On the Occurrence and Damage of the Invasive Nutria (*Myocastor coypus* Molina, 1782) in Palestine

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Abstract

The Nutria or Coypu (Myocastor coypus Molina, 1782) is one of the invasive vertebrate species residing in and near some aquatic habitats of Palestine (27,000 km²) and other neighboring countries. The animal was said to be introduced from Chile, South America, into Palestine by fish farmers for fur production in the early 1950s. It was released into many aquatic ecosystems for economic and ecological reasons, but it was proved to cause damage to agriculture, wildlife and other human properties. Hence, the current descriptive study comes to give notes on the occurrence and dangers of the invasive Nutria in Palestine. The study, which lasted three years (July 2018 – June 2021), was based on many procedures to satisfy its purposes. Frequent field visits, direct observations and photography, meetings and discussions with stakeholders, and fellow-up of local news and social media sites were common tools used throughout the succeeding stages of the study. The current study shows that the Nutria happens in great parts of northern and central and coastal Palestine, including the Hula Lake, the Jordan River and its tributaries, and many valleys of Palestine. Specimens of the animal caught from northern Wadi Arabah and Negev Desert as well. In spite of their polluted waters, Wadi Al-Muqatta in northern Jenin, West Bank, and the lower Jordan River harbor a population the invasive Nutria. The Nutria does not occur in the Gaza Strip and the three live specimens of the animal incidentally fell into fishing nets in 1997 seemed to come from Ashkelon; the closest city in the Palestinian land occupied by Israel since 1948. As far as the dangers of the invasive Nutria in Palestine are concerned, they include herbivory and destruction of aquatic plants, attack and feeding on agricultural crops, creation of "eat-outs" areas which is harmful to many freshwater animals including the Caspian Terrapin (Mauremys caspica), use of and disturbance to many water birds nests, competition with the Eurasian Otter (Lutra lutra), damages of burrowing behavior of Nutria to banks along waterways and other human properties, and aggressiveness towards humans and pets. Many measures have been applied to control the Nutria in Palestine. The role of the Palestinian carnivorous mammals in controlling the Nutria should be respected.

Keywords: *Nutria, Myocastor coypus, aquatic habitats, Hula Lake, Jordan River, Wadi Al-Muqatta, dangers, control measures, Palestine.*

1. Introduction

Palestine (27,000 km²) harbors more than 100 terrestrial mammalian faunistic species living in diverse ecosystems and habitats extending from north to south and from east to west (Qumsiyeh, 1996). Order Rodentia (rodents) makes up a large part of the Palestinian mammalian fauna because it is considered the largest among the existing mammalian orders worldwide (Boitani and Bartoli, 1983 and Harrison and Bates, 1991). Of the Palestinian rodents, two are considered the largest. The first inhabits several terrestrial environments, including dry and rocky ones, and is called the Indian Crested Porcupine (*Hystrix indica* Kerr, 1792), while the other, which is invasive (alien, exotic, or non-indigenous), resides in and near water bodies, lakes, wetlands, swamps, ponds, rivers and streams and is called the Nutria (*Myocastor coypus* Molina, 1782). The Nutria, which belongs to Echimyidae family, has many common or English names such as Coypu or Giant Swamp Rat or River Rat or Beaver Rat (Khalaf, 2022a). The animal is nominated among one of the 100 of the “world’s worst invaders” and is considered as a pest for numerous countries where it has been introduced (Bertolino et al., 2005; Bertolino and Genovesi, 2007; Bertolino and Ingegno, 2009). It is one of the largest Palestinian fresh water mammals, beside the Eurasian Otter (*Lutra lutra* Linnaeus, 1758) as pointed out by Ferguson (2002) and Khalaf (2020 and 2022b). It is a large herbivorous and semi-aquatic rodent that is native to subtropical and temperate South or Latin America, and has since been introduced to other continents such as North America, Europe, Asia and Africa, mainly by fur farmers (Qumsiyeh, 1996). It lives in burrows along with stretches of water, and feeds on stems of riparian plants (Prigioni et al., 2005). In spite of its value as a source of good fur (Saadoun et al., 2006), its destructive digging and feeding habits often bring it into conflict with humans (Moran, 1981 and 2003), and as a result, it was considered in many nations as an invasive and pest species that needs control (Carter and Leonard, 2002; Verbeylen, 2002; Bertolino et al., 2005).

Adult Nutria, usually weighs 4-9 kg, has a body length of 40-60 cm, and a tail of 30 to 45 cm. It has a dark brown coarse outer fur with a soft dense gray under the fur (Boitani and Bartoli, 1983). The animal is distinguished by its large bright orange and

yellow incisors, and its hind feet are webbed as a requirement for aquatic life. The nipples of female Nutria are high on either side, to allow her young to feed while the female is in the water. Besides its quick breeding biology (Qumsiyeh, 1996), the Nutria consumes large quantities of plants. An individual consumes about 25% of its body weight daily, and feeds throughout the year. They eat the base of the above-ground stems of plants, often digging into organic soil in search of roots and rhizomes. Nutria inhabits natural and man-made wetlands including freshwater marshes, brackish marshes and rarely salt marshes (Lyon and Milliet, 2000). Nutrias either build their own burrows, or occupy burrows that have been abandoned by beavers and other animals. They are also capable of building floating rafts of vegetation (Lyon and Milliet, 2000).

