

## References

- Bangs, E.E., and S.H. Fritts. 1996. Reintroducing the gray wolf to central Idaho and Yellowstone National Park. *Wildlife Society Bulletin* 24:402–12.
- CTIA (Cellular Telecommunications and Internet Association) 2006. Estimated Current U.S. Wireless Subscribers. Accessible at <http://www.ctia.org/>.
- Eisenberger, R., and R. Loomis. 2002. Visitor experience and media effectiveness: Rocky Mountain and Yellowstone National Parks. Report to the National Park Service. 41pp.
- Hahn, R.W., and J.E. Prieger. 2007. The Impact of Driver Cell Phone Use on Accidents. AEI Bookings Joint Center for Regulatory Studies. Published in the B.E. Journal of Economic Analysis and Policy.
- Haroldson, M.A. 2006. Grizzly bear capturing, collaring, and monitoring: unduplicated females. Pages 11–16 in C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: Annual report of the Interagency Grizzly Bear Study Team, 2005. U.S. Geological Survey, Bozeman, Montana.
- Knight, R.R., and L.L. Eberhardt. 1985. Population dynamics of Yellowstone grizzly bears. *Ecology* 66:323–334.
- Manni, M.F., M. Littlejohn, J. Evans, J. Gramann, and S.J. Hollenhorst. 2006. Yellowstone National Park Visitor Study, Summer 2006. Park Studies Unit Visitor Services Project Report 178. June 2007. 102pp.
- Mattson, D.J. 1997. Use of ungulates by Yellowstone grizzly bears (*Ursus arctos*). *Biological Conservation* 81:161–177.
- McEneaney, T. 2002. Piscivorous birds of Yellowstone Lake: their history, ecology, and status. Pages 121-134 in R. J. Anderson and D. Harmon, editors. Yellowstone Lake: hotbed of chaos or reservoir of resilience? Proceedings of the 6th Biennial Scientific Conference on the Greater Yellowstone Ecosystem. Yellowstone Center for Resources and the George Wright Society, Mammoth, Wyoming, USA.
- McEneaney, T. 2006. Yellowstone bird report 2005. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming.
- Miller, C.R., and L.P. Waits. 2003. The history of effective population size and genetic diversity in the Yellowstone grizzly (*Ursus arctos*): Implications for conservation. Proceedings of the National Academy of Sciences 100:4334–4339.
- Murphy, K.M., T. Potter, J. Halfpenny, K. Gunther, T. Jones, and P. Lundberg. 2006. Distribution of Canada lynx in Yellowstone National Park. *Northwest Science* 80:199–206.
- National Park Service (NPS). 2006. Management policies 2006. U.S. Department of the Interior, National Park Service, Washington, D.C., USA.
- NPS 2000. Director's Order #47: Soundscape Preservation and Noise Management
- NPS 2000. Director's Order/Reference Manual #53: Special Park Uses

- NPS 1973. Wilderness Recommendation. Yellowstone National Park, Idaho/Montana/Wyoming. 29pp.
- NPS 1974. Yellowstone National Park Master Plan. Yellowstone National Park, Wyoming. 34pp.
- NPS 1991. Yellowstone National Park Statement for Management. Yellowstone National Park, Wyoming. 79pp.
- NPS 1992. Parkwide Telephone Modernization Project Environmental Assessment. Yellowstone National Park, May 1992. 58pp.
- NPS 1998. Mammoth Area Cellular Communications Sites Environmental Analysis. Yellowstone National Park, May 1998. 14pp.
- NPS 1999. Old Faithful/Grant Village Cellular Communications Site Environmental Analysis. Yellowstone National Park, August 1999. 25pp.
- NPS 2000. Long-range interpretive plan. Yellowstone National Park. May 2000. 32pp.
- NPS 2003. Yellowstone National Park Business Plan. July 2003. 43pp.
- NPS 2007. Yellowstone National Park *Core Operations One-Year Report*. 94pp.
- NPS 2007. Yellowstone National Park, 2007 Visitor Survey Card Data Report, University of Idaho Park Studies Unit, Report # YELL 707. 4pp.
- Olliff, S.T., and S. Consolo Murphy. 2000. Seeking a scientific approach to backcountry management in Yellowstone National Park. *In* Cole, David N. and S.F. McCool, editors. Wilderness science in a time of change conference. Proceedings PMRS-P-000. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. (5) 348-353.
- Oosterhous, T., M. Legg, and R. Darville. 2007. What draws people to Yellowstone's backcountry? *Yellowstone Science* 15:3.
- Podruzny, S. 2006. Occupancy of bear management units (BMU) by females with young. Page 17 *in* C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: Annual report of the Interagency Grizzly Bear Study Team, 2005. U.S. Geological Survey, Bozeman, Montana.
- Redelmeier, D.A., and R.J. Tibshirani. 1997. Association between Cellular-Telephone Calls and Motor Vehicle Collisions. *The New England Journal of Medicine* Vol. 336, No. 7. February 13, 1997.
- Ruediger, B., J. Claar, S. Gniadek, B. Holt, L. Lewis, S. Mighton, B. Naney, G. Patton, T. Rinaldi, J. Trick, A. Vandehey, F. Wahl, N. Warren, D. Enger, and A. Williamson. 2000. Canada lynx conservation assessment and strategy. USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, and USDI National Park Service, Missoula, Montana.
- Smith, D.W., D.R. Stahler, D.S. Guernsey. 2006. Yellowstone Wolf Project Annual Report 2005. YCR-2006-04, National Park Service, Yellowstone Center for Resource, Yellowstone National Park, Wyoming.
- University of Utah (2008). Drivers On Cell Phones Clog Traffic. ScienceDaily. Retrieved January 6, 2008, from <http://www.sciencedaily.com/releases/2008/01/080102083801.htm>.

