The Impacts of Roads, Deforestation, and Disturbance on the Torrent Duck (*Merganetta armata*) in Northern Andes of Ecuador

All photographs by Elizabeth W. Goldsmith, 2006.

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Short Title: Impacts of Development on the Torrent Duck

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ABSTRACT

The Torrent Duck *(M. armata*) found throughout the Andes was studied over three weeks on four rivers in the Northern Andes of Ecuador, the Río Cosanga and Río Quijos on the Eastern slope and the Río Pilatón and Río Toachi on the Western slope, to examine the effects of development, deforestation, and disturbance on the local populations. A questionnaire was also given both orally to local residents and by email to birding professionals in Ecuador to collect data on the trend in Torrent Duck populations, behaviors, threats to the population, and the effects of past disturbances. Torrent Ducks were observed through point counts and direct observation at three view points along each river. Torrent Ducks were found on all four rivers during the study. Questionnaires both oral and by email described a decrease in Torrent Duck sightings over the last 20 years. Higher densities on the Río Cosanga and Río Pilatón demonstrate that in general Torrent Ducks are not impacted by the presence of human development. The lower density of Torrent Ducks on the Río Quijos and Río Toachi seem to correspond with a high rate of disturbance from oil and chemical spills. The watersheds of both the Río Toachi and Río Quijos also are more heavily deforested than their geographic counterparts, the Río Pilatón and Río Cosanga. Promotion of ecotourism for the Torrent Duck as well as a campaign to get the Torrent Duck formally declared threatened in Ecuador are two possible conservation strategies. Further study is greatly needed of this scarce species to determine population size and threats throughout its range.

RESUMEN

El Pato Torrentero (*Merganetta armata*) que se encuentra por todos los Andes estaba estudiado por tres semanas en cuatro ríos por el norte de los Andes del Ecuador, el Río Cosanga y el Río Quijos por la cordillera oriental y el Río Pilatón y el Río Toachi por la cordillera occidental, para examinar los efectos de las carreteras, la deforestación y el disturbio en las poblaciones locales. Se usaba un cuestionario oral a la gente local y por correo electronico a profesionales en Ecuador para colectar datos sobre la tendencia de la población del Pato Torrentero, el comportamiento, amenazas a la población, y los efectos de disturbios pasados. Se observaba el Pato Torrentero por recuentos del punto y observacion directa por tres puntos de vista en cada río. Se encontraron Patos Torrenteros en todos los ríos estudiados. Los cuestionarios ambos orales y por correo electronico mostraron una disminuisión de vistas del Pato Torrentero por los 20 años pasados. Densidades altas en el Río Cosanga y el Río Pilatón demuestran que en general los Patos Torrenteros no estan afectados por la presencia del desarrollo de seres humanos. Menos densidad del Pato Torrentero en el Río Quijos y el Río Toachi parece coresponder a la cantidad del disturbio por derrames del petróleo y químicas. También las cuencas del Río Toachi y Río Quijos tienen más deforestación que su equivalente geográfico, el Río Pilatón y Río Cosanga. Promoción del ecoturismo por el Pato Torrentero y una campaña para declarar la especie amenazada en el Ecuador son dos estrategias para sconservación. Más estudio de esta especie posiblemente amenazada es necesario para determinar el estatus de la población y amenazas en todo su ámbito.

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INTRODUCTION

The pace and nature of development have increased at an alarming rate in recent years. The effects of development, particularly in the Neotropics, on many species of avifauna are relatively unknown. It is well known that urbanization results in decreased species richness and diversity (Beissinger and Osborne 1982). The epitome of impacts of development in the Neotropics is habitat loss through deforestation. Wunder (2000) writes, "O ver the last two decades, tropical forests have experienced a relatively rapid decline"(23). It is well known that the effects of deforestation are widespread and varied, and many impacts are still unknown. Increased erosion and water pollution are two such far-reaching effects of development. Causes include deforestation as well as agriculture, road construction, trail use, excavation, extraction, and construction (Harden 2001).

The effects of erosion are exacerbated by roads, which expose soil to erosion by to a much greater degree than agricultural lands or pastures (Harden 2001). Along with the water comes suspended and eroded sediment and dissolved chemicals (Forman, Sterling, et al. 2003). The resulting sedimentation and water pollution collect in rivers and water systems and can be disastrous for aquatic invertebrates and other species. Roads also drastically change the movement of water throughout a watershed. In many instances roads serve simply as giant gutters, moving large quantities of water straight into rivers and streams. This change in the path of water movement from roads or other development can result in major disasters such as landslides, floods, and major sedimentation of bodies of water (Forman, Sperling, et al. 2003).

Birds can serve an important role in measuring the effects of development as biological indicators of environmental health. In recent years, the ecological and ornithological communities have become increasingly interested in the effects of development on birds. Outside of the more common effects of development, introduction of predators and competitors (Green 1996), habitat destruction (Green 1996), and habitat fragmentation, recent studies have shown some more subtle impacts on avian populations. Studies of roads and birds have found that road noise negatively impacts breeding grassland birds (Forman and Alexander 1998) and terrestrial insectivores (Canaday and Rivadeneyra 2001), and road gaps can seriously impede the movement of forest-dependent insectivores (Laurence et al. 2004). Birds have also proved themselves

adaptable to some developed areas and are capable of effectively utilizing human-modified habitats (Petit and Petit 2003).

Development can also contribute to a different kind of stress on avian populations through abrupt, intensive disturbances. These sudden disruptions such as natural disasters as well as less natural disasters such as petroleum spills from various stages of the manufacture process, chemical spills, accidents with transport trucks, and purposeful poisonings of rivers for fishing also create a stressful environment for all flora and fauna. One important and well studied example of disturbance is the Exxon Valdez oil spill on the Alaskan Coast. The impact of the spill on local seabird populations has been subject to great debate since the clean-up began. Though the effects of the spill were clearly devastating, Weins (1996) argues that seabird populations were surprisingly resilient in their recovery from the spill. On the other hand, Irons et al. (2001) argue that seabirds who are divers rather than surface feeders continued to be impacted by Exxon-Valdez years after the spill area had been cleaned. This argument about impacts of one-time, intensive stress on avian populations goes on throughout arenas of conservation and ornithology.

As rated in the Green(1996) analysis of the world's threatened Anatidae using the IUNC red list categories from 1994, two subspecies of the Torrent Duck, *M. armata colombiana* and *leucogenis*, are both under levels of threat. *M. armata colombiana* which is found throughout Ecuador is listed as Endangered. Yet little action has been taken throughout the range of *M. armata colombiana* to monitor and confirm the actual status of the Torrent Duck population or begin effects for conservation. This makes the Torrent Duck a perfect candidate for a study of the impact of development in the Ecuadorian Andes. Its uncommon populations, unusual habitat, and appealing nature could make it an important flagship species for conservation. The Torrent Duck extends throughout the Andes, from Venezuela to Argentina and has been separated into six subspecies (del Hoy et al. 1992). In Ecuador, only *M. armata colombiana* is found locally but scarce on both slopes from 700m to 3200m in altitude (Ridgely and Greenfield 2001, Vol. II). The species itself is unmistakable. A relatively small duck with a long, spiny tail, it prefers areas of fast rapids with exposed rocks. The coloration is surprisingly cryptic while swimming. Males have a white neck and head with

distinctive black striping while females are brown below with grey markings above. Body coloration varies by subspecies but is some combination of grey, white, black, and brown for both sexes.

Typical behavior includes very active foraging for aquatic invertebrates, especially mayfly and stonefly larvae (Ridgely and Greenfield 2001, del Hoyo et al. 1992, Hilty and Brown 1986, Fjeldsa and Krabbe 1990), around partially submerged rocks in Andean rapids and periodic resting out of the water on rocks. Ridgely and Greenfield (2001) and del Hoyo et al.(1992) both note that there is a possibility that fish is also eaten.. Adults often dive for extend periods of time and are capable of swimming across strong rapids. Apparently almost always live in pairs, male and female. Each pair has a territory generally estimated at 1 kilometer (Ridgely and Greenfield 2001, Handbook 1996), though Naranjo and Avila (2003) estimated actual territory length at around 1400 m. Nesting occurs in crevasses among rocks in dense vegetation. Each nest contains on average 3 to 4 eggs. Juveniles are brown and white with black and white spots (del Hoyo et al. 1992).

Most literature cites locally declining populations of Torrent Ducks for a variety of reasons including erosion from deforestation (Múnera-P. 2004), fishing and hunting, water pollution from mining, growth of cities and towns, pesticides (Múnera-P. 2004) and possible competition with introduced trout – disproved by Naranjo and Avila (2003). Green (1996) cites loss of habitat, introduced species, and pollution as the main threats to the *M. armata colombiana*. The general lack of scientific studies on this species and the apparent decrease in population numbers calls for further investigations into the activities and population trends of the Torrent Duck. The purpose of this study is to discern the actual trend of Torrent Duck populations in the Northern Andes of Ecuador and see if there is a correlation between habitat loss through development and deforestation and pollution from deforestation and disturbance. It is expected that more developed areas, especially deforested areas with high water sedimentation, will have fewer Torrent Ducks than more pristine areas.

