46.74	82.12	14.71	113	F, W
4501	Mound B	25	I / 2	83.31	66.53	66.97	17.46	154	F
4502	Mound B	14	I / 3	21.32	59.81	34.15	8.91	122	C
4503	Mound B	49	I / 1	39.56	62.33	51.12	10.81	85	C
4504	Mound B	30	I / 1	53.11	51.39	65.81	14.08	110	F, W
4505	Mound B	—	II / 1	24.29	35.36	43.35	10.57	60	F
4506	Mound B	16	I / 2	28.56	52.91	47.20	9.63	111	F
4507	Mound B	16	I / 1	14.74	34.62	55.32	8.51	64	F, W
4509	Mound B	13	I / 2	38.73	60.85	45.64	12.99	65	F
4510	Mound B	59	II / 1	34.49	71.42	41.45	10.60	112	F
4511	Mound B	39	I / 1	11.35	34.15	50.14	10.18	20	F
4512	Mound B	13	I / 3	12.40	37.65	48.57	7.50	42	F, W
4513	Mound B	13	II / 3	12.01	30.51	50.48	12.92	45	F
4514	Mound B	47	II / 1	10.98	31.48	39.59	7.13	46	F
4515	Mound B	15	II / 2	22.56	35.59	34.57	12.64	31	F
4516	Mound B	18	I / 2	16.80	40.89	32.16	15.33	30	F
4517	Mound B	13	II / 3	18.82	50.82	42.06	8.55	35	F
4518	Mound B	30	I / 1	17.58	29.29	45.16	13.25	43	F
189	9/14	10A	I / 1 & 2	118.64	116.50	48.27	25.66	124	F
450	9/14	14	I / 1	211.84	151.30	74.43	19.04	112	F
3568	South	62	I / 4	135.48	104.37	61.22	18.23	281	C, W
3589	5/6	6	III / 60–70 cm.	24.70	68.06	25.80	9.85	105	A, F, W
3600	9/14	9	I / 2	107.30	81.24	67.27	22.12	133	F, W
4447	Mound A	2	II / 1	98.23	87.63	68.73	17.01	196	F
4454	Mound A	1	II / 1	89.83	91.73	65.63	12.20	203	C
4458	Mound A	1	IV / 1	55.24	64.45	65.12	12.58	76	F
4469	5/6	5	I / 1	17.30	33.21	46.50	9.57	82	F
4473	Mound A	2	I / 1	17.13	55.17	34.91	6.92	67	A, F, W
4475	5/6	6	I / 1	21.78	30.56	45.83	11.68	85	F
4484	Mound A	1	II / 1	38.99	60.70	43.91	11.22	47	F
4488	Mound A	2	III / 2	20.49	38.66	58.47	11.01	107	F
4492	Mound A	50	I / 1	13.94	27.36	49.65	9.87	62	F

C = Complete or Near Complete >75%, F = Fragment <75%, A = Asphaltum Residue, O = Ochre, W = White Residue

Table 2

RELATIVE FREQUENCIES OF SANDSTONE SAWS AND FISHHOOKS ACROSS CA-SNI-25

	Sandstone Saws	%	Fishhooks Blanks/Complete	% Blanks/Complete	Fishhooks Total	%	Fishhooks/ Saw	Volume ($m.^3$)	%	Saws/$m.^3$	Fishhooks $m.^3$
East Locus	83	65.87	157/115	57.72/42.28	272	67.50	3.28	36.163	51.80	2.30	7.52
Mound B	29	23.02	70/31	69.31/30.69	101	25.06	3.48	18.411	26.37	1.58	5.49
Test Units	14	11.11	17/13	56.67/43.33	30	7.44	2.14	15.235	21.83	.92	1.97
Total	126	100.00	244/159	60.55/39.45	403	100.00	—	69.809	100.00	—	—

from Corral Harbor and other coastal areas adjacent to CA-SNI-25. We produced saws similar to those from the site and used them to make artifacts from wood, sea mammal bone, and marine shell. Production sequences, use-wear, and residue accumulation patterns were noted during cutting and tool production experiments with replicated saws.

