Avian Use of Saltcedar Communities in the Lower Colorado River Valley[1]

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Abstract.--Bird densities and bird species diversities (BSD) in saltcedar (Tamarix chinensis) stands of the lower Colorado River Valley were determined on a seasonal basis from May 1974 through February 1977. Comparisons were made between six saltcedar structural types as well as on a community level with seven other vegetation types. A method of determining the relative value of the communities, as well as the saltcedar structural types, based on density, density with 10 percent doves, BSD, BSD with 10 percent doves, number of species, structural diversity, and size of census area is described. Results showed the saltcedar community supported fewer birds than native communities, although tall, dense stands were valuable for nesting doves and rarer bird species in riparian communities along the lower Colorado River.

INTRODUCTION

Events of the past century have resulted in tremendous changes in the flora and fauna of the lower Colorado River Valley. The Colorado River has been channelized and controlled, and vast stretches of honey mesquite (Prosopus juliflora) have been converted to agricultural use--a practice which has continued at an accelerated rate in the past few years. These conditions have favored the Brown-headed Cowbird (Molothrus ater) and have reduced or extirpated the breeding populations of such species as the Yellow Warbler (Dendroica petechia) and Bell Vireo (Vireo bellii).

This loss of habitat has also been accompanied by a deterioration of the remaining bottomland by the now well-entrenched exotic saltcedar (Tamarix chinenses). First recorded in Arizona in the late 1800's, saltcedar was not an important species until after 1910 (Robinson 1965). Nevertheless, it is now present in pure communities or mixed with virtually all riparian community types, being absent only from a few stands of honey mesquite. Knowledge concerning those avian species which utilize saltcedar is essential for those agencies involved with river or riparian vegetation management.

Areas containing saltcedar are regularly swept by fire, as demonstrated by the fact that 21 of the 25 stands involved in our study have burned during the last 15 years. The other four stands of saltcedar developed after some other form of severe disturbance. Many of these areas obviously supported another community type in the past. Saltcedar is a fire-adapted species and shows a greater recovery rate than the native riparian species. Willow (Salix gooddingii) and arrowweed (Tesseria sericea) respond quickly after fire while honey mesquite shows slower growth. Species such as cottonwood (Populus fremontii) are killed during fire. With the initiation of a burn cycle, the dominance of an area by saltcedar becomes successively more complete (see Horton, these proceedings).

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METHODS

Structural Types

The saltcedar community (stands in which saltcedar is virtually the only tree was divided into six structural types, based on distribution and density of foliage at varying heights, as explained elsewhere in these proceedings (Anderson, Engel-Wilson, Wells, and Ohmart). Structural types IV and V (trees not dense and seldom taller than 5 or 3 m, respectively) represent typical stands found in the lower Colorado River Valley. Data were gathered in these areas from the summer of 1974 through February 1977. Beginning in 1976 data were gathered from about 18 transects averaging over 0.8 km in length, using censusing techniques described by Anderson, Engel-Wilson, Wells, and Ohmart (these proceedings). These included one transect in structural type I (dense vegetation at 10 to 20 m), established in March 1976; one transect in type II (dense vegetation at 5 to 10 m), established in June 1975; two transects in type III (trees dense, seldom exceeding 6 m), established in March 1976; four transects in type IV, eight transects in type V and two in type VI (sparse vegetation representing regrowth after disturbance), established in 1974.

Ranking Technique

We developed the ranking technique for assessing the relative value of structural types of saltcedar stands and of saltcedar compared to other community types. A rank value for bird density in the structural types of saltcedar was determined using all doves and 10 percent doves, by assigning the smallest value (1) to the structural type with the greatest density and the largest value (n) to the one with the smallest density. This was repeated using numbers of species and BSD with all doves and with 10 percent doves. A mean rank for these parameters was calculated for five seasonal periods throughout the year. The average of these seasonal values was the rank assigned to a particular type.

