Virtual Fencing Primer

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What is Virtual Fencing (VF)?

VF is an emerging precision agriculture tool capable of improving grazing systems for both livestock producers and land managers.

Tracking Livestock

VF collars use satellites to determine GPS location within a few meters, and use cellular signal to send and receive data and updates to the user. Users can monitor each animal's:

- Real-time location
- Historical tracks
- Pasture utilization

This is especially helpful on large, remote, or forested ranges where animals are otherwise hard to locate.

Reported benefits include:

- Faster roundups
- Alerts for stationary animals (who may be sick or have lost a collar)
- Faster response times for escaped animals

Containing Livestock

VF collars precisely contain or exclude livestock within user-defined boundaries without the need for physical fence. Using a smart device, the user draws a VF boundary in minutes and sends it to collars via cell signal, typically within an hour.
As an animal crosses a VF boundary, the collar emits an **audio cue**, followed by a **mild electric pulse** if needed.

UC ANR TRIAL RESULTS

- Livestock respond to audio cues alone **more than 90%** of the time.
- Immediately after first collaring, herds are contained within VF

boundaries **over 95%** of the time.

VF boundaries also let animals enter freely but contain them if they try to leave. While **not a replacement** for secure perimeter fence where 100% containment is needed, VF is a versatile alternative to cross fencing.

Applications of VF on Forested Rangeland

Some applications seeing active use and merit include:

- ✓ **Targeted grazing** to reduce flashy and brushy fuels to meet land management goals
- ✓ **Excluding livestock** from recent burns, active logging areas, riparian zones/meadows, infrastructure, recreational areas, archaeological sites, etc.
- ✓ **Rapid re-entry to areas after wildfire**, allowing grazing to resume in unburned sections without (or while) rebuilding lost fences
- ✓ **Tracking livestock** across remote terrain to reduce trips, shorten round-ups, and respond faster to downed or escaped livestock
- ✓ **Preventing escapes** from open gates or damaged fences
- ✓ **Minimizing public interaction** by keeping herds away from roads, trails, and populated areas
- ✓ **Offsetting the need** for cross-fence construction

VF Costs

VF costs include an initial investment (typically **$10K–$40K**) and annual recurring costs starting in year two (typically **$1K–$7K**).
Costs vary by:

- **Livestock type and number to collar** (cattle, goats, or sheep)
- **Cellular coverage** across your range — some VF systems use LoRaWAN base stations, while others rely solely on cell networks
    - **LoRaWAN:** Base stations are solar-powered cellular antennas placed on high points of the range. Ideal if cell reception is spotty or limited to ridgelines. Costs $4.5K–$10K each.
    - **Cellular:** Best for ranges with good, consistent coverage. Simpler setup and potentially lower total cost.
- **Whether you prefer to buy or lease collars** — some grants can't cover long-term equipment but would cover leased collars

When VF Can Be Cost-Effective

High costs and reliance on cell networks currently limit broader VF adoption, but it can be cost effective in certain scenarios:

- **Alternative to cross fencing:** Building new cross fencing can cost $41K per linear mile for materials and labor (based on current NRCS EQIP rates at nrcs.usda.gov). Whether installing new fence, replacing old ones, or rebuilding after wildfire, this cost can rapidly exceed a VF system.
- **Shared costs:** Agreements between permittee to buy collars and land agency to buy base stations can be successful.
- **External funding:** Some conservation programs (e.g. NRCS EQIP) are supporting VF funding, but few are active as of June 2025.

1) VF System Infrastructure

Infrastructure of Current VF Systems

COMPONENT 1

VF Collar

This is the unit that every adult animal in the herd wears on their neck. It contains:

- GPS receiver
- Cellular or LoRaWAN communication module

- Neckband and speaker (audio cues)
- Electrodes (electric pulse cues)
- Battery (single use or solar charged)

Current vendors: Gallagher, Vence, Nofence, Halter

COMPONENT 2

User Interface

A website or mobile app that displays a map of the pasture and locations of every herd member. The end user can:

- Monitor livestock locations and status
- Create, modify, and assign VF boundaries
- Mark infrastructure

Generally, the desktop version has more features while the app is designed for field use. Most vendors offer both desktop and mobile options.