A spatial analysis was conducted on the distribution of sandstone saws at the Tule Creek site. The site's various loci were grouped into three sections: East Locus, Mound B, and Test Units (Fig. 2) which consist of all other excavation units combined. The saws were plotted on plan-view maps for each locus and compared to associated features and artifacts across the site. To deal with the unequal volume of soil excavated from each locus, excavated soil volumes were standardized and compared (Table 2). Spatial analysis provided direct archaeological association of sandstone saws in a well-preserved village context.

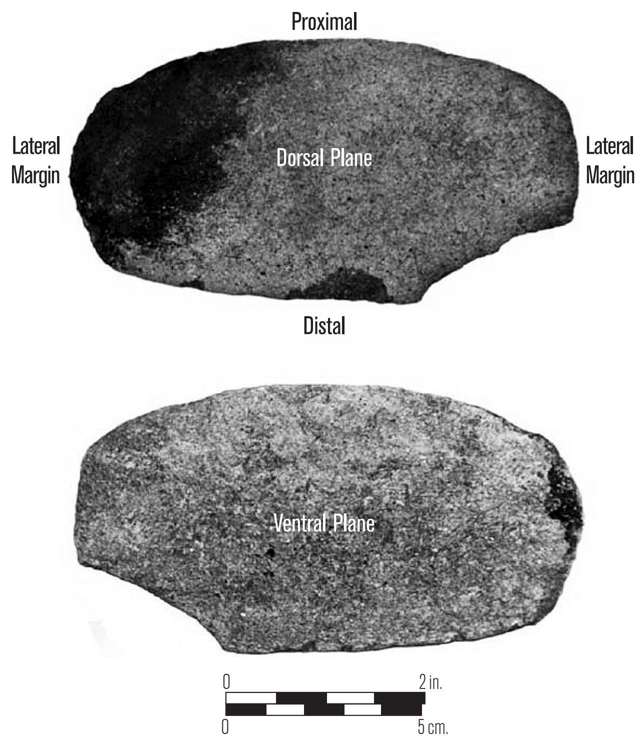

Figure 3. General morphology of the San Nicolas Island sandstone saw.

RESULTS

Artifact Morphology

Overall the sandstone saws are primary or cortical flakes with proximal ends thinned and straightened through the removal of the striking platform (Fig. 3). The margins or cutting edges are generally smooth with no sign of edge modifications. Artifact morphology varies from slightly circular to elliptical or rectangular and ranges in size between 226.88 mm. (8.93 in.) (Fig. 4f) and 40.67 mm. (2.51 in.) (Fig. 4a) with an average size of 100.68 mm. (3.96 in.) long, 58.49 mm. (2.30 in.) wide, and 15.06 mm. (.59 in.) thick (Fig. 4). Just under half (n=57, 45%) of the sandstone saws are complete or near complete and 69 (55%) are fragments less than 75% complete (Table 1).

Use-Wear and Residue Patterning

Visual examination of the archaeological specimens suggests a general pattern of use-wear and residue placement. The long distal edge of the sandstone saw is generally well worn and often exhibits parallel striations and smoothing from a repetitive back and forth cutting motion. With only a few exceptions the individual sandstone saws display signs of use on all margins and many show signs of use on one or both planes, particularly on the lower dorsal surface. Edge wear varies from light to heavy, with the margins dulled and thickened to the point of cutting edge exhaustion. The lightest use-wear is generally found along the thickest section of the proximal

Figure 4. Variations in sandstone saws.

a) The smallest (40.67 mm. x 37.48 mm.) complete sandstone saw recovered from CA-SNI-25.

b) Complete oval saw showing asphaltum stain in the upper left corner.

c) Complete circular sandstone saw.

d) Nearly complete rectangular sandstone saw with asphaltum stain in upper left corner.

e) Nearly complete sandstone saw showing white residue on lower dorsal surface.

f) The largest (226.88 mm. x 63.57 mm.) sandstone saw recovered from CA-SNI-25. The saw shows signs of heating and has an asphaltum stain on and near the left margin.

edge, where the striking platform had been removed. Distal edges exhibit the greatest amount of use-wear, whereas lateral margins show moderate amounts. There is no clear evidence of resharpening or retooling of the cutting edges, although use-wear may have obliterated signs of retouching (Fig. 3). In addition to edge wear damage, much of the assemblage is worn and polished on one or both faces, most likely caused by use as an abrader.