STUDY AREA

Ecuador is located on the Northwestern coast of South America. The Tropical Andes which bisect the country are at the top of most lists of the worlds most important biodiversity hotspots including Myers et al. (2000). The Eastern Andean slope in Ecuador and Peru is on the list of endemic bird areas with a priority rating of "urgent" by BirdLife International (2003). Ecuador is also classified as a developing nation and due to this development its famous landscape and biodiversity are changing at an alarming rate.

One of the important and unusual habitats of the Neotropics which is found along both slopes of the Andes is cloud forest or montane forest, which is found globally in tropical montane areas between 2000m and 3500m above sea level (Hamilton 1995). Characterized by generally shorter trees, more open canopy with thick under story, horizontal precipitation from the frequent cloudy mist which descends on the forest, and high numbers of epiphytes, cloud forests generally have a high diversity of flora and fauna and high endemism due to ecological island biogeography of mountain ecosystems. The fast Andean rivers of this study pass through cloud forest before slowing and growing into the slower lowland rivers which they feed into. Andean rivers are generally fast, direct, and rocky with dangerous rapids interspersed with open areas.

This study looked at four rivers in total, two on each slope of the Andes. Due to the rough terrain roads frequently follow rivers for long distances and at close proximity. In general, colonization then follows along these roads and spreads out up the valleys. The Eastern slope in this area is generally much less developed than the Western slope. The Eastern sites, the Río Cosanga and Río Quijos located in the Province of Napo, were located along two main roads the higher traffic route from Papallacta to Lago Agrio and lower traffic road from Baeza to Tena respectively. The two rivers unite just below Baeza and continue to join the Río Napo continuing to the city of Coca and into the Eastern lowlands. The people living within the Cosanga and Quijos watersheds generally rely on small dairy farms for their livelihood. Most of the milk in the area is bought by the Nestle Corporation and processed nearby. The source of the Cosanga river is in the relatively pristine area of the Sumaco National Park, where as the Quijos is fed by the highly populated Río Papallacta.

The Western area of study in the Province of Pichincha is significantly more developed. The Santo Domingo Road running from Aloag to Santo Domingo de los Colorados has a high traffic volume and follows first the Río Pilatón and then the Río Toachi after it joins with the Pilatón. The area is significantly more populated leading up to Sto. Domingo de los Colorados, one of the major Ecuadorian city. Farming appears to be the dominant profession in the study area but in the Sto. Domingo area, farms seemed to have a mix of cash crops such as fruit trees, dairy cattle, and other crops.

Study sites were chosen to display a gradient of development, amount of deforestation, water quality, and road use among other reasons. Also these sites are in areas with a variety of natural and human disturbances. The recently constructed OCP (Oleoducto de Crudos Pesados) Pipeline runs directly along the Quijos and Toachi for extended stretches. Entrix Inc analyzed the environmental consequences of the project before construction in 2001. They predicted that the pipeline would impact several areas of high biodiversity across Ecuador. The petroleum spills from the OCP as well as from trucks along major roads is one major source of periodic disturbance to these areas. Spills of other chemicals also often occur along major roads, such as a recent event on the Río Toachi. On 12 April 2006 a truck carrying sulfuric acid on the Santo Domingo Road crashed less than a kilometer away from Site #1 on the Río Toachi, dumping its cargo straight into the river. Spills on the Santo Domingo Road are a common occurrence (Balseca Ortiz 2006). Other common disturbances in these areas include landslides, flooding, and construction.

MATERIALS AND METHODS

A point count was conducted on four rivers on the Eastern and Western slope of the Andes mountains in Ecuador through direct observation. A point count was chosen over transects for a variety of reasons. Though transects are important for the estimation of Torrent Duck density as used by Naranjo and Avila(2003), a transect would be inefficient due to restricted time of the study, the rapid water flow of Andean rivers, occasional dense vegetation along river edges, and inconsistent riverbanks. A point count is a viable technique since ducks are restricted to a set area, the river and are quite active throughout this area (Bibby 2000).

Three sites were selected on each river (see Appendix 1 for site maps) separated by at least 2000 meters to eliminate the possibility of counting the same pair twice (see previous review of estimated range size). Sites were selected for easy access, habitats characteristic of the Torrent Duck, and a clear view both up and downstream. Bridges were preferred sites since they provided a relatively unobstructed view from the center of the river. Sites were found by personal suggestions, topographical maps, and searching on foot. Each day of a census for a particular river, two hours were spent at the site regardless of weather. When a duck was observed within the study area, the behavior, location, movement along the river, and time of observation were recorded in a field notebook. Observations on the height of the river, changes in the weather, activities of birds near the study site, and other subjects of interest were also noted.

Two field methods were used to measure the water quality of each river. First water samples were collected twice at each river. 1.5 liters of the sample were permitted to settle for 8-24 hours and then examined for sediment settling. If possible an estimation of the amount of sediment was made to the nearest 50 mL from markings on the measuring container. A sample of aquatic invertebrates was also taken at each site. Insects were caught using a small net and simply by examining submerged rocks along the riverbank. Using Camera and Fierro's guide to aquatic invertebrates, invertebrates were identified to taxonomic family using an identification key and drawing. The key also provided a contamination tolerance rating from 0 to 10, a rating of 10 signifying no toleration of contaminants and thus good water quality. Deforestation analysis of the two sites on the Eastern slope was accomplished using satellite imagery from GoogleEarth© and a vegetation map. The Western slope could not be analyzed using the GoogleEarth© satellite imagery because the whole Western slope is covered by cloud in the available images. Instead a physical map of Ecuador from the Instituto Geográfico Militar in Quito was used to estimate the watershed. Percent deforestation was estimated on the vegetation map after each watershed was determined.

The second major part of the study consisted of a questionnaire (see Appendix II) to understand the distribution of the Torrent Duck in Ecuador, population trends, and reactions of ducks to past disturbances. The informally observed decline in Torrent Duck numbers can not be confirmed with previous population data since there is no formal data

on Torrent Duck populations. There are many drawbacks to relying on the qualitative data of a questionnaire and good memories of participants, but interviews are the only way to collect information about past populations. Also qualitative observations on the effects of development and disturbance were sought through this method. Two groups of informants were sought. First, questionnaires were emailed to birding professionals throughout Ecuador, including ornithologists, field ecologists, bird guides, and other persons associated with the birding industry. Second, while in the field, residents who lived near the rivers were interviewed orally with the same questionnaire. Statistical analyses for both the field data and questionnaire data were performed using regression analysis in Microsoft Excel©.

BEHAVIORAL OBSERVATION AND POINT COUNTS

A total of 78 hours were spent in field observation of rivers with 9.5 hours of direct observation of the Torrent Duck between 18 April 2006 and 5 May 2006. Of the total 14 of sightings, a pair of Torrent Ducks was seen 9 times (64% of sightings). A single, adult male was seen 3 times, and a single, juvenile male was seen 2 times. The juvenile male was seen at Site #1 and Site #2 on the Río Cosanga. The most common behaviors exhibited were foraging, resting on rocks, and swimming to pass through an area. Foraging was most commonly observed in wide areas with relatively fast and shallow water rather than in steeper white water rapids. Diving from rocks and surface dives as well as more typical dabbling behavior were observed when ducks were in the water. One confirmed event of piscivory (described and discussed further in Appendix I) was observed on the Río Pilatón, an exception to the usual Torrent Duck diet of aquatic invertebrates.

All swimming was punctuated by frequent momentary pauses on exposed rocks. Travel upstream exhibited more frequent pauses than downstream, and travel in more drastic rapids was frequently augmented by climbing over rocks and occasionally flight. Two types of swimming behaviors were observed. The first was normal swimming, while the second style of swimming was accelerated with much of the duck's body was out of the water. This type of swimming was used to cross rapids and in courtship behavior. Flying was also observed both over short and long distances on three

occasions. It was never higher than 5 meters and always along the river's path. One time on the Río Cosanga a male Torrent Duck was observed flying upstream more than 45m from around a bend after leaving its mate and traveling downstream ten minutes before. On the Pilatón, a pair of ducks flew over a difficult area of rapids for about 15m, taking off from the water, after attempting to cross them swimming. Also possible courtship behavior and copulation was observed at Site #1 of the Río Cosanga on 18 April 2006 between 7:56 and 8:11 AM. The event occurred after 46 minutes of observation in the same area.

7:56 *-Male approaches female from behind. Female swims away and continues foraging up side of the river.*
-The pair perches on the same rock together.
8:09 *-Accelerated swimming together for about 10m in an area where the pair had previously been foraging.*
-Extensive head pointing by both male and female. A commonly exhibited behavior, but this lasted for about 20-30 seconds.
-Accelerated swimming again, the female leading with the male seemingly chasing behind her.
-Male "catches" female. Female is pushed under water for some seconds while male is partially submerged in the water above her.
-Female emerges from water and settles on a rock nearby.
-Male joins her on the same rock and pecks at her tail a few times.
8:11 *-Return to foraging after a short period of time of resting together on a rock.*

Copulation event took place in less than 30 seconds. The pair continued to forage and rest in the same area for 42 minutes before leaving downstream.

No competition with other birds was evident from field observations. The White-capped Dipper, which was encountered on each river studied, is the only possible competitor. It forages along the waters edge on boulders and rocks in white water rapid "picking at objects along water's edge"(Ridgely and Greenfield 2001, Vol. II p. 580), but when observed it preferred the shallow water which lapped up over the rocks amidst the rapids and rather than the slightly deeper, calmer areas water to forage further under rocks where Torrent Ducks were observed foraging.

