Animal incursions worldwide (2001-2022)

| Continent | Incursion location | Incursion date | Species | Origin continent | Location origin | Time between incursion & symptoms | Type of incursion | Borders crossed | Mode of travel | Incursion details | Phylogenetic analysis | Public health response | Local transmission | Unusual cross-species transmission | Reference(s) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Africa | South Africa | Jul-03 | Horse | Africa | Zimbabwe | 5 months | Human-mediated | International (shared border) | By land | Imported from Harare to Pietermaritzburg | No |  | No local transmission | No | Sabeta & Randles, 2005 (1) |
| Africa | Ethiopia | Sep-03 | Dog | Africa | Ethiopia |  | Natural | In-country | By land | Incursion from nearby towns that caused rabies outbreak in Ethiopian wolves of Bale Mountains National Park | No | Trap-vaccination-release of Ethiopian wolves; controlled by 2004 | Outbreak | Yes | Laurenson et al., 2005 (2) |
| Africa | South Africa | Aug-05 | Dog | Africa | Zimbabwe |  | Natural | International (shared border) | By land | Caused sharp increase in dog rabies cases in Limpopo province | Yes | Mass dog vaccination | No local transmission | No | Zulu et al., 2008 (3); Sabeta et al., 2011 (4); Townsend et al., 2013 (5) |
| Africa | South Africa | 2008 | Dog | Africa | South Africa |  | Natural | In-country | By land | Suspected incursion from Nkomazi that led to outbreak in other parts of Mpumalanga | Yes |  | Outbreak | No | Phahladira et al., 2012 (6) |
| Africa | South Africa | 2010 | Dog | Africa | South Africa |  |  | In-country | By land (presumed) | Imported from KwaZulu-Natal and bit local pet dog in Witpoortjie, resulting in outbreak in Gauteng Province | No |  | Outbreak | No | Sabeta et al., 2013 (7); Weyer et al., 2020 (8); Ngoepe et al., 2022 (9) |
| Africa | South Africa | 2011 | Dog | Africa | Lesotho |  |  | International (shared border) | By land (presumed) | Suspected incursion into Sisonke district, KwaZulu-Natal | Yes |  | No local transmission | No | Mollentze et al., 2013 (10) |
| Africa | South Africa | 2012 | Dog | Africa | South Africa |  | Natural | In-country | By land (presumed) | Suspected incursion from North West Province that led to jackal rabies outbreak in uThukela, KwaZulu-Natal | Yes |  | No local transmission | No | Ngoepe et al., 2022 (9) |
| Africa | South Africa | 2012 | Dog | Africa | Lesotho |  |  | International (shared border) | By land (presumed) | Rescued stray; secondary transmission to 1 human (owner) | Yes |  | Secondary transmission | No | Mollentze et al., 2013 (10) |
| Africa | Chad | 2014 | Dog | Africa | Chad |  | Human-mediated | In-country | By land (presumed) | Suspected human-mediated incursion into N’Djamena from surrounding area | Yes |  | No local transmission | No | Zinsstag et al., 2017 (11) |
| Africa | Tanzania | Sep-16 | Dog | Africa | Tanzania |  |  | In-country | By water (presumed) | Suspected incursion from Zanzibar that led to outbreak in Pemba facilitated by lapse in dog mass vaccination | Yes | Mass dog vaccination, PEP (subsidized); outbreak ended in 2018 | Outbreak | No | Lushasi et al., 2022 (12) |
| Africa | South Africa | 2016 | Jackal | Africa | South Africa |  | Natural | In-country | By land | Suspected incursion from North West Province that led to outbreak in Gauteng Province | Yes | PEP | Outbreak | No | Ngoepe et al., 2022 (9) |
| Asia | Iran | Jan-01 | Dog | Asia | Nepal | 5 days | Human-mediated | International | By air | Vaccinated against rabies after importation | No | PEP (owners) | No local transmission | No | Johnson et al., 2011 (13) |
| Asia | Israel | Mar-03 | Dog | Asia | Israel |  | Human-mediated | In-country | By land | Newly adopted by owner during trip to Beer Sheva and brought back to residence | No | Contact tracing, PEP, increased public awareness (tourists) | No local transmission | No | David et al., 2004 (14); David and Yakobson, 2011 (15) |
| Asia | Indonesia | Aug-03 | Dog | Asia | Indonesia |  | Human-mediated | In-country | By water | Imported from Sulawesi to Maluku islands for meat trade | No |  | No local transmission | No | Townsend et al., 2013 (5) |
| Asia | Bhutan | May-05 | Dog | Asia | India |  | Natural | International (shared border) | By land | Free-roaming dog that bit cow in Gongza village, resulting in outbreak that spread to other villages accessible to free-roaming dogs through road network | No | Mass dog vaccination, PEP, dog-catching, vaccination of exposed animals, increased public awareness | Outbreak | Yes | Tenzin et al., 2011 (16); Townsend et al., 2013 (5); Rinchen et al., 2020 (17); Rinchen et al., 2020 (18) |
| Asia | China | Feb-06 | Dog | Asia | China |  |  | In-country | By land | Suspected incursion from Hengshan city into Yongzhou city; led to secondary transmission to local free-roaming owned dog, which visited neighbouring farm and attacked pigs, causing outbreak with 20 pig deaths out of >50 exposed as no control measures were initiated | No |  | Outbreak | Yes | Jiang et al., 2008 (21) |
| Asia | Bhutan | 2007 | Dog | Asia | India |  | Natural | International (shared border) | By land | Incursion into Dala subdistrict, Chhukha, Bhutan | No | Culling; controlled by 2008 | No local transmission | No | Townsend et al., 2013 (5) |
| Asia | Indonesia | 2008 | Dog | Asia | Indonesia |  | Human-mediated | In-country | By water | Imported from Flores to Bali by fishermen with no border controls; bit owners and caused outbreak that spread to other regions with >200 human deaths including owner; delayed detection and response due to poor bite surveillance, non-existent PEP policies, insufficient vaccine stocks and prioritisation of culling | No | Culling, mass dog vaccination | Outbreak | No | Scott-Orr and Putra, 2009 (20); Clifton, 2010 (21); Batan et al., 2014 (22); Putra et al., 2013 (23); Mahardika et al., 2014 (24); Dibia et al., 2015 (25); Cliquet and Wasniewski, 2018 (26); De Jong et al., 2018 (27); Drake, 2020 (28); Rupprecht et al., 2020 (29); Ward and Brookes, 2021 (30) |