Many of the saws still retain an accumulation of residue embedded in the cutting edges or adhering to one or both faces. A minimum of 36 (29%) of the saws display a white residue embedded in the cutting edges or ground onto one or both faces, particularly the lower dorsal surface (Fig. 4e). Two specimens have long, thin striations consisting of the white residue radiating across the lower dorsal surface. Several saws (n=17; 13%) have traces of asphaltum visible on at least one face. Nine of these saws are stained with asphaltum in the upper left corner of the dorsal surface, suggesting use as an applicator (Fig. 4b, 4d). Three saws have a small amount of red ochre on the dorsal surface (Table 1). Additional specimens may have asphaltum, ochre, or some other residue that is not visible because they remain unwashed.

DISCUSSION

Replicative Experiments

Replicative studies were conducted to investigate production techniques and material selection preferences in the manufacturing of sandstone saws. A direct, hard-hammer percussion technique was used on raw materials gathered from San Nicolas Island in order to replicate sandstone saws similar to those found at CA-SNI-25. Through repeated experiments we discovered a direct link between selected core shape and derived tool morphology. What we found in the archaeological record at Tule Creek matched our own experiments with replicating sandstone saws. It appears that sandstone cores with acute striking platforms and relatively flat planes produced flakes with the most desired attributes for manufacturing saws.

Corral Harbor, located a short distance downslope from the site, contains a concentration of sandstone shingles eroding out of the cliff face into the surf zone. These shingles are subjected to constant cortical weathering by wind and water abrasion, producing naturally polished cobbles with all the attributes needed for manufacturing sandstone saws. While conducting our experiments, we identified a unique breakage pattern also found among the archaeological saws. If the flake failed to be driven from the core within a few strikes with the hammer stone, a fissure developed that split the flake from the bulb of percussion to the distal edge. In some instances the flake was split in the same manner while removing the striking platform and thinning the bulb of percussion. This is likely due to the presence of micro-fissures produced during the initial manufacturing stage that became more pronounced through hard-hammer percussion thinning. The breakage pattern is well represented by 19 (15%) of the saws in the artifact collection. Many of the archaeological specimens exhibiting this breakage pattern also have wear along the new margin created by the medial fracture. Once we determined the manufacturing sequence through replicative studies, the saws we produced were then used to cut and shape wood, whale bone, and abalone (*Haliotis rufescens*) shell.

Wood. Experimental materials were chosen from wood resources that would have been available to the indigenous inhabitants of the island. Drift wood, coyote brush (*Baccharis pitularis*), and silver lupine (*Lupinus albifrons*) were selected for cutting, carving, and processing with sandstone saws. The sharp distal edge of the saw was able to cut several small diameter twigs and branches of lupine and coyote brush. However, the sandstone's grit was soon embedded with a woody residue that made the tool relatively ineffective after several minutes of use. Using a second saw to cut into a small section of conifer drift wood quickly achieved similar results. The resulting woody residue deposited along the distal edge and angular micro-fracturing of the cutting edge was not found in the Tule Creek saws.