COMPONENT 3

Base Stations

Base stations are intermediary communication modules required for some VF systems. Instead of each collar connecting directly to the cellular network, collars communicate with a nearby base station through line-of-sight LoRaWAN radio signals, and the base station connects to the cellular network.
Although this adds infrastructure and cost, base stations are often essential on ranges with limited or inconsistent cellular signal, such as remote areas or landscapes with complex topography.

- The base station is installed where cell reception is reliable and there is good line of sight with the collars (e.g., a ridgetop).
- On landscapes with multiple ridges and valleys, more than one base station may be needed.
- Base stations usually operate with any major cellular provider available.
- VF vendors typically review publicly available FCC cellular coverage maps to help determine the expected level of service and number of base stations needed.

Comparing Direct-to-Cellular VF Systems with Base Station Systems

Pros and cons of Cellular Collars vs. Base Station Collars

Category	Cellular Collars	Base Station Collars
Pros	• Lower upfront cost • Simpler system • Significantly faster to deploy • Each collar is independent — if one fails, the rest still work • Generally, even a single bar of cell service is sufficient, though check-in times and updating the VF boundary may be slower	• Ideal for remote range with limited cell — only need cell signal where base stations are deployed (usually ridgetops) • 1–3 base stations generally enough (number varies by range geography) • Cheaper subscription costs than cell collars
Cons	• Relies on cell networks • May never have full range coverage • Requires some cell signal throughout range — may restrict use in complex topography and remote areas • Subscription costs can be higher than base stations	• Relies on cell networks • Can greatly increase upfront costs • More infrastructure to set up, maintain, and take down • The base station requires line-of-sight with collared livestock — collar won't report in or receive VF boundary changes without it • May never have full range coverage • May need to move the base station if herd goes to new pasture (base stations are not particularly mobile in current form) • Best location may not be practical (poor access issues) • Base stations are bottlenecks — if the base station goes down, the whole system can go down unless other base stations cover the area • Susceptible to damage, theft, etc. • Animals must always remain in line of sight with the base station to communicate — dead zones can be an issue for escapees

2) Location Tracking

How Do Collars Report Locations?

All VF collars use satellites to determine their location and the position of VF boundaries on the landscape. However, current VF systems do not use satellites to transmit data to the end user. Instead, communication between the collar and user occurs through cellular

networks. This includes routine location reporting and updates or adjustments to the VF boundary.

Benefits

- Know where every animal is within the last ~15 minutes
- Easier gathering
- Know where they've been
- Know when they're out
- Know if a collar falls off, the animal is down, or the collar is out of range

Limitations

- Locations might not update outside of coverage
- App may not work on range if cell reception is poor
- Locations update too slowly to be useful when actively moving livestock (bells still useful in this scenario)
- Solar batteries can fail if in the shade for too long — in practice, this can be 1 or 2 months on forested range

Location Tracking–Only Devices

These alternative devices only report animal locations and do not offer any virtual fence features.

mOOvement

- moovement.com.au
- $79 per tag
- $12 annually

Smart Paddock

- $69 per tag
- Annual fees apply

3) VF Containment

Tips for Initial Training

Animals may buck when first fitted with a collar, especially if they have not been collared before, but they typically settle within a minute. It is important to record each VF collar ID alongside other identifiers (such as ear tags) and enter these into the user interface to improve livestock tracking.

Livestock generally learn and understand VF collar cues and boundaries fast and intuitively. **A training period of 4 to 7 days** is crucial to help animals learn to respond primarily to audio cues and develop respect for the VF boundary.

TRAINING SETUP GUIDANCE

An ideal training pasture has a simple hardwire geometry with a single VF line excluding access to one side. The pasture should be large enough that animals encounter the VF boundary naturally a few times per day but not feel crowded.