| Asia | Bhutan | 2008 | Dog | Asia | Bhutan |  | Natural | In-country | By land | Incursion from south into southwest region | No |  | No local transmission | No | Rinchen et al., 2020 (17); Rinchen et al., 2020 (18) |
| Asia | China | Mar-09 | Dog | Asia | China |  | Human-mediated | In-country | By land | Suspected incursion from Sichuan Province; transport of dogs for meat trade enabled outbreak that resulted in >7,000 biting incidents and 20 human deaths | Yes | Culling, mass dog vaccination (limited), PEP (limited) | Outbreak | No | Zhao et al., 2011 (31); Zhang et al., 2014 (32); |
| Asia | Indonesia | Feb-10 | Dog | Asia | Indonesia |  | Human-mediated | In-country | By water | Incursion from Sumatra into Nias; led to outbreak that caused >20 human deaths | No | Culling, mass dog vaccination | Outbreak | No | Senior, 2012 (33); Townsend et al., 2013 (5); Rupprecht et al., 2018 (34) |
| Asia | China | 2010 | Dog | Asia | China |  |  | In-country | By land | Suspected incursion from Hebei Province into Shanxi Province; led to secondary transmission to local owned dog which attacked neighbour’s sheep, causing outbreak; spread attributed to high numbers of unvaccinated free-roaming dogs | Yes | Quarantine of exposed animals; sacrifice of associated animals (dog, sheep), mandatory vaccination of pets (owned dogs in the vicinity) | Outbreak | Yes | Zhu et al., 2011 (35) |
| Asia | China | Dec-10 | Dog | Asia | China |  | Natural | In-country | By land | Free-roaming; suspected incursion from Hebei Province into Shaanxi Province indicated by phylogenetic analysis; detected after secondary transmission to dog, which attacked neighbour's sheep and dog; spread due to unvaccinated free-roaming dogs, lack of border control and meat trade facilitating movement of dogs | Yes | Vaccination of exposed animals (dogs), sacrifice of associated animals (sheep) | Secondary transmission | No | Zhang et al., 2014 (32) |
| Asia | Russia | Feb-11 | Fox | Asia | Mongolia |  | Natural | International (shared border) | By land, water (frozen) | Suspected incursion through crossing of frozen river; led to outbreak | Yes |  | Outbreak | No | Adelshin et al., 2012 (36); Adelshin et al., 2015 (37) |
| Asia | Israel | Oct-11 | Dog | Asia | Israel | 2 months | Human-mediated | In-country | By land (presumed) | Unvaccinated; brought by owners on camping trip to coast of Sea of Galilee and Northern Israel and stayed outside, was bitten by local rabid stray dog and manifested symptoms after return to Israel | No | Contact tracing, PEP | No local transmission | No | David et al., 2012 (38) |
| Asia | Philippines | 2011 | Dog | Asia | Philippines |  | Human-mediated | In-country | By water (presumed) | Suspected long-distance migration from Central Luzon region to Tablas Island, Romblon; led to outbreak | Yes | Outbreak ended in 2012 | Outbreak | No | Tohma et al., 2016 (39) |
| Asia | Russia | Feb-12 | Fox | Asia | Mongolia |  | Natural | International (shared border) | By land, water (frozen) | Suspected incursion into through crossing of frozen river | Yes |  | No local transmission | No | Adelshin et al., 2015 (37) |
| Asia | South Korea | Apr-13 | Dog | Asia | South Korea |  | Natural | In-country | By land | Suspected incursion from Gangwon Province into Geyonggi Province | Yes |  | No local transmission | No | Oem et al., 2014 (40) |
| Asia | Israel | Sep-13 | Cow | Asia | Israel | 2 weeks | Human-mediated | In-country | By land | Suspected infection by jackal that had been shot in the vicinity and tested positive for rabies; 3 among group of >50 dairy calves transported from dairy farm in Kibbutz Ortal to Jezreel Valley; 2 out of 3 later transported to Kfar Yehoshua | No |  | No local transmission | No | David et al., 2015 (41) |
| Asia | China | 2014 | Red fox | Asia | Russia or Mongolia |  | Natural | International (shared border) | By land | Suspected incursion that led to secondary transmission to cow | Yes |  | Secondary transmission | Yes | Liu et al., 2014 (42) |
| Asia | China | 2014 | Raccoon dog | Asia | Russia or Mongolia |  | Natural | International (shared border) | By land | Suspected incursion that led to secondary transmission to goat | Yes |  | Secondary transmission | Yes | Liu et al., 2014 (42) |
| Asia | Malaysia | 2015 | Dog | Asia | Thailand |  |  | International (shared border) | By land |  | Yes |  | No local transmission | No | Leow et al., 2021 (43) |
| Asia | Malaysia | 2015 | Dog | Asia | Thailand |  |  | International (shared border) | By land |  | Yes |  | No local transmission | No | Leow et al., 2021 (43) |
| Asia | Bhutan | Oct-16 | Dog | Asia | Bhutan |  | Natural | In-country | By land | Stray, free-roaming; incursion from Meral and Sakteng subdistricts into Rangjung town; bit 3 humans and caused outbreak with >20 infected animals (dogs, cattle, cat); spread facilitated by large stray dog population and lack of public health response, as cases were previously detected in neighboring villages 2-3 months prior | No | PEP | Outbreak | Yes | Tenzin et al., 2017 (44) |
| Asia | India | Feb-16 | Jackal | Asia | India |  | Natural | In-country | By land | Incursion from West Bengal into Sikkim; bit 2 cows, causing secondary transmission; suspected infection by free-roaming dog while searching for food during winter, as dog vaccination coverage is low due to cultural beliefs that dogs should not be touched | No |  | Secondary transmission | Yes | Byrnes et al., 2017 (45) |
| Asia | Malaysia | Jul-17 | Dog | Asia | Indonesia |  | Human-mediated | International (shared border) | By land | Suspected incursion attributed to workers bringing dogs during construction of Pan Borneo Highway; bit 2 children; spread facilitated by minimal rabies control at border and interaction of owned and stray dogs, resulting in outbreak | Yes | Culling, mass dog vaccination, PEP | Outbreak | No | Rupprecht et al., 2018 (34); Taib et al., 2019 (46); Leow et al., 2021 (43); Ward and Brookes, 2021 (30); Senior, 2012 (33) |
