# Economic benefits of reintroducing the River otter (*Lontra Canadensis*) into rivers in New Mexico

Prepared for Amigos Bravos

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List of abbreviations

| | |
|---|---|
| BLM | Bureau of Land Management |
| BT | Benefit transfer |
| CB | Census Bureau |
| CV | Contingent Valuation |
| FS | Forest Service |
| FWS | Fish and Wildlife Service |
| NF | National Forest |
| NP | National Park |
| NWR | National Wildlife Refuge |
| PV | Present Value |
| SDR | Social discount rate |
| UK | United Kingdom |
| U.S. | United States |
| USDA | U.S. Department of Agriculture |
| USDI | U.S. Department of the Interior |
| USGS | U.S. Geological Survey |
| WTP | Willingness to pay |

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## Executive summary

The New Mexico Department of Game and Fish is evaluating the feasibility of reintroducing the river otter, a native species extirpated from the state, to two river systems in New Mexico. One of the aspects considered in that evaluation are the economic impacts associated with that reintroduction. In this study, we provide estimates of one side of those economic impacts, namely, of the economic benefits that reintroduction of river otters to the state is expected to generate. Ideally, such benefit estimates would be developed on the basis of primary research. This research would estimate non-market benefits of otter reintroduction via surveys that elicit the willingness to pay of residents and visitors for such reintroduction. It would also quantify potential market-based benefits of reintroduction, such as increased revenues in the tourism-related sectors that may result from the reestablishment of a charismatic species like the river otter. Finally, benefits estimates would also take into consideration the ecosystem service benefits that reintroduction of the river otter may yield, due to the otter as a keystone species in the aquatic systems it inhabits.

Given resource and information constraints, the generation of primary benefit estimates for the reintroduction sites in New Mexico is not possible at this time. Rather, we employ the second-best approach for benefits estimation, namely, benefits transfer. Benefits transfer is a valuation methodology that has been developed in the disciplines of environmental and natural resources economics to generate benefits estimates in cases where primary research is infeasible. We employ two benefits transfer approaches to develop lower and higher benefit estimates for different spatially defined populations of beneficiaries: residents of the counties in which reintroduction would take place; residents of New Mexico as a whole; recreation visitors from out of state engaging in angling and wildlife watching in New Mexico; and residents in the rest of the U.S.

Our estimates are conservative because they only include part of the benefits that would result from reintroduction. Specifically, they measure direct use values, that is, the benefits people receive from viewing otters, and non-use values, that is, the benefits people receive from simply knowing that this once native species is re-established in the state. We do not quantify the potential market value that reintroduction of otters may generate by affecting the species composition and behavior of game fisheries, thereby improving the attractiveness of the recolonized rivers to anglers, and resulting in increased revenue in the local sport fishing and tourism industries, and we do not quantify the potential ecosystem service benefits associated with otter reintroduction. Such quantification would require quantitative information on the effects of otters on particular aquatic species, specifically, crayfish and game fish. Nevertheless, our estimates indicate that the economic benefits of reintroduction are sizeable.

During a ten-year period, reintroduction of the river otter to New Mexico is estimated to generate total benefits of between $6 million and $9.5 million for residents of the reintroduction area, $9.8 million and $12.9 million for people in the state as a whole, around $5.8 million for anglers and wildlife watchers visiting from out-of-state, and between $1.2 million and $3.2 million for people living in the rest of the U.S. who do not

visit the state on vacation (all amounts measured in present value terms). The estimates of the benefits that individuals in the rest of the U.S. would receive assume that reintroduction of the otter to New Mexico would lead to an increase in the total U.S. river otter population of between 0.02 percent and 0.05 percent. These results indicate that the economic value of reintroducing river otters to the state is substantial. Even the lower-bound estimate of the benefits received by state residents only amounts to almost $10 million. If out-of-state anglers and wildlife viewers visiting the state are included, the lower-bound benefit estimate increases to almost $16 million. Given that it is not expected that reintroduction of the river otter will cause negative impacts on sport fisheries, or any other negative economic impacts for that matter, it appears likely that reintroduction of the species to New Mexico will generate net economic benefits to the residents of the counties in which otters re-establish themselves, the residents of the state as a whole, recreation visitors to the state, as well as to the country as a whole.

## Introduction[1]

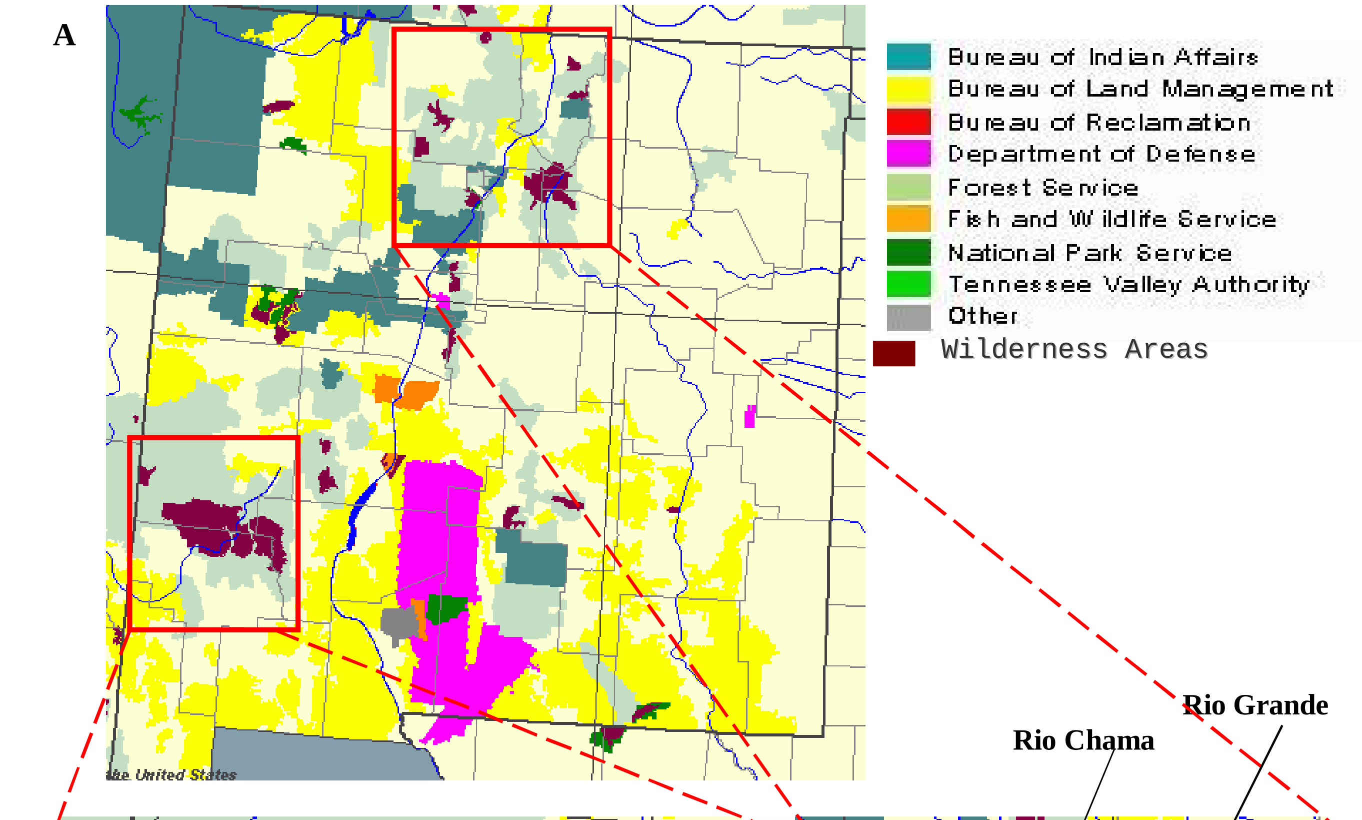
The New Mexico Department of Game and Fish (2004) is studying the feasibility of reintroducing river otters (*Lontra canadensis*) in New Mexico. That study will include, among other things, a sociopolitical assessment and an analysis of the economic impacts of river otter reintroduction (ibid.). The present study presents estimates of the economic benefits that the reintroduction of the river otter to New Mexico is expected to generate.

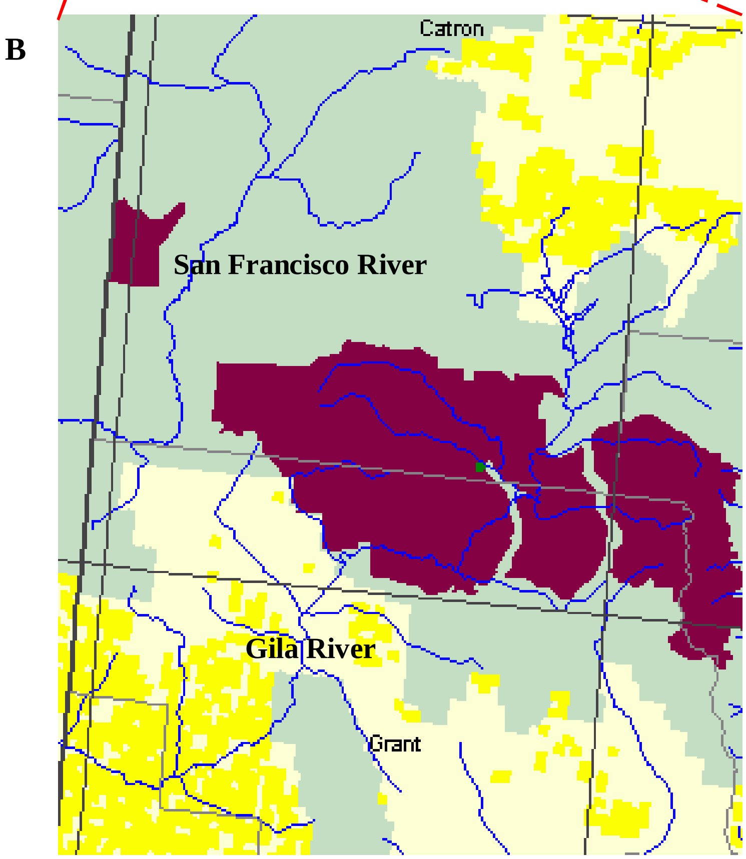
The rivers considered for reintroduction are the upper Rio Grande above Cochiti Lake, portions of the middle Rio Chama, the Gila, and the San Francisco (New Mexico Department of Game and Fish, 2004; see Figure 1). The prospective restoration sites are primarily located adjacent to, or on, federal and Indian lands. The restoration sites on the upper Rio Grande and Rio Chama are managed by the U.S. Bureau of Land Management (U.S. BLM). Adjacent lands include primarily the Carson and Santa Fe National Forests, Bandelier National Monument, Taos Pueblo lands, and Cochiti Pueblo lands. Restoration sites on the Gila/San Francisco River system are primarily located on the Gila and Apache National Forests.