Worldwide, there was a development of Nutria fur farms in the late 19th and early 20th centuries in many countries. From these farms, Nutria often escaped, or was deliberately released into the wild to provide a game animal or to remove aquatic vegetation (Carter and Leonard, 2002). In Uruguay and other countries, the Nutria has long been used for human food, after being trapped for its fur. Both fur and meat production is now increasing and new fresh, frozen and processed meat products are appearing commercially (Tulley et al., 2000 and Saadoun et al., 2006). In the United States of America (USA), the meat of Nutria was used for dog food products. In many regions of the world, the Nutria has become a pest due to its destruction of aquatic plants, marshes, swamps, and irrigation systems, chewing of man-made materials like wooden house panels, eroding river banks, and displacing native or indigenous animals. From a medical point of view, the Nutria hosts a nematode parasite (*Strongyloides myopotami*) that can infect the skin of humans, causing dermatitis or "Nutria Itch" similar to strongyloidiasis (Bonilla et al., 2000).

Studies on the biology, parasitology, ecology, and control of the Nutria were diverse and seemed to be extensive worldwide. The occurrence of the invasive Nutria was documented in various locations of the world (Purger and Kristufek, 1991; Özkan, 1999; Baroch et al., 2002; Bounds, 2000; Carter and Leonard, 2002; Murariu and Chisamera, 2004; Bertolino and Genovesi, 2007; Roll et al., 2008 and Adamopoulou and Legakis, 2016). However, the majority of the studies surveyed were found to

concentrate on the ecology and biology of the Nutria in the ecosystems it inhabits or invades (Gosling et al, 1988; Doncaster and Micol, 1989; Reggiani al., 1995; Taylor and Grace, 1995; Borgnia et al., 2000; D'Adamo et al., 2000; Lyon and Milliet, 2000; Tulley et al., 2000; Bollo et al., 2003; Guichón et al., 2003a and b; Meyer et al., 2005; Prigioni et al., 2005; Corriale et al., 2006; Saadoun et al., 2006; Bertolino and Ingegno, 2009; Gabrey et al., 2009; Nolfo-Clements, 2009; Salsamendi et al., 2009; Bertolino et al., 2011 and 2012; Marini et al., 2011; Robert et al., 2013; Farashi and Najafabadi, 2015; Hong et al., 2015; Gruychev, 2017; Jarnevich et al., 2017; Radoslav et al., 2017; Kawamura et al., 2018; and Kim et al., 2019). Because of its pest status to both wild and agricultural plants in addition to other human properties, and due to its negative impacts on other wildlife species; mainly aquatic species, the Nutria was controlled and eradicated. Accordingly, the studies regarding the control and management of the species seemed to be extensive and intensive. They escalate day by day in most of the countries harboring the invasive Nutria (Evans and Ward, 1967; Norris, 1967; Evans, 1970; Baker and Clark, 1988; Bo et al., 1994; Carter and Leonard, 2002; Verbeylen, 2002; Bertolino et al., 2005; Panzacchi et al., 2007; Bertolino and Viterbi, 2010 and Walther et al., 2011). Based on the previously mentioned studies, it appears that the work on the Nutria began in the late 1960s, after its problem worsened in the countries in which it invaded or settled.

Particular studies on the biology, ecology and control of the Nutria in the Middle East countries seemed to be limited and not extensive. In Israel, the Nutria is one of the invasive mammalian species occupying different aquatic habitats including the Hula Lake Hula and its associated Agmon wetland (Dimentman et al., 2012 and Meiri et al., 2019). The Nutria was introduced into Israel by fish farmers from Chile for fur production in the early 1950s (Bodenheimer, 1958) and for economic reasons they were released into the Jordan River (Roll et al., 2008). According to Mendelssohn and Yom-Tov (1999), the animal was also introduced into fish ponds to control reeds, but it proved to cause damage to fish pond dikes due to its burrowing behavior. The Nutria was mentioned among the vertebrate fauna causing damage to agriculture and plastic irrigation pipes (Moran, 1981 and 2003 and Moran and Keidar, 1993). It was one of a long list of wildlife species poached and hunted by guest Thai workers for food purposes (Yom-Tov, 2003). In the Hashemite Kingdom of Jordan or simply

Jordan, which is the closest country to Palestine, Khoury et al. (2012) indicated that the Nutria is one of eight mammals introduced into the country from abroad. The Nutria is the only species of introduced mammals that expands its range of distribution and is known to occur in the major permanent water bodies of Jordan (Amr, 2000 and 2012) including the Jordan River (Potts, 2011 and 2018). The animal was monitored along the Jordan, Yarmouk and Zarqa Rivers. Khoury et al. (2012) mentioned that a specimen was brought from the northern mouth of the Dead Sea; a salt lake lying between Palestine and Jordan. In Turkey, Kryštufek and Vohralík (2009) listed the Nutria as one of the main invasive mammals. Özkan (1999) recorded the Nutria in the European part of Turkey. Iliker et al. (2009) studied the C-band patterns of chromosomes of the Nutria and they found that the karyotype of the species is comprised of (2n) 42 chromosomes.