| Asia | Indonesia | 2019 | Dog | Asia | Indonesia |  | Human-mediated | In-country | By water | Imported from Bali or Sulawesi to Sumbawa Island to guard corn crops from wild monkeys | No |  | No local transmission | No | Ward and Brookes, 2021 (30) |
| Europe | France | Mar-01 | Dog | Africa | Morocco (via Spain) | 7 weeks | Human-mediated | Intercontinental, International (shared border) | By land, air/water (presumed) | Adopted by owners during camping trip in Morocco; no land border controls observed for rabies (FMD only); delayed reporting of contact with another dog by owners, resulting in fine for withholding information | No | Contact tracing, PEP, quarantine, controlled movement of dogs, sacrifice of associated animals (dog) | No local transmission | No | Bruyere-Masson et al., 2001 (47); Ribadeau-Dumas, 2016 (48); Alvarez et al., 2022 (49) |
| Europe | Albania | Mar-01 | Dog | Europe | Kosovo |  | Natural | International (shared border) | By land | Migrated and bit 3 humans; suspected infection by wild animal (wolf/fox) as no ORV along border | No | PEP | No local transmission | No | WHO Collaborating Centre for Rabies Surveillance and Research, 2001 (50); Blanton et al., 2007 (51); Korro et al., 2009 (52); Lika, 2010 (53) |
| Europe | Austria | Oct-01 | Dog | Europe | Serbia |  | Human-mediated | International | By land (presumed) | Illegally imported and sold to new owners | No | PEP, contact tracing, quarantine of exposed animals (dogs), sacrifice of associated animals (second dog of owners) | No local transmission | No | Office International des Epizooties, 2001 (54); McElhinney et al., 2011 (55) |
| Europe | Germany | Nov-01 | Dog | Asia | Azerbaijan | 2 days | Human-mediated | Intercontinental | By air | Adopted by worker; vaccinated and given health certificate without time for rabies antibodies to develop before importation | No | PEP, contact tracing | No local transmission | No | WHO Collaborating Centre for Rabies Surveillance and Research, 2001 (56); Johnson et al., 2011(13); Ribadeau-Dumas, 2016 (48); Alvarez et al., 2022 (49) |
| Europe | Germany | 2001 | Dog | Asia | Nepal |  | Human-mediated | Intercontinental | By air | Imported | No |  | No local transmission | No | Cliquet and Wasniewski, 2018 (26) |
| Europe | Austria | Jan-02 | Fox | Europe | Slovenia |  | Natural | International (shared border) | By land | Caused outbreak resulting in >20 rabid animals | No | ORV | Outbreak | No | Potzsch, 2014 (57); Singh et al., 2018 (58) |
| Europe | France | 2002 | Dog | Africa | Morocco (via Spain) | 7 weeks | Human-mediated | Intercontinental | By land, air/water (presumed) | Illegally imported without vaccination certificate | No | PEP | No local transmission | No | WHO Collaborating Centre for Rabies Surveillance and Research, 2001 (56); Lardon, 2010 (59); Johnson et al., 2011 (13); Mailles et al., 2011 (60); Ribadeau-Dumas, 2016 (48); Alvarez et al., 2022 (49) |
| Europe | Switzerland | May-03 | Dog | Africa | Algeria or Morocco | 1 month | Human-mediated | Intercontinental |  | Suspected to have been illegally imported; found abandoned in Switzerland; and brought to animal shelter, later adopted | No | PEP, vaccination of exposed animals | No local transmission | No | Zanoni and Breitenmoser, 2003 (61); Johnson et al., 2011 (13); Ribadeau-Dumas, 2016 (48); |
| Europe | Finland | Jun-03 | Horse | Europe | Estonia | 1 month | Human-mediated | International | By land/water | Imported without vaccination, in accordance with local guidelines (rabies vaccination recommended but not required, contrary to OIE standards); was released to pasture with other horses; bit veterinarian during examination | No | PEP (veterinarian), vaccination of exposed animals (horses), quarantine of exposed animals (horses) | No local transmission | No | Englund and Pringle, 2003 (62); Rimhanen-Finne et al., 2009 (63); Metlin et al., 2016 (64); Zoonoosikeskus (Zoonoses Centre), 2012 (65); Dominguez et al., 2016 (66) |
| Europe | France | 2004 | Dog | Africa | Morocco (via Spain) |  | Human-mediated | Intercontinental, International (shared border) | By land, air/water (presumed) | Vaccinated; illegally imported | No | PEP | No local transmission | No | Servas et al., 2005 (67); Lardon, 2010 (59); Ribadeau-Dumas, 2016 (48) |
| Europe | France | May-04 | Dog | Africa | Morocco (via Spain) |  | Human-mediated | Intercontinental, International (shared border) | By land, air/water (presumed) | Unvaccinated; illegally imported | No | Contact tracing, PEP | No local transmission | No | Servas et al., 2005 (67); Lardon, 2010 (59); Ribadeau-Dumas, 2016 (48) |
| Europe | France | Jul-04 | Dog | Africa | Morocco (via Spain) | 1 month | Human-mediated | Intercontinental, International (shared border) | By land, air/water (presumed) | Unvaccinated; Illegally imported via car but allowed to roam unleashed at 3 summer music festivals, exposing >150 humans | No | Culling (free-roaming dogs only) Contact tracing (hotline established), PEP, monitoring of animals | No local transmission | No | Health Protection Agency, 2005 (68); Servas et al., 2005 (67); Lardon, 2010 (59); Ribadeau-Dumas, 2016 (48); Alvarez et al., 2022 (49) |
| Europe | France | 2004 | Dog | Africa | Morocco (via Spain) |  | Human-mediated | Intercontinental, International (shared border) | By land (presumed), air/water (presumed) | Illegally imported | No |  | No local transmission | No | Johnson et al., 2011 (13); Alvarez et al., 2022 (49) |
| Europe | France | 2004 | Dog | Africa | Morocco (via Spain) |  | Human-mediated | Intercontinental, International (shared border) | By land (presumed), air/water (presumed) | Illegally imported; no pet passport | No | PEP | No local transmission | No | Johnson et al., 2011 (13); Mailles et al., 2011 (60); Alvarez et al., 2022 (49) |