The location of the rivers that would be targeted for reintroduction indicates that reintroduction would take place in an area that receives high volumes of recreation activities (Table 1). A large share of this recreation occurs on the National Forests (including Wilderness areas) in which the four rivers are located in New Mexico (Table 1). A large portion of visitors to these National Forests engage in fishing, wildlife watching along lakes and streamsides (Table 2), or non-motorized water activities (Table 1) such as rafting, kayaking, and swimming. All of these pursuits are likely to bring these individuals into contact with river otters. This suggests that reintroduction of river otters to New Mexico may generate substantial benefits in the form of non-consumptive direct use values associated with water-based recreation activities. These benefits are a function of people's enjoyment of viewing river otters in their natural environment. They are called direct use values because the individuals in question actually come into direct (if only visual) contact with the species.

However, individuals assign a number of other values to rare, threatened, and endangered species (see Table 3). Individuals may attach non-use values such as existence, stewardship, and bequest values to knowing that a particular species exists and is passed on to posterity, even though they may never come into contact with the species (Krutilla, 1967; Prato, 1998; Freeman, 2003). Similarly, in the case of option value, individuals

[1] I would like to thank Jon Klingel, Tom Serfass, Melissa Savage, Roger Peterson, and Frank Casey for the helpful comments they provided on earlier drafts.



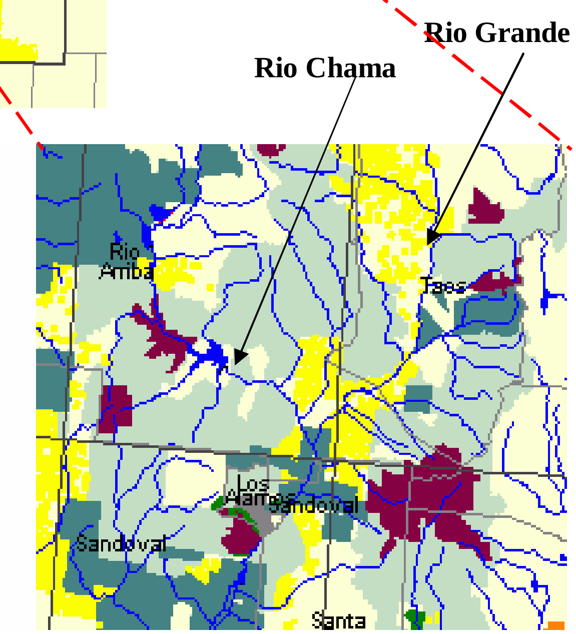




**Figure 1: Land ownership, New Mexico (panel A) and study areas (panel B)**
Source: U.S. Geological Survey 2003a and 2004a.

may derive benefits from knowing they will have the option of using the resource in the future should they wish to do so (Freeman, 2003; Prato, 1998).

**Table 1: Visitation levels of National Forests in the study area and numbers of visitors engaging in selected activities**

| | *Apache-Sitgreaves NF* | *Carson NF* | *Gila NF* | *Santa Fe NF* |
|---|---|---|---|---|
| Year | 2000-01 | 2002-03 | 2000-01 | 2002-03 |
| total visitors, millions (estimate) | 2.39 * | 1.11 | 1.83 | 1.52 |
| *of which engaged in:* | | | | |
| Fishing, % | 50.5 (19.6) | 8.2 (2.5) | 8.2 (2.8) | 9.4 (5.0) |
| Wildlife viewing, % | 73.5 (1) | 31.1 (3.0) | 34.9 (5.2) | 51.3 (1.4) |
| Non-motorized water activities, % | 6.4 (0) | 8.0 (5.0) | 0.9 (0.6) | 0.2 (0.1) |

*Notes*: Percentages do not add up since activities are not mutually exclusive. Numbers in parentheses indicate percentage of visitors who stated that the respective activity was their primary activity. * Visitation numbers are for the Apache-Sitgreaves National Forests combined. Given that the Apache NF is partly, and the Sitgreaves entirely, located in Arizona, the share of Apache-Sitgreaves visitors who recreate in New Mexico is likely substantially lower than the 2.39 million shown for the two forests as a whole.
*Sources*: U.S. FS (2002a; 2002b; 2004a; 2004b).

**Table 2: Wildlife-related recreation in New Mexico, 2001**

| *Activity* | *Number of individuals over 16 years of age who engaged in activity* | | |
|---|---|---|---|
| | *NM Residents* | *Non-Residents* | *Total* |
| *Individuals* | | Thousands | |
| Fishing and hunting | 237 | 142 | 379 |
| Fishing | 197 | 116 | 313 |
| - of which trout fishing: | 144 | 66 | 210 |
| Wildlife watching | 185 * | 202 | 387 |
| - of whom visiting lakes and streamsides on public lands | 120 | 132 | 324 |
| *Participation days* | | | |
| Fishing: | 2,091 | 394 | 2,485 |
| - of which trout fishing: | 1,540 | 248 | 1,788 |
| Wildlife watching | 5,209 | 1,173 | 6,382 |

*Source*: U.S. FWS and U.S. CB (2002). * Non-residential activities. Residential activities, i.e., those close to home, attracted a further 449 thousand people.

Non-use values and option values have long been established in economic theory as components of a resource's total economic value (Freeman, 2003; Krutilla, 1967). They have also been recognized as legitimate components of the economic value of natural resources by the courts (U.S. Court of Appeals, 1989) and by legislation (U.S. Department of the Interior, 1994).

As shown in Table 3, reintroduction of river otters to New Mexican rivers may also generate direct use market benefits in the sport fishing industry and associated tourism industries. For example, some studies show that river otters are opportunistic predators that prey predominantly on slower fish (New Mexico Department of Game and Fish, 2004). The reintroduction of river otters to streams used by anglers may therefore tend to reduce food competition for the fish desired by anglers. Given that New Mexico's rivers are highly frequented by anglers (Table 2), and that many of those rivers have large populations of fish that are undesirable from the anglers' perspective (New Mexico Department of Game and Fish, 2004), reintroduction of the river otter could have the effect of improving the overall recreational experience of these anglers.

**Table 3: Potential economic benefits associated with reintroduction of river otters to New Mexico***

| *Value category* | | *Potential benefit due to species reintroduction* |
|---|---|---|
| *Direct use values* | *B-1* | • Possibility of experiencing reintroduced native species (*recreation, tourism – increase in consumer surplus*) |
| | *B-2* | • Increased development opportunities for some sectors (*economic multiplier impacts of tourism sector – increase in producer surplus*) |
| | *B-3* | • Positive impacts of river otters on other valued species (*recreation, tourism – increase in consumer and producer surplus*) |
| | *B-4* | • Higher land values (*from increase in environmental quality*) [a, b] |
| *Option value* | *B-5* | Possibility of viewing otters and visiting intact/more biologically complete aquatic habitats in the future |
| *Indirect use values (ecosystem function values)* | *B-6* | Increase in ecosystem function values of occupied habitat [c] |
| *Non-use values* | *B-7* | Generation of stewardship, existence, bequest, and intrinsic values associated with otter reintroduction |

*Notes*: * Not all benefit categories may be applicable in every locale of otter reintroduction. Also, *B-4* and *B-5* are not mutually exclusive. [a] To the extent that land is used for marketed output, land values capture economic rents, and vice versa. [b] See for example Nelson *et al.* (2002). [c] Due to the ecological regulatory function of otters as keystone species in the aquatic systems they inhabit.
*Sources*: General value categories based on Barbier (2000) and Brown and Shogren (1998). Table adapted from Defenders of Wildlife (2004).

Such an increase in the relative attractiveness of New Mexican rivers may attract a larger number of anglers, leading to increased revenue in the associated recreation industry (outfitters, tour guides, hospitality industry, etc.). Due to the substantial size of the fishing industry in New Mexico (U.S. Fish and Wildlife Service and U.S. Census Bureau, 2002) and the multiplier effects of expenditures, the total impact on the regional economy from increased visitation by anglers may be substantial.