The relative value of saltcedar compared with other community types was achieved by assigning the smallest score to the community type with the greatest average density (or number of species, or BSD's, all structural types combined) and the largest score to that community type with the smallest density (or number of species, or BSD's) as described above for saltcedar structural types.

The number of species may increase with the diversity or size of area censused. We attempted to compensate for this by ranking the most heterogeneous community or structural types with the greatest diversity or largest census area last.

We assumed that each of the parameters considered were of equal importance, a point of potential contention.

RESULTS

Densities and Diversities

Types IV and V, 1974-76

Data for three consecutive summers (May, June, July) from structural types IV and V were fairly consistent. Large dove densities in type IV in 1976 and in type V in 1975 (Table 1) resulted in relatively depressed BSD's in those years. Type IV diversities with 10 percent doves were higher than those of type V in 1974 and 1975. Dove densities for 1976 in type IV increased threefold from 1975, depressing the diversity value just lower than that of type V.

Fall (October, November) data for type V were similar in the first two years but showed a rather dramatic increase in all parameters in 1976 (Table 1). Type IV showed greater values in 1975 than in 1974 and increased further in 1976. Few doves were present at this time of year and this is reflected in slight differences in BSD's with 10 percent doves and BSD. We feel that increased densities in the fall of 1975 and 1976 over 1974 can be traced in part to the much milder conditions which existed during the late fall and winter seasons, allowing increased and prolonged use of the saltcedar community, particularly by small wintering insectivores.

Diversity values appeared to be more closely correlated with the structural parameters than were densities or species numbers. For example, in the fall of 1974 and 1976, densities in type V were greater than those of type IV; the reverse was true in 1975. Diversity values, however, were always greater in type IV.

Types I - VI, 1976

Bird densities in the six saltcedar structural types generally follow the same annual pattern of low winter numbers, increasing in the spring and peaking in the summer (Table 2). Densities dropped in late summer and continued dropping through the following winter. Spring (March-April) densities were apparently

Table 1.--Summer and fall densities, diversities, and number of species in saltcedar. Structural types IV and V, lower Colorado River Valley 1974-1976.

Structural Type	Year	Density	Density with 10% Doves	BSD	BSD with 10% Doves	Number Species
SUMMER						
IV	1974	120	64	2.2801	2.7009	19
IV	1975	126	77	2.4377	2.6237	19
IV	1976	241	98	1.9255	2.6055	18
V	1974	129	91	2.4135	2.5871	21
V	1975	182	120	2.4022	2.5631	22
V	1976	131	86	2.4411	2.6760	20
FALL						
IV	1974	42	40	2.3878	2.3062	14
IV	1975	76	75	2.4033	2.3644	16
IV	1976	105	103	2.6336	2.5934	22
V	1974	60	55	2.2369	2.1274	14
V	1975	75	63	2.0881	2.0126	14
V	1976	110	110	2.5772	2.5772	22

related to structure. Abert's Towhee (Pipilo aberti) provides a good example of a species whose density was strongly correlated with structure in saltcedar, with 1, 5, 14, 19 and 27 birds per 40 ha in types V through I respectively.

The preference of nesting doves for dense vegetation at 3 to 6 m is strongly reflected in the bird density value of type II saltcedar in the summer. There were, in fact, as many doves in this type as birds of all species in most of the other structural types.

Type II continued to show a large dove population in late summer (August-September), although types I and III had higher populations of birds of other species. Type V had the greatest diversity values and a relatively large number of species, but by far the lowest density.

The dove population was extremely low in the fall. Diversities and numbers of species, however, continued to show an inverse relationship with structure as in late summer.

Densities during the winter (December-January-February) season of 1976-77 were high compared with the fall, and especially high compared with the previous winter (Table 2). The majority of these birds, however, were small insectivores such as the Ruby-crowned Kinglet (Regulus calendula), Orange-crowned Warbler (Vermivora celata), and Yellow-rumped Warbler (Dendroica coronata). As previously mentioned, the relatively mild winter was at least partly responsible for the densities of these birds. The monthly totals for these species in the saltcedar community as a whole decreased throughout the winter, whereas the total found in the cottonwood-willow community was higher in January and February than it was in December. This demonstrates that cottonwood-willow maintained a high value for these species throughout the winter--unlike saltcedar (Table 3).