| Europe | Germany | 2004 | Dog | Africa | Morocco | 27 days | Human-mediated | Intercontinental | By air | Imported without complete travel requirements; died in quarantine | No | PEP, contact tracing, sacrifice of associated animals with confirmed direct exposure (cat), vaccination of associated animals (dogs) | No local transmission | No | Johnson et al., 2011 (13); Ribadeau-Dumas, 2016 (48); Alvarez et al., 2022 (49) |
| Europe | Germany | Jan-05 | Fox | Europe | Germany |  | Natural | In-country | By land | Incursion after ORV preventive vaccination cordon | No | ORV (changed from baits to aerial, at 6-week intervals instead of every autumn) | No local transmission | No | Selhorst et al., 2012 (69); Cliquet and Wasniewski, 2018 (26) |
| Europe | Spain | 2005 | Dog | Africa | Morocco |  | Human-mediated | Intercontinental (shared border) | By land |  | No |  | No local transmission | No | European Food Safety Authority, 2007 (70) |
| Europe | France | Oct-07 | Dog | Africa | Morocco (via Portugal and Spain) | 15 days | Human-mediated | Intercontinental, International (shared border) | By water, land | Recently vaccinated before importation with visible injuries; had direct contact with 1 dog, leading to secondary transmission to 1 dog, with France losing rabies-free status for 2 years | No | Contact tracing, PEP | Secondary transmission | No | Eurosurveillance, 2008 (71); Gautret et al., 2011 (72); Johnson et al., 2011 (13); Ribadeau-Dumas, 2016 (48); Yamada et al., 2019 (73); Alvarez et al., 2022 (49) |
| Europe | Belgium | Oct-07 | Dog | Africa | Morocco | 1 month | Human-mediated | Intercontinental | By air/water (presumed) | Adopted by owner while on vacation in Morocco; cleared for importation despite not fulfilling rabies vaccination and serology requirements; brought to dog park; resulted in Belgium losing rabies-free status for 6 months | No | Contact tracing, PEP, 6-month quarantine (visitor dogs at dog park), sacrifice of associated pets, recommended pet vaccination, enhanced surveillance, restrictions, active fox surveillance, mandatory dog leashing | No local transmission | No | European Food Safety Authority, 2007 (70); Van Gucht and Le Roux , 2008 (74); Ehnert & Galland, 2009 (75); Johnson et al., 2011 (13); Ribadeau-Dumas, 2016 (48); Alvarez et al., 2022 (49) |
| Europe | Kosovo | Oct-07 | Fox | Europe | Republic of North Macedonia |  | Natural | International (shared border) | By land |  | No |  | No local transmission | No | Muji et al., 2012 (76) |
| Europe | Germany | 2007 | Dog | Africa | Morocco |  | Human-mediated | Intercontinental | By air/water (presumed) | Illegally imported | No |  | No local transmission | No | Ehnert & Galland, 2009 (75) |
| Europe | Finland | 2007 | Dog | Asia | India | <1 month | Human-mediated | Intercontinental | By air | Adopted from streets while attacked by stray dog and vaccinated shortly before importation | No | PEP | No local transmission | No | European Food Safety Authority, 2009; Johnson et al., 2011 (13); Zoonoosikeskus (Zoonoses Centre), 2012 (65); Väyrynen, 2020 (77) |
| Europe | France | Apr-08 | Dog | Africa | Gambia (via Senegal and Belgium) | 2 weeks | Human-mediated | Intercontinental, International (shared border) | By air, land | Fulfilled all travel requirements except serology; newly adopted and visibly wounded but given health certificate; brought into passenger cabin of plane | No | Contact tracing, PEP, 6-month quarantine of exposed animals (cats) | No local transmission | No | Eurosurveillance, 2008 (78); Roux and Gucht, 2008 (79); European Food Safety Authority, 2010 (80); Ribadeau-Dumas, 2016 (48); Cliquet and Wasniewski, 2018 (26); Alvarez et al., 2022 (49) |
| Europe | United Kingdom | Apr-08 | Dog | Asia | Sri Lanka | 6 days | Human-mediated | Intercontinental | By air | Vaccinated; imported by rescue group along with >10 animals despite not meeting minimum age requirement for travel; symptoms manifested while in quarantine | No | Contact tracing, PEP, sacrifice of associated animals (nearby dogs at quarantine center) | No local transmission | No | Catchpole et al., 2008 (81); Fooks et al., 2008 (82); Goddard et al., 2008 (83); Health Protection Agency, 2008 (84); WHO Collaborating Centre for Rabies Surveillance & Research, 2009 (85); European Food Safety Authority, 2010 (80); Johnson et al., 2011 (13); Johnson et al., 2011 (86); Fooks and Johnson, 2015 (87); Ribadeau-Dumas, 2016 (48); Alvarez et al., 2022 (49) |
| Europe | Germany | Jun-08 | Dog | Europe | Croatia | 6 months | Human-mediated | International | By land | Illegally imported to animal shelter without vaccination certificate; no border control measures reported at EU border | No | Contact tracing, PEP, quarantine of exposed animals | No local transmission | No | Johnson et al., 2011 (13); Weiss et al., 2009 (88); European Food Safety Authority, 2010 (80); Ribadeau-Dumas, 2016 (48); Alvarez et al., 2022 (49) |
| Europe | France | Oct-08 | Dog | Europe | Spain | 1 month | Human-mediated | International | By land | Found in car park and adopted | No | Contact tracing | No local transmission | No | Johnson et al., 2011 (13); |
| Europe | Italy | Oct-08 | Red fox | Europe | Slovenia |  | Natural | International (shared border) | By land | 1 fox bit 1 human, and caused rabies spread to other regions; ORV not maintained during that period | No | PEP, ORV (Emergency) | Outbreak | No | De Benedictis et al., 2008 (89); Fusaro et al., 2013 (90); Berg et al, 2015 (91); Rupprecht et al., 2020 (29); Kumar et al., 2021 (92); Lojkić et al., 2021 (93) |