Unfortunately, due to time constraints, the Quijos and the Toachi on the Western slope, received far less observation time and thus can not be effectively compared with the Eastern rivers (see *TABLE 1*). Ducks seen per hour were calculated in two different manners in an attempt to compare all four sites(see *FIGURE 1*). Overall the Cosanga has

the highest rate of observation, followed closely by the Pilatón. Both the Toachi and Quijos had low ratios. No correlations were found between number of individuals seen at a particular site and any landscape characteristic.

WATER QUALITY AND DEFORESTATION ANALYSIS

The results of the sedimentation analysis were inconclusive. Due to imprecise and insensitive equipment, little to no difference was seen between the sediment values. Only two samples had a visible amount of sediment fall out, the first from the Río Cosanga and the second from the Pilatón. Both of these samples were taken after heavy rains when a significant rise in the river was also seen. Aquatic invertebrate samples were taken from the Cosanga, Quijos, and Pilatón. No aquatic invertebrates could be found on the Toachi during 30 minute collection period similar to the other three rivers. This might be due to high water during the available collection time. All three rivers yielded the same four families of mayfly and stonefly larvae, all with relatively low contamination tolerance – Baetidae, Oligoneuridae, Leptophebiidae, and Perlidae. A Euthyplocidae, also a good water quality indicator, might have been identified during the Pilatón collection. According to the aquatic invertebrate analysis, all three rivers are of high water quality.

A preliminary deforestation analysis was performed using GoogleEarth to establish the watershed area and a vegetation map to estimate the deforested areas. Overall the Eastern slope showed a much lower percent deforestation with about 15% deforestation in the Cosanga watershed and 20% in the Papallacta-Quijos watershed. The Western slope on the other hand appeared to be severely deforested with about 50% deforested in the Pilatón watershed and 90% in the Toachi watershed (which includes the Pilaton). It is important to emphasize that these were only very rough estimates, but the difference in deforestation between the heavily deforested Western slope and more pristine Eastern slope.

QUESTIONNAIRE SUMMARY

A total of 19 questionnaires were answered orally at the four different study sites. Participants were not selected with any criteria, only that they lived in the area and recognized a verbal description of the Torrent Duck. Knowledge of and interest in the Torrent Duck populations varied drastically from interview to interview possibly

reflecting on the content. Only four expert questionnaires were received by email so this sample can certainly not be called a representative sampling of professionals. A brief summary of the answers to each question is given below. Figures will follow at the end of this section. Please note that quotes have been translated from Spanish to English for this paper. Multiple questions used a scale of 4-0 in responses, detailed below.

Scale Description

4 Very Common, seen everyday when visited, 10 sightings/10 visits
3 Common, seen most days when visited, 6-9 sightings/10 visits
2 Uncommon, seen few days when visited, 2-5 sightings/10 visits
1 Rare, hardly even seen when visited, 1 or less than 1 sightings/10 visits
0 Never Seen
NA Not Applicable

Question 2.1: How often did you see Torrent Ducks in appropriate habitats 20 years ago? 10 years ago? 5 years ago? Recently?

For results from the oral questionnaires, see *FIGURE 2* and for results from the email questionnaires, *FIGURE 3*. According to the oral questionnaires, average estimated frequencies of duck sightings at all sites for the past 20 years showed a statistically significant decrease from very common (3.7), twenty years past to uncommon (2.3) in recent years. This shows that local people are seeing fewer Torrent Ducks now than before though it does not reflect on actual population numbers. The same trend was shown in the email questionnaires. Average estimated frequencies of duck sightings for the past 20 years showed a statistically significant decrease from common (3) to very uncommon (1.5) in recent years.

Question 2.2: Of the times you see Torrent Ducks, how often do you see a single duck? A group(non-mating pair)? A mating-pair(a male and a female)? Juveniles? When you see juveniles, on average how many do you see?

According the oral questionnaires, it is rare (1) to see a single Torrent Duck, very uncommon (1.79) to see a group of more than two Torrent Ducks, common (3.11) to see a pair of Torrent Ducks, and rare (0.89) to see juveniles. On average, after impossible answers were removed from the data pool, when juveniles are seen on average there are 2. The low rate of juvenile sightings might also be because juveniles from a distance could be mistaken for small females. According to the email questionnaires, it is

uncommon (2) to see a single Torrent Duck, very rare (0.5) to see a group of more than two Torrent Ducks, uncommon (2.25) to see a pair of Torrent Ducks, and rare (1.25) to see juveniles. On average, when juveniles are seen on average there are about 3.

Question 2.3: How often do you see torrent ducks on the following rivers in Andean Ecuador? Please use the previous 4-0, NA scale. Be sure to include at which rivers you never see Torrent Ducks. Rivers: Rio Papallacta, Rio Cosanga, Rio Oyacachi, Rio Toachi, Rio Santo Domingo, Rio Blanco, Rio Mindo, Other (specify river name below)

For results from the oral questionnaire, see *FIGURE 4*, and for results from the email questionnaire, see *FIGURE 5*. During oral questionnaires, frequency ratings were usually only given by local residents about what ever river was closest along with local side streams. Tthe average frequency of seeing a Torrent Ducks on the major Ecuadorian rivers was as follows: Río Cosanga, uncommon (2); Rio Quijos, uncommon (1.67); Rio Pilatón, common (3); and Río Toachi, very common (3.5). Río Toachi frequency might be so high because of confusing with the Neotropical Cormant. Numerous local side streams were also cited to support Torrent Ducks. According to the email questionnaires the following rivers contain Torrent Duck populations: Río Cosanga, uncommon (2); Río Oyacachi, uncommon (2); Río Papallacta (1.67), Río Quijos, common (3), Río Mindo, uncommon (2.25), Río Toachi, uncommon (2). The Santo Domingo River was reported to not contain Torrent Ducks. Other rivers reported in all questionnaires are included in Appendix III.

Question 2.4: Overall, what would you say is the general trend of Torrent Duck populations today (Steady/Increasing/Declining)?

This question was often met with confusion by participants, and probably is not an effectively worded question. 21% of informants gave no specific or discernable answer to the question. Overall, 37% reported that the Torrent Duck population is constant, while 26% stated that the population is decreasing. 16% stated that it is increasing. 50% of participants of email questionnaire participants stated that the population was decreasing and 50% stated that it is constant. The responses to this question directly contradict the findings of Question 2.1. Multiple times, a participant

who described a clear decrease in Question 2.1 would give a contradictory answer for this question.

Question 2.5: Have you noticed a decline in the Torrent Duck population following a major environmental catastrophe, such as major landslides, oil spills, or other major river contamination? If yes, on what river? Please give details about the event.

8 participants stated that they had not seen a decrease in Torrent Duck populations after a major environmental catastrophe, where as 10 said they had seen a decrease in Torrent Ducks after a catastrophe. One did not answer this question. In Cosanga, a case of poisoning the river with Barbasco for fishing was cited as happening about 11 years in the past (Pilataxi Coyago 2006). Further back in the past this was a more common occurrence in smaller mountain streams. All three interviews on the Río Quijos cited oil spills in years past. Maria Pozo (2006) stated that an oil spill six years before resulted in a "total change" in river wildlife. Francisco Palma (2006) cited occasional breaks and spills from the nearby OCP pipeline.

On the Western slope, trucking accidents with petroleum or chemicals were cited on both the Pilatón and Toachi (Guallo, Agirre, Valiejo Araujo, and Gualán 2006). Miguel Gualán(2006) stated that since the most recent spill of sulfuric acid near his home in la Unión del Toachi he has not seen any Torrent Ducks. Milton Agirre (2006) stated that the foam resulting from the spill was quite high, but three or four days after the spill passed the ducks returned to the Toachi. It should be noted that during the interview with Agirre there was some confusion between Neotropical Cormorants and Torrent Ducks so this comment might refer to the Cormorant.

In the email questionnaires, three of the four participants stated that impacts on the population had been noted after a major environmental catastrophe, including petroleum and chemical spills, introduction of trout, and silt loads. The rivers and reasons are as follows: Blanco, release of trout into the river (Cisneros-Heredia 2006); Cosanga, petroleum spill and heavy silt (Lysinger 2006); Guajalito, petroleum spill and release of trout into the river (Cisneros-Heredia 2006); Papallacta, petroleum spill and heavy silt (Lysinger 2006); Quijos, petroleum spill and heavy silt (Lysinger 2006); Saloya, petroleum spill in the river (Freile 2006); Toachi, sulfuric acid spill (Cisneros-

Heredia 2006). Mitch Lysinger (2006) commented that the spills, "all seem to wash through after a while and on all of them I have subsequently seen breeding pairs with young. So, I couldn't say that I've noticed a real decline after such events."

Question 3.1: What behaviors are most commonly exhibited by Torrent Ducks when sighted (Foraging/Pre ening/Calling/Mating/ Resting/ Swimming/ Flying)?

A variety of behaviors were reported but usually focused on swimming, foraging, and resting on top of rocks as the most common and important. In the email questionnaires, reported behaviors were swimming, foraging, resting, and preening. Mitch Lysinger (2006) added, "Nervous behavior with a slow retreat seems to be the most common in my experience."

Question 3.2: Have you noticed any behavioral changes over the past years? If so please explain.

Only three participants cited changes in behavior. Increased fear and avoidance of humans were cited by two of the three. The third, Maria Pozo(2006) simply stated, "They do not exist". No behavioral changes were noted in email questionnaires.