Bone. San Nicolas Island has only two endemic terrestrial mammals, the island fox (*Urocyon littoralis dickeyi*) and the deer mouse (*Peromyscus maniculatus exterus*) (Schoenherr et al. 1999:345), neither of which is suitable for manufacturing bone tools. However, the island's marine resources are numerous (Schoenherr et al. 1999:345), and sea-mammal bone implements such as harpoon shanks, projectile points, bi-pointed gorges, and abalone pry bars are abundantly represented at CA-SNI-25. Replicative studies were conducted using a replicated saw to remove a small wedge from a blue whale (*Balaenoptera musculus*) rib. We found that the saw was relatively effective at scoring a groove into the cortical bone layer, but that the cutting edge dulled quickly and the loss of small flakes from the softer ventral (inside) surface created a ridge approximately 5 mm. up from the cutting edge. This prevented the saw from effectively cutting deeper without first removing the ridge and resharpening the edge. None of the archaeological specimens exhibit

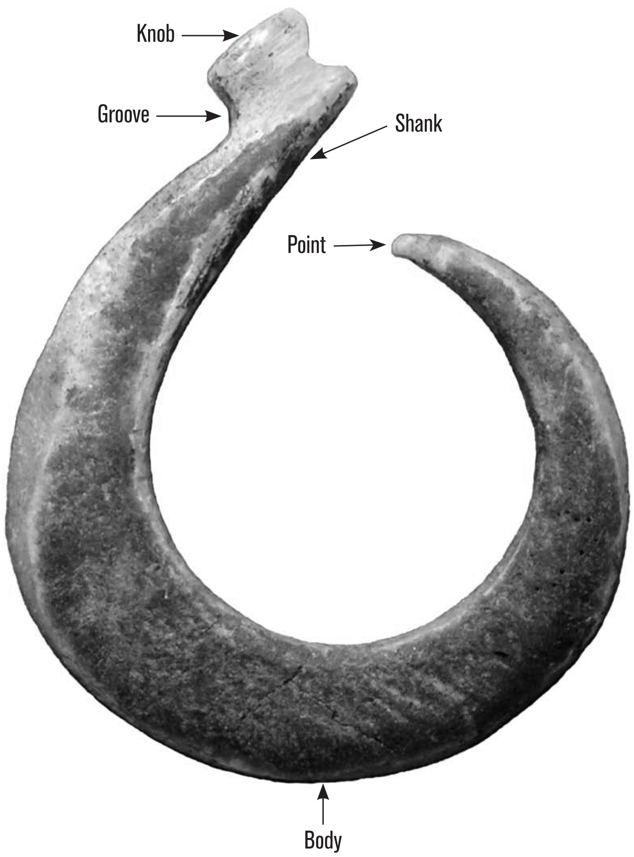

Figure 5. General morphology of the San Nicolas Island circular shell fishhook (*Haliotis cracherodii*).

obvious signs of retooling along the cutting edges. By using the groove produced by the sandstone saw as a guiding track for a stone burin followed by a wedge, a generally predetermined shape could be split free of the larger bone. White residue accumulated along the now slightly polished distal cutting edge of the tool, and micro-fractures were produced on the ventral plane of the distal edge. Though this use-wear pattern is represented at CA-SNI-25 (n=5, 4%), it occurs in relatively small numbers.

Shell. Excavations at CA-SNI-25 have identified in excess of 400 J-shaped and circular shell fishhooks (Fig. 5), fishhook blanks, and broken fragments in various stages of production (Fig. 6). Like other sites on the Channel Islands, fishhooks were produced from red abalone (*Haliotis rufescens*), black abalone (*Haliotis cracherodii*), Norris topshell (*Norrisia norrisii*), and California mussel (*Mytilus californianus*) (Cannon 2006; Meighan and Eberhart 1953:121). Providing evidence for the functional relationship between saws and fishhooks, a twined sea grass (*Phyllospadix* spp.) bag containing fishing implements, including a sandstone abrader (saw?), was found at the Nursery Site (CA-SCLI-1215) on San Clemente Island (Bleitz and Salls 1993:537–543). Our studies involving shell focused on the production of red abalone fishhooks with tools based on artifacts excavated from CA-SNI-25, including sandstone saws. These experiments followed the manufacturing sequence as defined by Strudwick (1986) and other scholars (Arnold 2001:109; Coles 1973:115; Hudson and Blackburn 1979:172–178; Miles 1963:40, 90; Miller 1988:85).