U.S. Fish and Wildlife Service. 1998. Pacific flyway management plan for the Rocky Mountain population of trumpeter swans. Subcommittee on Rocky Mountain trumpeter swans, Pacific flyway study committee, Portland, Oregon, USA.

## Glossary of Terms

Taken in part from the Cellular Telecommunications Industry Association (CTIA)

**Affected Environment:** The existing environment to be affected by a proposed action and alternatives.

**AMPS:** Advanced Mobile Phone Service (AMPS) is the original analog “cellular” service transmission standard first deployed in the United States, still used as a default standard for cellular systems in the U.S., and in some regions around the world.

**APE:** “Area of Potential Effect” The geographic area or areas within which an undertaking may cause changes in the character or use of cultural resources, if any resources exist there. This area always includes the actual site of an undertaking, but may also include other areas where the undertaking will cause changes in land use, traffic patterns, or other aspects that could affect cultural resources, including visual, atmospheric, or audible changes.

**Analog:** The traditional method of adapting radio signals so they can carry information. AM (Amplitude Modulation) and FM (Frequency Modulation) are the two most common analog systems. Analog has largely been replaced by digital technologies, which are more secure, more efficient and provide better quality.

**Antenna:** A device for transmitting and receiving radio frequency (RF) signals. Often camouflaged on existing buildings, trees, water towers or other tall structures, the size and shape of antennas are generally determined by the frequency of the signal they manage.

**Bandwidth:** The transmission capacity of a communications pathway. It is expressed in bits per second, bytes per second or in hertz (cycles per second).

**Base Station:** The central radio transmitter/receiver that communicates with mobile telephones within a given range (typically a cell site).

**Bluetooth:** The name for a technological standard (a communications protocol) that enables mobile devices equipped with a special chip to send and receive information wirelessly. Using Bluetooth, electronic devices such as desktop computers, wireless phones, electronic organizers and printers can communicate over short-ranges using the 2.4 GHz spectrum band.

**Broadband:** A transmission facility having a bandwidth (capacity) sufficient to carry multiple voice, video or data channels simultaneously. Broadband is generally equated with the delivery of increased speeds and advanced capabilities, including access to the Internet and related services and facilities “that provide 200 kbps upstream and downstream transmission speeds” (per the FCC’s Fourth Annual Report to Congress on the “Availability of Advanced Telecommunications Capability in the United States,” September 2004).

**Broadcast:** To transmit information over the airwaves to two or more receiving devices simultaneously. Information can be transmitted over local television or radio station, satellite systems or wireless data communications networks.

**BTA (Basic Trading Area):** A geographic area designed by Rand McNally to reflect business centers, and adopted by the FCC for the licensing of Personal Communications Services and some other wireless services. BTAs are composed of several neighboring counties associated by business and commuting patterns. The U.S. is divided into 493 BTAs

**Carrier:** Also known as service provider or operator, a carrier is the communications company that provides customers service (including air time) for their wireless phones.

**CDMA (Code Division Multiple Access):** A technology used to transmit wireless calls by assigning them codes. Calls are spread out over the widest range of available channels. Then codes allow many calls to travel on the same frequency and also guide those calls to the correct receiving phone.

**Cell:** The basic geographic unit of wireless coverage. Also, shorthand for generic industry term "cellular." A region is divided into smaller "cells," each equipped with a low-powered radio transmitter/receiver. The radio frequencies assigned to one cell can be limited to the boundaries of that cell. As a wireless call moves from one cell to another, a computer at the Mobile Telephone Switching Office (MTSO) monitors the call and at the proper time, transfers the phone call to the new cell and new radio frequency. The handoff is performed so quickly that it's not noticeable to the callers.

**Cell Site:** The location where a wireless antenna and network communications equipment is placed in order to provide wireless service in a geographic area.

**Cell Splitting:** A means of increasing the capacity of a wireless system by subdividing one cell into two or more smaller cells.

**Cellular:** A mobile communications system that achieves enhanced system capacity by dividing up a coverage area into regions called cells, then reusing the available spectrum from cell to cell (Frequency Reuse). When a mobile user moves from a cell to an adjacent cell, a hand-off must be performed to ensure uninterrupted service.

**Channel/Circuit:** A communications pathway that may take the form of a connection established over wireless, wired, or fiber optic facilities.

**Co-Location:** Placement of multiple antennas at a common site. Some companies act as brokers or cell site managers, arranging cell sites and coordinating many carriers' antennas at a single cell site.

**Council on Environmental Quality (CEQ):** Established by Congress with the Executive Office of the President with passage of the National Environmental Policy Act of 1969. CEQ coordinates federal environmental efforts and works closely with agencies and other White House offices in the development of environmental policies and initiatives.

**CSD (Circuit Switched Data):** One technological approach used for the exchange of data. A circuit connection is made that is exclusively reserved for the individual's use. This can be inefficient, as many communications do not require a dedicated communications channel, but only brief connectivity, for the transmission of short messages.

**CMRS (Commercial Mobile Radio Service) Provider:** An FCC designation for any wireless carrier or license owner whose wireless service is connected to the public switched telephone network and/or is operated for profit. Wireless services that are offered to the public are classified as CMRS, unlike private systems which are classified as "Private Mobile Services."

**Decibel (dBa):** In electronics and communication, the decibel is a logarithmic expression of the ratio between two signal power, voltage, or current levels. In acoustics, the decibel is used as an absolute indicator of sound power per unit area. A decibel is one-tenth of a Bel, a seldom-used unit named for Alexander Graham Bell, inventor of the telephone.