Question 3.3: On a whole when you see Torrent Ducks are they closer or further from roads (No Difference/Further/Closer)? Developed areas, such as farms, town areas, industry, etc… (No Difference/Further/Closer)?

See *FIGURE 6* for results from the oral questionnaires and *FIGURE 7* for the email questionnaires. 47% of participants interviewed orally stated that there was no difference in Torrent Duck distribution in relation to roads. 32% stated that Torrent Ducks tended to be found further from roads while 16% stated that they were frequently found closer to roads. In response to the second part, 47% stated that Torrent Ducks were found further from these developed areas while 37% stated that there was no difference in distribution and 11% stated that Torrent Ducks were found closer to these developed areas. For the email questionnaires, no majority answer was given for either part of this question. Two out of four responded that there was no difference in proximity to roads, one response of closer due to easy observation points, and one response of further. Two out of four participants responded that Torrent Ducks were found further from other development, one response of closer due to easy observation points, and one of no difference.

Question 3.4: Have you noticed disturbance, such as increased human visitation or nearby development, affecting Torrent Duck populations drastically? Please explain the disturbance observed.

Disturbance from human presence had a mixture of responses. 15 out of 19 participants stated that no affect had been seen. Those who did note an affect noted the quick retreat of Torrent Ducks from nearby persons. Though ecotourism was not noted as a negative effect in the oral interviews, Pozo(2006) suggested that the kayaking business in Baeza might have a negative impact on the local Torrent Duck population. In the email questionnaires, three of the four participants stated that they have noticed human disturbance in areas. The fourth, Mitch Lysinger, stated that the pair he sees most is located in the town of Cosanga.

Question 3.5: Have you ever observed attempted or successful predation on Torrent Ducks by hawks, cats, dogs, fox, etc…? If yes, please detail the observed incident.

No predation was reported for either group of questionnaires, though Palma(2006) did state that dogs were used in hunting the Torrent Duck.

Question 4.1: Have you ever heard reports of hunting of Torrent Ducks? If so, for what purpose (subsistence, sport, diet supplement, medicinal use)?

No reports of hunting were given by email questionnaire participants, but the majority of participants, 13 of 19, stated that there certainly was hunting of the Torrent Duck but this statement was usually followed by an explanation that hunting is difficult and rare. For the most part hunting seems opportunistic with rifles, nets (Agirre 2006), traps (Pilataxi Coyago 2006), or dogs (Palma 2006). The rapid water and elusive duck were usually two reasons for the usual failure to catch a Torrent Duck. One account of hunting for sport was reported by Sarah Ortiz Lema and her son, Mario Balseca Ortiz. A local man asked for permission to come hunt the resident three Torrent Ducks which lived in the Río Toachi near their family farm. The family refused permission, but the farm now has only a resident pair. Balseca Ortiz and Ortiz Lema hinted that the third duck might have been hunted despite their efforts. Milton Agirre (2006) reported hunting of a Torrent Duck for curiosity. The duck was thrown back to the river after it was

examined. Luis Viteri Arias (2006) reported two cases of fishermen accidentally catching a Torrent Duck with their fishing hooks.

Question 4.2: Any other local uses of the Torrent Duck population?

In both groups of questionnaires, no uses of the Torrent Duck were known outside of a source of food. The only response to this question was from Elsa Guerrero Solis(2006), who reported that sometimes Torrent Ducks are stuffed for exhibition.

Question 4.3: What is the attitude of the local population towards Torrent Ducks?

The most common description of the local attitude towards the Torrent Duck was "nothing". Both oral questionnaire and email questionnaire participants stated that local communities seemed more or less indifferent to the Torrent Ducks existence.

Question 4.4: Do you know of any mythology or traditional stories/beliefs about Torrent Ducks?

No local stories were known of the Torrent Duck in either group.

DISCUSSION OF RESULTS

The population of Torrent Ducks as experienced by both local residents and national birding professionals is decreasing. Though more analysis and more rigorous census techniques are needed to begin to study the actual population numbers, it does appear that people are seeing fewer Torrent Ducks in Northern Ecuador. Contrary to previous expectations, the presence of towns and settlements does not seem to affect the presence of Torrent Ducks. In response to Question 3.4 on the effects of human presence as disturbance, Mitch Lysinger (2006) wrote, "One of the most common pairs that I see are right next to the village of Cosanga where they seem unmolested and able to 'co-habitat' with the human population right nearby." This observation was confirmed throughout this study on both the Cosanga and Pilatón. The site directly adjacent to the town of Cosanga had the highest number of cumulative sightings, the highest cumulative number of Torrent Ducks seen, and the highest number of estimated residents – a mature pair, a solo adult male and a solo juvenile male. It can be concluded from the field and questionnaire results that human presence and settlement alone does not negatively impact Torrent Duck populations.

Preliminary deforestation analysis shows that the Western slope is far more heavily deforested than the Eastern slope. In comparison within the slopes, the Quijos appeared to be slightly more deforested than the Cosanga. On the Western slope, the Pilatón was clearly less deforested than the Toachi. This would be in accordance with findings from the point counts, but not from the questionnaire reports on Torrent Duck density (Question 2.3). The differences between the Río Cosanga and Río Quijos found throughout field study would support the assertion that deforestation, higher traffic, and periodic disturbance from oil spills would result in a lower population density of Torrent Ducks on the Quijos. It is difficult to support these assertions with the small amount of data collected in this study, but the comparison of the field data from the Río Cosanga and Río Quijos certainly a distinct contrast despite the similar frequency reports from the oral questionnaires (Cosanga, 2 and Quijos, 1.67) and identical rating (2) from the email questionnaires. As two rivers in fairly similar geographic situations, the human effects on the surrounding landscape are the most apparent characteristics which distinguish the two rivers from each other.

The stable population on the Pilatón in La Esperie seems to show the same results as the Río Cosanga in comparison with its geographic counter part, the Río Toachi. There are two important differences between the Pilatón and Toachi sites. First the presence of side streams at each point count on the Pilatón would suggest the possibility that Torrent Ducks are using these cleaner, less impacted streams as well as the more heavily impacted and more visible Río Pilatón. Torrent Ducks were reported to frequent the side stream which enters at Site #1 on the Pilatón more than the main river (Validivieso 2006) where a pair was observed informally after the completion of point counts on the Pilatón.

Along all of the rivers studied there were large numbers of side streams of varying sizes feeding into the main rivers. These streams seem to have less development along them perhaps due to the steeper incline and distance from main road. During the oral questionnaires, many side streams were reported (see Appendix IV) to support Torrent Ducks. These smaller streams may not be preferential habitat, but populations seem to be quite healthy within these streams from the results of the questionnaire. It is possible that either Torrent Ducks are periodically displaced into these side streams by disturbances

such as the sulfuric acid spill or they have vacated the main rivers over time for these smaller remote areas to escape the stresses of more developed areas.

The final aspect of development studied was disturbance. Two rivers, the Quijos and the Toachi had high frequencies of environmental disturbance throughout recent years. In comparison to their geographic counterparts, the Cosanga and Pilatón respectively, they have lower Torrent Duck population densities as well. The Quijos and the Toachi, both have a consistent history of petroleum and/or chemical spills as reported locally in oral questionnaires. On the Quijos, a break in the OCP pipeline within the last ten years (exact year not know) was reported by all three sources. The proximity of the Toachi to the major Santo Domingo Road results in a high frequency of petroleum and chemical spills including the recent sulfuric acid spill (Balseca Ortiz 2006). Though from field observations it is clear that Torrent Ducks are able to avoid spills, a pair was observed less than a kilometer from the site of the recent sulfuric acid spill less than a month afterwards. It is possible that with little effort a pair of Torrent Ducks could avoid a spill for a period of time by leaving for a cleaner side stream or upstream of a spill for a period of time and returning to their normal territory, when the danger has passed. Low population densities from both the Quijos and Toachi would suggest that prolonged stress might result in migration to another stream or a decline in population density.

The questionnaire data collection method, though important, could be a large source of bias and error. Participants frequently had a difficulty quantifying their observations and occasionally it seemed that comments or information were given in response to assumptions made about the interviewer rather than accounts of actual experience. On the Toachi a significant source of error was the frequent confusion between Neotropical Cormorants and Torrent Duck. The data from the Toachi should be revised with an effort to eliminate and focus the questionnaire solely on the Torrent Duck. Confusions due to the language differences are also possible. The email questionnaires also had a definite bias since all four were not members of local communities and had a clear pro-conservation attitude. Finally the uneven distribution of information about the four different sites makes comparisons difficult and less significant.

POSSIBILITIES FOR CONSERVATION AND FUTURE STUDY

Conservation of rare species is difficult task, but a rare species which is threatened by a force as indefinable as development and disturbance or as broad as deforestation can be a difficult cause to pursue. A few different possibilities for conservation were proposed by different sources throughout the questionnaire process. Habitat conservation and measures to decrease deforestation are two incredibly important aspects of any conservation plan for the Torrent Duck, particularly focusing on prevention of erosion and pollution of river habitat. Two other important aspects of a conservation plan in Ecuador are ecotourism and formal recognition of the threatened status of the Torrent Duck in Ecuador.