In addition, the reestablishment of charismatic fauna in some instances may attract additional visitors to the reintroduction areas. This has certainly been observed in the case of the gray wolf in Yellowstone National Park. Increased numbers of visitors result in increased revenues for the local tourism industry, and in multiplier effects in the larger, regional economy (U.S. FWS, 1994). However, it is unlikely that recreational visitation would increase substantially as a result of the reintroduction of the river otter to New Mexico. The principal reason for this is that otters exist in a large number of other states. Hence, those individuals for whom viewing river otters in the wild is a primary factor in selecting their visitation areas have ample opportunity to do so elsewhere. There may be, of course, impacts on the margin. Those visitors who currently chose to engage in recreational activities in places other than New Mexico only because there currently are no opportunities for viewing otters in that state, and who would relocate their recreation activities to New Mexico if there were otters in that state, would bring additional tourism revenue to the state as a result of river otter reintroduction. We argue, however, that the number of people to whom this applies is likely to be small.

Finally, reintroduction of the otter may generate indirect use values, or what more commonly are referred to as ecosystem service benefits. Ecosystem services are those functions provided by natural systems that indirectly benefit human well-being. These services constitute inputs for, and often make possible at all, human production of goods and services (Daily ***et al.***, 1997; Balmford ***et al.***, 2002). The services performed by ecosystems include the maintenance of hydrological and nutrient cycles, soil formation and erosion control, pollination, habitat provision, nursery for fish and game species, provision of food and water for humans and livestock, climate regulation, disturbance regulation, waste management, and biological control (ibid.). To the extent that the river otter improves the health, productivity, or biodiversity of rivers, these impacts may carry associated benefits for humans. One example of how the reintroduction of the river otter, a native keystone species in the aquatic systems targeted for reintroduction, may tend to increase biodiversity, species composition, or relative species abundance in these systems is by controlling crayfish populations. The crayfish is an invasive in the New Mexican rivers targeted for river otter reintroduction. Significant impacts by exotic crayfish on the native aquatic fauna have been documented in Arizona (Fernandez and Rosen, 1996) and presumably are also occurring in New Mexico (New Mexico Department of Game and Fish, 2004). Given that crayfish, where available, may constitute the main prey base of otters (New Mexico Department of Game and Fish, 2004), otters may reduce the negative impacts of the crayfish on other species desirable to humans, such as game fish.[2]

However, due to the scarcity of available information on the potential impacts that otter reintroduction may have on non-game fish and aquatic ecosystems in general, we do not attempt to estimate the economic value associated with potential market-based direct use and ecosystem service benefits. These values may be sizeable components of the total economic value of otter reintroduction, and it would be desirable to quantify them

[2] Perhaps one of the best-known cases in which reintroduction of a native top predator has had such a positive control effect on the populations of other species was the reintroduction of gray wolves to Yellowstone National Park (Ripple *et al.*, 2001; Ripple and Beschta, 2004).

through future research. Instead, our analysis focuses on non-use values and recreational direct use values for otters themselves (see benefits *B-1*, *B-5*, and *B-7* in Table 3). We estimate these values for people living in the proximity of the reintroduction areas, that is, people who live in the counties in which otter populations would be restored or who live in immediately adjacent counties; for people in New Mexico as a whole (see Table 4); for anglers and wildlife watchers from out of state who visit the state; and for people in the rest of the country who do not visit the state on recreation trips.

**Table 4: Population and per-capita income - New Mexico, and counties encompassing, or proximate to, reintroduction areas**

| | *New Mexico* | *County* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Taos* | *Rio Arriba* | *Santa Fe* | *Sandoval* | *Bernalillo* | *Los Alamos* | *Catron* | *Grant* | *Hidalgo* |
| | | **Rio Grande & Rio Chama** | | | | | | **San Franc.** | **Gila** | |
| Population, 2003 (estimate) | 1,874,614 | 31,269 | 40,731 | 136,423 | 98,786 | 581,442 | 18,802 | 3,415 | 29,818 | 5,234 |
| Avg. annual growth rate, 2000-2003, | 1.02 % | 1.41% | -0.37 % | 1.80 % | 3.20 % | 1.45 % | 0.83 % | -1.21 % | -1.28 % | -4.10 % |
| Population (2003): | | | | | | | | | | |
| <18 yrs | 26.8 % | 23.1% | 27.5 % | 22.7 % | 27.8 % | 24.9 % | 25.2 % | 18.7 % | 24.3 % | 28.6 % |
| < 5 yrs | 7.1 % | 5.9 % | 7.5 % | 5.7 % | 6.8 % | 7.0 % | 5.4 % | 4.1 % | 6.4 % | 6.5 % |
| 5-13 yrs | 13.3 % | 11.2% | 13.4 % | 11.5 % | 14.3 % | 12.3 % | 13.4 % | 9.1 % | 12.0 % | 15.1 % |
| 14-17 yrs | 6.3 % | 5.9 % | 6.6 % | 5.6 % | 6.7 % | 5.6 % | 6.4 % | 5.6 % | 6.0 % | 7.0 % |
| Per-capita money income (1999), 2003$ | 18,921 | 17,652 | 15,635 | 25,864 | 21,018 | 22,790 | 37,979 | 15,293 | 16,001 | 13,627 |

*Notes*: Average annual rate of population increase based on cumulative 2000-2003 increase reported in source. Income adjusted to 2003 prices based on consumer price index (Council of Economic Advisors, 2004).
*Source*: U.S. Census Bureau, *State and County Quick Facts* (http://quickfacts.census.gov/qfd/states/35000.html); U.S. Census Bureau, 2004a, 2004b, 2004c.

**Estimation of economic benefits associated with reintroduction of river otters to New Mexico**

Economic theory assumes that the benefit an individual receives from a good or service is commensurate with his or her willingness to pay (WTP) to obtain that good or service. Willingness to pay is defined as the total amount of resources, money or otherwise, that the individual is disposed to forego in order to obtain the good or service in question.

The approach used in quantifying the monetary value of economic benefits varies with the type of good under consideration. For goods traded in markets, prices can serve as an indicator of the minimum monetary value that consumers assign to these goods. By observing demand for a good at different price levels, it is often possible to construct a demand curve for the good that allows the estimation of the total economic value consumers assign to one unit of the good. In this case, an estimate of the benefits that people derive from the good can be based on people's ***observed*** WTP. However, there are many goods for which no markets in the conventional sense exist. For example, there is no market for river otter conservation. In the absence of markets, it is impossible to observe people's WTP for the good in question. However, the absence of markets does not necessarily imply the absence of benefits and WTP.

A variety of approaches have been developed in environmental economics to estimate the benefits people receive from resources (i.e., goods or services) for which no markets exist. However, not all of these approaches can capture all categories of values associated with these resources (see Figure 2). Specifically, of the approaches shown in Figure 2, only contingent valuation (CV) methods can capture non-use values. For this reason, contingent valuation generally is considered the approach of choice in estimating the economic value people attach to non-market resources (Arrow ***et al.***, 1996; Krupnick and Portney, 1991).

In contingent valuation, a hypothetical market is constructed for a particular good or service, and individuals then are asked to state their WTP for a specific change in the resource in question. Contingent valuation involves the construction of a survey instrument that creates a valuation context by describing the current state of the resource (***e.g.***, river otters have been extirpated in New Mexico, where they once existed), the change in the resource for which individuals are asked to state their WTP (***e.g.***, reintroduction of this native species to specific habitats in New Mexico, to establish viable populations in those habitats), and a means by which individuals can effect that change (***e.g.***, a one-time payment in the form of a contribution to an otter restoration fund, an income tax check-off, etc.). The principal challenge in applying contingent valuation is designing the survey instrument in such a way as to obtain unbiased and consistent value estimates (Diamond and Hausman, 1994; Stevens ***et al.***, 1991, 1993). However, this challenge can be overcome through careful design and administration of the instrument (Arrow ***et al.***, 1993).

Ideally, WTP is estimated on the basis of primary research at the policy site, that is, a survey conducted at the location of the resource change and its surroundings. Often, however, such site-specific studies do not exist, and due to a lack of resources it may not be feasible to carry them out for a given project. This is true in the case at hand – no primary studies exist that estimate individuals' WTP for reintroduction of the river otter to New Mexico, and no such study is planned. In these cases, the only alternative is to employ the second-best approach to estimating WTP, namely, benefits transfer.

