WATERFOWL HABITAT SELECTION ON A MULTIPURPOSE RESERVOIR IN EAST TEXAS

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Abstract: Aerial surveys were used to determine numbers of wintering waterfowl and their habitat preferences on Sam Rayburn Reservoir in East Texas during the winters of 1979 - 81. The magnitude of relative preference for 6 wetland types was defined as the mean difference between the ranks of wetland use and availability. A total of 23,277 waterfowl representing 14 species was tallied from 12 surveys. Mallard *(Anas platyrhynchos),* gadwall *(A. strepera),* American widgeon *(A. americana),* and teal (*Anas* spp.) were the most abundant species and composed 89.0% of the total. Ducks preferred scrub-shrub, emergent wetlands, and aquatic beds over unconsolidated bottom and shore, live forested wetlands, and dead forested wetlands ($P < 0.05$). Results suggest that waterfowl habitat management should be primarily considered in the design and construction phase of reservoir projects.

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The accelerating demand for water resources in the United States has resulted in an increased emphasis on reservoir construction. Nowhere is this more evident than in East Texas. There are now existing, or under construction, 90 dam and reservoir projects in the 100 easternmost counties of the state. Roughly another 50 projects are proposed for completion before 2030 (Texas Water Development Board 1977). Information on how these projects will affect the size and distribution of Texas' wintering waterfowl populations is badly needed. This is especially important because of the continuing threat to our natural wetlands from pollution, filling, channelization, and drainage (Cairns 1978).

Naturally occurring waterfowl habitat in the Pineywoods of East Texas is essentially limited to bottomland swamps, sloughs, and oxbows. Reservoirs that eliminate such habitats are potentially detrimental to waterfowl populations (White and Malaher 1964). In addition, these impoundments occupy a region where agriculture is extremely limited, and therefore, must provide all habitat requirements to be of any extensive value to waterfowl.

According to Wiebe et al. (1950), reservoirs built and operated for navigation, flood control, and power supply, without specific development and changes in mode of operation, do not offer good habitat for waterfowl. Most impoundments should provide resting areas for waterfowl, but beyond this, size, location, water level fluctuations, and adjacent land use will ultimately determine the true extent of their value (White and Malaher 1964).

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The quality of waterfowl habitat on any multipurpose reservoir is, in large part, determined by the extent and timing of water level fluctuations. Continuous wide fluctuations often associated with multipurpose reservoirs are the major limiting factor on aquatic and edge vegetation (Taylor and Taylor 1976). This is supported by Wiebe et al. (1950) who concluded that food production is the main obstacle to waterfowl use of impoundments operated for flood control and power generation. The major drawdowns in winter associated with this mode of operation destroy submerged vegetation and make edge vegetation unavailable because ducks will seldom cross open mudflats to feed (Wiebe 1946). Barstow (1963) reported that construction of subimpoundments, where water levels could be controlled, greatly increased the numbers of wintering waterfowl.

The objectives of this study were: 1) to monitor population levels of wintering waterfowl, and 2) to evaluate habitat preferences on Sam Rayburn Reservoir in East Texas.

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METHODS

Study Area

Sam Rayburn Reservoir is operated by the U.S. Army Corps of Engineers as part of a comprehensive plan for the Neches River Basin. Basin-wide plans are conceived to serve navigation, flood control, hydroelectric power, water supply for municipal and industrial uses, irrigation, recreation, and water quality (Fickessen 1965).

Sam Rayburn Dam is located 17.7 km northwest of Jasper on the Angelina River. The reservoir extends into Angelina, Sabine, San Augustine, and Nacogdoches Counties. Pool elevation averages 49 m and encompasses 40,300 surface ha (Head 1981). Mean low and high water levels for the period 1968 - 78 were 47.7 m and 50.4 m above mean sea level, respectively, with the lowest drawdowns usually occurring in fall or early winter.

Table 1. Area[a], % area, and rank of availability of the 6 wetland types on Sam Rayburn Reservoir in East Texas.

Wetland Type	Area (ha)	% Area	Rank of Availability
Unconsolidated bottom/shore	23,178	54.65	1
Forested (dead)	13,518	31.87	2
Forested (live)	3,548	8.37	3
Scrub-shrub	1,439	3.39	4
Aquatic bed	552	1.30	5
Emergent	179	0.42	6
Total	42,414	100.00	

[a] Area at a lake elevation of 49.3 m.