Ecotourism was first mentioned as a solution to the decline of the Torrent Duck by Enma Palacios Tinoco (2006) during an explanation of hunting of the Torrent Duck in the area around the town of Cosanga. Her reasoning was that if tourists will pay money to come to Cosanga to see this duck, then it must be something worth conserving. The Torrent Duck is certainly an enthralling species to see. Known as the white-water kayaker of the bird world, it is one of only a few torrential aquatic birds. The nimble grace of its movements never loses its appeal. During oral questionnaires, local residents would often account while beaming the swimming, foraging, and resting of this beautiful bird. Birding tourists in particular can bring a great deal of money into a community. Through ecotourism a monetary value can be put to the existence of a Torrent Duck population, rather than the more intangible value of existence (Vogel 1996). Particularly in the impoverished rural areas where Torrent Ducks are frequently found, even minor birding tourism would be a great boost to the local economy increasing support for the duck population from residents. Ecotourism would also give residents an incentive to stop local pressures on duck populations such as hunting and pestering by the local population. The hope with ecotourism is that it brings money into a community which allows that community to improve its economic standing. Economically stable communities are then able to put money and effort towards more sustainable development. The usual criticism of ecotourism is that increased human traffic damages the very species which is being viewed and conserved. The results of this study suggest

that Torrent Ducks are not impacted by human traffic and are certainly tolerant of viewing from a separated area such as a bridge.

Another source of significant mobilization for conservation of the Torrent Duck is the ornithological and environmental community. Freile (2006) noted that a past campaign to place the Torrent Duck in the Red Book of Ecuador, giving it the status of "Near Threatened", failed. If the scientific and environmental community recognizes the threat to the Torrent Duck, funds and aid will be more forthcoming to help conserve more pristine habitats and slow deforestation in areas where Torrent Ducks are still in high densities. Due to the unstable economic conditions of Ecuador, funds for conservation and research must be sought outside of the country. Lack of global awareness about the Torrent duck, because of its non-migratory status, make publication of and further research on the status of the Torrent Duck even more important to obtain funding (Green 1996).

The Torrent Duck is a species which demands further study for its own fascinating habitat and behaviors. Continuation of Naranjo and Avila's (2003) analysis of behaviors, territory size and competition is necessary especially throughout the range of both the Torrent Duck and the subspecies *M. armata colombiana.* Transect studies looking at territory size and population density would also be an important source of information. In continuation of this study, a broader look at the status of *M. armata colombiana* throughout Ecuador is important as well as an expansion of information gathered throughout Ecuador on the Torrent Duck. Examination of river and stream size in relation to Torrent Duck density is also needed both to confirm the use of side streams by Torrent Ducks and determine what habitat requirements the Torrent Duck has. Another possible study would be examining the effects of oil and chemical spills on Torrent Ducks with observation at the time of the spill and follow up analysis months and years afterwards to detail the effects over time on Torrent Duck populations. The effects of repetitive spills would be another type of disturbance that could be examined. Finally, a look at the impact of the growing rafting and kayaking industry on Torrent Duck populations as suggested by Maria Pozo (2006). Further study is greatly needed of this possibly threatened species to further examine population size, behavioral habits, and the effects of development and disturbance.

ACKNOWLEDGEMENTS

Special thanks to my project advisor, Charlie Vogt for giving me the chance to pass my days with such an amazing bird. Also to Sylvia Seger and Xavier Silva, my professors and the hard working academic directors of the SIT Ecuador CEC program. Thanks to SIT/World Learning Inc. and Macalester College for this amazing life opportunity. Muchisimas gracias a la familia Cazar-Baqueros y Gladys Pilataxi Coyago por toda su ayuda con mi proyecto y sus amistades. Also to Rodrigo Morales Vega, Alexandra and Juan Pablo, la Estación Biologica La Hesperia, Mario Balseca Ortiz, all of the questionnaire participants, and endless number of people who helped me throughout my project.

FIGURES AND TABLES

	Cumulative No. Visits	Cumulative Census Time (hrs)	Estimated No. of Residents	Cumulative Time of Direct Obs. (hrs)
Cosanga	17	29.67	6	7.08
Quijos	18	25.37	4	1.13
Pilatón	6	12.15	3	1.18
Toachi	6	10.67	2	0.03

TABLE 1: **Summary of the results of point census of the Torrent Duck in four rivers**. First column: Cumulative number of visits to all three sites for each river location., Second column: Cumulative hours spent in point census at all three sites for each river location., Third column: Estimated number of resident individual ducks in census area, Fourth column: Cumulative hours of direct observation of Torrent Ducks.

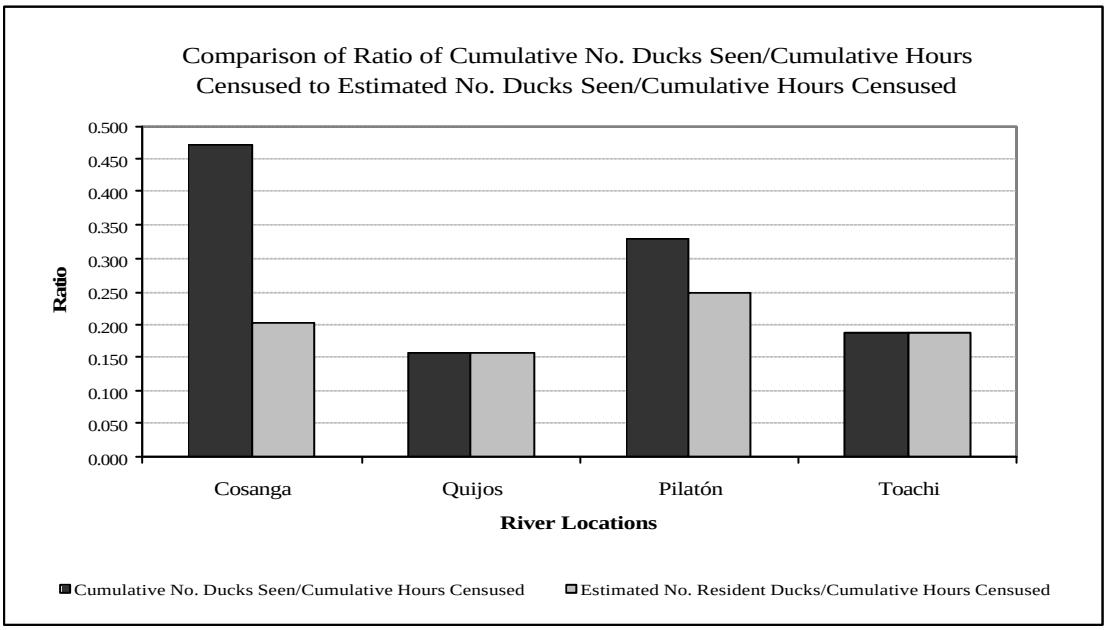

FIGURE 1: **Comparison of Ratio of Cumulative No. Ducks Seen/Cumulative Hours Censused to Estimated No. Ducks Seen/Cumulative Hours Censused.** Ratio method used to compare number of ducks seen in sites with drastically different census times. Comparison between the two methods for counting Torrent Ducks seen to eliminate bias towards preferred sites where the same ducks returned multiple times (eg. the Cosanga sites).

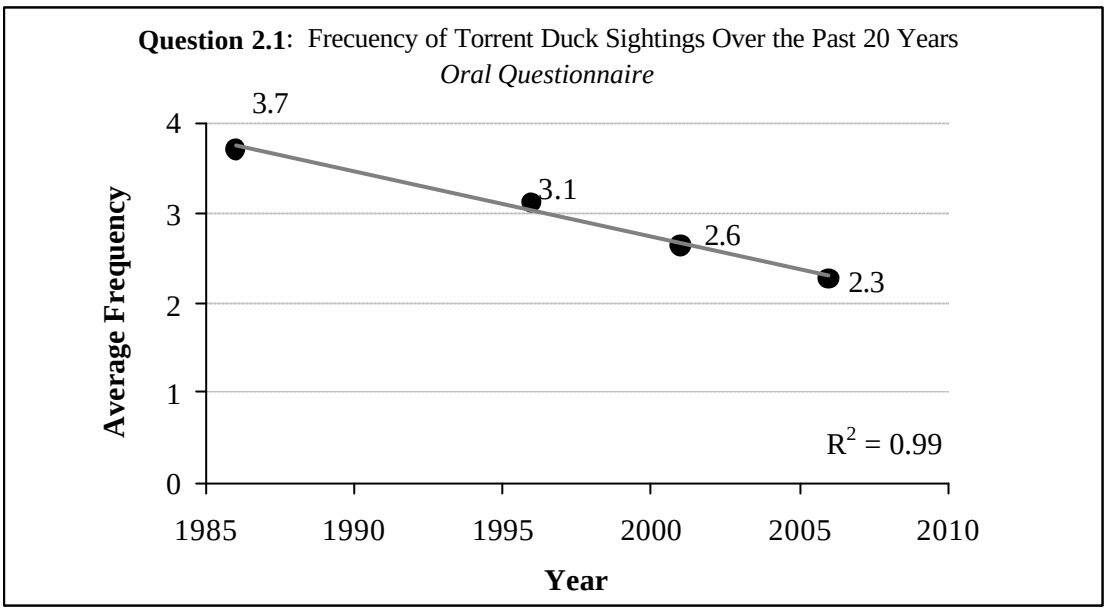

FIGURE 2 : **Frequency of Torrent Duck Sightings Over the Past 20 Years, *Oral Questionnaire.*** "How often did you see Torrent Ducks in appropriate habitat 20 years ago, 10 years ago, 5 years ago, and recently?" *Frequency Scale*: (4) *Very Common*, seen everyday when visited, 10 sightings/10 visits; (3) *Common*, seen most days when visited, 6-9 sightings/10 visits; (2) *Uncommon*, seen few days when visited, 2-5 sightings/10 visits; (1) *Rare*, hardly even seen when visited, 1 or less than 1 sightings/10 visits; (0) *Never* Seen.