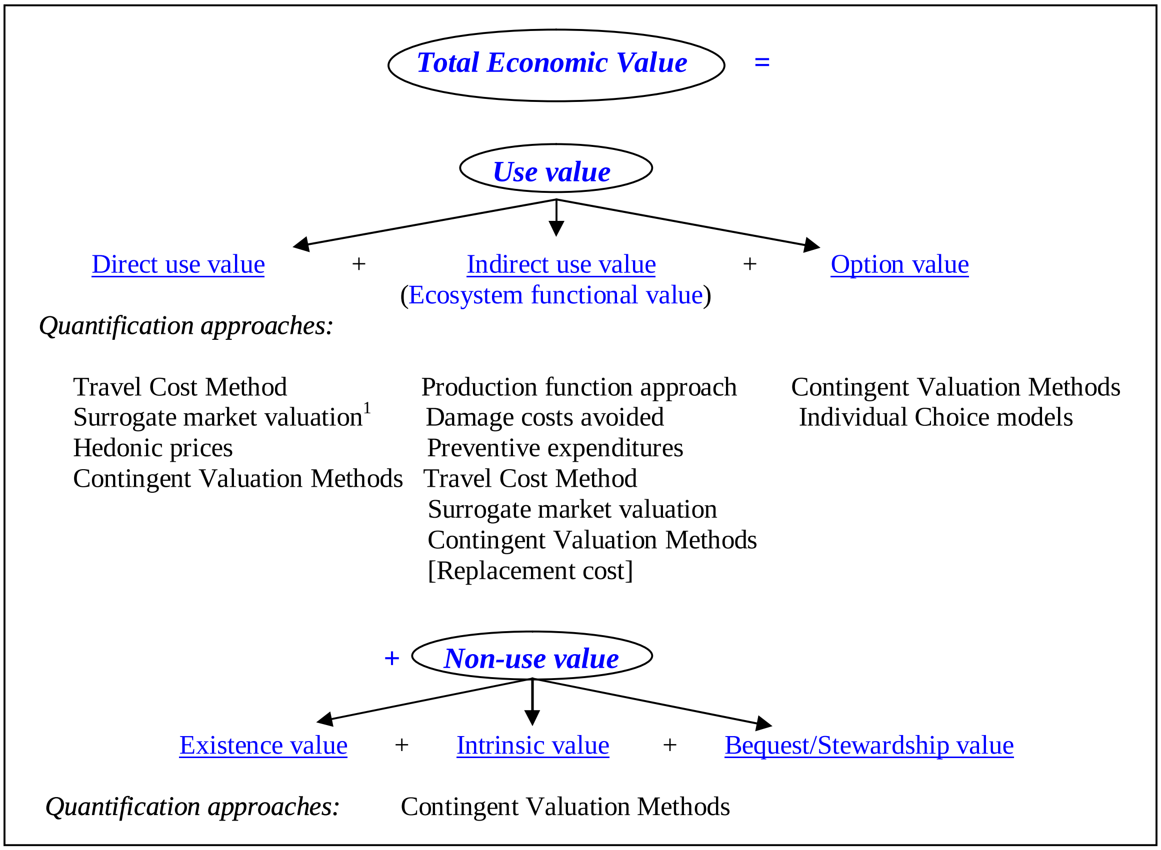



**Figure 2: Categories of economic values associated with environmental goods and services and available valuation approaches**

*Notes*: [1] Household production function models. Replacement cost is in brackets because its use in ecosystems valuation in many cases is problematic.

*Source*: Based on Barbier (2000).

## *Benefits transfer*

Benefits transfer (BT) is commonly defined as the adaptation of value estimates generated at a study site to another site (the "policy site") for which such estimates are desired but no primary data for their generation are available (Rosenberger and Loomis, 2001). Benefit transfer is a convenient tool for the efficient generation of benefit estimates, provided that several conditions are fulfilled that ensure the validity of the benefit estimates generated for the policy site. These conditions are: 1) that the policy context is defined precisely, including the type and magnitude of the expected policy impacts, the characteristics of the population affected, the type of value measure (average or marginal value) used, the category of value (direct use, indirect use, non-use, total economic value) measured, and the degree of certainty surrounding the transferred data; 2) that the data available for the study site are of sufficient quality (sample size, sound economic method, sound empirical technique, and sufficient number of similar study sites to allow credible statistical inferences) and that the background information is sufficient (population characteristics); and 3) that study and policy site possess similar characteristics (similar resource, type and degree of change in resource, and source of change; similar demographic characteristics, especially income and cultural background; and, if recreation activities are valued, a similar condition and quality of the recreational experience at both sites) (Rosenberger and Loomis, 2001; Brower, 2000).

*Approaches to Benefits Transfer (BT)*

Benefits transfer (BT) can take the form of a value transfer or of a function transfer. A value transfer is the application of a single-point or average-value estimate from a study site to the policy site. In a benefit function transfer, a model is used that statistically relates benefit measures to the independent study variables, that is, the study characteristics (demographics and resource characteristics). Benefit function transfers either are based on demand or benefit functions estimated for a study site, or on meta-analysis. Meta-analysis is commonly defined as a regression analysis of the findings of several empirical studies that systematically explores study characteristics as possible explanations for the variation of results observed across primary studies (Brouwer, 2000; U.S. EPA, 2000). In both function transfer approaches (demand and meta-analysis), the values of key variables from the policy case are inserted into the benefit function in order to develop policy-site-specific value estimates.

Although BT seems to become the approach of choice in cases where primary valuation studies cannot be carried out, it is not without problems. There rarely are policy sites whose most important WTP-relevant characteristics exactly match study sites for which original data have been generated. Furthermore, studies do not always measure all aspects of the perceived resource quality of the environmental amenities of a study site for which WTP is elicited and thereby prevent the incorporation of all relevant resource quality aspects into meta-analysis functions. For these reasons, meta-analysis-based BT potentially may introduce large errors into BT-based benefit estimates (see for example Kirchhoff *et al.*, 1997). Nevertheless, BT may provide a useful tool for estimating the order of magnitude of values (ibid.).

To date, only one study has been conducted that examined people's WTP for river otters. That study took place in the United Kingdom (UK) and estimated the WTP of residents in North Yorkshire for a 25 percent increase in the population of the local subspecies *Lutra lutra*, the European river otter (White *et al.*, 1997). White *et al.*'s findings therefore provide the only basis for a point value transfer to our New Mexico study area. Since there is no other WTP estimate available in the literature, we apply a single-point benefits transfer to estimate WTP of reintroduction of river otters to New Mexico based on White *et al.*[3] However, White *et al.*'s study examined WTP for a distinct, finite population increase (25 percent), not for reintroduction. Reintroduction is equivalent to a population increase by a factor of infinity. In addition to this quantitative difference in resource change, White *et al.*'s and our study contexts also differ in their qualitative nature. Specifically, it could be hypothesized that people's WTP for population increases of a still-existing rare species would be smaller than their WTP for the reintroduction of a formerly native species now extinct in the area. In that case, one would expect a benefits transfer based on WTP for population increases to result in a downward bias of WTP for reintroduction. This is especially true the smaller the evaluated change in population size in the source study.

Given that the source study (White *et al.*, 1997) population change is rather small (25 percent), we generate a second WTP estimate using a different benefits transfer approach, namely a benefit function transfer. A review of the recent literature suggest that meta-analysis appears to be emerging as the approach of choice in benefit function transfer (Smith, 1992; Loomis and White, 1996; Brouwer, 2000; U.S. EPA, 2000; Rosenberger and Loomis, 2001; Chattopadhyay, 2003). There exists one such meta-analysis of people's WTP for the conservation of rare, threatened and endangered species (Loomis and White, 1996) that can be used to construct a meta-analysis-based value estimate for the river otter. Loomis and White's meta-analysis function also generates WTP estimates for distinct, finite population increases. Hence, as in the case of using White *et al.*'s WTP estimates, the resulting estimates could again be expected to underestimate WTP for reintroduction of the river otter to New Mexico. We use the meta-analysis equation to estimate WTP for a 100 percent increase in the species' population in New Mexico. That value, of course, still is quantitatively different from an infinite increase. Nevertheless, it is larger than the 25 percent increase examined in White *et al.*'s study, and it represents the upper end of the population increases in the studies over which the meta-analysis function was estimated (Loomis and White, 1996).

The two estimation approaches generate different WTP estimates, which we use to develop estimates of the upper and lower bounds of the economic value of reintroducing river otters to New Mexico.

Before developing estimates of the monetary value of otter reintroduction, it is important to consider who the individuals are that stand to receive benefits from the reintroduction. Most obviously, benefits of reintroducing river otters accrue to those individuals living near the reintroduction sites, such as residents of the counties in which the rivers chosen for reintroduction are located. However, the conservation of rare, threatened or endangered species generated benefits beyond the locale of protection (Pate and Loomis, 1997; Loomis, 2000). Hence, benefit estimates should also be derived for the people of New Mexico as a whole. In many cases, species conservation may even generate benefits at the national level (Loomis, 2000). Research shows that the benefits people receive from the conservation of rare, threatened or endangered species commonly decrease with the distance of the individuals from the locale of protection (Loomis, 2000). Despite of

[3] If additional WTP estimates were available we could combine them and apply an average value benefits transfer instead of a single-point transfer.

the often times small size at the level of the individual, the aggregate value of these benefits may be substantial. Finally, visitors to the study area who engage in recreational activities are likely to receive benefits from species protection. In fact, the benefits received by a recreation visitor generally are higher than those experienced by an area resident (Loomis and White, 1996). In the case of the river otter, these benefits are likely to be highest, at the level of the individual, for those individuals who are most likely to recreate in the reintroduction areas. Specifically, visitors engaging in angling, wildlife viewing, and rafting or kayaking are likely to benefit from otter reintroduction. However, we could obtain information on out-of-state visitation only for the former two activities (see Table 2). Data for non-motorized water activities do exist for the national forests in our study area (see Table 1), but they do not distinguish between area or state residents on the one hand, and out-of-state visitors on the other.

*Time frame of analysis and choice of discount rate*

The benefits of reintroduction of river otters would be experienced by the present and future generations. Ideally, therefore, the benefits accruing to all future individuals who value river otters should be included in the analysis. However, because of the uncertainty of events increases with their temporal distance, and in order to generate conservative benefit estimates, we only estimate benefits over a ten-year time period, from 2005 to 2014.

As appropriate in an economic analysis of a public policy such as reintroduction of the river otter to New Mexico, we employ a social discount rate (SDR) to estimate the present value of the future benefits and costs of CHD (Arrow *et al.*, 1996). SDRs should decline over time to reflect increasing uncertainty over future states of the world, from four percent per year for the immediate future (1-5 years), to two percent for the medium future (26-75 years), to zero for the far-distant future (more than 300 years) (Weitzman, 2001). However, since our analysis only covers ten years, we follow EPA guidance (U.S. Environmental Protection Agency, 2000) and choose a three percent discount rate.