| Europe | Italy | Nov-08 | Fox | Europe | Italy |  | Natural | In-country | By land | Continued incursion into Belluno, Venzone Province following incursion from Slovenia; caused rabies spread to other regions | No | PEP, ORV (Emergency) | Outbreak | No | Fusaro et al., 2013 (90); Berg et al, 2015 (91); Rupprecht et al., 2020 (29); Kumar et al., 2021 (92); Lojkić et al., 2021 (93) |
| Europe | France | 2008 | Dog | Europe | Spain | 18 days | Human-mediated | International (shared border) | By land, air/water (presumed) | Found on highway and recently adopted; ilegally imported without vaccination | Yes | PEP | No local transmission | No | Mailles et al., 2011 (60); Alvarez et al., 2022 (49) |
| Europe | Germany | 2009 | Dog | Europe | Croatia |  | Human-mediated | International | By land | Imported; no border control measures reported | No |  | No local transmission | No | Tietjen et al., 2011 (94) |
| Europe | France | 2009 | Dog | Asia | Afghanistan |  | Human-mediated | Intercontinental | By air | Imported | No |  | No local transmission | No | WHO Collaborating Centre for Rabies Surveillance & Research, 2009 (95); Johnson et al., 2011 (13) |
| Europe | Germany | Feb-10 | Dog | Europe | Bosnia and Herzegovina (via Slovenia) | 22 days | Human-mediated | International (shared border) | By land | Newly bought before importation with incomplete travel documents (no record of rabies vaccination) but allowed through border control; history of biting by aggressive dog | No | Contact tracing, PEP, destroyed associated animals (unvaccinated cats) | No local transmission | No | Eismann et al., 2011 (96); Johnson et al., 2011 (13); European Food Safety Authority and European Centre for Disease Prevention and Control, 2012 (97); Ribadeau-Dumas, 2016 (48); Alvarez et al., 2022 (49) |
| Europe | Poland | 2010 | Fox | Europe | Belarus or Ukraine |  | Natural | International (shared border) | By land | Incursion into Rzeszow | No | ORV | No local transmission | No | Smreczak et al., 2012 (98) |
| Europe | Poland | 2010 | Fox | Europe | Belarus or Ukraine |  | Natural | International (shared border) | By land | Incursion into Lublin | No | ORV | No local transmission | No | Smreczak et al., 2012 (98) |
| Europe | Poland | 2010 | Fox | Europe | Russia or Ukraine |  | Natural | International (shared border) | By land | Incursion into Malopolskie region; caused outbreak, resulting from weak surveillance (minimal sample collection) | No | ORV (maintained) | Outbreak | No | Berg et al, 2015 (91); Ortiz et al., 2018 (99) |
| Europe | France | Jul-11 | Dog | Africa | Morocco (via Spain) | 4 days | Human-mediated | Intercontinental, International (shared border) | By water, land | Newly adopted; illegally imported without fulfilling all travel requirements (underage, unvaccinated, not microchipped, no travel certificate) | No | Contact tracing, PEP, (booster) vaccination of exposed animals (dogs), sacrifice of associated animals (cats) | No local transmission | No | Mailles et al., 2011 (60); Roberts and Lopez, 2011 (100); European Food Safety Authority and European Centre for Disease Prevention and Control, 2013 (101); Alvarez et al., 2022 (49) |
| Europe | Norway | 2011 | Arctic fox | Europe | Norway |  | Natural | In-country | By water (frozen) | Incursion from Svalbard mainland into Hopen Island by crossing frozen sea ice during winter; fought 4 dogs and was killed | No | (Booster) vaccination of exposed animals (dogs) | No local transmission | No | Roberts et al., 2011 (102) |
| Europe | Croatia | 2011 | Cow | Europe | Romania | 8 months | Human-mediated | International | By land | One of 1,000 unvaccinated cows imported with valid documents (health certificates) but no rabies vaccination required; 6 bulls exhibited symptoms | No | Sacrifice of associated animals (bulls in same box) | No local transmission | No | Lojkić et al., 2013 (103) |
| Europe | Norway | 2011 | Arctic fox | Europe | Russia |  | Natural | International | By water (frozen) | Incursion into Svalbard by crossing frozen sea ice | No |  | No local transmission | No | Simon et al., 2021 (104); Hueffer, 2022 (105) |
| Europe | Poland | 2011 | Fox | Europe | Russia |  | Natural | International | By land |  | No | ORV (intensified) | No local transmission | No | Berg et al, 2015 (91) |
| Europe | Netherlands | Feb-12 | Dog | Africa | Morocco (via Spain) | 1 day | Human-mediated | Intercontinental, international | By air, land/water (presumed) | Purchased in parking lot and illegally imported without vaccination; examined at customs but pet passport and vaccination status not checked; stayed in passenger cabin of plane | No | Contact tracing, PEP, (booster) vaccination of exposed animals (dogs), sacrifice of associated animals (cats) due to lack of available venue for quarantine | No local transmission | No | Roberts and Lopez, 2012 (106); Van Rijckevorse et al., 2012 (107); Ribadeau-Dumas, 2016 (48); Veda et al., 2021 (108); Alvarez et al., 2022 (49) |
| Europe | Greece | Oct-12 | Red fox | Europe | Republic of North Macedonia |  | Natural | International (shared border) | By land | Seen exhibiting symptoms by villagers; led to secondary transmission to 6 foxes and 2 dogs; spread attributed to neglect of ORV and lack of mountains | No | ORV, improved passive surveillance, mandatory pet vaccination, increased public awareness | Secondary transmission | Yes | Tsiodras et al., 2013 (109); Tsiodras et al., 2014 (110); Giannakopoulos et al., 2016 (111); Rupprecht et al., 2020 (29); Lojkić et al., 2021 (93) |
| Europe | Spain | Jun-13 | Dog | Africa | Morocco | 2 months | Human-mediated | Intercontinental | By land, air/water (presumed) | Attempted importation to Morocco 4 months prior but denied due to lack of serology test; illegally imported through Ceuta immediately after vaccination; later escaped, attacked 5 humans and died, resulting in loss of rabies-free status in Spain for 6 months; owners fined for not disclosing all information | No | Contact tracing, PEP, mandatory pet vaccination (animals in Castilla-La Mancha restriction area), serology of all exposed dogs, sacrifice of associated animals (dog with insufficient antibodies according to serology), restricted movement of pets | No local transmission | No | Suarez-Rodriguez at al., 2013 (112); Pérez de Diego et al., 2015 (113); Ribadeau-Dumas, 2016 (48); Veda et al., 2021 (108); Alvarez et al., 2022 (49) |