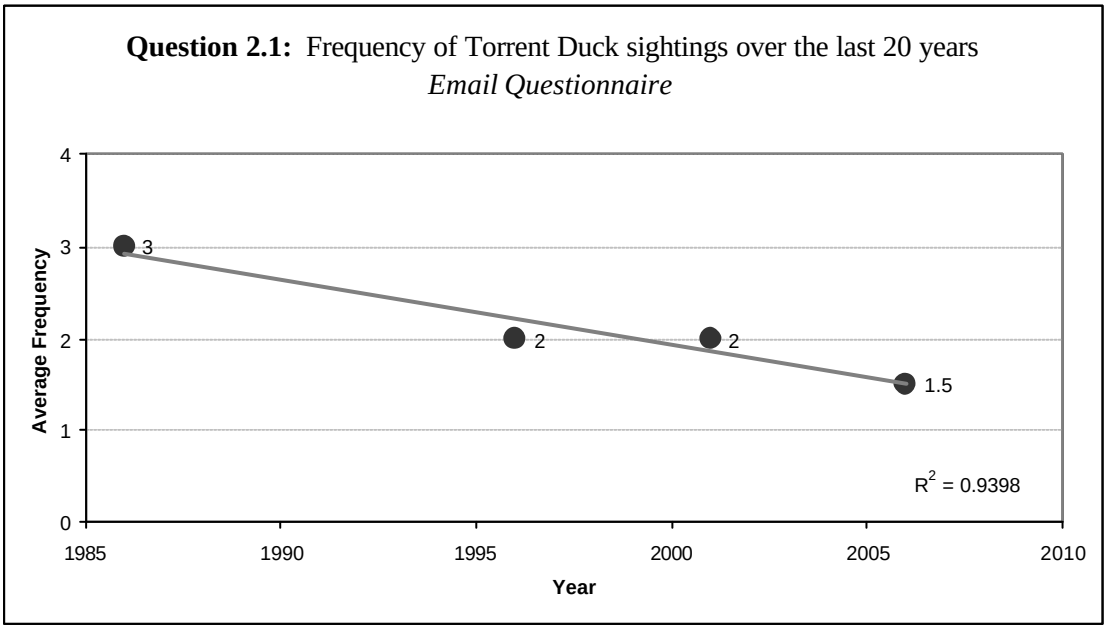

FIGURE 3 : **Question 2.1: Frequency of Torrent Duck Sightings Over the Past 20 Years, *Email Questionnaires.*** "How often did you see Torrent Ducks in appropriate habitat 20 years ago, 10 years ago, 5 years ago, and recently?" *Frequency Scale*: (4) *Very Common*, seen everyday when visited, 10 sightings/10 visits; (3) *Common*, seen most days when visited, 6-9 sightings/10 visits; (2) *Uncommon*, seen few days when visited, 2-5 sightings/10 visits; (1) *Rare*, hardly even seen when visited, 1 or less than 1 sightings/10 visits; (0) *Never* Seen.

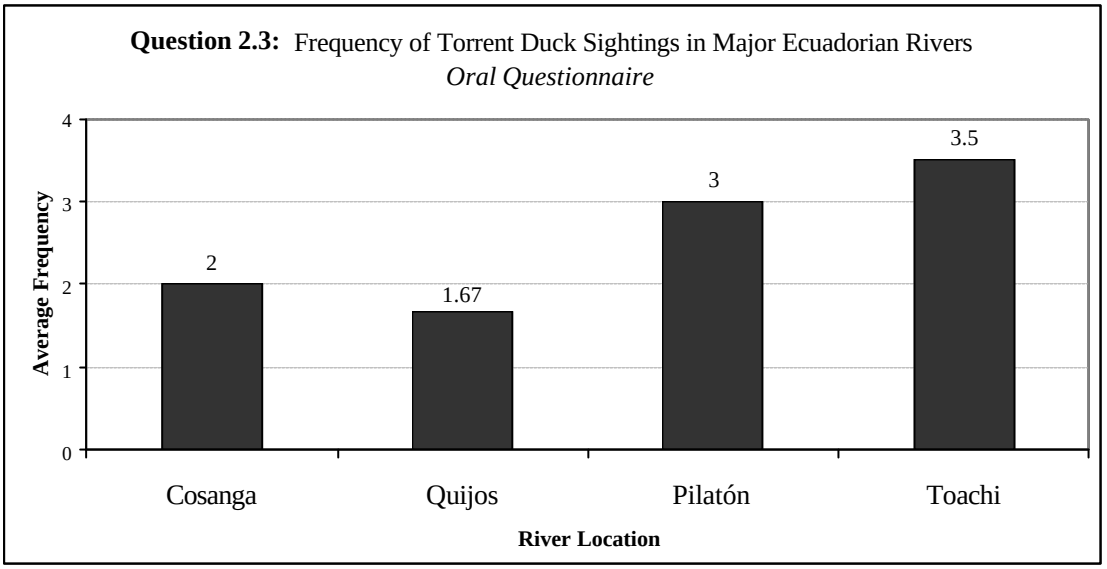

FIGURE 4 : **Question 2.3: Frequency of Torrent Duck Sightings on Major Ecuadorian Rivers, *Oral Questionnaire*.** "How often do you see torrent ducks on the following rivers in Andean Ecuador? Be sure to include on which rivers you **never** see Torrent Ducks." *Frequency Scale*: (4) *Very Common*, seen everyday when visited, 10 sightings/10 visits; (3) *Common*, seen most days when visited, 6-9 sightings/10 visits; (2) *Uncommon*, seen few days when visited, 2-5 sightings/10 visits; (1) *Rare*, hardly even seen when visited, 1 or less than 1 sightings/10 visits; (0) *Never* Seen.

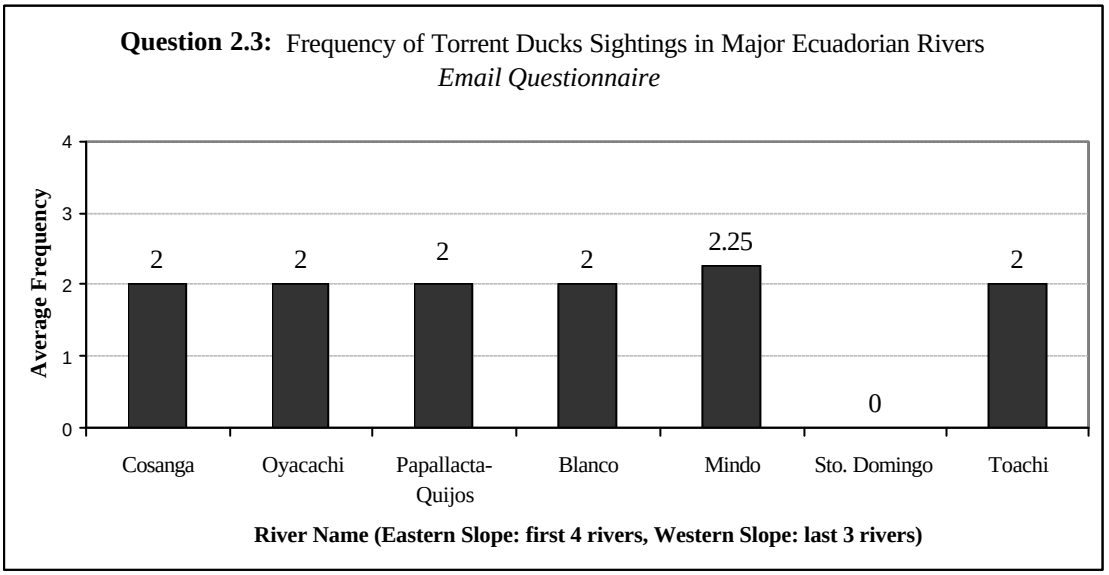

FIGURE 5 : **Question 2.3: Frequency of Torrent Duck Sightings on Major Ecuadorian Rivers, *Email Questionnaires*.** "How often do you see torrent ducks on the following rivers in Andean Ecuador? Be sure to include on which rivers you **never** see Torrent Ducks." *Frequency Scale*: (4) *Very Common*, seen everyday when visited, 10 sightings/10 visits; (3) *Common*, seen most days when visited, 6-9 sightings/10 visits; (2) *Uncommon*, seen few days when visited, 2-5 sightings/10 visits; (1) *Rare*, hardly even seen when visited, 1 or less than 1 sightings/10 visits; (0) *Never* Seen.