*Single point value estimate benefits transfer*

The only available study of people's WTP for river otter conservation was carried out by White *et al.* (1997). White *et al.* conducted a contingent valuation survey to estimate the WTP of local residents in North Yorkshire in the U.K., for a 25 percent increase in the population of river otters in England. They estimated average WTP of area residents at U.K.£ 11.9 (in 1997 prices). We use the WTP reported in that study as the basis for a benefit transfer to the river otter in New Mexico. Given that WTP is, among other things, dependent upon people's preferences, using WTP estimates from a different country as a basis for benefits transfer can be problematic. However, we argue that this is likely not the case here. In both the U.K. and the U.S., environmental laws such as the U.S. Endangered Species Act (ESA) (U.S. Congress, 1973) or The Conservation (Natural Habitats, &c.) Regulations 1994 in the U.K. demonstrate broad support for species conservation. Opinion polls and other research confirm this assessment (Gallup, 2004; White *et al.*, 1997).

The species studied by White *et al.* is the one found in Britain, the European river otter (*Lutra lutra*). The European river otter is slightly smaller than the Canadian river otter (*Lontra canadensis*), but otherwise the two are identical in appearance. Also, both in Britain and in the U.S., river otters are perceived as charismatic and "cute" (White *et al.*, 1997; Downing, 2004; New Mexico Department of Game and Fish, 2004). However, in the U.K. the river otter is considered a threatened and a flagship conservation species (White *et al.*, 1997), while in the U.S. it is not. This difference in conservation status and public awareness regarding river otters could suggest that WTP for otter conservation in New Mexico may be lower than in the U.K., and could impart an upward bias to our benefit estimates. On the other hand, the ongoing public information campaign by proponents of otter reintroduction and the media coverage that the reintroduction issue has attracted are likely to increase the level of public awareness of otters in the reintroduction area. Furthermore, White *et al.*'s survey results suggest that the public profile of a species may be as important as its threat status in determining people's WTP for its conservation. Since physical appearance and public profile of a species have been shown to be the primary determinants of people's WTP for a species' conservation (Samples *et al.*, 1986), and since our source study and policy site contexts are comparable in these two aspects, we argue that White *et al.*'s findings constitute a valid source for benefits transfer to our New Mexico policy site.

An additional factor arguing for the transferability of White *et al.*'s WTP estimates to the New Mexico case is that the White *et al.* study estimated the same values that are relevant in our study, namely, people's non-consumptive direct use and non-use values for river otters. As already pointed out, where the two contexts differ are the quantitative and qualitative nature of the resource change. White *et al.* examined people's WTP for a 25 percent population increase in river otter populations. On the other hand, what is being considered in New Mexico is the reintroduction of the otter, a native species now (presumed) extinct in the state. Hence, the nature of the resource change (population increase vs. reintroduction) differs in the two contexts. We discuss possible impacts of this difference in the valuation contexts in the next section.

The transfer of White *et al.*'s benefit estimate to the New Mexico river otter involves several steps. These have to do primarily with adjusting for income differences between White *et al.*'s study population and the population receiving benefits from otter reintroduction in New Mexico. This is necessary because WTP is, among other things, dependent on income (or more accurately, wealth, data on which however are harder to obtain), that is, on an individual's ability to pay (Arrow *et al.*, 1996).

In order to be able to transfer White *et al.*'s WTP estimate to our study context, we must first convert it to its UK equivalent. This is done by multiplying the WTP of residents in their study area by the ratio of the UK average per-capita income and the average per-capita income in their study area (North Yorkshire, UK).[4] We then convert their WTP, which is expressed in 1997 prices, to 2001 prices, by adjusting for 1997-2001 U.K. inflation. Next, we convert the resulting UK-equivalent, £-denominated WTP to its US, $-denominated equivalent using the purchasing power parity-adjusted ratio of U.S. GNP and U.K. GNP.[5] This adjustment takes the following form:

$$WTP_{US} = WTP_{UK}\ (\text{per-capita } GNP_{PPP\text{-}US} \,/\, \text{per-capita } GNP_{PPP\text{-}UK})^{\varepsilon}. \qquad \text{(eq. 1)}$$ [6]

We now can express White *et al.*'s WTP estimate in U.S. dollars at 2001 prices. However, in order to derive the estimated WTP of the average resident in our study area, we still need to convert the WTP estimate obtained via eq. (1) to its equivalent for our study area. This is achieved by multiplying the former by the ratio of the average population-weighted per-capita income of the counties in our study area and the average U.S. per-capita income.[7] Finally, we convert our WTP estimate to 2003 prices. Average WTP of New Mexico residents is estimated by adjusting for differences between the population-weighted average income in the reintroduction counties and average income in New Mexico as a whole.

White *et al.* (1997) did not estimate WTP of visitors for otter conservation. We estimate visitor WTP by multiplying our estimate of the WTP of the average study area household by the average of the WTP ratios of visitors and area residents observed in our meta-analysis WTP estimates (1.7:1). This ratio indicates that the average WTP of recreation visitors for otter conservation is 1.7 times as high as the average WTP of all local residents.

Since WTP for species and habitat protection seems to be an inverse function of distance from the locale of protection (Loomis, 2000), we employ a WTP distance-decay function to estimate the WTP for river otter conservation in New Mexico of those U.S. residents who do not live in or visit the study area ("Rest-of-U.S."). Loomis (2000) examined the WTP of people across the U.S. for the protection of a group of 62 threatened and endangered species in California. Based on the results of that study, he estimated a distance-decay function that expresses the decline in an individual's WTP for the protection of those species as a result of the distance at which the individual lives from the locale of protection. To estimate the WTP in the Rest-of-U.S. for reintroducing river

[4] The per-capita income ratio is based on data given in U.K.'s Office of National Statistics (UK ONS, 2001).

[5] Relative prices of traded and non-traded goods often differ between countries, thereby distorting income comparisons that are based on currency-based exchange rates (since the latter form on the basis of trade and financial flows only). To overcome or at least reduce this distortion, for purposes of accurate comparisons of local incomes across countries incomes are expressed in terms of their relative purchasing power in a reference country, which under current practice is the U.S. (World Resources Institute *et al.*, 1998). In 2001, the UK£ to US$ $GDP_{PPP}$ ratio was 0.7 (World Bank, 2003).

[6] WTP may be nonlinearly dependent on income level (Cropper and Simon, 1996). However, due to the lack of empirical studies on this issue, no estimates of the income elasticity factor ($\varepsilon$) of WTP are yet available (Cesar *et al.*, 2002). Therefore, WTP is assumed to be a linear function of income with an elasticity of one.

[7] In 1999, the population-weighted average per-capita income in our study area counties was 95.5 percent of the average national per-capita income (U.S. Census Bureau, 2004e).

otters to New Mexico, we therefore have to take into account the distance at which each of those individuals live from our study area. The WTP of a particular individual can then be estimated by multiplying the WTP of our average study area resident by the value the distance-decay function takes at the respective location, which is characterized by a particular distance from our study area. A convenient way to solve the potentially complex computational problem is to use the U.S. mean center of population (U.S. Census Bureau, 2004f), located approximately 1,100 miles from the center of our study area. Since the WTP distance decay function is linear up to that distance, we can derive the average WTP of individuals in the Rest-of-U.S. group by multiplying the value of the distance decay function at that distance, which is 0.65 (Loomis, 2000), by the WTP estimate of our average study area resident.

However, when estimating the WTP of individuals who do not live in New Mexico and who do not visit the reintroduction areas in that state, it is important to consider that populations of river otters currently exist in a number of states. An individual's WTP for species conservation depends on the size of the population increase (Loomis and Walsh, 1996). From the perspective of individuals in the Rest-of-U.S. group (i.e., those who do not live in or visit New Mexico), the result of reintroducing river otters to New Mexico will be an increase in the total population of river otters in the U.S. There is no estimate available for the current river otter population in the contiguous U.S. However, more than 4,000 river otters have been released in the lower U.S. in reintroduction programs since 1976 (New Mexico Department of Game and Fish, 2004). These otters were taken from states with large otter populations, such as Louisiana and Alaska, in which annually thousands of otters are trapped. Given the large amounts of prime and suitable otter habitat that exist in the contiguous U.S., the total population of river otters in the U.S. may perhaps range from 100,000 to 500,000 animals.

River surveys in the upper Rio Grande and Chama and the Gila and San Francisco river systems have identified 186 miles of prime river otter habitat in NM.[8] Using Melquist and Hornocker's (1983) observed otter densities of one otter per 1.7 to 3.7 miles, this prime habitat would be expected to sustain between 50 and 110 otters. The segments of prime river otter habitat in the two river systems are connected by considerable amounts of suitable habitat that would support otters as well. Estimates of the total population of river otters that the two river systems in NM could support may therefore range from about 100 to about 250 animals.

Given these estimates of the sizes of a reestablished NM and the total U.S. river otter populations, it is expected that reintroduction of the species in New Mexico likely will boost U.S. otter populations only marginally, by between 0.02 percent and 0.05 percent. To make our WTP estimates for individuals in the Rest-of-U.S. group consistent with our estimates for New Mexico residents and visitors, we scale the WTP estimate derived in our benefits transfer from our source study (White *et al.*), which assumes a 25 percent increase in local river otter populations, to the U.S. level. In doing so, we assume a WTP function that increases linear with population increases, so that WTP for a 0.02 (0.05)

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[8] Personal communication, Jon T. Klingel, independent biologist, formerly with the NM Department of Game and Fish, Jan. 07, 2005.

percent increase is 1/1250 (1/500) that of a 25 percent increase. However, this may result in an upward bias, since, unlike the residents and visitors, the remaining U.S. households would not receive the recreational use value associated with the otters that forms part of the WTP estimate reported in the source study. Also, possible non-linearity in the WTP function may lead to errors in these estimates. On the other hand, people may value the fact of reintroducing the otter to another state in which it once was a native more than what would be suggested by the mere numerical increase in total U.S. otter populations that such reintroduction to the state would bring about. In any case, these arguments show the high level of uncertainty surrounding the Rest-of-U.S. WTP estimates. These estimates should therefore be viewed with caution.