**Developed Area:** As used in this plan, include the areas that buildings are congregated for visitor use activities (visitor centers, gas stations, postal services, stores, restaurants, and lodging facilities. In some cases these areas may also include boardwalks, and paved walkways to thermal or scenic

features close the development. Major developed areas of the park include Mammoth Hot Springs, Tower-Roosevelt, Canyon Village, Lake, Grant Village, and Old Faithful.

**Digital:** Technological approach that converts signals (including voice) into the binary digits '0' and '1'. This data is compressed, and then transformed into electronic pulses for a wired network, optical light waves for fiber optic networks or radio waves for wireless networks. Digital wireless technology has largely superseded analog technology, because digital delivers more capacity and supports more applications, as well as offers better sound quality, and more secure signals.

**DSL (Digital Subscriber Line):** A digital line connecting the subscriber's terminal to the serving company's central office, providing multiple communications channels able to carry both voice and data communications simultaneously.

**Dual Band:** A wireless handset that works on more than one spectrum frequency, e.g., in the 800 MHz frequency and 1900 MHz frequency bands.

**Dual Mode:** A wireless handset that works on both analog and digital networks.

**EDGE:** Enhanced Data Rate for Global Evolution is an evolutionary step in the GSM-development path for faster delivery of data, delivered at rates up to 384 Kbps. The standard is based on the GSM technology platform and uses the TDMA approach (see TDMA, below).

**Electromagnetic Frequencies:** The transmission of electrical energy through wires, the broadcasting of radio signals and the phenomenon of visible light.

**Emergency Services:** Public services that respond to emergency situation including police, fire, rescue, and EMS.

**Endangered Species Act (ESA) (16 USC § 1531 et seq.):** An act to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved and to provide a program for the conservation of such endangered species and threatened species.

**Enhanced 911 (E-911):** 911 service becomes enhanced 911 emergency reporting service when there is a minimum of two species features added to it. E-911 provides ANI (Automatic Number Identification) and ALI (Automatic Location Information) to the 911 operator.

**ESMR (Enhanced Specialized Mobile Radio):** A single wireless device that combines a two-way radio, phone, mobile dispatch, radio paging and Mobile data capabilities, and operates on digital networks. Examples of ESMR service providers include Nextel Communications, Nextel Partners, and Southern LINC Wireless, among others.

**ESN (Electronic Serial Number):** The unique serial identification number programmed into a wireless phone by the manufacturer. Each time a call is placed, the ESN is transmitted to a nearby base station so the wireless carrier can validate the call. The ESN differs from the Mobile Identification Number, which identifies a customer's wireless phone number. MINs and ESNs are electronically monitored to help prevent fraud.

**Evolution-Data Optimized (EV-DO):** A wireless radio broadband data standard adopted by CDMA mobile service providers in United States, and other countries. EV-DO is aimed at delivering maximum downlink speeds of 3.1 Mb/s.

**Federal Regulatory Fee:** Annual communications regulatory fees as mandated by Congress. The fees require the FCC to recover the regulatory costs associated with its enforcement, policy and

rulemaking, user information, and international initiatives.

**FDD (Frequency Division Multiplexing):** Frequency-division multiplexing is a method in which numerous signals are combined for transmission on a single communications channel. Each signal is assigned a different frequency (subchannel) within the main channel.

**GPRS (General Packet Radio Service):** A packet technology approach that enables high-speed wireless Internet and other GSM-based data communications. It makes very efficient use of available radio spectrum for transmission of data.

**GPS (Global Positioning System):** A worldwide satellite navigational system, made up of 24 satellites orbiting the earth and their receivers on the earth's surface. The GPS satellites continuously transmit digital radio signals, with information used in location tracking, navigation and other location or mapping technologies.

**GSM (Global System for Mobile Communications):** A technological approach also based on dividing wireless calls into time slots. GSM is most common in Europe, Australia and much of Asia and Africa. Generally, GSM phones from the United States are not compatible with international GSM networks because the U.S. and many other nations use different frequencies for mobile communications. However, some phones are equipped with a multi-band capability to operate on such other frequencies.

**Handoff:** The process when a wireless network automatically switches a mobile call to an adjacent cell site.

**Historic District:** An area that generally includes within its boundaries a significant concentration of properties linked by architectural style, historical development, or a past event.

**iDEN (Integrated Digital Enhanced Network):** A specialized mobile technology that combines two-way radio, telephone, text messaging and data transmission into one digital network. iDEN is designed to give users quick access to information on a single device. Introduced by Motorola and used by AirTel Montana, Nextel Communications, Nextel Partners, and Southern LINC Wireless, among others.

**Infrastructure:** The basic facilities, equipment, and installations needed for the functioning of a system.

**Interconnection:** Connecting one wireless network to another, such as linking a wireless carrier's network with a local telephone company's network.

**Interoperability:** The ability of a network to coordinate and communicate with other networks, such as two systems based on different protocols or technologies.

**LAN (Local Area Network):** Is a small data network covering a limited area, such as a building or group of buildings. Most LANs connect workstations or personal computers. This allows many users to share devices, such as laser printers, as well as data. The LAN also allows easy communication, by facilitating e-mail or supporting chat sessions.

**Megahertz (MHz):** Is a unit of frequency equal to one million hertz or cycles per second. Wireless mobile communications within the United States generally occur in the 800 MHz, 900MHz and 1900MHz spectrum frequency bands.

**MIN (Mobile Identification Number):** The MIN, more commonly known as a wireless phone number, uniquely identifies a wireless device within a wireless carrier's network. The MIN is dialed

from other wireless or wireline networks to direct a signal to a specific wireless device. The number differs from the electronic serial number, which is the unit number assigned by a phone manufacturer. MINs and ESNs can be electronically checked to help prevent fraud.

**MSA (Metropolitan Statistical Area):** One of the 306 urban-centered cellular service areas based on the largest urban markets as designated by the U.S. government in 1980. Two “cellular” service operators are licensed in each MSA.