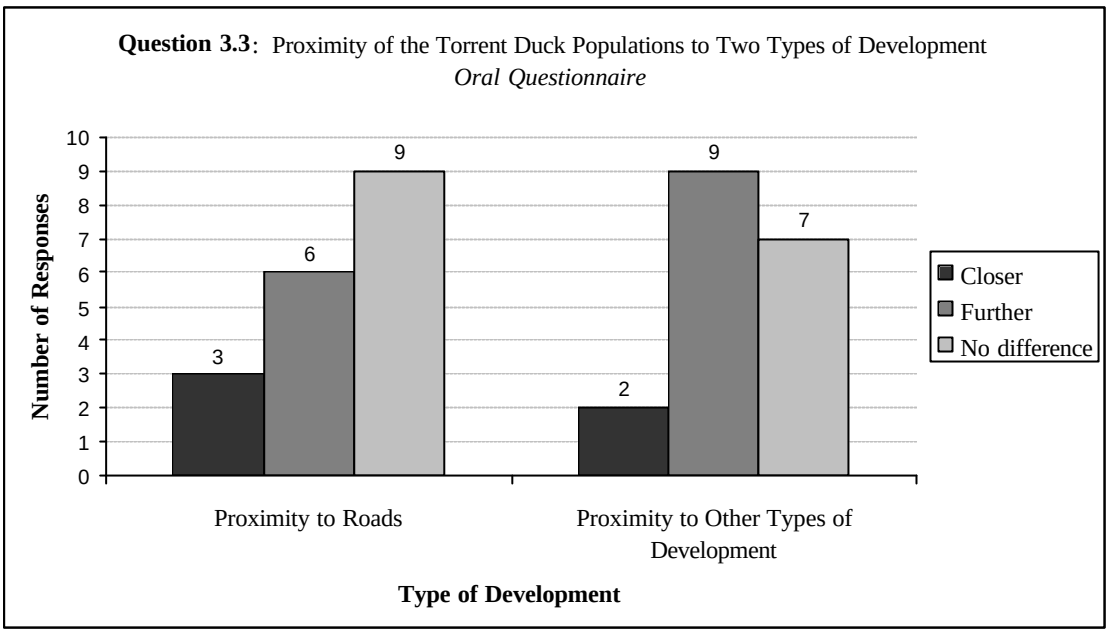

FIGURE 6 : **Question 3.3: Proximity of the Torrent Duck Populations to Two Types of Development, *Oral Questionnaires*. "**On a whole when you see Torrent Ducks are they closer or further from roads? Developed areas, such as farms, town areas, industry, etc…?"

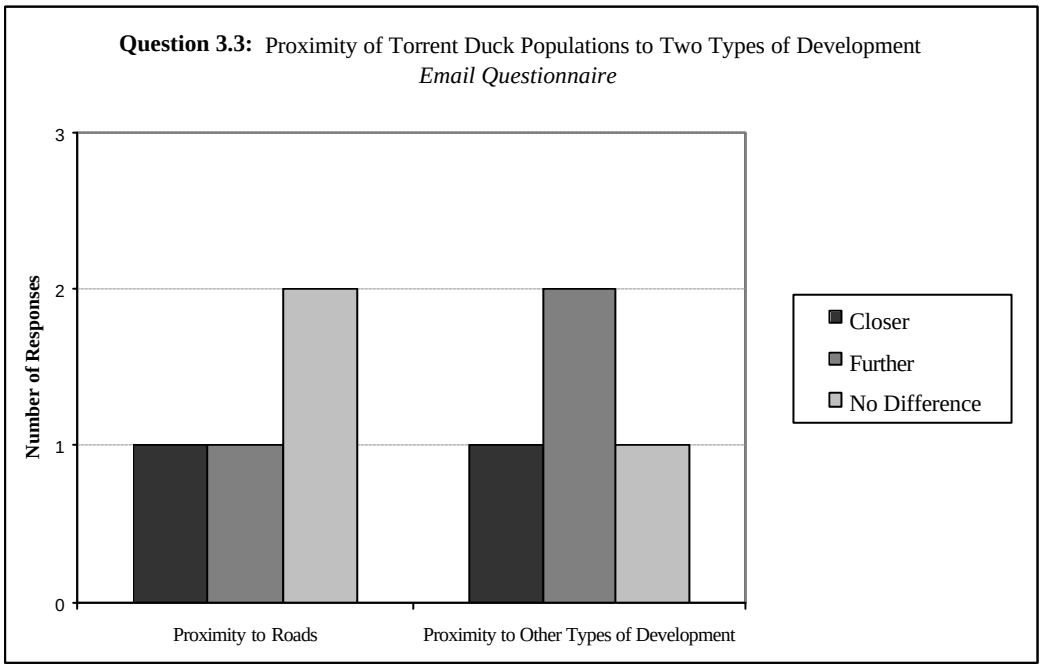

FIGURE 7 : **Question 3.3: Proximity of Torrent Duck Populations to Two Types of Development, *Email Questionnaires*. "**On a whole when you see Torrent Ducks are they closer or further from roads? Developed areas, such as farms, town areas, industry, etc…?"

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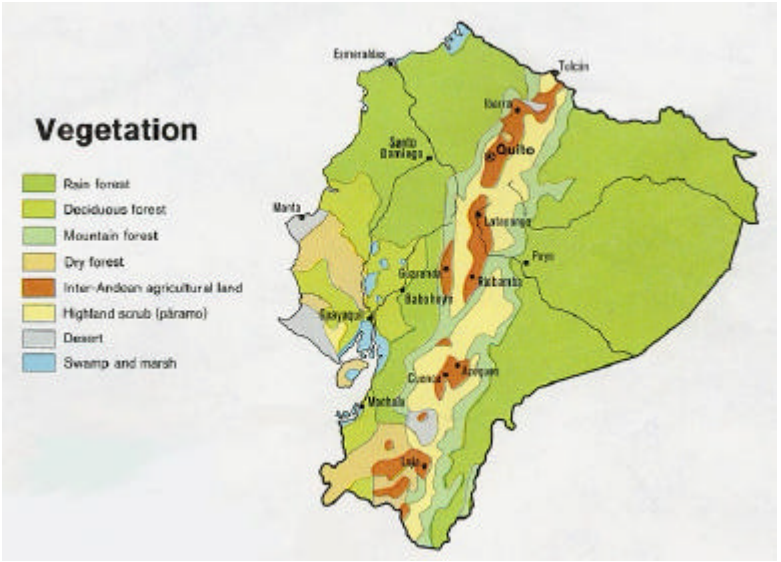
APPENDIX I: *Observation of Piscivory in Torrent Ducks on the Río Pilatón*

At the Río Pilatón Site #2, a concrete bridge crossing the Pilatón at the turnoff to Chitoa from the Santo Domingo Road, on 1 May 2006 at 13:52, a male adult Torrent Duck was seen eating a small fish. The event occurred between 20m and 10m from the point of observation. A pair of Torrent Ducks was observed foraging and moving upstream for 17 minutes previous to the sighting. This observation is notable since fish is not considered a major part of the Torrent Duck's diet. Hilty and Brown (1986) and Fjeldsa and Krabbe(1990) both describe a diet made up of aquatic invertebrates only, while both Ridgely and Greenfield (2001) and del Hoyo (1992) mention that fish is a possible part of the diet. The event occurred as follows.

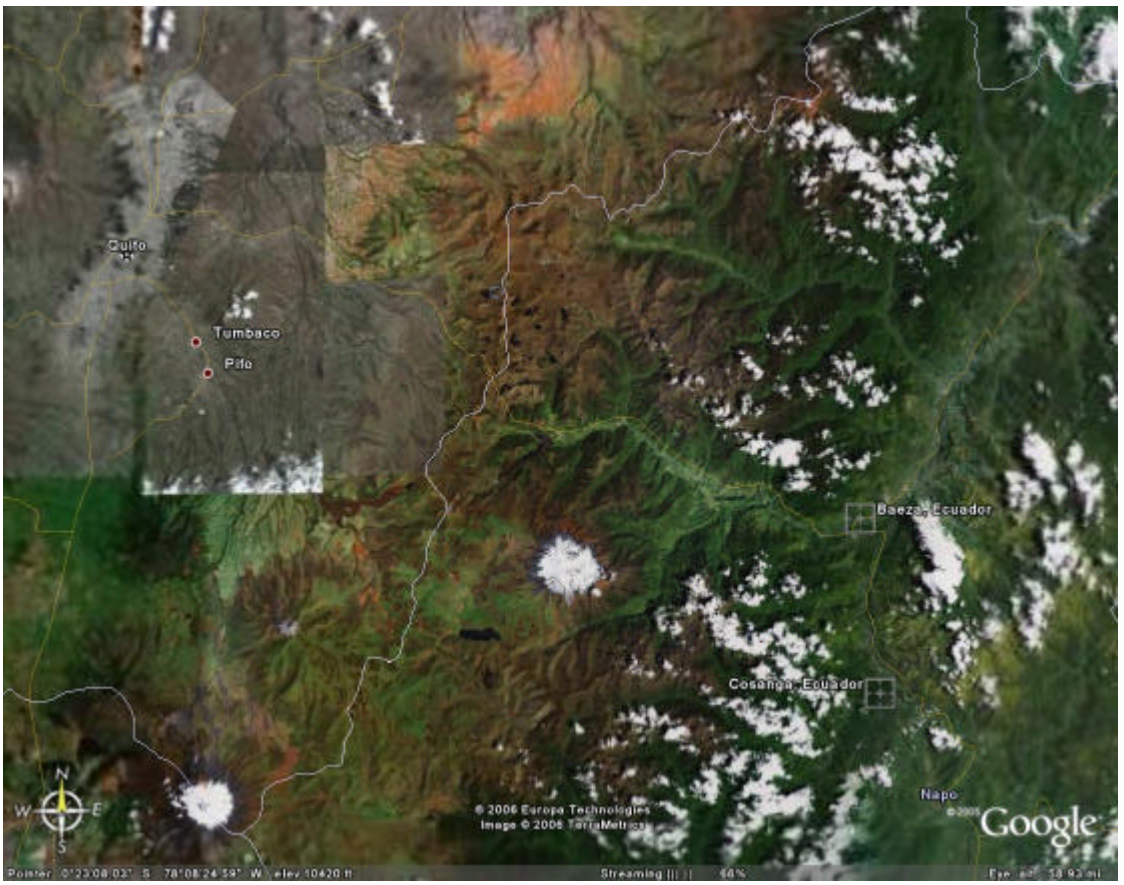
> 1:50 *Male and female begin to solely travel upstream without foraging. Climbing over rocks and swimming. Female is 20m downstream.*
> 1:51 *Pair moving upstream by accelerated swimming.*
> 1:52 ***Male climbs up onto a rock on the non-road side of the river with small fish in his mouth. Male shakes head back and forth to hit fish against rock for about 20 seconds. Fish is relatively still and male swallows fish. Shakes head up and down seemingly to aid in swallowing the fish.*** *Pair continues to move upstream.*