The Nutria was introduced to Palestine during the 1950s (Mendelssohn and Yom-Tov, 1999). In the West Bank of Palestine, the animal seems to exist in the northern governorate of Jenin in addition to the Jordan River. Faunal surveys in the other governorates of the West Bank have nothing to mention regarding the animal (Qumsiyeh, 2016). In the Gaza Strip, which lies at the southern part of the Palestinian coast along the eastern shore of the Mediterranean basin, no traces or literature confirmed the normal occurrence of the animal. However, many local studies highlighted the accidental occurrence of the animal in one occasion in 1997 (Abd Rabou, 2005 and 2020 and Abd Rabou et al., 2007). Accordingly, the current descriptive study comes to highlight the occurrence and dangers of the invasive Nutria (*Myocastor coypus* Molina, 1782) in Palestine. The importance of the study comes from the fact that it is the first ecological Palestinian study dealing with this invasive species.

2. Material and Methods

2.1. Palestine

Palestine (27,000 km²) is a geographic region in Western Asia usually considered to include three political masses: The West Bank, the Gaza Strip and the rest of the Palestinian lands occupied by Israel since 1948 (**Figure 1**). The West Bank (5,655

km²) is bordered by Jordan and the Dead Sea to the east and by the Palestinian lands occupied by Israel since 1948 to the south, west and north. It is composed of 11 governorates: Nablus, Qalqilya, Tubas, Salfit, Tulkarm, Jenin, Jericho and the Jordan Valley, Ramallah and Al-Bireh, Bethlehem, Hebron, and Jerusalem. The West Bank is nowadays studded with Israeli settlements into which Israeli law is pipelined (UNEP, 2003). The Gaza Strip (365 km²) is a small piece of a coastal land lying in the southern part of the Palestinian coast along the eastern shore of the Mediterranean basin. It is surrounded by the Palestinian lands occupied by Israel since 1948 from the east and north, Egypt to the south and the Mediterranean to the west. It is composed of five governorates: North Gaza, Gaza, Middle, Khan Younis, and Rafah (UNEP, 2003).

Figure (1): Palestine includes three political masses: The West Bank, the Gaza Strip and the rest of the Palestinian lands occupied by Israel since 1948

The Gaza Strip has a population of about 2.2 million. The population density is about 5,500 inhabitants per square kilometer, making the Gaza Strip one of the most densely populated areas in the world. All the Israeli settlements that crouched on the land of the Gaza Strip from north to south and from east to west were eradicated, and Israel withdrew from the entire Gaza Strip in late 2005. The majority of the Palestinian Territories that are bordered by Lebanon, Syria, Jordan, the Dead Sea, Egypt, the Red Sea and the Mediterranean Sea, and separate the two Palestinian masses of the West Bank and the Gaza Strip, have been under the occupation of Israel since 1948. So, if someone talks about Palestine, he or she definitely means the entirety of Palestine's 27,000 km² land that now consists of the West Bank and Gaza Strip in addition to the lands occupied by Israel since 1948 (**Figure 1**).

The climate of Palestine resembles that of the Mediterranean region which has four months of hot dry summer and a short winter with rain from November to March. The principal water resources in Palestine include groundwater, rivers, lakes, ponds, springs and harvested rainwater. The Jordan River, which is one of the main rivers of Palestine, is about 260 km long and drains a total area of 18,300 km² (UNEP, 2003). The river system that composes the Jordan River basin is composed of four tributaries: the Baniyas, the Hasbani, the Dan and the Yarmouk. The Baniyas, Hasbani and Dan meet in the northern Palestine to form the Upper Jordan River that flows into Lake Tiberias and the Yarmouk River flows in a southwesterly direction into the Lower Jordan forming the border between Jordan and Syria, the Jordan and Palestine. The Yarmouk River has a higher flow during the winter periods which is used to dilute the increasing salinity of the Jordan River (UNEP, 2003). The Jordan River and the other rivers, streams, lakes of Palestine are home to a diversity of plant and animal species including the Nutria (*Myocastor coypus* Molina, 1782); the core axis of the current study.

2.2. Procedure

The current study, which lasted three years (July 2018 – June 2021), was based on the following procedures:

1. Conducting frequent visits, eco-trips, direct observations and monitoring of the Nutria (*Myocastor coypus*) among other vertebrate fauna occurring in the accessible aquatic habitats and wetland ecosystems of Palestine, some of which are illustrated in **Figure 2**.

Figure (2): Some of the Palestinian aquatic habitats were commonly monitored for the occurrence of the Nutria and other wildlife species: (A & B) Hula Lake, (C) A NASA photograph showing the entire Tiberias Lake in North Palestine, (D) Tiberias Lake, (E & F) Jordan River, which lies between Palestine and Jordan, and (G & H) Wadi Al-Muqatta in northern Jenin, West Bank, with the Glossy Ibis (*Plegadis falcinellus*) is commonly seen there.

2. Carrying out frequent meetings and discussions with local inhabitants, farmers, and wildlife watchers and hunters in order to get more info and to close the gaps regarding the occurrence, ecology and risks of the Nutria in Palestine.
3. Pursuing news and social media sites that are always full of local news related to the diversity of wildlife forms in Palestine, with a special focus on the Nutria, whose presence is concentrated in humid environments and water bodies of Palestine.
4. Using professional binoculars and digital cameras was of an utmost priority throughout the succeeding stages of the current study for documentary and confirmatory purposes.