The results of our WTP estimates using the single-point value transfer approach are shown in the second column of Table 5. The estimated WTP of residents is highest in the counties through which the rivers flow that are targeted for otter reintroduction. WTP of the average New Mexico resident is estimated to be lower, due to the fact that the average income in New Mexico is lower than the average income in the counties in which reintroduction would take place. WTP of recreational visitors (anglers and wildlife viewers) is expected to be highest, because, based on findings reported in the literature (see for example Loomis and White, 1996), these individuals are expected on average to have a larger interest in wildlife, and because they engage in activities that may bring them into direct contact with otters.

**Table 5: Estimates of average per-capita WTP of different population segments based on two benefit transfer approaches**

| *Estimation approach:* | | *Single-point value BT* | *Meta-analysis BT – linear model, reduced* | *Meta-analysis BT – log-log model, reduced* |
|---|---|---|---|---|
| *Population* | | *Average per-capita WTP, lump sum, 2003 $* | | |
| County residents | | $ 9.55 | $ 13.37 | $ 7.03 |
| New Mexico residents | | $ 7.74 | $ 11.20 | $ 5.89 |
| Recreation visitors from out-of-state | | $ 17.81 | $ 22.89 | $ 18.13 |
| Rest-of-US | 0.02 % | $ 0.005 | -- | $ 0.005 |
| | 0.05 % | $ 0.013 | -- | $ 0.010 |

*Notes*: The single-point value benefits transfer-based WTP estimates are based on a study that estimated individuals' WTP for a 25 percent increase in river otter populations. The Meta-analysis estimates represent individuals' WTP for a hypothetical 100 percent increase in river otter populations (see text). County residents refers to the counties listed in Table 4. Recreation visitors include only anglers and wildlife viewers from out-of-state. Lump sum refers to one-time payment. In the case of Rest-of-U.S., 0.02 % and 0.05 % refer to WTP for a 0.02 % and 0.05 %, respectively, increase in U.S. river otter populations as a result of reintroduction of river otters to New Mexico. All values are adjusted for the respective non-response rates in the source studies (interpreted as expressing zero WTP). WTP of Rest-of-U.S. is also adjusted for WTP distance decay (Loomis, 2000). Population data for Rest-of-U.S. estimates from U.S. Census Bureau (2004d).

Our per-capita WTP estimates are based on the interpretation that non-responses in the source studies imply zero WTP. This assumption is extremely conservative because it implies that the reason why individuals chose not to reply to a survey was a lack of interest in or appreciation for the particular topic addressed in the instrument. However, individuals may have a variety of other reasons for not responding to a survey, such as time constraint, inconvenient timing, or privacy concerns, among others. Interpreting all non-replies as expressing zero WTP therefore is likely to substantially underestimate total WTP. Nevertheless, all WTP estimates shown in Table 5 have been derived by multiplying the WTP estimates by the applicable response rates. These rates were 64 percent in the White *et al.* study (used for residents of the reintroduction counties), 54.4 percent in the Loomis (2000) study (used for individuals in New Mexico and Rest-of-U.S. in the single-point value-based estimates), 49.2 percent in Loomis and White (1996) (used for all non-visitors in the meta-analysis-based estimates), and 60.6 percent for anglers and wildlife viewers from out-of-state (Loomis and White, 1996).

*WTP estimates based on Meta-analysis function transfer*

Loomis and White (1996) conducted a meta-analysis of 38 estimates of individuals' WTP for the protection of rare, threatened, and endangered species. The WTP estimates were obtained from 25 contingent valuation studies. The meta-analysis uses a multiple regression equation to try to explain the differences in the sampled WTPs as a result of differences in the various explanatory variables among the studies. The equation of the reduced model takes the following form:[9]

$$\begin{aligned} \text{WTP} = \ & c + \beta_1 \cdot \%\Delta\text{POP\_SIZE} + \beta_2 \cdot \text{PAYFREQUENCY} \\ & + \beta_3 \cdot \text{VISITOR} + \beta_4 \cdot \text{MARINE} + \beta_5 \cdot \text{BIRD} \qquad \text{(eq. 2)}, \end{aligned}$$

where $c$ is the intercept or constant term, the $\beta$'s are elasticities of WTP with respect to the independent variables, %ΔPOP_SIZE is the proposed percentage change in population size, PAYFREQUENCY is a dichotomous variable indicating the type of payment, coded 1 for one-time payment and 0 for an annual payment, VISITOR is a dichotomous variable indicating whether the respondent is a visitor (coded 1) or a local household (coded 0), MARINE is a dichotomous variable coded 1 for marine mammal and zero otherwise, and BIRD is a dichotomous variable coded 1 if the species is a bird, and 0 otherwise.

The slope coefficient ($\beta$'s) indicate the change in WTP that results from a one-unit change in a given independent variable. Loomis and White estimated both linear and double-log versions of equation 2. Their estimates of the slope coefficient for the two reduced models are shown in Table 6. For example, the slope coefficient for percent change in population size in the linear model is estimated at 0.61. This implies that an increase in population size by 10 percent would lead to an increase in a household's WTP by $6.10.

[9] The reduced models contain only those variables that Loomis and White found to be significant at the 0.1 level or higher.

**Table 6: Constant term and slope coefficients of the meta-analysis regression equation**

| | Linear specification, reduced model | Log-log specification, reduced model |
|---|---|---|
| *c* | -49.43 | -1.13 |
| $\beta_1$ | 0.61 | 0.80 |
| $\beta_2$ | 42.01 | 0.77 |
| $\beta_3$ | 23.55 | 0.77 |
| $\beta_4$ | 35.76 | 0.85 |
| $\beta_5$ | 21.72 | 0.65 |

*Note*: All variables significant at the 0.1 level.
*Source*: Table 3 in Loomis and White (1996).

We generate WTP estimates for river otter reintroduction via equation 2 by setting the independent variables such that they reflect the river otter reintroduction context. The obvious problem in using the equation to estimate WTP for reintroduction of a species is that reintroduction implies a population increase that is infinite for any reintroduced otter population.[10] Therefore, in order to be able to make use of the equation, one needs to select a finite value for the %ΔPOP_SIZE variable. The selection of such a finite value is somewhat arbitrary. However, in order to pick a conservative value, and because the meta-analysis equation was estimated over population changes that ranged up to 100 percent, we decided to chose 100 percent as the size of the population change variable.

In our estimation, the MARINE and BIRD variables assume values of zero, and the VISITOR variable is coded 1 to estimate WTP of visitors, and 0 to estimate WTP of households. Since Loomis and White's regression equation yields estimates of WTP per household, we adjust the WTP estimates generated with the equation to a per-capita basis in order to make them comparable to the per-capita single-point value WTP estimates, by dividing the values by the respective average household size.[11]

Since equation 2 was estimated to express WTP in 1993 prices, we adjust the resulting WTP estimates to 2003 prices by correcting for inflation in the consumer price index (Council of Economic Advisors, 2004). In addition, we adjust the per-capita WTP estimates for New Mexico for the difference in average per-capita income compared to the reintroduction counties. As in the single-point value benefit transfer, we derive our Rest-of-U.S. WTP estimates using the hypothesized 0.02 percent and 0.05 percent increases in national river otter populations brought about by the reintroduction of otters to New Mexico. In other words, when estimating the WTP of individuals in that group, the %ΔPOP_SIZE variable in equation 2 assumes values of 0.02 and 0.05 percent,

[10] This is true of course only from the perspective of local residents in the counties and New Mexico as a whole. Once the boundaries of analysis widen to include the U.S. as a whole, the population increase is no longer infinite. Rather, as explained in the single-point value estimation, it is expected to be fairly small.
[11] The average household size is 2.52 persons for the reintroduction counties (population-weighted average), 2.63 persons for New Mexico as a whole, and 2.59 persons for the U.S. as a whole (U.S. Census Bureau, 2004e).

respectively. WTP of individuals in that group was also adjusted for distance decay as described in the discussion of the single-point value-based estimation.

The results of the meta-analysis-based estimates of per-capita WTP for the different populations (residents of reintroduction counties, residents of New Mexico, anglers and wildlife viewers from out-of-state, and individuals living in the Rest-of-U.S. who do not visit New Mexico for recreational purposes) are shown in Table 5 for both reduced model specifications. As in our single-point value benefits transfer-based estimation, our meta-analysis-based per-capita WTP estimates incorporate the very conservative assumption that non-response rates in the source studies imply a WTP of zero. For all population groups except the Rest-of-U.S. group, the linear form of the meta-analysis benefits transfer yields higher WTP estimates than both the double-log meta-analysis model and the single- point value transfer. For the Rest-of-U.S. group, the linear model returns (invalid) negative WTP estimates (see Table 5). The fact that WTP of individuals in this group is estimated to be negative in the linear specification is likely caused by the small size in the changes in otter population from the perspective of that group (0.02 or 0.05 percent, respectively). These population changes lie well outside of the range of values over which the meta-analysis WTP equation was estimated.[12]

Estimated average per-capita WTP for otter reintroduction, adjusted for response rates, is highest for recreational anglers and wildlife watchers ($18.13 - $22.89 per person). Also, it is higher for residents of the reintroduction counties ($7.03 - $13.37 per person) than for residents of New Mexico as a whole ($5.89 - $11.20 per person) (Table 5). Due to the minimal impact that reintroduction of the otter to New Mexico would have on the total population of river otters in the U.S., and due to the assumed reduction in an individual's WTP with increasing distance from the locale of protection, the average per-capita WTP of people living outside of New Mexico is expected to be extremely small, ranging from $0.005 to $0.013 per individual. All of the cited values represent lump-sums, that is, one-time payments that correspond to the monetary value that individuals attach to the reintroduction of the river otter to New Mexico. For example, the results imply that the average resident in New Mexico is expected to be willing to make a one-time payment of between $5.89 and $11.20 to ensure reintroduction of otters to the state, while the average person in the U.S. not residing in the state and not visiting for recreational purposes is expected to be willing to make a one-time payment of between 0.5 cents and 1.3 cents for reintroduction of the species to New Mexico.