**MTA (Major Trading Area):** A geographic area designed by Rand McNally to reflect business centers, and adopted by the FCC for the licensing of Personal Communication Services and some other wireless services. MTAs are composed of neighboring basic trading areas (BTAs) associated with major business centers. The U.S. is divided into 51 MTAs, which do not reflect state boundaries.

**MTSO (Mobile Telephone Switching Office):** The central computer that connects wireless phone calls to the public telephone network. The MTSO controls the series of operations required to complete wireless calls, including verifying calls, billing and antenna handoffs.

**OFDM (Orthogonal Frequency Division Multiplexing):** A system for the transmission of digital message elements spread over multiple channels within a frequency band, in order to achieve greater throughput while minimizing interference and signal degradation through the use of multiple antennas.

**Packet:** A piece of data sent over a packet-switching network, such as the Internet. A packet includes not just the data comprising the message but also address information about its origination and destination.

**Packet Data:** Information that is reduced into digital pieces or ‘packets’, so it can travel more efficiently across networks, including radio airwaves and wireless networks.

**PCS (Personal Communications Services):** Defined by the FCC as a broad family of wireless services, commonly viewed as including two-way digital voice, messaging and data services. One set of “PCS” licenses established by the FCC operates in the 1900 MHz band.

**PDA (Personal Digital Assistant):** A portable computing device capable of transmitting data. These devices offer services such as paging, data messaging, e-mail, computing, faxes, date books and other information management capabilities.

**PIN (Personal Identification Number):** An additional security feature for wireless phones, much like a password. Programming a PIN into the Subscriber Information Module (SIM) on a wireless phone requires the user to enter that access code each time the phone is turned on.

**Protocol:** A standard set of definitions governing how communications are formatted in order to permit their transmission across networks and between devices.

**PSD (Packet Switched Data):** A technological approach in which the communication “pipe” is shared by several users, thus making it very efficient. The data is sent to a specific address with a short delay. This delay depends on how many users are using the pipe at any one time as well as the level of priority requested for your information. PSD is the technology used for data communication across the Internet and makes more efficient use of the network.

**RAWS:** “Remote Automated Weather Station” A self powered and automated weather data collection and retrieval platform that stores weather information digitally. Data retrieved is in digital format through satellite transmission, phone transmission, radio transmission or by direct connection with a personal computer. These stations are usually powered by solar panels and batteries and require annual maintenance to calibrate instruments. Frontcountry



automated weather station usually are powered by direct connection to a power source and phone line.

**Repeater:** Devices that receive a radio signal, amplify it and re-transmit it in a new direction. Used in wireless networks to extend the range of base station signals and to expand coverage. Repeaters are typically used in buildings, tunnels or difficult terrain.

**Roaming:** When traveling outside their carrier's local service area, roaming allows users to continue to make and receive calls when operating in another carrier's service coverage area.

**RSA (Rural Service Area):** One of the 428 rural markets across the United States, as designated by the FCC for the delivery of cellular service outside of the initial 306 MSAs.

**Smart Antenna:** A wireless antenna with technology that focuses its signal in a specific direction. Wireless networks use smart antennas to reduce the number of dropped calls, and to improve call quality and channel capacity.

**Smart Phone:** Wireless phones with advanced data features and often keyboards. What makes the phone "smart" is its ability to manage and transmit data in addition to voice calls.

**SMS:** Short Messaging Service enables users to send and receive short text messages (usually about 160 characters) on wireless handsets. Sometimes referred to as "text messaging."

**Spectrum Allocation:** Process whereby the federal government designates frequencies for specific uses, such as personal communications services and public safety. Allocation is typically accomplished through lengthy FCC proceedings, which attempt to adapt allocations to accommodate changes in spectrum demand and usage.

**Spectrum Assignment:** Federal government authorization for the use of specific frequencies within a given spectrum allocation, usually in a specific geographic location. Mobile communications assignments are granted to both private users such as businesses, and commercial providers such as wireless and paging operators. Spectrum auctions and/or frequency coordination processes, which consider potential interference to existing users, may apply.

**Spread Spectrum:** A method of transmitting a radio signal by spreading it over a wide range of frequencies. This reduces interference and can increase the number of simultaneous users on one radio frequency band.

**TCP/IP (Transmission Control Protocol/Internet Protocol):** A protocol permitting communications over and between networks, the TCP/IP protocol is the basis for the Internet communications.

**TDMA (Time Division Multiple Access):** A technological standard that permits the transmission of information by dividing calls into time slots, each one lasting only a fraction of a second. Each call is assigned a specific portion of time on a designated channel. By dividing each call into timed 'packets,' a single channel can carry many calls at once.

**Telecommunications Relay Service (TRS):** A telephone service that allows persons with hearing or speech disabilities to place and receive telephone calls.

**Third-Generation (3G):** A general term that refers to technologies which offer increased capacity and capabilities delivered over digital wireless networks.

**Tri-Band Handset:** Phones that work on multiple frequencies, typically in the 1900 MHz, 800 MHz, and 900 MHz frequencies used in the U.S. and elsewhere.

**Tri-Mode Handset:** Phones that operate in different modes, such as the CDMA, TDMA, and analog standards.

**UMTS (Universal Mobile Telecommunications Systems):** This is third generation technology generally based on W-CDMA (Wideband Code Division Multiple Access). UMTS promises a communications speed between 384 kbps and up to about 2 Mbps.

**Viewshed:** A physiographic area composed of land, water, biotic, and cultural elements which may be view and mapped from one or more viewpoints and which has inherent scenic qualities and/or aesthetic values as determined by those who view it.

**VoIP (Voice over Internet Protocol):** VoIP is not simply capable of delivering voice over IP, but is also designed to accommodate two-way video conferencing and application sharing as well. Based on IP technology, VoIP is used to transfer a wide range of different type traffic.