COMPARISON OF COMMUNITIES

Knowledge of the value of the different saltcedar structural types is necessary, but more important is the relative value of the saltcedar community as compared with other community types--many of which are either being displaced by saltcedar or lost in other ways. Communities to be compared include six riparian communities as well as desert wash and citrus orchard communities.

Community Densities

Bird densities in saltcedar were consistantly greater than those in arrowweed only (Tables 4 and 5) while numbers of species in seasons other than winter were comparable with other communities (Table 6). Winter densities

Table 2.--Densities, diversities and number of species in six saltcedar structural types, lower Colorado River Valley, December 1975 - February 1977.

Structural Type	December January February	March April	May June July	August September	October November	December January February
Total Density (N/40 ha)						
I	--	146	290	213	165	107
II	42	111	503	363	268	275
III	--	101	316	296	129	119
IV	25	39	241	187	105	50
V	29	54	131	89	110	125
VI	293	89	226	280	171	153
Density 10% Doves (N/40 ha)						
I	--	136	193	183	165	107
II	37	91	238	177	267	272
III	--	81	156	239	129	115
IV	20	28	98	155	103	49
V	27	50	86	75	110	125
VI	132	83	157	104	95	103
BSD						
I	--	2.1739	2.5036	1.8976	1.9097	1.7062
II	2.0383	2.2129	2.0411	1.8211	2.2582	1.9667
III	--	1.7179	1.8521	2.3969	2.3934	2.2683
IV	2.4850	2.5366	1.9266	2.4985	2.6336	2.3853
V	2.5825	2.4147	2.4411	2.7965	2.5772	2.0141
VI	1.6514	2.2435	2.5269	1.5361	1.8744	2.0174
BSD 10% Doves						
I	--	2.0930	2.7312	1.7129	1.9097	1.7062
II	1.9487	2.0597	2.5425	2.1160	2.2397	1.9367
III	--	1.6070	2.1643	2.3143	2.3934	2.2128
IV	2.5191	2.6939	2.6055	2.3894	2.5934	2.3272
V	2.5284	2.3437	2.6760	2.7972	2.5772	1.9908
VI	2.5715	2.1687	2.6214	2.7467	2.5127	2.2271
Number Species (N/40 ha)						
I	--	12	25	8	12	11
II	8	13	20	13	18	19
III	--	6	19	26	20	18
IV	12	15	18	23	22	14
V	15	13	20	24	22	19
VI	21	17	24	25	21	23

of birds in saltcedar are greater than those found in saltcedar-honey mesquite and arrowweed but included the greatest percentage and nearly the greatest dove densities of all communities. Densities decreased from summer through the winter while densities with 10 percent doves remained fairly stable through the fall. Although doves comprised fully 50 percent of the summer density in the saltcedar community, there were actually more doves in all of the other community types, excepting arrowweed and desert washes. There was a distinct relationship between departure of doves and rising BSD values from August through November (Tables 7 and 8). Bird densities in honey mesquite rose sharply in October-November, and bird densities in desert wash and saltcedar-honey mesquite not only increased from late summer to fall, but the greatest number of species occurred at this time.

Table 3.--Winter densities of small insectivores in cottonwood-willow and saltcedar communities, lower Colorado River Valley, 1976.

Community	Month	Ruby-crowned Kinglet	Yellow-rumped Warbler	Orange-crowned Warbler	Total	Percent of Total Population
Cottonwood-Willow	Dec	323	258	83	664	51
	Jan	340	516	92	984	57
	Feb	321	327	109	757	45
Saltcedar	Dec	152	535	47	734	59
	Jan	176	130	32	338	46
	Feb	89	100	6	195	32

Table 4.--Total densities for eight community types December 1975 - November 1976, lower Colorado River Valley.