| Europe | France | Oct-13 | Cat | Africa | Morocco | 11 days | Human-mediated | Intercontinental | By air | Imported with certificate of good health despite not meeting qualifications for importation (no vaccination); escaped home and was adopted twice by different owners | No | Contact tracing, PEP, monitoring of vaccinated animals, sacrifice of associated animals (non-vaccinated), restricted movement of pets, increased surveillance | No local transmission | No | Veterinary Record, 2013 (114); Ribadeau-Dumas, 2016 (48) |
| Europe | Slovakia | 2013 | Dog, fox, marten | Europe | Poland |  | Natural | International (shared border) | By land | Incursion despite ORV | No | ORV (continued) | No local transmission | No | Ondrejková et al., 2020 (115) |
| Europe | France | May-15 | Dog | Europe | Algeria | 9 days | Human-mediated | International | By air/land (presumed) | Illegally imported without fulfilling travel requirements (no vaccination, no identification, underage); brought to Algeria 4 months later by owners despite surveillance orders, escaped for a period; manifested symptoms upon return and had direct contact with 9 humans and 1 dog | No | Contact tracing, PEP, sacrifice of associated animals (unvaccinated), monitoring of vaccinated animals (dogs) for 6 months, catching of stray animals, restricted movement of pets, increased surveillance | No local transmission | No | European Food Safety Authority and European Centre for Disease Prevention and Control, 2015 (116); Veterinary Record, (2015) (117); Veda et al., 2021 (108); Alvarez et al., 2022 (49) |
| Europe | Slovakia | 2015 | Fox | Europe | Poland |  | Natural | International (shared border) | By land |  | No | ORV | No local transmission | No | Ondrejková et al., 2020 (115) |
| Europe | United Kingdom | Jan-20 | Sable | Europe | Russia (via Italy) |  | Human-mediated | International | By air (presumed) | Imported | No |  | No local transmission | No | European Food Safety Authority and European Centre for Disease Prevention and Control, 2021 (118) |
| Europe | France | Feb-20 | Dog | Africa | Morocco |  | Human-mediated | Intercontinental | By air/water (presumed) | Illegally imported (no vaccination) | No | PEP | No local transmission | No | Bacigalupo et al., 2022 (119); European Food Safety Authority and European Centre for Disease Prevention and Control, 2021 (118); Veda et al., 2021 (108); Alvarez et al., 2022 (49) |
| Europe | Poland | Jan-21 | Fox | Europe | Belarus or Ukraine |  | Natural | International (shared border) | By land | Observed to be ‘sick’, killed by dog; spread facilitated by limitation of ORV to borders only | No | Increased public awareness, increased rabies surveillance, hunting ban, cancellation of pet-centric events, mandatory leashing of dogs, emergency ORV | No local transmission | No | Smreczak et al., 2023 (120) |
| Europe | Germany | Jul-21 | Dog | Asia | Republic of Türkiye (via Bulgaria) | 11 days | Human-mediated | Intercontinental, international | By air (presumed) | Illegally imported (no vaccination) | No | Contact tracing, PEP | No local transmission | No | Alvarez et al., 2022 (49); European Food Safety Authority and European Centre for Disease Prevention and Control, 2022 (121) |
| Europe | France | Oct-22 | Dog | Europe | Morocco |  | Human-mediated | Intercontinental | By air/water (presumed) | Suspected to be illegally imported to shelter; bit several humans | No | Contact tracing, PEP, monitoring of shelter | No local transmission | No | Bacigalupo et al., 2022 (119) |
| North America | United States of America | 2001 | Raccoon | North America | United States of America |  | Natural | In-country | By land | Incursion from Pennsylvania into Ohio despite immune corridor from ORV; attributed to weakened surveillance | No | ORV (expanded) | No local transmission | No | Krebs et al., 2002 (122) |
| North America | Canada | Dec-02 | Arctic fox | Europe | Greenland |  | Natural | Intercontinental | By water (frozen) | Incursion by crossing through packed ice during winter | Yes |  | No local transmission | No | Nadin-Davis et al., 2008 (123) |
| North America | Canada | 2002 | Fox | North America | Canada |  | Natural | In-country | By water (frozen) | Incursion from mainland to Cartwright, Labrador by crossing through packed ice; overlap with red fox populations facilitated spread in arctic foxes | No |  | No local transmission | No | Nadin-Davis et al., 2008 (123) |
| North America | United States of America | 2003 | Dog | North America | United States of America |  | Human-mediated | In-country | By air | Imported | No | PEP | No local transmission | No | Lankau et al., 2014 (124) |
| North America | United States of America | Mar-04 | Dog | North America | Mexico |  | Natural | International (shared border) | By land |  | No | Mass dog vaccination, ORV, monitoring | No local transmission | No | Blanton et al., 2007 (51) |
| North America | United States of America | Jun-04 | Dog | Asia | Thailand | 2 days | Human-mediated | Intercontinental | By air | newly adopted and imported without vaccination; given health certificate despite history of respiratory illness; stayed in passenger cabin | No | Contact tracing, PEP | No local transmission | No | Castrodale et al., 2008 (125); McQuiston, 2008 (126); Ehnert & Galland, 2009 (75); Lankau et al., 2014 (124) |
| North America | United States of America | Jul-04 | Raccoon | North America | United States of America |  | Natural | In-country | By land | Suspected incursion from mid-Atlantic state to Ohio; detected despite weakened surveillance, limited testing | Yes | ORV, enhanced surveillance | No local transmission | No | Russell et al., 2005 (127); Henderson et al., 2008 (128); Slate et al., 2008 (129) |