**Voice Recognition:** The capability for wireless phones, computers and other devices to be activated and controlled by voice commands.

**WAN (Wide Area Network):** A general term referring to a large network spanning a country or around the world. The Internet is a WAN. A public mobile communications system such as a cellular or PCS network is a WAN.

**WAP (Wireless Application Protocol):** Wireless Application Protocol is a set of standards that enables wireless devices, such as phones, pagers and palm devices, to browse content from specially-coded Web pages.

**WCF (wireless communications facility):** Same as WTF, see below.

**W-CDMA:** Wideband Code Division Multiple Access, one of two 3G standards that makes use of a wider spectrum than CDMA and therefore can transmit and receive information faster and more efficiently.

**WiFi (Wireless Fidelity):** WiFi provides wireless connectivity over unlicensed spectrum (using the IEEE 802.11a or 802.11b,g,n, standards), generally in the 2.4 and 5 GHz radio bands. Wi-Fi offers local area connectivity to WiFi-enabled computers. WiFi was intended to be used for mobile devices and LANs, but is now often used for Internet access. It enables a person with a wireless-enabled computer or personal digital assistant (PDA) to connect to the Internet when in proximity of an access point. The geographical region covered by one or several access points is called a hotspot.

**Wi-Max:** An acronym that stands for Worldwide Interoperability for Microwave Access, a certification mark for projects that pass conformity and interoperability tests for the IEE 802.16 standards providing metropolitan area network connectivity for fixed wireless access at broadband speeds. Products that pass the conformity tests for WiMAX are capable for forming wireless connections between them to permit the carrying of Internet packet data. It is similar to WiFi in concept, but has certain improvements that are aimed at improving performance and should permit usage over much greater distances.

**Wireless:** Describing radio-based systems that allow transmission of telephone and/or data signals through the air without a physical connection, such as a metal wire or fiber-optic cable.

**Wireless Internet:** A general term for using wireless services to access the Internet, e-mail and/or the World Wide Web.

**Wireless Local Area Network (WLAN):** Using radio frequency (RF) technology, WLANs transmit

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and receive data wirelessly in a certain area. This allows users in a small zone to transmit data and share resources, such as printers, without physically connecting each computer with cords or wires.

**Wireless Private Branch Exchange (PBX):** Equipment that allows employees or customers within a building or limited area to use wireless devices in place of traditional landline phones.

**Wireless Services:** Any of a number of technologies or services “typically electronic” that allow the transfer of information over a distance without the use of electrical conductors “wires” using various radio frequencies without being physically wired together.

**WLL (Wireless Local Loop):** WLL is a system that connects wireless users to the public switched telephone network (PSTN) using wireless technology and other circuitry to complete the “last mile” between the wireless user and the exchange equipment. Wireless systems can often be installed faster and cheaper than traditional wired systems.

**WTF (wireless telecommunications facility):** The term includes all associated infrastructure (equipment, antennas, poles, towers, supports, structures, power, conduit, access roads, and other components) used for construction, operation and maintenance.

# Appendices

## Appendix 1. Observations, North American Bird Count

Observations during the North American Bird Migration Count, also known as the International Migratory Bird Day Count, on May 12, 2007, in Yellowstone National Park and from Gardiner to Livingston in Montana. Abbreviations are: SB-FB = Sedge Bay-Fishing Bridge; FB-C = Fishing Bridge-Canyon; C-N-M = Canyon-Norris-Mammoth; M-G = Mammoth-Gardiner (Wyoming); M-G = Mammoth-Gardiner (Montana); GV-PV = Gardiner Valley-Paradise Valley; and SV = Shield's Valley.

Species	Wyoming					Montana		Totals
	SB-FB	FB-C	C-N-M	M-G	M-G	GV-PV	SV	
Canada Goose	30	24	6			10	40	110
Trumpeter Swan						1	3	4
Green-winged Teal	20	6	8				25	59
Mallard	22	4	4			11	28	69
Northern Pintail	4						16	20
Blue-winged Teal		1					2	3
Cinnamon Teal	8						12	20
Northern Shoveler	6						14	20
Gadwall	44						12	56
American Wigeon	84						34	118
Lesser Scaup	76	10	44				46	176
Ring-necked Duck	4						20	24
Common Goldeneye	12	3						15
Barrow's Goldeneye	46	12	2					60
Bufflehead	20	4						24
Harlequin Duck		9						9
Common Merganser	8	2				4		14
Ruddy Duck	1							1
Common Loon							1	1
Eared Grebe							45	45
Western Grebe							26	26
American White Pelican	5					20		25
Great Blue Heron	2	2				3	2	9
Osprey		1			1	1		3
Bald Eagle	1					2	1	4
Northern Harrier			2			1	1	4
Swainson's Hawk	2							2
Red-tailed Hawk		1	1			5	4	11
Golden Eagle							1	1
American Kestrel			2			5	3	10
Merlin						1		1
Peregrine Falcon	1							1
American Coot	1		4				20	25
Sandhill Crane	6		4				25	35
White-faced Ibis							17	17
Killdeer	8	4	2			1	3	18
Spotted Sandpiper		3				2		5