Community	Dec, Jan, Feb	Mar, Apr	May, June, July	Aug, Sept	Oct, Nov
Cottonwood-Willow	148	172	336	262	210
Screwbean Mesquite	73	109	318	307	183
Honey Mesquite	193	193	323	195	270
Saltcedar-Honey Mesquite	42	111	295	184	177
Saltcedar	54	71	216	177	129
Desert Wash	68	115	176	118	185
Arrowweed	18	23	124	141	99
Orchard	158	158	678	540	135

Table 5.--Densities including 10% doves for eight community types December 1975 - November 1976, lower Colorado River Valley.

Community	Dec, Jan, Feb	Mar, Apr	May, June, July	Aug, Sept	Oct, Nov
Cottonwood-Willow	134	151	223	195	201
Screwbean Mesquite	58	82	174	218	159
Honey Mesquite	161	166	169	148	265
Saltcedar-Honey Mesquite	40	91	170	151	176
Saltcedar	26	62	119	126	120
Desert Wash	67	106	121	98	185
Arrowweed	17	23	101	135	99
Orchard	144	97	132	178	128

Table 6.--Number of species for eight community types found in the lower Colorado River Valley from December 1975 through November 1976.

Community	Dec, Jan, Feb	Mar, Apr	May, June, July	Aug, Sept	Oct, Nov
Cottonwood-Willow	28	40	35	41	34
Screwbean Mesquite	16	27	24	33	26
Honey Mesquite	19	30	22	28	27
Saltcedar-Honey Mesquite	16	20	20	19	22
Saltcedar	10	19	25	27	26
Desert Wash	16	20	20	21	30
Arrowweed	8	13	21	23	18
Orchard	17	20	18	25	17

Table 7.--BSD for eight community types found in the lower Colorado River Valley from December 1975 through November 1976.

Community	Dec, Jan, Feb	Mar, Apr	May, June, July	Aug, Sept	Oct, Nov
Cottonwood-Willow	2.7401	3.1762	2.8494	3.1817	2.9502
Screwbean Mesquite	2.6422	2.9067	2.4015	2.4451	2.8087
Honey Mesquite	2.1850	2.8608	2.1850	2.6826	2.6206
Saltcedar-Honey Mesquite	2.5428	2.4575	2.327	2.5476	2.5095
Saltcedar	1.8071	2.8537	2.405	2.7038	2.8167
Desert Wash	2.5047	2.2293	2.364	2.5706	2.7706
Arrowweed	1.9652	2.4643	2.665	2.7037	2.5160
Orchard	1.8823	2.0460	0.693	1.3052	2.2837

Table 8.--BSD with 10% doves for eight community types found in the lower Colorado River Valley from December 1975 through November 1976.

Community	Dec, Jan, Feb	Mar, Apr	May, June, July	Aug, Sept	Oct, Nov
Cottonwood-Willow	2.6941	3.2125	3.2225	3.3940	2.9067
Screwbean Mesquite	2.7721	3.1914	2.9040	2.4758	2.8263
Honey Mesquite	2.1561	2.8937	2.8276	2.7997	2.5844
Saltcedar-Honey Mesquite	2.4869	2.4888	2.675	2.4660	2.4971
Saltcedar	2.6848	2.8443	2.883	2.8544	2.7827
Desert Wash	2.4718	2.1516	2.564	2.5943	2.7706
Arrowweed	1.9652	2.4229	2.6108	2.6562	2.5160
Orchard	1.7105	2.2931	1.897	2.3454	2.1917