3. Results and Discussion

The Nutria is an invasive or exotic rodent species to the Palestine environment. Local literatures confirmed the introduction of the species 70 years ago from South America for fur production. The escape of many individuals from their breeding nurseries has resulted in the exploding occurrence in vast areas of Palestine, and as a result, the dangers of such occurrence on and in the aquatic habitats and their adjacent ecosystems seem to be considerable. It is worth mentioning that the Nutria is considered to be one of the most damaging invasive species worldwide because of the damage it causes to crops, native flora and fauna and drainage systems (Gosling et al., 1988).

3.1. Occurrence of Nutria in Palestine

The Nutria (*Myocastor coypus* Molina, 1782) is an actual invasive rodent residing in multiple ecosystems and habitats in Palestine (**Figure 3**). Here, the occurrence of Nutria in Palestine is discussed within three axes: The Palestinian lands occupied by Israel since 1948, the West Bank and the Gaza Strip as follows:

3.1.2. Occurrence of Nutria in the Palestinian Lands Occupied by Israel since 1948

The Nutria was originally introduced from Chile of South America to Palestine for fur farming in 1948 and 1956 (Roll et al., 2008). It seemed that the relatively hot climate of Palestine was not conducive to the growth of the animal's fur for which it was brought in, and therefore the fur farms for the animal failed. Later, some individuals of the Nutria escaped or freed from their breeders to the wild, and their numbers increased dramatically in the Hula Lake and its adjacent swamps in northern Palestine. After then, the Nutria gradually spread from the north of Palestine towards the south. The animal occupied many freshwater environments in Palestine, even some polluted ones. Nowadays, the Nutria is found in great parts of northern and central Palestine, including the Hula Lake, the Jordan River and its tributaries, and many valleys of Palestine (**Figures 2 and 3**). According to Ferguson (2002), Qumsiyeh (1996) and Khalaf (2022a), the Nutria has become one of the biodiversity components of a lot of humid areas in north and central Palestine including its coastal plain. They added that the animal was found in northern Wadi Araba (Arava Valley) and northern Al-Naqab Desert (Negev Desert). Such additions were not included in the distribution map of the Nutria drawn by Arbel (2008), who concentrated on the occurrence of Nutria in the northern and central parts of the country (**Figure 4**). According to Meiri et al. (2019), the country hosts about 130 mammalian species, with Nutrias (*Myocastor coypus*) and Brown Rats (*Rattus norvegicus*) are invasive breeders.

Figure (3): The Nutria was photographed in many Palestinian habitats including the Hula Lake and the Jordan River

Figure (4): The distribution of the Nutria in Palestine as drawn by Arbel (2008)

3.1.2. Occurrence of Nutria in the West Bank, Palestine

The Nutria seems to inhabit the northern parts of the West Bank represented by Wadi Al-Muqatta or the Jezreel Valley, which is a part of Marj Ibn Amer in Jenin Governorate, and the Jordan River which separates between Palestine and Jordan as pointed out by Atallah (1978), Qumsiyeh and Amr (1999), ARIJ (2007) and Khalaf (2022a). The banks of these two rivers or wadis are densely reeded and the adjacent lands were cultivated with various crops. As a result, they formed good feeding, breeding and resting habitats for the Nutria as well as other wildlife forms. These observations attest to the existence of permanent reproductive population in the two sites of question. Khoury et al. (2012) mentioned that a specimen was brought from the northern mouth of the Dead Sea. No literature confirmed the occurrence of the animal in the other West Bank governorates. This was apparent from various wildlife studies conducted in the West Bank (Qumsiyeh, 2014 and 2016 and Qumsiyeh et al., 2016). Monitoring of juveniles, sub-adults and adults of the Nutria was made easy by many wildlife observers living in the West Bank and in the Palestinian lands occupied by Israel since 1948. Such monitoring confirmed the breeding of the Nutria in the habitats it invaded and settled (**Figure 2**).

3.1.2.1. Jordan River

The Jordan River or River Jordan or Nahr Al-Shari'ah is a 251-kilometre-long river that flows roughly north to south through the Lake of Tiberias and on to the Dead Sea. Both Jordan and the West Bank take their names from the river. It lies in a structural depression and has the lowest elevation of any river in the world. The valley walls are steep, sheer, and bare, and they are broken only by the gorges of tributary wadis (seasonal watercourses). While the headwaters of the Jordan River are relatively unaffected, the Lower Jordan River consists primarily of untreated wastewater or sewage and agricultural return flows, groundwater seepage, as well as brackish water from springs diverted into the river away from the Lake Tiberias area. The Lower Jordan River in particular is extremely polluted. In spite of this catastrophic environmental situation of the Jordan River, it harbors a diversity of wildlife species including aquatic and terrestrial bird fauna in addition to the Nutria.

Khoury et al. (2006) and Potts (2011 and 2018) confirmed the occurrence of a great deal of bird fauna in the basin of Jordan River. The upper and lower parts of the Jordan River harbor the Nutria (*Myocastor coypus*) and the Eurasian Otter (*Lutra lutra*) as aquatic mammalian species.