Least Sandpiper	1						1	
Willet						22	22	
American Avocet	7					9	16	
Lesser Yellowlegs						4	4	
Greater Yellowlegs						1	1	
Wilson's Snipe						1	1	
Wilson's Phalarope	1		13			8	22	
California Gull	1						1	
Franklin's Gull						21	21	
Rock Pigeon				1		2	3	6
Mourning Dove						5	4	9
Calliope Hummingbird						1		1
Downy Woodpecker						1		1
Hairy Woodpecker			1			1		2
Red-naped Sapsucker						1		1
Northern Flicker (red-shafted)	3		1			3	3	10
Eastern Kingbird					1			1
Horned Lark					2			2
Tree Swallow	100	6				30		136
Violet-green Swallow	6					25		31
Northern Rough-winged Swallow						20		20
Bank Swallow		22						22
Clark's Nutcracker			2			2		4
Black-billed Magpie			1		6	11	2	20
American Crow		4				3		7
Common Raven	12	8	8			4	2	34
Black-capped Chickadee								
Mountain Chickadee	2		2					4
House Wren			1					1
Rock Wren	1							1
American Dipper		1						1
Ruby-crowned Kinglet	8	4	20					32
Mountain Bluebird	4	4	1			2	4	15
Townsend's Solitaire	1							1
American Robin	61	20						81
European Starling		6				7	8	21
Yellow-rumped Warbler	6	5	2					13
Orange-crowned Warbler			1					1
Yellow Warbler						3	4	7
Vesper Sparrow	15	8	9		2	2	5	41
Song Sparrow						1		1
Savannah Sparrow	10	26	4					40
Chipping Sparrow		2						2
Brewer's Sparrow							2	2
White-crowned Sparrow	20							20
Dark-eyed Junco	4		5					9
Red-winged Blackbird	1					11	12	24
Western Meadowlark		4				11	9	24
Yellow-headed Blackbird	4		2					6
Brewer's Blackbird	1	18				8	13	40

Brown-headed Cowbird	4	4					2	5	15
Common Grackle							2		2
Cassin's Finch		14	8						22
House Finch							14		14
Pine Siskin	2		7				8		17
American Goldfinch							2		2
House Sparrow							2		2
	686	242	167	1	12	251	543	1902	

## Appendix 2. 14 year summary of data collected during the North American Bird Migration Count

A 14-year summary of data collected during the North American Bird Migration Count, also known as the International Migratory Bird Day Count, during 1992–2006 in Yellowstone National Park and from Gardiner to Livingston in Montana.

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
<b>Number Species Recorded</b>	72	74	61	82	93	91	85	85	91	90	78	90	96	89	94
<b>Revised Number Species</b> (1996 Standards and Route)	86	74	75	82	93	91	85	85	91	90	78	90	96	89	94
<b>Total Individual Birds</b>															
Yellowstone NP, WY	1,545	1,793	2,408	1,797	1,038	1,073	826	750	967	895	716	839	1,085	927	1096
Yellowstone NP, MT	289	145	242	113	94	64	163	912	74	128	205	34	172	96	12
Park County, MT	139	89	248	313	949	413	1,974	936	656	609	2,709	547	1,852	1,423	794
Grand Totals	1,973	2,027	2,898	2,223	2,081	1,550	2,963	2,598	1,697	1,632	3,630	1,420	3,109	2,446	1,902
<b>Number Observers</b>	2	5	7	4	4	4	3	5	5	5	4	4	3	4	5
<b>Total Hours in the Field</b>	16	47.5	76.5	28	42	48	36	69	44	55	44	44	35	40	50
<b>Total Species: Yellowstone</b>	69	73	52	73	70	69	70	61	65	71	56	66	80	68	69

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## Appendix 3. General Summary of Wireless Telecommunications Facilities

*Wireless telephony*, also known as wireless telecommunications, includes mobile phones, pagers, and two-way enhanced radio systems, and relies on the combination of land lines, fiber, and an extensive network of elevated antennas, typically found on communications towers, to transmit voice and data information. This technology is known as the first and second generation (1G and 2G) of wireless deployment.

### KEY COMPONENTS

The key components of any wireless telecommunications networks include:

1. Antenna
2. Support Structure
3. Equipment Housing
4. Utility Connection(s)
5. Access Road(s)

Telecommunications is the transmission, emission or reception of radio signals, digital images, sound bytes or other information via wires, cables, and space, through radio frequencies, satellites, microwaves, or other electromagnetic systems. Telecommunications includes the transmission of voice, video, data, and broadband using wireless or satellite technologies.

*One-way communication* for radio and television uses a combination of antennas and receivers to transmit signals from the station to an antenna or group of antennas located on a broadcast tower, which then transmits to the receiving devices found in a radio or television.

*Two-way communication* through traditional land line telephone service utilizes an extensive network of land lines to transmit a phone call between two people. Fiber optic cable can deliver high-speed Internet connection, cable television reception, and an alternative to traditional land line telephones. It uses an extensive network of copper wire lines above and below ground.

The first generation of wireless telecommunications, known as 1G, operated on an analog system in the 800 megahertz (MHz) range. This technology only carries one conversation per channel, limiting the number of users. Wireless telecommunications continued operating with 1G technology through the 1980s, when digital technology appeared and led to second generation, or 2G, wireless technology. The 2G technology used digital circuit switching that allowed multiple conversations on the same channel and greatly increased capacity (Silicon Press 2007).

Currently in the United States, wireless telecommunications are using 3G technology. This technology allows both universal access and portability across different device types with a faster communications speed than the 2G systems (Silicon Press 2007). Third, fourth, and fifth generations (3G, 4G, and 5G) of wireless telecommunications include the ability to provide instant access to e-mail, the Internet, radio, videos, TV pod-casting, mobile commerce, and Global Positioning System (GPS), in one hand-held wireless telephone unit. Successful use of this technology requires the deployment of a significant amount of additional infrastructure, i.e., elevated antennas on above ground structures such as towers, bridges, water tanks, roof-tops, signage, electrical transmission towers, and light poles.

### WIRELESS TELECOMMUNICATIONS FACILITY (WCF) APPEARANCE AND DESIGN

The design of WCFs can vary greatly, depending on the type of technology used, and this technology continues to evolve rapidly. Fixed facilities used for wireless telecommunications are referred to as cellular base stations, cell stations, PCS ("Personal Communications Service") stations or telephone transmission towers. These base stations consist of antennas and electronic equipment. Because the antennas need to be high in the air, they are often located on towers, poles, water tanks, rooftops, or other support structures.