It is interesting to see how our WTP estimates for otter reintroduction compare with estimates for species protection reported in other studies. It should be noted, however, that WTP estimates from other studies can only serve as a very rough yardstick, due to the in some cases large differences in the valuation context, such as the type of species and its public image and the type and magnitude of hypothetic change species population, and the design of the survey instrument. Given these caveats, in Table 7 we present some

[12] Population changes in the studies upon which the meta-analysis equation was estimated ranged from 25 to 100 percent, with the majority of those studies evaluating WTP for 100 percent increases in the population of the target species (Loomis and White, 1996).

WTP estimates for reintroduction or population increases of species that, like the river otter, are off limits to direct consumptive use (trapping, hunting).

**Table 7: WTP estimates for species protection from other studies**

| *Species* | *Change* | *WTP per capita, 2003$* | *Survey population* | *Source* |
|---|---|---|---|---|
| Sea otter (*Enhydra lutris nereis*) | 100% increase | $27 | CA households | Loomis, 2004 |
| Red Wolf (*Canis rufus*) | Reintroduction | $57 | Area households | Rosen, 1997 |
| Gray Wolf (*Canis lupus*) | Reintroduction | $20 | Area households | U.S. FWS, 1994 |
| | Reintroduction | $89 | U.S. visitors | Duffield, 1992 |
| | Reintroduction | $149 | Local visitors | Duffield, 1992 |
| Bald Eagle (*Haliaeetus leucocephalus*) | 300% increase | $225 | WA visitors | Swanson, 1993 |
| | 300% increase | $323 | WA visitors | Swanson, 1993 |

As can be seen from a comparison of the values in Table 7 with the appropriate values in Table 5, our WTP estimates for river otter reintroduction are across the board lower than the values reported in Table 7. This seems reasonable, given that the river otter is not listed as threatened or endangered under the federal or state ESAs, but rather is only a species of concern, both federally and in New Mexico (New Mexico Department of Game and Fish, 2003). However, given that the river otter is generally seen as a particularly charismatic and endearing species, our comparatively low WTP estimates would also seem to confirm their conservative nature.

Based on our per-capita WTP estimates for river otter reintroduction, we now can examine the crucial economic issue from a policy-making perspective, namely, the size of total economic benefits people are expected to receive from river otter reintroduction.

*Total WTP for river otter reintroduction to New Mexico*

We derive estimates of total WTP for reintroduction of river otters to New Mexico for the four different populations shown in Table 5. These populations are 1) the residents of the reintroduction counties (see Table 4), 2) the residents of New Mexico as a whole, 3) anglers and wildlife viewers visiting from out-of-state, and 4) those individuals who live in the U.S. outside of New Mexico and do not visit the state for recreation purposes.

Estimates of total WTP over the ten-year period for each of the three populations vary among the three models in accordance with the differences in per-capita WTP estimates presented in Table 5. Total present value benefits of otter reintroduction for residents of the counties in the reintroduction area are estimated to range from $6 million to $11.2 million (Table 8). Benefits to people living in New Mexico as a whole are estimated to range from $10 million to $19 million. Recreation visitors from out-of-state engaging in fishing and wildlife viewing are expected to receive benefits of $5.8 million to $7.3

million. Finally, people living in the U.S. outside of New Mexico who do not visit the state for recreational purposes are estimated to receive benefits ranging from $1.2 million to over $3.2 million.

**Table 8: Estimates of total WTP of different populations**

| *Estimation approach:* | | *Single-point value BT* | *Meta-analysis BT – reduced linear model* | *Meta-analysis BT – reduced log-log model* |
|---|---|---|---|---|
| *Population* | | *Total WTP, lump sum, million 2003 $* | | |
| County residents | | $ 9.5 | $ 11.2 | $ 6.0 |
| New Mexico residents | | $ 12.9 | $ 18.7 | $ 9.8 |
| Recreation visitors from out-of-state | | $ 5.9 | $ 7.3 | $ 5.8 |
| Rest-of-U.S. | 0.02 % | $ 1.3 | -- | $ 1.2 |
| | 0.05 % | $ 3.2 | -- | $ 2.6 |

*Note*: Based on Table 5.

To develop estimates of the total WTP for reintroducing river otters to New Mexico, we aggregate WTP over these populations along three geographical boundaries. These are 1) the counties located in the proximity of the reintroduction area, 2) New Mexico as a whole, and 3) the U.S. as a whole (Table 9). The first constitutes our ***Local*** boundary, the second our ***State*** boundary, and the last our ***U.S.*** boundary. Given that a substantial part of the state's major angling and wildlife viewing recreation areas frequented by out-of-state visitors lies in the reintroduction counties, the WTP of these recreationists is included in the total WTP estimates for both the ***Local*** and the ***State*** boundaries (see Table 9). By adding the benefits received by the recreation visitors to those received by the residents, we obtain a measure of the total benefits generated within the boundaries of the counties and the state, respectively.

**Table 9: Estimates of total local, state, and national WTP for otter reintroduction to New Mexico based on the three benefits transfer models**

| *Estimation approach:* | | *Single-point value BT* | *Meta-analysis BT – reduced linear model* | *Meta-analysis BT – reduced log-log model* |
|---|---|---|---|---|
| *Population* | | *Total WTP, lump sum, million 2003 $* | | |
| Local | | $ 15.4 | $ 18.5 | $ 11.7 |
| State | | $ 18.8 | $ 26.0 | $ 15.6 |
| U.S. | 0.02 % | $ 20.0 | -- | $ 16.8 |
| | 0.05 % | $ 22.0 | -- | $ 18.2 |

*Notes*: Based on Table 8. ***Local*** boundary comprises reintroduction counties, but includes out-of-state anglers and wildlife viewers. ***State*** boundary includes all of New Mexico and out-of-state anglers and wildlife viewers. ***U.S.*** boundary includes all of the United States, adding to the WTP for the ***State*** boundary the WTP of U.S. residents who do not live in New Mexico and do not visit the study area.

Our estimates of total WTP only include the WTP of individuals 18 years and older, expressed in present value (PV) terms. We derive total WTP by aggregating per-capita

WTP over all individuals who in 2004 are 18+ years of age, and adding the discounted WTP of all individuals who enter the 18+ age group during the 10-year projection period.

As already discussed, the WTP estimates generated by our two benefit transfer approaches differ. In our study context, neither of the two approaches is clearly superior to the other. Therefore, and to reflect the uncertainty that inevitably characterizes WTP estimates based on benefit transfers, we use the results of both approaches to construct upper-bound and lower-bound estimates of total WTP for otter reintroduction to New Mexico. It should be pointed out, however, that even the upper-bound estimate is very conservative, because of our restrictive assumption that non-response to the WTP surveys in the source studies signifies zero WTP of non-respondents.

In our lower-bound estimate, we employ the WTP estimates generated with the double-log form of the meta-analysis equation (far right column in Table 5). As already discussed and for the reasons given above, the linear form of the meta-analysis benefit transfer yields negative WTP estimates for individuals in the Rest-of-U.S. group. Therefore, and despite of the fact that the linear form of the meta-analysis equation yields the highest WTP estimates at the level of the Local and State boundaries (Table 8), we chose the WTP estimates generated with the single-value point transfer (see Table 5) to construct our upper-bound WTP estimate. This adds to the conservative nature of our upper-bound benefit estimate.

Table 10 shows that the differences in total estimated WTP for reintroduction between the Local and State boundaries are not very large. In the lower-bound estimates, aggregate WTP in the counties in the vicinity of the reintroduction area accounts for 75 percent of aggregate WTP in New Mexico as a whole. In the upper-bound estimates, that number increases to 82 percent. The relatively small size in the increase in total WTP associated with increasing the boundary from the study area counties to the state as a whole has two causes. First, the study area counties account for more than half of the state's population (see Table 4). Second, their population-weighted average per-capita income is almost 20 percent higher than the state's average.

**Table 10: Lower and upper-bound estimates of total local, state, and national WTP for otter reintroduction to New Mexico**

| *Spatial boundary* | *Lower bound* | *Upper bound* |
|---|---|---|
| | *Total WTP, lump sum, million 2003 $* | |
| Local | $ 11.7 | $ 15.4 |
| State | $ 15.6 | $ 18.8 |
| U.S. | $ 16.8 | $ 22.0 |

*Notes*: Based on Table 9. Lower bound estimates based on Meta-analysis reduced log-log model estimates for New Mexico residents and out-of-state angler and wildlife viewers (Local), and for Rest-of-U.S. for reintroduction of river otters leading to a 0.02 percent population increase in U.S. otter populations. Upper bound estimate based on Single-point value benefits transfer model for New Mexico residents and out-of-state angler and wildlife viewers (Local), and for Rest-of-U.S. for reintroduction of river otters leading to a 0.05 percent population increase in U.S. otter populations.