USE BY VARIOUS GUILDS

The percentage of the total lower Colorado River Valley population of sixteen of the more common breeding species (representing six guilds) which would occur in saltcedar, using 40 ha of each of the six riparian community types, should approximate 16.6 percent (1/6 the population of a species) if there were no selection for a particular vegetative type by any of these species, i.e. if they were evenly distributed in all community types. Two of three small (<15 gm) insectivorous species apparently exhibited no selection against saltcedar (Table 9), occurring in densities at or slightly above the expected. Woodpeckers demonstrated much less flexibility in adapting to saltcedar, possibly as a result of body size in relation to tree limbs and trunks suitable for making nest cavities. The Ladder-backed Woodpecker (Picoides scalaris), the smallest species, was more common than the Gila Woodpecker (Melanerpes uropygialis); the Common Flicker (Colaptes auratus), the largest species, did not occur in saltcedar at all. Fifty to 86 percent of the population of three medium-sized insectivores were found in structural types I and II, but only the Summer Tanager (Piranga rubra) used saltcedar to any significant extent (Table 9). The density of Abert's Towhee was slightly above that which would be expected by chance while other ground feeders (Gambel's Quail, Lophortyx gambelii and the Crissal Thrasher, Toxostoma dorsale) were slightly below expected values (Table 9). All four species of granivores occurred at greater than expected levels although a constantly wet condition was probably the greater attractant for the Song Sparrow (Melospiza melodia), considered here to be a granivore.

OVERALL VALUE OF SALT CEDAR TO BIRDS

Value of Structure

The structural types found in saltcedar (all types except type VI) were ranked to

Table 9.--Differential use of community and structural types by foraging guilds of birds in the lower Colorado River Valley, 1976.

Species	Total/240 ha all communities	Total in saltcedar 40 ha	% total in saltcedar	% population in each structure, all communities					
				I	II	III	IV	V	VI
Small Insectivores									
Verdin	108.60	10.17	9.4	5.0	15.8	20.4	25.1	15.2	18.5
Lucy's Warbler	87.37	17.50	20.1	23.4	29.0	15.2	15.6	11.1	5.7
Black-tailed Gnatcatcher	34.03	5.83	17.1	27.2	9.6	9.6	23.7	20.8	9.0
Woodpeckers									
Ladder-backed Woodpecker	31.80	2.17	6.8	26.9	29.9	15.1	12.1	6.2	9.9
Gila Woodpecker	11.57	.17	1.4	42.0	31.3	11.1	5.9	3.7	5.9
Medium-sized Insectivores									
Northern Oriole	46.30	5.67	12.2	18.1	31.6	22.0	14.5	6.5	7.2
Summer Tanager	8.83	3.00	34.0	73.1	13.7	11.4	1.8	0.0	0.0
Yellow-breasted Chat	11.00	.17	1.5	33.2	37.4	17.9	10.2	1.3	0.0
Cactus Wren	7.73	.67	8.6	11.5	23.0	20.1	16.1	8.6	20.7
Ground Feeders									
Abert's Towhee	102.55	20.50	20.0	12.3	25.0	29.8	13.4	9.8	9.4
Crissal Thrasher	21.10	2.83	13.3	0.0	21.7	25.0	21.0	21.3	11.0
Gambel's Quail	93.25	13.67	14.7	0.6	23.5	12.0	18.1	24.7	21.1
Granivores									
Song Sparrow	9.17	2.00	21.8	69.7	4.8	21.6	3.8	0.0	0.0
Blue Grosbeak	40.78	9.50	23.3	15.3	22.6	19.7	14.0	12.1	16.3
House Finch	5.92	3.17	53.5	56.5	15.7	9.4	5.7	7.1	5.6
Brown-headed Cowbird	105.63	18.50	17.5	18.3	27.4	20.8	14.7	11.6	7.2
Flycatchers									
Ash-throated Flycatcher	65.52	6.83	10.4	10.8	24.7	17.4	17.9	12.0	17.2
Western Kingbird	8.37	1.00	12.0	4.8	45.2	12.1	17.4	4.8	15.5

determine their relative value. Type II can be seen to be, overall, the preferred structure by birds in general, followed by types I, III, V, and IV, the values of the last two being very close (Table 10). The changes in the avian community that occurred when saltcedar reached a structure of type II or I were significant not only in terms of increasing densities of some birds but also in the addition of species. For example, the White-winged Dove (Zenaida asiatica) and the Mourning Dove (Zenaida macroura), Abert's Towhee, Lucy's Warbler (Vermivora luciae) and the Black-chinned Hummingbird (Archilochus alexandri) were much more abundant in type II than in type III. Type I attracted the Song Sparrow and relatively high densities of Abert's Towhee as well as the Summer Tanager and Yellow-breasted Chat (Icteria virens) in the summer.