3.1.2.2. Wadi Al-Muqatta

Wadi Al-Muqatta or Nahal Qishon in Jenin; northern West Bank is home to beautiful biodiversity components in spite of its environmental tragedies (see **Figure 2**). The irregular flow of the river or wadi gave rise to the Arabic name "The Cut River" (Nahr Al-Muqatta) (Encyclopedia.com, 2000). The headwaters of Al-Muqatta River start from the hills of Al-Faqqa in northern Palestine near Jenin, and run to the west, penetrating Marj Ibn Amer, then flow intermittently (hence the name) to the northwest until it flows into Haifa Bay. Nowadays, Wadi Al-Muqatta, extends 5.2 km from the city of Jenin to the Israeli Separation Wall, and then extends to the Palestinian Mediterranean coast, is a mix of both fresh water and wastewater coming from the city of Jenin and its camp. It is one of main transboundary streams that convey the discharged wastewater from the West Bank towards the Israeli wastewater treatment plants (WWTPs). The Israelis treat the discharged wastewater on the Palestinians expense and get benefit from the treated wastewater (Ju'ub and Schetelig, 2004 and House of Water and Environment, 2012). In fact, Wastewater from Jenin City and Jenin Camp is collected and partially treated in Jenin WWTP, then flows by gravity through Wadi Al Muqatta towards the Israeli Gilbo' WWTP (House of Water and Environment, 2012). In addition to the wastewater tragedy, Wadi Al-Muqatta is now subject to other environmental problems including cutting and burning of trees and shrubs, overgrazing, discharge of solid waste of multiple categories, as well as changing its course and violating its sanctity. All these practices threaten the ecological integrity of Wadi Al-Muqatta and lead to the loss of much of its biodiversity.

From an ecological point of view, Wadi Al-Muqatta is considered by the local environmental agencies as a biodiversity hot spot in Palestine. In addition to the invasive Nutria, ARIJ (2007) confirmed the occurrence of other mammalian fauna

including the normally occurring Eurasian Otter (*Lutra lutra*) and Egyptian Mongoose (*Herpestes ichneumon*). The Caspian Turtle or Striped-neck Terrapin (*Mauremys caspica*) is a freshwater reptile that is common as well. The latter seems to occur in most freshwater and polluted rivers and wadis of Palestine including Wadi Gaza, which separates the Gaza Strip into two halves; north and south (MedWetCoast, 2002 and Abd Rabou, 2005). Like other avian studies on wadis and valleys (Khoury, 2001; Khoury et al., 2006 and Abd Rabou et al., 2007), recent field studies revealed that Wadi Al-Muqatta is studded with both aquatic and terrestrial avian or bird fauna, some of which were known to be negatively impacted by the invasive Nutria grooming, resting and eating behaviors.

3.1.3. Occurrence in the Gaza Strip, Palestine

The Nutria does not occur in the Gaza Strip, and there are no scientific literatures to the natural occurrence of the animal in this piece of Palestine. In a rare and unique incident, three live specimens of the Nutria accidentally fell into fishing nets while fishermen were working in the coastal marine waters of the Gaza Strip in 1997. The strange specimens, which no fishermen were familiar with before, were brought to Palestinian universities, and only one specimen was brought to the Islamic University of Gaza for scientific identification and preservation. The specimen was mummified and preserved at the Biology Department Exhibition at the time (**Figure 5**). The specimen remained preserved at the Exhibition until the end of 2008, when Israel launched a fierce war on the Gaza Strip and during the war; it bombed the entire scientific laboratory building of the Islamic University of Gaza that housed the Exhibition. The incidental occurrence of the three Nutria specimens in the Gaza Strip in 1997 can be explained by the fact that these individuals entered the Mediterranean Sea from Ashkelon, which is the city closest to the Gaza Strip from the north. In fact, Ashkelon appears to represent the maximum southern occurrence of the Nutria in Palestine as could be deduced from **Figure 4** (Arbel, 2008), from where the specimens were brought by sea to Gaza (Abd Rabou, 2005, 2011 and 2020 and Abd Rabou et al., 2007). The Nutria is skilled at swimming (Boitani and Bartoli, 1983). Such skills made the animal travels several kilometers to reach the seawaters of the Gaza Strip and to fall into the Gazan fishing nets. This event may be repeated in the

next future. The current rehabilitation of Wadi Gaza Nature Reserve and feeding it with treated or semi-treated sewage water coming from nearby sewage treatment plants may pave the way for the undesirable occurrence of this invasive animal in the future.

Figure (5): The lonely specimen of the Nutria preserved at the Biology Department Exhibition, Islamic University of Gaza (1997 – 2008)

3.2. Dangers of the Invasive Nutria in the Palestine Environment

Nutria damage is evident to varying degrees in every area they are found worldwide. The dangers of the Nutria in the Palestine environment can be explained in the light of the following axes.

3.2.1. Herbivory and Destruction of Aquatic Plants

The Nutria is a generalist herbivore; feeding on a wide range of native and non-native aquatic plants and riparian vegetation. It feeds upon the base of the plant stems, meristems, roots, and as a result, these plants are severely damaged. The extensive and intensive grazing of Nutrias leads to local extinctions of aquatic plants which can severely impact wetlands biota structure and function. Reeds; namely the Common Reed (*Phragmites australis*) and Giant Reed (*Arundo donax*), are among the most common aquatic, riparian and wetland monostand plants harvested by the Nutria.