At the local and state boundary levels, the differences between the lower and the upper bounds of the WTP estimates are also rather small, with the upper bound estimate being 20 percent higher than the lower bound estimate at the local boundary level, and 30 percent at the state level (see Table 10). Increasing the benefit accounting boundary to the national level has no dramatic effects either. Despite of adding a large number of individuals (the Rest-of-U.S. group), the fact that each individual is expected to receive only a very small benefit from the reintroduction results in total WTP of that group being far smaller than that of New Mexico residents.

**Discussion**

We discussed potential impacts of differences in the valuation context between our source studies (White *et al.*, 1997; Loomis and White, 1996) and our NM study case in the previous section, and argued why they do not affect the validity of our application of benefits transfer. The one possible exception is the difference in qualitative nature of change in the resource under consideration (the river otter populations). While both source studies examine people's WTP for population increases of a species, our study context in New Mexico concerns the reintroduction of a once native species now presumed extinct in the state. Our WTP estimates would be unbiased if WTP for reintroduction would be ***the same as*** WTP for population increases of the size examined in our source studies (25 and 100 percent, respectively). However, if we require of our estimates not that they be unbiased, but rather that they do not overestimate true WTP, then that requirement would be fulfilled as long as WTP for reintroduction is ***not lower than*** WTP for population increases. Unfortunately, we are not aware of studies that have examined people's WTP for reintroduction of a particular rare or threatened species in one area, and people's WTP for population increases of that species in another area. Therefore, we cannot know the difference in WTP between the two policy actions. However, it seems unlikely that WTP for population increases would generally be higher than WTP for reintroduction. Importantly, as mentioned in the source study for our benefits transfer that examined WTP for increases in otter populations (White *et al.*, 1997), the otter population in that study area is not considered critically threatened or endangered, but rather stable or slightly increasing (ibid.). Since reintroduction of the river otter represents the reconstitution of a keystone species to its native habitat and the restoration of a more complete ecosystem, we argue that it is reasonable to expect that reintroduction of the river otter has an associated WTP that is at least as high as that which would be associated with population increases.

We incorporate a number of additional assumptions that are expected to lead to a conservative (downward) bias in our WTP estimates. Most importantly, we interpret non-responses in the surveys as expressing a zero WTP of the non-respondents. As discussed in the foregoing section, that is an overly restrictive assumption as there are a variety of reasons that keep people from responding to surveys. If the ***non-response equals zero WTP*** assumption is dropped, then our estimates of total WTP almost double**.**

Furthermore, we did not use the highest WTP estimates generated by our benefits transfer models (those resulting from the linear form of the meta-analysis regression equation). Rather, we used the second-highest WTP to construct our upper-bound benefit estimate. Also, by only including those out-of-state recreation visitors who engage in fishing and wildlife watching, we exclude other recreationists who are likely to receive benefits from river otter reintroduction (***e.g.***, those engaging in non-motorized water activities; see Table 1), but for which no estimates exist of the share of out-of-state participants. In addition, the numbers of out-of-state visitors to New Mexico that we use do not include persons under the age of 16, so the benefits that accrue to that age group are not captured in this analysis. Our estimates of the total WTP for river otter reintroduction of out-of-state recreation visitors also assume that visitation levels do not increase during the ten-year period covered in our analysis. That is a conservative assumption, given the continuing population growth in the U.S. (U.S. Census Bureau, 2004d).

The foregoing are reasons why our benefits estimates are likely to be conservative. However, our estimates are conservative for another reason. The benefits we estimate are only those associated with the non-market direct use (recreation) and the non use values generated by the reintroduction of river otters to New Mexico. As pointed out in the introduction, there are several categories of benefits that reintroduction of river otters may produce, but that our estimates do not include due to a lack of data. These are the direct use market values associated with possible increases in visitation levels due to otter reintroduction, and the indirect or ecosystem service values that reintroduction of otters may generate via its impacts on aquatic habitats.[13] Of these potential benefits not quantified in this analysis, the market value generated by increased visitation levels of anglers may be the largest value category. In 2001, annual fishing-related expenditures in New Mexico by new Mexico residents were estimated at over $136 million. Visitors from out-of-state spent at least an estimated additional $32 million (U.S. FWS and U.S. CB, 2002).[14] Including the economic multiplier effects of fishing expenditures, the total economic impact of freshwater fishing in New Mexico in 2001 was estimated at $363 million (American Sportfishing Association, 2002). Given that trout are the single most important game fish in the state (see Table 2), and that the reintroduction of river otters may reduce food competition for trout from slower non-game fish that, together with crayfish, are expected to constitute the main diet of reintroduced otters to the state, even a small percentage increase in trout fishing could result in market benefits that could equal or surpass the non-market benefits estimated in this study. It would be useful to monitor the impacts of river otter reintroduction, should it occur, on the species composition and relative abundance of game and non-game fish in the rivers in which otters reestablish

[13] In some cases, reintroduction of river otters may produce additional, ancillary benefits. For example, in Pennsylvania, reintroduced river otters, due to their status as a flagship conservation species, have served to draw attention to water quality issues (personal communication with Tom Serfass, Frostburg State University, during public meeting on the reintroduction of river otters to New Mexico; Santa Fe, November 17, 2004). In New Mexico, these benefits may be less relevant, given that water is already a salient public policy issue.

[14] These values are minimum estimates. The survey from which they are taken (U.S. FWS and U.S. CB, 2002) distinguishes expenditures into those for hunting, those for fishing (reported above), and those that respondents could not assign in particular to either fishing or hunting. Expenditures in that "unspecified" category were an estimated $131 million, comparable in size to those directly attributed to fishing.

themselves. It would also be desirable to observe changes in angler visitation levels in those rivers, and conduct surveys aimed at determining to what extent those changes, if any, are attributable to an increased attractiveness of the fishing experience due to increased catches of game fish. Based on these data, and correcting for trends in angler visitation over time, estimates of the direct market value of otter reintroduction could be generated. Such estimates would be desirable as they are needed in order to complement the estimates generated in our study and would allow the estimation of the total economic value of river otter reintroduction.

Finally, we point out that our benefit estimates for people living in the U.S. outside of New Mexico and not visiting the state for recreation should probably be treated with some caution. These estimates are based on benefit transfers that assume linear behavior of people's WTP over otter population changes (in the case of our single-point value transfer estimate) or that apply WTP function outside of the range over which it was estimated (in the case of our meta-analysis based transfer estimates). Given in addition the uncertainty regarding the size of the total river otter population in the U.S. and the increase it would experience as a result of reintroducing the species to New Mexico, the estimates for people outside of New Mexico not visiting the study area are necessarily less reliable than our benefit estimates for local residents, people living in New Mexico, or recreation visitors from out-of-state.

## Conclusion

The objective of this study is to estimate the economic benefits associated with reintroduction of the river otter to four rivers in New Mexico – the upper Rio Grande, the middle and lower Gila, the middle Chama, and the San Francisco. Reintroduction of the river otter is expected to produce a number of different types of benefits. In economics, these are known as direct use benefits, comprising both market and non-market direct-use benefits; indirect use or ecosystem service benefits; and non-use benefits. Due to the absence of information that would allow the estimation of the impacts of river otter reintroduction on aquatic ecosystems, it is impossible at this time to quantify the market-based direct benefits and the ecosystem service benefits associated with otter reintroduction.

Since no research has been conducted in the study area on individuals' WTP for river otter reintroduction, we apply two benefits transfer approaches to develop estimates of average per-capita and total WTP for otter reintroduction to the New Mexico areas. Throughout our analysis, we make assumptions that tend to yield a conservative bias in our benefit estimates.

We estimate that during the ten-year period following reintroduction, reestablishment of river otters in the four rivers in New Mexico could generate non-market direct benefits and non-use benefits for people residing in the counties in proximity to the reintroduction areas that total between \$6 million and \$9.5 million. For residents of New Mexico as a whole, these benefits are estimated to range from \$9.8 million to \$12.9 million. In addition, anglers and wildlife watchers from out-of-state that visit New Mexico are estimated to receive non-market direct use and non-use benefits during that period totaling some $5.7 million to $5.8 million. In addition to these local and regional benefits, reintroduction is likely to generate benefits also to people that do not reside in or visit the reintroduction area. These benefits are expected to be so small at the level of each individual that even given the potentially large number of people affected, the aggregate value of these out-of-area benefits is estimated to be far smaller than the benefits that would accrue to residents of New Mexico or recreation visitors to the state. Depending on the size of the New Mexican river otter population after reintroduction and the size of the total U.S. river otter population, we estimate those out-of-area benefits to be between $1.2 million and $3.2 million. However, these out-of-area estimates are based on very rough estimates of the relative sizes of the population of New Mexican river otters after reintroduction and of the river otter population in the U.S. as a whole. Due to the uncertainty surrounding these population estimates, we consider the estimates of these out-of-area benefits much less reliable than the benefits to local residents, New Mexicans as a whole, and recreation visitors from out-of-state.

Our analysis shows that the reintroduction of river otters to New Mexico is expected to generate substantial economic benefits in the benefit categories included in this analysis. It should be added that the market-based direct benefits of reintroduction, not included in this analysis, could be substantial, and could be comparable in size to, or even larger than, the non-market direct benefits and non-use benefits for which we develop estimates in this study. Those market-based direct use benefits constitute part of the total economic value of otter reintroduction. It would desirable therefore that the biologic and demographic information relevant for their quantification be compiled so that these benefits may be estimated in future research.

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