| North America | United States of America | 2004 | Raccoon | North America | United States of America |  | Natural | In-country | By land | Incursion into Cape Cod from nearby areas; crossed vaccine barrier and led to outbreak in raccoons with transmission to other species (skunks, domestic animals, etc.) | No | ORV, trap-vaccination-release of raccoons and skunks | Outbreak | Yes | Wang et al., 2009 (130) |
| North America | United States of America | Feb-06 | Red fox | North America | United States of America |  | Natural | In-country | By land | Incursion from mid-Atlantic state to Tennessee; found during enhanced surveillance in non-ORV area; suspected infection by raccoon; ORV not recommended, considered ‘waste of resources’ | Yes | Enhanced surveillance (increased sampling) | No local transmission | No | Slate et al., 2008 (129) |
| North America | Canada | Jun-06 | Raccoon | North America | United States of America |  | Natural | International (shared border) | By land |  |  | ORV | No local transmission | No | Shwiff et al., 2013 (131); Stevenson et al., 2016 (132); Trewby et al., 2017 (133); Nadin-Davis, 2018 (134); Nadin-Davis et al., 2020 (135) |
| North America | United States of America | Mar-07 | Dog | Asia | India | 2 days | Human-mediated | Intercontinental, in-country | By air | Newly adopted before importation by volunteer veterinarian; no vaccination; given to 2nd veterinarian; despite symptoms and biting history (veterinarian owner, dog), health certificate obtained from 3rd veterinarian for travel | No | PEP, contact tracing, sacrifice of associated pets (dog) | No local transmission | No | Blanton et al., 2008 (136); Castrodale et al., 2008 (125); Ehnert & Galland, 2009 (75); Lankau et al., 2014 (124) |
| North America | United States of America | 2008 | Dog | Asia | Iraq | 3 days | Human-mediated | Intercontinental | By air | Adopted by soldier and kept on military base for 7 months before importation; transported with >20 dogs with no vaccination certificates, leading to 30-day quarantine for all animals; diagnosed in quarantine centre | No | Contact tracing, PEP, vaccination of associated animals (dogs, cat); 6-month quarantine of exposed animals (dogs, cat) | No local transmission | No | Mangieri et al., 2008 (137); Lankau et al., 2014 (124); Hercules et al., 2018 (138) |
| North America | United States of America | Jan-10 | Cow | North America | Mexico | 5 months | Human-mediated | International (shared border) | By land | Imported without documentation; presumed unvaccinated suspected infection by vampire bat | Yes |  | No local transmission | No | Blanton et al., 2011 (139); Pieracci et al., 2020 (140) |
| North America | United States of America | Jan-13 | Raccoon | North America | United States of America |  | Natural | In-country | By land | Incursion from mainland Georgia to Jekyll Island by crossing bridge; led to outbreak | No | Outbreak ended in 2017 | Outbreak | No | Ortiz et al., 2018 (99) |
| North America | Canada | Jul-13 | Dog | North America | Canada | 1 month | Human-mediated | In-country | By air | Found in area with ongoing outbreak, scavenging for food with other dogs (mother and newborn litter); not vaccinated before importation due to no vaccination requirement for in-country travel; suspected infection by arctic fox | Yes | PEP, quarantine of exposed animals (mother and litter dogs), sacrifice of associated animals (dog negative for rabies but euthanized at request of owner) | Outbreak | Yes | Curry et al., 2016 (141) |
| North America | Canada | Dec-14 | Dog | North America | Canada | 0 days | Human-mediated | In-country | By air, land | Found in construction work camp; not vaccinated before importation due to no vaccination requirement for in-country travel; manifested symptoms during travel and bit owner; suspected infection by arctic fox | Yes | PEP, vaccination of exposed animal (dog), 45-day quarantine of exposed animal (dog) | No local transmission | No | Curry et al., 2016 (141) |
| North America | United States of America | May-15 | Dog | Africa | Egypt | 4 days | Human-mediated | Intercontinental | By air | Found on street and imported by animal rescue organization along with >30 pets (dogs, cats) despite fracture injury; transported in same crate with own puppy; falsified vaccination certificate | No | Contact tracing, PEP, vaccination of exposed animals (puppy, booster for vaccinated dogs), quarantine of exposed dogs (puppy) | No local transmission | No | Sinclair et al., 2015 (142); Pieracci et al., 2020 (140); Latzer et al., 2022 (143) |
| North America | Canada | Dec-15 | Raccoon | North America | United States of America |  | Human-mediated | International (shared border) | By land/water (presumed) | Suspected long-distance incursion by stowing away on truck or ship; picked up by animal control along with 2 dogs; escaped cage and fought with dog; led to outbreak (>400 animals) | No | PEP, mass vaccination, ORV, enhanced surveillance (increased testing of sick animals), increased public awareness | Outbreak | Yes | Stevenson et al., 2016 (132); Trewby et al., 2017 (133); Lobo et al., 2018 (144); Gilbert & Chipman, 2020 (145); Nadin-Davis et al., 2020 (135) |
| North America | Canada | 2015 | Raccoon | North America | United States of America |  | Natural | International (shared border) | By land |  | Yes |  | No local transmission | No | Birhane et al., 2017 (146); Trewby et al., 2017 (133); Nadin-Davis et al., 2020 (135) |
| North America | Canada | 2015 | Raccoon | North America | United States of America |  | Natural | International (shared border) | By land |  | Yes |  | No local transmission | No | Trewby et al., 2017 (133) |