Relative Community Value

The communities, including the two non-riparian communities, were analyzed to determine their overall relative value to birds during 1976 using the "ranking" technique discussed above. Ranked in this way cottonwood-willow communities proved the most valuable, followed by honey mesquite, screwbean mesquite, saltcedar-honey mesquite, desert wash, saltcedar, orchard and arrowweed (Table 10). Since orchards do not represent a naturally occurring community, it can be seen that saltcedar is only slightly more valuable than arrowweed (Table 11).

DISCUSSION

It has been demonstrated that the saltcedar community does not compare favorably with essentially native communities (except arrowweed, which lacks trees). Nevertheless, in the face of present environmental conditions and continuing loss of native vegetation, a concomitant increase in the proportion of the riparian habitat dominated by saltcedar is inevitable. Of particular interest was the comparison between saltcedar and orchards. The occurrence of these communities in the lower Colorado Valley has been relatively recent, and both present a uniform monoculture regardless of structural types. The birds have thus responded in a similar overall manner to these exotic communities.

Although it would appear that few species of birds are actually attracted to saltcedar during the breeding season, the addition of one or more of the native tree species, even in small numbers, would no doubt greatly enhance the overall attractiveness of an area. Addition of cottonwood or willow trees would add nest site potential, an important community component, especially for the woodpecker and flycatcher guilds. Screwbean or honey mesquite, if infested with mistletoe, would attract frugivores, a guild entirely missing from pure saltcedar.

Managing areas of saltcedar for structural types I and II appears to have significant potential (Ohmart and Anderson, MS[5/]). Saltcedar type II and mature orchards support the greatest densities of doves (Mourning Dove in orchards, both species in saltcedar type II), which are important game species in the lower Colorado River Valley. Saltcedar type I provides a habitat for avian species which are normally restricted to cottonwood-willow communities, such as the Summer Tanager, and is another important reason land managers should strongly consider managing saltcedar communities. Fire prevents saltcedar from reaching maturity and/or persisting as mature communities for any length of time along the lower Colorado River. Maintenance of mature

Table 10.--Relative value of saltcedar structural types to birds as determined by Ranking Technique, lower Colorado River Valley, March 1976-February 1977. Lower rank indices indicate greater relative value.

Structural Type	Density	Density 10% Doves	BSD	BSD 10% Doves	Number Species	Size of Census Area	Grand Rank
I	2.6	2.2	3.8	3.8	4.0	1.0	2.90
II	1.2	1.6	3.6	3.6	2.6	1.2	2.30
III	2.6	2.6	3.6	3.4	3.2	2.8	3.03
IV	4.6	4.6	1.8	1.4	2.8	4.0	3.20
V	4.2	4.0	1.0	1.8	1.8	5.0	3.13

5/ Manuscript in preparation discussing management alternatives of saltcedar communities for wildlife.

Table 11.--Relative value of eight community types in 1976 using Ranking Technique. Lower rank indices indicate greater relative value.