Classification of the wetland habitats on Rayburn Reservoir was the result of work by Head (1981) and the senior author and follows the new U.S. Fish & Wildlife Service guidelines (Cowardin et al. 1979). Waterfowl preferences for 6 wetland types were evaluated in the course of this study. The 6 types were, in increasing order of abundance, emergent (EM), aquatic bed (AB), scrub-shrub (SS), forested (live) (FL), forested (dead) (FD), and unconsolidated bottom and shore (UB) (Table 1).

Emergent wetlands on Rayburn Reservoir were best developed on temporarily, seasonally, or semipermanently flooded sites. The most common plant species on the wetter sites included Baldwin's spikerush *(Eleocharis baldwinii)* and hydrochloa *(Hydrochloa caroliniensis).* Drier sites with good soils were dominated by panic grasses (*Panicum* spp.), flatsedge (*Cyperus* spp.), and teal lovegrass *(Eragrostis hypnoides).*

Aquatic beds were habitats dominated by submergent, floating-leaved, or floating plants. This wetland type could be found in all water regimes except temporarily flooded, but was best developed on permanently or semipermanently flooded sites. Most commonly encountered plant species included muskgrass (*Chara* sp.), elodea (*Elodea* sp.), wildcelery *(Vallisneria americana),* longleaf pondweed *(Potamogeton nodosus),* and lotus *(Nelumbo lutea).*

Scrub-shrub wetlands were characterized by at least 30% aerial coverage of woody vegetation less than 6 m tall. Best development occurred in seasonally flooded water regimes and on alluvial deposits at the mouths of creeks. The dominant shrubs in this habitat on Sam Rayburn were buttonbush *(Cephalanthus occidentalis)* and black willow *(Salix nigra).* Scrub-shrub wetlands ofter had a well developed herbaceous understory which varied greatly in species composition among sites. However, in some areas the cover of buttonbush had become so thick as to completely shade out any understory.

Forested (live) wetlands deemed available to waterfowl during the 2 winters of this study occupied 3,548 ha. Live forested wetlands were areas dominated by woody vegetation greater then 6 m tall. Much of the forested habitat in the reservoir backwaters was not available to waterfowl because lake levels never rose high enough to flood these areas. The available sites on the reservoir were dominated by species tolerant to extensive flooding during the growing season such as sweetgum *(Liquidambar styraciflua)* and black willow. Herbaceous ground cover was extremely limited, although the shrub layer was usually quite well developed.

Forested (dead) wetlands were formed when forests were inundated for long periods during the growing season. This habitat is almost a trademark of East Texas reservoirs. Stands of dead sangs were most often encountered in semi-permanently and permanently flooded water regimes. Herbaceous hydrophytes were usually lacking except on sites where drawdowns exposed the soil in late summer. This type occupied 13,518 ha.

Unconsolidated bottom and shore lacked large stable substrates suitable for abundant plant growth. Unconsolidated bottom always contained less than 30% areal coverage of plants, as did unconsolidated shores, except for pioneer species that became established during favorable conditions. Where soils were good, unconsolidated shores often produced stands of annual grasses and sedges that are valuable as waterfowl foods. Unconsolidated shore is always located adjacent to

unconsolidated bottom and taken together they are often termed "open water." This habitat made up the bulk of Rayburn, as it does on many artificial impoundments.

Waterfowl Inventories

Waterfowl inventories were conducted on Sam Rayburn Reservoir November-February 1979 - 80 and November-March 1980 - 81. Censuses were conducted at least once a month and biweekly when possible. Most inventories were performed during the early morning hours, although it was occasionally after 1200 h before a survey was completed. We used a Cessna 172 aircraft and generally followed the direction of the shoreline at an altitude of 30 - 60 m. An effort was made to observe the entire lake surface to prevent bias in the evaluation of habitat preferences. Time required to complete a survey averaged about 4 hours.

The senior author and a chartered pilot recorded waterfowl numbers and noted their location on a map. The same pilot was used throughout the 2 winters of the study. During the first winter, waterfowl observations were recorded on 15 min quadrangles supplied by the Texas Forest Service. In 1980 - 81 these were replaced with 1:62,500 scale (approximate) photo mosaics produced by the U.S. Department of Agriculture.