These monocotyledonous plants are commonly preferred by the Nutria as pointed out by Marini et al (2013). In Louisiana, Nutria is known to feed on the roots and rhizomes of many native plant species, and because of this behavior, it is considered wasteful feeder (Linscombe et al., 1981), and estimates suggest that Nutria may waste more than 90% of the plant material damaged while feeding on the bases of plants. An average of 1,100 g of vegetation was estimated to be consumed per individual Nutria per day, which amounts to approximately 25% of individual body mass consumed per day (Taylor et al., 1997 and Link, 2006). Similarly, Nutria can severely damage coastal marshes of USA by decimating native plants that hold marsh soils together and support the survival of native wildlife species (USDA, 2020).

3.2.2. Feeding on Agricultural Crops

The Nutria, as previously mentioned, is vegetarian in the sense that it feeds on roots, tubers, shoots, and leaves of plants. Nutria feed on aquatic and semi-aquatic vegetation, but they will venture into crops and gardens to eat a range of vegetables, including corn, sugarcane, beets, cabbage, carrots, potatoes, melons, wheat, alfalfa, clover, soybeans, etc. According to Kuhn and Peloquin (1974), the Nutria attacks and feeds on a variety of native and crop plants such as rice, sugarcane, alfalfa, ryegrass, and fruit and nut trees. In USA, sugarcane and rice are the primary crops damaged by the Nutria. Other crops damaged by the animal include corn, table beets, alfalfa, wheat, barley, oats, peanuts, various melons, and a variety of vegetables (Borgnia et al., 2000). This depredation can lead to significant losses, especially for small farmers (USDA, 2020). Locally, The Nutria has the ability to cause significant economic damage by feeding on the agricultural crops prevailing in its existence areas. Many Palestinian farmers have suffered from the extensive damage to corn and other crops where Nutria inhabits streams and drainage ditches in agricultural lands. In the light of these facts, the Nutria was considered by Palestinian and non-Palestinian farmers as a vertebrate pest that needs control measures. In the vast country, many vertebrate species including mammalian fauna were listed as pests because of their damage to agricultural crops and other human properties (Moran, 1981 and 2003 and Moran and Keidar, 1993).

3.2.3. Creation of "Eat-Outs" Areas

In the Palestinian areas rich in Nutria, the majority of reed and other aquatic plant biomass were subject to extensive removal due to the "eat-outs" behavior of the animal. Such removals result in big patches in the wetland and riparian environments, and as a result, the habitats of biota could be highly disrupted and negatively impacted (Taylor and Grace, 1995 and Link, 2006). Humans are not far a way from such impacts; especially those who are dependent on marshes, swamps and other wetland forms. According to Bertolino et al. (2005), the various activities of the Nutria may pose an indirect threat to marshland birds, reducing the availability of suitable habitats for nesting and breeding. Fish and crabs depend on swamps, marshes and wetlands for shelter and protection from predators and as a source of food can be negatively impacted since the plants and sediments support many insects and other invertebrates.

Jordan River and Hula Lake, as examples, are home to a diversity of freshwater fishes that depend on the biota of these ecosystems to satisfy their feeding, nesting and protection needs (Goren, 1974; Degani et al., 1998; Gophen et al., 1998 and Hamidan, 2004). The loss of these species, in turn, reduces the value of these areas for commercial fisheries and for local ecotourism. The Caspian Terrapin or the Stripe-necked Turtle (*Mauremys caspica*) is a common freshwater turtle present in most freshwater habitats of Palestine including the wadis environments of both the Gaza Strip and the West Bank (Abd Rabou, 2005 and EQA, 2015). This species relies much on the wetland habitats where the Nutria prevails. Destruction of wetlands and their reeds and plants may in a way or another hurt the populations of this unique terrapin (Figure 6).

3.2.4. Use of and Disturbance to Water Birds Nests

In the Palestinian aquatic habitats, adults and sub-adults of the Nutria were found to be repeatedly using the nests of water birds (aquatic birds) including ducks and geese (waterfowls) and wading birds (waders) for grooming or resting, eating after their removal of the eggs from the nests. Ecological monitoring carried out in Hula Lake, Jordan River, Wadi Al-Muqatta in northern Jenin, and other parallel environments showed that these habitats support a diversity of both terrestrial and aquatic birds. The

disturbances of the Nutria to the nests of some water birds were noted as well. The Nutria, in most cases, was found to remove, destroy and sink the eggs of aquatic birds from the nests to be later utilized in the grooming or resting or eating activities. The nests of Eurasian Coots (*Fulica atra*), Common Moorhens (*Gallinula chloropus*), Mallards (*Anas platyrhynchos*) and Black-winged Stilts (*Himantopus himantopus*) were just examples monitored in Wadi Al-Muqatta and other aquatic habitats in Palestine (**Figure 7**).