- Water, feed, supplements, shade, etc. should be placed far away from the VF boundary
- Avoid placing uncollared livestock in adjacent pastures during the training period
- VF boundaries only enforce audio and pulse cues if the animal attempts to leave
- Escaped livestock often re-enter on their own once calm to return to the herd or get water — if not, they should be moved back as soon as possible

Some Lessons Learned for Designing Virtual Fences

- **Proper training is key.** Well-trained livestock respond primarily to audio cues alone, which improves compliance and minimizes the need for the electric pulse.
- **Straight or curved VF lines** are easier for livestock to understand and respect than sharp angles, pinch points, and bottlenecks.
- **Larger VF areas extend battery life.** When animals are far from a boundary, the collar checks location periodically. As animals approach, collars check more rapidly — precise within a few feet but draws more battery power. Frequent collar cues also drain the battery faster.
- **Livestock respond to collar cues, not landscape features.** Cattle, sheep, and goats *mostly* respond to the VF boundary through collar cues. However, some users report that livestock can become hesitant to cross areas where VF boundaries were previously active.
- **Compliance improves** when livestock have access to what they need within the VF area — water, supplements, quality forage, shade or shelter, their calf, or the rest of the herd.
- **Livestock typically respect VF boundaries more than 95% of the time,** but occasional straying is normal. VF should not replace physical fencing where complete containment is critical (e.g., near busy roads). Success is best measured by how well most of the herd is contained rather than focusing on a few outliers.

- **Your first year/season may be spent learning how to use VF!** This is still valuable.

Potential Uses for Inclusion and Exclusion Virtual Fences

> **NOTE**
>
> Many vendors allow you to have inclusions and exclusions active at the same time.

Livestock & Grazing

- Rotational grazing
- Resting forage
- Prevent overgrazing
- Target grazing fuels / weeds
- Utilize hard-to-fence areas
- Back up for weak fences and open gates
- Reduce time, labor, and fencing costs
- Avoid toxic plants and spreadable weeds
- Exclude from crops / orchards

Resource Conservation

- Protect water systems
- Preserve meadows & sensitive habitat
- Protect timber seedlings
- Protect cultural/historic sites
- Prevent erosion & protect sensitive soils
- Guard wildlife habitat
- Reduce human / livestock interactions (trails, campgrounds, 4x4 routes, etc.)
- Protect infrastructure (homes, roads, vehicles, wells)

Benefits

- Extreme flexibility for adaptive management
- VF takes minutes/hours to deploy; building/maintaining fence takes days/months/years and labor, fuel, and materials
- Hardwire fence can fail without you knowing (gates left open, tree over the fence, etc.)
- Can largely eliminate the need for cross fencing

Limitations

- **NOT** a replacement for fence where 100% containment is needed (e.g., along busy roads)
- You cannot see it on the landscape
- Activation/deactivation in low coverage areas may take longer or fail
- Small VFs can drain batteries
- GPS inaccuracy — may need to think of VF boundary as a 50′ barrier instead of a line
- VFs may have fewer hinge points than needed

4) Virtual Fence Vendor Options and Costs

Features Common to All Current VF Systems

- GPS collar
- Individual animal locations and tracking
- VF inclusion boundaries
- Audio cues before electric pulse
- Alerts: stationary collar, low battery, etc.
- Remote updates to VF firmware
- Reliance on cellular networks

Features Currently Unique to Each VF Vendor

- Whether collars can communicate directly to the cellular network, or if they need base stations
- Solar powered or single-use battery
- VF exclusion boundaries (some systems offer none; others offer 1 or multiple)
- Cost structure
- Various other bells and whistles

How Much Does a VF System Cost?

Cost depends on herd size, need for and number of base stations required, and the vendor's cost structure. Upfront costs will usually be significantly more than costs every year after. As a rough estimate, **year 1 may be $10K–$40K** while **every year after may be $1K–$8K**.