Total Density		Density with 10% Doves		Number of Species	
Honey Mesquite	2.0	Cottonwood-Willow	2.0	Cottonwood-Willow	1.0
Cottonwood-Willow	2.4	Honey Mesquite	2.4	Honey Mesquite	2.8
Orchard	2.6	Screwbean Mesquite	3.8	Screwbean Mesquite	3.2
Screwbean Mesquite	4.0	Orchard	4.0	Desert Wash	4.4
Saltcedar-Honey Mesquite	5.4	Saltcedar-Honey Mesquite	4.4	Saltcedar	4.8
Desert Wash	5.4	Desert Wash	4.8	Saltcedar-Honey Mesquite	5.4
Saltcedar	6.4	Saltcedar	6.8	Orchard	5.4
Arrowweed	7.8	Arrowweed	7.8	Arrowweed	6.8

Bird Species Diversity (BSD)		BSD with 10% Doves		Community Diversity		Grand Rank	
Cottonwood-Willow	1.0	Cottonwood-Willow	1.2	Saltcedar-Honey Mesquite	1.0	Cottonwood-Willow	2.47
Screwbean Mesquite	3.2	Screwbean Mesquite	2.6	Arrowweed	1.0	Honey Mesquite	3.50
Saltcedar	3.4	Saltcedar	2.7	Desert Wash	3.0	Screwbean Mesquite	3.83
Arrowweed	4.2	Honey Mesquite	4.0	Orchard	4.0	Saltcedar-Honey Mesquite	4.40
Honey Mesquite	4.8	Arrowweed	5.2	Honey Mesquite	5.0	Desert Wash	4.63
Desert Wash	4.8	Desert Wash	5.4	Screwbean Mesquite	6.2	Saltcedar	5.10
Saltcedar-Honey Mesquite	4.8	Saltcedar-Honey Mesquite	5.4	Saltcedar	6.6	Orchard	5.27
Orchard	7.8	Orchard	7.8	Cottonwood Willow	7.2	Arrowweed	5.47

saltcedar communities for 20 or more years would enhance the overall value of this plant species for birds.

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Table 11.4 — Relative value of trade commodity goods in 1671 valley barter exchanges, Upper Teal Basin (Ochre Confederacy relative value)

Item	Value	Item	Value	Item	Value
Copper kettle	6.0	Cotton print	2.0	Obsidian blade	1.5
Iron hatchet	4.5	Glass beads	2.5	Stone mortar	3.0
Awl	1.0	Brass bells	1.5	Sinew bow	2.5
Tobacco (1 oz)	0.5	Dried meat	1.0	Horse (trade)	8.0
Salt (pouch)		Salt cake			
Woven blanket	4.0	Pottery (large)	0.5	Jerky	1.0
Bronze vessel	3.0	Bronze bell	2.0	Tallow	
				Ochre pigment	0.5
Obsidian	4.0	Salt cake	0.5	Hide	2.0
Turquoise	3.0	Bronze	1.0	Arrowheads	0.5

Item	Value	Item	Value	Item	Value
Tobacco	1.0	Cotton	1.5	Salt cake	2.0
Flint	0.5	Wool	1.0	Honey Mesquite	1.0
Corn (dried)		Sunflower			
Jerky (deer)	0.5	Buffalo robe	2.0	Arrowhead	1.0
Feathers	0.1	Beaver pelt	1.5	Hominy	0.5
Horse	0.5	Turquoise	1.0	Dried Meat	0.5
Obsidian	0.5	Copper	1.0	Bronze bell	1.0
Pottery (large)	0.5	Honey Mesquite	1.0	Obsidian Blade	1.0
Flint	0.5	Cotton	1.5	Arrowhead	1.0

Barter is the oldest form of trade in the Ochre Confederacy. Long before the arrival of Spanish traders, Native peoples exchanged goods at fixed rates established by custom and negotiated at trade fairs held at river crossings and mountain passes. The Ochre Confederacy maintained a standard table of relative values for the most commonly traded goods, updated annually at the autumn trade fair.

The table above lists values in arbitrary units. One unit is approximately the value of one pound of dried corn or one tanned deerskin. Values reflect both the labor required to produce a good and its scarcity in the trading network. Copper kettles, for example, were highly valued because they were difficult to obtain and durable once acquired.

Merchants who traveled the full length of the trade route between the Ochre Confederacy and the Spanish settlements could earn substantial profits by buying goods cheaply at one end and selling them at the other. Some traders made several journeys per year and became wealthy enough to own multiple pack animals and employ assistants.

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