Evaluating Habitat Preferences

Evaluation of habitat preferences followed the method developed by Johnson (1980). The method uses ranks of use and availability, rather than measured values, to determine relative preferences. The magnitude of relative preference is determined by the mean difference between the ranks of use and availability (TBAR). Habitats with the highest use or availability receive a rank of 1. A tabular F value distributed as Snedecor's F with $I - 1$ and $J - I + 1$ degrees of freedom (I = number of resource components and J = number of replicate samples) was used to test the null hypothesis that the wetland types were used in proportion to their availability. Individual aerial surveys served as replicate samples. The Bayesian decision procedure developed by Waller and Duncan (1969) was then used to test for significant differences between preferences for each wetland type.

Although not statistically testable, negative TBAR values indicated that, on the average, use exceeded availability. Conversely, positive TBAR values indicated that, generally, availability exceeded use. These relationships have often been the basis of conclusions concerning absolute proference and avoidance (Johnson 1980).

RESULTS

Waterfowl Populations

A total of 23,277 waterfowl representing 14 species was counted on 12 aerial surveys of Rayburn Reservoir. Four hundred seventy-six observations accounted for 11,420 waterfowl during the 6 surveys made in the winter of 1979 - 80. A total of 11,807 waterfowl was tallied from 547 observations during the inventories conducted in the winter of 1980 - 81. Student's t tests indicated no difference in mean population size between the 2 winters ($P > 0.05$).

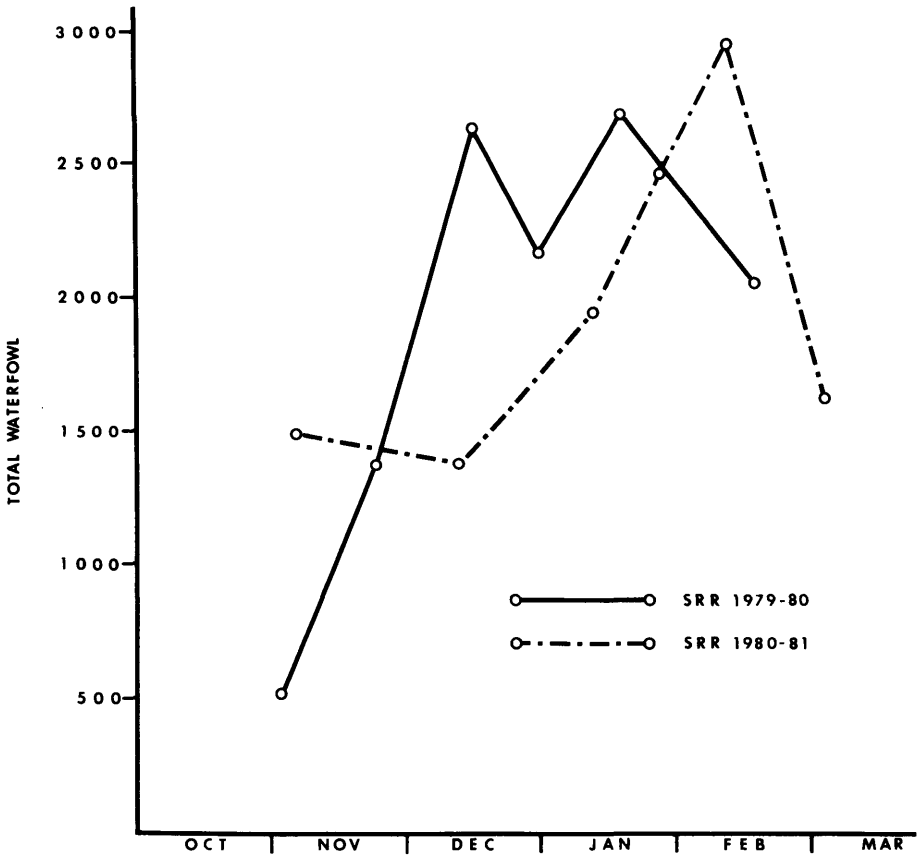

Fig. 1. Total waterfowl counts on Sam Rayburn Reservoir (SRR) during the winters of 1979 - 81.