The Black-winged Stilt was found to build its nests on muddy substrates in shallow water bodies in open areas of both Jordan River and Wadi Al-Muqatta. The nesting behavior of the Black-winged Stilt was confirmed by Ashoori (2011) who studied the breeding ecology of the bird in Boujagh National Park, Northern Iran. In fact, there was a considerable disturbance of the Nutria to the local water bird nests either being floating amid the aquatic plants as in the case of Eurasian Coots, Common Moorhens and Mallards or built in the open water as in the case of Black-winged Stilts. It was monitored that the Nutria interfered with brooding birds such as the Black-winged Stilt and used its floating nests as resting sites (Local Observations). Analogous results were revealed by Bertolino et al. (2011) who pointed out that camera surveys confirmed the disturbance caused by the Nutria on the nests of the Eurasian Coot, Common Moorhen, Mallard and Great Crested Grebe (*Podiceps cristatus*) as common breeding aquatic birds in three Mediterranean wetlands in central Italy. The Nutria used them as resting platforms, thus destroying or sinking the eggs. More or less similar results were obtained by Angelici et al. (2012) who studied the cumulative impacts of Nutria and Norway Rats (*Rattus norvegicus*) on the nests of waterbirds in Italy as well.

Figure (6): Destruction of wetland habitat by the Nutria may hurt the population of the Caspian Terrapin (*Mauremys caspica*) [The Photo was taken in Wadi Al-Muqatta, Jenin, North West Bank]

Figure (7): Aquatic birds commonly disturbed by the Nutria in multiple aquatic habitats in Palestine: (A) Eurasian Coot (*Fulica atra*), (B) Common Moorhen (*Gallinula chloropus*), (C) Black-winged Stilt (*Himantopus himantopus*) and (D) Mallard (*Anas platyrhynchos*)

3.2.5. Competition with the Eurasian Otter (*Lutra lutra*)

The Eurasian Otter (**Figure 8**) is a carnivore (Mustelidae family) that flourishes in the perennial streams of the Palestinian coastal plain, the Jordan River and the streams flowing into the Lake of Tiberias, Hula Lake, and further south towards the Dead Sea (Qumsiyeh, 1996; SPNI, 2015 and Khalaf, 2022b). EQA (2015) pointed out that Wadi Al-Muqatta, northern Jenin, is host to the declining Eurasian Otter among other freshwater wildlife species. The Eurasian Otter seemed not to occur in the Gaza Strip (Abd Rabou et al., 2007 and Abd Rabou, 2009 and 2019), though skeleton remains of the animal were found during excavations done in 1981 in Wadi El-Hesi, North of Gaza District, South-west Palestine (Khalaf, 2020 and 2022b). The population of this animal in Palestine underwent a dramatic decline since the 1960s because of different factors including illegal hunting, roadkills, water pollution, and disappearance of wetland habitats. Recently, the regional status of the Eurasian Otter has been categorized as "Critically Endangered" (SPNI, 2015 and Khalaf, 2022b). The animal feeds upon organisms prevailing in its habitats which include fish, small birds, mammals and invertebrates including insects. It may also feed upon plant material on occasion (Yom-Tov, 1986 and Qumsiyeh, 1996). Khalaf (2022a) pointed out that where the Nutria is established, the endangered Eurasian Otter population is disappearing. Such a fact was confirmed by Eid et al (2020) who pointed out that one of the threats facing the Eurasian Otter in Jordan is its competition with the invasive Nutria. In the past, it was said that some Palestinians might trap and kill the Eurasian Otter instead of the Nutria which is considered as a pest because of its destruction behavior to crops and other vegetation forms. The consumption of the Nutria of about 25% of its body weight daily on wetland plants (LeBlanc, 1994) may indirectly affect other riparian species inhabiting the West Bank such as the Persian Otter and the Jungle or Swamp or Reed Cat (*Felis chaus*) as revealed by Khoury et al. (2012).

Figure (8): The Eurasian Otter (*Lutra lutra*) which is now rarely inhabiting the freshwater habitats of Palestine is in an actual competition with the Nutria [Photo was taken by Erez Ehrlichman] <https://www.ynetnews.com/business/article/Hk3UI9gX8>

3.2.6. Damages of Burrowing Behavior of Nutria

The Nutria is avid digger and often digs its own burrows in banks along waterways, streams, rivers and other wetland habitats of Palestine and worldwide. Multiple entrances to a single burrow system are common. The Nutria burrows can damage flood control levees that protect low-lying areas, weaken the foundations of reservoir dams, buildings, embankments and roadbeds; and erode the banks of streams, lakes, and ditches. In Israel, Mendelssohn and Yom-Tov (1999), pointed out that the Nutria was introduced into fish ponds to control reeds because of its vegetarian habit, but it caused much damage to fish pond dikes due to its burrowing behavior. Such impacts cause costly repairs, damage to equipment, and threats to human health and safety. Nutria burrows can undermine the banks of streams and can cause considerable erosion, which can increase sedimentation and decrease water quality. Nutria burrows can cause banks, roadways, and dikes to collapse, threatening the integrity of nearby homes (Link, 2006).