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A WCF needs the following components: the support structure, the equipment building, the antennas, the utilities, and the access. Most support structures are made of aluminum, steel, stainless steel, wood, plastic or composite materials. There are four main types of facilities, which include mainly tower structures:

1. **Lattice Tower:** A lattice tower is typically three-sided with a triangular base and is often used in heavy loading conditions.
2. **Monopole Tower:** This is a tower that is a single pole. The heights of these structures generally do not exceed 200 feet. Antennas are mounted on the exterior of the tower.
3. **Guyed Tower:** These facilities are supported by guy wires anchored into the ground. Most radio and television towers are guyed towers. These structures can reach more and 300 feet in height.
4. **Stealth Tower or Other Type of Facility:** These facilities are poles, towers, or other structures that are designed to look like something else such as a tree or a sign. Many municipalities require these types of towers in their zoning regulations. They are generally more expensive than the other types of towers to install because of added materials needed to disguise the appearance of the facility, also known as a “stealth” facility.



**Various Examples of Wireless Communications Facilities**



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In addition to free standing support structures, antennas can also be placed on existing structures such as rooftops and signs.

The above support structures (or base stations) are used to house an antenna. An antenna is a structure or device that is used to radiate or receive electromagnetic waves. Generally a support structure will house multiple antennas from each carrier. In urban and suburban areas, wireless providers commonly use panel or sector antennas for their base stations. These antennas consist of rectangular panels, about 1 by 4 feet in dimension. The antennas are usually arranged in three groups of three antennas each. One antenna in each group is used to transmit signals to wireless phones, and the other two antennas in each group are used to receive signals from wireless phones.

WCFs include operating equipment, which is often called the Base Transmitter Station or BTS, or an equipment shelter. The electronic equipment associated with these facilities can be housed in either an equipment room within a pre-existing building, in a specially constructed outdoor equipment shelter, and/or in specialty cabinets designed by cellular providers or equipment vendors. Equipment cabinets range in size and capacity from one small cabinet that can be the size of a 2-foot by 2-foot square to the size of a refrigerator. Multiple cabinets may be required if a company decides to expand the capacity of a site, or there may be multiple cabinets associated with one structure that houses multiple providers' antennas. Equipment cabinets may be concealed to reduce visual impacts.

**Equipment housing/shelters** for a WCF typically include:

- environmental control (air conditioning and heating units)
- electrical power supply (DC battery packs and /or AC power and/or a power generator)
- a connection to local telephone lines (either a T-1 or E-1 line, similar to a regular phone line, or a microwave antenna placed near the main antennas)
- back-up power supply
- radio transceivers
- data interface which mediates between the telephone company and radios
- noise filters
- coaxial cables connecting the antennas to the equipment room/cabinet.

#### Technological Limits, Possibilities and Design Options

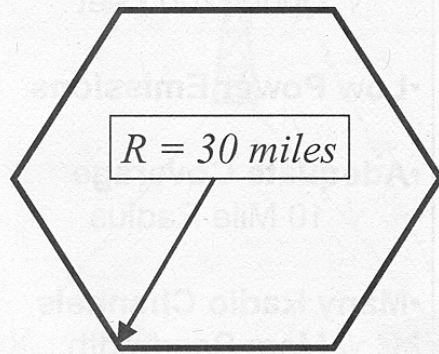
The Cellular Concept –

##### How Wireless Telecommunications Technology Works

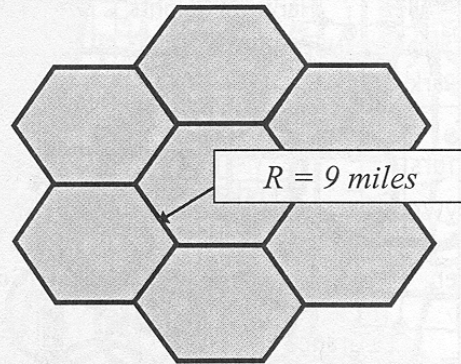
Wireless communications are transmitted through the air via radio waves of various frequencies. An elevated antenna or antenna set transmits and/or receives these radio signals. The area covered by an antenna set is commonly referred to as a "cell". Cellular systems are composed of interconnected neighboring "cell sites" forming a honeycomb effect. These cell sites operate on low amounts of electric energy.

# Frequency Re-Use Technology

## Then...& Now



Early systems used high power on high antennas to maximize range, but channels could not be re-used for great distances.



Modern systems use low power and low antennas, radio channels can be re-used more closely, increasing capacity.

In essence, cellular service is a low power two-way radio. In a cellular system each station is independent of, and interdependent with, the network. Each site is independent in that it provides service to a portion of the local area. However, each site is interdependent due to the way that the frequency channels are grouped for re-use.

### Location, Siting and Design Options for Minimizing Negative Impacts

Preferred location and conditions for wireless telecommunications facilities depend on the interplay of various location, siting, and design variables. The development of a multi-site wireless telecommunications network is an interactive process in which proposed site designs are tested and modified. A proposed site is not fixed to a particular point, rather a location is sought within an initial search area or "search ring" that may extend a half mile to a mile from its center. Because there are many variables involved, there are often potential alternatives that must be investigated. Just as the provider must try to optimize the network design for technical efficiency, the park would always work towards optimizing any potential design for minimum visual impacts.