Upfront Costs

- Cost to lease or buy each collar
- Cell or base station subscription fees per collar (only for purchased collars)
- Cost to buy each base station / tower (if needed)
- Taxes and shipping fees

Costs Every Year After

- Leasing cost per collar
- Cell or base station subscription fees per collar (only for purchased collars)
- Replacement cost as needed for batteries/collars/base stations outside warranty

- Taxes and shipping fees

Factors Impacting Vendor Decision and Total Cost

- What is the cell coverage quality across my range?
- For base stations: what is the size / geography of my range?
- How many animals will be collared? Plan to collar all adult livestock for best results.
- What happens when collars wear out, are lost, or hardware is outdated?
  - *Leased collars:* Vendor replaces (Halter, Vence)
  - *Purchased collars:* Vendor replaces if warranty is still active; if not, required to purchase new units (Gallagher, Nofence)
- What can I afford in year 1?
- What can I afford every year after?
- Do I have options to offset or justify the cost?
  - Base stations can be shared by neighboring operations using the same VF vendor — a cost-sharing opportunity
  - Some agencies (like the USFS) have purchased base stations while the rancher covers the collars
  - Am I eligible for funding? (See below)
  - Would purchasing a VF system be cheaper than building/maintaining a fence?
  - Would purchasing a VF system significantly change my operation (e.g., opening up previously hard-to-fence range)?

Vendor Comparison Guide (February 2026)

VF Vendor Comparison: Gallagher, Nofence, Halter, and Vence. Note: Contact v accurate and current costs. Additional fees may apply. Base station number vari

Feature	Gallagher	Nofence	Halter
Requires cell reception	Yes	Yes	Yes
Can work with satellites only	No	No	No
Requires Base Station / Tower	LoRaWAN collars: Yes Cellular collars: No	No	Yes

Feature	Gallagher	Nofence	Halter
Battery Type	Solar-powered collar	Solar-powered collar	Solar-powered collar
Battery life	7 to 10 years	5 to 10 years	Collar replaced free in
Warranty	3 years for all equipment	5 years for all equipment	Lifetime for all equipr
Cost Per Collar (Year 1)*	20–59: $300 | 60+: $250 Purchase	Cattle: 5–24: $349 | 25–99: $309 | 100–249: $280 | 250+: $250 Sheep/Goat: 5–24: $269 | 25–99: $239 | 100–249: $225 | 250+: $215 Purchase	$72 Lease
Annual Subscription Cost Per Collar (Year 2+)*	LoRaWAN Collars: $18 sub Cellular Collars: $24 sub	Monthly: 5–99 collars: $6.50 / 100 collars: $4.50 Annual: 5–99 collars: $45 / 100 collars: $35	N/A
Base Station*	1st Base station: $6,000 2nd Base Station(s): $5,000	N/A	$4,500
Subscription / Leasing Cost Per Collar (Year 2+)*	LoRaWAN Collars: $18 sub Cellular Collars: $24 sub	<50 animals: $52 sub >50 animals: $36 sub	$72 Lease
Company Contact	Cheyenne Lambley cheyenne.lambley@gallagher.com	sales.us@nofence.no	Charlotte Mondale charlotte.mondale@h

* Note: Contact vendors directly for the most accurate and current costs. Additional fees may apply. Base station number varies by range geography.

Current Funding Opportunities in California

1) NRCS EQIP for California (prices based on county)

- **Practice (382) Fencing:** Covers a base cost, plus funding for a base station and implementation per animal in year 1
- **Practice (528) Grazing Management:** Covers funds for subscription/leasing costs for years 2–5 for adaptive management
- Contact: nrcs.usda.gov/getting-assistance/payment-schedules

2) California Department of Food and Agriculture (CDFA) Healthy Soils Program

- VF is not an eligible practice for HSP Incentive Grants directly, but prescribed grazing on rangelands is — VF can serve as a tool to implement that practice
- Contact: cdfa.ca.gov/oars/healthysoils

3) State Water Resources Control Board Nonpoint Source Pollution 319 Grant Funding

- VF is eligible to qualified applicants who can demonstrate it will reduce nonpoint source (NPS) pollution
- Contact: waterboards.ca.gov – 319 Grants