After a hammerstone and anvil were used to create a rough teardrop-shaped abalone shell blank, the blank was then thinned through abrasion on a sandstone slab. Then a hafted chert drill and driftwood vise were used to biconically perforate the blank. The outer edges of the blank were then ground smooth, using first the coarse ventral surface and then the smoother cortical surface of the sandstone saw. The distal edge of the saw was then used to cut a wedge-shaped incision into the blank, reaching from the outer edge almost to the central perforation (Fig. 7). The wedge-shaped cross section of the saws allowed both faces to widen the incision while the distal edge cut deeper into the shell. By choosing which direction to place the faces of the saw, a degree of control was obtained as to where the majority of material would be removed as the incision widened. The lateral margin of the saw is thinner and sharper than the distal edge and is useful in finishing the separation of the point from the shank. A rhizoconcretion (fossil root cast) was used as a reamer to smooth and expand the inner perforation and shape the inner edge of the point. The saw was then used to thin the shank and shape the knob of the hook. Again, the rough ventral surface was used as a rasp to quickly remove excess material, and the smoother cortical surface was used as a file for finishing work. The cortical surface of the saw was also used to refine, shape, and sharpen the point. The final step utilized the thin lateral margin of a sandstone saw to incise a narrow groove around the knob for attaching cordage (Fig. 5). This step could have been achieved by using a separate small flake of sandstone or one of the numerous expedient flake tools found at the site.

The sandstone saws proved to be remarkably well suited for the production of abalone shell fishhooks. The long distal edge allowed for efficient sweeping strokes, rapidly cutting into the abalone shell with little applied

Figure 6. Stages of circular shell fishhook production.

a) Teardrop shaped *Haliotis* spp. fishhook blank rough chipped with hammer and anvil technique.

b) Fishhook with majority of epidermis removed through abrasion on sandstone slab.

c) Fishhook blank biconically perforated with Monterey chert drill.

d) Fishhook blank with edges ground to shape on ventral plane of sandstone saw.

e) Wedge shaped incision cut with distal edge of sandstone saw.

f) Point and shank separated through completion of wedge shaped incision with distal edge of sandstone saw (see Figure 5).

g) Point carefully abraded with distal edge of sandstone saw's cortical plane.

h) Shank abraded with the distal edge of the sandstone saw's ventral plane.

i) Groove incised around knob with thin lateral margins of sandstone saw.

pressure. By reducing the pressure needed to cut into the delicate hooks, particularly near the point, the saws may have decreased the frequency of hook breakage during manufacturing, a conclusion which is supported by our replicative studies. It took us approximately 20 minutes to complete a fishhook, with as much as a third of the time dedicated to refining and shaping the point. The fine grit cortex of the saw functioned very well at refining and sharpening the point of the hook during this stage of manufacture. It is also likely that sandstone saws functioned as resharpening tools for hooks dulled or broken from contact with rocks and kelp in turbid near-shore waters (McKenzie 2007). The resulting use-wear was characterized by a smooth and semi-rounded edge and a smoothing and polishing of the faces. The use-wear that developed on the replicated saws is very similar to

Figure 7. Replication of an abalone (*Haliotis rufescens*) shell fishhook showing sandstone saw abrading wedge shaped groove to free point from shank.

the artifactual assemblage, and the residue deposited on the saw during the grinding process also had a similar appearance, particularly when we wet the saw to keep the abalone shell dust, a lung irritant, to a minimum. The water on the saw, combined with the powdered shell, produced a thick white paste that coated the saw with a residue not unlike that found on the archaeological specimens.

Spatial Correlation of Saws and Hooks at CA-SNI-25

During excavation we noted that sandstone saws and fishhooks were often closely associated. In some instances, small concentrations of materials would contain both saws and hooks. One such feature from East Locus consisted of several fishhook blanks, a large rhizoconcreation, a small bone tool, and a sandstone saw. All of this material was burned and deposited in a single pocket of ashy soil. In addition, at least one pit feature, also from East Locus, contained both a sandstone saw and a fishhook blank near the bottom of the pit.