3.2.7. Pathogen Contamination

Little information is present in the literature regarding the diseases of the Nutria in the wilderness of Palestine. In other places of the world, the Nutria was known as a

reservoir of several pathogens and can impact public health and safety. Such diseases and parasites of the Nutria can contaminate drinking water supplies and swimming areas. Many of the water bodies and rivers of Palestine are commonly used in irrigation, recreation and swimming and the presence of Nutrias may cause contamination of these lagoons with parasites in spite of the fact that a great deal of these aquatic habitats are known to be contaminated with pathogenic agents including parasites because of wastewater, agricultural and solid waste disposal. For example, Wadi Al-Muqatta and the lower Jordan River are highly polluted with a variety of pollutants including toxins (EQA, 2015). A lot of studies confirmed that the Nutria is host for *Strongyloides myopotami*; a nematode parasite that can cause the "nutria itch" or "marsh itch". This parasite can infect the skin of humans and causes dermatitis and severe rashes similar to that of strongyloidiasis (Choe et al., 2014 and USDA, 2020). The Nutria was also found to be a reservoir for the agents causing leptospirosis, toxoplasmosis and other zoonotic diseases (Martino et al., 2014). The Nutria habit of defecating in the water can contaminate it with *Giardia* and other parasites, including flatworms (Platyhelminthes), roundworms (Nematoda), etc (Dunlap and Thies, 2002; Link, 2006; Zanzani et al., 2016; Kim et al., 2018 and USDA, 2020). It is worth mentioning that strongyloidiasis, giardiasis, amoebiasis, ascariasis, toxoplasmosis and other parasitic diseases are common in Palestine (Nijem and Al-Amleh, 2009; Markovich et al., 2014 and Hamarsheh and Amro, 2020).

3.2.8. Aggressiveness towards Humans and Pets

The Nutria is a robust rodent that can reach a weight exceeding 7-8 kg. It can act fiercely, which often brings upon physical harm not only in human beings, but also in pets (animals kept by human beings as a source of companionship and pleasure). Two main pet species are commonly considered in the Palestine urban and rural environments; the Domestic Cat (*Felis catus*) and the Domestic Dog (*Canis familiaris*). The inevitable confrontation that sometimes occurs between the Nutria and the pet may lead to injuries and scratches in the bodies of Domestic Cats, Domestic Dogs and other pets. Not only that, but the collapse of the burrows that the Nutria builds near the banks of rivers and streams may cause injuries among the pampered animals, the people who care for them, and the farmers who do their work

near the areas where the Nutria is present. The large, orange incisors that the Nutria possesses cause fear and terror for the human being who is not used to facing this animal, especially children and women. Gazan fishermen who caught three individuals of the Nutria in 1997 in the Mediterranean waters of the Gaza Strip reported that they were terrified and possessed by fear and panic over the shape of the animal and its orange incisors that they had never seen an animal possessed before (Personal Communications). It is worth mentioning that the teeth of Nutrias have special enamel that includes iron which makes the enamel stronger and also makes the orange color (Srot et al., 2013 and USDA, 2020). The entry of the Nutria to a few homes near Wadi Al-Muqatta in northern Jenin, West Bank, was reported. The Nutria caused fear and terror among children and women, which prompted homeowners to contact the competent authorities, especially the Civil Defense Forces, to deal with the animal, trap and kill it, and remove it from their homes.

3.3. Control of Nutria

Live and dead baited traps of various shapes and sizes, firearms, and detection dogs have been applied to systematically seek out and remove the Nutria from infested wetlands and region in Palestine. Leghold or foothold traps, which are indiscriminate, were said to be applied for the same purpose as well. Meanwhile, the high reproduction and dispersal rates of the animal make control methods difficult, costly, and often ineffective (Willner et al., 1979 and Kim, 1980). In many countries worldwide, live baited traps have been placed on floating rafts to effectively catch Nutria (Chapman et al., 1978 and Cocchi and Riga, 2008). In Palestine, it is recommended for farmers and residents to apply several fencing methods to exclude Nutrias from their farms, home gardens and lawns, and the fence must be buried deep in the soil. Moreover, sheet metal shields can effectively protect trees and shrubs from the damage that can result from Nutria attacks. Bulkheads can be used to deter the burrowing of Nutrias into river and wetland banks. Although these control methods can be theoretically and easily suggested, they are very expensive to implement and may not always be available, effective or even practical. In fact, many control measures have been applied in Britain to remove and eradicate the Nutria, some of which demonstrated good results (Gosling, 1981; Gosling and Baker, 1987 and 1989,

and Gosling et al., 1988). In fact, Palestine is home to many carnivorous mammals which can play as a control agent of environmental vertebrate as well as invertebrate pests including the Nutria. The examples may include the Golden Jackals (*Canis aureus*), Gray Wolf (*Canis lupus*), Red Fox (*Vulpes vulpes*) and the Jungle Cat (*Felis chaus*). The Domestic Dogs (*Canis familiaris*) are good predators of the nutria as well. More or less of these Palestinian mammalian fauna were mentioned by many authors to prey on Nutrias worldwide where predators included the Jaguar (*Panthera onca*), Mountain Lion (*Puma concolor*), Ocelot (*Leopardus pardalis*), Little Spotted Cat (*Leopardus tigrinus*), Red Wolf (*Canis rufus*), Red Fox (*Vulpes vulpes*) and Ermine (*Mustela erminea*) have been reported to consume Nutria regularly (Willner et al., 1979).

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