During the 1st field season total waterfowl numbers first peaked at 2,624 on 15 December (Fig. 1). A slight decline in numbers followed; however, a 2nd peak occurred on 19 January when 2,678 waterfowl were tallied. Observations made during the winter of 1980 - 81 revealed a somewhat different pattern. On the 1st survey (6 Nov) we recorded 1,492 birds. Total waterfowl numbers had declined by the time of the 2nd survey on 11 December. This trend then reversed, but numbers did not peak until 13 February 1981 at 2,938.

Dabbling ducks (Anatinae) accounted for about 91% of all waterfowl observed on Rayburn (Table 2). Mallard, gadwall, American widgeon, and teal were the most abundant species and composed 89% of the total. Green-winged teal *(Anas crecca)* and blue-winged teal *(A. discors)* were tallied together because of the difficulty in distinguishing between them in late fall and early winter. However, no blue-winged teal were positively identified later than the end of November in either year.

Inventories indicated that only 6% of all the waterfowl wintering on the lake were divers (Aythyinae). In decreasing order of abundance these were ring-necked

Table 2. Results of aerial waterfowl inventories on Sam Rayburn Reservoir during the winters of 1979 - 81.

	TOTAL	%
Ducks:		
Dabblers:		
Mallards	10999	47.35
Gadwalls	4404	18.96
Widgeon	3601	15.50
Teal	1678	7.22
Wood Duck	330	1.42
Pintail	25	0.11
Northern Shoveler	3	0.01
Subtotal	21090	90.58
Divers:		
Ring-necked Duck	1077	4.64
Scaup	268	1.15
Bufflehead	81	0.35
Canvasback	4	0.02
Subtotal	1430	6.16
Miscellaneous:		
Unidentified Ducks	740	3.18
Hooded Merganser	9	0.04
Whistling Swan	5	0.02
Canada Goose	3	0.01
Subtotal	757	3.26
TOTAL	23277	100.00

ducks *(Aythya collaris)*, scaup (*Aythya* spp.), buffleheads *(Bucephala albeola)*, and canvasbacks *(Aythya valisineria)*. Unidentified ducks accounted for 3.2% of the total.

Habitat Selection

The hypothesis that waterfowl used the wetland types in proportion to their availability was rejected ($P < 0.01$) in the preference analysis test (calculated $F(5,7) = 26.83$). Ducks as a group preferred SS and EM to all other types ($P < 0.05$). Aquatic bed appeared to be the only other type used in excess of its availability as indicated by a negative TBAR value. In decreasing order of preference these types were followed by UB, FL, and FD. Multiple comparisons for differences in wetland type preference are best described in tabular form (Table 3).

An effort was made to discern changes in preference for individual wetland types between the 2 winters by first calculating TBAR and its associated standard deviation for each habitat for each winter. TBAR's for 1979 - 80 and 1980 - 81

Table 3. Mean differences in ranks of use and availability (TBAR), ranks of preference (RANK), and multiple comparisons for 6 wetland types on Sam Rayburn Reservoir. Figures are based on all duck sightings 1979 - 81.

Wetland Type	TBAR	RANK	Multiple Comparisons[a]
SS	-2.167	1	A
EM	-2.083	2	A
AB	-0.500	3	B
UB	0.750	4	C
FL	1.667	5	C D
FD	2.333	6	D

[a] Wetland types with the same letter had no significant difference in preference ($P > 0.05$).

were then compared for each wetland type using Student's t tests. Aquatic beds were preferred significantly more during the 1980 - 81 season ($P < 0.01$). Dead and live forested wetlands were preferred slightly less ($P < 0.10$). The preference for UB, SS, and EM remained unchanged between winters ($P > 0.10$).

Habitat preferences were evaluated for all species that were observed on greater than 50% of the aerial surveys and for which at least 200 individuals were tallied. Mallard, gadwall, American widgeon, teal, wood duck *(Aix sponsa)*, and ring-necked duck met these 2 criteria. Although the rank of relative preference varied among species, SS, EM, and AB were consistently the most preferred habitats. These 3 types had negative TBAR values for all species, an indication that use exceeded availability. Conversely, UB, FD, and FL were consistently the least preferred and all associated TBAR values were positive. The greatest variation among species exhibited itself in the Waller - Duncan multiple comparisons tests for differences in wetland preference within each species. As before, results of these tests are best described in tabular form (Table 4).