Sandstone saws and fishhooks were widely distributed across the site, but occurred in horizontal and vertical stratigraphic concentrations (Table 3). Of the 83 saws and 272 fishhooks from East Locus, 22 saws (26%) and 45 fishhooks (17%) were found in Stratum I, Level 1. In the first two levels of Stratum II, 32 saws (39%) and 120 hooks (44%) were identified, while the remaining saws and fishhooks were somewhat evenly dispersed throughout other strata and levels. Roughly half of the 29 saws and 101 fishhooks from Mound B were excavated from Stratum I, levels 1 and 2. The first two levels of Stratum II contained 30 percent of the saws and 40 percent of the fishhooks. Among the Test Units, 7 saws (50%) and 7 hooks (23%) were found in Stratum I, levels 1 and 2. An additional 3 saws (21%) and 8 hooks (26%) were uncovered in Stratum II, Level 1. At Mound B, which contains older components than East Locus and the Test Units, no sandstone saws or fishhooks were found below Stratum II, Level 3, indicting a temporal

Table 3

STRATAGRAPHIC DISTRIBUTION OF SANDSTONE SAWS AT CA-SNI-25

	East Locus	East Locus %	Overall %	Mound B	Mound B %	Overall %	Test Units	Test Units %	Overall %	Stratum Level Total	Stratum Level %
Stratum I											
Level 1	22	26.50	17.46	10	34.48	3.85	5	35.71	3.97	37	29.37
Level 2	3	3.61	2.38	5	17.24	.96	2	14.29	1.59	10	7.94
Level 3	—	—	—	3	10.34	.96	—	—	—	3	2.38
Level 4	—	—	—	—	—	—	1	7.14	.79	1	.79
Sub-Total	**25**	**30.12**	**19.84**	**18**	**62.07**	**5.77**	**8**	**57.14**	**6.35**	**51**	**40.48**
Stratum II											
Level 1	25	30.12	19.84	6	20.69	.96	3	21.43	2.38	34	26.98
Level 2	7	8.43	5.56	3	10.34	.96	—	—	—	10	7.94
Level 3	9	10.84	7.14	2	6.90	—	—	—	—	11	8.73
Level 4	5	6.02	3.97	—	—	—	—	—	—	5	3.97
Level 5	—	—	—	—	—	—	—	—	—	—	—
Level 6	—	—	—	—	—	—	—	—	—	—	—
Level 7	—	—	—	—	—	—	—	—	—	—	—
Level 8	1	1.20	.79	—	—	—	—	—	—	1	.79
Sub-Total	**47**	**56.63**	**37.30**	**11**	**37.93**	**1.92**	**3**	**21.43**	**2.38**	**61**	**48.41**
Stratum III											
Level 1	1	1.20	.79	—	—	—	1	7.14	.79	2	1.59
Level 2	1	1.20	.79	—	—	—	1	7.14	.79	2	1.59
Sub-Total	**2**	**2.41**	**1.59**	—	—	—	**2**	**14.29**	**1.59**	**4**	**3.17**
Stratum IV											
Level 1	—	—	—	—	—	—	1	7.14	.79	1	.79
Sub-Total	—	—	—	—	—	—	**1**	**7.14**	**.79**	**1**	**.79**
Undifferentiated	9	10.84	7.14	—	—	—	—	—	—	9	7.15
Total	**83**			**29**			**14**			**126**	
Total %			**65.87**			**23.02**			**11.11**		**100.00**

*Percentages contain rounding errors.

correlation between the introduction of sandstone saws and abalone shell fishhooks at this site (Table 3).