### Antenna Height

Antenna height is an area of potential conflict between service providers - who seek to gain the widest possible signal coverage - and the park concerned with visual impacts. Generally speaking, the higher the antenna, the greater the coverage area, therefore, the greater the cost efficiency for the provider during initial roll out of a system. On the other hand, the height of an antenna mount is an important factor affecting how obtrusive a structure is visually. In some areas, it may be in the park's interest to require a potential provider to increase the frequency of antenna locations while lowering the height of each installation thereby achieving the same coverage with less visual impact. It is clear that there are some areas that require more protection or mitigation than others to address

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visual impacts. The challenge in planning for wireless telecommunications facilities is to protect resources while providing services to the visitor and for operations.

Wireless telecommunications systems are normally developed in phases. In the initial “coverage” phase, some providers who need multiple antenna sites, seek to locate a few taller mounts in strategic points along major highways and other areas of anticipated higher usage, to gain the widest signal pattern at the lowest cost. Later, as use of the system increases, the antenna mounts may become shorter, and more would be installed to increase the capacity of the system. The developed areas of Yellowstone National Park are not likely to expand, and visitation has been relatively constant for the last decade, though cell phone users have been increasing nationally, regionally, and locally. Lowering the antenna heights in the initial coverage phase is technologically possible, however, it may require the service providers to over-build their system, without any assurance that the over-built system will ever be used to full capacity or be of the design to best serve the area.

#### Horizontal Spacing

The spacing between cell towers in a network depends strongly on the antenna height. Typically, the lower the antenna mount, the smaller the cell, and more sites are needed to get the desired coverage. In Yellowstone National Park, the developed areas of the park are relatively compact in nature. Providing for cell coverage in the developed areas of the park may, in many cases, require a single mounting structure, that would allow for the required co-location opportunities for competing companies. As the cell sites may not “see” each other due to distance or topography, additional infrastructure needs to be in place for the network to function. Links between the sites need to be established back to a switching station either via a cable either buried, or strung on poles, or via a microwave link. Yellowstone currently has a system of microwave dishes within the park provided by the Qwest telephone company that link remote sites within the park.

Another aspect of horizontal separation is the separation of ground mounts from certain areas of sensitivity. The potential visual impact of tall structures underlies the link between structure height and a zone of sensitivity around certain uses. An improperly located and sited 150-foot or 200-foot mount may have a visual impact on scenic vistas miles away, even though the facility itself is located in a developed area of the park. Thus, consideration must be given to locating taller structures that are visually obtrusive at some distance away from visually sensitive areas, such as geyser basins, campgrounds, trails, or roads.

#### Use of Existing Structures

Wireless telecommunications antennas can be mounted on existing tall structures such as power transmission line towers or poles, buildings, water tanks, fire lookouts, and utility poles. When this can be done, it eliminates many of the concerns that arise when new, freestanding antenna mounts are proposed. Thus, an adequate inventory of suitable tall structures (including communication towers that can accommodate additional antennas) is another important tool to provide for suitable sites that minimize impacts.

#### Siting to Limit Visual Impact

It is possible to greatly reduce visual impacts through careful placement of the facility on certain sites. This would entail placement with respect to trees and/or buildings that can help screen the mount from line-of-site vantage points at ground level. Other strategies include placement outside the normal line of vision, such as inside a curve if near a roadway, and screening of the base and lower level of the mount through vegetation and/or intervening buildings or uses.

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## Mount Design

As defined in this plan, a mount is any supporting structure used to hold wireless telecommunications antennas at a desired height. The mount can consist of an existing building, water tank or similar structure or it can be a tower or pole fabricated specifically for that purpose and ground-mounted or mounted on the top or side of a building.

There are three basic types of fabricated mounts currently used by the industry. These include the steel lattice mounts, monopoles, and guyed mounts.

### WIRELESS TELECOMMUNICATIONS FACILITY INFRASTRUCTURE AND ZONING

The location of antennas used for transmitting radio signals and wireless data is critical to attaining a functioning wireless telecommunications network. With the deployment of 1G wireless, only two competing wireless cellular providers existed, both in the 800 MHz band. With the deployment of 2G, and the entrance of four competing PCS providers operating in the 1,900 MHz band, along with the Enhanced Specialized Mobile Radio (ESMR) system operating in the 850 MHz band, the wireless marketplace became fiercely competitive. “Speed to market” and “location, location, location” became the slogans for the competing 1G and 2G providers. The concept of sharing facility base stations was not part of the strategy; each provider sought to have the fastest deployment, and develop the largest customer base, resulting in a quick return on the cost of deployment.

Coincidentally, as local governments began to adopt development standards for the wireless communications industry, the industry strategy changed. The cost associated with each provider developing an autonomous inventory of facility base stations put a financial strain on the ability to deploy the networks. Therefore, most of the wireless providers divested their internal real estate departments and tower inventories. This change gave birth to a new industry—vertical real estate. The new industry included a consortium of tower builders, tower owners, site acquisition, and site management firms. No longer was a tower being built for an individual cellular, ESMR, or PCS provider, but towers were built for a multitude of potential new tenants who would share the facility without the individual cost of building, owning, and maintaining the facility. Sharing antenna space on the tower between multiple providers is called co-location.

The vertical real estate business model for new towers was founded on tall tower structures intended to support as many wireless providers as possible. As a result, local landscapes became dotted with all types of towers, and communities began to adopt regulations that tried to inhibit wireless telecommunications towers within their jurisdictional boundaries. Wireless deployment came to a halt in many geographical areas. Second generation wireless providers paid large sums of money for the rights to provide wireless services. But the license agreements between the wireless providers and the Federal Communications Commission (FCC) mandated the networks be deployed within a specific time period, and local government agencies were prohibiting the deployments through new zoning standards. This prompted the adoption of Section 704 of the Telecommunications Act of 1996, facilitating the placement of these facilities on federal lands.

The present model for new facilities provides for shorter structures that provide a smaller service area, better reflecting the need for more successful connectivity and resulting in fewer dropped calls and better overall service.

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