| North America | United States of America | Mar-16 | Raccoon | North America | United States of America |  | Human-mediated | In-country | By land | Suspected human-mediated incursion from Connecticut into New York | Yes | Enhanced surveillance, increased public awareness | No local transmission | No | Brunt et al., 2020 (147) |
| North America | United States of America | Dec-16 | Cat | North America | United States of America |  | Human-mediated | In-country | By air/land (presumed) | Imported from Iowa to New York for vacation without vaccination; attacked 1 dog, 3 humans; suspected infection by skunk | Yes |  | No local transmission | No | Brunt et al., 2021 (148) |
| North America | United States of America | Dec-16 | Otter | North America | United States of America |  | Natural | In-country | By water | Suspected incursion from Connecticut into New York | Yes |  | No local transmission | No | Brunt et al., 2020 (147) |
| North America | United States of America | Feb-17 | Cat | North America | United States of America | 5 months | Human-mediated | In-country | By air/land (presumed) | Newly adopted before importation from North Carolina to Arkansas along with >10 other pets (cats, dogs) then later surrendered to Humane Society of Summit County in Ohio; vaccinated but not for rabies (according to facility guidelines, rabies vaccination only administered at time of spay/neuter); suspected infection by raccoon | Yes | PEP, vaccination of exposed animals (recommended), 6-month quarantine of exposed animals (cats) | No local transmission | No | Singh et al., 2018 (58) |
| North America | United States of America | Nov-17 | Cat | North America | United States of America |  |  | In-country | By land (presumed) | Imported from Westchester County to Long Island without vaccination; bit veterinary staff; suspected infection by raccoon | Yes |  | No local transmission | No | Brunt et al., 2020 (147) |
| North America | United States of America | Dec-17 | Dog | Africa | Egypt | 1 day | Human-mediated | Intercontinental | By air | Iimported from with 3 other dogs by animal rescue organization despite visible injuries; suspected falsified rabies vaccination document; bit 1 human (flight parent) before boarding plane | No | Contact tracing, PEP, booster vaccination of exposed animals (dogs), quarantine of exposed animals (dogs), monitoring | No local transmission | No | Blanton et al., 2009 (149); Hercules et al., 2018 (138); Chevalier & Havas, 2019 (150); Latzer et al., 2022 (143) |
| North America | United States of America | Jan-19 | Dog | Africa | Egypt (via Canada) | 1 month | Human-mediated | Intercontinental, international (shared border) | By air, land | Recently fostered before importation with >20 other dogs; bit 1 human (veterinary technician) during examination; had rabies vaccination certificate but serologic testing showed lack of vaccination in some dogs, indicating vaccination failure or falsification of vaccination certificate | No | PEP, suspension of dogs entering USA from Egypt, vaccination of exposed animals (booster) and 45-day monitoring, 6-month quarantine of exposed animals (unvaccinated dogs), quarantine of imported animals (dogs) and serologic monitoring | No local transmission | No | Raybern et al, 2019 (151); Latzer et al., 2022 (143) |
| North America | United States of America | May-21 | Anteater | North America | United States of America | 2 months | Human-mediated | In-country | By air/land (presumed) | Imported from Virginia zoo to Tennessee Zoo; suspected infection by raccoon | Yes | Contact tracing, PEP, vaccination of exposed animal (tamandua) that was presumed unvaccinated due to missing vaccination records), quarantine of exposed animal (tamandua) | No local transmission | No | Grome et al, 2022 (152) |
| North America | United States of America | Jun-21 | Dog | Asia | Azerbaijan | 3 days | Human-mediated | Intercontinental | By air, other | Imported with >30 other animals (dogs, cat) by animal rescue organization; serologic testing showed insufficient levels despite confirmed vaccination, indicating vaccination failure due to underdosing | No | Contact tracing, PEP, (booster) vaccination of exposed animals (dogs, cat), serologic monitoring and 45-day quarantine of imported animals (dogs), suspension of dog importations from DMRVV high-risk countries | No local transmission | No | Williams & Pieracci, 2021 (153); Whitehill et al., 2022 (154) |
| North America | Canada | Jul-21 | Dog | Asia | Iran (via Germany) | 11 days | Human-mediated | Intercontinental | By air | Newly adopted and imported by animal rescue organization; presumed vaccinated but was not revaccinated upon arrival despite vaccination policy for young dogs | No | Contact tracing, PEP, (booster) vaccination of exposed animals (dog), 3-month quarantine of exposed animal (dog) due to delayed identification | No local transmission | No | Rebellato et al., 2022 (155) |
| South America | Brazil | 2006 | Dog | South America | Bolivia |  | Natural | International (shared border) | By land | Attributed to high numbers of free-roaming dogs | No | Mass dog vaccination | No local transmission | No | Galhardo et al., 2019 (156) |
| South America | Peru | 2015 | Dog | South America | Peru |  | Natural | In-country | By land | Incursion from Puno into Arequipa; attributed to low vaccination rate among free-roaming dogs, commonly found foraging in water channels throughout city that collect garbage for foraging during dry season; led to outbreak | No | Mass dog vaccination, culling (stray dogs) | Outbreak | No | Castillo-Neyra et al., 2017 (157); Castillo-Neyra et al., 2017 (158); Raynor et al., 2020 (159) |
| South America | Brazil | 2015 | Dog | South America | Bolivia |  | Natural | International (shared border) | By land | Further spread led to outbreak in Mato Grosso do Sul | No | Outbreak ended in 2015 | Outbreak | No | Benavides et al., 2019 (160) |

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