A further correlation between sandstone saws and fishhooks becomes apparent when comparing their relative frequencies from various loci. The distribution of saws and hooks varies across the site, although there are discrete patterns worth noting. As the number of fishhooks increases, so does the relative number of saws (Table 2). The combined totals for the individual Test Units consisted of 11 percent of the sandstone saws and over 7 percent of the total fishhooks, blanks, and fragments. Mound B produced slightly more than 23 percent of the sandstone saws and just over 25 percent of the fishhooks, blanks, and fragments. Approximately 66 percent of the sandstone saws and 68 percent of the fishhooks were excavated from East Locus. A least squares linear regression analysis of the saws and hooks produced a positive correlation with a Pearson's r coefficient of 0.99508 and a coefficient of determination r^2 of 0.99018, indicating a strong linear dependence between the two variables (Fig. 8).

A pattern that supports the idea that fishhooks were manufactured on site is the ratio of fishhook blanks (~60%) to complete fishhooks (~40%) for all loci (Table 2). East Locus appears to be the focal point of production and contains the vast majority of fishhooks and sandstone

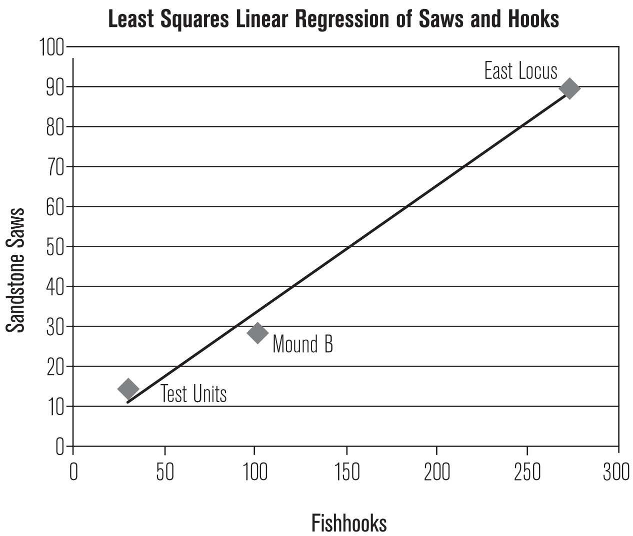

Figure 8. Linear regression analysis of sandstone saws and fishhooks at CA-SNI-25.

saws. The further removed from East Locus, the lower the concentration of hooks and saws recovered for each cubic meter of excavated soil. For instance, East Locus contained approximately 31 percent more saws and 27 percent more hooks then Mound B, and 60 percent more saws and 72 percent more fishhooks than the Test Units for every cubic meter of soil excavated (Table 2). However, Table 2 shows that the ratio of fishhooks to saws is similar at the various loci. East Locus and Mound B contained over three fishhooks for each saw recovered and the Test Units contained just under two hooks for each saw.

CONCLUSIONS

Due to the prominent location and size of the Tule Creek site, it was probably visited by several early antiquarians and archaeologists, but Malcolm J. Rogers alone noted the presence of sandstone saws. Recently, while conducting surveys along the relatively well studied northwest coast of San Nicolas Island, we observed multiple sandstone saws on the surface of several other sites. The absence of this tool type in the archaeological literature is probably due to the relatively rare occurrence of flaked sandstone tools and a lack of appreciation for expediently produced tools derived from coarse grained materials (Clevenger 1982:16). Spatial and descriptive analyses and replicative studies suggest that shell fishhook manufacturing was the primary function of these tools. The significance of this tool lies in the relationship between the Nicoleño and their maritime adaptation. Sandstone saws were likely utilized in the manufacture and maintenance of fishhooks to aid in the exploitation of marine fisheries and for the production of commodities for trade to the mainland (Rick et al. 2005:195).

Although this study goes a long way toward determining the possible use of sandstone saws, further investigations could prove beneficial to understanding this and other expedient tool kits produced from local materials. This study was designed to document and describe the distribution of the sandstone saws at Tule Creek and to understand their function and significance. Additional research on the white residue may narrow the possibilities for the function of these tools and their role in Nicoleño society. Our study suggests, however, that the saws recovered from CA-SNI-25 were used predominately to manufacture shell fishhooks. We hope that this paper encourages other archaeologists to pay close attention to expedient artifacts, which might ultimately prove to be important components (tools) used to manufacture economically significant goods and commodities.

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