Table 4. Results of the Waller-Duncan multiple comparison tests for habitat preferences within 6 waterfowl species. Wetland types underscored by the same line were not significantly different in relative preference ($P > 0.05$).

	Rank of Preference					
Species	1	2	3	4	5	6
Mallard	SS	EM	AB	UB	FD	FL
Gadwall	EM	SS	AB	FL	UB	FD
Widgeon	EM	AB	SS	UB	FL	FD
Teal	EM	SS	AB	FL	UB	FD
Wood duck	EM	SS	AB	FL	FD	UB
Ring-necked duck	EM	AB	SS	FD	FL	UB

DISCUSSION

Total waterfowl numbers seemed quite low during both winters considering the large size of Rayburn Reservoir and that it lies in a major duck migration corridor (Bellrose 1976:22). Gorham (1975) and Hobaugh (1977) reported that waterfowl use was positively correlated with impoundment size, and Siegler (1945) suggested that construction of large lakes should be a primary objective of any waterfowl management in East Texas. However, Copelin (1961) reported that more ducks used small flood-retarding impoundments than all of the larger reservoirs in the area. Wind and wave action on large lakes containing extensive amounts of open water reduces the attractiveness of the area to waterfowl, especially dabblers (Chabrack 1979).

Despite large expanses of open water, Rayburn has a high shoreline development that resulted from flooding of existing dendritic drainage patterns. This produced numerous coves of varying size where ducks could feed and loaf in shallow, calm waters. Considering this, and the fact that ducks depend upon wariness and flight to escape danger, cover in the classical sense would not seem to be a major limiting factor on waterfowl populations. On the other hand, the abundance and availability of food has been well established as the primary obstacle to increasing carrying capacities on large multipurpose reservoirs (Wiebe 1946, Wiebe et al. 1950, Barstow 1963, White and Malaher 1964, U.S. Dept. of Agriculture 1971, Taylor and Taylor 1976, Chabreck 1979).

Abundance of emergent and semi-emergent food plants is controlled by the schedule of receding water levels during the summer months. Lowest lake levels on Rayburn typically occur in the fall, but the long growing season allows many plants to complete the cycle of establishment, flowering, and fruiting before rising lake levels in the winter inundate them.

Availability is a reflection of both food plant abundance and water levels. No matter how lush the plant growth, it must be flooded to provide waterfowl with feeding opportunities. Going 1 step farther, different waterfowl species have individualized requirements with regard to water depths at feeding sites (White and James 1978, Chabreck 1979). In the winter of 1980 - 81 lake levels continued to recede throughout the winter. Stands of waterfowl food plants were abundant in many areas, but remained unavailable because ducks would not switch to dryland feeding. There are indications that total waterfowl numbers are much higher during winters with abnormally high lake levels (James Wengier, Ranger, Sam Rayburn Project Office, pers. commun.).

The 3 wetland habitats apparently under-used in proportion to their availability composed approximately 95% of the total lake surface. The commonality between UB, FD, and FL seemed to be a lack of abundant food resources. Vegetated unconsolidated shore did, in certain areas, produce abundant quantities of sedges and grasses, although never to the same extent as SS and EM. Unconsolidated bottom and shore was aloso the most susceptible to wind and wave action.

Dead forested wetlands have been reported as preferred by waterfowl (Ouchley 1976); however, it appears that the sites in that study had a much higher component of live plant material. These wetlands on Rayburn were composed mainly of dead bottomland oaks (*Quercus* spp.), water hickories *(Carya aquatica),* and occasional pines (*Pinus* spp.) (Head 1981). Upon initial inundation these areas

were undoubtedly very beneficial to waterfowl for feeding and loafing. Waterfowl were evidently quite abundant the first few winters after deliberate impoundment of water began in 1965 (Gary Spencer, Texas Parks & Wildlife Dept., pers. commun.). However, most bottomland hardwood species cannot tolerate extensive flooding during the growing season such as occurs on Rayburn, and substantial mortality of the woody vegetation ensued. With the disappearance of mast as a food source, these wetlands lost their attractiveness to waterfowl.