APPENDIX II: *Reference and Site Maps*

MAP 1: **Physical Reference Map of South America.** From the Central Intelligence Agency. Accessed 10 May 2006 through Google.com. http://www.odci.gov/cia/publications/factbook/reference_maps/south_america.html. Ecuador's location is highlighted.
MAP 2: **Physical Reference Map of Ecuador.** Created by the Central Intelligence Agency(1991). Accessed on 10 May 2006 through Google.com. http://209.15.138.224/ecuador_maps/m_ecuador_rel91x.htm. Study area in the Northern secton of the Andes which passes directly through the center of the country.



MAP 3: **Vegetation Map of Ecuador**. Created by the Central Intelligence Agency (1991). Accessed 10 May 2006 through Google.com. http://209.15.138.224/ecuador_maps/m_ecuador_veg_1973x.htm. Study area consisted of cloud forest, noted on this map as "Mountain Forest".



MAP 4: **Two Eastern Sites of the Río Cosanga and Río Quijos**. The Cosanga runs South to North and meets with the Quijos East of Baeza. The Quijos unites with the Río Papallacta and runs West to East past Baeza.

APPENDIX III: *Questionnaire, English Version*

Questionnaire on the Torrent Duck (*M. armata*) in Northern Andean Ecuador

for Elizabeth Goldsmith
Project Advisor, **Charlie Vogt**

This questionnaire is available in Spanish or English. Please use whichever language is most comfortable. This questionnaire will be used in a final paper on an independent study project for an SIT: Ecuador Comparative Ecology and Conservation, a university level study abroad program, titled "The Effects of Roads, Disturbance, and Deforestation on the Torrent Duck (*M. armata)* in Northern Andean Ecuador". Please answer all questions to the best of your knowledge. All information is helpful, so please feel free to add as many comments, thoughts, ideas, or anecdotes as possible in the final section. Please return questionnaires by May 7, 2006 via email to ewgoldsmith@gmail.com or via post to:

Elizabeth Goldsmith
c/o El Experimento de Convivencia Intemacional del Ecuador
Hernando de la Cruz N31-37 y Mariana de Jesús
Quito, Ecuador

Please send questions or comments to ewgoldsmith@gmail.com. I will be in the field from April 17, 2006 to May 7, 2006. Please note that any information given in this survey could be used in the independent study project paper and future publications.

Thanks again for your time and knowledge,
Elizabeth Goldsmith

Part I: Participant's Personal Information

Name:_____

Date of Survey Completion:_____

Occupation:_____

If not an Ecuadorian citizen, time in Ecuador:_____

Country of Citizenship:_____

Address:_____

Email:_____

Telephone:_____

Would you be interested in receiving a copy of the final results?_____

Part II: Amount of Torrent Duck Sightings

All responses are on a scale of 4-0: Very Common(4) to Never(0). NA if Not Applicable.

Scale Description

4 Very Common, seen everyday when visited, 10 sightings/10 visits
3 Common, seen most days when visited, 6-9 sightings/10 visits
2 Uncommon, seen few days when visited, 2-5 sightings/10 visits
1 Rare, hardly even seen when visited, 1 or less than 1 sightings/10 visits
0 Never Seen
NA Not Applicable

1. How often did you see Torrent Ducks in appropriate habitats…

   a) …20 years ago?

   4 **3** **2** **1** **0** **NA**

   b) …10 years ago?

   4 **3** **2** **1** **0** **NA**

   c) …5 years ago?

   4 **3** **2** **1** **0** **NA**

   d) …Recently?

   4 **3** **2** **1** **0** **NA**

2. Of the times you see Torrent Ducks, how often do you see…

   a) …A single duck?

   4 **3** **2** **1** **0** **NA**

   b) …A group(non-mating pair)?

   4 **3** **2** **1** **0** **NA**

   c) …A mating-pair(a male and a female)?

   4 **3** **2** **1** **0** **NA**

   d) …Juveniles?

   4 **3** **2** **1** **0** **NA**

e) When you see juveniles, on average how many do you see? _____

3. How often do you see torrent ducks on the following rivers in Andean Ecuador? Please use the previous 4-0, NA scale. Be sure to include at which rivers you **never** see Torrent Ducks.

_____Río Papallacta **_____Río Cosanga**

_____Río Oyacachi **_____Río Toachi**

_____Río Santo Domingo **_____Río Blanco**

_____Río Mindo **_____Other** (specify river name below)

_____

4. Overall, would you say is the general trend of Torrent Duck populations today?

Steady **Increasing** **Decreasing**

5. Have you noticed a decline in the Torrent Duck population following a major environmental catastrophe, such as major landslides, oil spills, or other major river contamination? **Yes** **No**

If yes, on what river? _____

Please give details about the event._____

_____

_____

Part III: Observed Torrent Duck Behaviors

1. What behaviors are most commonly exhibited by Torrent Ducks when sighted?

Foraging **Preening** **Calling** **Mating** **Resting**

Flying **Swimming** **Other**_____

2. Have you noticed any behavioral changes over the past years? If yes, please explain.

_____

_____

_____

3. On a whole when you see Torrent Ducks are they closer or further from…

a) ….Roads?

No difference **Further** **Closer**

b) …Developed areas, such as farms, town areas, industry, etc…?

No difference **Further** **Closer**

4. Have you noticed disturbance, such as increased human visitation or nearby development, affecting Torrent Duck populations drastically? **Yes** **No**
Please explain the disturbance observed. _____

_____

_____

5. Have you ever observed attempted or successful predation on Torrent Ducks by hawks, cats, dogs, fox, etc…? **Yes** **No**
If yes, please detail the observed incident._____

_____

_____

Part IV: Local Perceptions of Torrent Ducks

1. Have you ever heard reports of hunting of Torrent Ducks? **Yes** **No**

If so, for what purpose (subsistence, sport, diet supplement, medicinal use)?

_____

_____

2. Any other local uses of the Torrent Duck population?

_____

_____

_____

3. What is the attitude of the local population towards Torrent Ducks?

_____

_____

_____

4. Do you know of any mythology or traditional stories/beliefs about Torrent Ducks?

_____

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_____

Part V: Further Comments/Thoughts/Anecdotes

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APPENDIX IV: *List of Rivers and Streams with reported Torrent Duck Populations*

Frequency Scale: (4) *Very Common*, seen everyday when visited, 10 sightings/10 visits; (3) *Common*, seen most days when visited, 6-9 sightings/10 visits; (2) *Uncommon*, seen few days when visited, 2-5 sightings/10 visits; (1) *Rare*, hardly even seen when visited, 1 or less than 1 sightings/10 visits; (0) *Never* Seen. *Some confusion between the Neotropical Cormorant and Torrent Duck occurred in this interview.

River Name	Frequency Rating
Cosanga Area	
Arenilla	2
Chontas	2
Cosanga	1.86
Pumayaco	1
Vermejo	2
Yanuyacu	2,1
Baeza Area	
Chalpi	3
Papallacta	1
Quijos	1.67
La Eperie Area	
Achitoa	?
Pilatón	3
Santana	4
Tandapi	2
Alluriquin Area	
Baba	4
Dorado	4
Lelia	1
Meme	4
Mulatuta	4
Quininde	4
San Gabriel	4
Tanti	1
Toachi	3.25
Other Areas	
Blanco	3
Cinto	2
Guayabamba	4
Hollin	1
Mindo	2.33
Nambillo	2
Naranjal	4
Oyacachi	1.67
Saloya	1

APPENDIX V: *Photographs, Elizabeth Goldsmith*

Photo 1: **Pair of Torrent Ducks resting on boulder**. Río Cosanga: Site #3, 21 April 2006

Photo 2: **Pair of Torrent Ducks Swimming**. Río Pilatón: Site #2, 1 May 2006.

***Photo 3*: Male Torrent Duck swimming**. Río Pilatón: Site #2, 2 Mayo, 2006

***Photo 4*: Male Torrent Duck swimming**. Río Pilatón: Site #2. May 2, 2006

Photo 5: **Male Torrent Duck climbing boulder**. Río Pilatón: Site #2. May 2, 2006.

Photo 6: **Male Torrent Duck flying over rapids**. Río Pilatón: Site #2. May 2, 2006.