The reason for the low preference rating of FL wetlands is not quite so obvious. It is important to remember that FL sites on Rayburn are dominated by species tolerant to flooding during the growing season. Most common among these were sweetgum, black willow, and buttonbush which do not produce waterfowl foods of good quality. An occasional water oak *(Quercus nigra)* or willow oak *(Q. phellos)* was observed, but their presence was of little consequence especially since acorn production was poor in 1979 and 1980 (Gary Spencer, pers. commun.). Because woody vegetation often formed a closed canopy, herbaceous plant production was severely limited.

Of all the wetland types available on Rayburn Reservoir, SS, EM, and AB were most heavily utilized by ducks. However, because the preference for these types is relative, care should be taken in making absolute statements about their ultimate suitability as wintering waterfowl habitat.

Scrub-shrub and EM wetlands seemed to produce the greatest quantity and diversity of potential waterfowl food plants. The slightly higher preference for SS over EM may be accounted for by the greater abundance of buttonbush which was used somewhat as a food source (Johnson 1981) and possibly as screening cover. Aquatic beds, consisting primarily of wildcelery or longleaf pondweed, also undoubtedly provided opportunities for feeding. Aquatic beds also serve as excellent habitat for macroinvertebrates (Kercher 1939, Krull 1970), which are also used as a food resource.

A significant increase in the preference for AB during 1980-81 was the most notable change in habitat selection between the 2 winters of this study. Lake levels during the winter of 1980 - 81 remained lower than the lowest level recorded during the previous growing season. Obviously, emergent and semi-emergent food plant availability declined with decreasing water levels and certain areas lost their utility as feeding sites. However, the decreasing water levels made many submergent aquatic beds more accessible to ducks, especially dabblers.

Improvement of waterfowl habitat on existing reservoirs is severely limited by a lack of water level control for this purpose. Within this operational framework, planting of emergent waterfowl foods is risky because small, yet critical, water level fluctuations are hard to predict. Artificial propagation of desirable aquatic macrophytes on semipermanently or permanently flooded sites should be more cost-effective, given that soil and water quality conditions are suitable.

Where dense, relatively unpreferred, FL wetlands have replaced SS through natural succession, controlled burning at low water may be beneficial by opening the canopy and thereby encouraging herbaceous plant production. Manual cutting or prescribed burning should also be considered for SS where species such as buttonbush have become dense enough to inhibit penetration by waterfowl.

It is evident that extensive management of waterfowl habitat is best considered before reservoir projects are completed. Construction of dikes, across drainages

that would otherwise become shallow coves upon inundation, would allow efficient management of desirable food plants and water depths. Such subimpoundments could take advantage of the drawdown which normally occurs in late summer. However, fall and early winter rains may be inadequate to reflood the vegetation to desirable depths, creating the need for pumps. This may make the cost of such projects prohibitive.

In lieu of the above, relatively preferred habitat can be developed by carefully planning timber harvests prior to inundation. Forests, situated at elevations where most trees would be killed by permanent flooding, should be cleared in order to promote aquatic plant productivity. Dead timber reduces the area available for aquatic growth and its decomposition stains the water, produces organic acids, and increases the biochemical oxygen demand (Atlantic Flyway Council 1972). Some trees could be left for loafing spots, wave control, and to enhance fish and non-game habitat where needed.

Seasonally flooded sites at the proposed mean pool elevation should be developed into SS and/or EM by removing any existing timber and allowing secondary succession to re-vegetate the area with shrubs and herbaceous hydrophytes. Soil quality should be a major consideration in site selection if adequate cover of natural vegetation is to be expected.

Higher sites, subject to occasional flooding during winters of abnormally high lake levels, should be managed for mast-producing hardwoods. Species that are at least moderately tolerant of some flooding, even after the onset of the growing season, and which might be considered for the East Texas area are water hickory, deciduous holly *(Ilex decidua)*, water oak, and southern red oak *(Quercus falcata)* (Broadfoot and Williston 1973). These sites, at periods of normally lower water, would also benefit upland game species by providing hardwood habitat that is elsewhere being replaced by even-aged pine plantations.

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